ONLINE JOURNAL OF ANIMAL AND FEED RESEARCH

An International Peer-Reviewed Journal which Publishes in Electronic Format

Volume 10, Issue 6, November 2020

ISSN 2228-7701

Online Journal of Animal and Feed Research

An international peer-reviewed journal which publishes in electronic format (online)

Online J. Anim. Feed Res., 10 (6): November 27, 2020

Editorial Team

Join OJAFR Team

As an international journal we are always striving to add diversity to our editorial board and operations staff. Applicants who have previous experience relevant to the position may be considered for more senior positions (Section Editor, SE) within OJAFR. All other members must begin as Deputy Section Editors (DSE) before progressing on to more senior roles. Editor and editorial board members do not receive any remuneration. These positions are voluntary.

If you are currently an undergraduate, MSc or PhD student at university and interested in working for OJAFR, please fill out the application form below. Once your filled application form is submitted, the board will review your credentials and notify you within a week of an opportunity to membership in editorial board.

If you are Ph.D., assistant or associate editors, distinguished professor, scholars or publisher of a reputed university, please rank the mentioned positions in order of your preference. Please send us a copy of your CV or ORCID ID or briefly discuss any leadership positions and other experiences you have had that are relevant to applied Animal and Feed Researches or publications. This includes courses you have taken, editing, publishing, web design, layout design, and event planning.

If you would like to represent the OJAFR at your university, join our volunteer staff today! OJAFR representatives assist students at their university to submit their work to the OJAFR. You can also, registered as a member of OJAFR for subsequent contacts by email and or invitation for a honorary reviewing articles.

Download OJAFR Application Form

Volume 10 (6); November 27, 2020

Research Paper

Histomorphologal and histochemical structure in the duodenum of sheep (*Ovis aries*) and rabbit (*Oryctolagus cuniculus*) - a comparative study.

Mohammad HJ, Ali KA, Al-Ali ZAJR.

Online J. Anim. Feed Res., 10(6): 251-258, 2020; pii: S222877012000034-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.34

Abstract: This study aimed to compare the histomorphometric and histochemical features of the duodenum twenty sheep (n=10) and rabbit (n=10) adult males. The samples were collected from slaughterhouse and markets of Misan and were used for histological studies of two types of stains, hematoxylin and eosin, and special stains (Periodic acid Schiff stains). In histological approach, in both animals, the wall of the duodenum consists of four layers (mucosa, submucosa, muscularis and serosa). In both animals, the mucosa of the duodenum lined by simple columnar epithelium and has number of villi compose of absorptive (enterocytes) and goblet cells only in duodenum, the submucosa occupied by Brunner's glands. Brunner's glands are varying in secretory unit acinai in rabbit serous and mucous acini while in sheep the mucus acini. There is significant difference in thickness of layers between sheep and rabbits. Mucosa, sub mucosa and muscularis layers in sheep showed more thickness than in rabbits, but there is non- significant (P>0.05) differences between the thickness of the serosa in sheep and rabbit in the duodenum. On the other hand, the columnar cells showed a weakly reaction with Periodic acid Schiff stain (PAS), but goblet cells in sheep and rabbits shown strong reaction with PAS. While the Brunner's glands were strong reaction with PAS in sheep and weakly reaction with PAS in rabbit. In conclusion, this study showed that sheep and rabbits have similarities and differences in the duodenum; that is, the layers of this organ has different thicknesses and respond differently to periodic acid Schiff stain.
Keywords: Duodenum, Histochemistry, Histomorphology, Rabbit, Sheep
[Full text-PDF] [HTML] [ePub]

Research Paper

Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia.

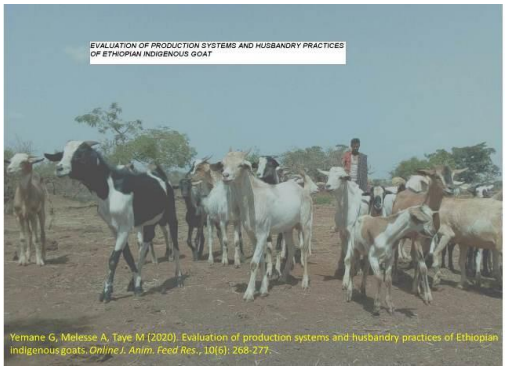
Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A.

Online J. Anim. Feed Res., 10(6): 259-267, 2020; pii: S2228770120000035-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.35

Abstract: Twenty-four qualitative and nine quantitative variables on a total of 251 adult cattle from two purposively selected districts were recorded to characterize Harmo cattle at its natural production environment in 2019. Effect of sampled district, sex and age on the quantitative measurements and qualitative characteristics were analyzed using General linear model (GLM) procedure and non-parametric (Chi-square) test of Statistical Analysis System (SAS 9.0) respectively. The qualitative characteristics and quantitative measurements of Harmo cattle were partially affected by district, sex and age categories. Majority of Harmo cattle were horned (100%) with lyre shaped (83.73%) upward orientation (92.46%) and wide horn spacing (≥ 30 cm) (96.03%). They also possess straight edged ear (97.22%). Harmo cattle hump was erected (98.81%), and small (88.1%) and found at cervical thoracic (78.57) position. The results also revealed that Harmo cattle were characterized by flat face (99.21%), straight back profile (88.49%), long tail (95.24%) and large dewlap (75%). Body color pattern of Harmo cattle was uniform (61.11%), spotty (26.98%) and others (11.9%). Red and light-red were the body and head color of the majority of the studied cattle populations. Beside their large horns Harmo cows also possess medium (38.8%) and large (42.4%) naval flap. Similarly, the oxen also possess medium (46.4%) and large (50%) preputial sheath. The overall measurements of body length, Heart girth, Height at withers, Pelvic width, Muzzle circumference, Ear length, Horn length, Canon bone length, Hock circumference for Harmo oxen and cows were 127.8±1.22, 146.7±1.37, 121.7±0.92, 35.5±0.45, 39.5±0.35, 21.2±0.31, 65.5±2.08, 25.0±0.30, 33.0±0.28 and 121.3±0.43, 138.9±0.48 116.5±0.32, 35.0±0.16, 36.9±0.12, 21.3±0.11, 61.8±0.73, 24.0±0.11, 31.3±0.10, respectively. These results show Harmo cattle possess long and thin body and long ear and horn in comparison with most of the Ethiopian cattle breeds. The thin body of Harmo cattle might be due to shortage of available feed in and around the breeding tract of the breed. The long ear and horn may help them to adapt the hot bushy grazing land environment and protect themselves from the enemy existed in their natural habitat.
Keywords: Biometry, Breeding, Harmo Cattle, Morphometric characterizes, Raya-Azebo.
[Full text-PDF] [HTML] [ePub]

Research Paper

Evaluation of production systems and husbandry practices of Ethiopian indigenous goats.



Yemane G, Melesse A, Taye M.

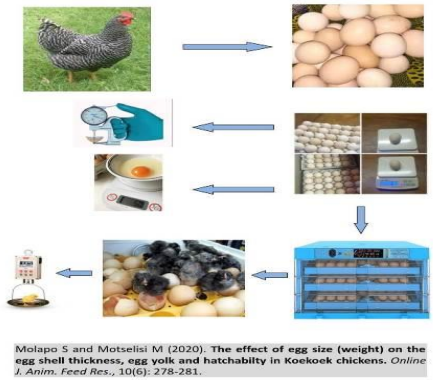
Online J. Anim. Feed Res., 10(6): 268-277, 2020; pii: S2228770120000036-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.36

Abstract: The study was conducted in Limu Seka, Nono Benja and Omo Nada districts of Jimma zone with the objectives to assess production system and husbandry practices of indigenous goat. Data were collected through questionnaire, focal group discussion and secondary data. A total of 210 households were selected for an interview and case study. Data were analyzed by descriptive statistics and ranking index. The results showed that the overall family size and mean goats flock size per household are 7.10 and 7.78 respectively. The farming activities were mixed crop and livestock systems. Natural pasture (herbs and shrubs), fallow land, crop residues and non-conventional feeds were the feed resources of the study area. Free grazing/browsing, riverside grazing/browsing, aftermath grazing, and herding were the major grazing management types for goats in the dry season. In wet season, grazing management were herding and tethering alone and both herding and tethering together. In the study area, rivers were the main source of water in both dry and rainy season. All households in all the study districts provide nighttime shelter (house) for goat throughout the year. On average about 63.8% and 61.9% of respondents have been practicing fattening and castrating goat. Castration was primarily practiced to improve fattening and get a better price. Disease, feed shortage and lack of superior genotypes were major constraints of goat production in the study area. In general, goat production system and husbandry practices in the study area was traditional with mixed livestock system that challenged by serious disease problem and feed shortage, so interference is needed to solve identified problems.
Keywords: Indigenous breeds, Husbandry practices, Jimma zone, Rural farming system

[Full text-PDF] [HTML] [ePub]

Research Paper

The effect of egg size (weight) on the egg shell thickness, egg yolk and hatchabilty in Koekoek chickens.



Molapo S and Motselisi M.

Online J. Anim. Feed Res., 10(6): 278-281, 2020; pii: S222877012000037-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.37
Abstract: The aim of this study was to determine the effect of egg size on egg shell, egg yolk, fertility rate and hatchability of Koekoek chickens. A Complete Randomized Design (CRD) was used with egg size being the treatment factor. The treatments were large (>55g), medium (45-54g) and small (<44g) sized eggs. Eggs were collected from the nests and weighed using the digital scale and classified according to their respective weights before incubation. The egg yolk weight was measured with the digital scale. The shell thickness was measured using a Vanier caliper. The fertile and infertile eggs were identified. The fertility rate, hatching percentage and embryonic mortality were recorded. Data collected was subjected to statistical analysis by using one way analysis of variance (ANOVA). The medium sized eggs had higher fertility and hatchability percentage compared to large and small sized eggs. The mortality was higher in large and small sized eggs. Therefore, select eggs at the range of 45 to 55 grammes for incubation can be useful to increasing hatchability.
Keywords: Koekoek breed chickens, Egg size, Fertility rate, Hatchability, Embryo mortality.

[Full text-PDF] [HTML] [ePub]

Research Paper

On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia.

Golla K, Mekuriaw Y, Hailemelekot M.

Online J. Anim. Feed Res., 10(6): 282-289, 2020; pii: S222877012000038-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.38

Abstract: The study was conducted in Amhara region of Ethiopia, with the objective of characterizing the goat husbandry practice and on-farm monitoring of growth performance. The data were collected by interviewing 180 sample households who are selected purposively from three agro ecologies using semi- structured questioner. Besides, on farm monitoring of growth performance of 60 kids owned by farmers was done for three months. The data was analyzed using SPSS (version 20). Majority of households (68.9%) have an experiences of feeding crop residue for their goat and faced feed shortage mainly during dry season (65.6%). The main source of water for goat was river which is 51.1% in wet season and 88.9% in dry season. 51.7% of goat keepers had a separate goat house. The major disease reported were anthrax (40.6%), goat pox (26.7%) and foot and mouth disease (12.8). Purpose of goat keeping was mainly for income source (62.8%). 84.4% of the goat owners are experienced selection of male and female animal for production purpose. Body length and height (60.6%) and color (34.4%) were used as major selection criteria. Higher kidding was reported during months of October (20.55%), November (39.44%) and December (18.88%). Drought (42%), shortage of feed and water (38.5%), disease and parasite (16%), inconvenient climate condition (2%) and lack of breeding male (1%) were reported as major problems in the breeding objective. The overall birth weight, 60 days and 90 days weight of kids was 1.69±0.08 kg, 7.45±0.41 kg and 12.02±0.25 kg, respectively. The survival rate of kids up to 90 days of age was 74%. The production system of the area was characterized by mixed crop-livestock farming system on which crop residue was the main feed source of the goats as other livestock species. Even though the current productivity of goats in the area is fairly good, full potential need to be exploited by improving husbandry practices, applying appropriate disease prevention methods and applying strategic forage development and feeding practices.
Keywords: Birth weight, Husbandry practices, Indigenous goats, On-farm monitoring, Survival rate

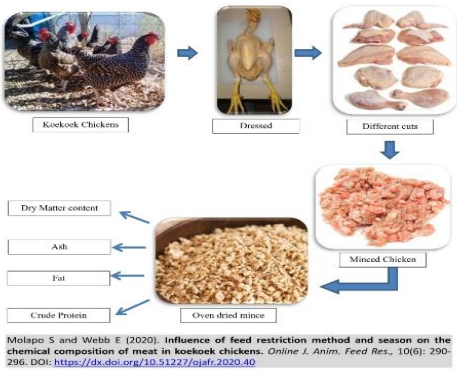
[Full text-PDF] [HTML] [ePub]

Research Paper

Influence of feed restriction method and season on the chemical composition of meat in Koekoek chickens.

Molapo S and Webb E.

Online J. Anim. Feed Res., 10(6): 290-296, 2020; pii: S222877012000039-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.39



Abstract: The main objective of the study was to determine the effect of restricted feeding and season on carcass chemical composition of Koekoek chickens. Two hundred and seventy hens and 27 cocks were used. The experiment was designed as a factorial of two seasons and four feeding regime treatments. The four treatments were consisted of chickens full-fed during both rearing and laying phases (AA), those shifted to restricted feeding during the laying phase (AR), birds fed restrictedly during the rearing phase and shifted to full feeding in the laying phase (RA) and those fed restrictedly during both rearing and laying phases (RR). Each treatment had seven replicates (10 birds per replicate) with an exception of RR treatment which was replicated six times (10 birds per replicate). Data was collected at 18 and 32 weeks of age. Data collected was subjected to SPSS (17.00) statistical package and analyzed by using multi- factorial analysis of variance (ANOVA). At the age of 18 weeks, feed restriction had an impact on dry matter, fat and crude protein percentage. At 32 weeks of age, birds that were fed restrictedly had reduced fat content and increased crude protein. The lowest crude protein percentage was recorded in chickens that were allocated to full feeding for the entire study (AA). Chickens that were allotted to summer treatment had a higher dry matter and crude protein content than chickens that were in winter treatment at 18 weeks of age. Koekoek chickens that were in summer and winter treatments performed differently in terms dry matter, ash, crude fat and crude protein percentages at the age of 32 weeks. Based on the findings of this study it is concluded that chickens with higher slaughter weights resulted in a lower crude protein and higher amount of fat regardless of the slaughter age. Chicken meat that was produced in winter had a higher dry matter and crude protein content compared to that produced in summer at the slaughter age of 18 weeks. In the laying phase the meat of Koekoek chickens that were reared in winter had a higher dry matter, ash, fat and crude protein percentages than that of chickens produced in summer suggesting that the cold winter conditions have the potential to preserve the nutrient composition of chicken meat.
Keywords: Chemical composition, Feed restriction, Koekoek chickens, Temperature.
[Full text-PDF] [HTML] [ePub]

Research Paper

Effect of adding rapeseed oil, fish oil and selenium on the diet enriched with vitamin E and zinc on the yield and organoleptic properties of eggs.

Bahrami Y, Rezvannejad E and Ahadi F.

Online J. Anim. Feed Res., 10(6): 297-301, 2020; pii: S222877012000040-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.40

Abstract: The present study was investigated the simultaneous effect of fish oil and rapeseed, selenium, vitamin E and zinc supplementation on laying hens. 288 white-line layers were used from 45 weeks of age. The experiment was conducted using a completely randomized design with four replications for 75 to 90 days. Performance of hens and organoleptic properties of eggs were evaluated. The results showed that there was no any significant difference between groups on the yield. Results obtained from the tasters including overall taste, natural smell and overall acceptability showed that although increasing fish oil to 2% + 2% rapeseed oil did not have a significant effect on the overall taste and overall acceptability of eggs in this group, but were significantly reported in natural smell. Therefore, diet with 2% fish oil+2% rapeseed oil (T3) can be considered as an enriched omega-3 ratio without showing major quality drop in eggs acceptance.
Keywords: Egg taste, Fish oil, Laying hen, Quality of egg, Rapeseed oil

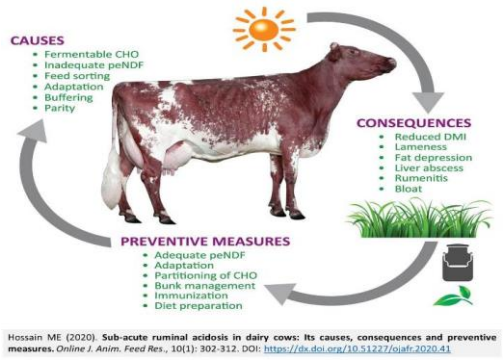
[Full text-PDF] [HTML] [ePub]

Review

Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures.

Hossain ME

Online J. Anim. Feed Res., 10(6): 302-312, 2020; pii: S222877012000041-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.41



Hossain ME (2020). **Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures.** *Online J. Anim. Feed Res.*, 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

Abstract: The Current feeding programs for cattle prescribe concentrate rich diets to meet their ever increasing demands for high levels of milk production. These diets, however, can impair rumen health and thus cattle production, milk yield and welfare. High energy diets are rapidly fermented in the rumen because they are high in fermentable starch, low in NDF and contain finely chopped digestible forages. Feeding rapidly fermentable diet to the cows predominantly adapted to digest and metabolize forage based total mixed ration (TMR) substantially increases short term milk yield, but the risk of sub- acute ruminal acidosis (SARA) increases. Additionally, too high concentrate to forage ratio, too fast a switch from high forage to high concentrate, diet composed of highly fermented feeds, improperly mixed TMR and mycotoxins in feed also increases the incidence of SARA in dairy herds. SARA causes depressed feed intake, cycling feeding, reduced cud chewing, poor fibre digestion, rumenitis, mastitis, metritis, dehydration, diarrhoea, abomasal displacement, pulmonary bacterial emboli, systemic inflammation, liver abscesses, low milk fat, low milk protein, sore hooves, laminitis and low fertility. Therefore, SARA is a major challenge for animal health, productivity, economic efficiency and welfare issue even in well managed dairy herds. Feeding higher amounts of forages, supplying adequate peNDF, processing grains less thoroughly, reducing fermentability of the carbohydrate fraction and adapting rumen to the dietary changes are the key factors to be considered for preventing SARA. Continued research for accurate quantification of peNDF in diet, grain processing, optimization of meal size, dietary cation-anion balance, narrow-spectrum rumen modifier, inoculation of lactate utilizing microbes, inhibition of lactate producing microbes and innovation of the unique fermentability characteristics of feed ingredients to promote sufficient buffering and rapid absorption of VFA from rumen will explore new horizon for reducing incidence of SARA in future.
Keywords: Acidosis, Cattle, Dairy herd, Rumen, Total mixed ration.

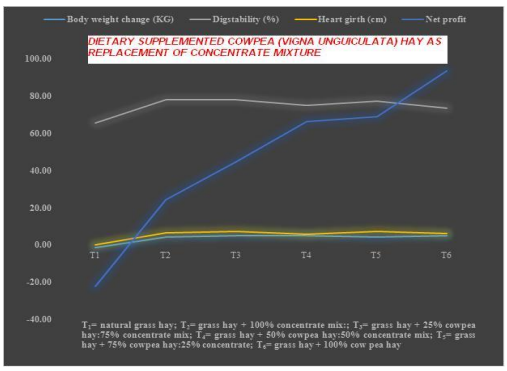
[Full text-PDF] [HTML] [ePub]

Research Paper

Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats.

Amare B and Girmay A.

Online J. Anim. Feed Res., 10(6): 313-320, 2020; pii: S222877012000042-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.42



Abstract: The study were conducted at Sekota district using twenty four yearling male Aberegelle goats for 100 days to evaluate the effect of substitution of concentrate mix with cowpea hay on biological and economic benefits. The treatments were natural grass hay alone (T1) and supplemented with 100% concentrate mix (T_2), 75: 25% (T_3), 50:50% (T_4), 25:75% (T_5) concentrate mix: cowpea hay and 100% cowpea hay (T_6) per head per day. Randomized complete block design with six treatments and five replications was used. The crude protein (CP) content of grass hay, concentrate mix and cowpea hay were 6.80, 16.30 and 19.62%, respectively. Daily hay dry matter (DM) intake of the control was significantly higher ($P<0.05$) than other treatments. Apparent DM, organic matter (OM), acid detergent fiber (ADF), neutral detergent fiber (NDF), CP digestibility and body weight change of supplemented treatments were significant ($P<0.001$) as compared to the control, however there were no significant differences in intake, digestibility, linear body measurement and growth performance of goats fed different proportion of concentrate and cowpea hay. However, sole

cowpea hay supplementation performs better in terms of net return and farmers' preference. Therefore, supplementation of sole cowpea hay would be both biologically, economically and socially acceptable level for Abergelle goats bred.
Keywords: Cowpea, Digestibility, Feed intake, Ruminant.

[Full text-PDF] [HTML] [ePub]

Research Paper

Prevalence of gastrointestinal parasites in camel in potential areas of Ethiopia (the case of Afar regional state).

Ahmed EF, Aregawi WG, Urge B and Endris M.

Online J. Anim. Feed Res., 10(6): 321-325, 2020; pii: S222877012000043-10
DOI: https://dx.doi.org/10.51227/ojafr.2020.43

Abstract: A cross sectional study was conducted from April, 2017 to October, 2018 to determine the prevalence of gastrointestinal tract (GIT) helminthes and protozoan parasites in relation to contributing risk factors in camels of afar region. Accordingly, a total of 407 camels were examined. Random and purposive sampling was made in the respective districts for screening of camels. Fecal samples were collected and processed by sedimentation and floatation methods. The coprological finding indicated that about 30.22% (n = 123) of the camels harbored and excreted helminthes and protozoan parasites. Of which, the prevalence of nematodes, protozoa, cestodes, and trematodes were 144 (35.38%), 28 (22.76%), 8 (6.50%) and 5 (4.07%), respectively. The most frequently encountered parasites were *Strongylus* sp. 68 (55.28%), *Trichuris* sp. 40 (32.52%) *Strongyloides* sp. 36 (29.27%), Coccidia 28 (22.76%), Moniezia 8 (6.50%), and Paraphystomum 5 (4.07%), respectively. 17.44% of the cases were single infection while 10.57% were mixed infections. Age and body condition of the animals were significantly associated (P<0.05) with the occurrence of parasites. In conclusion, gastrointestinal parasites are the major health problems of camel in the study areas. Therefore, it is important to undertake the detailed epidemiological investigations such as seasonal dynamics, fecal culture for larvae recovery and species identification to generate parasite mitigation methods.

Keywords: Afar region, Camel, Gastrointestinal parasite, Prevalence, Risk factors.

[Full text-PDF] [HTML] [ePub]

Archive

Online Journal of Animal and Feed Research

ISSN: 2228-7701

Frequency: Bimonthly

Current Issue: 2020, Vol: 10, Issue: 6 (November 25)

DOI Prefix: 10.51227

Publisher: SCIENCELINE

Online Journal of Animal and Feed Research is an international peer-reviewed journal, publishes the full text of original scientific researches, reviews, and case reports in all fields of animal and feed sciences, bimonthly and freely on the internet ...view full aims and scope

www.ojafr.ir

» OJAFR indexed/covered by Scopus, NLM Catalog, CABI, CAS, Ulrich's™, GALE, HINARI, NSD,

AKSTEM, BASE, ZDB, ICV, EZB ...details

» Open access full-text articles is available beginning with Volume 1, Issue 1.

» Full texts and XML articles are available in RICeST.

» This journal is in compliance with Budapest Open Access Initiative and International Committee of Medical Journal Editors' Recommendations.

» High visibility of articles over the internet.

» Copyright & Publishing Rights Policy ...details

» Publisher Item Identifier ...details

» This journal encourage the academic institutions in low-income countries to publish high quality scientific results, free of charges... view Review/Decisions/Processing/Policy

Scienceline Publication, Ltd
Editorial Offices:
Ömer Nasuhi Bilmen Road, Dönmez Apart., G Block, No:1/6, Yakutiye, Erzurum/25100, TURKEY
Atatürk University, Erzurum 25100, Turkey
796-704 Montrose St, Winnipeg, Manitoba R3T 2N2, CANADA
Phone: +90 538 770 8824 (TURKEY); +1 209 732 4265 (CANADA)
Homepage: www.science-line.com
Emails: administrator@science-line.com ; saeid.azar@atauni.edu.tr

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 251-258; November 27, 2020

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.34

HISTOMORPHOLOGAL AND HISTOCHEMICAL STRUCTURE IN THE DUODENUM OF SHEEP (*Ovis aries*) AND RABBIT (*Oryctolagus cuniculus*); A COMPARATIVE STUDY

Hawraa Jabbar MOHAMMAD[1], Ali Khalaf ALI[1]✎✉, Zainab Abdul Jabbar Ridha AL-ALI[1]

[1]*Department of Biology, College of Science, University of Misan, Maysan, Iraq*

✉Email: Dr.AliKhalaf@uomisan.edu.iq; ORCID: 0000-0003-2273-6433

✎*Supporting Information*

RESEARCH ARTICLE

PII: S222877012000034-10

Received: October 16, 2020

Revised: November 18, 2020

ABSTRACT: This study aimed to compare the histomorphometric and histochemical features of the duodenum twenty sheep (n=10) and rabbit (n=10) adult males. The samples were collected from slaughterhouse and markets of Misan and were used for histological studies of two types of stains, hematoxylin and eosin, and special stains (Periodic acid Schiff stains). In histological approach, in both animals, the wall of the duodenum consists of four layers (mucosa, submucosa, muscularis and serosa). In both animals, the mucosa of the duodenum lined by simple columnar epithelium and has number of villi compose of absorptive (enterocytes) and goblet cells only in duodenum, the submucosa occupied by Brunner's glands. Brunner's glands are varying in secretory unit acinai in rabbit serous and mucous acini while in sheep the mucus acini. There is significant difference in thickness of layers between sheep and rabbits. Mucosa, sub mucosa and muscularis layers in sheep showed more thickness than in rabbits, but there is non- significant (P>0.05) differences between the thickness of the serosa in sheep and rabbit in the duodenum. On the other hand, the columnar cells showed a weakly reaction with Periodic acid Schiff stain (PAS), but goblet cells in sheep and rabbits shown strong reaction with PAS. While the Brunner's glands were strong reaction with PAS in sheep and weakly reaction with PAS in rabbit. In conclusion, this study showed that sheep and rabbits have similarities and differences in the duodenum; that is, the layers of this organ has different thicknesses and respond differently to periodic acid Schiff stain.

Keywords: Duodenum, Histochemistry, Histomorphology, Rabbit, Sheep

INTRODUCTION

Evolution between animals causes many changes so that it can adapt to its environments. Each animal species has unique characters that help them survive and can consume different types of feed (Salama et al., 2019). Rabbits are considered economically significant animals as they have the advantage of their meat and furring, are used as pets, and they are substantial at scientific and medical experiences (Salama et al., 2019). On the other hand, sheep have been able to use lignocellulosic materials and convert them to animal products of high nutritional value, such as meat, milk, wool/fur, hide, and manure (Saeed et al., 2018). Fermentation organs are depend on a symbiotic relationship with a community of microbes, primarily bacteria with fibrinolytic ability in either their foregut (which the rumen of ruminants and the pseudo-ruminants) or their hindgut (which the cecum and colon of non-ruminant herbivores), for fiber digestion (Crowley et al., 2017; Kingston-Smith et al., 2012).

Given the comparative investigations of the digestive tract it can be said that the level of development of each segment is directly related to the living environment, nutritional and metabolic needs (Kotze et al., 2010). The small intestine is a long, tubular organ, connects the stomach to the large intestine and can be divided into duodenum, Jejunum and Ileum based on anatomy and function, the duodenum is a tiny fraction of the small intestine, it is the site of most of the breakdown of the food passing through it, the duodenum is line with duodenal sub mucosal glands, which secrete an alkaline mucus that supports the intestinal enzymes and aids in the absorption of nutrients (Cunningham and Klein, 2007). In histological approach, the duodenum wall has four concentric layers: mucosa, submucosa, muscularis and serosa, and this structure have also been observed in other mammalian species (Gadelha-Alves et al., 2008). The surface epithelium of small intestine is covers by the villi which are already protruded into the intestinal lumen and it also lines the crypts which are extended to the connective tissue (Mohamed et al., 2019). Kadadi (2012) descripted that the villi are finger like projections forms of a core of reticular tissue covers by surface epithelium, Also, among the villi are small openings of the simple tube glands called the intestinal glands (crypts of Lieberkuhn). Whereas, Al-Shamary et al. (2017) stated that the crypts of Lieberkühn are simple tubular glands called intestinal glands that were extend from the muscularis mucosa till the bases of the villi, they were lined by a simple columnar epithelium. Calamar et al. (2014) reported that the sub-mucosa tunic is formed of loose connective tissue and provides support for the vascular and nerve network. The Brunner's glands: are branched tubuloalveolar glands, located in sub mucosa, they existed at each

Citation: Mohammad HJ, Ali KA, Al-Ali ZAJR (2020). Histomorphologal and histochemical structure in the duodenum of sheep (*Ovis aries*) and rabbit (*Oryctolagus cuniculus*) - a comparative study. *Online J. Anim. Feed Res.*, 10(6): 251-258. DOI: https://dx.doi.org/10.51227/ojafr.2020.34

mammalian species (AL-Baghdady et al., 2012). The muscularis layer of small intestine composes of two layers of smooth muscle cells internal-circular and external-longitudinal (Calamar et al., 2014). The intestine has no serosa, the layer external to the tunica muscularis would be referred to as the adventitia (Nzalak, 2010).

This study aimed to compare the histomorphometric and histochemical similarities of the duodenum of sheep (herbivorous ruminant) and rabbit (herbivorous and coprophagous).

MATERIALS AND METHODS

Surgical procedures

The present study was carried out in the department of biology Sciences at the University of Misan. A total of ten sheep, adult males, were collected from local slaughterhouses and ten rabbits, were weight of 1.5 - 2.5kg and their age is almost three months adult males, were collected from Misan city. The experiments on rabbits followed the guidelines provided by the University's Animal Ethics Committee. The rabbits were raised under standard procedures and euthanized following the animal euthanization protocol. A physical examination was performed to all animals to guarantee they were all in the right health conditions before the euthanasia. The euthanizing procedures were done by placing 2 mL of chloroform (CHCl3) on cotton and then set on the animal's nose, according to Blackshaw et al. (1988). By using appropriate tools as scissors, tweezers and scalpels regional gross dissection was performed of each specimen. The abdomen of the rabbits was incised, and the duodenum extracted. Then, taken 1 cm from duodenum.

Histological examination

All duodenum samples of rabbits and sheep were fixed in 10% neutral buffered formalin promptly. After fixation for 72 hours, all samples were processed with a series of ascending ethanol concentrations (70%, 2h. 80%, 30min. 96%, three changes, 2h each. 100% abslute, 9h than 100% hour) to dehydrate them. Then, all samples were cleared with xylene for one hour and embedded in paraffin wax to make paraffin blocks. Finally, sections were cut at 7-micrometer thickness and processed with two stains (Luna, 1968). Hematoxylin and Eosin and Periodic Acid-Schiff (PAS) stains were used to stain all tissue sections for histomorphometry identification and carbohydrates determinations, respectively (Luna, 1968).

Micromorphometric measurements

Ten slides were made duodenum, and to detect the thickness of mucosa, submucosa, muscular, and serosa, we followed the literature methods which by using the optical microscope with the exact ophthalmic scale (ocular micrometer) after the exact ophthalmic scale was matched with the theatrical scale using the magnification force (Galigher and Kozloff, 1964).

Statistical analysis

The values were expressed as mean ± SD (standard deviation). The statistical analysis of the data was performed to know the significant differences using t-test at $P<0.05$ of probability (Al-Rawi and Khalaf Allah, 2000).

RESULTS and DISCUSSION

Histological study

Histological examination results show that the mucosa of duodenum has number of villi compose of absorptive (enterocytes) and goblet cells only (Figures 1 and 2). The columnar cells have nucleus round found in near the base, and cytoplasm was eosinophilic, while goblet cells are unicellular in its apical part becomes puffy due to mucigen droplets accumulation and have nucleus is irregularly oval or triangular at the base and in both species have same characteristic, and cytoplasm seen clear post staining with hematoxylin and eosin stain. These results are similar to the study of Parveen et al. (2013). However, the stem cells give rise to 4 major epithelial cells: the absorptive enterocytes which make up about 80% fall small intestinal epithelial cells; the goblet cells which produces a variety of mucins and trefoil peptides needed for epithelial growth and repair; the enteroendocrine cells which export peptide hormones; and the paneth cells which secretes antimicrobial cryptdins or defensins, digestive enzymes, and growth factors (Korkmaz and Kum, 2016). Ergun et al. (2003) stated that absence paneth cells in the villi of small intestine and that these cells were differentiated as such toward the base of the crypts. Lamina propria: in both animals consist from loose connective tissue containing blood vessel, nerves, lymphatic assembles, and the intestinal glands or called crypts of lieberkuhn extended to below mascularis mucosa and consists of the columnar cells, the goblet cells and the Paneth's cells (Figures 5 and 6), these glands well developed appeared simple tubular and this finding similarity with (Hassan and Moussa, 2015). Mascolaris mucosa composed of smooth muscle fiber, it located at the base of the crypt is thin in rabbit but it thicker and very clear in sheep. Muscularis mucosa thin layer of circular smooth muscle fibers at the blow of the crypt but seen more thickness in sheep consistent with Lesson and Lesson (1988). Submucosa layer seen as a thin layer of loose connective tissue abundantly supplied by blood vessels, lymphocytes, collagen and elastic fiber ,it locate below mucosa layer, in the duodenum contains glands called (Brunner's glands), Brunner's glands are developed very increased in density in the sub

Citation: Mohammad HJ, Ali KA, Al-Ali ZAJR (2020). Histomorphologal and histochemical structure in the duodenum of sheep (*Ovis aries*) and rabbit (*Oryctolagus cuniculus*) - a comparative study. *Online J. Anim. Feed Res.*, 10(6): 251-258. DOI: https://dx.doi.org/10.51227/ojafr.2020.34

mucosa of the duodenum sheep than in rabbit, these are simple tubular. Brunner's glands are vary in secretory unit acinai in rabbit serous and mucous acini where characterized by their relatively wide lumen and their cells appeared pale, while in sheep the mucus acini. In both animals sub mucosa only in the duodenum has Brunner's glands are simple tubular. The duodenum is the site of most of the breakdown of the food passing through it (Elnasharty et al., 2013). Brunner's glands have function neutralizes chyme entering to the duodenum from the pylorus, protecting the mucous membrane, and bringing the intestinal contents to the optimum pH for pancreatic enzyme action (Emel et al., 2010). Hassan and Moussa (2015) reported that duodenum goat didn't exhibit any glands of Brunner at the sub mucosa layer nor did the sub mucosa of jejunum contain any glands or lymphoid nodules. The muscularis layer composed by an inner circular and an outer longitudinal layer of smooth muscles and between connective tissue, similar findings were reported in sheep (Kumar et al., 2015). The serosa layer formed by the loose connective tissue had collagen, elastic and also reticular fibers along with varying amounts of fatty tissue, few blood capillaries, and flat mesothelial cells layer as reported in domestic animals (Stinson and Calhoun, 1993).

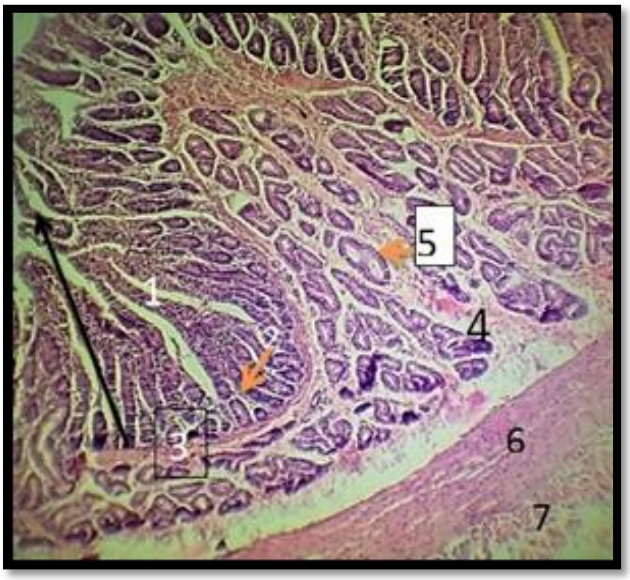


Figure 1 - The duodenum of the sheep showing mucosa, contain villi (1) gland (crypt) of Liebrkuhn (2). muscolaris mucosa (3). Submucosa (4) Brunner's glands (5). muscularis (6) serosa(7). H&E.100X

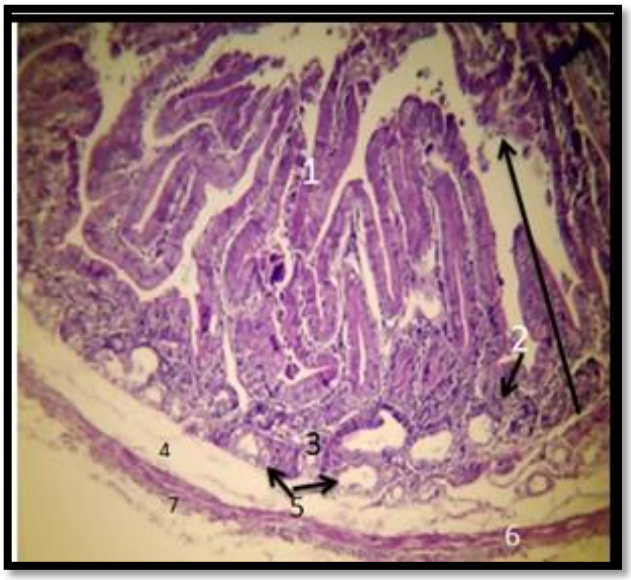


Figure 2 - The duodenum of the rabbit showing mucosa, contain villi (1) gland (crypt) of Liebrkuhn (2) . muscolaris mucosa (3) ,sub mucosa (4), Brunner's gland(5) . muscularis (6) serosa(7). H&E.100X

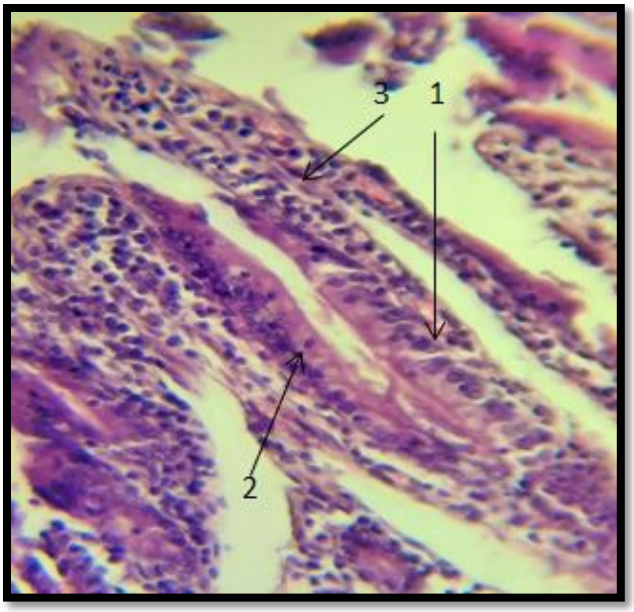


Figure 3 - The villi of the sheep in doudenum consist of enterocytes (1), goblet cells (2), (lacteal) (3) of villi consist of loose connective tissue H&E.100X

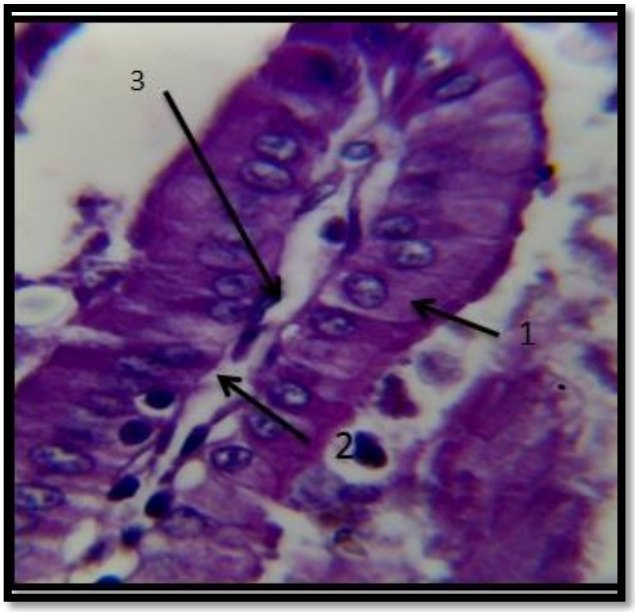


Figure 4 - The villi of the rabbit in doudenum consist of enterocytes (1), goblet cells (2), (lacteal) (3) of villi consist of loose connective tissue H&E.100X

Citation: Mohammad HJ, Ali KA, Al-Ali ZAJR (2020). Histomorphologal and histochemical structure in the duodenum of sheep (*Ovis aries*) and rabbit (*Oryctolagus cuniculus*) - a comparative study. *Online J. Anim. Feed Res.*, 10(6): 251-258. DOI: https://dx.doi.org/10.51227/ojafr.2020.34

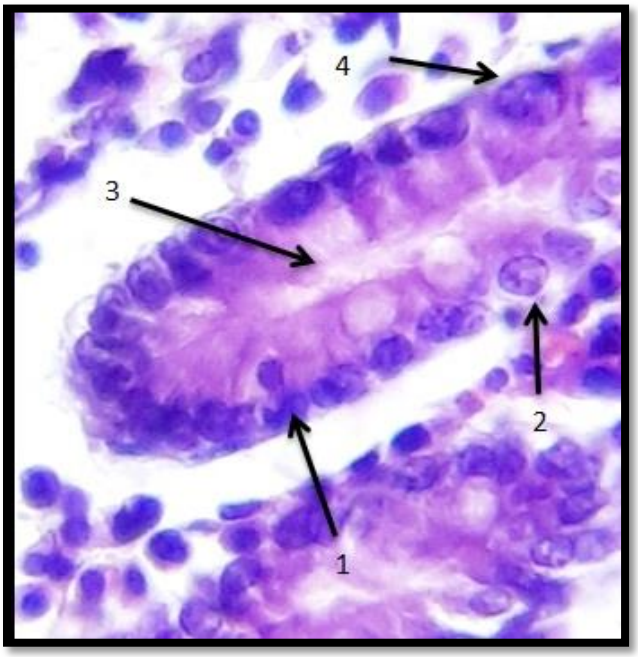


Figure 5- The glands (crypt) of liebrkuhn in the sheep showing (1) goblet cell, (2) columner cells, (3) leumn.(4) Paneth cells H&E400x

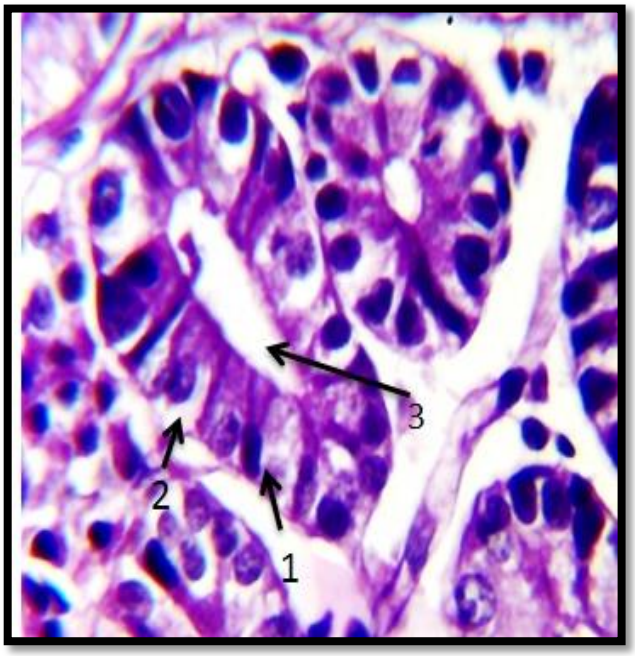


Figure 6 - The glands (crypt) of liebrkuhn in the rabbit showing (1) goblet cell, (2) columner cell, (3) leumn.(4) Paneth cells H&E400

Histomorphometeric study

The thickness of sheep mucosa layer in the duodenum (2146.31±158.24) significantly (P<0.05) large in comparison to the duodenum of the rabbits where the value found were 846.84±55.03 (Table 1). The villi height of sheep in the duodenum (951.85±263.88) significantly (P<0.05) large in comparison to the duodenum sections of rabbit small intestine where the values found were 566.90±127.8 and 510.90±78.87 (Table 1) respectively. The thickness of sheep submucosa layer in the duodenum (228.61±54.77), significantly (P<0.05) large comparison to sections the duodenum of the rabbits where the values found was 58.32±16.49, respectively (Table 1). The thickness of sheep muscularis layer in the duodenum 264.22±101.37, significantly (P<0.05) was large in comparison to the same section of the rabbits where the values found was 69.99±29.99 respectively. There were non- significant (P>0.05) differences between the thickness of the serosa in sheep and rabbit in the duodenum (Table 1). In this respect, Mandir et al. (2005) consider that increase in thickness of intestinal epithelial tissue as well as the development of the gut itself can occur during three main mechanisms, that are elevation of cell production from the intestinal crypts, raise in number of crypt (by crypt fission) or by altered apoptosis. The thickness of the mucosa in rabbit duodenum (846.84±55.03) and this result disagree with study Tomaszewska et al. (2014), which observed in guinea pigs female mucosa thickness of duodenum was (488.3 ±99.81), this difference might be related to the nature of the nutrition intake of the animals. Alves et al. (2004) reported that measurements of villi height give an indication of the likely maturity and functional capacity of enterocytes Villi height was in the mucosa duodenum of rabbit was 566.90±127.81 and this result accordance with study of Yu and Chiou (1997) which was their result (543±15) in rabbit. As wall this result disagrees with Mohammadpour (2011) observed villi high of guinea pig in mucosa duodenum was 785.00±87.67, this difference might be related due vary in species.

Table 1 - Mean thickness of mucosa, submucosa, muscularis, and serosa in Duodenum of the small intestine of the sheep and rabbit n=10

Organ	Mucosa		Sub mucosa		Musclaris		Serosa		Height villi	
Small intestine	Sheep	Rabbit	Sheep	Rabbit	Sheep	Rabbit	Sheep	Rabbit	Sheep	Rabbit
Duodenum	2146.31^{a} ±158.24	846.84^{b} ±55.03	228.61^{a} ±54.77	58.32^{b} ±16.49	264.22^{a} ±101.37	69.99^{b} ±29.09	2013.37^{a} ±5850.70	46.66^{a} ±21.99	951.85^{a} ±268.88	566.90^{b} ±127.81

*value represent (mean± SD); *different letters refer to (p<0.05) significant difference between values. *the similar letters refer to non-significant (P>0.05) difference between values.

Histochemical study

In both animals, the columnar cells gave a weakly reaction with PAS (Figure 7) and this may be indicate a lack of mucus secretion by these cells and this finding consistent with study of Andleeb et al. (2009). Goblet cells in sheep and rabbits, these cells gave strong reaction with PAS and this is evidence of neutral mucus in duodenum. Moreover, Kadadi (2012) stated that duodenal goblet cells in sheep stained with magenta indicating presence of PAS positive material in their secretion. Jawad et al. (2019) stated that crypts of Lieberkuhn in the tunica mucosa of the duodenum in rabbits positive reaction with PAS. In addition, Brunner's glands of the sub mucosa layer in gave a strong reaction with PAS in sheep duodenum (Figure 7), while in the rabbits were Brunner's glands mixed gland (serous cells a weak reaction with

Citation: Mohammad HJ, Ali KA, Al-Ali ZAJR (2020). Histomorphologal and histochemical structure in the duodenum of sheep (*Ovis aries*) and rabbit (*Oryctolagus cuniculus*) - a comparative study. *Online J. Anim. Feed Res.*, 10(6): 251-258. DOI: https://dx.doi.org/10.51227/ojafr.2020.34

PAS and mucous cells moderate reaction with PAS (Figures 8 and 9). Kadadi (2012) which reported that Brunner's glands in sheep showed positive reaction with PAS. However, Sub-mucosal glands are varying with species and there are three types of acini (mucus, serous and mixed). In previous studies; Mohammadpour (2011) and Krause, (2000) observed that Brunner's glands in Guiana pig and moose they mucos acina only. The studies uses different techniques depend on species, duodenal sub-mucosal glands were reported to contain neutral or acidic mucin glycoproteins or the combination of both types of mucin (Takehana et al., 1991; Krause, 2000). Andleeb et al. (2009) reported that Brunner's glands in Gaddi goat gave strong reaction with PAS and this is evidence of the presence of neutral carbohydrates.

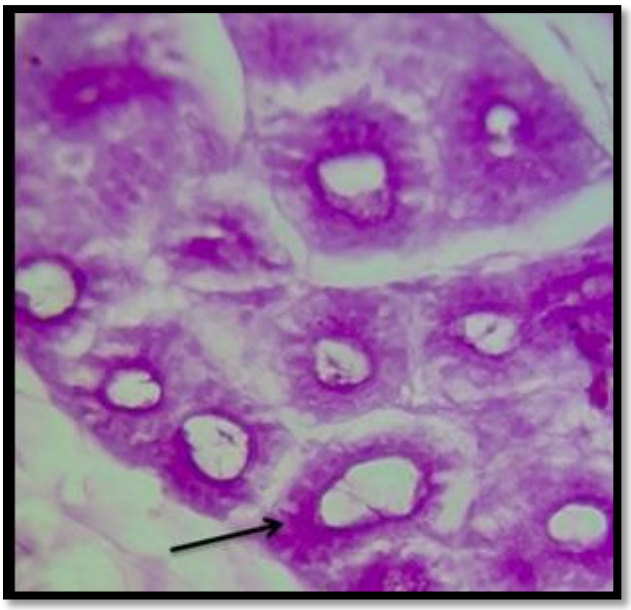


Figure 7 - The Brunner's gland of the sheep duodenum showing (*mucous acini*) gave strong reaction with PAS.400X

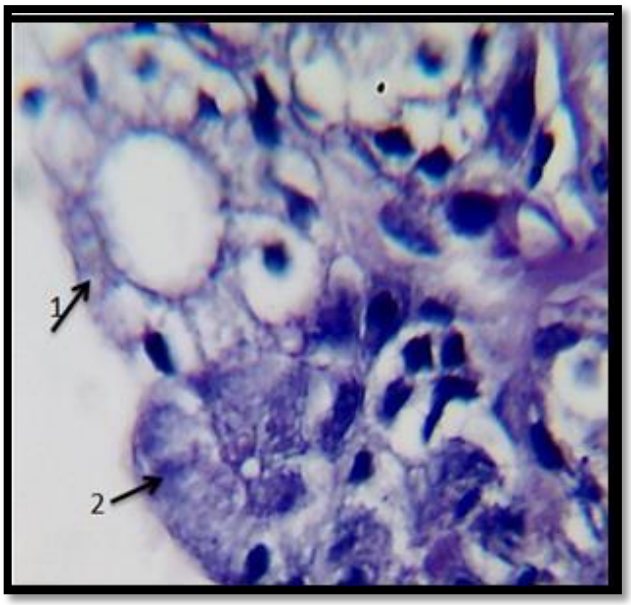


Figure 8 - The Brunner's gland of the rabbit duodenum showing (1) serous cells gave weakly reaction with PAS. (2) mucous cells moderate reaction with PAS.400X

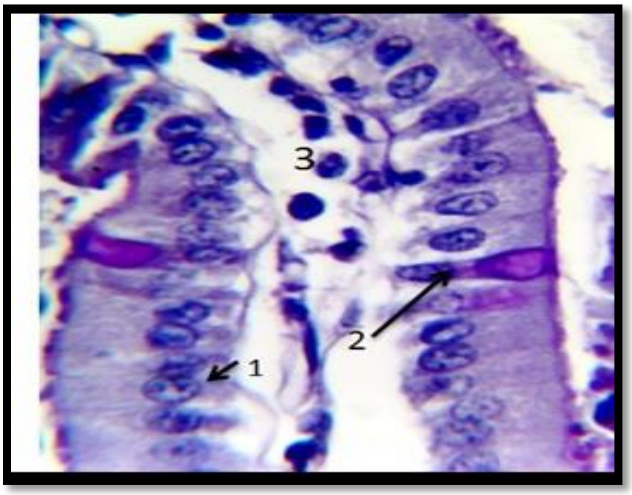


Figure 9 - The villi of the rabbit doudenum consist of enterocytes (1) and goblet cells (2) showing strong reaction with PAS . (lacteal) (3) of villi consist of loose connective tissue.PAS.400x

CONCLUSION

These findings indicated similarities and some different between herbivores species. In sheep and rabbits, the duodenum is composed of four layers: mucosa, submucosa, muscular, and serosa. In both animals, in duodenum, the submucosa is occupied by Brunner's glands. Brunner's glands are vary in secretory unit acinai in rabbit serous and mucous acini while in sheep the mucus acini. There is significant difference in thickness of layers between sheep and rabbits. Mucosa, sub mucosa and muscularis layers in sheep showed more thickness than in rabbits, but there is non-significant differences between the thickness of the serosa in sheep and rabbit in the duodenum. On the other hand, the columnar cells showed a weakly reaction with PAS, but goblet cells in sheep and rabbits shown strong reaction with Periodic acid Schiff stains (PAS). While the Brunner's glands were strong reaction with PAS in sheep submucosa.

Citation: Mohammad HJ, Ali KA, Al-Ali ZAJR (2020). Histomorphologal and histochemical structure in the duodenum of sheep (*Ovis aries*) and rabbit (*Oryctolagus cuniculus*) - a comparative study. *Online J. Anim. Feed Res.*, 10(6): 251-258. DOI: https://dx.doi.org/10.51227/ojafr.2020.34

DECLARATIONS

Acknowledgements

The authors thank the head of the Biology Department at the College of Sciences for his cooperation.

Conflict of interest

The authors declare no conflict of interest.

Authors' contribution

All authors contributed equally to this research work. All authors read and approved the final manuscript.

REFERENCES

AL-Baghdady EF, AL-Mehanna NH, and Kadhim KH (2012). The distribution of the goblet cells, paneth cells and brunner's glands in duodenum of adult one Humped Camels (Camelus dromedarius). Al-Qadisiyah Journal of Veterinary Medicine Sciences, 11(2): 46-52. Google Scholar ; DOI: https://doi.org/10.29079/vol11iss2art190

Al-Shamary ER, Jarad AS, Taher IA, Al-Saffar FJ, and Naji WA (2017). Some histo-morphometric and histochemical comparsion aspect of the duodenum in Collard Dove (Frivaldszky), Ruddy Shelduck (Pallas) and Owl (Otus Scors brucei) in south Iraq. Journal of Entomology and Zoology Studies, 5(6): 923-928. Google Scholar ; Link

Al-Rawi KM, and Khalaf Allah AM (2000). Design and Analysis of Agricultural Experiments. University of Mosul. Ministry of Higher Education and Scientific Research. Dar Al Kuttab for printing and publishing. Mosul. Iraq. Google Scholar

Alves A, Pinheiro V, Mourão JL, Pires I, Oliveira J, and Gama A. (2004). Measurement of rabbit's intestinal villus: Preliminary comparison of two methods. In Proceedings of the 8th World Rabbit Congress, Puebla, Mexico, pp. 422-426. Google Scholar ; Link

Andleeb RR, Bhardwaj RL, and Sharma KB (2009). Histochemical studies on the small intestine of Gaddi goat. Indian Journal of Animal Physiology, 2: 75-78. Google Scholar

Blackshaw JK, Fenwick DC, Beattie AW, and Allan DJ (1988). The behavior of chickens, mice and rats during euthanasia with chloroform, carbon dioxide and ether. Laboratory Animals, 22(1): 67-75. Google Scholar ; DOI: https://doi.org/10.1258%2F002367788780746674

Calamar CD, Patruica S, Dumitrescu G, Bura M, Dunea IB, and Nicula M (2014). Morpho-histological study of the digestive tract and the annex glands of Chinchilla laniger. Scientific Papers Animal Science and Biotechnologies, 47(1): 269-274. Google Scholar ; Link

Crowley EJ, King JM, Wilkinson T, Worgan HJ, Huson KM, Rose MT, and McEwan NR (2017). Comparison of the microbial population in rabbits and guinea pigs by next generation sequencing. PloS one, 12(2): e0165779. Google Scholar ; DOI: https://doi.org/10.1371/journal.pone.0165779

Cunningham JG, and Klein BG (2007).Textbook of Veterinary Physiology, 4th ed: WB Saunders/Elsevier Science, Philadelphia, USA. Pp. 720. Google Scholar ; Link

Elnasharty MA, Abou-Ghanema II, Sayed-Ahmed A, and Elnour AA. (2013). Mucosal-Submucosal Changes in Rabbit Duodenum during Development. World Academy of Science, Engineering and Technology, I :7-14. Google Scholar ; Link

Emel E, Leven E, Aseman O, and Aytul K (2010). Histomorphology of the Brunner gland in the Angora rabbit. Journal of Animal and Veterinary Advances, 9(5): 887-891. Google Scholar ; DOI: http://dx.doi.org/10.3923/javaa.2010.887.891

Ergun E, Ergun L, Asti RN, and Kurum A (2003). Light and electron microscopic morphology of Paneth cells in the sheep small intestine. Revue de Médecine Vétérinaire, 154(5): 351-355. Google Scholar ; Link

Hassan SA, and Moussa EA (2015). Light and scanning electron microscopy of the small intestine of goat (Capra hircus). Journal of Cell and Animal Biology, 9(1): 1-8. Google Scholar ; Link

Gadelha-Alves R, Rozensztranch AMS, and Rocha-Barbosa O (2008). Comparative intestinal histomorphology of five species of Phyllostomid Bats (Phyllostomidae, Microchiroptera): ecomorphological relations with alimentary habits. International Journal of Morphology, 26(3): 591-602. Google Scholar ; DOI: http://dx.doi.org/10.4067/S0717-95022008000300014

Galigher AE, and Kozloff EN (1964). Essentials of practical microtechnique.1st ed. lea and febiger. Philadelphia, pp. 40-45. Google Scholar

Jawad I, Kadhim KH, Kadhim DM, and Sadiq DH. (2019). A comparative histomorphological and histochemical study of the goblet cells and brunner's glands in the duodenum of Rabbits and Rats. Research Journal of Pharmacy and Technology, 12(5): 2421-2424. Google Scholar ; DOI: https://doi.org/10.5958/0974-360X.2019.00406.2

Kingston-Smith AH, Marshall AH, and Moorby J M (2012). Breeding for genetic improvement of forage plants in relation to increasing animal production with reduced environmental footprint. Animal, 7(S1): 79-88. Google Scholar ; DOI: https://doi.org/10.1017/S1751731112000961

Kadadi SP (2012). Histology and histochemical study of human brunner's glands in comparison with a few mammals, phD. Thesis, Rajiv Gandhi University Health Sciences, Karnataka, Bangalore, pp. 155. Google Scholar ; Link

Korkmaz D, and Kum S (2016). Histological study of the small intestine of the dromedary. Journal of Camel Practice and Research. 23(1): 111-116. Google Scholar ; DOI: http://dx.doi.org/10.5958/2277-8934.2016.00018.7

Krause WJ (2000). Brunner's glands: A structural, histochemical and pathological profile. Progress in Histochemistry and Cytochemistry, 35(4): 255–367. Google Scholar ; DOI: https://doi.org/10.1016/S0079-6336(00)80006-6

Kumar PA, Kumar PAW, Singh GU, Poonia AM, and Parkash T (2015). Histoarchitecture and histochemistry of the ileum of sheep (Ovis Aries). Haryana Veterinarian, 54(1): 50-52. Google Scholar ; Link

Mandir N, FitzGerald AJ, and Goodlad RA (2005). Differences in the effects of age on intestinal proliferation, crypt fission and apoptosis on the small intestine and the colon of the rat. International Journal of Experimental Pathology, 86(2): 125-130. Google Scholar ; DOI: https://doi.org/10.1111/j.0959-9673.2005.00422.x

Mohammadpour AA (2011). Morphological and histochemical study of guinea pig duodenal submucosal glands. Bulgarian Journal of Veterinary Medicine, 14(4): 201−208. Google Scholar ; Link

Mohamed AMA, Taha AM, and Ali AM (2019). Morphology of Intestinal Goblet Cells of The Dromedary (Camelus dromedarius). Anatomy Journal of Africa, 8(1): 1379-1384. Google Scholar ; Link

Lesson TS, Lesson, C. R., and Paparo, A. A. (1988). Text/atlas of histology. W. R. Saunders Co., Philadelphia, London, Toronto. pp. 434-456. Google Scholar

Luca F, Perry GH, and Di Rienzo A. (2010). Evolutionary adaptations to dietary changes. Annual Review of Nutrition, 30: 291–314. Google Scholar ; DOI: https://doi.org/10.1146/annurev-nutr-080508-141048

Luna LG (1968). Manual of Histologic Staining Methods of the Armed Forces Institute of Pathology.3rd ed., McGraw Hill Book Co., New York, pp. 368. Google Scholar

Parveen K, Pawan K, Gurdial S, and Amit P (2013). Histological architecture and histochemistry of duodenum of the sheep (Ovis aries). Indian Journal of Veterinary Anatomy, 25(1): 30-32. Google Scholar ; Link

Saeed OA, Sazili AQ, Akit H, Alomon AR, Samsudin AAB (2018). Effect of corn supplementation on purine derivatives and rumen fermentation in sheep fed PKC and urea-treated rice straw. Tropical Animal Health and Production, 50: 1859–1864. Google Scholar ; DOI: https://doi.org/10.1007/s11250-018-1636-1

Salama WA, Refaie AM, Amin HF, and Abdel-Mawla LF. (2019). Use of untreated and autoclave-treated wheat germ meal in growing Rabbit diets. World Veterinary Journal, 9(3): 192-200. Google Scholar ; Link

Stinson ALW and Calhoun ML (1993). Text Book of Veterinary Histology. 4th ed., Lea and Febiger, Philadelphia.

Takehana K, Abe M, Iwasa K, Hiraga T, and Miyata H (1991). Carbohydrate histochemistry of bovine duodenal glands. Journal of Veterinary Medical Science, 53(4): 699-706. Google Scholar ; DOI: https://doi.org/10.1292/jvms.53.699

Tomaszewska E, Dobrowolski P, Puzio I, Prost L, Kurlak P, Sawczuk P, and Kostro K (2014). Acrylamide-induced prenatal programming of intestine structure in guinea pig. Journal of Physiology and Pharmacology, 65(1): 107-15. Google Scholar ; PMID: 24622835.

Yu B, and Chiou PW (1997). The morphological changes of intestinal mucosa in growing rabbits. Laboratory Animals, 31(3): 254-263. Google Scholar ; DOI: https://doi.org/10.1258%2F002367797780596301

Citation: Mohammad HJ, Ali KA, Al-Ali ZAJR (2020). Histomorphologal and histochemical structure in the duodenum of sheep (*Ovis aries*) and rabbit (*Oryctolagus cuniculus*) - a comparative study. *Online J. Anim. Feed Res.*, 10(6): 251-258. DOI: https://dx.doi.org/10.51227/ojafr.2020.34

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 259-267; November 27, 2020

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.35

BODY MORPHOMETRIC MEASUREMENTS IN HARMO CATTLE (RAYA-AZEBO CATLTLE) IN SOUTHERN TIGRAY OF ETHIOPIA

Amine MUSTEFA[1]✉, Teklewold BELAYHUN[1], Awoke MELAK[1], Mulata HAYELOM[2], Abebe HAILU[1] and Abraham ASSEFA[1]

[1]*Ethiopian Biodiversity Institute, P. O. Box 30726, Addis Ababa, Ethiopia*

[2]*Mekelle Biodiversity Center, P. O. Box, 30726, Mekelle, Ethiopia*

✉Email: aminemustefa32@gmail.com; ORCID: 0000-0003-3788-4156

Supporting Information

RESEARCH ARTICLE

PII: S222877012000035-10

Received: October 20, 2020

Revised: November 21, 2020

ABSTRACT: Twenty-four qualitative and nine quantitative variables on a total of 251 adult cattle from two purposively selected districts were recorded to characterize Harmo cattle at its natural production environment in 2019. Effect of sampled district, sex and age on the quantitative measurements and qualitative characteristics were analyzed using General linear model (GLM) procedure and non-parametric (Chi-square) test of Statistical Analysis System (SAS 9.0) respectively. The qualitative characteristics and quantitative measurements of Harmo cattle were partially affected by district, sex and age categories. Majority of Harmo cattle were horned (100%) with lyre shaped (83.73%) upward orientation (92.46%) and wide horn spacing (≥ 30 cm) (96.03%). They also possess straight edged ear (97.22%). Harmo cattle hump was erected (98.81%), and small (88.1%) and found at cervical thoracic (78.57) position. The results also revealed that Harmo cattle were characterized by flat face (99.21%), straight back profile (88.49%), long tail (95.24%) and large dewlap (75%). Body color pattern of Harmo cattle was uniform (61.11%), spotty (26.98%) and others (11.9%). Red and light-red were the body and head color of the majority of the studied cattle populations. Beside their large horns Harmo cows also possess medium (38.8%) and large (42.4%) naval flap. Similarly, the oxen also possess medium (46.4%) and large (50%) preputial sheath. The overall measurements of body length, Heart girth, Height at withers, Pelvic width, Muzzle circumference, Ear length, Horn length, Canon bone length, Hock circumference for Harmo oxen and cows were 127.8±1.22, 146.7±1.37, 121.7±0.92, 35.5±0.45, 39.5±0.35, 21.2±0.31, 65.5±2.08, 25.0±0.30, 33.0±0.28 and 121.3±0.43, 138.9±0.48 116.5±0.32, 35.0±0.16, 36.9±0.12, 21.3±0.11, 61.8±0.73, 24.0±0.11, 31.3±0.10, respectively. These results show Harmo cattle possess long and thin body and long ear and horn in comparison with most of the Ethiopian cattle breeds. The thin body of Harmo cattle might be due to shortage of available feed in and around the breeding tract of the breed. The long ear and horn may help them to adapt the hot bushy grazing land environment and protect themselves from the enemy existed in their natural habitat.

Keywords: Biometry, Breeding, Harmo Cattle, Morphometric characterizes, Raya-Azebo.

INTRODUCTION

Ethiopia have the largest cattle population size in Africa (60.39 million heads) without counting some zones of the highly populated Regions (Afar and Somali) (CSA, 2018). Majority of the cattle population are indigenous breeds, which are found in the rural part of the country, while some exotic and crossbreds also exist mainly in the urban and peri-urban areas (Roessler et al., 2018; Abebe et al., 2020). Beside the large population size distributed widely throughout the country, farmers and pastoralists get multiple functions from their productions and services. Cattle genetic resources serve as sources of meat, milk, hide, manure, draft power and nutrient recycling (Getachew and Gashaw, 2001).

Diversity in animal genetic resource is important for current and future research and development works. Diversity allows the indigenous genetic resources to adapt and produce in a more diversified agro ecologies. Variation with in and among breeds is also one of the key inputs in genetic improvement and conservation programs (Delgado Bermejo et al., 2019). It is more likely to bring genetic improvement in a population with high variation than low variation. This increment in production and productivity will in turn help us to answer the food security problems; market requirements and nutritional gaps. Similarly, as the variation within and among breeds increase it brings a good opportunity to find adaptable breeds to the changing agro ecology due to different factors including the climate change. Therefore, to better understand the level of diversity and potential of our indigenous animal genetic resources, proper characterization works are crucial (EBI, 2016). However, in Ethiopia there is a gap of harmonizing the characterization works, keeping proper production and reproduction records and positivity towards conservation of the indigenous animal genetic resources.

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

Even if there are different sources of information like Domestic Animal Genetic Resources Information System (DAGRIS) of the International Livestock Research Institute (ILRI), based on the current available information from the country's focal institute for Animal Genetic Resources (Ethiopian Biodiversity Institute) and the website Domestic Animal Diversity Information System (DAD-IS) of the Food and Agriculture Organization of the United Nation (FAO), there are 28 recognized indigenous cattle breeds in Ethiopia (EBI, 2016). However, only a small number of recognized cattle breed types have a fair description of their physical appearance, indications of their level of production, reproduction and genetic attributes (Ayalew et al., 2004). With some general information, cattle of the present study area are generally referred as Raya-Azebo (Raya) cattle in the existing literature. Raya-Azebo cattle also locally known as 'Harmo' cattle breed found in Southern Tigray which is one of the cattle breeds classified under the Sanga breed group. Harmo cattle is known for its long horns and adaptation to hot environment (Zerabruk et al. 2007).

Most of the Ethiopian indigenous animal genetic resources are facing more threats including the indiscriminate crossbreeding with exotic breeds for the sake of genetic improvement for production traits (EBI, 2016). Harmo cattle is one of the breeds which is under risk due to indiscriminate crossbreeding with Holstein Frisian and interbreeding with the highland zebus. For the purpose of designing conservation and sustainable utilization program to the breed, updated information on phenotypic characterization (quantitative, qualitative and performance records) is required. Unfortunately, the information we have currently on the breed is the studies of Zerabruk et al. (2007) on few morphometric traits which is done twelve years ago. Therefore, it is important to update the results through routine characterization and inventories due to the dynamism of genetic resources (Hoffmann, 2010; Lozano-Jaramillo et al., 2019). Thus, the current study is planned to characterize the morphology and qualitative characteristics of Harmo cattle under the farmers' condition and to relate it with different production and adaptation traits.

MATERIALS AND METHODS

Description of the study areas

This study was conducted in Raya Azebo and Alamata districts of Southern Tigray Zone in Northern Ethiopia in 2019 (Figure 1). Raya Azebo is situated in latitude of 12° 39' 59.99" N and longitude of 39° 44' 59.99" E, similarly, Alamata is also situated in latitude of 12° 19' 60.00" N and longitude of 39° 29' 59.99" E. The selected study sites (three sites "Kebeles" within each district) are categorized as lowland (500 – 1500 m.a.s.l) with 20 – 30 ^{0}C and dry with mean annual rainfall 633 – 770 ml. Mixed crop-livestock production system is the main farming practices with crops being more dominant (Taddese et al., 2013; Bewket et al., 2015).

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

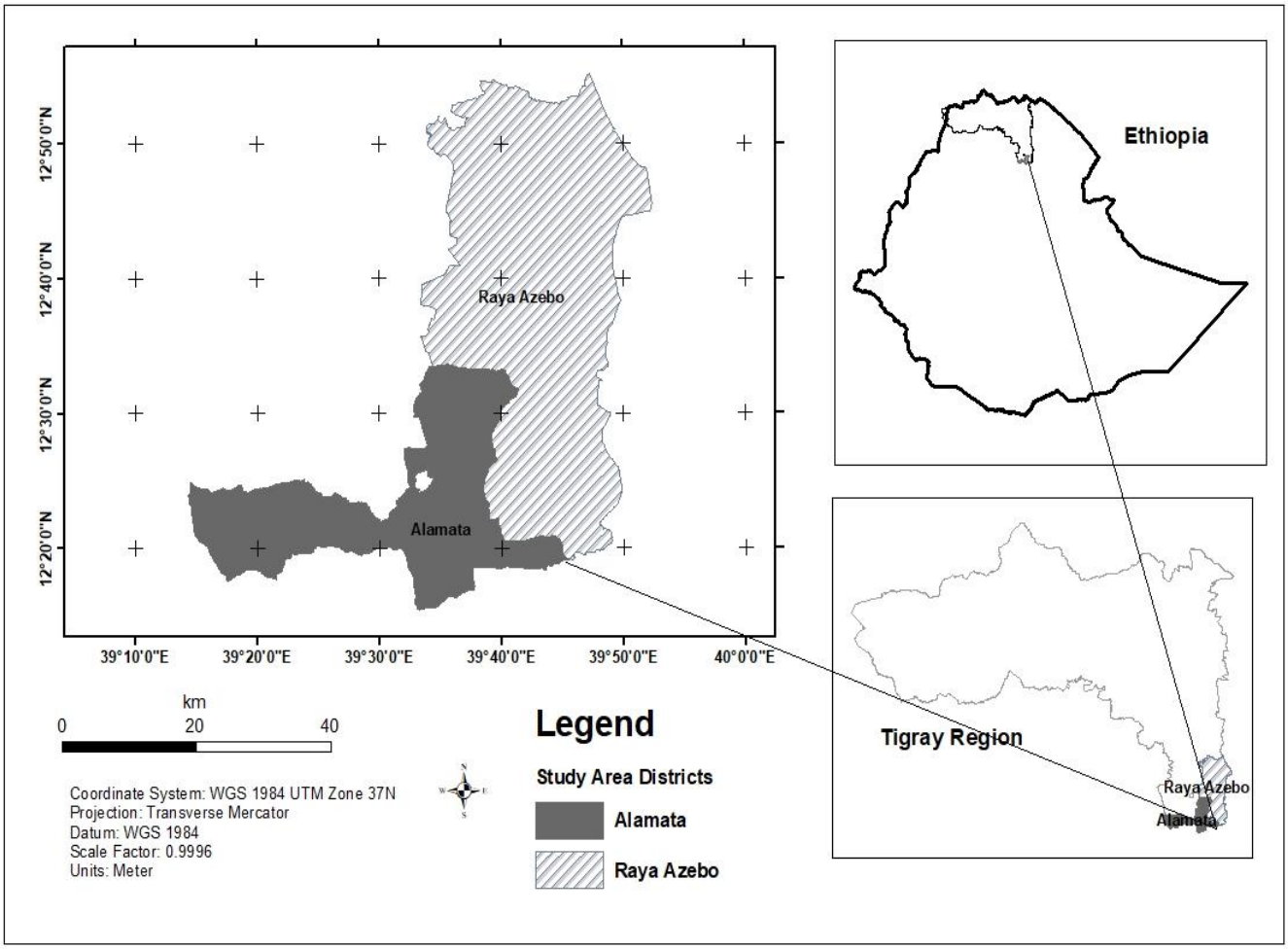


Figure 1- Map of the study areas

Site selection and sampling method

In defining sampling frame, available background information on the existence Raya cattle in the study area was captured through short pilot survey and focus group discussions done by a team of Ethiopian Biodiversity Institute researchers and livestock experts from Southern Tigray zone, Raya Azebo and Alamata districts. Additionally, the information (origin of Harmo cattle, its unique features and densely populated areas) of the earlier study done by Zerabruk et al. (2007) was also taken as an input to select study areas. For the purpose of selecting pure Harmo cattle, the cattle populations from the high and mid altitude areas within the districts were not considered, as they did not show distinct features due to the interbreeding with the highland cattle populations. Therefore, samples were not taken from high and mid-altitude areas. Six study kebeles were selected purposively taking into account the cattle population size, dominant agro-ecology, and indigenous knowledge on cattle population types. Male to female ratio (28 oxen and 223 cows) of the sampled animals were adapted from FAO guideline for Animal Genetic Resource Characterization (FAO, 2012). Animals were randomly selected from herds of representative households.

Table 1 - Sampled number of animals by district and by age and their proportion.

District /Location	Age			Total	Proportion
	3 – 5 years	6 – 7 years	≥ 8 years		
Raya Azebo	44	50	32	126	0.50
Raya Alamata	35	50	40	125	0.50
Total	79	100	72	251	1.00
Proportion	0.31	0.40	0.29	1.00	-

Data collection

Twenty-four qualitative traits (horn presence, horn spacing, horn shape, horn orientation, body color pattern, body color, head color, muzzle pigment, eyelid pigment, hoof pigment, ear shape, hump shape, hump size, hump position, udder size, teat size, face profile, back profile, rump profile, testes size, tail length, naval flap width, preputial sheath and dewlap width), and nine quantitative measurements (body length, heart girth, height at wither, pelvic width, muzzle circumference, ear length, horn length, canon bone length and hock circumference) were recorded from 251 mature

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

animals under the effect of district, sex and age of each sampled animal. For the purpose of analysis age groups were categorized in to three; group one 3 – 5 years, group two 6 – 7 years and group three 8 years and above as per the grouping of Tatum (2011). For the body measurements, animals were carefully handled by trained laborers and stand properly on flat grounds with parallel legs. Animals which were aggressive and did not stand properly were not measured. The measurements were carried out by two researchers: one measuring while the other recording data. On the same time, two other researchers handle the qualitative data recording. To minimize the subjective error, all the measurements were taken by the same researcher throughout the study. Quantitative measurements were taken using textile tape measurement in centimeter unit, and early in the morning before the animals were fed and watered.

Data management and analysis

Data were entered and managed using Microsoft Excel© worksheet. Outliers were corrected after running normality test procedure of Statistical Analysis Software 9.0 (SAS, 2002). Analysis of data on quantitative measurements was carried out using the General Linear Model procedure of SAS 9.0 software. Means were separated using the adjusted Tukey-Kramer test (SAS, 2002). Similarly, analysis of qualitative data was carried out using the frequency procedure (chi-square test) of SAS 9.0 software. The model used for the analysis was: $Yijk = \mu + Ai + Bj + Ck + eijk$, Where Yijk is an observation, μ is the overall mean, Ai is the fixed effect of district, Bj is the fixed effect of the sex, Ck is the fixed effect of age group and eijk is the random error attributed to the nth observation. Due to the non-significant effects of the interactions among the above factors, it was removed from the analysis and results. Traits like udder size, teat size and naval flap width were analyzed for females only by eliminating the males and fitting district and age as fixed factors while traits like testes size and preputial sheath were analyzed for males only by eliminating the females from the analysis fitting district and age as fixed factors.

RESULTS

Quantitative measurements

The overall mean, standard error (SE), standard deviation (SD), minimum, maximum and coefficients of variation (CV) of the measured quantitative traits are presented in Table 2. For all morphometric traits measured the coefficient of variation was within the range of 4.26 and 7.80. Relatively higher coefficient of variation (18.87%) was calculated for horn length implying higher variation in terms of horn length. The difference between the minimum and maximum value is sizeable in most cases. A range of 54 cm for heart girth, 37 cm for body length, 28 cm for height at withers, and a range of about 62 cm for horn length were observed. The results show there were high variations among Harmo cattle over the measured quantitative traits which is a better ground for genetic improvement due to selection.

Least square means, standard error (SE), and pairwise comparison of the measured quantitative traits under the effects of district, sex and age are presented in Table 3 and 4. Sampled district had a significant ($p<0.01$) effect on five of the total nine measured traits and it is indicated that four of the body measurements were higher for the cattle population of Alamata. Based on this, cattle population of Alamata district had larger muzzle and hock, and longer ear and horn than the cattle populations of Raya Azebo. However, the canon of the cattle from Raya Azebo was longer than those of Alamata. Similarly, sex of the cattle populations affected six out of the nine measured traits indicating oxen had longer body, height at wither, canon and heart girth measurements than the cows. Significant differences were not recorded between the two sexes in pelvic width, ear length and horn length.

The results also revealed that four out of the nine measurements were affected by age of the cattle population. Based on this, slight increment in pelvic width, muzzle circumference, ear and horn length was observed as the age of the cattle population increases.

Table 2 - Overall mean (cm), SE, SD, CV, Minimum and Maximum body measurements of Harmo cattle breed.

Variables	Overall mean ± SE	SD	Minimum	Maximum	CV
Body length	122.0±0.42	6.65	106	143	5.45
Heart girth	139.8±0.46	7.45	114	168	5.33
Height at withers	117.1±0.31	4.98	102	130	4.26
Pelvic width	35.0±0.15	2.42	28	42	6.90
Muzzle circumference	37.2±0.13	2.01	31	44	5.41
Ear length	21.3±0.11	1.66	16	25	7.80
Horn length	62.1±0.74	11.72	30	92	18.87
Canon bone length	24.1±0.11	1.66	19	29	6.90
Hock circumference	31.5±0.10	1.55	28	35	4.91

SE = Standard Error, SD = Standard Deviation, CV = Coefficient of variation

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

Table 3 - Least square means (cm) with standard error and pairwise comparison of body measurements in each district and sex category

Variables	District			Sex		
	Raya Azebo	Alamata	*p* - value	Male	Female	*p* - value
N	126	125		28	223	
BL	124.2±0.72	125.1±0.81	0.3086	127.8±1.22	121.3±0.43	<0.0001
HG	142.4±0.80	143.3±0.91	0.3049	146.7±1.37	138.9±0.48	<0.0001
HW	119.0±0.54	119.1±0.61	0.8021	121.7±0.92	116.5±0.32	<0.0001
PW	35.39±0.27	35.0±0.30	0.2376	35.5±0.45	35.0±0.16	0.2652
MC	37.91±0.21	38.9±0.23	0.0150	39.5±0.35	36.9±0.12	<0.0001
EL	21.00±0.18	21.5±0.21	0.0226	21.2±0.31	21.3±0.11	0.6493
HL	61.53±1.22	65.8±1.37	0.0024	65.5±2.08	61.8±0.73	0.0889
CBL	24.91±0.18	24.1±0.20	<0.0001	25.0±0.30	24.0±0.11	0.0024
HC	31.85±0.16	32.4±0.18	0.0016	33.0±0.28	31.3±0.10	<0.0001

N = number of observations, BL= Body length, HG = Heart girth, HW = Height at withers, PW = Pelvic width, MC = Muzzle circumference, EL = Ear length, HL = Horn length, CBL = Canon bone length, HC = Hock circumference.

Table 4 - Least square means (cm) and pairwise comparison of body measurements with standard error in each age category

Variables	Age			*p* - value
	3 – 5 years	6 – 7 years	≥ 8 years	
N	79	100	72	
Body length	123.5±0.83	124.5±0.83	126.0±0.93	0.0548
Heart girth	142.1±0.93	143.0±0.93	143.3±1.04	0.5625
Height at withers	118.6±0.62	119.4±0.62	119.2±0.70	0.4873
Pelvic width	34.3±0.31^{b}	35.6±0.31^{a}	35.8±0.34^{a}	0.0001
Muzzle circumference	37.6±0.24^{b}	38.2±0.24^{b}	38.8±0.27^{a}	0.0003
Ear length	20.9±0.21^{b}	21.5±0.21^{a}	21.3±0.23^{ab}	0.0246
Horn length	57.8±1.41^{c}	64.6±1.41^{b}	68.6±1.58^{a}	<0.0001
Canon bone length	24.5±0.21	24.4±0.21	24.6±0.23	0.7706
Hock circumference	31.9±0.19	32.1±0.19	32.4±0.21	0.1530

N = number of observations

Qualitative characteristics

The overall Harmo cattle qualitative characteristics by district, sex and age are presented under Tables 5 – 7. Majority of the cattle population were horned (100%) with lyre shaped (83.73%) upward orientation (92.46) and wide horn spacing (≥ 30 cm) (96.03%). They also possess straight edged ear (97.22%). Harmo cattle hump was erected (98.81%), and small (88.1%), and found at cervical thoracic (78.57) position. The results also revealed that Harmo cattle population had flat face (99.21%) and straight back profile (88.49%), long tail (95.24%) and large dewlap (75%). Body color pattern of Harmo cattle population was uniform (61.11%), spotty (26.98%) and others (11.9%). Red and light-red body and head color was observed on majority of the cattle. Beside their large horns Harmo cows also possess medium (38.8%) and large (42.4%) naval flap. Similarly, the oxen also possess medium (46.4%) and large (50%) preputial sheath. The qualitative characteristics of Harmo cattle were partially affected by district, sex and age categories.

Table 5 - Qualitative characteristics of Harmo cattle under district and sex effect

Variables	District			Sex		
	Raya Azebo	Alamata	*P*-value	Male	Female	*P*-value
Horn spacing			1.00			0.9092
Narrow	4.0	4.0		3.6	4.0	
Wide	96.0	96.0		96.4	96.0	
Horn shape			0.8645			0.7629
Curvy	15.9	16.7		14.3	16.5	
Lyre	84.1	83.3		85.7	83.5	
Horn orientation			0.2329			0.3989
Forward	5.6	9.5		3.6	8.0	
Upward	94.4	90.5		96.4	92.0	
Ear shape			0.0073			0.0067
Round edged	5.6	0.0		10.7	1.8	

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

Straight edged	94.4	100		89.3	98.2	
Hump shape			0.2227			0.0003
No Hump	0.8	0		0	0.5	
Erect	99.2	98.4		92.9	99.5	
Dropping	0	1.6		7.1	0	
Hump size			0.0368			<0.0001
No Hump	0.8	0		0	0.5	
Small	92.8	83.3		71.4	90.1	
Medium	6.4	14.3		17.9	9.4	
Large	0	2.4		10.7	0	
Hump position			<0.0001			<0.0001
No Hump	0.8	0		0	0.5	
Thoracic	33.3	8.7		78.6	13.8	
Cervical thoracic	65.9	91.3		21.4	85.7	
Face profile			0.3649			0.0170
Flat	98.4	100		96.4	99.5	
Concave	0.8	0		0	0.5	
Convex	0.8	0		3.6	0	
Back profile			<0.0001			0.0176
Curved	19.8	3.2		25.0	9.8	
Straight	80.2	96.9		75.0	90.2	
Tail length			0.3995			0.2069
Short	0.8	0.00		0.00	0.45	
Medium	3.2	5.56		10.71	3.57	
Long	96.0	94.44		89.29	95.98	
Dewlap width			0.6625			0.6434
Small	0	0		0	0	
Medium	23.8	26.2		21.4	25.5	
Large	76.2	73.8		78.6	74.5	

District effect

The study shows effect of district on four out of the twenty-four qualitative traits recorded. Based on this, some round edged ear shape was found in Raya Azebo while all the cattle populations from Alamata had straight edged ear. One third of the cattle populations from Raya Azebo possess thoracic hump position while almost all the cattle from Alamata had cervical thoracic hump position. One fifth of the Raya Azebo cattle's back profile was curved while straight back profile was observed on almost all Alamata cattle populations.

Table 6 - Qualitative characteristics of Harmo cattle under age effect

Variables	Overall % (N)	Age			
		3 – 5	6 – 7	≥ 8	*P*-value
Horn spacing					0.0721
Narrow	4.0(10)	0.0	5.0	6.9	
Wide	96.0(242)	100	95	93.1	
Horn shape					0.0284
Curvy	16.3(41)	25.0	14.0	9.7	
Lyre	83.7(211)	75.0	86.0	90.3	
Horn orientation					0.0286
Forward	7.5(19)	13.7	6.0	2.8	
Upward	92.5(233)	86.3	94.0	97.2	
Ear shape					0.9796
Round edged	2.8(7)	2.50	3.0	2.8	
Straight edged	97.2(245)	97.50	97.0	97.2	
Hump shape					0.2111
No Hump	0.4(1)	0	1.0	0	
Erect	98.8(249)	97.5	99.0	100	
Dropping	0.8(2)	2.5	0	0	
Hump size					0.1849
No Hump	0.4(1)	0	1.0	0	

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

Small	88(222)	81.2	89.0	94.4	
Medium	10.3(26)	16.3	9.0	5.6	
Large	1.3(3)	2.5	1.0	0	
Hump position					0.2224
No Hump	0.4(1)	0	1.0	0	
Thoracic	21(53)	28.8	18.0	16.7	
Cervical thoracic	78.6(198)	71.2	81.0	83.3	
Face profile					0.3626
Flat	99.2(250)	97.5	100	100	
Concave	0.4(1)	1.3	0	0	
Convex	0.4(1)	1.2	0	0	
Back profile					0.7988
Curved	11.5(29)	11.3	13.0	9.7	
Straight	88.5(223)	88.7	87.0	90.3	
Tail length					0.4592
Short	0.4(1)	0.00	0.00	1.39	
Medium	4.4(11)	3.75	6.00	2.78	
Long	95.2(240)	96.25	94.00	95.83	
Dewlap width					0.9383
Small	0 (0)	0	0	0	
Medium	25.0(63)	25.0	24.0	26.4	
Large	75.0(189)	75.0	76.0	73.6	

Sex and age effect

The study also revealed that cattle sex affects six out of the twenty-four qualitative traits recorded. Based on this, some of the Harmo oxen had round edged ear and dropping hump shape while almost all cows had straight edged ear and erect hump shape. About one third of the oxen had medium to large hump while almost all cows possess small hump. Most oxen possess hump at the thoracic position while most cows had cervical thoracic hump position. Curved back profile was observed on one fourth of the oxen while most of the cows possess straight back profile. The results also show effect of age categories (five out of twenty-four) on the recorded qualitative traits. Based on this, horn of the cattle populations tends to be upward lyre shape as they get aged. Similarly, naval flap width, udder and teat size of the cows becomes large and long as their age progress. Harmo oxen possess small testes and medium to long preputial sheath, while, the cows had medium udder and teat size and medium to large naval flap width.

Table 7 - Body color and sex-limited characteristics of Harmo cattle under the effect of district, age and sex.

Variables	Overall % (N)	District		Age			Sex	
		Raya Azebo	Alamata	3 – 5	6 – 7	≥ 8	Male	Female
Body color pattern		P=0.7515		P=0.1069			P=0.1253	
Uniform	61.1(154)	57.9	64.3	57.5	67.0	56.9	46.4	63.0
Spotty	27.0(68)	28.6	25.3	31.2	17.0	36.1	28.6	26.7
Pied	7.1(18)	7.9	6.4	6.3	10.0	4.2	14.3	6.3
Shaded	4.8(12)	5.6	4.0	5.0	6.0	2.8	10.7	4.0
Body color		P=0.9460		P=0.6168			P=0.4588	
Red	38.9(98)	39.7	38.1	37.50	42.0	36.1	42.8	38.4
Light red	14.3(36)	12.7	15.9	11.25	17.0	13.9	3.6	15.6
Black	8.7(22)	7.1	10.3	7.50	7.0	12.5	3.6	9.4
Black + White	16.3(41)	17.5	15.1	20.00	12.0	18.1	25.0	15.2
Black + Red	7.1(18)	7.9	6.4	6.25	10.0	4.2	10.7	6.7
Red + White	11.5(29)	11.9	11.1	13.75	8.0	13.9	10.7	11.6
White	3.2(8)	3.2	3.2	3.75	4.0	1.4	3.6	3.1
Testes size		P=0.2062		P=0.2734				
Small	67.9(19)	71.4	57.1	50.0	88.9	80.0		
Medium	21.4(6)	23.8	14.3	28.6	11.1	20.0		
Large	10.7(3)	4.8	28.6	21.4	0	0		
Preputial sheath		P=0.4002		P=0.5359				

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

Short	3.6(1)	4.8	0	0	11.1	0	
Medium	46.4(13)	52.4	28.6	57.1	33.3	40.0	
Long	50.00(14)	42.8	71.4	42.9	55.6	60.0	
Udder size		P=0.7393		P<0.0001			
Small	8.9(20)	7.6	10.1	22.7	4.4	1.5	
Medium	62.5(140)	64.8	60.5	68.2	75.8	38.8	
Large	28.6(64)	27.6	29.4	9.1	19.8	59.7	
Teat size		P=0.6911		P<0.0001			
Short	8.0(18)	6.7	9.2	21.2	3.3	1.5	
Medium	58.5(131)	61.0	56.3	69.7	68.1	34.3	
Long	33.5(75)	32.4	34.5	9.1	28.6	64.2	
Naval flap width		P=0.9323		P<0.0279			
Absent	3.1(7)	3.8	2.5	3.0	2.2	4.5	
Small	15.6(35)	16.2	15.1	18.2	16.5	11.9	
Medium	38.8(87)	39.1	38.7	47.0	44.0	23.9	
Large	42.4(95)	40.9	43.7	31.8	37.3	59.7	

DISCUSSION

Quantitative measurements

Oxen were dominant over cows on most of the measurements, which follow the Rensch's rule (Rensch, 1950) where the males of a particular species are usually larger than the females. The differences between the oxen and cows may be further ascribed to the testosterone hormones secreted within the oxen which leads to enhancement of muscle mass and skeletal development (Baneh and Hafezian, 2009). The sexual dimorphism of the animals may be ascribed to the differences in the endocrine system of the two sexes; estrogen hormone has a limited effect for growth in females (Chriha & Ghadri, 2001; Baneh and Hafezian, 2009). The results were in line with the results of Genzebu et al. (2012) on Arado cattle and Endashaw et al. (2015) on Mursi cattle who reported that oxen were larger than cows. Similarly, dominance of bucks over does were reported in Ethiopia (Mustefa et al., 2019).

Figure 2- Harmo Oxe (left). Harmo Cow (right)

Even if, Raya Azebo (Figure 2) was the reported origin of Harmo cattle populations, most of the quantitative measurement results show cattle populations from Alamata district were larger than those of Raya Azebo. This might be due to the long term interbreeding with the Ethiopian highland breeds. These results were also in line with the results of Endashaw et al. (2015) on Mursi cattle who reported differences within the same cattle breed among different districts. Age differences count a little on the observed differences in quantitative measurements which might be due to the nature of the sampling (selecting adult animals only), however, increment in horn length was observed as the animals get aged.

Harmo cattle breed had longer and tall body than Horro, Sheko, Arado and Ogaden cattle breeds however some other cattle breed like Begait possess longer and taller body than Harmo cattle (Takele et al., 2007; Dessalegn et al., 2012; Fasil et al., 2014 and Mulugeta, 2015). Hearth girth measurements of Harmo breed was lower than Ogaden, Arsi and Begait cattle breeds. However, Harmo cattle were one of the Ethiopian indigenous cattle genetic resources which

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

possess large horns and ears. These results also show Harmo cattle breed possess long and thin body, and long ear and horn in comparison to most of the Ethiopian cattle breeds. The thin body of Harmo cattle might be due to shortage of available feed in and around the breeding tract of the breed. The long ear and horn may help them to adapt the hot bushy grazing land environment and protect themselves from the enemy existed in their natural habitat.

Qualitative characteristics

Too much significant differences in qualitative characteristics was not observed among the two sampling districts and the three age categories, which shows how unique characteristics the cattle populations from the different district and age categories share. These results are in line with the results of Endashaw et al. (2015) who observed similar qualitative characteristics among the different sampling location within the Mursi cattle breed. On the other hand, some effects of sex on the qualitative characteristics was observed which might be due to the sexual dimorphism which follow the Rensch's rule (Rensch, 1950).

Conclusion

Harmo (Raya-Azebo) cattle populations were characterized in 2019 based on FAO guidelines to update the available information for in-situ conservation purpose. Accordingly, two districts were covered; Raya Azebo and Alamata. Sizable variations were recorded among the sampled animals, which may help the further in-situ conservation and genetic improvement program. Partial effects of district, sex and age were observed. Based on these results, the cattle population from Alamata district were partially dominant over their Raya Azebo counterparts in some quantitative variables. Similarly, males were dominant over females in most of the studied variables. On the other hand, slight increment in the quantitative variables were recorded as the age of the cattle increases. The overall results show Harmo cattle possess long and thin body, and long ear and horn in comparison with most of the Ethiopian cattle breeds. The thin body of Harmo cattle might be due to shortage of available feed in and around the breeding tract of the breed. The long ear and horn may help them to adapt the hot bushy grazing land environment and protect themselves from the enemy existed in their natural habitat.

DECLARATIONS

Corresponding Author

E-mail: aminemustefa32@gmail.com

Authors' Contribution

All authors contributed to the study conception and design. AM, TB, AM, and MH collect data. Amine Mustefa contribute on data analysis and the write up of the manuscript. AH and AA review the manuscript. All authors read and approved the final manuscript.

Conflict of interests

The authors have not declared any conflict of interests.

Acknowledgements

The authors are highly indebted to the Ethiopian Biodiversity Institute (EBI) for covering all the budget needs of the work. Our special appreciation also goes to the smallholder farmers /breeders for providing their animal to this work for free. We also take this opportunity to thank the animal science experts and development agents in the district for their endless help during the data collection. A special word also goes to our friend and work partner Mr. Tadesse Hunduma for mapping the study area.

REFERENCES

Abebe AS, Alemayehu K, Johansson AM, Gizaw S (2020). Breeding practices and trait preferences of smallholder farmers for indigenous sheep in the northwest highlands of Ethiopia: Inputs to design a breeding program. PLOS One, 15(5): e0233040. https://doi.org/10.1371/journal.pone.0233040

Baneh H and Hafezian S H (2009) Effect of environmental factor on growth traits in Ghezel sheep. African Journal of Bio-technology, 8: 2903-2907. https://doi.org/10.5897/AJB09.284

Bewket W, Radeny M, and Mungai C (2015) Agricultural Adaptation and Institutional Responses to Climate Change Vulnerability in Ethiopia. CCAFS Working Paper no. 106. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Chriha A and Ghadri G (2001). Caprine in the Arab world. 2. ed. Department of Livestock Production. Fateh University: Libby Conservation of Biodiversity and Environments in the Arab Countries. 478p. Google Scholar

CSA (Central Statistical Agency) (2018). Federal Democratic Republic of Ethiopia Agricultural Sample Survey Volume II Report on Livestock and Livestock Characteristics. https://www.worldcat.org/title/agricultural-sample-survey-volume-ii-report-on-livestock-and-livestock-characteristics-private-peasant-holdings/oclc/58954342

Dejenie T. Legese K, Tomas Z and Kiros S (2013). Index of Potential Contamination for Intestinal Schistosomiasis among School Children of Raya Alamata District, Northern Ethiopia. Momona Ethiopian Journal of Science (MEJS), 5(2):32-48. https://doi.org/10.4314/mejs.v5i2.91489

Delgado Bermejo JV, Martínez Martínez MA, Rodríguez Galván G, Stemmer A, Navas González FJ, and Camacho Vallejo ME. (2019). Organization and management of conservation programs and research in domestic animal genetic resources. Diversity, 11: 235. https://doi.org/10.3390/d11120235

EBI (Ethiopian Biodiversity Institute) (2016). Ethiopian National Strategy and Plan of Action for conservation and utilization of Animal Genetic Resources. Addis Ababa, Ethiopia. Link

Endashaw T, Tadelle D, Aynalem H, Wudyalew M and Okeyo M (2015). On-farm phenotypic characterization of Mursi cattle in its production environment in South Omo Zone, Southwest Ethiopia. Animal Genetic Resources, Food and Agriculture Organization of the United Nations. 10p. http://www.fao.org/3/a-i5198t.pdf

FAO (Food and Agricultural Organization of the United Nations) (2012). Phenotypic characterization of animal genetic resources. Food and Agriculture Organization of United Nations. Rome, Italia. http://www.fao.org/3/a-i4787e.pdf

Fasil G, Solomon A, Manaye M and Tesfu F T (2014). On-farm phenotypic characterization of Ogaden cattle populations of Jigjiga zone, southeastern Ethiopia. Ethiopian Journal of Animal Production, 14: 66 – 83. Link I Google Scholar

Genzebu D, Hailemariam M and Belihu K (2012) Morphometric characteristics and livestock keeper perceptions of "Arado" cattle breed in Northern Tigray, Ethiopia. Livestock Research for Rural Development, 24: Article #6. http://www.lrrd.org/lrrd24/1/hail24006.htm

Hoffmann I (2010). Climate change and the characterization, breeding and conservation of animal genetic resources. Animal Genetics, 41: 32-46. https://doi.org/10.1111/j.1365-2052.2010.02043.x

Lozano-Jaramillo M, Bastiaansen J, Dessie,T, and Komen H (2019). Use of geographic information system tools to predict animal breed suitability for different agro-ecological zones. Animal, 13(7): 1536-1543. https://doi.org/10.1017/S1751731118003002

Mulugeta FG (2015). Production system and phenotypic characterization of Begait cattle, and effects of supplementation with concentrate feeds on milk yield and composition of Begait cows in Humera ranch, Western Tigray, Ethiopia. PhD Dissertation Addis Ababa University, Debre Zeit, Ethiopia. 114p. Google Scholar

Mustefa A, Gizaw S, Banerjee S, Abebe A, Taye M, Areaya A and Besufekad S (2019) Growth performance of Boer goats and their F1 and F2 crosses and backcrosses with Central Highland goats in Ethiopia. Livestock Research for Rural Development, 31: Article #89. http://www.lrrd.org/lrrd31/6/amine31089.html

Rensch B (1950). Die Abhangigkeit der relative sexual differenz von der korpergrosse. Bonner Zoologische Beitrage, 1: 58 – 69.

Roessler R, Mpouam SE, Schlecht E (2019). Genetic and nongenetic factors affecting on-farm performance of peri-urban dairy cattle in west Africa. Journal of Dairy Science, 102(3): 2353-2364. DOI: https://doi.org/10.3168/jds.2018-15348

SAS (Statistical Analysis System) (2002) Institute Inc., Cary, NC, USA.

Takele T, Workneh A and Hegde B P (2007). On-farm Characterization of Sheko Breed of Cattle in Southwestern Ethiopia. Ethiopian Journal of Animal Production, 7(1): 89 – 105. Link I Google Scholar

Tatum J D (2011) Animal age, physiological maturity, and associated effects on beef tenderness. White paper Research and Knowledge Management, pp.12. https://www.beefresearch.org/CMDocs/BeefResearch/PE_White_%20Papers/Animal_Age.pdf

Zerabruk M, Vangen O and Haile M (2007). The status of cattle genetic resources in North Ethiopia: On-farm characterization of six major cattle breeds. Animal Genetic Resources Information, 40: 15-32. https://doi.org/10.1017/S1014233900002169

Citation: Mustefa A, Belayhun T, Melak A, Hayelom M, Hailu A and Assefa A (2020). Body morphometric measurements in Harmo cattle (Raya-Azebo cattle) in Southern Tigray of Ethiopia. *Online J. Anim. Feed Res.*, 10 (6): 259-267. DOI: https://dx.doi.org/10.51227/ojafr.2020.35

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 268-277; November 27, 2020

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.36

EVALUATION OF PRODUCTION SYSTEMS AND HUSBANDRY PRACTICES OF ETHIOPIAN INDIGENOUS GOATS

Gutu YEMANE[1]✉, Aberra MELESSE[2], Mestawet TAYE[2]

[1]*Department of Animal Science, Alage ATVET College, P. O. Box 77, Alage, Ethiopia*
[2]*School of Animal and Range Sciences, Hawassa University, P. O. Box 05, Hawassa, Ethiopia*

✉Email: gutuyemane@gmail.com; ORCID: 0000-0001-7134-7923

Supporting Information

ABSTRACT: The study was conducted in Limu Seka, Nono Benja and Omo Nada districts of Jimma zone with the objectives to assess production system and husbandry practices of indigenous goat. Data were collected through questionnaire, focal group discussion and secondary data. A total of 210 households were selected for an interview and case study. Data were analyzed by descriptive statistics and ranking index. The results showed that the overall family size and mean goats flock size per household are 7.10 and 7.78 respectively. The farming activities were mixed crop and livestock systems. Natural pasture (herbs and shrubs), fallow land, crop residues and non-conventional feeds were the feed resources of the study area. Free grazing/browsing, riverside grazing/browsing, aftermath grazing, and herding were the major grazing management types for goats in the dry season. In wet season, grazing management were herding and tethering alone and both herding and tethering together. In the study area, rivers were the main source of water in both dry and rainy season. All households in all the study districts provide nighttime shelter (house) for goat throughout the year. On average about 63.8% and 61.9% of respondents have been practicing fattening and castrating goat. Castration was primarily practiced to improve fattening and get a better price. Disease, feed shortage and lack of superior genotypes were major constraints of goat production in the study area. In general, goat production system and husbandry practices in the study area was traditional with mixed livestock system that challenged by serious disease problem and feed shortage, so interference is needed to solve identified problems.

Keywords: Indigenous breeds, Husbandry practices, Jimma zone, Rural farming system

RESEARCH ARTICLE

PII: S222877012000036-10

Received: September 11, 2020

Revised: October 16, 2020

INTRODUCTION

Goat provide multifunctional role and it's the easiest and most readily accessible source of credit available to meet immediate social and financial obligations (Abraham et al., 2017a). Goat production is one of the largest agricultural sectors in developing countries in which Africa shares about 35% of the world goat population (Skapetas and Bampidis, 2016). Ethiopia has long been renowned as a source of the large diversity of farm animal genetic resources in which 32.74 million goat are reared (CSA, 2018). In the last 10 years, the goat population in Ethiopia increased more rapidly than sheep and cattle populations (FAOSTAT, 2016).

Goats (*Capra hircus*) have a key role in ensuring food security and economic livelihood to smallholder farmers in rural areas (Monau et al., 2020). Indigenous goats have high significance due to their adaptive traits that are relevant for climate change and low maintenance. Compared to cattle, these genetic resources have become even more important under changing climates (Monau et al., 2020). They are important sources of income and play a vital role as sources of meat and milk for owners in different production systems and agro-ecological zones of Ethiopia. The existing goat populations are adapted to the harsh environmental situation that characterized by low levels of input and technologies, feed scarcity and disease. Goats are managed in low-input, extensive grazing systems based on communal lands and native pastures (Tesfahun et al., 2017; Yemane et al., 2020).

In Ethiopia, various factors could be considered to categorize small ruminant production systems like degree of integration with crop production, contribution to livelihood, level of input and intensity of production, agro-ecology, and length of growing period and relation to land and type of commodity to be produced. In the country goat are kept under traditional extensive systems and raised in two major production systems: mixed crop-livestock and pastoral/agro-pastoral production systems (Sheriff and Alemayehu, 2018). However, urban and peri-urban production system was also reported in the country. Despite there are large populations of goats, their productivity and the contribution to the country's national economy are low (Solomon et al., 2014). One possible contributing factor for minimal benefit could be the absence of a clear strategy to improve livestock production and productivity in Ethiopia (Chebo and Alemayehu, 2012; Molla, 2020). According to Sheriff and Alemayehu (2018), there is lack of organized and up-to-date information on small

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res.*, 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

ruminant production systems in Ethiopia. Defining production system is a base for genetic improvement of farm animals with a sound breeding objective. Farmers in different production systems have different trait preferences due to the varying production activities and available resources (Abraham et al., 2017; 2018).

From the country's total goat populations, Oromia regional state had 8.59 million heads of goat (CSA, 2018). As the study area, Jimma zone share large goat population in which goats play a major role for the smallholder farmers. Despite their importance, information provided on goat production system and husbandry practices specific to the study districts was very few till yet. Accordingly, assessing these goat production systems is vital to deliver documented information and it is a pre-requisite for proper breeding program. Therefore, this study was assessed to identify goat production systems and husbandry practices in the study area.

MATERIALS AND METHODS

The current study was conducted in three districts (Limu Seka, Nono Benja and Omo Nada) of Jimma zone, Oromia Regional State of Ethiopia. The zone lies between 35^0 -$37^{0\prime}$ E longitudes and 7^0- $8^{0\prime}$ N latitude at an elevation ranging from 880 to 3360 meters above sea level.

Sampling and data collection procedures

Multi-stage sampling techniques were applied to select districts and kebeles for the study. At the first stage out of the twenty districts, three districts (Limu Seka, Omo Nada and Nono Benja) were purposively selected based on their goat population potential. In the second stage, four, three and two kebeles were purposively and proportionally selected from Limu Seka, Omo Nada and Nono Benja districts, respectively. Moreover, care was taken to select representative sample size by considering goat flock size of at least two females and one male goat per household and willingness of households to participate in the study. In the third stage, the number of households from each selected kebeles was determined according to the proportionate sampling technique. The sample size of 210 households was determined according to the Arsham (2007), using the following formula: $N = 0.25/SE^2$ where: N = sample size, SE = standard error (0.0345) with 95% confidence level. In the sampling process, households those keep at least three matured goats were considered. Accordingly, one focal group discussion was held per kebele including key informants. In the study, both primary and secondary data were used.

Questionnaires and group discussion

General information list of FAO (2012), was used as a checklist in designing the questionnaire. Trained enumerators along with the researcher administrated the semi-structured questionnaires to the sampled households. General information of the area, topography, climatic data, and population size were obtained from secondary data. Participatory focus group discussion with goat owners, elderly farmers, village leaders were also made. The questionnaire was designed to address the description of the production environment (general household characteristics, goat flock size and farming activities) and goat husbandry practices like feeding, watering, housing, castration and fattening practices of households in the study area were assessed. Moreover, constraints of goat production were also assessed.

RESULTS

General household characteristics

The family size, household age, sex, educational level, age structure and marital statuses of households in the study districts are presented in Table 1. The overall family size in the study area is 7.10. There was a significant difference ($P<0.05$) in the average family size of respondents between districts. Average family size was significantly higher in Omo Nada district than Nono Benja and Limu Seka districts. The overall households' age in the study area was 44.89 years with majority (90.5%) of the households were male headed. In the study area, the sampled households had different educational backgrounds in which majority (73.8%) of them were illiterate. A higher proportion of the households ranged within an age of 31 to 40 years (44.3%). The study further revealed that the majority (91.4%) of the respondents were married.

Goat flock size and farming activities

The current result showed that all respondents across all districts were practicing both livestock and crop production. The overall mean goats flock size per household was 7.78 (Table 2). There was a significant difference between districts in goat population ($P<0.05$). Respondents in Nono Benja had significantly lower number of goats than Omo Nada and Limu Seka districts. There was significant difference between districts ($P<0.05$) on the suckling male kid, weaned male kid less than one year and castrated goat which was higher in Limu Seka district. In the study area, males accounted for about 30.2% and females 69.8% of the total flock. In the study area, matured female greater than one year constituted 43.8% of the whole population while matured males of the same age were only 7.2% of the population. The ratio between matured male greater than one-year age and their female counterparts was accordingly 1:6.

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res.*, 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

Table 1 - General household characteristics

HH characteristics	Limu Seka	Nono Benja	Omo Nada	Overall
Family size (Mean±SE)	6.72±0.13[a]	7.28±0.21[ab]	7.48±0.16[b]	7.10±0.09
Age (Mean±SE)	44.12±0.65	45.15±0.87	45.75±0.84	44.89±0.44
	N (%)	N (%)	N (%)	N (%)
Sex				
Male	85*(90.4)	42*(91.3)	63*(90)	190*(90.5)
Female	9(9.6)	4(8.7)	7(10)	20(9.5)
X^2-value	61.44	31.39	44.80	137.62
Educational status				
Illiterate	68*(72.3)	32*(69.6)	55*(78.6)	155*(73.8)
Elementary (1-8)	24(25.5)	14(30.4)	13(18.6)	51(24.3)
Secondary (9-10)	2(2.1)	-	2(2.9)	4(1.9)
X^2-value	37.66	3.43	21.77	73.35
Age structure (year)				
≤30	4(4.3)	-	3(4.3)	7(3.3)
31-40	42*(44.7)	21(45.7)	30*(42.9)	93*(44.3)
41-50	33(35.1)	14(30.4)	16(22.9)	63(30)
>50	15(16)	11(23.9)	21(30)	47(22.4)
X^2-value	72.08	7.04	67.05	170.60
Marital status				
Married	87*(92.6)	42*(91.3)	63*(90)	192*(91.4)
Widowed	7(7.4)	4(8.7)	7(10)	18(8.6)
X^2-value	68.08	31.39	44.80	144.17

X^2= Chi square; *= (p<0.05); Different superscripts within a row denote significant differences at P<0.05 between districts; N= Number of respondents; SE=Standard error; HH=Households

Table 2 - Average number of goat with their respective age category (Mean±SE)

Goat age category	Limu Seka	Nono Benja	Omo Nada	Overall
Total goat	8.35±3.06[b]	6.56±1.9[a]	7.81±2.57[b]	7.78±2.76
Suckling male kid	0.81±0.08[b]	0.41±0.09[a]	0.77±0.09[b]	0.71±0.05
Suckling female kid	1.42±0.12[a]	1.10±0.09[a]	1.37±0.10[a]	1.33±0.06
Weaned male kid (< 1 year)	0.78±0.07[b]	0.36±0.07[a]	0.58±0.08[ab]	0.62±0.04
Weaned female kid (< 1 year)	0.69±0.06[a]	0.52±0.11[a]	0.77±0.07[a]	0.68±0.04
Matured male (> 1 year)	0.60±0.06[a]	0.47±0.08[a]	0.55±0.07[a]	0.56±0.04
Matured female (> 1 year)	3.46±0.08[a]	3.43±0.10[a]	3.31±0.10[a]	3.40±0.05
Castrated	0.55±0.05[b]	0.23±0.06[a]	0.44±0.05[ab]	0.44±0.03

[a-b] Different superscript letters within a row denote significant differences at P<0.05

Goat husbandry practices

Feed source and feeding management. The current study showed that the availability of feed resources depends on seasonal factors (Table 3). The feed resources of the study area were natural pasture especially herbs and shrubs, fallow land, crop residues and non-conventional feeds (household and Chat leftovers, *atella* of *tella* and *areke*). During the dry season, when feed scarcity is the main problem, farmers provide different supplements to their animals. The supplements that are provided to goats were homemade feed; non-conventional feeds like households and Chat (*Catha edulis*) leftovers, *atella* of *tella* and *areke* that are the byproducts of locally made beverages; common salt; and crop residues of maize, teff, and sorghum. Grazing management practiced in the study area depended on the season of the year. Free grazing/browsing, riverside grazing/browsing, aftermath grazing, and herding were the major grazing management types for goats in the dry season. In wet season, grazing management were herding and tethering alone and both herding and tethering together. In wet season, grazing management types was significantly different between districts (P<0.05). A higher proportion (65.2%) of respondents in Nono Benja district practiced herding only. As a whole, in wet season 51.4%, 19.5% and 29% of the households practiced herding, tethering, and herding and tethering together, respectively. Aftermath and riverside browsing are an important source of goat feed from the start of the dry season to the start of the short rainy season, after which their importance declines in case of aftermath.

Water source and watering system

The main sources of water in the study area are rivers, springs, rainwater, water wells, and pond though their importance was unlike in different seasons. In all study districts, rivers were the main source of water in both dry and rainy season (Table 4). Source of water in both dry and rainy season showed a significant difference between districts at P<0.001. In Limu Seka and Nono Benja districts none of the households responded dam or ponds as a source of water but in Omo Nada 24.3% of households in the rainy season and 42.9% in dry season use dam as a source of water. Majority of the respondents in the study area are traveling a distance of 1-5 km to get a watering point during both in

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res*., 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

rainy (61.4%) and dry seasons (54.3%) while more respondents (40%) in Omo Nada district go a long distance (6-10 km) during the dry season. The watering frequency in the study area was different from season to season (Table 4). During rainy season, the majority (77.6%) of respondents watered goats freely and about (22.4%) were watered once in a day. In contrast, during dry season goats were watered once in a day (52.9%), followed by once in two days (47.1%). However, more (57.1%) respondents in Omo Nada water their goat once in two days.

Table 3 - Feed resources and grazing management during different seasons.

Feed resources	Limu Seka N (%)	Nono Benja N (%)	Omo Nada N (%)	Overall N (%)	X^2
Dry season					
Natural pasture only	17(18.1)	10(21.7)	12(17.1)	39(18.6)	
Fallow land +Natural pasture + CA + CR	67(71.3)	27(58.7)	47(67.1)	141(67.1)	
Non-conventional feeds	10(10.6)	9(19.6)	11(15.7)	30(14.3)	2.94^{ns}
Wet season					
Natural pasture only	45(47.9)	27(58.7)	36(51.4)	108(51.4)	
Fallow land+Natural pasture + Non-conventional feeds	49(52.1)	19(41.3)	34(48.6)	102(48.6)	1.45^{ns}
Grazing management type					
Dry season					
Free grazing/browsing	47(50)	25(54.3)	40(57.1)	112(53.3)	
River side grazing/browsing	16(17)	7(15.2)	10(14.3)	33(15.7)	
Stubble/aftermath grazing	21(22.3)	6(13)	12(17.1)	39(18.6)	
Herding	10(10.6)	8(17.4)	8(11.4)	26(12.4)	3.36^{ns}
Wet season					
Herding only	46(48.9)	30(65.2)	32(45.7)	108(51.4)	
Tethering only	14(14.9)	5(10.9)	22(31.4)	41(19.5)	
Herding and tethering	34(36.2)	11(23.9)	16(22.9)	61(29)	13.12^{*}

Chi square (X^2) value denotes significance difference between districts,* (P<0.05); ns= non-significant (P>0.05); N= Number of households; CA=Crop aftermath; CR=Crop residues

Table 4 - Water source, frequency of watering and distance to nearest watering point

Variables	Limu Seka (%)		Nono Benja (%)		Omo Nada (%)		Overall (%)	
	RS	DS	RS	DS	RS	DS	RS	DS
Source of water								
Dam/pond	-	-	-	-	24.3	42.9	8.1	14.3
River	63.8	76.6	67.4	89.1	44.3	44.3	58.1	68.6
Spring	21.3	6.4	13	6.5	2.9	4.3	13.3	5.7
Rain water	14.9	-	19.6	-	28.6	-	20.5	-
Water well	-	17	-	4.3	-	8.6	-	11.4
X^2 value							51.41^{***}	75.2^{***}
DNWP								
Watered at home	7.4	6.4	6.5	6.5	12.9	10	9	7.6
<1km	26.6	12.8	23.9	6.5	24.3	7.1	25.2	9.5
1–5 km	60.6	54.3	65.2	71.7	60	42.9	61.4	54.3
6–10 km	5.3	26.6	4.3	15.2	2.9	40	4.3	28.6
X^2 value							2.55^{ns}	13.14^{*}
FW								
Freely available	73.4	-	80.4	-	81.4	-	77.6	-
Once a day	26.6	56.4	19.6	60.9	18.6	42.9	22.4	52.9
Once in 2 days	-	43.6	-	39.1	-	57.1	-	47.1
X^2 value							1.75^{ns}	4.46^{ns}

Chi square (X^2) value denotes significance difference between districts, *:P<0.05; ***:P<0.001; ns= non-significant (P>0.05); DNWP=Distance to nearest watering point, FW=Frequency of watering, RS=Rainy season, DS=Dry season

Housing system

All households in all the study districts provide nighttime shelter for goat throughout the year to protect them from predators (Table 5). Majority (66.2%) of farmers kept their goat in a separate house with a roof at night, while 22.4% of them kept goats inside their family house and 11.4% kept goat in a house that is attached to the main family house (adjoin house) and shares family house roof externally. About 59% and 41% of the households responded that goat house's roof was constructed from iron sheet and grass, respectively while the wall was constructed from wood and the floor was from soil (earth). The majority of walls were made up of Eucalyptus trees that are abundantly available in the study areas. Majority of goat (63.8%) were housed with sheep and calves while 36.2% were housed alone, but none of the households responded with equines and cattle in the same house.

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res*., 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

Table 5 - Goat housing in the study area

Housing / Types of house	Limu Seka N%	Nono Benja N%	Omo Nada N%	Overall N%	X^2
With roof					
In a family house	21(22.3)*	11(23.9)	15(21.4)	47(22.4)	
Separate house	63(67)	28(60.9)	48(68.6)	139(66.2)	
Attached to main family house with roof	10(10.6)	7(15.2)	7(10)	24(11.4)	1.09^{ns}
Type of roof					
Iron sheet	59(62.8)	28(60.9)	37(52.9)	124(59)	
Grasses	35(37.2)	18(39.1)	33(47.1)	86(41)	1.71^{ns}
Kids housed with adult					
Yes	16(17)	4(8.7)	7(10)	27(12.9)	
No	78(83)	42(91.3)	63(90)	183(87.1)	2.67^{ns}
Goat housed					
Together with sheep and calve	62(66)	28(60.9)	44(62.9)	134(63.8)	
Alone	32(34)	18(39.1)	26(37.1)	76(36.2)	0.38^{ns}

Chi square (X^2) value denotes significance difference between districts, ns-(P>0.05);
N= Number of households; * = figures in parenthesis are percent's

Fattening practices

Fattening practices of goats in the study districts is presented in Table 6. Goat fattening practice was significantly (P<0.05) different among districts. In the study area, on average about 63.8% of respondents have been practicing goat fattening. Majority of farmers in Limu Seka (73.4%) and Omo Nada (61.4%) districts fatten goat, while only about 47.8% of respondents in Nono Benja were fattening goat. Respondents in the study area were fattening different categories of goats. Majority of them (53.8%) fatten young male, castrates and older males. Females were fattened when they get older or when they stopped giving birth, otherwise, they kept for breeding to produce replacement flock. Types of feed resources given to fattening goat was significantly different between districts (P<0.05). Feed resources used for fattening were natural pasture, crop residues, homemade boiled grain of maize and bean, household leftovers, chat leftover (Gheraba), local brewery residues (atella of areke and tella), mill house by product and porridge (the heated thick mixture of maize, barley and bean powder with water). Utilization of porridge as feed resource was reported only by goat milk users in Limu Seka district because they use it especially to fatten castrated goat and for milking does. Fattening was practiced both during the wet and dry seasons. About 55% of the respondents reported that duration of fattening goats is about 4-6 months while 29.7% of the respondents reported that until they were fattened with no time limit.

Table 6 - Fattening practices of goats in the three districts

Variables	Limu Seka N%	Nono Benja N%	Omo Nada N%	Overall N%	X^2
Goat fattening					
Yes	69(73.4)[1]	22(47.8)	43(61.4)	134(63.8)	
No	25(26.6)	24(52.2)	27(38.6)	76(36.2)	9.01*
Categories of animals fattening					
Young male + Castrates + Older male	39(52)	13(50)	26(59.1)	78(53.8)	
Culled young male + Older female	14(18.7)	7(26.9)	4(9.1)	25(17.2)	
Castrates + Older males only	22(29.3)	6(23.1)	14(31.8)	42(29)	3.98^{ns}
Types of feed for fattening					
NP only	32(42.7)	7(26.9)	15(34.1)	54(37.2)	
NP + Boiled maize grain, sorghum and bean	12(16)	9(34.6)	9(20.5)	30(20.7)	
NP + HL+ CL+ LBR	11(14.7)	6(23.1)	15(34.1)	32(22.1)	
NP + Mill house by product	9(12))	4(15.4)	5(11.4)	18(12.4)	
NP + CR+ Porridge	11(14.7)	-	-	11(7.6)	19.94*
Season of fattening					
Dry season	25(33.3)	8(30.8)	18(40.9)	56(35.2)	
Wet season	50(66.7)	18(69.2)	26(59.1)	89(64.8)	0.96^{ns}
Duration of fattening					
Until they get fattened	21(28)	8(30.8)	14(31.8)	43(29.7)	
4-6 months	44(58.7)	14(53.8)	21(47.7)	79(54.5)	
>6 months	10(13.3)	4(15.4)	9(20.5)	23(15.9)	1.65^{ns}

Chi square (X^2) value denotes significance difference between districts, 1: figures in parenthesis are percent's; *: Significant at (P<0.05); ns= non-significant (P>0.05); N= Number of households, NP=Natural pasture, HL=Household leftover, CL=Chat leftover, LBR= Local brewery residue, CR=Crop residues

Castration practices

Goat's castration practice in the study area is showed in Table 7. On average about 61.9% of respondents, castrate goats. Castration practice was significantly different between districts (P<0.05). In Limu Seka and Omo Nada district, about 70.2% and 60% of farmers practiced goat castration, while in Nono Benja only 47.8% of them castrate their goat. About 54.6% of the respondents were performing modern type of castration procedure at a veterinary clinic by using Burdizo castrator, while 45.4% were practicing traditional methods. In the traditional method, goats were castrated by experienced farmers using material like iron hammer and stone. Castration was primarily practiced to improve fattening

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res*., 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

and get a better price (81.5%). In all districts, the reported age of castration was from 6-18 months and >18 months; however, the majority (64.6%) of respondents practiced at the age of 12-18 months. Among farmers, those practiced castration; about 89% of them provided a supplement for their goat. Once they castrate goat, they feed for different lengths of time. About 53% and 47% of farmers supplement their goat for 4-6 months and greater than 6 months, respectively.

Constraints of goat production

In the study area as reported by respondents, the three primary constraints of goat production were disease, feed shortage and lack of superior genotype with an index of 0.36, 0.258 and 0.201, respectively.

Table 7 - Castration practices of goats in the study area

Variables	Limu Seka N%	Nono Benja N%	Omo Nada N%	Overall N%	X^2
Castration practice					
Yes	66(70.2)[1]	22(47.8)	42(60)	130(61.9)	
No	28(29.8)	24(52.2)	28(40)	80(38.1)	6.72*
Castration method					
Traditional	29(43.9)	12(54.5)	18(42.9)	59(45.4)	
Modern	37(56.1)	10(45.5)	24(57.1)	71(54.6)	0.91ns
Reasons for castration					
Improve fattening and better price	56(84.8)	16(72.7)	34(81)	106(81.5)	
Control breeding	4(6.1)	3(13.6)	3(7.1)	10(7.7)	
Reduce aggressiveness	6(9.1)	3(13.6)	5(11.9)	14(10.8)	1.95ns
Age of castration					
6- 12 months	12(18.2)	7(31.8)	10(23.8)	29(22.3)	
12- 18 months	46(69.7)	11(50)	27(64.3)	84(64.6)	
> 18 months	8(12.1)	4(18.2)	5(11.9)	17(13.1)	2.96ns
Supplementation of castrated goat					
Yes	61(92.4)	18(81.8)	37(88.1)	116(89.2)	
No	5(7.6)	4(18.2)	5(11.9)	14(10.8)	2.01ns
Length of supplementation					
4-6 month	36(59)	10(58.8)	15(40.5)	61(53)	
> 6 month	25(41)	7(41.2)	22(59.5)	54(47)	3.42ns

Chi square (X^2) value denotes significance difference between districts, 1: Figures in parenthesis are percent's *-Significant at (P<0.05); ns= non-significant (P>0.05); N=Number of households.

Table 8 - Constraints of goat production in the study area prioritized using index values

Constraints	Limu Seka	Nono Benja	Omo Nada	Overall
Water shortage	0.142	0.145	0.162	0.150
Feed shortage	0.259	0.243	0.267	0.258
Lack of superior genotypes	0.207	0.207	0.188	0.201
Disease	0.349	0.366	0.367	0.360
Market	0.004	0.004	-	0.002
Predator	0.011	-	-	0.005
Thief	0.007	-	0.017	0.009
Poor veterinary service	0.014	0.022	-	0.011
Limited extension service	0.007	0.014	-	0.006

Index = sum of [(3 × number of responses for 1st rank + 2 × number of responses for 2nd rank + 1 × number of responses for 3rd rank)]/(3 × total responses for 1st rank + 2 × total responses for 2nd rank + 1 × total responses for 3rd rank).

DISCUSSION

General household characteristics

The overall family size in the current study corroborate with Yadeta (2016) in west Shoa of Oromia region who reported 7.1; but was higher than that of Alubel (2015) who reported 6.8 in Ziquala, Tanqua Abergelle and Lay Armachiho districts. The overall households' age in the study area was consistent with that of Mohammed et al. (2016), who reported 45.32 years in Jimma zone of southwest Ethiopia. Male that could be due to female's workload inside the house dominated the majority of the households and men play a leading role in decision-making. The current result was slightly lower than that of Teshager et al. (2013) who reported male dominated HH heads (95.6%) in Ilu Aba Bora zone. The sampled households had different educational backgrounds in which majority of them were illiterate. However, the result was lower than Mohammed et al. (2016) who reported 80% of illiteracy in Jimma zone, which may indicate improvement through the existence of farmers training center in their specific kebeles. The community is in high productive age group and contributes more for goat production.

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res.*, 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

Goat flock size and farming activities

Farming activities in the study area are characterized by mixed crop and livestock system. Similar findings have been reported by Tegegn et al. (2016) in Bench Maji zone; Yadeta (2016) in West Shoa of Oromia region; Abraham et al. (2017a) in western Tigray; Beyene et al. (2018) in Dawuro zone of Ethiopia. The relative higher goat flock size in Limu Seka indicates the importance of goat production and a strong opportunity for breeding activities in the district. The overall mean goats flock size per household in the study area was higher than that of Dhaba et al. (2012) and Beyene et al. (2018) who reported 3.99 in Ilu Aba Bora and 5.69 flock sizes in Dawuro zones, respectively, that may be due to the varying management activities and available resources. However, the current finding is lower than the report of Alefe (2014) in Shebelle zone, Tsigabu (2015) in Nuer zone, Belete et al. (2015) in Bale zone and Tegegn et al. (2016) in Bench Maji zone of Ethiopia who reported 37.65, 16.9, 13.5 and 9.8 goat flock size per household, respectively. The current result indicates that the goat flock size in the study area was small which might be resulted from farmers raise goats and other livestock species with crop production that enforce them not to keep large flock due to population growth and decreasing grazing/browsing land as a result of increasing ploughing land for crop production. The current finding agreed with that of Tegegn et al. (2016), Tegegn, and Askale (2017) who reported small goat flock size in the mixed crop-livestock production systems. Focus group discussion revealed that males were castrated at an early age for fattening to fetch better price and to reduce aggressiveness that makes management simpler. They are also sold at an early age than females and slaughtered for home consumption, although some bucks were kept for breeding. As a result, the numbers of male goats become smaller. Tegegn and Askale (2017) also reported smaller proportion of males (36.4%) and larger proportion of females (63.6%). Male to female ratio of this finding was slightly higher than the report of Alubel (2015) with 1:4-1:5 for Abergelle and Central highland goats and; lower than the report of Abegaz (2014) with 1:7 and 1:12 for Western Lowland and Abergelle goats, respectively, and Belete et al. (2015) with 1:8 in Bale zone.

Goat husbandry practices

Feed source and feeding management

The use of natural pasture (shrubs and herds) as feed source may be due to goat's preference to browse herbs and leaf of small trees than fibrous feed especially during dry period. The type of animal feed under the current study is similar with the reports of Mohammed et al. (2016) in Jimma zone of Oromia region, Shewangzaw et al. (2018) in Amhara region and Beyene et al. (2018) who reported natural pasture, fallow land, crop residues and non-conventional feeds are the common feed resources in their studied areas. Grazing/browsing management in the study area bespeaks that goats are under controlled feeding and close supervision in wet season by herders, and tethered for the purpose of avoiding crop and vegetation damage, saving labor and protecting from predators. The result concurs with Dhaba et al. (2012) and Arse et al. (2013) who reported tethered feeding. According to focal group discussion, feed shortage occurs during the dry season of the year. The major feed shortage months extend from mid-November up to April, while in some years it can goes up to May.

Water source and watering system

Similar with the current result, Alubel (2015) and Shewangzaw et al. (2018) reported that rivers as the most important sources of water during dry and wet seasons. During group discussions, respondents were reported that in dry season water shortage has occurred in all study areas and kids of less than 1 month watered at home. The reason was kids are not able to move long distance with an adult that was also reported by Alubel (2015). The current result implies that water is freely available in rainy season due to rain. On the other hand, 1-2 days of watering is common in dry season that is explained due to shortage of water in dry season that resulted from springs and some small rivers got dried off. Similarly, Alubel (2015) and Yadeta (2016) reported free access to water during wet season and in the dry season watered either once in a day or once in two days. The current study disagreed with that of Belete et al. (2020) in Bale zone and Alefe (2014) in Shebelle zone of southeastern Ethiopia who reported that common two to three days of watering.

Housing system

Housing is one of the major goat husbandry practices that protect them from extreme temperature, rain, wind, predators, and theft by reducing stress and making management easier. The housing system in the current study concurs with the report of Dhaba et al. (2012) and Yadeta (2016) in western Ethiopia who reported that adjoin house, separately constructed house, and main house with a family. However, it disagrees with the report of Mahilet (2012) in east Hararghe that 79.9% of the farmers kept their goats in the main family house; and Alubel (2015) in Ziquala district, majority (83.82%) of farmers confine their goats without roof and (18.18%) confine their goats in family house. Similar to the current findings, Dhaba et al. (2012) reported that farmers in Ilu Aba Bora zone sheltered goat and sheep together (47%) and goat separately (53%). In contrast, Alubel (2015) reported that 61% of respondents in Lay Armachiho district housed their goat together with other animals, while majority of (>70%) respondents in Ziquala and Tanqua Abergelle districts did not house goat together with other animals except sheep. The current result bespeaks that in all study districts all sex and age groups of goats were housed together except newborn kids. The result agrees with the report of Mahilet (2012) and Alubel (2015) that all sex and age group of goats were housed together at night except newborn kids. Focal group discussion indicated that for the first two weeks kids were kept on temporary pens (bedding materials) to

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res.*, 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

reduce physical injuries and enables them kept dry, clean and warm at night. Some farmers keep dam and kids indoor for at least the first two days of kidding and give care for both which may increase kid survival. Such practice is important to strengthen association between kids and dams and avoids trampling on newborn by other animals. Hundie and Geleta (2015) also reported the practice in western Ethiopia.

Fattening practices

The difference on goat fattening practices between districts could be resulted from varied farmers management practices and awareness on fattening. Relative to other districts in Nono Benja goat fattening was less common, which might be due to lack of good extension service and awareness. The current finding contradicts with the report of Alefe (2014) in Shebelle zone of southeastern Ethiopia that none of the respondents practiced fattening and Belete et al. (2015) in Bale zone that about 79.2% of the respondents were not practicing fattening. On the other hand, the current finding is lower than that of (Zergaw et al., 2016) who reported 70.4% of respondents practiced goat fattening for Central highland and Woyto-Guji goat type in Konso and Meta Robi districts of Ethiopia. Significant different between districts on types of feed resources may be resulted from different management system of farmers or availability of different feeds in the districts. According to respondents in Limu Seka district, porridge can increase milk production and decrease fattening duration. Natural pasture, crop residues, and chat gheraba are also reported as a source of feed for goat fattening by Shenkute et al. (2010) in Western Ethiopia and (Belete et al., 2020) in Bale zone. In general, improved feeding and management methods did not support fattening practices of goat in the study area.

Castration practices

The significant difference between districts on goat castration could be due to lack of awareness on the importance of castration in this district that resulted from weak extension service. The current finding was, lower than (Shenkute et al., 2010) in Western Ethiopia who reported that all HHs in goat dominant areas castrate goat. However, it disagrees with that of Tsigabu (2015) for Nuer zone reported where only 14.45% of farmers practiced goat castration. Less number of respondents where performing castration at a veterinary clinic by using Burdizo castrator when compared with the report of Dhaba et al. (2012) in which 91% of the respondents performed castration at veterinary clinics in Ilu Aba Bora zone. In agreement with the present results, goat castration has been reported in different parts of Ethiopia mainly to improve fattening and obtain more prices (Tegegn et al., 2016; Tegegn and Askale, 2017). Age of castration reported by majority of respondents in the current study was similar with the reports of Dhaba et al. (2012) and Tsigabu (2015) from 6 months to 24 months. The current result revealed that male kids that are more than six months of age were subjected to castration for fattening. Usually, better bucks with good body conformation and having a potential for fattening are subjected to castration at a young age for the market, which results in loss of important gene because of negative selection of breeding males. This will also limit the number of bucks that are available for breeding, which may lead to an increment of inbreeding rate.

Constraints of goat production

The three primary constraints of goat production were disease, feed shortage and lack of superior genotype in order. Disease problem may have resulted from climatic condition, poor veterinary and limited extension service. Disease and feed shortage were the constraint of goat production as reported by Belete et al. (2015); Fikru and Gebeyew (2015); Tesfahun et al. (2017); Tegegn and Askale (2017) and Beyene et al. (2018) in different places of Ethiopia.

CONCLUSION

Indigenous goats in the study area are kept in a mixed crop-livestock production system with small flock size. Natural pasture, fallow land, crop residues and other non-conventional feeds were the main feed resources. Rivers are the most important sources of water during dry and wet seasons. Majority of respondents were practiced goat fattening and castration, even if, it varies between districts. The major constraints of goat production were disease, feed shortage and lack of superior genotypes. In general, goat management system practiced in the study areas was traditional in the mixed production system in which indigenous goats were constrained by disease problem and a seasonal shortage of feed.

DECLARATIONS

Corresponding author

Email: gutuyemane@gmail.com

Ethics (consent to participate)

The research article meets all applicable standards with regard to ethics and integrity. As a researcher along with the co-authors, the paper has been submitted with full responsibility, following due ethical procedure, and there is no duplicate publication, fraud or plagiarism.

Authors' contribution

All authors contributed equally on drafting and organizing the manuscript and approved the final manuscript.

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res.*, 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

Availability of data
Data sharing is not applicable to this article.

Consent to publish
Not applicable.

Conflict of interest
Authors certify that there is no competing interest with any financial organization concerning the material discussed in the manuscript.

Acknowledgement
The authors would like to thank zone and districts Livestock and Fishery resource office for facilitating and supporting the study as well as the study communities those participated in an interview.

REFERENCES

Abegaz S (2014). Design of community based breeding programs for two indigenous goat breeds of Ethiopia. PhD thesis. Vienna, Austria: University of Natural Resources and Life Sciences, Vienna. Google Scholar ; Link

Abraham H, Gizaw S and Urge M (2017). Begait Goat Production Systems and Breeding Practices in Western Tigray, North Ethiopia. Open Journal of Animal Sciences, 7: 198-212. Google Scholar ; DOI: http://doi.org/10.4236/ojas.2017.72016

Abraham H, Gizaw S and Urge M (2018). Identification of breeding objectives for Begait goat in western Tigray, North Ethiopia. Tropical Animal Health and Production,50:1887–1892. Google Scholar ; http://doi.org/10.1007/s11250-018-1640-5

Alefe T (2014). Phenotypic Characterization of Indigenous Goat types and their Production System in Shabelle Zone, South Eastern Ethiopia. MSc Thesis Submitted to the School of Animal and Range Sciences, School of Graduate Studies, Haramaya University, Ethiopia.P.112. Google Scholar

Alubel A (2015). On-farm phenotypic characterization and performance evaluation of Abergelle and Central highland goat breeds as an input for designing community-based breeding program. MSc Thesis Submitted to the School Of Animal and Range Sciences, School Of Graduate Studies, Haramaya University, Ethiopia. 128p. Google Scholar ; Link

Arse G, Feyisa H, Gurmessa U, Merga M & Girma D (2013). Assessment on challenges and opportunities of goat farming system in Adami Tulu, Arsi Negelle and Fantale districts of Oromia Regional State, Ethiopia. African Journal of Agricultural Research. 8(1): 26-31. Google Scholar ; DOI: https://doi.org/10.5897/AJAR12.1568

Arsham H (2007). Business statistical decision science and systems stimulation Merrie School of business Charles at Mount Royal, Baltimore, Maryland, 2120, University of Baltimore, UAS, Pp. 100. Google Scholar

Belete A, Kefelegn K and Kefena E (2015). Assessment of production and reproduction system of indigenous goat types in Bale Zone, Oromia, Ethiopia. Academia Journal of Agricultural Research 3(12): 348-360. Google Scholar ; DOI: https://doi.org/10.15413/ajar.2015.0143

Belete A, Kefelegn K, Kefena E (2020). On Farm Phenotypic Characterization of Indigenous Goats Types in Bale zone, Oromia Region, Ethiopia. International Journal of Livestock Production (in press). Link

Beyene A, Alilo AA, Mola M (2018). Assessment of sheep and goat (Small ruminants) production system in Esera district of Dawro zone, Southern Ethiopia. Journal of Advanced Dairy Research. 6:215. Google Scholar ; DOI: https://doi.org/10.4172/2329-888X.1000215

CSA (2018). Agricultural sample survey. Report on livestock and livestock characteristics. The Federal Democratic Republic of Ethiopia, Central Statistical Agency (CSA). Vol. II. Report on Livestock and livestock characteristics (private peasant holdings). Statistical Bulletin 587, Addis Ababa, Ethiopia, April 2018. Google Scholar

Chebo C and Alemayehu K (2012). Trends of cattle genetic improvement programs in Ethiopia: Challenges and opportunities. Livestock Research for Rural Development, 24: Article #109. Google Scholar ; Link

Dhaba U, Belay D, Solomon D and Tolamariam T (2012). Sheep and goat production systems in Ilu Aba Bora zone of Oromia Regional State, Ethiopia: Feeding and management strategies. Global Veterinaria 9(4):421–429. Google Scholar ; Link

FAO (2012). Draft Guidelines on Phenotypic Characterization of Animal Genetic Resources. Commission on Genetic Resources for Food and Agriculture. Thirteenth, Regular session, Rome, 18-22 July 2012. Link

FAOSTAT (2016). Food and agricultural organization of the United Nations, statistical division. Google Scholar ; Link

Fikru S and Gebeyew K (2015). Sheep and goat production system in Degehabur zone, Eastern Ethiopia: Challenge and Opportunities. Journal of Advances in Dairy Research, 3:134. Google Scholar ; Link

Hundie D and Geleta G (2015) Assessment on production situation and breeding practices of Horro sheep under traditional management in Horro Guduru and East Wollega zone, West Ethiopia. Global Journal of Animal Breeding and Genetics 3: 146-152. Google Scholar ; Link

Mahilet D (2012). Characterization of Hararghe Highland Goat and their Production System in Eastern Hararghe. MSc thesis, Submitted to the School of Graduate Studies of Haramaya University, Ethiopia. Google Scholar ; Link

Mohammed H., Yisihak K. & Meseret M. 2016. Characterization of Livestock Production System in three Selected Districts of Jimma Zone, Southwest Ethiopia. Journal of Reproduction and Infertility 7 (2): 47-62. Google Scholar ; Link

Molla M (2020). Conservation-based breeding program for indigenous sheep breeds in Ethiopia: the way forward. Online Journal of Animal and Feed Research, 10(1): 17-24. Google Scholar ; Link

Monau P, Raphaka K, Chimboza PZ and Gondwe T (2020). Review paper on sustainable utilization of indigenous goats in Southern Africa. Diversity, 12: 20. Google Scholar ; DOI: https:// doi.org/10.3390/d12010020

Shenkute B, Legasse G, Tegegne T and Hassen H (2010). Small ruminant production in coffee-based mixed crop-livestock system of Western Ethiopian Highlands: Status and prospectus for improvement. Livestock research for Rural Development. Volume 22, Article #186. Google Scholar ; Link

Sheriff O and Alemayehu K (2018). Small ruminant production systems and breeding programs in Ethiopia: achievements, challenges and lessons learned: a Review. Online Journal of Animal and Feed Research, 8(3): 59-73. Google Scholar ; Link

Shewangzaw A, Aschalew A, Addis G, Malede B and Assemu T (2018). Small ruminant fattening practices in Amhara region, Ethiopia. Agriculture & Food Security, 7:64. Google Scholar ; DOI: https://doi.org/10.1186/s40066-018-0218-9

Skapetas B, and V. Bampidis (2016). Goat production in the world: present situation and trends. Livestock Research for Rural Development, 28: 11. Google Scholar ; Link

Solomon AK, Mwai O, Grum G, Haile A, Rischkowsky B, Solomon G and Dessie T(2014). Review of goat research and development projects in Ethiopia. ILRI project report. Nairobi, Kenya: International Livestock Research Institute. Google Scholar ; Link

SPSS Version, 24.0. (2016). Software Package for Social Sciences for Window , SPSS Inc. USA. Link

Tegegn F and Askale G/M (2017). Goat production system and breeding practices in pastoral and mixed production system in southwestern part of Ethiopia. Agricultural and biological Journal of North America, 8(3): 67-71. Link

Tegegn F, Kefyalew A & Solomon A. (2016). Characterization of goat production systems and trait preferences of goat keepers in Bench Maji zone, southwestern Ethiopia. African Journal of Agricultural Research, 11(30): 2768-2774. Google Scholar ; DOI: https://doi.org/10.5897/AJAR2015.10170

Tesfahun B, Kebede K and Effa K (2017). Traditional goat husbandry practices under pastoral systems in South Omo zone, southern Ethiopia. Tropical Animal Health and Production 49(3) 625-632. Google Scholar ; DOI: https://doi.org/10.1007/s11250-017-1240-9

Teshager A, Belay D and Taye T. (2013). Socioeconomic and Farm Characteristics of Smallholder Cattle Producers in Ilu Aba Bora Zone of Oromia Regional State, South Western Ethiopia. Global Veterinaria, 10(5): 607-612. Google Scholar ; Link

Tsigabu G 2015. Phenotypic Characterization of Goat Type and Their Husbandry Practices in Nuer Zone of Gambella People Regional State, South Western Ethiopia. M.Sc. Thesis presented to Haramaya University, Dire Dawa, Ethiopia. Link

Yadeta N (2016). Production and Reproduction Performances, Producers' Trait Preferences and Marketing System of Small Ruminants in Ada Barga and Ejere Districts of West Shoa Zone, Ethiopia, M.Sc. Thesis, Jimma University, Ethiopia. Google Scholar ; Link

Yemane G, Melesse A and Taye M (2020). Characterization of indigenous goat population by applying morphometrical traits and structural indices. Journal of Veterinary Research Advances, 02(01): pp. 22-31. Link

Zergaw N, Dessie T, and Kefelegn K. (2016). Description of production system and on-farm phenotypic characterization of Central Highland and Woyto-Guji goat breeds in Ethiopia. Animal Genetic Resources, 58:43-51, Google Scholar ; Link

Citation: Yemane G, Melesse A, Taye M (2020). Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. *Online J. Anim. Feed Res.*, 10(6): 268-277. DOI: https://dx.doi.org/10.51227/ojafr.2020.36

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 278-281; November 27, 2020

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.37

THE EFFECT OF EGG SIZE (WEIGHT) ON THE EGG SHELL THICKNESS, EGG YOLK AND HATCHABILITY IN KOEKOEK CHICKENS

Setsumi MOLAPO and Mahlehla MOTSELISI

Department of Animal Science, National University of Lesotho, P.O. Roma 180, Lesotho

Emails: setsomimolapo@gmail.com; sm.molapo@nul.ls; ORCID: 0000-0002-4426-8901

Supporting Information

RESEARCH ARTICLE

PII: S222877012000037-10

Received: September 12, 2020

Revised: October 16, 2020

ABSTRACT: The aim of this study was to determine the effect of egg size on egg shell, egg yolk, fertility rate and hatchability of Koekoek chickens. A Complete Randomized Design (CRD) was used with egg size being the treatment factor. The treatments were large (>55g), medium (45-54g) and small (<44g) sized eggs. Eggs were collected from the nests and weighed using the digital scale and classified according to their respective weights before incubation. The egg yolk weight was measured with the digital scale. The shell thickness was measured using a Vanier caliper. The fertile and infertile eggs were identified. The fertility rate, hatching percentage and embryonic mortality were recorded. Data collected was subjected to statistical analysis by using one way analysis of variance (ANOVA). The medium sized eggs had higher fertility and hatchability percentage compared to large and small sized eggs. The mortality was higher in large and small sized eggs. Therefore, select eggs at the range of 45 to 55 grammes for incubation can be useful to increasing hatchability.

Keywords: Koekoek breed chickens, Egg size, Fertility rate, Hatchability, Embryo mortality.

INTRODUCTION

Chicken rearing is one of the most suitable activities to improve the livelihoods of the poor due to the advantages it has in terms of the small amount of capital required and the relative ease to set-up such a production system in the rural communities (Ja'afa-Furo and Gabdo, 2010; Stringer et al., 2020). In Lesotho, indigenous chickens remain predominant in the rural areas regardless of the introduction of exotic birds. Indigenous chickens have low output expressed in terms of low egg production, small egg size, slow growth rates and poor survival rate of chicks (Aganga et al., 2003).

Egg weight is one of the aspects affecting the quality of the egg and it is used among other factors as one of the external indicators for detecting quality of eggs (Jacob et al., 2000; Hegab and Hanafy, 2019). In the production cycle, the hen begin to lay small eggs and in a matter of few weeks she will go to medium and then large eggs as the birds age. Alasahan and Copur (2016) reported a positive correlation between egg weight, fertility and hatchability. Khurshid et al. (2003) discouraged the use of small and large sized eggs because of the indirect effects that prevent or reduce hatching.

The basic trend when hens grow is for eggs to become thin shelled. The hen is genetically capable of placing only a finite amount of calcium in the shell and she loses some of her ability to mobilize calcium from the bone (Gupta, 2008). Insufficient egg weight loss during incubation can reduce the gas exchange through the egg membrane promoting a decreased hatchability (Jones et al., 2010). Small and large eggs have high mortality percentage than medium egg, especially in local breeds (Abudabos et al., 2017).

This study was conducted to investigate the effect of egg size on the egg quality and hatchability of Koekoek chickens under Lesotho conditions.

MATERIALS AND METHODS

Ethical approval

The research and ethics committee in the Department of Animal Science of the National University of Lesotho approved this study based on international welfare standards for use of animals in conducting research. The study was conducted at the Department of Animal Science Experimental Farm of the National University of Lesotho located 35 km from Maseru, the capital of Lesotho. Koekoek chickens were collected using the egg trays from the flock comprised of cocks and hens, in the ratio of 1:10. Eggs were collected in clean nests three times a day to reduce cracking incidences.

Citation: Molapo S and Motselisi M (2020). The effect of egg size (weight) on the egg shell thickness, egg yolk and hatchability in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 278-281. DOI: https://dx.doi.org/10.51227/ojafr.2020.37

Five hundred and forty eggs were allocated into three egg size treatments in a Complete Randomized Design (CRD). The treatments were small (<44g), medium (45-54g) and large (>55g). Each egg was taken as an experimental unit and there were three replicates per treatment and sixty (60) eggs per replicate. Ten eggs from each replicate were taken to determine the shell thickness and egg yolk. The shell thickness was measured using a Vanier caliper. The egg yolk was measured using a 0.01 g sensitivity level electronic scale. Eggs collected within eight days were taken to a sure hatch machine for incubation. Dirty, cracked and irregular shaped eggs were not selected for incubation. A 0.01 g sensitivity level electronic scale (RADWAG) was used to weigh the eggs. Eggs were fumigated with formalin potassium permanganate in a ratio 1:2 for 15 minutes before they were placed in an incubator. The temperature and humidity were set to 37.5°C and 82.5%, respectively for incubation and 37.0°C and 85% for hatching. The eggs that were less than eight (8) days old were placed in an incubator. During the incubation period, the eggs were not turned for the first three days. From the fourth day to the eighteenth day, egg turning was done three times a day. The eggs were candled on 7th day of incubation period in a dark room with the eggs held before a light. The infertile eggs were determined by the appearance of clear interior of the eggs and the fertile eggs were determined by presence of blood vessels. The numbers of infertile eggs were recorded. At the 18th day, the eggs were removed from trays and placed into the hatching trays until hatching time. The incubator was not disturbed for the last three (3) days of incubation. The chicks were removed from the incubator on the morning of the 22nd day. The fertility rate and hatching percentage of eggs were calculated as follows:

$$\text{Fertility rate} = \frac{\text{Total number of fertile eggs}}{\text{Total number of incubated}} \times 100$$

$$\text{Hatching percent} = \frac{\text{Total number of eggs hatched}}{\text{Total number of fertile eggs}} \times 100$$

Eggs that failed to hatch were broken to determine the developmental stage of an embryo. The embryo mortality rate was measured by assessing at the developmental stage at which the un-hatched chick died using Hamburger and Hamilton (1992) method. An incubator was opted for instead of natural hatching due to the fact that it would be difficult to control the experiment since it would be difficult to get hens of the same age, size and behaviour. Above all, it would not be practical to assume that the hens would brood at the same time. Data was recorded in excel spreadsheet and averages were calculated. Data was tested for normal distribution. The analyses were done on transformed data. ANOVA was used to separate the effects of egg size on shell thickness, egg yolk, egg fertility, hatching percentage and embryo mortality. If significant, treatment effects were analysed and differences between treatments were tested by Duncan's new multiple-range test. The General Linear Models Procedure; SPSS (17.00) was used. Threshold for significance was $p< 0.05$.

RESULTS AND DISCUSSION

The results on shell thickness show that the small eggs had significantly thicker ($P<0.5$) shells than medium and large eggs (Table 1). Increase in the egg size reduced the shell thickness by 8.3% and 25% comparatively to medium and small eggs respectively. Therefore, the chances of egg cracking and as well allowing more foreign bodies to penetrate (infection) an egg are higher and hence lower hatchability. This negative correlation between the shell thickness and egg size was also reported by Suki and Park (2001). The egg yolk weight from large eggs was significantly ($P<0.05$) heavier than in medium and small sized eggs by 11.3% and 25.4% respectively (Table 1). Suki and Park (2001) also reported the proportion of egg yolk to be less in small eggs than in large ones.

Table 1 - Effect of egg size on egg shell thickness and egg yolk of Koekoek chickens

Treatment (Egg size)	Shell thickness (mm)	S.E	Egg yolk (g)	S.E
Large	0.45^{a}	0.09	19.57^{a}	0.81
Medium	0.55^{b}	0.03	17.36^{b}	0.40
Small	0.60^{c}	0.15	14.60^{c}	0.24

^{abc} Means within a row with no common superscript differ significantly p<0.05), S.E-standard error

Table 2 - Fertility rate and hatching percentage of different egg sizes

Treatment (Egg size)	Fertility rate (%)	S.E	Hatching percent (%)	S.E
Large	91.10^{a}	2.02	72.23^{a}	3.19
Medium	94.47^{a}	1.73	75.67^{a}	2.40
Small	88.60^{a}	1.93	71.00^{a}	3.86

^{abc} Means within a row with no common superscript differ significantly p<0.05), S.E-standard error

Citation: Molapo S and Motselisi M (2020). The effect of egg size (weight) on the egg shell thickness, egg yolk and hatchability in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 278-281. DOI: https://dx.doi.org/10.51227/ojafr.2020.37

Table 2 - Effect of egg size on embryonic mortality of Koekoek chickens

Treatment (Egg size)	Early mortality (%)	S.E	Late mortality (%)	S.E
Large	8.89	1.11	17.78	1.11
Medium	2.22	2.22	11.11	0.95
Small	7.78	2.94	12.22	2.01

[abc] Means within a row with no common superscript differ significantly p<0.05), S.E-standard error

The results on egg fertility (Table 2) show that eggs at the range of medium size had insignificantly (P<0.05) higher fertility rate compared to small and large sized eggs by 3.37% and 5.8% respectively. Seeker et al. (2004) also found higher fertility in medium size eggs. The hatching percentage was higher in medium sized eggs (75.7%) compared to large (72.2%) and small sized eggs (71%) despite the differences being insignificant (p>0.05). This means that the medium size eggs have 3.4% and 4.7% better chances of hatchability than large and small eggs respectively. Asuquo and Okon (1993) reported an improved hatching percentage in eggs within the weight range of 45-56 grams than in small eggs. Medium size eggs yield 75% hatchability compared with 50-70% of small and large eggs (Hassan and Nordskog, 1971). Large eggs hatch poorly as compared to medium eggs (Khurshid et al., 2003). However, in a study that was conducted in New Hampshire and Red Rhode Island, De Witt and Schwakbach (2004) observed that large eggs had higher hatchability. Mbajiorgu (2011) also found that large-sized eggs of Venda chickens (60-69 g) had higher (p<0.05) hatchability than medium (<50-59 g) and small-sized eggs (<49 g).

During the early stage of chick development, the embryonic mortality was lower in small eggs (2.2%) than large and medium eggs with the early embryo mortality rates of 8.9% and 7.8% respectively (Table 3). During the late embryonic development the results show that the mortality rates of 17.8%, 11.1% and 12.2% for large, medium and small size eggs respectively. These results reveal an overall high embryonic mortality in large eggs than in other egg sizes even though the differences are not significant (p>0.05). In support of these results, Monira et al. (2003) and Hasin et al. (2006) emphasized that the medium eggs normally have the lowest embryonic mortality with large eggs having the highest. Similarly, Jacob et al. (2000) also pointed out that medium sized eggs normally show the least mean score of embryo mortality at late stage of embryo development. Some researchers have also indicated that large eggs have higher incidences of embryo mortality at most developmental stages compared to medium and small eggs (Khushid et al., 2003; Monira et al., 2003; Hasin et al., 2006; Grochowska et al., 2019).

The thin egg shells in large eggs could be a possible reason for high mortality in large eggs. Eggs with thin shells are capable of losing more moisture during the during incubation because the thinner egg shell are more porous. This is in line with Islam (2001) who stated that water loss is one of the most important causes of embryonic death. Eggs with the poor shell quality, such as thin, porous or sandy shells should not be set for incubation (Parkhurst and Mountney, 1988). The relative humidity required for survival of an embryo should be 60-75%, and the large eggs are said to be losing about 10-20% of their weight during storage and incubation (Parkhurst and Mountney, 1988). The higher embryonic death rate in small eggs can be attributed to more accumulation of calcium during shell formation hence a thicker shell and low moisture and exchange of gases. In support of these results, Jones et al. (2010) reported that insufficient egg weight loss during incubation can reduce the gas exchange through the egg membranes promoting increased embryonic deaths. Monira et al. (2003) also suggested that early deaths are the results of excess weight loss in eggs.

CONCLUSION

Egg size in Koekoek chickens had influence in the shell thickness, egg yolk, fertility rate, hatching percentage and embryo mortality. Thick and thin shells impact negatively on the hatchability of eggs. Incubating medium sized eggs improved the hatching percentage and reduced the embryonic death rates in Koekoek chickens. Therefore, farmers are advised to select eggs at the range of 45 to 55 grammes for incubation. This will ensure increased hatching percentage while other egg grades (small and large) can be used as table eggs.

DECLARATIONS

Corresponding Author
E-mail: sm.molapo@nul.ls ; setsomimolapo@gmail.com

Acknowledgements
The Department of Animal Science of the National University of Lesotho is acknowledged for funding this research.

Authors' Contribution
The authors contributed equally in this manuscript.

Conflict of interests
The authors have not declared any conflict of interests.

Citation: Molapo S and Motselisi M (2020). The effect of egg size (weight) on the egg shell thickness, egg yolk and hatchability in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 278-281. DOI: https://dx.doi.org/10.51227/ojafr.2020.37

REFERENCES

Abudabos AM, Aljumaah RS, Algawaan AS, Al-Sornokh H and Al-Atiyat RM (2017). Effects of Hen Age and Egg Weight Class on the Hatchability of Free Range Indigenous Chicken Eggs. Brazilian Journal of Poultry Science, 19(1): 33-40. Doi: https://dx.doi.org/10.1590/1806-9061-2016-0264

Aganga AA, Tshenyane SO and Molefhe L (2003). Influence of feed type on egg production of Tswana laying chicken. International Journal of Poultry Science, 2:256-258. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.494.3244&rep=rep1&type=pdf

Alasahan S and Copur AG (2016). Hatching Characteristics and Growth Performance of Eggs with Different Egg Shapes. Brazilian Journal of Poultry Science, 18 (1): 001-008. Doi: http://dx.doi.org/10.1590/1516-635x1801001-008

Asuquo BO and Okon B (1993). Effects of age in lay and egg size on fertility and hatchability of chicken eggs. Nigeria Journal of Animal Production, 20: 122-124. Doi: https://doi.org/10.1080/00128325.1993.11663183

De Witt F and Schwalbach LMJ (2004). The effect of egg weight on the hatchability and growth performance of New Hampshire and Rhode Island Red chicks. South African Journal of Animal Science, 34 (Suppl. 2), 62-64. Doi: https://www.sasas.co.za/journals/the-effect-of-egg-weight-on-the-hatchability-and-growth-performance-of-new-hampshire-and-rhode-island-red-chicks/

Grochowska E, Kinal A, Sobek Z, Siatkowski I, and Bednarczyk M (2019). Field study on the factors affecting egg weight loss, early embryonic mortality, hatchability, and chick mortality with the use of classification tree technique. Poultry Science, 98(9): 3626–3636. Doi: https://doi.org/10.3382/ps/pez180

Gupta L (2008). Factors influencing shell quality. Global Ag Media: The poultry site. https://www.thepoultrysite.com/articles/factors-influencing-shell-quality

Hamburger V and Hamilton HL (1992). A series of normal stages in the development of the chick embryo. Development Dynamics, 195: 231–272. Doi: https://doi.org/10.1002/aja.1001950404

Hasin BM, Ferdaus AJM, Islam MA, Uddin MJ and Islam MS (2006). Marigold and Orange Skin as Egg Yolk Color Promoting Agents. International Journal of Poultry Science, 5:979-987. Doi: https://doi.org/10.3923/ijps.2006.979.987

Hassan GM and Nordskog AW (1971). Effects of egg size heterozygosis on embryonic growth and hatching speed. Genetics, 67: 279-285. PMID: 5569212

Hegab IM and Hanafy AM (2019). Effect of egg weight on external and internal qualities, physiological and hatching success of japanese quail eggs (Coturnix coturnix japonica). Brazilian Journal of Poultry Science, 21(3): eRBCA-2018-0777. Doi: https://doi.org/10.1590/1806-9061-2018-0777

Islam MA, Bulbul SM, Seeland G and Islam ABMM (2001). Egg quality of different chicken genotypes in summer and winter. Pakistan Journal of Biological Sciences, 4:1411-1414. Doi: https://scialert.net/abstract/?doi=pjbs.2001.1411.1414

Ja'afar-Furo MR and Gabdo BH (2010). Identifying major factors of poultry production as sustainable enterprise among farmers using improved methods in rural Nigeria. *International Journal of Poultry Science*, 9(5): 459-463. Doi: https://scialert.net/abstract/?doi=ijps.2010.459.463

Jacob, JP, Miles RD and Mather B (2000). *Egg Quality*. Institute of Food and Agricultural Sciences. University of Florida, Gainesville. http://edis.ifas.ufl.edu

Jones DR, Musgrove MT, Anderson KE and Thesmar HS (2010). Physical quality and composition of retail shell eggs. *World Poultry Science Journal*, 89 (3):582. Doi: https://doi.org/10.3382/ps.2009-00315

Khurshid A, Farooq M, Durrani FR, Sarbiland K and Chand N (2003). Predicting egg weight, shell weight, shell thickness and hatching chick weight of Japanese Quails using various egg Traits as regressors. *International Journal of Poultry Science*, 2 (2): 164-167. Doi: https://scialert.net/abstract/?doi=ijps.2003.164.167

Mbajiorgu CA (2011). Effect of hatching egg size on hatchability and chick hatch-weight of indigenous venda chickens. Indian Journal of Animal Research, 45(4), 300-304. https://www.indianjournals.com/ijor.aspx?target=ijor:ijar1&volume=45&issue=4&article=010

Monira KN, Salahudding M and Miah G (2003). Effect of Breed and Holding Period on Egg Quality Characteristics of Chicken. I*nternational Journal of Poultry Science 2:* 261-263. Doi: https://dx.doi.org/10.3923/ijps.2003.261.263

Parkhurst GR and Mountney GJ (1988). *Poultry meat and egg production*. Springer Science and Business Media. New York, Philadelphia. Doi: https://doi.org/10.1007/978-1-4757-0683-3

Stringer LC, Fraser EDG, Harris D, Lyon C, Pereira L, Ward CFM, and Simelton E. (2020). Adaptation and development pathways for different types of farmers. Environmental Science and Policy, 104: 174-189. Doi: https://doi.org/10.1016/j.envsci.2019.10.007

Suki YO and Park C (2001). Effect of Breed and Age of Hens on the Yolk to Albumin Ratio in Two Different Genetic Stocks. Poultry Science, 80:855–858. Doi: https://doi.org/10.1093/ps/80.7.855

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 282-289; November 27, 2020 ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.38

ON-FARM MONITORING OF GROWTH PERFORMANCE OF INDIGENOUS GOAT IN AMHARA REGION OF ETHIOPIA

Kefyalew GOLLA[1], Yeshambel MEKURIAW[2], Birhan KASSA[3]✎✉, Mussie HAILEMELEKOT[2]

[1]*South Gonder Zone Office of Agriculture, PO Box 550, Debre Tabor, Ethiopia*
[2]*Bahir Dar University, College of Agriculture and Environmental Sciences, PO Box 550, Bahir Dar, Ethiopia*
[3]*Andassa Livestock Research Center, P.O. Box 27, Bahir Dar, Ethiopia*

✉Email: birhankassa56@gmail.com; ORCID: 0000-0003-1949-8737

✎*Supporting Information*

RESEARCH ARTICLE

PII: S222877012000038-10

Received: October 16, 2020

Revised: November 17, 2020

ABSTRACT: The study was conducted in Amhara region of Ethiopia, with the objective of characterizing the goat husbandry practice and on-farm monitoring of growth performance. The data were collected by interviewing 180 sample households who are selected purposively from three agro ecologies using semi- structured questioner. Besides, on farm monitoring of growth performance of 60 kids owned by farmers was done for three months. The data was analyzed using SPSS (version 20). Majority of households (68.9%) have an experiences of feeding crop residue for their goat and faced feed shortage mainly during dry season (65.6%). The main source of water for goat was river which is 51.1% in wet season and 88.9% in dry season. 51.7% of goat keepers had a separate goat house. The major disease reported were anthrax (40.6%), goat pox (26.7%) and foot and mouth disease (12.8). Purpose of goat keeping was mainly for income source (62.8%). 84.4% of the goat owners are experienced selection of male and female animal for production purpose. Body length and height (60.6%) and color (34.4%) were used as major selection criteria. Higher kidding was reported during months of October (20.55%), November (39.44%) and December (18.88%). Drought (42%), shortage of feed and water (38.5%), disease and parasite (16%), inconvenient climate condition (2%) and lack of breeding male (1%) were reported as major problems in the breeding objective. The overall birth weight, 60 days and 90 days weight of kids was 1.69±0.08 kg, 7.45±0.41 kg and 12.02±0.25 kg, respectively. The survival rate of kids up to 90 days of age was 74%. The production system of the area was characterized by mixed crop-livestock farming system on which crop residue was the main feed source of the goats as other livestock species. Even though the current productivity of goats in the area is fairly good, full potential need to be exploited by improving husbandry practices, applying appropriate disease prevention methods and applying strategic forage development and feeding practices.

Keywords: Birth weight, Husbandry practices, Indigenous goats, On-farm monitoring, Survival rate

INTRODUCTION

In Ethiopia; almost all goats are managed under extensive traditional systems and produce the lowest compared to other sub-Saharan African countries (Tesfahun et al., 2017). Ethiopian indigenous goats are genetically less productive as compared to temperate breeds (Mohammed et al., 2012; Abraham et al., 2018). Goats are important for diversified production, creating employment, increasing income, building capital, contributing to human nutrition and reducing risk, in efforts made so far to improve the productivity of indigenous goats is very little as compared to the concerns given to other livestock species such as cattle and sheep (Solomon et al., 2010). Despite the huge resource potential, production and export opportunities, goat production in Ethiopia is relatively undeveloped. There is considerable potential for goat production in the country, where goat milk and skin are valued commodities (ESGPIP, 2008; Mayberry et al., 2018).

Indigenous goats can inhabit a wide range of climates (Bangley, 2006) and have a huge socio-economic importance (FAO, 1999). For their small body size, goats have physical and bio-physical advantages over large ruminants. In recent years, it is increasingly becoming physically and bio-physically impossible to keep dairy and beef cattle in highly populated highlands of Ethiopia. Dairy goats, therefore, offer alternative to dairy cattle in such areas in Africa (Mohamed et al., 2002; Alemayehu and Kebede, 2017; Kahi and Wasike, 2019). The growing demand for meat from small ruminants, improving infrastructure (transport and information technology), and improvement in small ruminant husbandry techniques among producers provide opportunities to enhance the contribution of goats to smallholder farmers' livelihoods (Getahun, 2008). The current contribution of goats to the country's economy and producers livelihoods is however still below the total potential production capacity (Girma et al., 2000). Given the large population size with diverse breeds and their wide distribution across various agro-ecological zones and production systems, there is a huge potential to utilize goats to raise the socio-economic status of producers by improving goat productivity (Girma et al. 2000; Sheriff et al., 2020). Tach Gayint district is a place in which 23.7 % of the district is "Kola" (lowland) and 63.2% is "Woyna Dega" /mid land/ which is suitable for small ruminant production especially for goats. However, goat production and productivity are challenged by shortage of feed, poor management system and disease (TGWADO, 2015). Even though the area has high number of goat population and potential for goat production, there is great problem in utilizing

Citation: Golla K, Mekuriaw Y, Kassa B, Hailemelekot M (2020). On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia. *Online J. Anim. Feed Res.*, 10(6): 282-289. DOI: https://dx.doi.org/10.51227/ojafr.2020.38

this resource potential optimally and more than 45% of the population living under poverty is supported by relief (TGWADO, 2015). This problem emanated from a number of factors such as low level of management skills, unavailability of inputs for goat production, needs and interests of individuals, poor agricultural practices and attitude. However, the above factors have not yet been extensively studied, therefore, there is a need to assess goat husbandry practices and productivity at farmer's level to fill the existing problems in the area. Therefore, it is better to systematically describe the productivity of goats in order to plan and design appropriate research and development interventions that are relevant for better improvement. Therefore, this study was conducted to fill the existing information gap with regard to husbandry practices and productivity of goat in Tach Gayint district. Therefore, the objective of this study was characterizing the smallholder goat husbandry practice and on-monitoring productivity of goat under the existing management condition.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Tach Gayint district, Amhara region, Ethiopia. The district is located between 11º23'-11º44' north latitudes, and 38º20'- 38º44' east longitudes. It extends for about 40 kilometers in the north-south direction and about 44 km in the east-west direction and has a semi- compact shape and an area of 995 km2 and 82540.7 ha. The topography of the district consists of gorges and rugged terrain (54 %), mountains (23 %), and plain land (22%), and it is divided into three agro- climatic zones: "Kola" (23.7%) altitude >500, "Woyna Dega" (63%) altitude>1500 and "Dega"(13.1%) altitude >2300 More than 90 percent of its population lives in rural areas engaged predominantly on subsistence agricultural production. Agricultural production is mixed crop livestock and crop production is predominantly rain fed. Average annual rainfall is about 600-1000 mm. The Mean annual maximum temperature ranges between 21-23°C (TGDADO, 2015).

Sampling Methods and Data Collection

Sampling Techniques. The sampling method was multistage sampling technique. For the purpose of this study agro-climatic distribution of the district was used in order to stratify the Kebele in the district. Based on topography and agro-climate of the area, the district was divided into three strata as low land (23.7%), midland (63.2 %) and highland (13.1%), (TGWADO, 2015). In the second stage, a proportional allocation technique was used in order to determine the number of sample Kebele from each stratum. In this manner, proportionally, two Kebele from the lowland, three Kebele from the midland and one Kebele from the highland i.e., a total of six Kebele were selected to undertake the study. Finally, households used for the study were selected using simple random selection method after identifying the goat owners from the community. Household that has at least 3 goats were selected for the survey. Accordingly, 30 households from each Kebele total of 180 households were randomly selected to participate in husbandry practices and productivity study of goats.

Data Sources. Both primary and secondary data were used on various aspects of goat husbandry practices. The primary data were collected from sample respondents through structured and semi structured questionnaire and through monitoring on growth of goats. The questionnaire covers various aspects of goat husbandry practice. Structured questionnaire was used to collect information on the following variables: purposes of keeping goats, feeds and feeding, breeding systems, housing, diseases and parasites and veterinary services. Secondary data were obtained from district Agricultural Development Office, Zonal Agricultural Department, NGOs and other published and unpublished sources. For data collection, development agents (DA's) working in the district were recruited, intensively trained and administered the questionnaire for 180 selected households in selected six Kebeles under the close supervision of the researcher.

Focus group discussion

In addition to informal survey collect qualitative data through focus group discussion before conducting the survey. Three focus group discussions were held at each agro-ecology with 9-12 key informants selected from the area, mainly the elders and those who have experienced goat keepers.

Flock monitoring

The study also includes monitoring of the, birth weight, pre -weaning growth rate and survival rate of kids. To make these monitoring 20 households from the three Kebeles of different agro ecologies (a total of sixty does) that have late pregnant goats were selected purposively from each three agro-ecologies by the researcher and development agents. The monitoring was done for three months. The birth weight of the kids was taken as soon as they are born using spring balance. The subsequent weight of kids was taken at 15 days interval and the analysis was made for birth weight, 60 days and 90 days weight. The live weight measurement was taken before feeding and watering and survival rate of kids was recorded starting from their birth.

Data analysis

The collected data was organized, summarized and analyzed using SPSS statistical package (SPSS version 20). A one-way analysis of variance was applied for quantitative dependent variable by a single factor (independent) variable

Citation: Golla K, Mekuriaw Y, Kassa B, Hailemelekot M (2020). On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia. *Online J. Anim. Feed Res*., 10(6): 282-289. DOI: https://dx.doi.org/10.51227/ojafr.2020.38

such as livestock holdings, mortality rate, and flock dynamics. The difference between means was separated via Tukey HSD. In addition to this, General Linear Model (GLM) procedures were used to analysis the monitoring data. The following model was used:

$Y_{jkl} = \mu + S_i + B_j + P_k + A_l + e_{ijkl}$

Where:

Y_{jkl} = Observation (birth weight, pre- weaning growth) ithsex thejth birth type born in the kth parity and the lth agro ecology

μ = the overall mean common to all animals in the study

S_i = fixed effects of the ith sex (1=male, 2=female)

B_j = fixed effects of the jth birth type (1= single, 2= multiple)

P_k = fixed effects of the kth parity (p= 1, 2, 3 and >4)

A_l = fixed effect of the lth agro-ecology (highland, midland and lowland)

e_{jkl} = is the random error

RESULTS and DISCUSSION

Husbandry practices

Housing: Goats were mainly housed during rainy season; unlike other livestock species they were housed on fenced barn at the homestead. While, if the number was small they also commonly housed with sheep and other cattle inside a house. Respondents indicated that they had a separate goat house (51.7%), and a house attached to the main a house (36.7%), crash (8.9%), and ground of the main house (1.7%) and in the main house (1.1%) to shelter their goat (table 8). And majority of the respondents indicated that they separately housed fattening and young kids in the house. This might be due to giving of special care for them to fatten in short period of time and to follow the growth of kids, respectively. Majority of the respondents (85%) responds that as they clean the house of goats daily. The remaining cleans the house/barn once a week, twice a week and three times a week. Majority of the respondents (97.2% in wet season and 85% in dry season) indicated that they clean the barn daily (Table 2).

Table 1 - Type of house used for goat production

Type of housing	Frequency	Percent
In the main house	2	1.1
A house attached to the main house	66	36.7
A separately constructed sheep and goat house	93	51.7
Crash /barn/	16	8.9
Ground of the main house	3	1.7
Total	180	100.0

Table 2 - Hygienic practice of the barn in the study area

Hygienic practice of the barn	Dry season		Wet season	
	Frequency	Percent	Frequency	Percent
Daily	153	85.0	175	97.2
Once per week	4	2.2	2	1.1
Twice per week	7	3.9		
Three times per week	11	6.1		
Monthly	2	1.2	1	0.6
Not clean /only changing the barn	3	1.7	2	1.1
Total	180	100.0	180	100.0

Feeds and Feeding

From the total respondents 68.9% of them reported that they have experience of feeding crop residue for their goats, while 31.1% didn't have experience of feeding of crop residue for their goats. The main reason for low level of feeding of crop residue was unavailability (24.4%) and not accepted by goats (6.1%). The major crop residues reported were pea straw (37.2%) and haricot bean straw (22.8%). About 77.8% of interviewed farmers indicated that they have experienced feed shortage for their goats. Shortage of feed was reported during dry season (65.6%), rainy season (2.2%) and throughout the year (11.1%); and the others had enough feed throughout the year. As a main reason the feed shortage was due to shrinkage and declining in productivity of grazing land (34.4%), cultivation, settlement and protection on

Citation: Golla K, Mekuriaw Y, Kassa B, Hailemelekot M (2020). On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia. *Online J. Anim. Feed Res*., 10(6): 282-289. DOI: https://dx.doi.org/10.51227/ojafr.2020.38

grazing land (15%), drought (17.8%) and an increase in human population (6.7%). The survey revealed that 77.2% of them let their animals to graze/browse with other flocks; while the others didn't let their goats to graze. 56.1% of the respondents indicated that they supplement their goats during dry season, wet season and throughout the year with respective percentage of 43.3%, 2.2% and 10.6%. Farmers which were not supplementing because they didn't have accessibility of concentrate feeds and expensiveness of concentrate feeds.

Table 3- Major crop residues used for feeding of goats in Tach Gayint district

Major crop residues	Percent respondents
Teff straw	3.9
Pea straw	37.2
Wheat straw	2.8
Haricot bean straw	22.8
Lentil straw	0.6
Vetch straw	1.7
Chick pea straw	2.2

Table 4 - Seasonal Grazing/browsing system for goats in Tach Gayint district

Grazing system	Dry season (%)	Wet season (%)
Free grazing	46.2	18.9
Partial grazing /tethered grazing	39.4	22.2
Zero grazing /tethered grazing	14.4	58.9

Table 5 - Reasons for non-supplementing respondents in the study districts

Reasons for non-supplementation of concentrate feeds	Frequency	Percent
Not accessible	64	35.6
Expensive	11	6.1
Not want to offer sheep and goats	14	7.8

Water source and watering frequency:

The respondents revealed that the major water sources for their goat were sourced from river 51.1% in rainy season and 88.9% in dry season (Table 6). As the respondents revealed, during rainy season watering was once because many of the grass were fresh that holds water and during dry season watering frequency was twice and once a day (Table 7).

Table 6 - Water source in dry and wet season for goats in Tach Gayint district

Source of water	Percent in wet season	Percent in dry season
River	51.1	88.9
Pond	1.1	-
Rain water	19.4	-
Water harvest	1.7	-
Deep well	5.6	2.2
Pipe	0.6	-
Spring	20.6	8.9

Table 7- Watering frequency in dry and wet season for goats in Tach Gayint district

Watering frequency	Wet season		Dry season	
	Frequency	Percent	Frequency	Percent
Any time required	92	51.1	16	8.9
Once a day	71	39.4	126	70.0
Twice a day	12	6.7	37	20.6
Every three days	5	2.8	1	0.6
Total	**180**	**100.0**	**180**	**100.0**

Citation: Golla K, Mekuriaw Y, Kassa B, Hailemelekot M (2020). On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia. *Online J. Anim. Feed Res*., 10(6): 282-289. DOI: https://dx.doi.org/10.51227/ojafr.2020.38

Goat diseases and vaccination strategy:

The major diseases reported by the farmers were anthrax (40.6%) goat pox (26.7%) and foot and mouth disease (12.8) (Table 8). The reported diseases mainly occurred during long drought following floods and after small rainy season (Bett et al., 2017). Anthrax, foot and mouth diseases, Internal and External parasite were also reported on the same working area by Assefa et al. (2015) and PPR as a major goat disease was also reported by Wondwosen (2007). The reported diseases affect all age group of goat flock (73.3%) following pregnant does and new born kids. Majority of the respondents (96.7%) treat their sick animals by collecting medicaments from the public veterinarian clinic; the remaining respondents visit private clinics. About 86.1% of the respondents indicated that they have an access for veterinary service within 1-10 km from their homestead. About 53.9% (n=97) respondents indicated that their goats received vaccine in recent times where as 46.1% (n=83) of respondents revealed that they didn't receive a vaccination. As indicated by 51.1% respondents, had face their goat death in this year and majority of death was reported during March which might be due to the short rainy season occurred in the area (Figure 1).

Table 8 - Common goat disease and parasites in Tach Gayint district

Major disease	Number	Percent respondents
Anthrax	73	40.6
Goat pox	48	26.7
Foot and mouth disease (FMD)	23	12.8
Nematodes /round worm/	10	5.6
PPR	2	1.1
Total	159	88.3

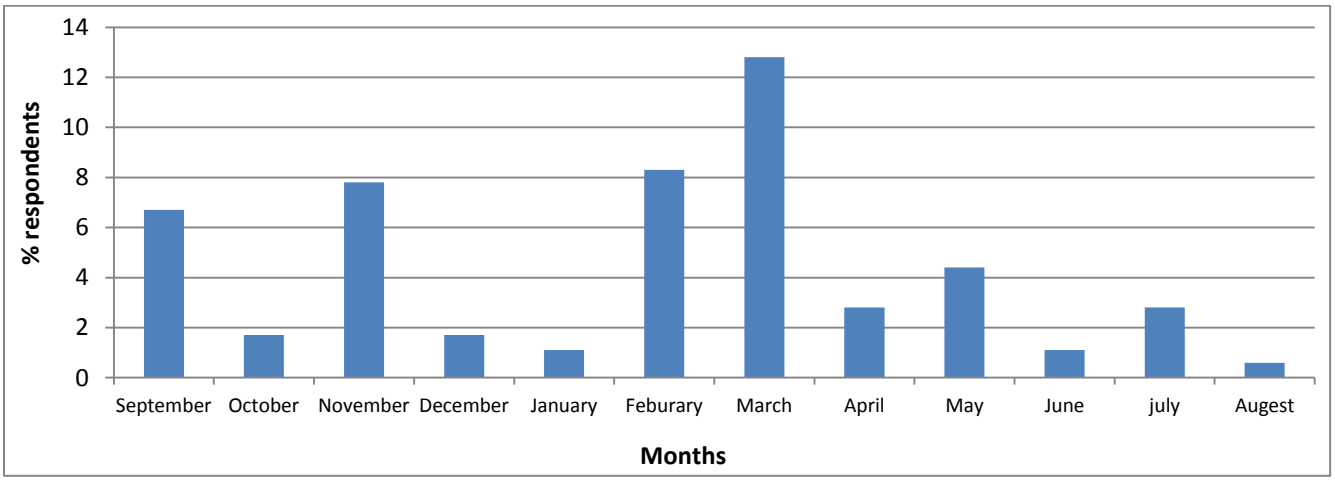


Figure 1 - Monthly Goat death reported in Tach Gayint district

Breeding objective

Purpose of keeping goats. Respondents indicated that they keep goat on their herd for many purposes from which income source through selling of the live goat is the major one (Table 9). From the focus group discussion result, it was observed that farmers also keep goats for different miscellaneous purposes viz. for dowry, social heritage and for other cultural values.

Selection criteria's and trait preference in goat production. From the total respondents, 84.4% of them experienced selection of male and female animal for production purpose. And 62.8% of respondents indicated that they had kept breeding male goat in their flock and the remaining 37.2% use neighboring goats and any buck in the field for mating of their doe. From the total farmers, 34.4% of them reported that they experienced color as basic selection criteria on goat production system (Table 10). And the main selective color by the community was reddish white (23.3%), red (8.3%), white (5.6%) and the combination of these all (47.8%). In the goat production system, kidding occurred throughout the year with varying response (Figure 2). Higher kidding was reported during October, November and December months with respective percentage of 20.55%, 39.44% and 18.88%. This might be due that in these months there is better grazing land, green grass and crop residues. In the breeding objective of the area, the major constraints those hinder productivity of goats were summarized in (Figure 3). Respondent's experiences culling of goats in their flock (45%) and the remaining 52.8% hadn't experience culling of goats in their flock. As the respondents indicate the culling criteria's of goats in the flock were old age, sickness, reproductive problem, physical defect, unwanted color, and others with respective percentage of 16.1%, 19.4%, 2.8%, 5%, 2.8% and 3.3%.

Citation: Golla K, Mekuriaw Y, Kassa B, Hailemelekot M (2020). On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia. *Online J. Anim. Feed Res.*, 10(6): 282-289. DOI: https://dx.doi.org/10.51227/ojafr.2020.38

Table 9 - Purpose of keeping goats in the study district		
Purposes	**Frequency**	**Percent**
Sale/income source	113	62.8
Sale/income source and for meat	58	32.2
Sale/income source, for meat and manure	9	5.0
Total	**180**	**100.0**

Table 10 - Major selection criteria's of goat in the production system of the working district		
Selection criterion	**Frequency**	**Percent**
Color	62	34.4
Tail	5	2.8
Body length and height	109	60.6
Have no criteria	4	2.3
Total	**180**	**100.0**

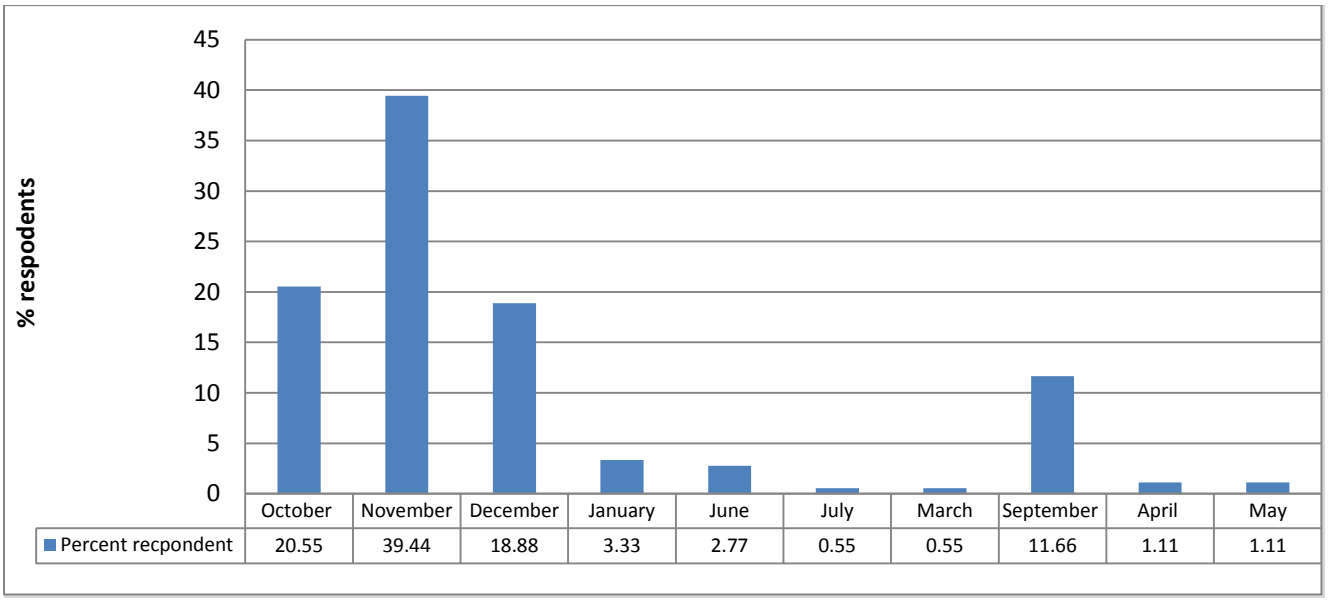


Figure 2 - Months of intensive kidding in the study area

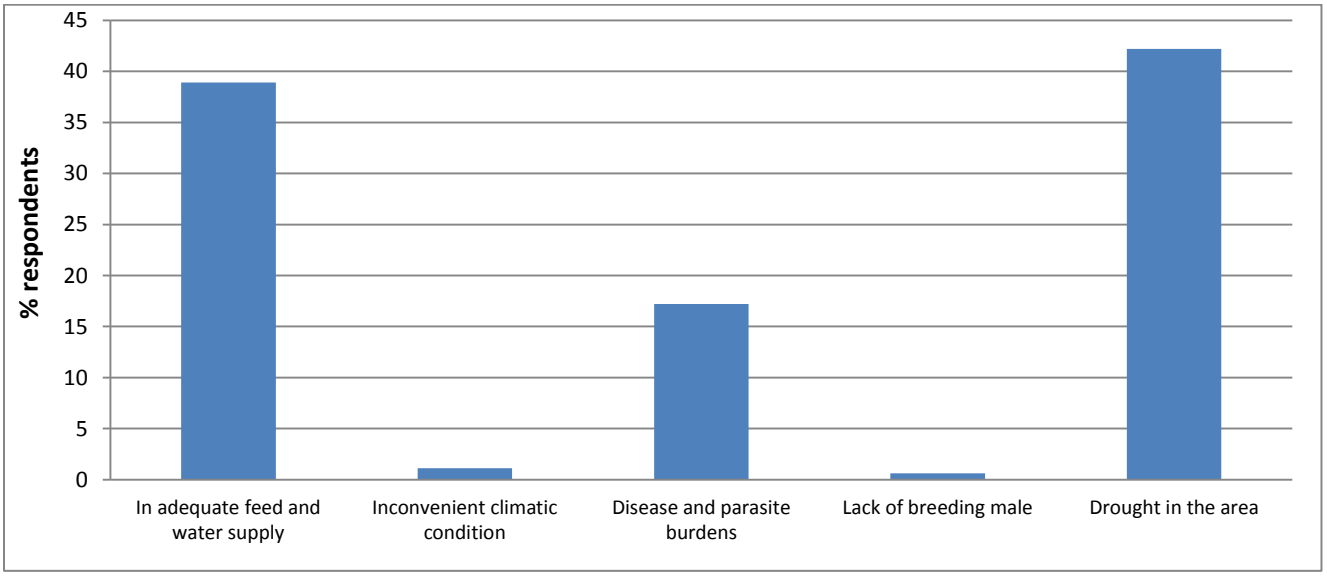


Figure 3 - Major problems in the breeding objectives those hindering productivity of goats

Citation: Golla K, Mekuriaw Y, Kassa B, Hailemelekot M (2020). On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia. *Online J. Anim. Feed Res.*, 10(6): 282-289. DOI: https://dx.doi.org/10.51227/ojafr.2020.38

Growth performance, pre-weaning weight and survival rate of goats

The overall birth weight of kids was 1.69±0.08 kg and there was statistically significantly difference among agro-ecologies where higher birth weight was obtained from midland (Table 11). The overall 60 and 90 days weight of kids was 7.45±0.41 kg and 12.02±0.25 kg (Table 11). This result was higher than Agraw (2010) for highland goats and lower than the report of Zeleke (2007) for Somali goat kids and Tesfaye (2009) for goats at Metema district. Comparable results were reported by Belay and Mengistie (2013) for Abergelle kids. Similarly the weaning weight was also lower than Zeleke (2007) which was reported to be 11.67 kg for Somali goats and this difference might also be breed and production environment difference.

As indicated in the table above (Table 11), birth weight, 60 days and 90 days weight was influenced by the independent variables of agro-ecology, sex, parity and birth type. Similarly, significant effect of parity, sex and birth weight was also reported by Tesfaye (2009). Kids born at midland and lowland had better weight and also Survival rate. The 90 days weight was higher in the midland agro-ecologies than the others, which might be due to the presence of optional feed staffs from crop production. As a normal physiology, males had received higher birth weight, 60 days and 90 days weight. Kids born from parity 3 does had receive better birth, 60 and 90 days weight, this might be due to the act that does of these parity had better reproductive physiology both in uterine and mammary system.

Kids born at midland and lowland had better weight and also Survival rate. The 90 days weight was higher in the midland agro-ecologies than the others, which might be due to the presence of optional feed staffs from crop production. As a normal physiology, males had received higher birth weight, 60 days and 90 days weight. Kids born from parity 3 does had receive better birth, 60 and 90 days weight, this might be due to the act that does of these parity had better reproductive physiology both in uterine and mammary system. The survival rate of the current monitoring was 74%. And the result was higher than Belay and Mengistie (2013) for Abergelle goats reported as 69% and 57% for the Borana kids and comparable with Arsi-Bale kids which was 75%.

Table 11 - Birth weight, weaning weight and 90 days weight of goats in the study area

Factors	N	Birth weight	N	60 days weight	90 days weight
Over all	60	1.69±0.08	52	7.45±0.41	12.02±0.25
Agro ecology		*		NS	***
Highland	20	1.56±0.17^{b}	16	7.42±0.21	9.60±0.228^{b}
Mid land	20	1.69±0.17^{a}	19	7.54±0.04	12.53±0.151^{a}
Lowland	20	1.65±0.13^{ab}	17	7.51±0.07	10.38±0.754^{ab}
Parity		**		*	**
1	14	1.64±0.08^{b}	12	7.63 ± 0.32^{a}	12.22±.31^{b}
2	21	1.69±0.07^{ab}	16	7.18 ± 0.07^{a}	12.53±.29^{ab}
3	9	1.79±0.21^{a}	9	7.74 ± 0.07^{a}	13.03±.34^{a}
>4	16	1.72±0.11^{ab}	15	6.45 ± 0.07^{b}	13.03±0.34^{a}
Sex		*		*	NS
Male	21	1.71±0.10	20	7.16 ± 0 .28	12.01±0.27
Female	39	1.62±0.11	32	6.86 ± 0.25	11.03±0.28
Birth type		**		*	**
Single	42	1.79±0.18	39	7.75 ± 0.40	12.53±0.151
Multiple	18	1.59±0.08	13	6.64 ± 0.17	10.38±0.754

CONCLUSION

Based on the husbandry practice adopted by the area, the production system of the survey district was characterized by mixed crop-livestock farming system on which crop residue was the main feed source of the goats as well as the other livestock species. The majority of the households do not possess private grazing land, which confirms that the goat production is mainly dependent on grazing/browsing and crop residues. Improvement of productive performance of goats need follow up and continuous evaluation of herd productive performance which allow to understand the major environmental factors to arrange continuous feeding and health monitoring in the flock. The monitoring data also indicated that, reproductive performance and birth weight of the kids was affected by agro-ecology and other factors; these facts assure improvement and designing the production system in the scientific way of goat production will improve the performance and income level of the farmer. As shown in the paper the goat production system is constrained by different problems those affect the breeding program and production potential, which shows the production system in the area is neglected and less attention was given for goat production. While other figures like the reproductive performance shows better result that indicate as the breed had better potential compared with other goat breeds of the country.

Citation: Golla K, Mekuriaw Y, Kassa B, Hailemelekot M (2020). On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia. *Online J. Anim. Feed Res*., 10(6): 282-289. DOI: https://dx.doi.org/10.51227/ojafr.2020.38

DECLARATIONS

Recommendations

- As interlinked problems were reported by the result, more emphasis on improvement of the feeding practice, health monitoring and breeding program needs to be placed on the improvement of the productive and reproductive performance of goats.
- Characterization of the breed in the study area should better be conducted to well understand the potential of the breed and to set further conservation strategies.

Conflict of interests

The authors declare that they have no competing interests.

Authors' contribution

All authors contributed equally to this research work. All authors read and approved the final manuscript.

REFERENCES

Abraham H, Gizaw S, and Urge M. (2018). Identification of breeding objectives for Begait goat in western Tigray, North Ethiopia. Tropical Animal Health and Production, 50: 1887–1892. Google Scholar ; DOI: https://doi.org/10.1007/s11250-018-1640-5

Agraw A (2010). Phenotypic Characterization and Husbandry Practices of North-Western Highland Goats In West Gojjam Zone Of Amhara Region, Ethiopia. MSc thesis submitted to Bahir Dar University. Bahir Dar, Ethiopia.

Alemayehu K, and Kebede D (2017). Evaluation of Morphometric and Reproductive Traits of Indigenous Dairy Goat Types in North Western Amhara, Ethiopia. Iranian Journal of Applied Animal Science, 7(1), 45-51. Google Scholar ; Link

Assefa G, Hilemelekot M, Taye M, Wuletaw Z and Tesfa A (2015). A Survey on breeding practice, and productive performance of simada cattle in tach gayint district, Ethiopia. Journal of Life Science and Biomedicine, 5 (6): 171-180. Google Scholar ; Link

Belay D and Mengistie T (2013). Evaluation of Growth Performance of Abergele Goats under Traditional Management Systems in Sekota District, Ethiopia. Pakistan Journal of Biological Sciences, 16: 692-696. Google Scholar ; Link

Bett B, Kiunga P, Gachohi J, Sindato C, Mbotha D, Robinson T, Lindahl J, and Grace D (2017). Effects of climate change on the occurrence and distribution of livestock diseases. Preventive Veterinary Medicine, 137(Pt B):119–129. Google Scholar ; DOI: https://doi.org/10.1016/j.prevetmed.2016.11.019

ESGPIP (2008). "Ethiopia Sheep and Goat Productivity Improvement Program", Sheep and Goat Production Handbook for Ethiopia, Alemu Yami and R C Merkel (Eds.), pp. 5-26, Brana Printing Press, Addis Ababa, Ethiopia. Google Scholar

FAO (1999). Production Year Book: Food and Agricultural Organization (FAO). 52, Rome, Italy. Google Scholar

Getahun K (2008). Productive and Economic Performance of Small Ruminants in Town Production Systems of the Highlands of Ethiopia, Doctoral Thesis, Hohenheim University, Cuvllier Verlag, Gottingen, Germany. Google Scholar

Girma A, Merkel R and Tilahun S (2000). Enhancing food security and income generation potential of families in southern Ethiopia through improved goat production and extension. In: Markel, R.C., Girma Abebe. And Goetsch, A.L (eds), The opportunities and challenges of enhancing goat production in East Africa: Proceeding of a conference held at Awassa, Debub University. pp. 113–117. Google Scholar

Kahi A, and Wasike C (2019). Dairy goat production in sub-Saharan Africa: current status, constraints and prospects for research and development. Asian-Australasian Journal of Animal Sciences, 32(8):1266-1274. Google Scholar ; DOI: https://doi.org/10.5713/ajas.19.0377

Mayberry D, Ash A, Prestwidge D, and Herrero M (2018). Closing yield gaps in smallholder goat production systems in Ethiopia and India. Livestock Science, 214: 238-244. Google Scholar ; DOI: https://doi.org/10.1016/j.livsci.2018.06.015.

Mohamed M, Bezabih E, Jabbar M and Ehui S (2002). Analysis of Economic and Nutritional Impacts of Market-oriented dairy production in the Ethiopian highlands. Forth Coming,Socio-economic and Policy Working Paper International Livestock Research Institute ILRI, Livestock Policy Analysis. Addis Ababa, Ethiopia. Google Scholar

Sheriff O, Alemayehu K and Haile A (2020). Production systems and breeding practices of Arab and Oromo goat keepers in northwestern Ethiopia: implications for community-based breeding programs. Tropical Animal Health and Production, 52(3): 1467–1478. Google Scholar ; DOI: https://doi.org/10.1007/s11250-019-02150-3.

Solomon A, Girma A and Kassahun A (2008). Sheep and Goat Production Systems in Ethiopia in: Alemu Yami and Merkel R.C. Sheep and Goat Production Handbook for Ethiopia, ESGPIP. Ethiopian Ministry of Agriculture and Rural Development, Ethiopia, 28-32. Link

Tesfahun B, Kebede K and Effa K (2017). Traditional goat husbandry practice under pastoral systems in South Omo zone, southern Ethiopia. Tropical Animal Health and Production, 49: 625–632. Google Scholar ; DOI: https://doi.org/10.1007/s11250-017-1240-9.

Tesfaye T (2009). Characterization of goat production systems and on- farm evaluation of the growth performance of grazing goats supplemented with different protein sources in Metema Woreda, Amhara Region, Ethiopia. MS Thesis. Haramaya University, Haramaya, Ethiopia. Google Scholar

Wondwosen K (2007). Husbandry practices of goats in Dalocha district, Southern Ethiopia. MSc. thesis submitted to Haramaya University. Google Scholar

Zeleke M (2007). Environmental influences on pre-weaning growth performance and mortality rates of extensively managed Somali goats in Eastern Ethiopia. Livestock Research for Rural Development, 19: Article #186. Link

Citation: Golla K, Mekuriaw Y, Kassa B, Hailemelekot M (2020). On-farm monitoring of growth performance of indigenous goat in Amhara region of Ethiopia. *Online J. Anim. Feed Res*., 10(6): 282-289. DOI: https://dx.doi.org/10.51227/ojafr.2020.38

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 290-296; November 25, 2020

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.39

INFLUENCE OF FEED RESTRICTION METHOD AND SEASON ON THE CHEMICAL COMPOSITION OF MEAT IN KOEKOEK CHICKENS

Setsumi Motsoene MOLAPO[1] and Edward WEBB[2]

[1] *Department of Animal Science, National University of Lesotho, P.O. Roma 180, Lesotho*
[2] *Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria 0002, South Africa*

Emails: setsomimolapo@gmail.com; sm.molapo@nul.ls; ORCID: 0000-0002-4426-8901

Supporting Information

RESEARCH ARTICLE

PII: S222877012000039-10

Received: September 30, 2020

Revised: October 29, 2020

ABSTRACT: The main objective of the study was to determine the effect of restricted feeding and season on carcass chemical composition of Koekoek chickens. Two hundred and seventy hens and 27 cocks were used. The experiment was designed as a factorial of two seasons and four feeding regime treatments. The four treatments were consisted of chickens full-fed during both rearing and laying phases (AA), those shifted to restricted feeding during the laying phase (AR), birds fed restrictedly during the rearing phase and shifted to full feeding in the laying phase (RA) and those fed restrictedly during both rearing and laying phases (RR). Each treatment had seven replicates (10 birds per replicate) with an exception of RR treatment which was replicated six times (10 birds per replicate). Data was collected at 18 and 32 weeks of age. Data collected was subjected to SPSS (17.00) statistical package and analyzed by using multi- factorial analysis of variance (ANOVA). At the age of 18 weeks, feed restriction had an impact on dry matter, fat and crude protein percentage. At 32 weeks of age, birds that were fed restrictedly had reduced fat content and increased crude protein. The lowest crude protein percentage was recorded in chickens that were allocated to full feeding for the entire study (AA). Chickens that were allotted to summer treatment had a higher dry matter and crude protein content than chickens that were in winter treatment at 18 weeks of age. Koekoek chickens that were in summer and winter treatments performed differently in terms dry matter, ash, crude fat and crude protein percentages at the age of 32 weeks. Based on the findings of this study it is concluded that chickens with higher slaughter weights resulted in a lower crude protein and higher amount of fat regardless of the slaughter age. Chicken meat that was produced in winter had a higher dry matter and crude protein content compared to that produced in summer at the slaughter age of 18 weeks. In the laying phase the meat of Koekoek chickens that were reared in winter had a higher dry matter, ash, fat and crude protein percentages than that of chickens produced in summer suggesting that the cold winter conditions have the potential to preserve the nutrient composition of chicken meat.

Keywords: Chemical composition, Feed restriction, Koekoek chickens, Temperature.

INTRODUCTION

Currently, high cost of poultry products makes it impossible for an average person in the country to consume an adequate quantity of animal protein. These price increases are a reflection of corresponding high costs of feeds which result in low production and short supply of poultry. Quantitative feed restriction early in rearing reduces the dry matter and crude protein percentage of meat in birds (Arrazola et al., 2019; Algam et al., 2020). The ash content was reported to be similar in *ad libitum* and restricted fed chickens (Renema et al., 1999; Farghly et al., 2019). Renema et al. (2007) explained that the percentage of crude fat in poultry meat is dependent on the severity of early feed restriction. In a study conducted by Crounch et al. (2002) it was observed that carcass fat was reduced in restricted-fed turkeys.

Higher moisture content was reported in chickens meat produced during the summer (Bianchi et al., 2007). However, the results of Akşit et al. (2006) suggest lower moisture content in thighs chickens that were reared under increased environmental temperature while Barbour et al. (2010) reported non-significant differences between the two groups of chickens. Summer conditions retarded the protein content in chickens Akşit et al., 2006 and Bianchi et al., 2007). Barbour et al. (2010) reported that environmental temperature did not affect the dry matter content. Akşit et al. (2006) reported that the ash content is negatively correlated to the level of temperature. Bianchi et al. (2007) also reported a lower ash percentage in summer reared chickens as against the ones produced during the winter season. Carcass fat was higher in chickens that were exposed to higher temperatures or summer conditions (Bianchi et al., 2007; Rosa et al., 2007; Barbour et al., 2010; Zaboli et al., 2019).

In order to have a meaningful and sustainable poultry production, it is necessary to study the means of producing an acceptable quality of chicken meat at reduced costs in different seasons. An alternative feed management practice that addresses this issue it is important and that is why this research project focused on the effects of feed restriction and season on carcass chemical composition of Koekoek chickens. With the research information obtained from this study, the farmers would be able to choose the appropriate feeding level and season so as to reduce the feeding costs without compromising the quality of meat from Koekoek chickens.

Citation: Molapo S and Webb E (2020). Influence of feed restriction method and season on the chemical composition of meat in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 290-296. DOI: https://dx.doi.org/10.51227/ojafr.2020.39

MATERIALS AND METHODS

Two hundred and seventy hens and twenty seven cocks of Koekoek chickens were bought at eight weeks of age. Ten hens and one cock were randomly selected and placed in each pen. The chickens were given stress pack in water to combat traveling stress and lasoda vaccine to prevent Newcastle disease. They were fed pullet grower mash from arrival day up to 18 weeks of age, and then fed laying mash from 19 to 32 weeks. Koekoek chickens under restricted feeding were fed 70% of full feeding. Koekoek chickens were offered fresh water without restriction and fed the same commercial feeds but at different quantities per day. The experiment was designed as a 4 feeding levels × 2 seasons (summer and winter) factorial arrangement in a completely randomized design. Treatments comprised: AA (chickens full-fed during both rearing and laying phases), AR (chickens full-fed during the rearing phase and shifted to restricted feeding during the laying phase), RA (chickens fed restrictedly during the rearing phase and shifted to full feeding in the laying phase) and RR (chickens fed restrictedly during both rearing and laying phases). Treatments AA, AR and RA were replicated seven times except treatment RR which was replicated six times. Therefore, there were twenty seven experimental units.

At 18 and 32 weeks of age, one Koekoek chicken per replicate was slaughtered from chickens that were allocated to AA, AR, RA and RR treatments. Birds were starved for 12 hours before slaughtering. The slaughtering procedure was followed as outlined by Jones (1984). Following the weighing and measuring of organs and tissues, they were returned to their respective individual carcasses and stored at -40^{o}C. The carcass composition was carried out on birds without feathers with all carcass components. Thawed carcasses were dissected and then be emptied into the blender (mincer) to be homogenized. The duplicate sample (200g) of each homogenate was freeze dried and then ground. The ground sample was then chemically analyzed for dry matter, protein, fat, and ash (Van Marle-Köster and Webb, 2000).

Data obtained and collected were stored in the computer under Microsoft excel and then finally analyzed using multi factorial analysis of variance with the aid of SPSS (17.00) statistical package. The same study was done in two different seasons being the summer and winter.

Ethical approval

The Department of Animal Science of the National University scientific and ethics committee approved the study protocol.

RESULTS AND DISCUSSION

The findings of this study as illustrated in Table 1 revealed that Koekoek chickens which were full-fed in the rearing phase had the dry matter content of 96.66% and 96.85% for chickens that were in AA and AR treatments respectively while chickens that were subjected to restricted feeding had dry matter content of 89.14% and 90.07% for chickens in RA and RR treatments respectively at 18 weeks of age. The dry matter content of chickens that were in full feeding was higher ($p<0.05$) than the one in feed restricted chickens by 7.39 percent.

At the age of 32 weeks, there were no significant differences observed in the dry matter content of chickens that were subjected to different treatments except for chickens that were in AA treatment. Koekoek chickens that were full-fed for the entire study (AA) had lower ($P<0.05$) dry matter content (95.17%) as compared to chickens that were in AR, RA and RR treatments with dry matter contents of 95.87%, 95.99% and 95.95% respectively. The chickens in AR, RA and RR treatments were not different ($P>0.05$) in terms of dry matter content. The findings of this study clearly indicated that the dry matter content failed to respond positively to body weight in chickens that were in AA treatment at 32 weeks of age. It was also observed that the dry matter content of chickens that were full-fed in the rearing phase (AA and AR) declined during the laying phase while the dry matter of chickens that were feed restricted during the rearing phase (RA and RR) increased in the laying phase.

Table 1 - Dry matter, ash, crude fat and crude protein percentages of meat from Koekoek chickens that were subjected to different feeding level treatments

Age wks \ Treatments	Nutrient (%)	AA	AR	RA	RR	S.E
18	DM	96.66^{a}	96.85^{a}	89.14^{b}	90.07^{b}	0.24
	Ash	8.65	8.61	8.56	8.23	0.11
	Fat	43.44^{a}	41.53^{a}	33.47^{b}	32.72^{b}	0.47
	CP	37.94^{a}	40.75^{a}	49.98^{b}	50.79^{b}	0.57
32	DM	95.17^{a}	95.87^{b}	95.99^{b}	95.95^{b}	0.10
	Ash	6.13	6.17	6.06	6.32	0.15
	Fat	51.90^{a}	45.25^{b}	50.20^{a}	40.02^{c}	0.69
	CP	39.71^{a}	41.93^{ab}	41.77^{ab}	45.14^{b}	0.67

^{ab} Means within a row with no common superscript differ significantly ($p<0.05$). AA=full feeding during rearing and laying. AR= full feeding during rearing and restricted during laying, RA=restricted feeding during rearing and full feeding during laying, RR=restricted during rearing and laying, S.E=standard error. DM=Dry matter, CP=Crude protein.

Citation: Molapo S and Webb E (2020). Influence of feed restriction method and season on the chemical composition of meat in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 290-296. DOI: https://dx.doi.org/10.51227/ojafr.2020.39

These results are in agreement with the results of Robinson et al. (1991) who reported a significantly higher dry matter percentage in *ad libitum* fed chickens than in restricted fed chickens. The carcass ash contents of chickens were 8.65%, 8.61%, 8.56% and 8.23% for chickens that were subjected to AA, AR, RA and RR treatments respectively. The results on the carcass ash percentage did not differ (P>0.05) between chickens that were allocated to different feeding treatments. In spite of insignificant differences between chickens that were subjected to different treatments, Koekoek chickens that were full-fed (AA and AR) had higher carcass ash content than their counterparts by 2.67 percent. This insignificant differences showed that the carcass ash content was not related to the slaughter weight hence a non-significant correlation (r= 0.076) between ash content and slaughter weight.

At the age of 32 weeks the meat ash percentage was higher (6.32%) in chickens there were allotted to restricted feeding for both rearing and laying phases (RR) as compared to the ash content of chickens that were in AA, AR and RA treatments with the ash percentages of 6.13%, 6.17% and 6.06% respectively. These results pointed out that chickens that were feed restricted for a longer period had higher carcass ash content. The findings of this study showed that the higher the slaughter weight the lower the ash content in Koekoek chickens at the age of 32 weeks. The ash percentage had insignificant negative correlation (r= -0.110) with the slaughter weight. The carcass ash content had no significant correlation with crude protein, fat and dry matter percentages. This means that the ash content cannot be estimated by relating it either with body weight or any of the nutrients. The results also revealed a decline of 27.50% in ash content across all treatments from 18 to 32 weeks of age meaning that the older the chickens the lesser the ash content.

Renema et al. (1999) also reported the similar ash content between full fed and restricted fed chickens. Koekoek chickens that were allocated to full feeding and restricted feeding had different carcass fat percentages. An average crude fat percentage of chickens that were full-fed (AA and AR) was higher (P<0.05; 42.49%) than the ones of Koekoek chickens that were feed restricted (RA and RR) with an average fat content of 33.10%. The findings implied that heavier chickens at slaughter age had higher crude fat percentage. This can be clearly confirmed by the positive (p<0.01) correlation (r=0.635) between slaughter weight and crude fat percentage. The crude fat percentage also had a positive correlation (r=0.682) with the dry matter percentage while the opposite was true with the crude protein percentage (r= -0.627; p<0.01).

At the age of 32 weeks, the crude fat percentages of Koekoek chickens that were full-fed (AA and RA) were different (p<0.05) from crude fat percentages of birds that were under feed restriction (AR and RR). Birds that were in AA treatment had higher fat content of 51.90% and they were not significantly different from Koekoek chickens that were in RA treatment with the crude fat content of 50.20 percent. The lowest (p<0.05) percentage (40.02%) of the crude fat was recorded in Koekoek chickens that were in RR treatment followed by chickens that were subjected to AR treatment with 45.25 percent. It was also observed that the crude fat content increased as chickens were getting older across all the feeding level treatments. Chickens in RA treatment had the highest increase with reference to crude fat as compared to crude fat content of chickens in other treatments while chickens in AR treatment had the lowest fat accumulation from 18 to 32 weeks of age. The highest crude fat percentage obtained from chickens that were in RA treatment can possibly be attached to the compensatory growth shown by the same group of chickens. The crude fat percentages increased by 16.30%, 8.22%, 33.33%, and 18.24% for chickens that were in AA, AR, RA and RR treatments respectively.

The results of this study are in accord with the findings of Renema et al. (1999) who stated that the higher crude fat content was found in birds that had heavy body weights compared to lower body weights chickens. Crounch et al. (2002) also indicated that turkeys that were feed restricted had lower crude fat during the rearing when compared to the ones that were full fed. These results were also supported by Hassanabadi and Moghaddam (2004) who concluded that carcass fat content of restricted fed birds was lower (p<0.05) than of control fed birds. Renema et al. (1999) also indicated that carcass lipid remained significantly greater in *ad libitum* fed birds than in restricted fed birds.

The results of this study as depicted in Table 1 indicated that crude protein percentage of birds that were under full feeding were different (p<0.05) from the one of the birds that were under restricted feeding during rearing phase. Koekoek chickens that were full-fed obtained a lower percentage of crude protein (39.35%) while birds that were raised under feed restriction had crude protein of 50.39 percent. This indicated that an average crude protein percentage of restricted fed chickens was higher than the one of full-fed chickens by 21.91 percent. These results evidently illustrated that chickens with high body weight and fat content had reduced crude protein content hence why the crude protein is negatively correlated (p<0.01) with the body slaughter weight (r = -0.467), crude fat content (r = - 0.627), dry matter content (r= -0.553) and ash (r = -0.295; p<0.05).

At the age of 32 weeks Koekoek chickens that were full-fed for the entire study (AA) obtained lower (p<0.05) percentage of crude protein (39.71%) than chickens that were exposed to feed restriction for the entire study (RR) which had highest protein content (45.14%). The crude protein percentages of Koekoek chickens that were in AR (41.93%) and RA (41.77%) treatments were statistically (p>0.05) similar and were different (p<0.05) from chickens that were in AA and RR treatments. The results also showed a negative (p<0.01) correlation (r= -0.547) between the slaughter weight and crude protein.

The findings of this study disclosed that the crude protein percentage of chickens that were initially on full feeding in the rearing and later shifted to restricted feeding during the laying phase (AR) increased by 2.81% while the one of chickens that were fed restrictedly during rearing and full-fed during laying (RA) declined drastically by 16.42 percent. Koekoek chickens that were full-fed for the two phases increased their protein content by 5.21% from 18 to 32 weeks of age. The protein percentage of chickens that were exposed to restricted feeding for the whole study (RR) decreased by

Citation: Molapo S and Webb E (2020). Influence of feed restriction method and season on the chemical composition of meat in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 290-296. DOI: https://dx.doi.org/10.51227/ojafr.2020.39

11.12%. These results indicated that despite chickens in restricted feeding having higher protein content there is a possibility of a decline in the crude protein percentage if they are slaughtered at an older age. This was also confirmed by De Beer and Coon (2007) who stated that the carcass protein content generally decreases as chicken age increases. The results from this study are related to the findings of Renema et al. (1999) who reported the similar percentages of protein in chickens that were in different feeding regimes of which the similar fashion of results was observed in this study at 32 weeks of age since chickens in AA, AR and RR had statistically similar carcass protein contents.

The results in Table 2 show that the dry matter percentage of meat from Koekoek chickens that were reared in two different seasons was significant. Chickens that were kept during summer season had higher ($p<0.05$) dry matter (94.12%) than the ones that were allocated to winter conditions with 92.24 percent. This showed that dry matter content of chickens that were reared in summer was 2% higher than the one of chickens that were kept in winter.

During the laying phase (32 weeks) there was a significant difference in the percentage of dry matter observed between Koekoek chickens that were reared in summer and winter seasons. Birds in summer season had a higher ($p<0.05$) dry matter (96.20%) compared to birds that were raised in winter season which had the dry matter content of 95.29%. These results showed that cold winter condition hindered the dry matter content by almost one percent. It was also observed that the dry matter content increased with the increase in age. This can be confirmed by the fact that the dry matter content increased by 2.16% and 3.20% in chickens that were exposed to summer and winter conditions respectively between 18 and 32 weeks of age. This is clearly indicating that the higher dry matter content in chickens that were kept in summer was possibly due to the higher weights that chickens experienced in summer.

The results of this study are in accordance with the findings of Akşit et al. (2006) who noted that chickens that were raised under higher temperature had lower moisture content compared to the ones that were raised under lower temperatures. Contrary to the results of this study, Chen et al. (2007) found no differences between the moisture content of chickens that were subjected to different number of sunlight hours in a day. Barbour et al. (2010) also reported the non-significant differences in the moisture content of chickens that were exposed to different temperatures. In contradicting with the findings of the current study, Bianchi et al. (2007) concluded that chicken meat produced in summer would have higher content of moisture.

Table 2 - Dry matters, ash, crude fat and crude protein percentages of meat from Koekoek chickens that were reared either in summer or winter season

Age wks \ Season	Nutrient (%)	Summer	Winter	S.E
18	DM	94.12[a]	92.24[b]	0.48
	Ash	8.50	8.52	0.21
	Fat	37.72	37.86	0.94
	CP	46.43[a]	43.29[b]	1.15
32	DM	96.20[a]	95.29[b]	0.19
	Ash	6.03[a]	6.31[a]	0.30
	Fat	45.22[a]	48.47[b]	1.37
	CP	38.04[a]	46.24[b]	1.36

[ab] Means within a row with no common superscript differ significantly ($p>0.05$), S.E- Standard Error

The results as shown in Table 3 demonstrated that there was an interaction ($p<0.01$) between feeding level and season on the dry matter content of Koekoek only at the slaughter age of 18 weeks. The results portrayed that the percentage of the dry matter in chickens that were subjected to restricted feeding in winter (WRA and WRR) was 4.13% less than the one of chickens that were feed restricted during summer season (SRA and SRR). With references to chickens that were full-fed, it was established that the dry matter content was similar with 96.74% and 96.78% for chickens that were in summer and winter seasons respectively. The feeding level and season interactive results clearly showed that the differences in the dry matter were mainly due to the different slaughter weights that were noticed to be higher in summer season at the age of 18 weeks.

At the age of 18 weeks (rearing phase) as shown in Table 2 it was observed that chickens that were kept in summer and winter seasons obtained similar ($p>0.05$) meat ash contents. The ash content of chickens reared in summer and winter seasons were 8.50% and 8.52% respectively. During the laying phase (32 weeks) chicken meat ash percentages were 6.03% and 6.31% for chickens that were in summer and winter treatments respectively. These results indicated that cold winter conditions boosted the content of ash by 4.44 percent. This clearly showed that the ash content was negatively associated with the slaughter weight of chickens. It was also observed that the meat ash content decreased with an increase in age. The ash content of meat from chickens that were subjected to summer treatment deteriorated by 29.06% and the one from chickens that were kept in winter declined by 25.95% from 18 to 32 weeks of age. This evidently showed that the meat ash quality was negatively affected by high temperatures in summer than low temperatures in winter meaning that low temperatures were able to preserve the mineral and the vitamin components in chicken meat.

The results of this study are in line with the findings Akşit et al. (2006) who reported that the ash content seemed to decrease with an increase in age. The results by Bianchi et al. (2007) also stated that chickens meat produced in winter had a higher ash content compared to the one produced in summer. Persia et al. (2003) found that the tibia ash percentage in chickens' meat was not affected by the high temperature and this was not in agreement with the finding of this study. In contradicting with the results of the current study Chen et al. (2007) disclosed that the relative ash percentage is not influenced by the different photoperiods.

Citation: Molapo S and Webb E (2020). Influence of feed restriction method and season on the chemical composition of meat in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 290-296. DOI: https://dx.doi.org/10.51227/ojafr.2020.39

Table 3 - Effect of feeding level and season on the chemical composition of meat from Koekoek chickens

Meat chemical composition	SAA	S.E	WAA	S.E	SAR	S.E	WAR	S.E	SRA	S.E	WRA	S.E	SRR	S.E	WRR	S.E
% DM	96.96[a]	0.62	96.36[b]	0.62	96.52[a]	0.62	97.19[b]	0.62	91.67[a]	0.62	86.61[b]	0.62	91.33[a]	0.67	88.82[b]	0.62
% Ash	8.48	0.22	8.82	0.22	8.71	0.22	8.51	0.22	8.40	0.22	8.72	0.22	8.42	0.24	8.03	0.24
% Fat	43.45	1.30	43.42	1.30	43.08	1.30	39.98	1.30	32.87	1.30	34.07	1.30	31.47	1.41	33.97	1.41
% CP	39.36	1.41	36.52	1.41	42.30	1.41	39.19	1.30	53.47	1.41	46.48	1.41	50.60	1.52	50.98	1.41
% DM	96.05	0.27	94.30	0.27	96.29	0.27	95.45	0.27	96.30	0.27	95.69	0.27	96.18	0.29	95.72	0.29
% Ash	5.88	0.41	6.38	0.41	5.46	0.41	6.89	0.41	6.12	0.41	5.99	0.41	6.65	0.44	5.99	0.44
% Fat	47.76	1.88	56.04	1.88	42.97	1.88	47.53	1.88	49.67	1.88	50.73	1.88	40.48	2.05	39.56	2.05
% CP	35.70	1.86	43.72	1.86	39.93	1.86	43.94	1.86	35.76	1.86	47.78	1.86	40.75	2.01	49.52	2.01

[ab] Means within a row with no common superscript differ significantly ($p<0.05$ and $p<0.01$). SAA=full feeding during rearing and laying in summer season. SAR=full feeding during rearing and restricted during laying in summer season, SRA=restricted feeding during rearing and full feeding during laying in summer season, SRR-restricted during rearing and laying in summer season, WAA=full feeding during rearing and laying in winter season. WAR=full feeding during rearing and restricted during laying in winter season, WRA=restricted feeding during rearing and full feeding during laying in winter season, WRR=restricted during rearing and laying in winter season, S.E=standard error, Sig=Significance level. %DM=Percentage Dry matter, % Ash=Percentage Ash, %Fat=Percentage fat, %CP=Percentage crude protein.

Citation: Molapo S and Webb E (2020). Influence of feed restriction method and season on the chemical composition of meat in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 290-296. DOI: https://dx.doi.org/10.51227/ojafr.2020.39

During the rearing phase (18 weeks) the fat percentages were statistically similar ($p>0.05$) between the summer and winter seasons. The results in Table 2 depicted that chickens reared in summer season had insignificantly higher crude fat percentage (37.86%) than winter reared chickens which had the fat content of 37.72 percent. The differences ($p<0.05$) in the percentage of crude fat were observed at the age of 32 weeks between chickens that were reared in summer and winter seasons. Koekoek chickens that were in winter treatment outperformed their counterparts by 6.71% with reference to crude fat content. The crude fat percentage seemed to increase with age despite of season in which chickens were produced. Chickens that were subjected to summer conditions managed to accumulate 7.72% while the ones raised in winter conditions accumulated 10.61% of the crude fat between 18 and 32 weeks of age.

The results in the rearing phase (18 weeks) are supported by the findings of Chen et al. (2007) who reported the non-significant differences in the total fat content of chickens that were subjected to different photoperiods. On the other hand, Bianchi et al. (2007) and Bogosavljević-Bosković et al. (2006) stated higher lipid content in chickens that were kept in summer as opposed to the ones kept in winter. Barbour et al. (2010) also confirmed that birds that were heat acclimatized had higher percentage of fat than the ones that were not exposed to heat. The higher crude fat percentage in chickens that were raised in winter is believed to be the outcome of high feed intake and as a result they were able to accumulate more fat.

At the age of 18 weeks as demonstrated in Table 2 the results illustrated that chickens that were in summer treatment had higher ($p<0.05$) crude protein content (46.43%) compared to chickens that were kept in winter season (43.29%). Koekoek chickens that were in summer treatment were 6.76% higher than the winter reared chickens with respect to crude protein percentage. At this phase of production, the protein content seemed to respond positively to the body weight of chickens since the higher slaughter weights that were experienced during the summer season resulted in a higher crude protein content. The opposite pattern of the results was observed in chicken meat at the slaughter age of 32 weeks. Koekoek chickens that were exposed to winter conditions had higher ($p<0.05$) crude protein content (46.24%) as compared to the ones that were subjected to summer treatment (38.04%). Koekoek chickens with higher body weights had lower crude protein percentages. It was also observed that the meat crude protein content of chickens that were exposed to warm summer condition declined by 18.07% over a period of 14 weeks while the protein content of chickens that were reared in winter increased by 6.38 percent. These results reflected that the meat of chickens produced in summer deteriorate in value as chickens get older while the opposite is true with the chickens raised in winter.

The results from this study are supported by the findings of Bianchi et al. (2007) and Blahova et al. (2007) who pointed out that the protein level was lower in chicken meat that was produced in summer of which it was the case in this study especially at the slaughter age of 32 week. Akşit et al. (2006) and Rosa et al. (2007) also argued that the protein content corresponded negatively with the amount of heat allotted to chickens. Contrary to the findings of this study other researchers reported the similar performance in chickens that were exposed to different temperatures (Chen et al., 2007; Barbour et al., 2010).

CONCLUSION

Chickens with higher slaughter weights resulted in a lower crude protein and higher amount of fat in the regardless of the slaughter age. Chicken meat that was produced in winter had a higher dry matter and crude protein content compared to that produced in summer at the slaughter age of 18 weeks. In the laying phase the meat of Koekoek chickens that were reared in winter had a higher dry matter, ash, fat and crude protein percentages than that of chickens produced in summer suggesting that the cold winter conditions have the potential to preserve the nutrient composition of chicken meat. In order to have chicken meat with higher a protein content and low fat content it is recommended that Koekoek chickens be raised on feed restriction (RR) if a farmer is aiming at producing meat from either 18 or 32 weeks old chickens. The meat produced from chickens that were in RA and AR treatments cannot be ruled out because of its higher crude protein except that it cannot be recommended to people who cannot eat meat with more fat. It is also recommended that the best season to rear Koekoek chickens is summer if the target is to slaughter them at the age of 18 weeks based on the higher crude protein and dry matter contents. In a case where chickens would be slaughtered at an older age (32 weeks) it would be advantageous to keep Koekoek chickens in winter so as to obtain higher ash (mineral and vitamin content) and crude protein percentages.

DECLARATION

Corresponding author
E-mails: sm.molapo@nul.ls; setsomimolapo@gmail.com

Authors' contribution
The two authors contributed in developing the content of this manuscript.

Availability of data
The data can be availed to the journal upon request.

Citation: Molapo S and Webb E (2020). Influence of feed restriction method and season on the chemical composition of meat in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 290-296. DOI: https://dx.doi.org/10.51227/ojafr.2020.39

Consent to publish
Not applicable

Conflict of interest
The authors declare they have no competing of interests.

Acknowledgement
The authors would wish to acknowledge the Department of Animal Science of the National University of Lesotho for their support through the whole process of developing this publication.

REFERENCES

Akşit M, Yalcin S, Özkan S, Metin K, Özdemir D (2006). Effects of temperature during rearing and crating on stress parameters and meat quality of broilers. Poultry Science. 85(11): 1867-74. Google Scholar I Doi: https://doi.org/10.1093/ps/85.11.1867

Algam TA, Osman RH, Zomrawi WB and Abdalhag MA (2020). Effect of phase feeding on broiler performance. Online Journal of Animal and Feed Research, 10(1): 36-40. DOI: https://dx.doi.org/10.36380/scil.2020.ojafr5 I Link

Arrazola A, Mosco E, Widowski TM, Guerin MT, Kiarie EG, and Torrey S (2019). The effect of alternative feeding strategies for broiler breeder pullets: 1. Welfare and performance during rearing. Poultry Science, 98(9): 3377–3390. Google Scholar I Doi: https://doi.org/10.3382/ps/pez170

Barbour EK, Tayeb I, Shaib H, and Abrahim IM (2010). Physiological and carcass traits in heat stressed broilers differing in heat acclimatization, chemical or feed restriction treatments. Agriculture and Biology journal of North America. 1(2): 65-74. Google Scholar I Link

Bianchi M, Petracci M, Sirri F, Folegatti E, Franchini A, and Melazzi A (2007). The influence of season and market class of broiler chickens on breast meat quality traits. Poultry Science, 86(5): 959-963. Google Scholar I Doi: https://doi.org/10.1093/ps/86.5.959

Blahova J, Dobsikova R, Strakova E, and Suchy P (2007). Effect of low environment temperature on performance and blood system in broiler chickens (Gallus domesticus). Acta Veterinaria Brno, 76(8): 17-23. Google Scholar I Doi: https://doi.org/10.2754/avb200776S8S017

Bogosavljević-Bosković S., Kurćubić V., Petrović M., Dosković V. (2006): The effects of season and rearing systems on meat quality traits. Czech Journal of Animal Science, 51: 369-374. Google Scholar I https://doi.org/10.17221/3953-CJAS

Chen H, Huang RL, Zhang HX, Di KQ, Pan D, and Hou YG (2007). Effects of photoperiod on ovarian morphology and carcass traits at sexual maturity in pullets. Poultry Science, 86(5): 917-920. Google Scholar I Doi: https://doi.org/10.1093/ps/86.5.917

Crounch AN, Grimes JL, Christensen VL, and Kruegert KK (2002). Effect of physical restriction during rearing on large white turkey breeder hens. 3. Body and carcass composition. Poultry Science, 81(12): 1792-1797. Google Scholar I Doi: https://doi.org/10.1093/ps/81.12.1792

De Beer M, and Coon CN (2007). The effect of different feed restriction programs on reproductive performance, efficiency, frame size, and uniformity in broiler breeder hens. Poultry Science, 86(5): 1927-1939. Google Scholar I Doi: https://doi.org/10.1093/ps/86.9.1927

Farghly M, Mahrose K, Ahmad E, Rehman Z and Yu, S. (2019). Implementation of different feeding regimes and flashing light in broiler chicks. Poultry Science, 98(5): 2034-2042. Google Scholar I Doi: https://doi.org/10.3382/ps/pey577

Hassanabadi A, and Moghaddam HN (2004). Effect of early feed restriction on performance characteristics and serum thyroxin of broiler chickens. International Journal of Poultry Science, 5 (12): 1156-1159. Google Scholar I Doi: https://doi.org/10.3923/ijps.2006.1156.1159

Persia ME, Utterback PL, Biggs PE, Koelkebeck KW, and Parson CM (2003). Interrelationship between environmental temperature and dietary nonphytate phosphorus in laying hens. Poultry Science, 82(11): 1763-1768. Google Scholar I Doi: https://doi.org/10.1093/ps/82.11.1763

Renema RA, Robinson FE, and Zuidhof MJ (2007). Reproductive efficiency and metabolism of female broiler breeders as affected by genotype, feed allocation, and age at photo stimulation. 2. Sexual maturation. Poultry Science, 86(10): 2267-2277. Google Scholar I Doi: https://doi.org/10.1093/ps/86.10.2267

Renema RA, Robinson FE, Newcombe M, and McKay RI (1999). Effect of body weight and feed allocation during sexual maturation in broiler breeder hens. 1. Growth and carcass characteristics. Poultry Science, 78(5): 619-628. Google Scholar I Doi: https://doi.org/10.1093/ps/78.5.619

Robinson, F. E., N. A. Robinson, and T. A. Scott, 1991.Reproductive performance, growth rate and body composition of full-fed versus feed-restricted broiler breeder hens. Canadian Journal of Animal Science, 71:549–556. Google Scholar I Doi: https://doi.org/10.4141/cjas91-065

Rosa PS, Faria Filho DE, Dahlke F, Viera BS, Macari M, and Furlan RL (2007). Performance and carcass characteristics of broiler chickens with different growth potential and submitted to heat stress. Brazilian Journal of Poultry Science, 9(3): 181-186. Google Scholar I Doi: https://doi.org/10.1590/S1516-635X2007000300007

Van Marle–Köster E and Webb EC (2000). Carcass characteristics of South African native chicken lines. South African Journal of Animal Science, 30(1): 53-56. Google Scholar I Doi: https://doi.org/10.4314/sajas.v30i1.3876

Zaboli G, Huang X, Feng X, and Ahn DU (2019). How can heat stress affect chicken meat quality? - a review. Poultry Science, 98(3): 1551–1556. Google Scholar I Doi: https://doi.org/10.3382/ps/pey399

Citation: Molapo S and Webb E (2020). Influence of feed restriction method and season on the chemical composition of meat in Koekoek chickens. *Online J. Anim. Feed Res.*, 10(6): 290-296. DOI: https://dx.doi.org/10.51227/ojafr.2020.39

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 297-301; November 27, 2020

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.40

EFFECT OF ADDING RAPESEED OIL, FISH OIL AND SELENIUM ON THE DIET ENRICHED WITH VITAMIN E AND ZINC ON THE YIELD AND ORGANOLEPTIC PROPERTIES OF EGGS

Yadollah BAHRAMI[1], Elham REZVANNEJAD[2] and Farhan AHADI[3]

[1]*PhD of Animal Biotechnology, Young Researchers Elite Club, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran*
[2]*PhD, Department of Biotechnology, Institute of Science and High Technology and Environmental Sciences, Graduate University of Advanced Technology, Kerman, Iran*
[3]*DVM, Department of Animal Science, Islamic Azad University, Marageh Branch, Marageh, Iran*

Email: bahrami97@gmail.com; ORCID: 0000-0002-9816-9685

Supporting Information

ABSTRACT: The present study was investigated the simultaneous effect of fish oil and rapeseed, selenium, vitamin E and zinc supplementation on laying hens. 288 white-line layers were used from 45 weeks of age. The experiment was conducted using a completely randomized design with four replications for 75 to 90 days. Performance of hens and organoleptic properties of eggs were evaluated. The results showed that there was no any significant difference between groups on the yield. Results obtained from the tasters including overall taste, natural smell and overall acceptability showed that although increasing fish oil to 2% + 2% rapeseed oil did not have a significant effect on the overall taste and overall acceptability of eggs in this group, but were significantly reported in natural smell. Therefore, diet with 2% fish oil+2% rapeseed oil (T3) can be considered as an enriched omega-3 ratio without showing major quality drop in eggs acceptance.

Keywords: Egg taste, Fish oil, Laying hen, Quality of egg, Rapeseed oil

Short Communication

PII: S222877012000040-10

Received: July 24, 2020

Revised: November 19, 2020

INTRODUCTION

What is always about egg in mind is its nutritional value, but eggs also have other important effects that make this valuable protein component separate from other foods. Eggs are a good source of necessary protein, vitamins and minerals, and can be an important nutrient in the diet of individuals (Bourre and Galea, 2006). Simopoulos and Salem (1989) showed that in Greece, hens that were allowed to feed freely, especially those fed with weed and ALA-rich grains, had a good growth, and their eggs had more omega-3 fatty acids than other hens grown in cage. Wild birds also had eggs with more concentrations of omega-3 fatty acids (Leskanich and Noble, 2007).

Food sources of omega-3 fatty acids can be divided into two categories of plant and animal products. Plant sources of this type of fatty acids contain high level of LNA, but other levels of omega-3 fatty acids are low in these categories of food sources. Among the plants that contain these fatty acids are fennel, walnut, soya, canola oil, and some green plants such as some algae (Kumar et al., 2016). Animal sources of these fatty acids contain high levels of EPA and DHA fatty acids and low levels of LNA. Among the animal resources, fish are rich in these types of fatty acids (Thng et al., 2020; Chekaniazar and Shahryar, 2018). Therefore, eggs fed with certain amounts of fish oil are also a source of nutrients for omega-3 fatty acids for humans. Using a proper combination of vegetable oils and fish oil can provide good results in increasing the amount of omega-3 fatty acids in egg yolk.

Researchers have reported that omega-3 fatty acids are more unsaturated type and longer chains of unsaturated fatty acids with multiple double bond (LC n-3 PUFA) such as Eicosapentaenoic (EPA), Ducosapentaenoic (DPA) and Docosahexaenoic (DHA), which causes to upgrade the power of the immune system (Molfino et al., 2014). Alpha-Linolenicacid (LNA) has little metabolic activity or not at allused until it is converted to DHA (Molfino et al., 2014).

The use of omega-3 fatty acids in vegetable or sea oils, along with appropriate levels of vitamins, especially vitamins A and E, in poultry diets, has a significant effect on health improvement, increasing performance and in particular increasing the deposition of omega-3 fatty acids long chain in the meat. It also increases concentration of lipid (fat)-soluble vitamins (Beynen, 2004; Galea, 2003). Finally, by consuming omega-3 product by human communities, reducing cardiovascular diseases, improving health and increasing human life is possible (Bourre, 2005). Enrichment of animal products such as bird meats, eggs, milk, etc., in addition to proper meet of nutritional deficiencies, is being carried out to increase the amount of important material needed for body to increase the health or reduce the disease by improving the

Citation: Bahrami Y, Rezvannejad E and Ahadi F (2020). Effect of adding rapeseed oil, fish oil and selenium on the diet enriched with vitamin E and zinc on the yield and organoleptic properties of eggs. *Online J. Anim. Feed Res.*, 10(6): 297-301. DOI: https://dx.doi.org/10.51227/ojafr.2020.40

immune system (Bourre, 2005). Among the essential nutrients of the body, unsaturated fatty acids such as omega-3 as well as some vitamins and minerals such as vitamin E and selenium are very important in the diet (Fisinin et al., 2008).

Hulan et al. (1988) by adding 5% of fish powder to the diet of laying hens found that total amounts of omega-3, EPA, DPA, and DHA fatty acids were significantly increased in carcass. Feeding of hens with 0, 4, 8 and 12% of fish powder did not have an effect on mortality, feed consumption efficiency and body weight, but by increasing levels of fish powder in the diet, the amounts of EPA, DHA and omega-3 fatty acids in eggs were increased. Also, all treatments increased the amount of omega-3 fatty acids in breast meat. In general, the addition of fish oil increases the ratio of omega-3 to omega-6 in total tissues (Hulan et al., 1988). Ebeid (2011) reported that increasing omega-3 levels of the diet plays a protective role against coccidiosis factor in birds.

Thus, due to the existence of different amounts of unsaturated fatty acids in vegetable and animal oils, and since so far, the simultaneous use of different amounts of fish oil and rapeseed oil in the diet has not been investigated on the quality of eggs in laying hens. The present study was designed to evaluate and compare the different amounts of this compound in the diet of laying hens.

MATERIALS AND METHODS

A total of 288 laying hens at the laying eggs peak were used in the poultry farm of Islamic Azad University. Diets included fish oil and rapeseed oil with a level of 4% combined with organic selenium (Selplex Organic Selenium Formation from Saccharomyces cerevisiae) and the same levels of organic zinc (Bioplex-Zn) and vitamin E and formulated according to NRC's recommendations (Council, 1994) with a uniform energy, protein, fiber, amino acids and minerals (Table 1). The experiment was conducted using a completely randomized CRD-based design (4 treatments, each with four iterations) for 75 to 90 days.

Table 1 - Components and compositions of control and experimental diets

Food components	Treatment *	Control
Corn grain	40.00	50.50
Soybean *Meal*	21.75	22.5
Wheat	24.50	11.00
Starch	0.00	6.00
Oil additives [1]	4.00	0.00
Oyster Powder	8.00	8.00
powder of bone	1.35	1.20
DDL-Methionine	0.20	0.10
Salt	0.20	0.20
Vitamin supplement 2	0.25*	0.25
Mineral supplement 3	0.25*	0.25
Calculated nutrient compositions (on dry matter)		
Metabolism energy (kcal / kg)	2869	2813
Crude protein (%)	15.78	15.55
Crude fiber (%)	3.15	3.28
Crude fat (%)	5.25	2.43
Calcium (%)	3.40	3.34
Available phosphorus (%)	0.33	0.33
Lysine (%)	0.85	0.80

[1]Rapeseed oil and Fish oil. [2] Per kilogram of supplied vitamins: 3520000 IU vit.A, 1000000 IU vit. D_3, 4400 IU vit.E, 880 mg vit.K_3, 738.5 mg vit.B_1, 1600 mg vit.B_2, 3136 mg vit.B_3, 13860 mg vit.B_5, 984.8 mg vit. B_6, 192mg vit. B_9, 4mg vit.B_{12}, 60mg biotin, 80000 mg choline chloride 80000 and 400 mg antioxidant.[3] Per kilogram of supplied minerals: 25870mg Zn, 30000mg Fe, 29760mg Mn, 2400mg Cu, 346.8mg I, and 80 mg Se. *All treatment diets received same levels of 50mg/kg vit. E + 50mg/kg Zn and two different levels of 0.1 and 0.2 mg/kg Sel-Plex®.

Performance

The performance traits including egg weight, daily feed intake, feed efficiency and egg percentage were determined during the experiment. Feed intake was measured every two weeks, and on the last day (end of each period) the remaining food was collected from each unit and the total diet was deducted. Then, by dividing the amount of feed consumed by that unit of test, each hen's feed intake per day of the same unit of experiment was obtained.

Organoleptic quality

Organoleptic test is performed using peers and a single sex to provide the best oil, alone or in combination, in terms of acceptable smell and taste for human nutrition. An educated and volunteer specialist (with conditions between 20 and 50 years old, without sensitivity to the hens and its products, a permanent consumer of eggs at least once a week) was used for this organoleptic evaluation. The eggs were boiled and evaluated in water at the same time and at a set temperature. The maximum score from 10 to at least 2 for an appreciable trait such as taste, smell and a general result (acceptability) was assigned and results evaluated.

Citation: Bahrami Y, Rezvannejad E and Ahadi F (2020). Effect of adding rapeseed oil, fish oil and selenium on the diet enriched with vitamin E and zinc on the yield and organoleptic properties of eggs. *Online J. Anim. Feed Res*., 10(6): 297-301. DOI: https://dx.doi.org/10.51227/ojafr.2020.40

Statistical analysis

The gathered data were analyzed after the normalization test using SAS 9.1 software and comparison of means was done using Duncan's multiple tests. The statistical model of the plan is as follows: $y_{ij} = \mu + t_i + e_{ij}$. Where, y_{ij}= observed values of each dependent variable; μ=Overall mean; t_i=Effect of treatment; e_{ij}=Random error

Ethical approval

The research and ethics committee in the Department of Animal Science of *Isfahan (Khorasgan) Branch of Islamic Azad University* approved this study based on international welfare standards for use of animals in conducting research.

RESULTS and DISCUSSION

Performance

There was no any significant difference between treatments and control groups on performance traits (Table 1). Same results were reported by Meluzzi et al. (2000) who used different oils for enrichment of laying hen eggs (fish oil and fat at 3% level with different levels of vitamin E), and also Dalle Zotte et al. (2015) feeding the laying hens in a diet containing 3% fatty fish oil. These results are also consistent with a study by Al-Sultan (2005), which showed no change in the production of eggs. However, Novak and Scheideler (2001) reported that feed intake for hens fed 10% flaxseed oil diet was significantly higher than those received soya oil diets (P<0.05). Dong et al. (2018) reported that hens fed fish oil showed poor performance compared with soybean oil or coconut oil, and especially egg weight was significantly decreased due to dietary fish oil.

An examination of the results of egg quality tests including overall taste, natural smell and overall acceptability showed that although increasing fish oil to 2% with 2% rapeseed did not have a significant effect on the overall taste and overall acceptability of eggs in this group, but were significantly reported in natural smell by the panelists (Table 2). The eggs of treatment 2 followed by treatment 1 (1% of fish oil + 3% of rapeseed oil) with the highest score of natural smell were accepted by the panelists. This means that the existence of more fish oil can change the smell of the enriched product, although it contains a much higher amount of vitamins and omega-3 fatty acids and elements. Generally, by study the results of the overall acceptability and taste of the tested samples, the consumption of the eggs of treatment 3 and 4, which contained the same amounts of both fish oil and rapeseed, seems very suitable in among of the level of enrichment of this product. Galobart et al. (2001) and Qi and Sim (1998) did not observed any significant effects on egg quality and performance in similar studies. (Brelaz et al., 2019) by using eight treatments diets with fish waste oil (0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5%) found and increased percentage of feed intake until 2.5% of fish waste oil in some of diets. They also were observed significant differences in flavor. Eggs from birds fed diets up to 2% present better acceptance by the tasters, while for higher levels of fish waste oil there was a considerable drop in acceptance.

Table 2 – Hen performance and organoleptic quality of the eggs

Parameters / Treatments	Feed Intake (g/b/d)	Egg production (%)	Organoleptic quality		
			Flavor	Normal smell	Acceptability
1	121.44	84.27	3.75 [b]	3.45 [b]	7.25 [a]
2	121.55	84.29	3.75 [b]	3.90 [a]	7.45 [b]
3	121.45	84.36	4.10 [c]	3.15 [b]	7.25 [c]
4	121.47	84.34	4.00 [c]	3.35 [c]	7.25 [d]
SEM[2]	0	0	0.142	0.131	0.350
Pvalue[1]	ns	ns	ns	**	ns

[a,b,c,d] Values in the same row and variable with no common superscript differ significantly. The consumers ranked flavor and normal smell of boiled eggs (5 min in boiling water) using a 5-point scale (1-5: bad to very good) and the acceptability of the eggs using a 9-point scale (1=bad; 3=acceptable; 6=good; 9=very good). At 1 week of storage a freshly boiled eggs sample was added to the consumer test as a blinded control. [1]**=p<0.01, *=p<0.05, non-significant (ns)=p>0.05. [2] Standard error of mean of twelve observations from each treatment. *All treatment diets received same levels of 50mg/kg vit. E + 50mg/kg Zn and two different levels of 0.1 and 0.2 mg/kg Sel-Plex®. (T1: 3%RO+1%FO+0.1 mg/kg Sel-Plex®; T2: 3%RO+1%FO+0.2 mg/kg Sel-Plex®; T3: 2%RO+2%FO+0.1 mg/kg Sel-Plex®; T3: 2%RO+2%FO+0.2 mg/kg Sel-Plex®).

CONCLUSION

Results of this study showed that using 0.1 and 0.2 mg/kg organic selenium levels with the same levels of vitamin E and organic zinc in diets containing rich fatty acids (omega-3 and -6) and also combining fish oil with a rich plant source from omega-3 (rapeseed oil), the transmission of fish smell to eggs can be reduced. Therefore, using a 2% omega-3 oil (fish) +

Citation: Bahrami Y, Rezvannejad E and Ahadi F (2020). Effect of adding rapeseed oil, fish oil and selenium on the diet enriched with vitamin E and zinc on the yield and organoleptic properties of eggs. *Online J. Anim. Feed Res*., 10(6): 297-301. DOI: https://dx.doi.org/10.51227/ojafr.2020.40

2% omega-6 oil (rapeseed) can be considered as a good ratio of omega-3 without making major quality drop in eggs acceptance.

DECLARATIONS

Corresponding Author

E-mail: bahrami97@gmail.com

Acknowledgements

Financial support of **Young Researchers Elite Club, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran, is highly acknowledged.**

Authors' Contribution

Both authors contributed equally in this manuscript.

Conflict of interests

The authors have not declared any conflict of interests.

REFERENCES

Al-Sultan S (2005). Effect of dietary fish oil on production traits and lipid composition of laying hens. International Journal of Poultry Science 4(8): 586-588. Google Scholar

Beynen FBA (2004). Relationships between the intake of n-3 polyunsaturated fatty acids by hens and the fatty acid composition of their eggs. International Journal of Poultry Science 3(11): 690-696. Google Scholar

Bourre JM (2005). Where to find omega-3 fatty acids and how feeding animals with diet enriched in omega-3 fatty acids to increase nutritional value of derived products for human: what is actually useful ? The journal of nutrition, health & aging 9(4): 232-242. Google Scholar

Bourre JM and Galea F (2006). An important source of omega-3 fatty acids, vitamins D and E, carotenoids, iodine and selenium: a new natural multi-enriched egg. The journal of nutrition, health & aging 10(5): 371-376. Google Scholar

Brelaz K, Cruz F, Brasil R, Silva A, Rufino J, Costa V and Viana Filho G (2019). Fish Waste Oil in Laying Hens* Diets. Brazilian Journal of Poultry Science 21(4). http://dx.doi.org/10.1590/1806-9061-2019-1069 I Google Scholar

Chekaniazar S and Shahryar HA (2018). Omega-3 enrichment of broiler dark meat: reducing unlike fats and fishy taint for consumer acceptance. Online Journal of Animal and Feed Research 8(3): 74-83. Google Scholar

Council NR (1994). Nutrient Requirements of Poultry, National Academy Press. Washington, DC. Google Scholar

Dalle Zotte A, I A, V G and Marchesini G (2015). Dietary enrichment of n-3 PUFA for laying hens: Effect of different sources on production, composition and quality of eggs. Google Scholar

Dong XF, Liu S and Tong JM (2018). Comparative Effect of Dietary Soybean Oil, Fish Oil, and Coconut Oil on Performance, Egg Quality and Some Blood Parameters in Laying Hens. Poultry Science 97(7): 2460-2472. https://doi.org/10.3382/ps/pey094 I Google Scholar

Ebeid TA (2011). The impact of incorporation of n-3 fatty acids into eggs on ovarian follicular development, immune response, antioxidative status and tibial bone characteristics in aged laying hens. animal 5(10): 1554-1562. https://doi.org/10.1017/S1751731111000619 I Google Scholar

Fisinin V, Papazyan T and Surai P (2008). Producing specialist poultry products to meet human nutrition requirements: Selenium enriched eggs. World's poultry science journal 64(1): 85-98. https://doi.org/10.1017/S0043933907001742 I Google Scholar

Galea F, Bourdillon, A., Rouillère, H. (2003). Effect of different levels and sources of omega-3 fatty acids in diets for laying hens on eggs acid profile. Scientific Report of the 24th ISF World Congress. Google Scholar

Galobart J, Barroeta AC, Baucells MD, Cortinas L and Guardiola F (2001). Alpha-tocopherol transfer efficiency and lipid oxidation in fresh and spray-dried eggs enriched with omega3-polyunsaturated fatty acids. Poultry science 80(10): 1496-1505. https://doi.org/10.1093/ps/80.10.1496 I Google Scholar

Hulan HW, Proudfoot FG, Ackman RG and Ratnayake WMN (1988). Omega-3 Fatty Acid levels and performance of broiler chickens fed Redfish meal or Redfish oil. Canadian Journal of Animal Science 68(2): 533-547. https://doi.org/10.4141/cjas88-059 I Google Scholar

Kumar A, Sharma A and Upadhyaya KC (2016). Vegetable Oil: Nutritional and Industrial Perspective. Current genomics 17(3): 230-240. Google Scholar

Leskanich CO and Noble RC (2007). Manipulation of the n-3 polyunsaturated fatty acid composition of avian eggs and meat. World's Poultry Science Journal 53(2): 155-183. https://doi.org/10.1079/WPS19970015 I Google Scholar

Meluzzi A, Sirri F, Manfreda G, Tallarico N and Franchini A (2000). Effects of dietary vitamin E on the quality of table eggs enriched with n-3 long-chain fatty acids. Poultry science 79(4): 539-545. https://doi.org/10.1093/ps/79.4.539 I Google Scholar

Molfino A, Gioia G, Rossi Fanelli F and Muscaritoli M (2014). The role for dietary omega-3 fatty acids supplementation in older adults. Nutrients 6(10): 4058-4073. https://doi.org/10.3390/nu6104058 I Google Scholar

Novak C and Scheideler SE (2001). Long-Term Effects of Feeding Flaxseed-Based Diets. 1. Egg Production Parameters, Components, and Eggshell Quality in Two Strains of Laying Hens1. Poultry science 80(10): 1480-1489. https://doi.org/10.1093/ps/80.10.1480 I Google Scholar

Qi G-H and Sim JS (1998). Natural Tocopherol Enrichment and Its Effect in n−3 Fatty Acid Modified Chicken Eggs. Journal of Agricultural and Food Chemistry 46(5): 1920-1926. https://doi.org/10.1021/jf9707804 I Google Scholar

Simopoulos AP and Salem N, Jr. (1989). n-3 fatty acids in eggs from range-fed Greek chickens. The New England journal of medicine 321(20): 1412. https://doi.org/10.1056/nejm198911163212013 I Google Scholar

Thng A, Ting JX, Tay HR, Soh CY, Ong HC and Tey D (2020). The use of predicted apparent metabolizable energy values to understand the oil and fat variability in broilers. Online Journal of Animal and Feed Research 10(4): 85-92. Google Scholar

Citation: Bahrami Y, Rezvannejad E and Ahadi F (2020). Effect of adding rapeseed oil, fish oil and selenium on the diet enriched with vitamin E and zinc on the yield and organoleptic properties of eggs. *Online J. Anim. Feed Res*., 10(6): 297-301. DOI: https://dx.doi.org/10.51227/ojafr.2020.40

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 302-312; November 27, 2020

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.41

SUB-ACUTE RUMINAL ACIDOSIS IN DAIRY COWS: ITS CAUSES, CONSEQUENCES AND PREVENTIVE MEASURES

Emran HOSSAIN

Professor and Head, Department of Animal Science and Nutrition, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University, Zakir Hossain Road, Khulshi, Chattogram-4225, Bangladesh

Email: emran@cvasu.ac.bd; ORCID: 0000-0002-1750-7284

Supporting Information

REVIEW

PII: S222877012000041-10

Received: September 18, 2020

Revised: October 20, 2020

ABSTRACT: Current feeding programs for cattle prescribe concentrate rich diets to meet their ever increasing demands for high levels of milk production. These diets, however, can impair rumen health and thus cattle production, milk yield and welfare. High energy diets are rapidly fermented in the rumen because they are high in fermentable starch, low in NDF and contain finely chopped digestible forages. Feeding rapidly fermentable diet to the cows predominantly adapted to digest and metabolize forage based total mixed ration (TMR) substantially increases short term milk yield, but the risk of sub- acute ruminal acidosis (SARA) increases. Additionally, too high concentrate to forage ratio, too fast a switch from high forage to high concentrate, diet composed of highly fermented feeds, improperly mixed TMR and mycotoxins in feed also increases the incidence of SARA in dairy herds. SARA causes depressed feed intake, cycling feeding, reduced cud chewing, poor fibre digestion, rumenitis, mastitis, metritis, dehydration, diarrhoea, abomasal displacement, pulmonary bacterial emboli, systemic inflammation, liver abscesses, low milk fat, low milk protein, sore hooves, laminitis and low fertility. Therefore, SARA is a major challenge for animal health, productivity, economic efficiency and welfare issue even in well managed dairy herds. Feeding higher amounts of forages, supplying adequate peNDF, processing grains less thoroughly, reducing fermentability of the carbohydrate fraction and adapting rumen to the dietary changes are the key factors to be considered for preventing SARA. Continued research for accurate quantification of peNDF in diet, grain processing, optimization of meal size, dietary cation-anion balance, narrow-spectrum rumen modifier, inoculation of lactate utilizing microbes, inhibition of lactate producing microbes and innovation of the unique fermentability characteristics of feed ingredients to promote sufficient buffering and rapid absorption of VFA from rumen will explore new horizon for reducing incidence of SARA in future.

Keywords: Acidosis, Cattle, Dairy herd, Rumen, Total mixed ration.

INTRODUCTION

The sub-acute ruminal acidosis (SARA) is a global threat which causes reduced dry matter intake and digestibility (Coon et al., 2019), change in bacterial density, assorted variety and community structure of the microorganism in the rumen (Plaizier et al., 2017), reduced microbial protein synthesis (de Veth and Kolver, 2001), decreased milk yield (Stone, 1999), reduced milk fat substance (Coon et al., 2019), modified lipid profile of milk (Jing et al., 2018), decreased conception rate (Khalouei et al., 2016), liver abscess (Wiese et al., 2017) and laminitis (Nocek, 1997). SARA has been characterized as a condition portrayed by critical ruminal pH and increased accumulation of short chain unsaturated fatty acids (SCFA) because of an imbalance between the production of fermentation acids by rumen microorganisms and the retention, absorption and buffering of those acids (Allen et al., 2006). SARA results altered volatile fatty acids, i.e., acidic, propionic and butyric acids towards elevated butyric and propionic acids and increased lactic acids in the rumen in 5-10 mmol/l (Enemark et al., 2002). An edge estimation rumen pH of 5.5 to 5.8 is typically used to characterize SARA (Yang and Beauchemin, 2006) since the vast majority of the cellulolytic microorganisms don't increase below pH 6.0 (Russell and Wilson, 1996). SARA is a result of feeding highly fermentable carbohydrate to the cows adjusted to process and use dominatingly forage based diets (Krause and Oetzel, 2006). However, it might likewise happen in pasture fed dairy cows when digestibility of the field forages are substantially high.

SARA is a typical issue in practically all the dairy herds not just for animal health, profitability and productivity (Plaizier et al., 2008), yet additionally for animal welfare issues (Krause and Oetzel, 2006). It was accounted for that, SARA decreased milk yield by 2.7 kg/day, milk fat production by 0.3% and milk protein production by 0.12% (Stone, 1999). Lameness is another important animal welfare issue in dairy herds and SARA has been perceived as an important hazard factor for laminitis (Nocek, 1997). Lameness is normally the most important purpose behind untimely culling of

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

cows in a dairy herd. Furthermore, SARA has an immediate human health concern. Low ruminal and intestinal pH due to SARA expands the hazard for shedding enterohemorrhagic *E. coli*, for example, 0157:H7 (Russell and Rychlik, 2001). Dairy cows require high energy diets to fulfill their elevated needs for increased levels of milk production. However, high energy diets are quickly fermented in the rumen and magnify the danger of SARA. Accordingly, this is a significant challenge for dairy owners to improve animal health, profitability and financial effectiveness without challenging SARA.

CAUSES OF SARA

Feeding rapidly fermentable carbohydrate

Feeding quickly fermentable diets to the cows recently adjusted to digest and utilize forage based diet is the most agreed explanation of SARA in dairy herds. In any case, all in all, too high concentrate to forage proportion, too quick a change from high forage to high concentrate and low peNDF content in diet are generally regular to SARA. SARA is brought about by the accumulation of VFAs and lactic acid in the rumen. As feed is digested in rumen, VFAs are produced, consumed or buffered in rumen. However, pH in the rumen drops if production of VFAs are quick and ingestion or buffering is low which surpasses the limit of the rumen to keep up harmony and at last a cyclic example of SARA happens. In a normal healthy rumen, lactic acid production normally rises to lactic acid use. In this manner, lactic acid focus is in every case brief and infrequently discernible. Under typical rumen pH, lactate-using microscopic organisms, for example, *Megasphaera elsdenii* and *Selenomonas ruminantium*, proceed to multiply and begin processing lactate to change over in different VFAs, which are then effectively protonated and retained (Goad et al., 1998). Most of the lactate produced can be used by these microbes. In any case, because of feeding overabundance fermentable carbohydrate, abundance propionate gathers in the rumen, lower ruminal pH, restrain multiplication of cellulolytic microscopic organisms and favor the development of lactate-producing microorganisms. As lactate delivering microscopic organisms multiply, pH pointedly dips under 6.0 and hinders the development of useful lactate using microbes. The turnover time of lactate using microscopic organisms is much slower than lactate creating microorganisms. Thus, lactate production quickly surpasses lactate use (Russell and Allen, 1984). Lactic acid is around multiple times more grounded than the other rumen acids and makes rumen pH drop forcefully. As an outcome, there is an imbalance of lactic acid digestion alongside expansion of VFAs coming about in SARA.

Inadequate peNDF in diet

In ruminant animal, salivary buffer production relies upon length and force of cud chewing. Chewing time is influenced by the substance of coarse fiber in the diet. The measure of genuine coarse fiber is evaluated by estimating the peNDF which has been characterized as the capacity of a feed to invigorate chewing and buffering of salivation in the rumen (Mertens, 1997). The fundamental factor that decides dietary peNDF content is the particle size appropriation and NDF substance of the diet, however different elements, for example, particle delicacy can likewise assume a purpose. Mature forages of appropriate chop length are a decent source of peNDF in contrast with cereal grains and crop residues (Krause and Combs, 2003). Besides invigorate saliva production, they add to rumen buffering through their inborn buffering component. Accordingly, as the measure of peNDF reduces in diet, chewing time just as salivary buffer production likewise reduces proportionately and causes frequency of SARA (Yang and Beauchemin, 2006).

Insufficient rumen buffering

Ruminant animals have restricted framework for buffering natural acids produced from ruminal fermentation of carbohydrates (Oetzel, 2015). In saliva the fact that, the genuine impact of buffering on ruminal pH is substantial in a forage based diet, in any case, it is moderately little on diets enhanced with quickly fermentable carbohydrate. There are two unique sorts of buffering i.e., exogenous and endogenous buffering. Dietary buffering is the exogenous buffering framework which decides real dietary cation-anion contrast (DCAD). Thusly, diets high in Na and K comparative with Cl and S have higher DCAD edge to kill higher ruminal pH for keeping up normal health and milk yield (Hu and Murphy, 2007). Forages normally have higher DCAD, however, concentrates have extremely low DCAD potential and consequently, diets wealthy in concentrate are consistently helpless to SARA (Oetzel, 2015). Endogenous buffers produced *in vivo* by cow are discharged into the rumen through the salivation. Coarse, stringy feeds contain progressively viable fiber and invigorate more salivation production during eating than do finely ground TMR and concentrate work. Therefore, as the degrees of quickly fermentable carbohydrate increments in diet, cows become increasingly inclined to SARA.

Inadequate adaptation

A fast increment of highly fermentable concentrate in diet of the cows adjusted to process forage based diets expands the hazard for SARA since rumen microorganisms and the rumen wall can't adjust proportionately to the abrupt dietary changes. Deficient concentrate feeding during dry off period may likewise expand the danger of SARA due to damage of the ruminal papillae to build as needs be and disruption of rumen microbial population to adjust to unexpected high concentrate diets took care of later on (Dirksen et al., 1984). The short chain unsaturated fatty acids (SCFA) are generally viewed as luminal development factors and expanding their production modifies expansion of alimentary tract in ruminants. In light of gradually elevated SCFA fixation got from progressively expanding quickly

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

fermentable diet, the ruminal epithelium endeavor to adjust slowly by expanding epithelial expansion, cell capacity and tissue penetrability (Penner et al., 2011). In any case, out of nowhere elevated quickly fermentable carbohydrate of the diet suddenly changes the rate of production of SCFA, for the most part acetic acid, propionate and butyrate (Plaizier et al., 2008). The rumen microorganisms and the rumen walls can't adjust proportionately to these abrupt dietary changes and at last SARA happens.

Sorting of TMR particle

Specifically sorting relatively progressively tasteful medium size forage particles even from a homogenous TMR is a typical inclination among dairy cows which lead them to expend a real imbalanced fiber consumption (Leonardi and Armentano, 2003) than determined in TMR. Ongoing examination shows that, lactating dairy cows exhibit higher degrees of sorting for medium size forage and concentrate particle against longer forage and smaller grain particles when taken care of a low forage diet. This kind of sorting conduct altogether reduces intake of sufficient peNDF from the TMR which continuously contributes to the occurrence of SARA in dairy herds.

Other causes

Dry matter intake in primiparous cows is lower than the older cows. In this way, apparently, the primiparous cows are at lower danger of SARA than the older cows. Nonetheless, consequences of a few examinations demonstrate that, primiparous cows are at higher hazard for SARA (Krause and Oetzel, 2006). Primiparous cows may require time to become acclimated to learn control their feed consumption when acquainted with a high-energy diet just because in the wake of calving. They may likewise endure experiencing issues accessing feed bunks when older cows are available in a similar line (Oetzel, 2015).

CONSEQUENCES OF SARA

Milk fat depression

The relationship between SARA and milk fat depression is not consistent and it is really difficult to determine if a herd has a low milk fat test or not (Oetzel, 2015). Milk fat percentage generally depends on feed, breed, season and days in milk (Palmquist et al., 1993). According to the most popular substrate supply limitation theories, milk fat synthesis is limited by poor acetate supply since acetate is the principal precursor for biosynthesis of milk fat (Thomas and Martin, 1988). However, the reduced ratio of acetate to propionate with highly fermentable diet is predominantly due to increased ruminal production of propionate. Additionally, ruminal infusion of acetate to cows suffering from SARA has only a marginal or no impact on milk fat synthesis (Bauman and Griinari, 2001). Therefore, substrate limitation theory appears almost immaterial (Bauman et al., 2011).

According to recent research, excessive intake of unsaturated fat is the most predictable reason of milk fat depression in dairy cows (Vargas-Bello-Pérez and Garnsworthy, 2013). Ruminant's diets are mostly consisting of unsaturated fatty acids that are extensively bio-hydrogenated in rumen. Conjugated linoleic acids are the unique intermediates in the biohydrogenation process and represent a mixture of positional and geometric isomers of octadecadienoic acid with variable conjugated double bonds (e.g., 7-9, 8-10, 9-11, 10-12) and can exist in different configurations (cis-trans, trans-cis, cis-cis, or trans-trans (Bauman et al., 1999). However, the major isomer of CLA in milk fat is cis-9, trans-11 which represents 80 to 90% of the total CLA (Parodi, 1977). Recent studies have demonstrated that, the cis-9, trans-11 isomers are produced in normal proportion only under healthy ruminal condition and they can prevent cancer and tumor (Ip et al., 1999).

Under certain dietary conditions, such as high-concentrate, low-fiber diets, lower acetate to propionate molar ratio and decreased rumen pH, typical pathways of rumen biohydrogenation are altered to produce some unique fatty acid intermediates so that the concentration of the trans-10, cis-12 isomer increases in milk fat (Griinari and Bauman, 1999). These fatty acids are absorbed at the small intestine, taken up by the mammary gland and ultimately inhibit milk fat synthesis (Oetzel, 2015). Studies with pure isomers have ascertained that, the trans-10, cis-12 CLA is a potent inhibitor of milk fat synthesis. The inhibition mechanism involves a coordinated reduction in mRNA abundance decreasing the Δ9-desaturase activity in the biochemical pathways of fat synthesis (Bauman et al., 2011).

In a series of studies, administration of CLA supplements to lactating dairy cows exhibited a dramatic reduction in the content and yield of milk fat. In a study, abomasal infusion of 60% CLA resulted greater than 50% reduction in milk fat (Giesy et al., 1999). In another study, abomasal infusion of the pure isomers of trans-10, cis-12 CLA reduced milk fat percentage and yield by 42 and 44%, respectively (Bauman et al., 1999). However, similar amount of cis-9, trans-11 CLA infusion had no effect on milk fat depression (Baumgard et al., 2000). Additionally, SARA may increase trans fatty acid uptake of host animals, perhaps by inhibiting certain bacteria which are responsible for complete biohydrogenation of fatty acids in the rumen (Plaizier et al., 2008).

Lameness

When the microvasculature of the corium is affected by vasoactive substances, then vascular destruction is inevitable. When blood is not returned to circulation by the musculature of the vascular system, then seepage and

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

hemorrhage result. Laminitis is associated with inflammation of local corium which involves vascular breakdown, hemorrhage and exudation of the serum from capillary beds. As the horn tissue of the sole grows, the hemorrhage moves to the external surface and ultimately, external tissue of the sole exhibits internal hemorrhage which is the visual symptom of laminitis (Nocek, 1997).

The progression from SARA to laminitis is associated with several systemic phenomena. However, the most common strategic and critical apex in the entire process is the reduction of ruminal pH which results metabolic and digestive disorders, localized trauma and vascular destruction. Destruction of the hemodynamics of the peripheral microvasculature due to SARA has been identified as a major etiological factor associated with development of laminitis (Nocek, 1997). Various theories have been developed to explain the pathogenesis of laminitis. Elevation of vasoactive substances especially histamine and endotoxins have been reported during occurrence of laminitis (Nocek, 1997). Elevated serum histamine concentration was related with corium tissue breakdown and elevated endotoxins were related with bacteriolysis due to decline of ruminal pH (Nocek, 1997)..

Histamine has long been identified as a potent vasodilator and arterial constrictor (Chavance, 1946). Brent (1976) indicated that, histamine increases capillary permeability and arteriolar dilatation. Windholz et al. (1976) identified histamine as a potent vasodilator and Chavance (1946) identified histamine as a potent arterial constrictor. If histamine is an arterial constrictor and vassal dilator, blood pressure and flow would increase to the capillary beds (Nocek, 1997). As a result, pooling, vessel rupture, serum seepage and hemorrhage will occur. However, if the reverse is the case, then pooling would also occur because of constriction of veins rather than arteries. In any event, the impedance of blood flow and pressure build up within capillaries will force fluid through the vessels into the interstitial tissue spaces setting up ischemia (Nocek, 1997).

In equine research, endotoxin administration resulted in vasoconstriction and arteriovenous shunting, which lead to poor perfusion of the digit and laminitis (Hunt, 1990). Boosman et al. (1991) administered endotoxin to cattle and created histopathologic lesions in the digit consistent with laminitis.

Liver abscess

SARA is associated with a chain of events that liberate *Fusiformis necrophorus*, *Fusobacterium necrophorum*, gram-negative, obligate anaerobic bacterium which is the primary etiologic agent of liver abscess (Oetzel, 2015). Low ruminal pH damages the surface of the rumen wall and causes ulceration of the epithelium. Once the ruminal epithelium is damaged, bacteria transported to the liver through portal circulation, causing liver abscesses. Infection in the liver originates from a necrobacillary rumenitis. Two biovars have been identified. Biovar A (F necrophorum necrophorum) the more virulent and predominant biovar in the rumen microflora isolated in pure culture from liver abscess. Biovar B (F necrophorum funduliforme) is isolated from microabscesses in rumen wall and less commonly isolated from liver abscesses. Arcanobacterium pyogenes, streptococci, staphylococci and Bacteroides spp are most frequently recovered from mixed cultures. F necrophorum, alone or with other bacteria, colonizes through the area of superficial necrosis produced in rumen under condition of SARA. Leukotoxin facilitate resistance to phagocytosis. Bacterial emboli from the lesions invade the hepatic portal venous system and transported to the liver, where they establish infectious foci of necrobacillosis which eventually develop liver abscesses (Krause and Oetzel, 2006).

Reduced feed intake

Reduced dry matter intake is supposed to be a reliable clinical sign and a few examinations have indicated a depressed hunger (Shinozaki, 1959), lower rumen motility (Ash, 1959), decreased fiber digestibility (Hoover, 1986) and reduced feed consumption (Fairfield et al., 2007) due to SARA. The depression in feed intake may have been because of elevated production of unstable unsaturated fats, particularly propionate and changes in the osmolarity in the rumen (Allen, 2000). It was accounted for that, grain induced SARA decreased *in situ* fiber digestibility in the rumen because of increased rumen acidity (Krajcarski-Hunt et al., 2002) and increased VFA production in rumen (Khafipoor et al., 2007). In any case, SARA prompted by feeding horse feed pellets came about no adjustment in DMI. The dissimilarity between the impacts of grain initiated SARA and pellet *induced* proposes that there may have different variables answerable for intake depression. A few examinations have demonstrated that grain-instigated SARA causes an expansion in acute stage proteins in blood, which is a marker of aggravation (Gozho et al., 2007). It has been indicated that irritation of different organs of the cow decreases feed intake (Andersen et al., 2003). Subsequently, the irritation coming about because of grain actuated SARA could add to the feed intake depression. This supposition that is fortified by the perception that enlistment of SARA by supplanting hay feed with hay pellets did not bring about aggravation and furthermore did not bring about feed intake depression (Khafipoor et al., 2007).

Cyclic feeding

Cyclic feeding design has been portrayed as the most reliable manifestation of SARA (Britton and Stock, 1987). Normally, the image is one of cyclic feed intake as the cow eats its proportion and subsequently declines further feed because of an uncommon fall in rumen pH coming about increased osmolality of the rumen liquid. Upon reestablishment of normal rumen conditions, appetite is often regained (Fulton et al., 1979). The course proceeds and subsequently, cyclic feeding creates.

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

Feed sorting

It has been accounted for that, whenever given chance, ruminants select diet trying to reduce the impacts of low ruminal pH to help keep up a sound ruminal condition. It has additionally been accounted for that, lactating dairy cows experiencing SARA favored long forage particles (Yang and Beauchemin, 2006) perhaps in endeavor to address their issue for peNDF. It was detailed that, feed sorting was influenced by the extents of purposefully induced acidosis of the cows. Both high and safe cows change their sorting conduct in light of acidosis difficulties and acidosis was related with elevated sorting for the longer particles against the shorter one.

Poor feed efficiency

Low ruminal pH disrupts ruminal mucosa causing ulceration of the epithelium (Krause and Oetzel, 2006). Moreover, over the top keratinization of the ruminal epithelium happened as an outcome of SARA results decreased absorptive limit (Krehbiel et al., 1995), reduced profitability and increased feed costs because of poor digestibility and lower feed effectiveness. It was accounted for that, ruminal NDF digestion declined from 52% for cows with a mean ruminal pH of 6.4 to 44% for cows encountering rehashed scene of SARA with a mean ruminal pH of 5.8.

Impaired microbial protein synthesis

SARA reduces digestibility of organic matter subsequently brings down the productivity of microbial protein amalgamation in rumen which at last declines the yield of microbial protein except if increasingly fermentable carbohydrate is provided. The reduced microbial protein blend expands the requirement for increasingly supplemental feed protein in the diet of the host animal (Beauchemin et al. 2003).

Abomasal displacement

SARA has frequently been considered as a hazard factor for abomasal displacement (Shaver, 1997; Enemark, 2008). Although a causal relationship has not been demonstrated, in any case, increased in reverse and forward progression of ruminal gasses among stomach and the front stomachs are accepted to bring about abomasal atony and dilatation and subsequent removal (Sarashina et al., 1990). The hypothesis is upheld by the finding that a low fiber content in the feed proportion is the most important single factor in the event of abomasal dislodging (Shaver, 1997) and that the foundation of a practical fiber tangle in the drifting layer is accepted to be of significance in the more continuous production and ingestion of VFA in the forestomachs (Enemark, 2008). The event of abomasal ulcers has been connected to management and feeding of acidic diets comprising of concentrates and silage.

Rumenitis

Rumenitis is one of the most incessant spin-offs of rumen acidosis. The pathogenesis is not plainly seen, however, an increased production of VFA especially butyrate and propionate just as a brief ascent in ruminal lactate focus and variances in the osmolality of the rumen liquid may confuse advancement of rumenitis (Krehbiel et al., 1995). Parakeratosis is an outcome of increased lactate production which results mucosal sore. Mucosal injuries in rumenitis encourage passageway of *Fusobacterium necrophorum* and once in a while *Acanobacterium pyogenes* and help their subsequent colonization in the submucosa. Embolic spread to the liver makes development of hepatic boil with metastasis the aspiratory course by means of back vena cava causing burst of minor pneumonic corridors into the bronchi. Clinically these scenes may prompt epistaxis and haemoptysis portrayed by bleeding, frothing expectorate around the gag and nostrils showing indications of lethal rumenitis (Nordlund et al., 1995; Enemark, 2008).

Bloat

Swell is of specific issue in dairy herds kept up on high concentrate diet. The genuine connections have not yet been built up however the mix of decreased rumen motility brought about by a low fiber ration and subsequently a low rumen pH, extreme production of mucopolysaccharides and arrival of obscure macromolecules from rumen microorganisms because of bacterial crumbling should bring about the development of a steady froth upsetting eructation of gases from rumen (Cheng et al., 1998). In any case, rumen balance because of low rumen pH may likewise contribute accumulation of free gases coming about swell.

Diarrhoea

The diarrhoea has been related with SARA in dairy herds (Oetzel, 2015). It was accounted for that, cows expending low fiber diets and experiencing SARA had more fluid excrement than cows on high forage diet. Excrement from cows with SARA seemed more brilliant and more yellowish than the dung of cows without SARA (Kleen et al., 2003). Frothy dung and loose bowels propose poor ruminal and broad hindgut fermentation related with SARA. Fermentation in the hindgut produces VFA and carbon dioxide. These VFAs can be consumed, yet gas is gotten away in hindgut and produces rises in dung giving them the 'frothy' appearance. Hindgut fermentation likewise brings about increased acidity of the hindgut substance. The increased acidity prompts sloughing of the epithelial cells in the digestive organ discharged with faces. As hindgut gets serious acidic, more water from epithelial cells come to neutralize it. As a result, poor consistency of the ingesta and at last the runs happens.

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

Infertility

SARA may influence fertility of dairy cows in a roundabout way Besides calving and potentially the health of the infant calf (Enemark, 2008). Cycling feeding is an outcome of SARA which may diminish accessibility of energy and some other indispensable supplements to the cows and the infant by diminishing DMI during early lactation. This condition is related with fertility in cows during post-partum and deficient development of the ova (Britt, 1995).

Economic loss

SARA has extraordinary financial result to the dairy ventures everywhere throughout the world. The monetary lose due to SARA results from reduced milk production, poor proficiency of milk production, untimely automatic separating and increased passing loss (Krause and Oetzel, 2005). It was assessed to be US$1.12/day per cow monetary loss in herds determined to have SARA (Stone, 1999). It was likewise revealed that, decreased feed consumption due to SARA came about impeded development in calves and evaluated in lost US$10-13 for each animal alongside extra loss from liver sore happened in 15% of the cases.

PREVENTIVE MEASURES

Physically effective fiber (peNDF)

The peNDF identifies with the physical attributes of a feed which shows its capability to animate chewing (Mertens, 1997). Extended fodder particles in the feeding regimen contain adequate peNDF which advances chewing and salivary emission that support the acids coming about because of feed processing. In this manner, particle length of forages and the measure of forage fiber in the diet assume huge purpose on rumen pH through salivary buffering. Moreover, long forage fiber makes a skimming mat in the rumen, which animates reticulo-ruminal compressions to expel VFA by means of ingestion and section of liquid from rumen to bring down gut and in this manner decrease the danger of SARA.

Fibres are digested gradually than starch and sugar. In this way, incorporating peNDF in the diet hinders the rate of carbohydrate processing in the rumen. Reduced rate of carbohydrate absorption reduces the rate of VFA production, consequently, forestalls enormous drops in rumen pH. Feeding long particle fiber can likewise move the site of starch processing from rumen to the lower gut, which incompletely reduces the hazard for ruminal acidosis (Yang and Beauchemin, 2006). It has, in this way, been suggested that, in any event 40% of the feed particles of dietary TMR for dairy cows ought to be longer than 8 mm in size.

The peNDF substance of the diet can be increased either by expanding NDF content or by expanding cleave length of forages (Beauchemin and Penner, 2009). Whichever way of expanding the peNDF substance of the diet at last builds chewing time and salivary discharge. The expanding peNDF substance of the diet by expanding the NDF content is generally more powerful as far as forestalling SARA than expanding forage particle length. In any case, more exploration is expected to more readily characterize the connections between dry matter intake, peNDF content and ruminal fermentability of diet.

Preparation of diet

Diets devoured by cows may contrast as often as possible from those that have been detailed because of mistakes in blending and feed sorting. It was accounted for that, cows favor littler feed particles than bigger ones (Leonardi and Armentano, 2003) which demonstrates that, regardless of whether the diet contains adequate peNDF, the bit that is really devoured may not. Some dairy ranchers add water to TMR to diminish dry matter substance so as to abstain from sorting. Adding water is intended to tie proportion particles together and make it hard to sorting against bigger forage particles. It was accounted for that, adding water to diminish a TMR dry matter from 80 to 64% decreased sorting for the littlest particles. Adding water to the rations can conceivably bring down dry matter intake in view of the filling impact of higher dampness proportions. Adding molasses to a dry TMR has been fairly appeared to forestall sorting by restricting activity (DeVries and Gill, 2012). Moreover, sorting can be limited by keeping away from over the top measures of long material in the TMR. It has been recommended that, additional roughage or straw ought not be longer than 2.5-5.0 cm (Shaver, 2002).

Fermentability of feed

The carbohydrate divisions inside diet contrast in their rate of absorption. Sugars and starches are digested quicker than fiber. Dietary starch is provided basically by grains and its rate of absorption in the rumen relies upon the sort of grain and how it is prepared. One way to deal with hinder the rate of fermentation is to supplant a bit of the grain with non-forage fiber sources, for example, beet mash, soybean structures, horse feed feast, distiller's grains, brewer's grains and corn gluten feed (Grant, 1997). Utilization of non-forage fiber sources decreases the measure of starch digested in the rumen. Besides, the best technique to decrease fermentation rate in the rumen is to expand the extent of forage in the diet. Adding forage to the diet not just builds chewing time and saliva emission, it additionally reduces VFA production round the day (Beauchemin et al., 2003). However, as the measure of forage increments in TMR, energy content declines proportionately.

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

Partitioning of carbohydrate

It has been suggested that, for lactating dairy cows creating in excess of 30 kg of milk general rules for carbohydrate portion can be considered as CF=15-17%, ADF=19-21%, NDF (TMR) =27-30%, NDF (Forage) =21-22%, nonstructural carbohydrates, 35 to 40% and starch, 28 to 30%, sugar 6% (Beauchemin and Penner, 2009). The ruminally degradable starch, NDF and carbohydrate ought to be 60 to 70%, 50 to 60% and 50 to 55% of the absolute starch, NDF and carbohydrate substance of the diet. These rules should just be considered without bargaining energy prerequisites of the cows being referred to. Different rules in regards to physical structure and the proportions of auxiliary to nonstructural carbohydrate incorporate forage NDF to ruminally degradable starch >1:1; NDF: nonstructural carbohydrates >0.9 and <1.2 and 15 to 20% eNDF with particle size >3.8 cm long.

Dietary protein

Dietary protein levels have been accounted for to impact the occurrence of laminitis. Manson and Leaver (1988) contrasted diets and 16.1 versus 19.8% crude protein. The high protein diet fundamentally affected motion during clinical weakness for dairy cows somewhere in the range of 3 and 26 wk baby blues. It was considered the impact of 15.3 versus 18% dietary unrefined protein on solid calves and on those influenced with laminitis. It was seen that, high rates of ruminally degradable protein were answerable for faltering and laminitis. In any case, little data is accessible with respect to purpose of protein in the improvement of weakness. A few propositions include unfavorably susceptible histaminic responses to specific kinds of proteins (Nilsson, 1963) or a connection between high protein supplementation (Bazeley and Pinsent, 1984).

Dietary yeast

Utilization of microorganism to forestall neurotic changes in dairy cow is notable. Nocek et al. (2002a,b) announced that, inoculation of microorganisms into rumen was viable against SARA. Three kinds of lactate using microorganisms i.e., *Enterococcus faeccium*, *Lactobacillus plantarum* and *Sacchoromyces cerevisae* were applied intraruminaly. These microorganisms after immunization, viably forestalled collection of lactic acid and lead to high ruminal pH. However, direct immunization of *Selenomonas ruminantium* and *Megasphaera elsdenii* was sketchy since their endurance was short (Owens et al., 1998). *In vitro* examinations proposed that, Saccharomyces cerevisiae communicated with rumen microorganisms to diminish lactate collection. It infers that, yeast supplement might be helpful to the cows experiencing ruminal acidosis. In any case, Saccharomyces cerevisiae reduced the impact of a grain-put together ruminal acidosis challenge with respect to rumen fermentation. Conversely, Li et al. (2013) revealed that, assembly of short chain fatty acid settled ruminal pH. Hereditary control of lactolytic microscopic organisms is a generally new thought with the point of expanding the lactate transformation limit and acid opposition of the microorganisms yet no industrially accessible item has yet been produced (Martin and Dean, 1989). Supplementation of dicarboxylic acids, for example, fumarate and maleate may likewise act along these lines however documentation is not yet accessible (Owens et al., 1998).

Chewing activity

The dairy cows normally burn through 2 to 6 h/d for eating, 3 to 9 h/d for ruminating and a limit of around 14 h/d for chewing relying on the diet. Expanding peNDF of the diet either by expanding the NDF content or expanding the slash length of forages builds chewing time and thus salivary discharge. It was accounted for that, each extra kilogram of peNDF in a peNDF lacking diet can expand chewing time by up to 5-7 h/d contrasted with the diets containing satisfactory peNDF. In this manner, a little increment in peNDF substance of the diet can be successful when diets are low in fiber. Vegetable forages and high protein feeds have more buffering limit than grains (Jasaitis et al., 1987). Forages having little particles are less viable in invigorating rumination which brings about less saliva production. For instance, rate of salivation production for new grass, silage and grass feed was 0.94 ml, 1.13 ml and 3.25 ml/g individually (Bailey, 1958).

Although, expanding peNDF substance of diet builds chewing time, however the expansion in saliva yield because of increased chewing is not as incredible as expected since the increased progression of salivation during chewing is joined by a reduction in resting salivation discharge (Maekawa et al., 2002). It was accounted for that, the net increment altogether salivary emission because of 1 h/d additionally chewing is around 7 L which may support just around 0.5 kg of ground grain. Consequently, the net impact of the steady saliva production on mean rumen pH is moderately little although an expansion in salivation emission during eating can help decrease the degree to which pH dips under 5.8 after suppers.

Fermentation modifiers

Feed added substances that help change the microbial environment of the rumen, for example, sodium bicarbonate, yeast, bacterial direct took care of microbials and monensin can help limit acidosis. Buffers might be added to most lactating cow's diet as a prudent step in avoidance of acidosis (Garry, 2002). They might be included situations where the fiber content in the feed is excessively low. It has been accounted for that, the expansion of 150 g of sodium bicarbonate to the lactation feed every day positively affected the milk yield (Downer and Cummings, 1985). Thus, a beneficial outcome has been shown on feed intake and milk fat rate. Sodium bicarbonate at 0.5 to 0.75% of DMI might be brought into the proportion progressively because of their low attractiveness. Buffers might be offered free decision to cattle

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

dependent on the presumption that, ruminants will promptly expend the sum expected to reduce the impacts of SARA. Sodium bicarbonate can be given either blended into the ration or free choice. In any case, blending the bicarbonate into the ration was more compelling than giving it free decision.

Adaptation

Surface zone of ruminal papillae is influenced by diet (Xu and Allen, 1999). Offering high roughage diets during dry period may diminish papillae surface territory which reduces rate of VFA absorption (Allen et al., 2006). It was accounted for that, rumen papillae altogether increased in size and capacity to assimilate VFA was increased when animals were changed from roughage and straw based diet to a high energy diet containing a blend of grass feed and grain two wk preceding refreshing (Mertens, 1992). Dirksen et al. (1985) stressed the significance of versatile changes of the rumen mucosa for anticipation of acidosis. It was seen that, rumen papillae increased from 10 mm2 to 60 mm2 when cows were presented to high concentrate diets from four to six wks. Rumen papillae seemed to arrive at their most extreme length at 4 to 5 wk post-calving. *In vivo* VFA absorption rates performed at 14 wk post-calving were substantially more prominent around then contrasted and when cows were taken care of the feed straw diet. In another investigation, Stone et al. (2003) assessed papillae size and their capacity to retain valerate in 4 Holstein calves and watched substantial changeability in papillae size and ruminal ingestion of valerate.

Of the SCFAs, butyrate has been accounted for to be the most powerful trigger of epithelial expansion in colonic epithelial cells. Intra-ruminal mixture of butyrate has for some time been known to incite ruminal epithelial expansion *in vivo*. However, rather than *in vivo* investigations, butyrate has been appeared to evoke an inhibitory impact on ruminal epithelial multiplication *in vitro*. These differentiating results demonstrate that, butyrate alone can't advance epithelial expansion legitimately, rather acts through the arrival of certain hormones and development factors. It was accounted for that, EGF, IGF-1, GH, insulin and glucagon fixation increased in a portion subordinate way because of ruminal mixtures of blended SCFA which animated multiplication of ruminal epithelium for adjustment to the subsequent changes.

Immunization

There exist positive relationships between the counter *Streptococcus bovis* and hostile to Lactobacillus IgG in serum and salivation and pervasiveness of SARA (Shu et al., 1999). Contrasted with control group, guides in the vaccinated group had higher ($P<0.05$) feed consumption, lower ($P<0.05$) ruminal concentrations of lactate and lower quantities of *Streptococcus bovis* and Lactobacillus. So also, polyclonal antibodies arranged against *S. bovis* or *Fusobacterium necrophorum* when applied to calves, substantially decreased rumen concentrations of target microscopic organisms and increased pH in steers took care of high-grain diets (Calsamiglia et al., 2012). These investigations recommend that, the danger of lactic acidosis can be decreased by inoculation against *S. bovis* and Lactobacillus (Gill et al., 2000). In another examination, the danger of *lactic acidosis* in sheep was reduced by inoculation with a live *Streptococcus bovis* antibody (Shu et al., 1999).

Bunk management

Congestion, rivalry for bunk space, constrained access to feed, rare TMR push-up in the bunk, segment feeding, stall comfort and long milking parlor time increment the danger of SARA (Stone, 2004). In this way, the components of the stall must be sufficient for the size of animal that is being housed, particularly stall length, width and jump space. Moreover, satisfactory stall space ought to be given to permit ruminating to roughly 12 to 14 h/d. Ideal materials ought to be given for cow comfort.

CONCLUSION

Sub-acute ruminal acidosis (SARA) is a multi-factorial silent threat for financial issue, animal health and welfare even in well managed dairy herds. As efficiency builds up, the interest for quickly fermentable carbohydrate increments proportionately which makes high yielding cows increasingly prone to SARA. Along these lines, planning high energy diet with satisfactory peNDF is a reliable predictor under traditional feeding framework. Moreover, subclinical course of the disease with complex etiology and pathogenesis confound its outline, analysis, monitoring and avoidance. Cautiously adjusting rumen to changes in diet, reducing fermentability of carbohydrate part, providing adequate peNDF to keep up ideal digesta pool that invigorate satisfactory salivary buffer course through rumination and elevate ruminal motility to expand VFA absorption are the fundamental variables to be considered in controlling SARA.

DECLARATIONS

Corresponding Author

E-mail: emran@cvasu.ac.bd

Authors' Contribution

I am the sole contributor of the manuscript.

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

Conflict of interests

None.

Acknowledgements

The author acknowledges Department of Animal Science and Nutrition, Chattogram Veterinary and Animal Sciences University.

REFERENCES

Allen MS (2000). Effects of diet on short-term regulation of feed intake by lactating dairy cattle. Journal of Dairy Science, 83 (7):1598-1624. https://doi:10.3168/jds.S0022-0302(00)75030-2

Allen MS, Voelker JA, Oba M. Physically effective fiber and regulation of ruminal pH: More than just chewing. Production Diseases in Farm Animals. NP Joshi and TH Herdt, ed. Wageningen Academic Publishers, Wageningen, the Netherlands. 270-8. Google Scholar

Andersen PH (2003). Bovine endotoxicosis - Some aspects of relevance to production diseases. A review. Acta Veterinaria Scandinavica, Supplement, 44 (98):141-155. https://doi:10.1186/1751-0147-44-s1-s141

Ash RW (1959). Inhibition and excitation of reticulo-rumen contractions following the introduction of acids into the rumen and abomasum. The Journal of Physiology, 147 (1): 58-73. https://doi:10.1113/ jphysiol.1959.sp006221

Bailey CB (1958). Nutritional Ecology of the Ruminant. 2nd edn. Cornell University Press. Google Scholar

Bauman DE and Griinari JM (2001). Regulation and nutritional manipulation of milk fat: Low-fat milk syndrome. Livestock Production Science, 70 (1-2):15-29. https://doi.org/10.1016/S0301-6226(01)00195-6 I Google Scholar

Bauman DE, Baumgard LH, Corl BA and GriinaridJM (1999). Biosynthesis of conjugated linoleic acid in ruminants, pp. 1-14. Google Scholar

Bauman DE, Baumgard LH, Corl BA, Griinari DJ. Biosynthesis of conjugated linoleic acid in ruminants. Proceedings - American Society of Animal Science, 77: 1-14. Google Scholar

Bauman DE, Harvatine KJ and Lock AL (2011). Nutrigenomics, Rumen-Derived Bioactive Fatty Acids and the Regulation of Milk Fat Synthesis. Annual Review of Nutrition, 31 (1):299-319. https://doi:10.1146/ annurev.nutr.012809.104648

Baumgard LH, Corl BA, Dwyer DA, Saebø and Bauman DE (2000). Identification of the conjugated linoleic acid isomer that inhibits milk fat synthesis. American Journal of Physiology - Regulatory Integrative and Comparative Physiology, 278 (1 47-1):R179-R184. https://doi:10.1152/ajpregu.2000.278.1.r179

Bazeley K and Pinsent PJ (1984). Preliminary observations on a series of outbreaks of acute laminitis in dairy cattle. The Veterinary Record, 115 (24):619-622. https://doi:10.1136/vr.115.24.619

Beauchemin K and Penner G (2009). New developments in understanding ruminal acidosis in dairy cows. InTri-State dairy nutrition conference. pp 1-12. Google Scholar

Beauchemin KA, Yang WZ, Morgavi DP, Ghorbani GR, Kautz W and Leedle JAZ (2003). Effects of bacterial direct-fed microbials and yeast on site and extent of digestion, blood chemistry, and subclinical ruminal acidosis in feedlot cattle. Journal of Animal Science, 81 (6):1628-1640. https://doi:10.2527/2003.8161628x

Boosman R, Németh F and Gruys E (1991). Bovine laminitis: clinical aspects, pathology and pathogenesis with reference to acute equine laminitis. The Veterinary quarterly, 13 (3):163-171. https://doi:10.1080/01652176.1991.9694302

Brent BE (1976). Relationship of acidosis to other feedlot ailments. Journal of animal science, 43 (4):930-935. https://doi:10.2527/jas1976.434930x

Britt JH (1995). Relationships between postpartum nutrition, weight loss and fertility. Cattle Practice, 3:79-83. Google Scholar

Britton RA and Stock RA (1987). Acidosis, rate of starch digestion and intake. Annual report-Oklahoma Agricultural Experiment Station. Proceedings of the 1986 Feed Intake Symposium: 125-137. Google Scholar

Calsamiglia S, Blanch M, Ferret A and Moya D (2012). Is subacute ruminal acidosis a pH related problem? Causes and tools for its control. Animal Feed Science and Technology, 172 (1-2):42-50. https://doi:10.1016/j.anifeedsci.2011.12.007

Chavance J (1946). Histamine theory and treatment of laminitis. Veterinary medicine, 41:199-201. PMID: 21028740 I Google Scholar

Cheng KJ, McAllister TA, Popp JD, Hristov AN, Mir Z and Shin HT (1998). A Review of Bloat in Feedlot Cattle. Journal of Animal Science, 76 (1):299-308. https://doi:10.2527/1998.761299x

Coon RE, Duffield TF and DeVries TJ (2019). Short communication: Risk of subacute ruminal acidosis affects the feed sorting behavior and milk production of early lactation cows. Journal of Dairy Science, 102 (1):652-659. https://doi:10.3168/jds.2018-15064

De Veth MJ and Kolver ES (2001). Diurnal variation in pH reduces digestion and synthesis of microbial protein when pasture is fermented in continuous culture. Journal of Dairy Science, 84 (9):2066-2072. https://doi:10.3168/jds.S0022-0302(01)74651-6

DeVries TJ and Gill RM (2012). Adding liquid feed to a total mixed ration reduces feed sorting behavior and improves productivity of lactating dairy cows. Journal of Dairy Science, 95 (5):2648-2655. https://doi:10.3168/jds.2011-4965

Dirksen G, Liebich HG, Brosi G, Hagemeister H and Mayer E (1984). Morphology of the rumen mucosa and fatty acid absorption in cattle–important factors for health and production. Zentralblatt fur Veterinarmedizin Reihe A, 31 (6):414-41430. PMID: 6435341 I Google Scholar

Dirksen GU, Liebich HG and Mayer E (1985). Adaptive changes of the ruminal mucosa and their functional and clinical significance. Bovine Practitioner, 20:116-120. Google Scholar

Downer JV and Cummings KR (1985). A ten year review of lactation study. Journal of Dairy Science, 68 (Suppl. 1):191-201. Google Scholar

Enemark J, Jorgensen RJ and Enemark P (2002). Rumen acidosis with special emphasis on diagnostic aspects of subclinical rumen acidosis: a review. Veterinarija ir zootechnika, 20 (42):16-29. Google Scholar

Enemark JMD (2008). The monitoring, prevention and treatment of sub-acute ruminal acidosis (SARA): A review. Veterinary Journal, 176 (1):32-43. https://doi:10.1016/j.tvjl.2007.12.021

Fairfield AM, Plaizier JC, Duffield TF, Lindinger MI, Bagg R, Dick P and McBride BW (2007). Effects of prepartum administration of a monensin controlled release capsule on rumen pH, feed intake, and milk production of transition dairy cows. Journal of Dairy Science, 90 (2):937-945. https://doi:10.3168/jds.S0022-0302(07)71577-1

Garry FB (2002). Indigestion in Ruminants. Large animal internal medicine, 3:722-747. Google Scholar

Giesy JG, Viswanadha S, Hanson TW, Falen LR, McGuire MA, Skaric CH and Vinci A (1999). Effects of calcium salts of conjugated linoleic acid (CLA) on estimated energy balance in Holstein cows early in lactation. Journal of Dairy Science (Supplement), 1 (1):74-74. Google Scholar

Gill HS, Shu Q and Leng RA (2000). Immunization with Streptococcus bovis protects against lactic acidosis in sheep. Vaccine, 18 (23):2541-2548. https://doi:10.1016/S0264-410X(00)00017-7

Goad DW, Goad CL and Nagaraja TG (1998). Ruminal Microbial and Fermentative Changes Associated with Experimentally Induced Subacute Acidosis in Steers. Journal of Animal Science, 76 (1):234-241. https://doi:10.2527/1998.761234x

Gozho GN, Krause DO and Plaizier JC (2007). Ruminal lipopolysaccharide concentration and inflammatory response during grain-induced subacuteruminai acidosis in dairy cows. Journal of Dairy Science, 90 (2):856-866. https://doi:10.3168/jds.S0022-0302(07)71569-2

Grant RJ (1997). Interactions among Forages and Nonforage Fiber Sources. Journal of Dairy Science, 80 (7):1438-1446. https://doi:10.3168/jds.S0022-0302(97)76073-9

Griinari JM and Bauman DE (1999). Biosynthesis of conjugated linoleic acid and its incorporation into meat and milk in ruminants. Advances in conjugated linoleic acid research, 1 (1):180-200. Google Scholar

Hoover WH (1986). Chemical Factors Involved in Ruminal Fiber Digestion. Journal of Dairy Science, 69 (10):2755-2766. https://doi:10.3168/jds.S0022-0302(86)80724-X

Hu W, Murphy MR, Constable PD and Block E (2007). Dietary cation-anion difference effects on performance and acid-base status of dairy cows postpartum. Journal of Dairy Science, 90 (7):3367-3375. https://doi:10.3168/jds.2006-515

Hunt RJ, Allen D and Moore JN (1990). Effect of endotoxin administration on equine digital hemodynamics and starling forces. American journal of veterinary research, 51 (11):1703-1707. PMID: 2240793 | Google Scholar

Ip C, Banni S, Angioni E, Carta G, McGinley J, Thompson HJ, Barbano D and Bauman D (1999). Conjugated Linoleic Acid–Enriched Butter Fat Alters Mammary Gland Morphogenesis and Reduces Cancer Risk in Rats. The Journal of Nutrition, 129 (12):2135-2142. https://doi:10.1093/jn/129.12.2135

Jasaitis DK, Wohlt JE and Evans JL (1987). Influence of Feed Ion Content on Buffering Capacity of Ruminant Feedstuffs *In vitro*. Journal of Dairy Science, 70 (7):1391-1403. https://doi:10.3168/jds.S0022-0302(87)80161-3

Jing L, Dewanckele L, Vlaeminck B, Van Straalen WM, Koopmans A and Fievez V (2018). Susceptibility of dairy cows to subacute ruminal acidosis is reflected in milk fatty acid proportions, with C18:1 trans-10 as primary and C15:0 and C18:1 trans-11 as secondary indicators. Journal of Dairy Science, 101 (11):9827-9840. https://doi:10.3168/jds.2018-14903

Khafipoor E, Krause DO, Plaizier JC. (2007). Induction of subacute ruminal acidosis (SARA) by replacing alfalfa hay with alfalfa pellets does not stimulate inflammatory response in lactating dairy cows. Journal of Animal Science, 90:654-654. Google Scholar

Khalouei H, Alamouti AA, Mohammadi-Sangcheshmeh A, Farzaneh N, Plaizier JC and Khafipour E (2016). 0146 Subacute ruminal acidosis negatively affects conception rate in Holstein heifers. Journal of Animal Science, 94 (suppl_5):69-69. https://doi:10.2527/jam2016-0146

Kleen JL, Hooijer GA, Rehage J and Noordhuizen JPTM (2003). Subacute ruminal acidosis (SARA): A review. Journal of Veterinary Medicine Series A: Physiology Pathology Clinical Medicine, 50 (8):406-414. https://doi:10.1046/j.1439-0442.2003.00569.x

Krajcarski-Hunt H, Plaizier JC, Walton JP, Spratt R and McBride BW (2002). Short communication: Effect of subacute ruminal acidosis on in situ fiber digestion in lactating dairy cows. Journal of Dairy Science, 85(3):570-573. https://doi:10.3168/jds.S0022-0302(02)74110-6

Krause KM and Combs DK (2003). Effects of forage particle size, forage source, and grain fermentability on performance and ruminal pH in midlactation cows. Journal of Dairy Science, 86 (4):1382-1397. https://doi:10.3168/jds.S0022-0302(03)73722-9

Krause KM and Oetzel GR (2006). Understanding and preventing subacute ruminal acidosis in dairy herds: A review. Animal Feed Science and Technology, 126 (3-4):215-236. https://doi:10.1016/j.anifeedsci.2005.08.004

Krehbiel CR, Britton RA, Harmon DL, Wester TJ and Stock RA (1995). The effects of ruminal acidosis on volatile fatty acid absorption and plasma activities of pancreatic enzymes in lambs. Journal of animal science, 73 (10):3111-3121. https://doi:10.2527/1995.73103111x

Leonardi C and Armentano LE (2003). Effect of quantity, quality, and length of alfalfa hay on selective consumption by dairy cows. Journal of Dairy Science, 86 (2):557-564. https://doi:10.3168/jds.S0022-0302(03)73634-0

Li S, Khafipour E, Yoon I and Scott M and Plaizier J (2013). Saccharomyces cerevisiae fermentation product stabilized rumen microbial communities of lactating dairy cows during subacute ruminal acidosis. In, Congress on Gastrointestinal Function Meeting, Chicago, IL. Google Scholar

Maekawa M, Beauchemin KA and Christensen DA (2002). Effect of concentrate level and feeding management on chewing activities, saliva production, and ruminal pH of lactating dairy cows. Journal of Dairy Science, 85 (5):1165-1175. https://doi:10.3168/jds.S0022-0302(02)74179-9

Martin SA and Dean GF (1989) Use of genetically engineered rumen bacteria may aid in prevention of acidosis in cattle. Feedstuffs, 1989:17-18,38. Google Scholar

Mertens DR (1992). Nonstructural and structural carbohydrates. Large dairy herd management, 1:219-235. Google Scholar

Mertens DR (1997). Creating a System for Meeting the Fiber Requirements of Dairy Cows. Journal of Dairy Science, 80 (7):1463-1481. https://doi:10.3168/jds.S0022-0302(97)76075-2

Nilsson SA (1963). Clinical, morphological, and experimental studies of laminitis in cattle. ActaVeterinariaScandinavica, 4 (Suppl. 1):304, pp. 304. Google Scholar

Nocek JE (1997). Bovine Acidosis: Implications on Laminitis. Journal of Dairy Science, 80 (5):1005-1028. https://doi:10.3168/jds.S0022-0302(97)76026-0

Nocek JE, Allman JG and Kautz WP (2002a). Evaluation of an indwelling ruminal probe methodology and effect of grain level on diurnal pH variation in dairy cattle. Journal of Dairy Science, 85 (2):422-428. https://doi:10.3168/jds.S0022-0302(02)74090-3

Nocek JE, Kautz WP, Leedle JAZ and Allman JG (2002b). Ruminal supplementation of direct-fed microbials on diurnal pH variation and in situ digestion in dairy cattle. Journal of Dairy Science, 85 (2):429-433. https://doi:10.3168/jds.S0022-0302(02)74091-5

Nordlund KV, Garrett EF and Oetzel GR (1995). Herd-based rumenocentesis: a clinical approach to the diagnosis of subacute rumen acidosis. Food Animal Medicine and Management, 17 (8):s48-s48. Link | Google Scholar

Oetzel GR (2015). Subacute Ruminal Acidosis in Dairy Herds: Physiology, Pathophysiology, Milk Fat Responses, and Nutritional Management. pp 89-119. Google Scholar

Owens FN, Secrist DS, Hill WJ and Gill DR (1998). Acidosis in Cattle: A Review. Journal of Animal Science, 76 (1):275-286. https://doi:10.2527/1998.761275x

Palmquist DL, Denise Beaulieu A and Barbano DM (1993). Feed and Animal Factors Influencing Milk Fat Composition. Journal of Dairy Science, 76 (6):1753-1771. https://doi:10.3168/jds.S0022-0302(93)77508-6

Parodi PW (1977). Conjugated Octadecadienoic Acids of Milk Fat. Journal of Dairy Science, 60 (10):1550-1553. https://doi:10.3168/jds.S0022-0302(77)84068-X

Penner GB, Steele MA, Aschenbach JR and McBride BW (2011). Ruminant nutrition symposium: Molecular adaptation of ruminal epithelia to highly fermentable diets. Journal of Animal Science, 89 (4):1108-1119. https://doi:10.2527/jas.2010-3378

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

Plaizier JC, Krause DO, Gozho GN and McBride BW (2008). Subacute ruminal acidosis in dairy cows: The physiological causes, incidence and consequences. Veterinary Journal, 176 (1):21-31. https://doi:10.1016/j.tvjl.2007.12.016

Plaizier JC, Li S, Danscher AM, Derakshani H, Andersen PH and Khafipour E (2017). Changes in Microbiota in Rumen Digesta and Feces Due to a Grain-Based Subacute Ruminal Acidosis (SARA) Challenge. Microbial Ecology, 74 (2):485-495. https://doi:10.1007/s00248-017-0940-z

Russell JB and Allen MS (1984). Physiological basis for interactions among rumen bacteria using Streptococcus bovis and Megasphaeraelsdenii as a model. American Society for Microbiology, pp. 239-247. Google Scholar

Russell JB and Rychlik JL (2001). Factors that alter rumen microbial ecology. Science, 292 (5519):1119-1122. https://doi:10.1126/science.1058830

Russell JB and Wilson DB (1996). Why Are Ruminal Cellulolytic Bacteria Unable to Digest Cellulose at Low pH? Journal of Dairy Science, 79 (8):1503-1509. https://doi:10.3168/jds.S0022-0302(96)76510-4

Sarashina T, Ichijo S, Takahashi J and Osame S (1990). Origin of abomasum gas in the cows with displaced abomasum. Nippon juigakuzasshi The Japanese journal of veterinary science, 52 (2):371-378. https://doi:10.1292/jvms1939.52.371

Shaver R (2002). Rumen acidosis in dairy cattle: Bunk management considerations. Advanced Dairy Technology, 14 (Dm):241-249. Google Scholar

Shaver RD (1997). Nutritional Risk Factors in the Etiology of Left Displaced Abomasum in Dairy Cows: A Review. Journal of Dairy Science, 80 (10):2449-2453. https://doi:10.3168/jds.S0022-0302 (97)76197-6

Shinozaki K (1959). Studies on experimental bloat in ruminants 5. Effects of various volatile fatty acids introduced into the rumen on the rumen motility. Tohoku Journal of Agricultural Research, 9 (4):237-250. Google Scholar

Shu Q, Gill HS, Hennessy DW, Leng RA, Bird SH and Rowe JB (1999). Immunisation against lactic acidosis in cattle. Research in Veterinary Science, 67 (1):65-71. https://doi:10.1053/rvsc.1998.0284

Stone WC (1999). The effect of subclinical rumen acidosis on milk components. In, Proceedings Cornell nutrition conference for feed manufacturers. Link I Google Scholar

Stone WC (2004). Nutritional approaches to minimize subacute ruminal acidosis and laminitis in dairy cattle. Journal of Dairy Science, 87 (SUPPL. 1). https://doi:10.3168/jds.S0022-0302(04)70057-0

Stone WC, Bulkley SL, Aneshansley DJ and Alcaraz AL (2003). An evaluation of rumen papillae in Holstein heifers during the transition period. Journal of Dairy Science, 86 (Suppl 1):227-227. Google Scholar

Thomas PC and Martin PA (1988). The Influence of Nutrient Balance on Milk Yield and Composition. Nutrition and Lactation in the Dairy Cow, pp. 97-118. https://doi:10.1016/b978-0-408-00717-7.50011-3

Vargas-Bello-Pérez E and Garnsworthy PC (2013). Trans fatty acids and their role in the milk dairy cows. International Journal of Agriculture and Natural Resources, 40(3): 449-473. Google Scholar

Wiese BI, Campbell J, Hendrick S and Penner GB (2017). Ruminal pH, short-chain fatty acid concentrations, and serum acute phase protein concentrations during finishing for steers with and without rumen and liver pathology. Canadian Journal of Animal Science, 97 (4):581-589. https://doi.org/10.1139/cjas-2016-0212

Xu J and Allen MS (1999). Effects of dietary lactose compared with ground corn grain on the growth rate of ruminal papillae and rate of valerate absorption from the rumen. South African Journal of Animal Science, 29. Google Scholar

Yang WZ and Beauchemin KA (2006). Physically effective fiber: Method of determination and effects on chewing, ruminal acidosis, and digestion by dairy cows. Journal of dairy science, 89(7): 2618-2633. https://doi.org/10.3168/jds.S0022-0302(06)72339-6 I Google Scholar

Citation: Hossain ME (2020). Sub-acute ruminal acidosis in dairy cows: Its causes, consequences and preventive measures. *Online J. Anim. Feed Res*., 10(1): 302-312. DOI: https://dx.doi.org/10.51227/ojafr.2020.41

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 313-320; November 27, 2020 ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.42

EFFECT OF DIETARY SUPPLEMENTED COWPEA (*Vigna unguiculata*) HAY AS REPLACEMENT OF CONCENTRATE ON PERFORMANCE AND ECONOMIC EFFICIENCY OF ABERGELLE GOATS

Bewketu AMARE[1] and Ayalew GIRMAY[2]

Sekota Dry Land Agriculture Research Center, P.o.box 62, Sekota, Ethiopia

Email: bewketa21@gmail.com; ORCID: 0000-0002-5739-7438

Supporting Information

RESEARCH ARTICLE

PII: S222877012000042-10

Received: August 13, 2020

Revised: Revised 24, 2020

ABSTRACT: The study were conducted at Sekota district using twenty four yearling male Aberegelle goats for 100 days to evaluate the effect of substitution of concentrate mix with cowpea hay on biological and economic benefits. The treatments were natural grass hay alone (T1) and supplemented with 100% concentrate mix (T_2), 75: 25% (T_3), 50:50% (T_4), 25:75% (T_5) concentrate mix: cowpea hay and 100% cowpea hay (T_6) per head per day. Randomized complete block design with six treatments and five replications was used. The crude protein (CP) content of grass hay, concentrate mix and cowpea hay were 6.80, 16.30 and 19.62%, respectively. Daily hay dry matter (DM) intake of the control was significantly higher (P<0.05) than other treatments. Apparent DM, organic matter (OM), acid detergent fiber (ADF), neutral detergent fiber (NDF), CP digestibility and body weight change of supplemented treatments were significant (P<0.001) as compared to the control, however there were no significant differences in intake, digestibility, linear body measurement and growth performance of goats fed different proportion of concentrate and cowpea hay. However, sole cowpea hay supplementation performs better in terms of net return and farmers' preference. Therefore, supplementation of sole cowpea hay would be both biologically, economically and socially acceptable level for Abergelle goats bred.

Keywords: Cowpea, Digestibility, Feed intake, Ruminant.

INTRODUCTION

In Ethiopia feeding of ruminant depend on crop residues and poor quality hay. As a result, the digestibility and intake of these feeds are low which results in poor performance (Mekuriaw and Asmare, 2018; Wamatu et al., 2019). Despite the potential economic benefits, cereal grain and concentrate supplementation to low-quality feeds is unaffordable by smallholder farmers in addition to scarcity and its use as human food. Therefore, there is a need to look for protein sources that farmers could get from their own farm with minimum cost. One potential way could be through the use of fodder trees, shrub and herbaceous legumes. One of such fodder legumes is cowpea which is relatively drought-resistant plant (Paul et al., 2020). Sekota dry land research center had recommended two varieties of cowpea which have potential to produce high biomass ranging from1.8 to 2.1 DM t/ha (SDARC, 2008). And most of the farmers grown local cultivar for seed production, biomass during dry season and used the haulm for feeding selected animals such as ill, lactating and castrated animals. This illustrates cowpea is an excellent source of protein ranging from 19.5-26% which could be a substitute for more expensive concentrates (Owolabi et al., 2012).

However, in Ethiopia information on feeding value of cowpea hay in relation to goat performance is scanty especially as a substitute to conventional protein supplement. Therefore, the objective of the study was to evaluate the effect of substitution of concentrate mixture with cowpea hay on feed intake, digestibility and weight change of Abergelle goats and to determine the economic feasibility.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Sekota district, Ethiopia. It is located between 12^0 23' and 13^0 16' north and 38^0 44' and 39^0 21' east (CSA, 2014). The altitude ranges from 1340-2200 meters above sea level (WZAD, 1995). Annual rainfall ranges between 350-650 mm (AMAREW, 2006).

Feed intake, body weight and linear body measurement

Natural pasture grass hay was purchased from farmers and hand chopped to a size of about 1-10 cm. Cowpea were planted in Sekota research center farm and harvested at 50% blooming. The concentrate mixture was composed of 70% wheat bran and 30% Noug seed cake. The feed were offered in two equal proportions at 0800 and 1600 hour. The feed

Citation: Amare B and Girmay A (2020). Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats. *Online J. Anim. Feed Res*., 10(6): 313-320. DOI: https://dx.doi.org/10.51227/ojafr.2020.42

was formulated based on metabolizable energy and crude protein requirements for maintenance and growth of Aberegelle goat (Bewketu Amare et al., 2015) weighting 15-20 kg and with expected 70g/day weight gain. Grass hay was offered ad libitum allowing 20% refusal. Water and salt licks had available free choice. Daily feed offers and refusals per goat were collected and weighted to determine daily feed intake. Samples of feed offered and refused were collected, bulked and sub-samples were taken after thoroughly mixing for determination of nutrient composition. Live body weights of goat were measured every 10 days after overnight fasting. Average daily weight gain was calculated as the difference between final and initial weight divided by 90 days. Metabolizable energy intake were estimated as follows: ME (MJ/kg) = 0.0157* digestible organic matter intake (AFRC, 1993): Microbial N production=1.34* Metabolizable energy intake (ARC, 1984). Linear body measurements were measured using tape meter (Deboer et al., 1974). The total gain was calculated as the difference of initial and final measurement.

Experimental animal's management and treatments

Twenty four intact yearling male Aberegelle goats were purchased from local market. Age of goat was determined by looking at their dentition and information gathered from the owners. All goats were de-wormed, injected against internal and external parasite as well as vaccinated against disease. Randomized Complete Block Design (RCBD) was used. Treatments were a basal diet of natural pasture grass hay alone (T_1) and supplemented with 100% concentrate mix (T_2), 75:25% (T_3), 50:50% (T_4), 25:75% (T_5) concentrate mix: cowpea hay and 100% cowpea hay (T_6) per head per day.

Digestibility trial

Digestibility trial was conducted after the end of feeding trial. All goats were fitted with fecal collection bags for five days of adaptation period before the resumption of actual collection of feces for nine consecutive days. The daily feces output of each goats were collected and weighted. After thorough mixing, 30% of the daily fecal excretion of each goat were sampled and stored at -20 °C. After nine days, feces were thawed and sub-sample from each plastic bag and pooled per goat. Apparent digestibility of nutrients was calculated as the proportion of the difference between nutrient consumed and nutrient in feces to nutrient consumed.

Chemical analysis

Samples of feed offer, refusal and feces were dried in an oven at 60°C for 72 hours and ground to pass through 1mm sieve. All samples were analyzed for DM, ash, OM and N contents (AOAC, 1995). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) contents were analyzed according to the procedure of VanSoest and Robertson (1985). Hemicelluloses, cellulose and soluble matter were calculated as NDF minus ADF, ADF minus ADL and 100 minus NDF, respectively.

Economic analysis and farmers assessment of the feeding trial

Partial budget analysis was performed using the procedure of Upton (1979). In the tradition of Sekota farmers, natural pasture grass and cowpea hay were sold with local name of Mewogeya and Shekeme, respectively. They sold a single Mewogeya and Shekeme with 80 and 45 birr. A single Mewogeya and Shekeme weights on average of 70 kg and 25 kg then after translate in to selling price of hay per kilogram, respectively. The buying and selling price of each goat was determined by inviting well experienced goat dealers who know market price of different size of goat in the area. The feed, labor, load and unload, transport and medicament cost were considered as total variable costs. The net return was calculated by subtracting total variable cost (TVC) from total return (TR). The marginal rate of return (MRR) measures the increase in net return (ΔNR) associated with each additional unit of expenditure (ΔTVC). The gross margin analysis was also used to examine the relative contribution of price, weight and their interaction from the gross return (Baur et al., 1989). Sensitivity analysis was also done to capture the likely change in prices of input (feed) and fattened goats. In Ethiopia, the price of animal feed for the last five years has shown an average of 20% increment (USAID, 2013). Thus, sensitivity analysis was hypothesized for 20% increase in feed cost and 20% decrease in selling price of goats. After finishing the feeding trial, a field day was organized and farmer perceptions toward the technology were assessed.

Statistical analysis

Data on feed intake, digestibility, growth and economic parameters were analyzed using the General Linear Model (GLM) procedure of SAS (2003). Mean values were compared by Duncan's Multiple Range Test (Duncan, 1955). The model, $Y_{ij} = \mu + T_i + B_j + e_{ij}$ was used, where: Y_{ij} = Individual observation; μ = Overall mean; T_i = Treatment effect; B_j = Block effect and e_{ij}= Random error

RESULT AND DISCUSSIONS

Chemical composition of treatment feeds

Except natural pasture grass hay, all other ingredients had medium and high CP contents (Table 1). The CP content of cowpea hay in the current experiment is within the range of 19.4 to 26% reported by Alexander et al. (2007) and 18.78–20.22% for different level of fertilizer supplemented cowpea forage (Hasan et al., 2010). The CP content of grass hay in

Citation: Amare B and Girmay A (2020). Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats. *Online J. Anim. Feed Res*., 10(6): 313-320. DOI: https://dx.doi.org/10.51227/ojafr.2020.42

this experiment is higher than 5.15% CP (Ajebu Nurfeta., 2010), respectively. However, it was lower than 7.5-10.9% CP of harvested native pasture hay at 90 and 170 days from Andasa area (Yihalem et al., 2004). This difference in nutrient content of hay could be due to variation plant species, sampling, and method of preparation, climate, plant fraction and stage of maturity at harvesting.

Table 1 - Chemical composition of treatment feeds

Type of feed	DM %	Nutrient (% DM)								
		Ash	OM	CP	NDF	ADF	ADL	HC	C	SM
Natural grass hay	90.00	10.00	90.00	6.80	75.00	44.44	19.99	30.56	24.45	25.00
Cowpea hay	91.00	10.00	90.00	19.62	57.77	31.11	15.50	26.66	15.61	42.23
Wheat bran	89.00	14.00	86.00	11.88	68.88	13.33	6.60	55.55	6.73	31.12
Noug seed cake	88.00	10.00	90.00	26.62	42.22	33.33	13.30	8.89	20.03	57.78
Concentrate mix	88.70	12.80	87.20	16.30	60.88	19.33	8.61	41.55	10.72	39.12
Refusal hay										
T_1	90.00	8.75	91.25	6.56	76.11	53.33	25.27	22.78	28.06	23.89
T_2	90.00	8.50	91.50	6.90	73.89	52.78	24.44	21.11	28.34	26.12
T_3	90.00	8.50	91.50	6.52	74.44	52.22	30.83	22.22	21.39	25.56
T_4	90.00	8.00	92.00	6.58	71.85	52.59	29.25	19.26	23.34	28.15
T_5	90.00	7.75	92.25	8.09	74.99	56.94	28.05	18.06	28.89	25.00
T_6	90.00	8.50	91.50	7.07	73.89	56.11	32.77	17.78	23.34	26.12

DM=dry matter; OM= organic matter; CP = crude protein; NDF=neutral detergent fiber; ADF = acid detergent fiber; ADL= acid detergent lignin; HC=hemicelluloses; C=cellulose; SM=soluble matter. T_1= natural grass hay alone; T_2= natural grass hay + 0% cowpea hay: 100% concentrate mix:; T_3= natural grass hay + 25% cowpea hay: 75% concentrate mix; T_4= natural grass hay + 50% cowpea hay: 50% concentrate mix; T_5= natural grass hay + 75% cowpea hay:25% concentrate mix; T_6= natural grass hay + 100% cowpea hay: 0% concentrate mix

Dry matter and nutrients intake

Supplementation resulted in significantly greater DM, OM, CP and ME intake compared to the control however, statistically similar among supplemented treatments (Table 2). The non-significant difference in NDF and ADF could be due to the higher fiber content of the basal diet in the control. Similarity, substitution rate obliviously due to similar intake of basal diet among supplemented treatments and substituting concentrate mixture with cowpea hay had no negative effect on basal diet intake. Similarly, Patra et al. (2006) observed does fed concentrate containing soybean and leaf mixtures had similar DM, OM and CP intake among treatments with basal diet of wheat straw. On the other hand, Foster et al. (2009) found reduced DM and OM intakes with increasing levels of pigeon pea hay as a supplement to grass hay compared with the control. Moreover, the total DM intake per body weight in all treatments was within the range of 2–6% recommended for goats (ARC, 1980). The higher intake of hay for the control might be due to the deficiency of nutrients in the hay and is an attempt for goat trying to satisfy their nutrient requirement through relatively more hay intake. All treatments were above the minimum CP and energy requirement for maintenance and rumen function of 33 g/day CP and 3.31 MJ/day ME, respectively for 15 kg goats (Kearl, 1982). The microbial nitrogen production in the supplemented group was greater than 10.2-10.9 g/day of Adilo sheep (Ajebu Nurfeta et al., 2013).

Table 2 - Dry matter and nutrients intake of Abergelle goat fed on natural pasture grass hay and supplemented with different proportion of cowpea hay and concentrate mix

Intake (g/day)	Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
Hay DM	885.07^{a}	769.51^{b}	692.38^{b}	740.46^{b}	710.75^{b}	765.97^{b}	20.38	0.0001
Cowpea hay DM	-	-	93.71^{d}	178.64^{c}	276.72^{b}	356.54^{a}	29.21	0.0001
Concentrate mix DM	-	295.42^{a}	225.00^{b}	148.37^{c}	75.00^{d}	-	24.05	0.0001
Total DM	885.07^{c}	1064.93^{ab}	1011.09^{b}	1067.46^{ab}	1062.47^{ab}	1122.52^{a}	22.39	0.0001
Total OM	796.56^{c}	950.17^{ab}	903.68^{b}	956.56^{ab}	954.13^{ab}	1010.27^{a}	20.07	0.0001
Total CP	60.19^{e}	100.48^{d}	102.15^{cd}	109.59^{bc}	114.85^{ab}	122.04^{a}	4.46	0.0001
Total NDF	663.80^{b}	756.99^{a}	710.41^{ab}	748.87^{a}	738.59^{ab}	780.46^{a}	14.12	0.001
Total ADF	393.32^{b}	399.08^{b}	380.34^{b}	413.31^{ab}	416.44^{ab}	451.32^{a}	8.41	0.001
EMN	11.26^{b}	15.69^{a}	14.89^{a}	15.23^{a}	15.59^{a}	15.76^{a}	0.39	0.0001
EME (MJ/day)	8.40^{b}	11.72^{a}	11.12^{a}	11.36^{a}	11.63^{a}	11.76^{a}	0.29	0.0001
Substitution rate	-	0.39^{a}	0.60^{a}	0.44^{a}	0.49^{a}	0.34^{a}	0.05	0.01
% live body weight	5.96^{a}	5.18^{b}	4.89^{b}	5.45^{ab}	5.26^{b}	5.47^{ab}	0.11	0.01

$^{a-e}$ Means within a row not bearing a common superscript are significantly different; SEM=standard error of mean; DM=dry matter; OM=organic matter; CP=crude protein; NDF=neutral detergent fiber; ADF =acid detergent fiber; EME=estimated metabolizable energy; EMN=estimated microbial nitrogen; T_1= natural grass hay alone; T_2= natural grass hay + 0% cowpea hay: 100% concentrate mix:; T_3= natural grass hay + 25% cowpea hay: 75% concentrate mix; T_4= natural grass hay + 50% cowpea hay: 50% concentrate mix; T_5= natural grass hay + 75% cowpea hay: 25% concentrate mix; T_6= natural grass hay + 100% cowpea hay:0% concentrate mix.

Citation: Amare B and Girmay A (2020). Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats. *Online J. Anim. Feed Res*., 10(6): 313-320. DOI: https://dx.doi.org/10.51227/ojafr.2020.42

Apparent digestibility

Apparent DM, OM, ADF, NDF and CP digestibility of supplemented treatments were significant (P<0.001) as compared to control group, however similar among supplemented treatments. This might suggest that supplementation of cowpea and concentrate mixture might have favored comparable and high rumen fermentation and increased production of rumen biomass (McDonald et al., 2002). The DM digestibility values obtained in supplemented treatments fell within the range of 70% to 79% deemed as indicative of high digestible level (Lee, 2008), and that of control was found within the range of 60% to 65% regarded as moderately acceptable digestibility for average animal performance (Devendra and McLeory, 1982).

Table 3 - Apparent digestibility of nutrients in Abergelle goat fed on natural pasture grass hay and supplemented with different proportion of cowpea hay and concentrate mix

Digestibility (%)	Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
DM	65.58^{b}	77.85^{a}	77.93^{a}	75.05^{a}	77.07^{a}	73.21^{a}	1.26	0.0001
OM	67.31^{b}	78.68^{a}	78.56^{a}	75.80^{a}	77.74^{a}	74.36^{a}	1.18	0.0001
CP	50.66^{b}	76.19^{a}	74.43^{a}	72.07^{a}	73.09^{a}	70.42^{a}	2.07	0.0001
NDF	63.68^{c}	76.48^{ab}	77.53^{a}	70.42^{abc}	74.29^{ab}	69.69^{bc}	1.47	0.001
ADF	57.50^{b}	68.01^{a}	69.77^{a}	62.45^{ab}	69.44^{a}	62.71^{ab}	1.54	0.01

$^{a-c}$Means within a row not bearing a common superscript are significantly different; SEM= standard error of mean; DM=dry matter; OM= organic matter; CP = crude protein; NDF=neutral detergent fiber; ADF=acid detergent fiber; T_1= natural grass hay alone; T_2= natural grass hay + 0% cowpea hay: 100% concentrate mix; T_3= ad libitum natural pasture grass hay + 25% cowpea hay: 75% concentrate mix; T_4= natural grass hay + 50% cowpea hay: 50% concentrate mix; T_5= natural grass hay + 75% cowpea hay: 25% concentrate mix; T_6= natural grass hay + 100% cowpea hay: 0% concentrate mix.

Body weight change

Supplementation significantly improved (P<0.001) final weight, weight gain and feed conversion efficiency as compared to the control, however statistically similar among supplemented treatments. Despite the CP and ME intake of the control used in this experiment was above the minimum nutrient requirement for maintenance of goats (Kearl, 1982), goats were unable to maintain body weight fed hay alone. This might be presumably have due to high fiber content, low digestibility, higher minimum nutrient requirement for maintenance of this breed and higher urinary loss. Moreover, the similarity in body weight change among supplemented treatments reflects that the supplements are comparable in their nutrient supply. Similar weight gain was also reported when cotton seed cake substituted Leucaena leucocephala at varying levels (Ndemanisho et al., 1998). However, forage to concentrate ratio was reported to affect average daily gain in kids where increasing the concentrate portion (Haddad, 2005). Furthermore, Karachi and Zengo (1998) and Keba (2009) reported increased body weight gain by increasing the amount of pigeon pea leaves which is not consistent with the current experiment. Generally, cowpea hay can be comparable supplementary value as sole or mixture with concentrate and provide similar performance as compared with concentrate mix. This is important in the areas where concentrate is not available especially for smallholder farmers.

Table 4 - Body weight change and feed conversion of Abergelle goat fed on natural pasture grass hay and supplemented with different proportion of cowpea hay and concentrate mix

Digestibility (%)	Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
Initial body weight	16.20	16.45	15.90	14.60	15.85	15.90	0.37	0.06
Final body weight	14.85^{b}	20.70^{a}	20.80^{a}	19.57^{a}	20.20^{a}	20.75^{a}	0.59	0.0001
Total weight gain	-1.35^{b}	4.25^{a}	4.90^{a}	4.97^{a}	4.35^{a}	4.85^{a}	0.51	0.0001
Daily gain (g/day)	-15.00^{b}	47.22^{a}	54.44^{a}	55.19^{a}	48.33^{a}	53.89^{a}	5.64	0.0001
FCE	-0.017^{b}	0.044^{a}	0.054^{a}	0.052^{a}	0.045^{a}	0.049^{a}	0.01	0.0001

$^{a-b}$Means within a row not bearing a common superscript are significantly different; SEM = standard error of mean; FCE=feed conversion efficiency; T_1= natural grass hay alone; T_2= natural grass hay + 0% cowpea hay:100% concentrate mix:; T_3= natural grass hay + 25% cowpea hay:75% concentrate mix; T_4= natural grass hay + 50% cowpea hay:50% concentrate mix; T_5= natural grass hay + 75% cowpea hay:25% concentrate mix; T_6= natural grass hay + 100% cowpea hay:0% concentrate mix.

Linear body measurement

Most traits of supplemented goats were higher (P<0.05) linear body measurement than control (Table 6). This could be due to supplementation caused muscle and fat cover accumulation around the vertebrae, in the loin and leg region as well as skeletal development (Tesfa et al., 2013). The average values for final HG and BL of current study were comparable with Abergelle goats under on farm condition (Halima Hassen et al., 2012).

Economic analysis of the feeding trial

Even though the analysis revealed that feeding with supplementation in the trial was profitable, goats fed entirely sole hay (T_1) lost 22.33 ETB which was in line with Jemberu et al. (2010) for Simada sheep (-30 ETB/sheep). The reasons

Citation: Amare B and Girmay A (2020). Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats. *Online J. Anim. Feed Res*., 10(6): 313-320. DOI: https://dx.doi.org/10.51227/ojafr.2020.42

for the negative net return might be due to relatively lower body weight, poor body condition and conformation as a result of lower nutrient intake. There is only significant difference when the level of cowpea hay was above 50% of the supplement as compared with the control. Moreover, the higher net return and rate return in T_6 was due to lower cost of feed per live weight gain as a result of availability of cowpea hay in the area. In addition to weight gain, time of purchasing feeds, time of buying and selling price of goats were a major contributor for improving profitability. Generally, the result of this study suggested that the importance of formulating cheap feed source that can substitute expensive industrial by-products and supplementation of natural grass hay with sole cowpea hay was economically beneficial than sole concentrate mix or mixture with cowpea hay for Abergelle goats.

Table 5 - Linear body measurement of Abergelle goat fed on natural pasture grass hay and supplemented with different proportion of cowpea hay and concentrate mix

Parameters	Treatments						SEM	P-value
	T_1	T_2	T_3	T_4	T_5	T_6		
Final HG (cm)	57.25^{b}	64.13^{a}	64.63^{a}	63.67^{a}	64.75^{a}	63.75^{a}	0.68	0.0001
Final BL (cm)	56.75^{c}	62.75^{ab}	62.75^{ab}	62.67^{ab}	63.88^{a}	59.88^{b}	0.75	0.0001
Final HW (cm)	56.63^{c}	64.00^{ab}	64.38^{ab}	61.17^{b}	64.88^{a}	62.75^{ab}	0.77	0.0001
Final PW (cm)	9.00^{b}	11.25^{a}	11.50^{a}	11.83^{a}	12.00^{a}	11.75^{a}	0.31	0.01
Final CW (cm)	12.50^{b}	14.50^{a}	14.38^{a}	13.83^{ab}	13.75^{ab}	13.75^{ab}	0.22	0.06
Final CD (cm)	19.81^{b}	22.19^{a}	22.36^{a}	22.03^{a}	22.40^{a}	22.06^{a}	0.24	0.0001
Final BV (cm^3)	12.08^{b}	18.34^{a}	18.66^{a}	17.32^{a}	18.70^{a}	17.78^{a}	0.63	0.001
Total HG gain (cm)	0.00^{b}	6.88^{a}	7.38^{a}	6.00^{a}	7.50^{a}	6.50^{a}	0.68	0.0001
Total BL gain (cm)	0.00^{c}	6.00^{ab}	6.00a^{b}	7.67^{a}	7.13^{a}	3.13^{b}	0.81	0.0001
Total HW gain (cm)	0.00^{c}	7.38^{ab}	7.75^{ab}	4.67^{b}	8.25^{a}	6.13^{ab}	0.78	0.0001
Total PW gain (cm)	0.00^{b}	2.25^{a}	2.50^{a}	2.50^{a}	3.00^{a}	2.75^{a}	0.35	0.01
Total CW gain (cm)	0.00^{b}	2.00^{a}	1.88^{a}	1.17^{ab}	1.25^{ab}	1.25^{ab}	0.25	0.01
Total CD gain (cm)	0.00^{b}	2.38^{a}	2.55^{a}	2.08^{a}	2.59^{a}	2.25^{a}	0.24	0.0001
Total BV gain (cm^3)	0.00^{b}	6.26^{a}	6.59^{a}	4.90^{a}	6.63^{a}	5.70^{a}	0.65	0.001

$^{a-c}$Means within a row not bearing a common superscript are significantly different; SEM = standard error of mean; HG=heart girth; BL=body length; HW=height at whiter; PW=pelvic width; CW=chest width; CD=chest depth; BV=body volume; T_1= natural grass hay alone; T_2= natural grass hay + 0% cowpea hay:100% concentrate mix:; T_3= natural grass hay + 25% cowpea hay:75% concentrate mix; T_4= natural grass hay + 50% cowpea hay:50% concentrate mix; T_5= natural grass hay + 75% cowpea hay:25% concentrate mix; T_6= natural grass hay + 100% cowpea hay:0% concentrate mix.

Table 6 - Economic analysis of the feeding trial Abergelle goat fed on natural pasture grass hay and supplemented with different proportion of cowpea hay and concentrate mix

Parameters (birr)	Treatments						SEM	P-value
	T_1	T_2	T_3	T_4	T_5	T_6		
Grass hay cost	42.98^{a}	38.13^{b}	33.62^{b}	35.96^{b}	33.81^{b}	37.19^{b}	1.08	0.001
Cowpea hay cost	-	-	11.44^{d}	21.79^{c}	33.91^{b}	43.51^{a}	3.74	0.0001
Concentrate mix cost	-	67.61^{a}	51.37^{b}	33.87^{c}	17.12^{d}	-	5.69	0.0001
Feed cost (1+2+3)	42.98^{d}	105.75^{a}	96.42^{b}	91.63^{b}	84.85^{c}	80.71^{c}	4.69	0.0001
Feed loan and unload	8.59^{c}	10.63^{ab}	9.96^{b}	10.51^{ab}	10.35^{ab}	11.06^{a}	0.25	0.0001
Feed transport	17.19^{e}	69.34^{a}	54.54^{b}	41.48^{c}	27.22^{d}	14.88^{f}	4.44	0.0001
Total feed cost (4+5+6)	68.77^{f}	185.72^{a}	160.93^{b}	143.62^{c}	122.42^{d}	106.65^{e}	8.69	0.0001
Labor	58.33	58.33	58.33	58.33	58.33	58.33	0.00	0.06
Medicament cost	3.24	2.36	2.36	2.36	2.36	2.36	0.17	0.06
TVC (7+8+9)	130.33^{f}	246.41^{a}	221.62^{b}	204.31^{c}	183.1^{d}	167.34^{e}	8.63	0.0001
Initial goat purchase	337.50	382.22	369.17	323.33	351.11	373.33	13.40	0.06
Total cost (10+11)	467.83^{c}	628.63^{a}	590.78^{ab}	527.65^{bc}	534.22^{b}	540.67^{b}	17.45	0.0001
Selling price	445.50^{b}	652.93^{a}	635.35^{a}	593.97^{a}	602.87^{a}	634.05^{a}	21.39	0.0001
Net return	-22.33^{b}	24.30^{ab}	44.57^{ab}	66.32^{a}	68.65^{a}	93.38^{a}	12.46	0.01
AFRR (%)	-19.04^{b}	14.71^{ab}	33.21^{ab}	53.17^{a}	53.67^{a}	73.24^{a}	9.93	0.01
MRR from control	-	0.22	0.73	1.16	1.72	3.13	-	-
Marginal rate of return	-	0.22	-0.16	-1.09	-0.25	-1.57	-	-

$^{a-f}$Means within a row not bearing a common superscript are significantly different; SEM= standard error of mean; AFRR=annual financial rate of return; Δ=change; TVC=total variable cost; MRR=marginal rate of return; T_1= natural grass hay alone; T_2= natural grass hay + 0% cowpea hay: 100% concentrate mix:; T_3= natural grass hay + 25% cowpea hay: 75% concentrate mix; T_4= natural grass hay + 50% cowpea hay: 50% concentrate mix; T_5= natural grass hay + 75% cowpea hay: 25% concentrate mix; T_6= natural grass hay + 100% cowpea hay: 0% concentrate mix.

Citation: Amare B and Girmay A (2020). Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats. *Online J. Anim. Feed Res*., 10(6): 313-320. DOI: https://dx.doi.org/10.51227/ojafr.2020.42

Different components of the gross margin

The contribution of weight and price change for gross return is described in the Table 7. The current result of gross margin as percentages of financial return indicates that weight gain, as a whole, accounted for 55.46% of the gross margin while price changes and the interactions accounted for 26.06 and 18.48%, respectively. This suggests that weight change over the feeding periods relatively played an important role in the determination of profitability

Sensitivity analysis

The sensitivity analysis of the current result is done in Table 8. Relatively speaking, the analysis indicated that profitability was highly affected by changes in selling price of goat. Generally, T_6 was better to resist the fluctuation of the enterprise.

Table 7 - Gross margin of the feeding trial in Abergelle goats fed on natural pasture grass hay and supplemented with different proportion of cowpea hay and concentrate mix

Treatments	Price	Weight	Interaction
T_1	53.60	32.58	13.82
T_2	19.12	61.76	19.12
T_3	19.42	61.15	19.42
T_4	21.26	57.48	21.26
T_5	19.44	61.11	19.45
T_6	18.92	62.17	18.96
Mean	26.06	55.46	18.48
SEM	6.03	4.75	1.90
P	0.06	0.06	0.06

SEM= standard error of mean; T_1= natural grass hay alone; T_2= natural grass hay + 0% cowpea hay:100% concentrate mix:; T_3= natural grass hay + 25% cowpea hay:75% concentrate mix; T_4= natural grass hay + 50% cowpea hay:50% concentrate mix; T_5= natural grass hay + 75% cowpea hay:25% concentrate mix; T_6= natural grass hay + 100% cowpea hay:0% concentrate mix.

Table 8 - Sensitivity analysis of the feeding trial in Abergelle goat fed on natural pasture grass hay and supplemented with different proportion of cowpea hay and concentrate mix

Parameters (birr)	Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	SEM	P-value
NR_0	-22.33^{b}	24.30^{ab}	44.57^{ab}	66.32^{a}	68.65^{a}	93.38^{a}	12.46	0.01
NR_1	-30.93^{b}	3.15^{ab}	25.28^{ab}	48.00^{a}	51.68^{a}	77.24^{a}	12.13	0.01
NR_2	-111.43^{b}	-106.29^{b}	-82.50^{ab}	-52.47^{ab}	-51.93^{ab}	-33.43^{a}	10.58	0.01
NR_3	-120.03^{ab}	-127.43^{b}	-101.79^{ab}	-70.80^{ab}	-68.89^{ab}	-49.57^{a}	10.47	0.01
$\triangle NR_1$ (%)	9.83	16.59	-5.48	34.83	30.40	30.24	10.67	0.06
$\triangle NR_2$ (%)	98.40	113.00	-28.40	223.30	214.80	220.60	83.74	0.06
$\triangle NR_3$ (%)	108.20	129.60	-33.90	258.10	245.20	250.80	94.12	0.06

$^{a-d}$Means within a row not bearing a common superscript are significantly different; SEM = standard error of mean;; NR_0= Initial net return; NR_1= Net return with 20% increase in feed price without a change in selling price; NR_2= Net return with 20% decrease in selling price without changes in feed price; NR_3= Net return with 20% increase in feed price and 20% decrease selling price; Δ=change; TCP=total cost of production; TVC=total variable cost; T_1= natural grass hay alone; T_2= natural grass hay + 0% cowpea hay:100% concentrate mix:; T_3= natural grass hay + 25% cowpea hay:75% concentrate mix; T_4= natural grass hay + 50% cowpea hay:50% concentrate mix; T_5= natural grass hay + 75% cowpea hay:25% concentrate mix; T_6= natural grass hay + 100% cowpea hay:0% concentrate mix.

Farmers assessment of the feeding trial

Among supplemented group farmers prefer treatment 6, however control group were least selected. This shows that T_6 was not only better economically, but also was recognized by farmers as a preference choice. Farmers around Zekolla were impressed with the technology being demonstrated. Because of notable improvement in growth performance, body condition, conformation, libido, locally availability of cowpea hay and health status were the major observations compiled from the respondents. The drawbacks for the feed supplementation raised by farmers were the amount and frequency of feed given to the animal per day is too much that may cause animal health; fattening without castration and younger age of goats may reduce the response to feeding; unavailability of concentrate fed and lack of finance to undertake the technology; high cost and labor intensive; indoor feeding not consider farmer practice. Therefore in agreement with Baltenweck et al. (2020), to make the farmers adopt this feeding practice the cowpea hay preparation method should be available; provision of adequate credit is necessary; extension worker should be committed to popularize the technology specially for pre-urban and urban area in which they have fattening experience; awareness creation through training is essential that long period fattening affect quality of meat and total return from production; fattening at younger age highly preferred by abattoirs and fast growth in lean meat and overall body condition. Strengthening market linkage with abattoir for better market value is essential. The farmer expects a minimum rate of return of 50% if he/she is to adopt a new practice as compared to the practice he/she used to do. In this experiment, the rate of return was above the recommendation of CIMMYT (1985). However, further evaluation under on farm condition should be done in order to maximize the profit and easy adoption of the technology.

Citation: Amare B and Girmay A (2020). Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats. *Online J. Anim. Feed Res*., 10(6): 313-320. DOI: https://dx.doi.org/10.51227/ojafr.2020.42

CONCLUSION AND RECOMMENDATION

The present study revealed that there were no significant differences in intake, digestibility, linear body measurement and growth performance of goats fed different proportion of concentrate and cowpea hay. However, sole cowpea hay supplementation performs better in terms of net return and farmers' preference. Therefore, supplementation of sole cowpea hay would be both biologically and economically the optimum level for Abergelle goats bred. Moreover, the result suggests that cowpea hay could replace concentrate mix in goats feeding in which concentrates are not available or expensive for smallholder farmers in the rural area.. Therefore, intervention in disseminating the use of cowpea hay is essential as the forage could be a useful feed in improving the productivity of goat under intensive production system. Verification of the proposed feeding regime under smallholders is essential as well as the performance and economics of length of stay in feedlots should be further study in the future

DECLARATIONS

Authors' contribution

All authors contributed equally to this research work. All authors read and approved the final manuscript.

Acknowledgements

The Authors would like to thank Sekota dry land agricultural research center for their support during data recording and feeding of animal.

Conflict of interests

The authors declare that we have not conflict of interest. Bewketu Amare and Ayalew Girmay have declared and agree the rule of the journal and put the signatures on the declaration form. Bewketu Amare is first Author whereas Ayalew Girmay is second Author of the papers. The contribution of the Author Bewketu Amare is from initiation of the paper until final write up. But, Ayalew Girmay was contributed for presentation of the paper in regional review.

REFERENCES

AFRC (Agricultural Food and Research Council) (1993). Energy and protein requirements of ruminants. An advisory manual prepared by the Agricultural Food and Research Council technical committee on responses to nutrients. CAB International, Wallingford, UK, 342pp. https://books.google.com/books/about/Energy_and_Protein_Requirements_of_Rumin.html

Ajebu N, Meseret T and Aster A (2012). Effects of substituting maize with kocho on intake, digestibility, nitrogen utilization and body weight gain in sheep fed a basal diet of Rhodes grass hay. Ethiopian journal of applied Science Technology, 3(2):13-24. http://journals.ju.edu.et/index.php/ejast/article/view/861

Alexander G, Ravi D, Reddy RCh, Saxena KB, Hanson JU, padhyaya HD, Blümmel M. (2007). Forage yield and quality in pigeon pea germplasm lines. An open access Journal .International crop research institute for semi-arid tropics, 3(1) 1-3. http://oar.icrisat.org/id/eprint/2879

AMAREW (Amhara Micro-enterprise development, Agricultural Research, Extension and Watershed Management) (2006). Unpublished. Bahir Dar, Ethiopia, 45pp. https://www.oecd.org/countries/ethiopia/42319183.pdf

AOAC (Association of Official Analytical Chemists) (1995). Animal Feed: Sample preparation (950.02) and Official methods of analysis. 16th edition. Association of Analytical Chemists, Viriginia, USA. http://www.aoac.org/techprog/Intro98.htm

ARC (Agricultural Research Council) (1980). The Nutrient Requirements of Ruminant Livestock. CAB International, Wallingford, UK. https://www.amazon.com/Nutrient-Requirements-Ruminant-Livestock-Agricultural/dp/0851986196

Baltenweck I, Cherney D, Duncan A. et al (2020). A scoping review of feed interventions and livelihoods of small-scale livestock keepers. Nature Plants, 6: 1242–1249 https://doi.org/10.1038/s41477-020-00786-w

Baur H, Sissoko K and Debrah S (1989). The economics of peasant cattle fattening in Mali. African Research Network for Agricultural by-products (ARNAB). Overcoming constraints to the effective utilization of agricultural by-products as animal feed. Proceeding of the fourth annual workshop held at the institutes of animal research, Mankon station, Bameeda, Cameroon, ARNAB, Addis Ababa, Ethiopia, 49-60pp. https://cgspace.cgiar.org/bitstream/handle/10568/50032/Overcoming_Constraints.pdf

Bewketu A, Tewoderos A and Likawent Y (2015). Evaluation of body weight change and carcass characteristics of Abergelle and Abergelle X Baka cross (50%) goat fed hay supplemented with different level of concentrate mixture. In press: proceedings of the annual regional conference of completed livestock research activities. Amhara regional Agricultural Research institute (ARARI), Bahir Dar, Ethiopia. www.arai.gov.et

CIMMYT (International Maize and Wheat Improvement Center) (1985). From Agronomic Data to Farmers Recommendations. Economics Programme. Mexico. 32pp. http://repository.cimmyt.org/xmlui/bitstream/handle/10883/830/13803.pdf

CSA (Central Statistics Authority, 2014). Report on livestock and livestock characteristics statistics. I(2), Addis Ababa, Ethiopia, 417pp. http://www.csa.gov.et/ehioinfo-internal

De Boer H., Dumont B.L., Pomeroy R.W. and Weninger J.H (1974). Manual on E.A.A.P. reference methods for assessment of carcass characteristics in cattle. Livestock Production Science. 1: 151-164. http://aei.pitt.edu/50083/1/B0053.pdf

Devendra C. and Mcleroy B.G (1982). Goat and sheep production in the tropics. Long man, London and New York, 84pp. http://www.worldcat.org/oclc/8451618

Duncan, D. B (1955). Multiple range and multiple F tests. Biometrics, 11:1–42. http://garfield.library.upenn.edu/classics1977/A1977DM02600001.pdf

Foster JL, Adesogan AT, Carter JN, Blount AR., Myer RO and Phatak SC (2009). Intake, digestibility, and nitrogen retention by sheep supplemented with warm-season legume hays or soybean meal. Journal Animal Science, 87(9):2891–2898 https://doi.org/10.2527/jas.2008-1637

Haddad SG. (2005). Effect of dietary forage: concentrate ratio on growth performance and carcass characteristics of growing Baladi kids. Small Ruminant Research, 57(1): 43-49 https://doi.org/10.1016/j.smallrumres.2004.05.001

Halima H, Michael B, Barbara R and Markos T (2012). Phenotypic characterization of Ethiopian indigenous goat populations. African Journal of Biotechnology, 11(73), 13838-13846, https://doi.org/10.5897/AJB12.2092

Hasan M.R., Akbar M.A., Khandaker Z.H. and Rahman M.M (2010). Effect of nitrogen fertilizer on yield contributing character, biomass yield and nutritive value of cowpea forage. Bangladesh Journal of Animal Science, 39(1&2): 83 – 88. https://doi.org/10.3329/bjas.v39i1-2.9680

Jemberu D, Solomon M, Firew T, and Kurt J (2010). Effect of supplementation of Simada sheep with graded levels of concentrate, mix on feed intake, digestibility and live weight parameters. Tropical Animal Health Production, 42(5):841-848. https://doi.org/10.1007/s11250-009-9496-3

Karachi M and Zengo M (1998). Legume forages from pigeon pea, leucaena and sesbania as supplements to natural pastures for goat production in western Tanzania Agro forest System,39: 13-21. https://doi.org/10.1023/A:1005859617603

Kearl LC (1982). Nutrient requirements of ruminants in developing countries. International feed stuff Institute, Uttah, USA, 120pp. https://digitalcommons.usu.edu/etd/4183

Keba F (2009). Sheep production system in Damot Gale Woreda and supplementary value of pigeon pea (Cajanus cajan) and sweet potato root (Ipomoea batatus) in sheep fattening diets. Master of scienceThesis, Hawassa University, Ethiopia.

Lee R (2008). Ruminant nutrition for glaziers. ATTRA national sustainable agricultural information service. www.attra.ncat.org, 7-15pp.

McDonald R.E., Edward R.A., Greenhalgh J.F.D. and Morgan G.A (2002). Animal nutrition. 6th edition. Pearson Educational Limited. Edinburgh, Great Britain, 544pp, ISBN13: 9780582419063; ISBN10: 0582419069, https://m.barnesandnoble.com/w/animal-nutrition-peter-mcdonald/1100484409

Mekuriaw Y, and Asmare B (2018). Nutrient intake, digestibility and growth performance of Washera lambs fed natural pasture hay supplemented with graded levels of Ficus thonningii(Chibha) leaves as replacement for concentrate mixture. Agriculture & Food Security, 7:30. Doi: https://doi.org/10.1186/s40066-018-0182-4

Ndemanisho, EE, Mtenga, LA, Kimbi, EFC, Kimambo, AE, Mtengeti, EJ (1998). Substitution of dry Leucaena leucocephala (DLL) leaves for cotton seed cake (CSC)as a protein supplement to urea treated maize stover fed to dairy weaner goats. Animal Feed Science Technology, 73(3-4): 365-374. https://doi.org/10.1016/S0377-8401(98)00139-4

Owolabi AO, Ndidi US, James UD, and Amune FA (2012). Proximate, Antinutrient and Mineral Composition of Five Varieties (Improved and Local) of Cowpea, Vigna unguiculata, Commonly Consumed in Samaru Community, Zaria-Nigeria. Asian Journal of Food Science and Technology, 4:70-72. 4(2):70-72 .ISSN: 2042-4876.

Patra AK, Sharma K, Dutta N and Pattanaik AK (2006). Effect of partial replacement of dietary protein by a leaf mixture on nutrient utilization by goats in pre-and late gestation. Small Ruminant Research, 63(1-2): 66-74. https://doi.org/10.1016/j.smallrumres.2005.02.008

Paul BK, Groot JC, Maass BL, Notenbaert AM, Herrero M, Tittonell PA (2020). Improved feeding and forages at a crossroads: Farming systems approaches for sustainable livestock development in East Africa. Outlook on Agriculture, 49(1): 13-20. doi: https://doi.org/10.1177%2F0030727020906170

SAS (Statistical Analysis System) (2003). Statistical Analysis System Institute, Inc.cary, NC. Science. Uppsala, Sweden.

SDARC (Sekota dry land agriculture research center) (2013). Annual report of research center in 2013.

Tesfa G, Tegene N, Girma A and Arth L. G (2013). Effect of supplementing grazing Arsi-Bale sheep with molasses-urea feed block on weight gain and economic return under farmers' management condition. Journal of Cell and Animal Biology, 7(10):125-131. https://doi.org/10.5897/JCAB11.030

Upton M (1979). Farm management in Africa: The principle of production and planning. Oxford University press, UK. 282-298pp. https://www.abebooks.co.uk/products/isbn/9780192156464/30743147345

USAID (United States Agency for International Development of the United States Government) (2013). Agricultural Growth Project - Livestock Market Development. Value chain analysis for Ethiopia. USAID bulletin, 150pp. https://www.usaid.gov/sites/default/files/documents/1860/AGP-LMD

Van Soest PJ, and Robertson BJ (1985). Analysis of forage and fibrous food. A laboratory manual for animal science 613. Cornell University, Ithaca, New York, USA. http://www.worldcat.org/oclc/223471931

Wamatu J, Alkhtib A, and Gardi M (2019). Leveraging traditional crops for food and feed: a case of hulless barley (hordeum vulgare) landraces in Ethiopia. Journal of Experimental Biology and Agricultural Sciences 7(1):42-50. http://dx.doi.org/10.18006/2019.7(1).42.50

WZAD (Waghimra Zone Agricultural Department Office) (1995). Waghimra Zone Baseline Data. 65pp. https://en.m.wikipedia.org/wiki/Wag_Hemra_Zone

Yihalem D, Berhan T and Solomon M (2004). Effect of harvesting date on composition and yield of natural pasture in northwestern. Ethiopia Tropical Science, 45(1):19-22. https://doi.org/10.1002/ts.40

Citation: Amare B and Girmay A (2020). Effect of dietary supplemented cowpea (*Vigna unguiculata*) hay as replacement of concentrate on performance and economic efficiency of Abergelle goats. *Online J. Anim. Feed Res*., 10(6): 313-320. DOI: https://dx.doi.org/10.51227/ojafr.2020.42

2020 SCIENCELINE

Online Journal of Animal and Feed Research

Volume 10, Issue 6: 321-325; November 27, 2020

ISSN 2228-7701

DOI: https://dx.doi.org/10.51227/ojafr.2020.43

PREVALENCE OF GASTROINTESTINAL PARASITES IN CAMEL IN POTENTIAL AREAS OF ETHIOPIA (THE CASE OF AFAR REGIONAL STATE)

Endris F. AHMED[1]✉, Weldegebrial G. AREGAWI[2], Beksisa URGE[3] and Medina ENDRIS[4]

[1]*Afar Pastoral and Agro-pastoral Research Institute, P.O. Box 16, Samara, Afar, Ethiopia*
[2]*Ethiopian Institute of Agricultural Research, Mehoni Agricultural Research Center, P.O. Box , 47, Mekhoni, Tigray, Ethiopia*
[3]*Ethiopian Institute of Agricultural Research, Holeta Agricultural Research Center, P.O. Box 2003, Addis Ababa, Ethiopia*
[4]*Semera Regional Veterinary laboratory, Afar, Semera, P.O. Box 33, Semera, Afar, Ethiopia*

✉Email: endrisf@yahoo.com

Supporting Information

RESEARCH ARTICLE

PII: S222877012000043-10

Received: October 07, 2020

Revised: November 18, 2020

ABSTRACT: A cross sectional study was conducted from April, 2017 to October, 2018 to determine the prevalence of gastrointestinal tract (GIT) helminthes and protozoan parasites in relation to contributing risk factors in camels of afar region. Accordingly, a total of 407 camels were examined. Random and purposive sampling was made in the respective districts for screening of camels. Fecal samples were collected and processed by sedimentation and floatation methods. The coprological finding indicated that about 30.22% (n = 123) of the camels harbored and excreted helminthes and protozoan parasites. Of which, the prevalence of nematodes, protozoa, cestodes, and trematodes were 144 (35.38%), 28 (22.76%), 8 (6.50%) and 5 (4.07%), respectively. The most frequently encountered parasites were *Strongylus* sp. 68 (55.28%), *Trichuris* sp. 40 (32.52%) *Strongyloides* sp. 36 (29.27%), Coccidia 28 (22.76%), Moniezia 8 (6.50%), and Paraphystomum 5 (4.07%), respectively. 17.44% of the cases were single infection while 10.57% were mixed infections. Age and body condition of the animals were significantly associated (P<0.05) with the occurrence of parasites. In conclusion, gastrointestinal parasites are the major health problems of camel in the study areas. Therefore, it is important to undertake the detailed epidemiological investigations such as seasonal dynamics, fecal culture for larvae recovery and species identification to generate parasite mitigation methods.

Keywords: Afar region, Camel, Gastrointestinal parasite, Prevalence, Risk factors.

INTRODUCTION

Camel is anatomically and physiologically well adapted to harsh climatic conditions of desert. They are valued as riding, baggage, drought animal as well as best food provider in the arid areas. Camels are important milk producers in arid lands and camel milk is an essential food for livelihood of people and it may be the only milk available in places where other milking animals cannot be maintained (Hoter et al., 2019). Camel is an important animal component of the fragile desert eco-system, with its unique bio-physiological characteristics, thus, has become an icon of adaptation to challenging ways of living in arid and semi-arid regions (Bikaner, 2008; Burger et al., 2019).

The production, productivity and health of camel are affected by several factors. Parasites and parasite borne diseases are the major constraints in improvement production and productivity efficiency (Djerbouh et al., 2018; Desta, 2019). Among important camel health problems, different types of gastrointestinal (GIT) parasites over emphasize camel production in the study areas (Barji et al., 2010).

Notwithstanding the immense action made to control GIT Parasitosis, farmers in Ethiopia continue to incur significant losses due to insufficient availability of information and best practices on the epidemiology of the GIT parasites (Fentahun, 2020). GIT parasites are associated stunted growth rate, weight loss, copious diarrhea, reduced feed intake, and anemia in severe cases which results in loss of production and productivity of domestic animals (Fentahun, 2020). In young stock, GIT parasitism is responsible to reduce growth rate by 30%, even with a minimum level of parasite burden (Urge, 2020).

Despite these facts, information about the occurrence and species composition of GIT parasites of camel is limited in Afar region of Northern Ethiopia. This study were therefore conducted to generate recent information on the occurrence

Citation: Ahmed EF, Aregawi WG, Urge B and Endris M (2020). Prevalence of gastrointestinal parasites in camel in potential areas of Ethiopia (the case of Afar regional state). *Online J. Anim. Feed Res*., 10(6): 321-325. DOI: https://dx.doi.org/10.51227/ojafr.2020.43

and species diversity of camel GIT parasites, identify risk factors associated with the occurrence of GIT parasites, and to recommend an appropriate helminthes control and prevention options that could be used in the camel rearing areas.

MATERIALS AND METHODS

Study area

The study was conducted from April to October 2018 in selected districts of Afar region. Afar National Regional State is one of the nine federal states of Ethiopia located in the northeastern part of the country 588 kms far from the capital. The total geographical area of the region is about 270,000 km^2. It is geographically located between 39^{o}34' and 42^{o}28' East Longitude and 8^{o}49'and 14^{o}30'North Latitude. The climate in most of the region is hot with maximum temperature of 45 ^{0}C in August and minimum temperature of 20 ^{0}C in January. The altitude ranges from 116 m below sea level to 1500 m above sea level. The region has an area of Low Land, with an irregular drainage system and depression, which, is 114 m below sea level as well as some of the exposed rocks. 35.47 % of the region has an elevation less than 400 m above sea level whereas 51.44% has an elevation between 400 to 900 and 13.09 % has an elevation above 900 m above sea level. The region has a number of perennial rivers that include Awash, Mille, Kesem Kebena, Awura, Gulina, Dewe, Borkena, Telalak, and numerous seasonal rivers that flows to different basins. In the region there are also a number of lakes, such as Lake Asahle, Lake Dalol, Lake Afdera, Lake Abe, and Lake Gemeri are some examples of the lakes in the region. The study was conducted in seven districts of afar national regional state namely Chifra, Erebti, Burimodayito, Gewane, Dalifage, Yallo and Elidar which are potential areas for camel.

Study animals

The study was conducted on traditionally managed camel herd selected from seven districts (Chifra, Gewane, Bure Mudaytu, Elidar, Yalo, Dalifage and Megale) of Afar region. For the prevalence study, age groups and sexes were randomly selected from the selected herds. Due to the absence of written records, the age of animal was determined by dentition. Study animal related information of each sampled camel such as sex, age and body condition score were collected at the time of the study. Camel breeds in Ethiopia are one humped which are categorized under *camellus dromedarous* breed. Animals that had not treated for internal parasites for at least two months during the study were considered for sampling.

Study design

A cross sectional study design was used to determine the occurrence and prevalence of GIT parasites in the selected districts. From each selected district two peasant associations (PAs) or kebeles were selected giving a total of 14 kebelles from the entire five zones of the region. The study districts and kebeles were selected based on the inclusion criteria such as potential camel population, accessibility, and willingness of the pastoralists to participate in the study.

Sample size determination

Sample size was determined according to Thrusfield (2005) using an average expected prevalence rate of 50% (as there was no previous report in the districts), 95% confidence intervals (CI) and 5% desired accuracy. Accordingly a total of 384 animals were calculated to be included in the study. However, the sample size for GIT parasites was inflated to 407 in order to increase the representativeness of the samples to the wider population. Sampling animals were proportionally distributed to the selected districts and PAs based on their camel population.

Laboratory analysis

The fecal samples were collected per rectum with new, unused gloves for each animal. Collected samples were put into fecal pots, labeled and kept cool prior to transportation to the laboratory where they were immediately examined or stored at refrigerated temperature (4 °C) for a maximum of one day before processing. The sedimentation and floatation techniques as described by Hansen and Perry (1994) were used for parasite examination. Identification of eggs of each species of camel parasites were done according to the procedure described by Soulsby (1982) and Urquhart et al. (1987).

Data analysis

The collected data were entered and coded to computer using excel spreadsheets and analysis was carried out using STATA, version 11. The prevalence (p) calculated as p = d/n, where d is the number of camels diagnosed as having a given parasite egg/oocyst at that point in time and n = number of camels at risk at that point in time. Descriptive statistics was used to show the frequencies and chi square analysis was used to identify factors associated with the occurrence of parasites. The level of significance was set at $P<0.05$.

RESULTS

Of 407 fecal samples examined, a total of 123 were found positive for at least one GIT parasite giving an overall prevalence of 30.22% (123/407). Positive camels were harbored and excreted helminthes and/or protozoan parasites. The prevalence of nematodes, protozoa, cestodes, and trematodes were 144 (35.4%), 28 (6.9%), 8 (1.97%) and 5 (1.23%), respectively (Table 1). Of the 132 positive facial samples, six types of helminthes/protozoan parasites

Citation: Ahmed EF, Aregawi WG, Urge B and Endris M (2020). Prevalence of gastrointestinal parasites in camel in potential areas of Ethiopia (the case of Afar regional state). *Online J. Anim. Feed Res*., 10(6): 321-325. DOI: https://dx.doi.org/10.51227/ojafr.2020.43

eggs/oocyst encountered in descending order of prevalence were *Strongylus* sp. 68 (55.28%), Trichuris 40 (32.52%), *Strongyloides* sp. 36 (29.27%), Coccidia 28 (22.76%), Moniezia 8 (6.50%), and Paraphystomum 5 (4.07%). Majority of the GIT parasite infection type were occurred in single (17.44%), while the remaining occurred in mixed infections with two (10.56 %), three (1.97%) and four (0.25%) parasites (Tables 2 and 3).

The occurrence of camel GIT helminthes in the present study was significantly influenced by age and body condition ($P<0.005$), where significantly higher prevalence were observed in adult animals than young, and in animals with poor body condition than in animals with poor body condition (Table 4). Sex wise, the prevalence of GIT parasites in female and male camels were 96 (23.59%) and 27 (6.63%), respectively there was no significant variations. In addition, there were no significant differences in the prevalence of camel GIT infection among the selected study districts ($P>5\%$). Of the selected six districts higher camel GIT prevalence was observed in Gewane (5.65%) followed by Yalo and Megale with 4.9% prevalence rates in both districts (Table 4).

Table 1 - Prevalence of camel GIT parasites in selected districts of Afar region

Parasite category	Parasite species	Positive number	Prevalence (%)
Nematodes	*Strongylus*	68	16.7
	Trichuris	40	9.83
	Strongyloides	36	8.85
Protozoan	Coccidia	28	6.9
Ceastode	Moniezia	8	1.9
Trematodes	Paraphystomum	5	1.23

Table 2 - Species of camel GIT parasite infection identified and their prevalence in selected districts of Afar region

Infection type (N)	Family/ies	Species	Prevalence	
			Frequency (N)	Percentage (%)
Single (71)	Nematode	*Strongylus*	22	5.41
		Strongyloides	21	5.16
		Trichuris	4	0.98
	Protozoan	Coccidia	16	3.93
	Cestode	Monezia	6	1.47
	Trematode	Paramphistomum	2	0.49
Two parasite (43)	Nematode and Protozoan	Strongyloides & Coccidia	1	0.25
	Trematode and Nematode	Paramphistomum & Strogylus	2	0.49
	Nematode	Strongyiodes & Strongylus	2	0.49
	Nematode	Strongyloides & Trichuris	5	1.23
	Nematode and Protozoan	Strongylus & Coccidia	11	2.70
	Nematode	Strongylus & Trichuris	22	5.40
Three parasite (8)	Cestode & Nematode	Monezia, Strongylus & Trichuris	1	0.25
	Trematode and Nematode	Paramphistomum, Strongylus & Trichuris	1	0.25
	Nematode	Srongylus, Trichuris & Strongyloides	6	1.47
Four parasite (1)	Nematode & Cestode	Strongylus, Trichuris, Monezia & Strongyloid	1	0.25
Total			123	30.22

Table 3 - Prevalence of camel GIT parasites observed in single and mixed infestation in selected districts of Afar region

Infection type	Frequency (N)	Percentage (%)
Single	71	17.44
Two parasite	43	10.57
Three parasite	8	1.97
Four parasite	1	0.24

Citation: Ahmed EF, Aregawi WG, Urge B and Endris M (2020). Prevalence of gastrointestinal parasites in camel in potential areas of Ethiopia (the case of Afar regional state). *Online J. Anim. Feed Res*., 10(6): 321-325. DOI: https://dx.doi.org/10.51227/ojafr.2020.43

Total	123	30.22

Table 4 - Prevalence of Camel GIT parasites in relation to hypothesized risk factors

Risk factors		No. examined	No. positive	Prevalence (%)	X^2 (p-value)
Sex	Female	332	96	23.59	5.41 (0.228)
	Male	75	27	6.63	
Age	Adult	324	98	24.08	8.62 (0.0005)
	Young	83	25	6.14	
Body condition score	Good	280	17	4.18	10.13(0.000)
	Poor	127	106	26.04	
Districts	Chifra	52	16	3.93	7.92 (0.84)
	Gewane	60	23	5.65	
	Bure Mudaytu	51	14	3.44	
	Elidar	55	14	3.44	
	Yalo	60	20	4.91	
	Dalifage	70	16	3.93	
	Megale	59	20	4.91	
Total		**407**	**123**	**30.22**	

DISCUSSION

Camel parasites are the most important camel health problems in Afar region of Ethiopia. The current finding indicated that the overall prevalence of camle GIT parasite was 30.22% in the selected study districts. The dominat parasites identified in the area were *Strongylus* sp. 68 (55.28%), Trichuris 40 (32.52%) *Strongyloides* sp. 36 (29.27%), Coccidia 28 (22.76%), Moniezia 8 (6.50%), and Paraphystomum 5 (4.07%) in descenmding order. Single parasitism (17.44%) and mixed infection 10.46 %, was recorded in the camel rearing areas. The result was in line with the findings of Bekele, (2002). However, the present finding was lower than the studies of Mohammed et al. (2008) who reported 91.5% prevalence rate of GIT parasites in camel.

This difference might be related to differences in the management practices and microclimates of the study areas. The study revealed adult camels (24.08%) were more prone to infection than young camels. This finding was consistent with the study of Mohmuda et al. (2007), who reported an increasing rate of infection with age of camels. The variations could be exposure risk of adult camels due to physiological differences, such as stress, pregnancy, lambing, inadequate nutrition, and infectious diseases. In addition, a significantly higher GIT parasite prevalence was observed in camels with poor body condition than in camels in good body condition. This could be due to the impact of the parasites that causes weight loss, copious diarrhea and reduced feed intake.

The distribution of parasites among the different districts of the study was not significantly different which could be due to similarity on the management system of the animals across the region. The study also showed no significant differences between the two sexes. However, female camels (23.59%) were more vulnerable to parasites than male camels (6.63%). The probable reason could be stress factors that reduce immunity of female camels to infections (Magzoub et al., 2000). Similar results were also reported by other authors (Valcarcel and Romero, 1999). On contrarily, Gulland and Fox (1992), reported higher rate of infection in male than female camels.

CONCULUSION AND RECOMMENDATIONS

The study showed that gastro-intestinal parasites were prevalent in the study areas. The current finding indicated that the overall prevalence of camel gastro-intestinal tract parasite was 30.22% in the study districts. The dominant parasites identified in the area were Strongylus sp. 68(55.28%), Trichuris 40 (32.52%) Strongyloides sp. 36 (29.27%), Coccidia 28 (22.76%), Moniezia 8 (6.50%), and Paraphystomum 5 (4.07%) in descending order. single parasitism (17.44%) and mixed infection 10.46 %, was recorded in the camel rearing areas. Therefore, it is important to undertake the detailed epidemiological investigations such as seasonal dynamics, fecal culture for larvae recovery and species identification to generate parasite mitigation methods.

DECLARATIONS

Acknowledgements

The authors acknowledge livestock owners, communities and officials in the study districts for their unreserved co-operation and assistance during field work.

Citation: Ahmed EF, Aregawi WG, Urge B and Endris M (2020). Prevalence of gastrointestinal parasites in camel in potential areas of Ethiopia (the case of Afar regional state). *Online J. Anim. Feed Res*., 10(6): 321-325. DOI: https://dx.doi.org/10.51227/ojafr.2020.43

Authors' contribution
All authors contributed equally to this research work. All authors read and approved the final manuscript.
Availability of data and materials
Data will be made available up on request of the primary author.

Consent to publish
Not applicable.

Competing interests
The data can be available to the journal upon request.

Conflict of interest
The authors declare they have no competing of interests.

REFERENCE

Bekele T (2002). Epidemiological studies on GIT helminths of dromedary in semi-arid .lands of eastern Ethiopia. Veterinary Parasitology, 105: 139-152. DOI: https://doi.org/10.1016/s0304-4017(01)00583-0

Bikaner Website (2008). Online Article on Camel, National Research Center on Camel, Jorbeer, Bikaner (Rajasthan) India. https://nrccamel.icar.gov.in/

Borji H, Razmi G, Movassaghi AR, (2010): A study on gastrointestinal helminths of camels in Mashhad abattoir Iran. Iranian journal of Veterinary Research, 11: 174-179. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1045.999&rep=rep1&type=pdf

Burger PA, Ciani E, and Faye B (2019). Old world camels in a modern world - a balancing act between conservation and genetic improvement. Animal Genetics, 50(6): 598–612. Doi: https://doi.org/10.1111/age.12858

Central Statistical Agency. (2009): Animal population census in Afar region. Addis Ababa, Ethiopia.

Desta AH (2019). Major helminth parasites of camelus dromedarius in afar pastoral area of Ethiopia. Iraqi Journal of Veterinary Sciences, 33: 117-122. DOI: https://doi.org/10.33899/ijvs.2019.125524.1046

Djerbouh A, Lafri I, Kechemir-Issad N and Bitam I (2018). Endo- and ectoparasites (Ixodidae) of camels (*Camelus dromedarius*) from Southern Algeria. Livestock Research for Rural Development, 30: Article #141. http://www.lrrd.org/lrrd30/8/djerb30141.html

Fentahun T (2020). Systematic review on gastrointestinal helminths of domestic ruminants in Ethiopia. Online Journal of Animal and Feed Research, 10(5): 216-230. Link

Gulland F and Fox M (1992): Epidemiology of Nematode Infections of Soay on St. Kilda. Parasitology, 105(3): 481-492. https://doi.org/10.1017/S0031182000074667

Hansen and Perry J, and B. Perry (1994). Epidemiology, Diagnosis and Control of Helminthes Parasites of Ruminants 2nd Ed. Nairobi, Kenya, Hrad, ISBN: 92-9055-703-1., Pp. 171. https://orcid.org/0000-0002-8599-7895 I Google Scholar

Hoter A, Rizk S, and Naim HY (2019). Cellular and molecular adaptation of arabian Camel to heat stress. Frontiers in Genetics, 10: 588. https://doi.org/10.3389/fgene.2019.00588

Magzoub M, Omer OH, HarouMagzoub EM, Omer M, Haroun OH, and Mahmoud OM (2000) Effect of season on gastrointestinal nematode infection in Saudi Arabian camels (Camelus dromedarius). Journal of Camel Practice Research, 7 (1): 107-108. Google Scholar

Mohamed AM, Mahmoud R, Abdella GA. and Abou EE. (2008). The influence of Some Nematode Parasitism on Lipid Metabolism and Lipoprotein Profile in Dromedary Camel. Journal of Camel Science, 1: 63-67. Llink: https://www.cabdirect.org/cabdirect/abstract/20103054788

Mohammed AK, Sackey AKB, and Gefu AO (2007). Common health problems of the one humped camel (Camelus dromedarius) introduced into sub-humid climate in Zaria, Nigeria. Research Journal of Animal Sciences, 1(1): 1-5. https://medwelljournals.com/abstract/?doi=rjnasci.2007.1.5

SOULSBY EJL (1982). Helminths. Arthropods and Protozoa of Domestic Animals, 7th Ed. Bailliere Tindall, London, UK, PP.231-250. Link, Google Scholar

Thrusfield M (2005). Veterinary Epidemiology. 3rd edition, Blackwell Science Ltd., Oxford, London. UK. pp. 234-238. Google Scholar

Urge B, Mark T, and Siyoum T (2020). Identifying Helminthes Infection in Calves Reared by Smallholder Farmers in Central Areas of Ethiopia. International Journal of Scientific and Management Research, 3: 9-15. http://ijsmr.in/doc/ijsmr_01_6888_23.pdf

Urquhart GM, Armour J, and Duncan JL (1987). Veterinary Parasitology 3rd End. Long man Scientific and Technical Burnt Mill, Harlow, UK. pp. 238. Google Scholar I https://www.abebooks.com/servlet/BookDetailsPL?bi=30660616938

Valcarcel F and Romero CG (1999). Prevalence and Seasonal Pattern of *Trichostrongylus* in a Dry Area Central Spain. Journal of Veterinary Medicine, Series B, 46(10): 673-681. https://doi.org/10.1046/j.1439-0450.1999.00297 I Google Scholar

Citation: Ahmed EF, Aregawi WG, Urge B and Endris M (2020). Prevalence of gastrointestinal parasites in camel in potential areas of Ethiopia (the case of Afar regional state). *Online J. Anim. Feed Res*., 10(6): 321-325. DOI: https://dx.doi.org/10.51227/ojafr.2020.43

Instructions for Authors

OJAFR EndNote Style | Manuscript Template | Sample Articles | Declaration form

Manuscripts as Original Research Paper, Review, Short Communication and Case Reports are invited for rapid peer-review publishing in the *Online Journal of Animal and Feed Research (ISSN 2228-7701)*.

Papers can be in any relevant fields of Animal Sciences (Animal Nutrition, Physiology, Reproduction, Genetics and Breeding, Behavior, Health, Husbandry and its economic, Animal products and Veterinary medicines of domestic animals) and relative topics. The journal does encourage papers with emphasis on the nutritive value and utilization of feeds that is depended to methods of Improvement, Assessment, Conserving and Processing feeds, Agronomic and climatic factors, Metabolic, Production, Reproduction and Health responses to dietary inputs (e.g., Feeds, Feed Additives, Specific Feed Components, Mycotoxins). Also, Mathematical models relating directly to animal-feed interactions, Analytical and experimental methods for Feed Evaluation as well as Animal Production studies with a focus on Animal Nutrition that do have link to a feed (Food Science and Technology) are acceptable relative topics for OJAFR.

Submission

The manuscripts should be submitted using our **online** submission system. For facile submission, please embed all figures and tables at the end of the manuscript to become one single file for submission. Once submission is complete, the system will generate a manuscript ID and password sent to author's contact email. If you have any difficulty in submitting the manuscript, kindly send via email: editors@ojafr.ir. All manuscripts must be checked (by English native speaker) and submitted in English for evaluation in totally confidential and impartial way.

Supplementary information:

Author guidelines are specific for each journal. Our MS Word template can assist you by modifying your page layout, text formatting, headings, title page, image placement, and citations/references such that they agree with the guidelines of journal. If you believe your article is fully edited per journal style, please use our Word template before submission. Supplementary materials may include figures, tables, methods, videos, and other materials. They are available online linked to the original published article. Supplementary tables and figures should be labeled with a "S", e.g. "Table S1" and "Figure S1". The maximum file size for supplementary materials is 10MB each. Please keep the files as small as possible to avoid the frustrations experienced by readers with downloading large files.

Submission to the Journal is on the understanding that:

1. The article has not been previously published in any other form and is not under consideration for publication elsewhere;
2. All authors have approved the submission and have obtained permission for publish work.
3. Researchers have proper regard for conservation and animal welfare considerations. Attention is drawn to the *'Guidelines for the Treatment of Animals in Research and Teaching'*. Any possible adverse consequences of the work for populations or individual organisms must be weighed against the possible gains in knowledge and its practical applications. If the approval of an ethics committee is required, please provide the name of the committee and the approval number obtained.

Ethics Committee Approval

Experimental research involving human or animals should have been approved by author's institutional review board or ethics committee. This information can be mentioned in the manuscript including the name of the board/committee that gave the approval. Investigations involving humans will have been performed in accordance with the principles of *Declaration of Helsinki*. And the use of animals in experiments will have observed the *Interdisciplinary Principles and Guidelines for the Use of Animals in Research, Testing, and Education* by the New York Academy of Sciences, Ad Hoc Animal Research Committee. If the manuscript contains photos or parts of photos of patients, informed consent from each patient should be obtained. Patient's identities and privacy should be carefully protected in the manuscript.

Presentation of the article

Main Format:

First page of the manuscripts must be properly identified by the title and the name(s) of the author(s). It should be typed in Times New Roman (font sizes: 12pt in capitalization for the title and the main text, double spaced, in A4 format with 2cm margins. All pages and lines of the main text should be numbered consecutively throughout the manuscript. The manuscript must be saved in a .doc format, (not .docx files). Abbreviations in the article title are not allowed except the well-known ones.

Manuscripts should be arranged in the following order:

a. TITLE (brief, attractive and targeted)
b. Name(s) and Affiliation(s) of author(s) (including post code) and corresponding E-mail
c. ABSTRACT
d. Key words (separate by semicolons; or comma,)
e. Abbreviations (used in the manuscript)
f. INTRODUCTION;
g. MATERIALS AND METHODS
h. RESULTS
i. DISCUSSION
j. CONCLUSION
k. DECLARATIONS
l. REFERENCES
m. Tables;
n. Figures

The sections "RESULTS AND DISCUSSION" can be presented jointly.
The sections "DISCUSSION AND DISCUSSION" can be presented jointly.

Article Sections Format:

Title should be a brief phrase describing the contents of the paper. Title Page should include full names and affiliations of the author(s), the name of the corresponding author along with phone and e-mail information. Present address(es) of author(s) should appear as a footnote.

Abstract should be informative and completely self-explanatory, briefly present the topic, state the scope of the experiments, indicate significant data, and point out major findings and conclusions. The abstract should be 150 to 300 words in length. Complete sentences, active verbs, and the third person should be used, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided. No literature should be cited.

Following the abstract, about 3 to 7 **key words** should be listed.

Introduction should provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution. It should be understandable to colleagues from a broad range of scientific disciplines.

Materials and Methods should be complete enough to allow experiments to be reproduced. However, only truly new procedures should be described in detail; previously published procedures should be cited, and important modifications of published procedures should be mentioned briefly. Capitalize trade names and include the manufacturer's name and address. Subheadings should be used. Methods in general use need not be described in detail.

Results should be presented with clarity and precision. The results should be written in the past tense when describing findings in the author(s)'s experiments. Previously published findings should be written in the present tense. Results should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the results but should be put into the discussion section.

Discussion should interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. The Results and Discussion sections can include subheadings, and when appropriate, both sections can be combined.

Conclusion should be brief and tight, providing a few specific tasks to accomplish: 1-Re-assert/Reinforce the Thesis; 2-Review the Main Points; 3- Close Effectively. The Conclusion section should not be similar to the Abstract content.

Declarations including Ethics, Consent to publish, Competing interests, Authors' contributions, and Availability of data and materials are necessary.

Acknowledgments of persons, grants, funds, etc should be brief.

Tables should be kept to a minimum and be designed to be as simple as possible. Tables are to be typed double-spaced throughout, including headings and footnotes. Each table should be on a separate page, numbered consecutively in Arabic numerals and supplied with a heading and a legend. Tables should be self-explanatory without reference to the text. The details of the methods used in the experiments should preferably be described in the legend instead of in the text. The same data should not be presented in both table and graph forms or repeated in the text.

The Figure legends should be typed in numerical order on a separate sheet. Graphics should be prepared using applications capable of generating high resolution GIF, TIFF, JPEG or PowerPoint before pasting in the Microsoft Word manuscript file. Use Arabic numerals to designate figures and upper case letters for their parts (Figure 1). Begin each legend with a title and include sufficient description so that the figure is understandable without reading the text of the manuscript. Information given in legends should not be repeated in the text.

DECLARATIONS

Please ensure that the sections: Ethics (and consent to participate), Consent to publish, Competing interests, Authors' contributions, and Availability of data and materials are included at the end of your manuscript in a Declarations section.

Consent to Publish

Please include a 'Consent for publication' section in your manuscript. If your manuscript contains any individual person's data in any form (including individual details, images or videos), consent to publish must be obtained from that person, or in the case of children, their parent or legal guardian. All presentations of case reports must have consent to publish. You can use your institutional consent form or our consent form if you prefer. You should not send the form to us on submission, but we may request to see a copy at any stage (including after publication). If your manuscript does not contain any individual person's data, please state "Not applicable" in this section.

Authors' Contributions

For manuscripts with more than one author, OJAFR require an Authors' Contributions section to be placed after the Competing Interests section. An 'author' is generally considered to be someone who has made substantive intellectual contributions to a published study. To qualify as an author one should 1) have made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) have been involved in drafting the manuscript or revising it critically for important intellectual content; and 3) have given final approval of the version to be published. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content. Acquisition of funding, collection of data, or general supervision of the research group, alone, does not justify authorship.
We suggest the following format (please use initials to refer to each author's contribution): AB carried out the molecular genetic studies, participated in the sequence alignment and drafted the manuscript. JY carried out the immunoassays. MT participated in the sequence alignment. ES participated in the design of the study and performed the statistical analysis. FG conceived of the study, and participated in its design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript. For authors that equally participated in a study please write '**All/Both authors contributed equally to this work**.' Contributors who do not meet the criteria for authorship should be listed in an acknowledgements section.

Competing Interests

Competing interests that might interfere with the objective presentation of the research findings contained in the manuscript should be declared in a paragraph heading "Competing interests" (after Acknowledgment section and before References). Examples of competing interests are ownership of stock in a company, commercial grants, board membership, etc. If there is no competing interest, please use the statement "The authors declare that they have no competing interests.". *Online Journal of Animal and Feed Research* adheres to the definition of authorship set up by the International Committee of Medical Journal Editors (ICMJE). According to the ICMJE authorship criteria should be based on 1) substantial contributions to conception and design of, or acquisition of data or analysis and interpretation of data, 2) drafting the article or revising it critically for important intellectual content and 3) final approval of the version to be published. Authors should meet conditions 1, 2 and 3. It is a requirement that all authors have been accredited as appropriate upon submission of the manuscript. Contributors who do not qualify as authors should be mentioned under Acknowledgements.

Change in authorship

We do not allow any change in authorship after provisional acceptance. We cannot allow any addition, deletion or change in sequence of author name. We have this policy to prevent the fraud.

Acknowledgements

We strongly encourage you to include an Acknowledgements section between the Authors' contributions section and Reference list. Please acknowledge anyone who contributed towards the study by making substantial contributions to conception, design, acquisition of data, or analysis and interpretation of data, or who was involved in drafting the manuscript or revising it critically for important intellectual content, but who does not meet the criteria for authorship. Please also include their source(s) of funding. Please also acknowledge anyone who contributed materials essential for the study.

Authors should obtain permission to acknowledge from all those mentioned in the Acknowledgements. Please list the source(s) of funding for the study, for each author, and for the manuscript preparation in the acknowledgements section. Authors must describe the role of the funding body, if any, in study design; in the collection, analysis, and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication.

Data Deposition

Nucleic acid sequences, protein sequences, and atomic coordinates should be deposited in an appropriate database in time for the accession number to be included in the published article. In computational studies where the sequence information is unacceptable for inclusion in databases because of lack of experimental validation, the sequences must be published as an additional file with the article.

References

An OJAFR reference style for EndNote may be found here.

How to install additional styles? Please click here

1. All references to publications made in the text should be presented in a list with their full bibliographical description.
2. In the text, a reference identified by means of an author‘s name should be followed by the date of the reference in parentheses. When there are more than two authors, only the first author‘s surname should be mentioned, followed by ’et al‘. In the event that an author cited has had two or more works published during the same year, the reference, both in the text and in the reference list, should be identified by a lower case letter like ’a‘ and ’b‘ after the date to distinguish the works.
3. References in the text should be arranged chronologically (e.g. Kelebeni, 1983; Usman and Smith, 1992 and Agindotan et al., 2003). 'et al.' should not be italic. The list of references should be arranged alphabetically on author's surnames, and chronologically per author. If an author's name in the list is also mentioned with co-authors, the following order should be used: Publications of the single author, arranged according to publication dates - publications of the same author with one co-author - publications of the author with more than one co-author. Publications by the same author(s) in the same year should be listed as 1992a, l992b, etc.
4. Names of authors and title of journals, published in non-Latin alphabets should be transliterated in English.
5. A sample of standard reference is "1th Author surname A, 2th Author surname B and 3th Author surname C (2013). Article title should be regular, in sentence case form, and 9 pt. Online Journal of Animal and Feed Research, Volume No. (Issue No.): 00-00." (Journal titles should be full and not italic.)
6. If available please add DOI numbers or the link of articles at the end of each reference.

Examples (at the text):

Abayomi (2000), Agindotan et al. (2003), (Kelebeni, 1983), (Usman and Smith, 1992), (Chege, 1998; Chukwura, 1987a,b; Tijani, 1993,1995), (Kumasi et al., 2001).

Examples (at References section):

a) For journal:

Lucy MC (2000). Regulation of ovarian follicular growth by somatotropin and insulin- like growth factors in cattle. Journal of Dairy Science, 83: 1635-1647. Link, DOI

Kareem SK (2001). Response of albino rats to dietary level of mango cake. Journal of Agricultural Research and Development, Pp. 31-38. Link, DOI

Chikere CB, Omoni VT and Chikere BO (2008). Distribution of potential nosocomial pathogens in a hospital environment. African Journal of Biotechnology, 7: 3535-3539. Link, DOI

b) For symposia reports and abstracts:

Cruz EM, Almatar S, Aludul EK and Al-Yaqout A (2000). Preliminary Studies on the Performance and Feeding Behaviour of Silver Pomfret (Pampus argentens euphrasen) Fingerlings fed with Commercial Feed and Reared in Fibreglass Tanks. Asian Fisheries Society Manila, Philippine, 13: 191-199. Link, DOI

c) For edited symposia, special issues, etc., published in a journal:

Korevaar H (1992). The nitrogen balance on intensive Dutch dairy farms: a review. In: A. A. Jongebreur et al. (Editors), Effects of Cattle and Pig Production Systems on the Environment: Livestock Production Science, 31: 17-27. Link, DOI

d) For books:

AOAC (1990). Association of Official Analytical Chemists. Official Methods of Analysis, 15th Edition. Washington D.C. pp. 69-88. Pelczar JR, Harley JP, Klein DA (1993). Microbiology: Concepts and Applications. McGraw-Hill Inc., New York, pp. 591-603. Link, DOI

e) Books, containing sections written by different authors:

Kunev M (1979). Pig Fattening. In: A. Alexiev (Editor), Farm Animal Feeding. Vol. III. Feeding of Different Animal Species, Zemizdat, Sofia, p. 233-243 (Bg). Link, DOI

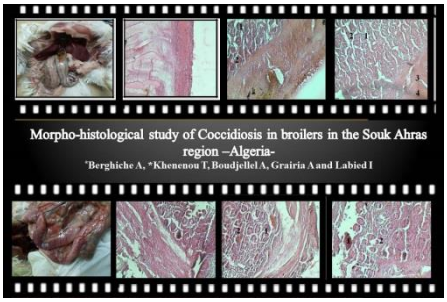
In referring to a personal communication the two words are followed by the year, e.g. (Brown, J. M., personal communication, 1982). In this case initials are given in the text. Where available, URLs for the references should be provided.

Formulae, numbers and symbols

1. Typewritten formulae are preferred. Subscripts and superscripts are important. Check disparities between zero (0) and the letter 0, and between one (1) and the letter I.
2. Describe all symbols immediately after the equation in which they are first used.
3. For simple fractions, use the solidus (/), e.g. 10 /38.
4. Equations should be presented into parentheses on the right-hand side, in tandem.
5. Levels of statistical significance which can be used without further explanations are *P < 0.05, **P < 0.01, and ***P<0.001.
6. In the English articles, a decimal point should be used instead of a decimal comma.
7. Use Symbol fonts for "±"; "≤" and "≥" (avoid underline).
8. In chemical formulae, valence of ions should be given, e.g. Ca2+ and CO32-, not as Ca++ or CO3.
9. Numbers up to 10 should be written in the text by words. Numbers above 1000 are recommended to be given as 10 powered x.
10. Greek letters should be explained in the margins with their names as follows: Aα - alpha, Bβ - beta, Γγ - gamma, Δδ - delta, Eε - epsilon, Zζ - zeta, Hη - eta, Θθ - theta, Iι - iota, Kκ - kappa, Λλ - lambda, Mμ - mu, Nν - nu, Ξξ - xi, Oo - omicron, Ππ - pi, Pρ - rho, Σσ - sigma, Tτ - tau, Yυ - ipsilon, Φφ - phi, Xχ - chi, Ψψ - psi, Ωω - omega. Please avoid using math equations in Word whenever possible, as they have to be replaced by images in xml full text.

Abbreviations
Abbreviations should be presented in one paragraph, in the format: "term: definition". Please separate the items by ";".
E.g. ANN: artificial neural network; CFS: closed form solution; ....

Graphical Abstract:
Authors of accepted articles should provide a graphical abstract (a beautifully designed feature figure) to represent the paper aiming to catch the attention and interest of readers. Graphical abstract will be published online in the table of content. The graphical abstract should be colored, and kept within an area of 12 cm (width) x 6 cm (height) or with similar format. Image should have a minimum resolution of 300 dpi and line art 1200dpi.
Note: Height of the image should be no more than the width. Please avoid putting too much information into the graphical abstract as it occupies only a small space. Authors can provide the graphical abstract in the format of PDF, Word, PowerPoint, jpg, or png, after a manuscript is accepted for publication.
If you have decided to provide a Professional Graphical Abstract, please click **here**.



Review/Decisions/Processing

Firstly, all manuscripts will be checked by Docol©c, a plagiarism finding tool. The received papers with plagiarism rate of more than 40% will be rejected. Manuscripts that are judged to be of insufficient quality or unlikely to be competitive enough for publication will be returned to the authors at the initial stage. The remaining manuscripts go through a double-blind review process by two reviewers selected by section editor (SE) or deputy SE of OJAFR, who are research workers specializing in the relevant field of study. We always try to avoid delays in the reviewing process, but it relies on the time and cooperation of the referees that works without any remuneration, hence, it may take 2 weeks to 2 months. One unfavorable review means that the paper will not be published and possible decisions are: accept as is, minor revision, major revision, or reject. The corresponding authors should submit back their revisions within 14 days in the case of minor revision, or 30 days in the case of major revision.

To submit a revision please click here, fill out the form, and mark "Revised", mention the article code (for example OJAFR-1108), attach the revision (MS word) and continue submission. Manuscripts with significant results are typically reviewed and published at the highest priority. After review and editing the article, a final formatted proof is sent to the corresponding author once again to apply all suggested corrections during the article process. The editor who received the final revisions from the corresponding authors shall not be hold responsible for any mistakes shown in the final publication.

The submissions will be processed free of charge for invited authors, authors of hot papers, and corresponding authors who are editorial board members of the *Online Journal of Animal and Feed Research*. This journal encourages the academic institutions in low-income countries to publish high quality scientific results, free of charges.

Plagiarism: There is an instant policy towards plagiarism (including self-plagiarism) in our journals. Manuscripts are screened for plagiarism by Docol©c, before or during publication, and if found they will be rejected at any stage of processing.

Date of issue
All accepted articles are published bimonthly around 25th of January, March, May, July, September and November, each year in full text on the Internet.

The OA policy
Online Journal of Animal and Feed Research is an Open Access journal which means that all content is freely available without charge to the user or his/her institution. Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author. This is in accordance with the *BOAI definition of Open Access*.

Submission Preparation Checklist
Authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to the following guidelines:
- The submission has not been previously published, nor is it before another journal for consideration (or an explanation has been provided in -Comments to the Editor).
- The submission file is in Microsoft Word, RTF, or PDF document file format.
- Where available, URLs for the references have been provided.
- The text is double-spaced; uses a 12-point font; and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.
- The text adheres to the stylistic and bibliographic requirements outlined in the Author Guidelines.

Scienceline Publication, Ltd
Editorial Offices:
Ömer Nasuhi Bilmen Road, Dönmez Apart., G Block, No: 1/6, Yakutiye, Erzurum/25100, TURKEY
Atatürk University, Erzurum 25100, Turkey
796-704 Montrose St, Winnipeg, Manitoba R3T 2N2, CANADA
Phone: +90 538 770 8824 (TURKEY); +1 209 732 4265 (CANADA)
Homepage: www.science-line.com
Emails: administrator@science-line.com ; saeid.azar@atauni.edu.tr

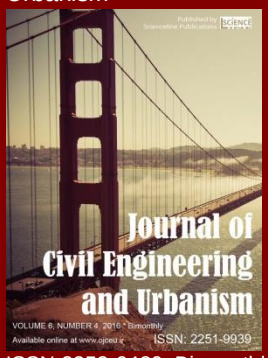
SCIENCELINE PUBLISHING CORPORATION

Scienceline Publication Ltd is a limited liability non-profit non-stock corporation incorporated in Turkey. Scienceline journals that concurrently belong to many societies, universities and research institutes, publishes internationally peer-reviewed open access articles and believe in sharing of new scientific knowledge and vital research in the fields of life and natural sciences, animal sciences, engineering, art, linguistic, management, social and economic sciences all over the world. Scienceline journals include:

Online Journal of Animal and Feed Research

ISSN 2228-7701; Bi-monthly
View Journal I Editorial Board
Email: editors@ojafr.ir
Submit Online >>

Journal of Civil Engineering and Urbanism

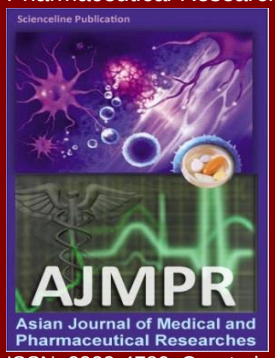


ISSN 2252-0430; Bi-monthly
View Journal I Editorial Board
Email: ojceu@ojceu.ir
Submit Online >>

Journal of Life Sciences and Biomedicine

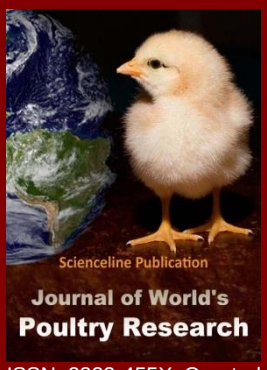
ISSN: 2251-9939; Bi-monthly
View Journal I Editorial Board
Email: editors@jlsb.science-line.com
Submit Online >>

Asian Journal of Medical and Pharmaceutical Researches



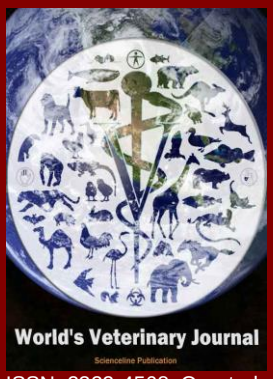
ISSN: 2322-4789; Quarterly
View Journal I Editorial Board
Email: editor@ajmpr.science-line.com
Submit Online >>

Journal of World's Poultry Research



ISSN: 2322-455X; Quarterly
View Journal I Editorial Board
Email: editor@jwpr.science-line.com
Submit Online >>

World's Veterinary Journal

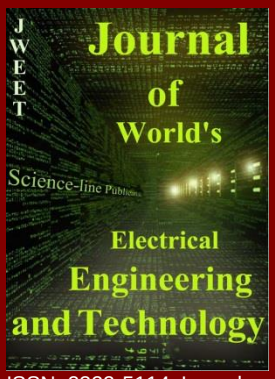


ISSN: 2322-4568; Quarterly
View Journal I Editorial Board
Email: editor@wvj.science-line.com
Submit Online >>

Journal of Educational and Management Studies

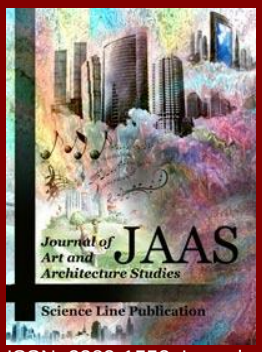
ISSN: 2322-4770; Quarterly
View Journal I Editorial Board
Email: info@jems.science-line.com
Submit Online >>

Journal of World's Electrical Engineering and Technology



ISSN: 2322-5114; Irregular
View Journal I Editorial Board
Email: editor@jweet.science-line.com
Submit Online >>

Journal of Art and Architecture Studies



ISSN: 2383-1553; Irregular
View Journal I Editorial Board
Email: jaas@science-line.com
Submit Online >>

Asian Journal of Social and Economic Sciences

ISSN: 2383-0948; Quarterly
View Journal I Editorial Board
Email: ajses@science-line.com
Submit Online >>

Journal of Applied Business and Finance Researches

ISSN: 2382-9907; Quarterly
View Journal I Editorial Board
Email: jabfr@science-line.com
Submit Online >>

Scientific Journal of Mechanical and Industrial Engineering

ISSN: 2383-0980; Quarterly
View Journal I Editorial Board
Email: sjmie@science-line.com
Submit Online >>