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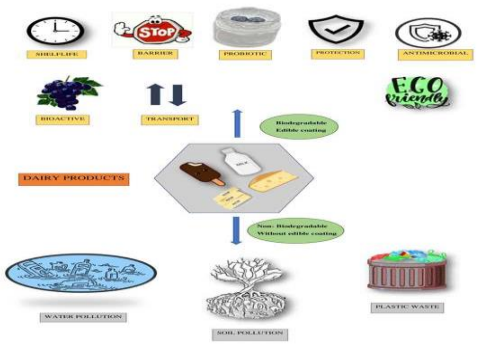
Review

Edible coatings and the need for biodegradable polymers with focus on dairy products

Richard NSh.

Online J. Anim. Feed Res., 12(4): 173-178, 2022; pii: S222877012200023-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.23

Abstract



Natural polymers are non-toxic, affordable, and abundantly accessible; hence they're often used in edible coatings. Covering vegetables with edible coatings that include antimicrobials, browning inhibitors, and nutraceuticals is a unique way to increase their nutritional value. Natural polymers are non-toxic, affordable, and abundantly accessible; hence they're often used in edible coatings. Covering vegetables with edible coatings that include antimicrobials, browning inhibitors, and nutraceuticals is a unique way to increase their nutritional value. Most edible coatings employ non-toxic, inexpensive, readily accessible natural polymers. Using biodegradable synthetic polymers and liquid and solid lipids, nano systems may be built at room temperature. To minimise food waste, edible food packaging utilises high-quality, low-impact packaging materials. Dairy consumer goods are among the industries targeted by the attack. Polymer nanocomposites, a kind of nano reinforcement, may act as a small gas barrier by increasing the difficulty of passing through the material. To put it simply, we now have the ability to accurately estimate the shelf life of our products thanks to developments in packaging technology, as well as biodegradable packaging and several other advantages. Packaging nanotechnology applications are categorised by their principal function. In conclusion, biodegradable synthetic polymers and liquid and solid lipids may also be used to create nano systems at ambient temperature. It is argued that recent advances in the usage of nano systems such nanoparticles, nanotubes, composites, and emulsions, are reviewed critically in this study. For food preservation purposes, nano dispersions may be supported by polymers, although the main focus of this article was on providing information on nano systems and how they can be used in various food substrates.
Keywords: Biodegradable, Dairy products, Edible coating, Food industry, Nanotechnology.

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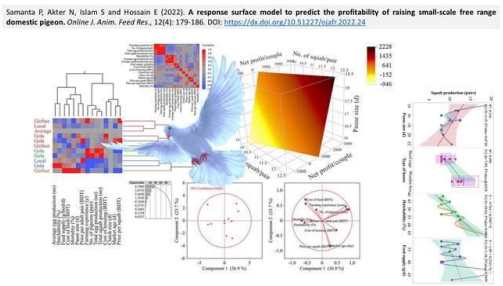
Research Paper

A response surface model to predict the profitability of raising small-scale free range domestic pigeon

Samanta P, Akter N, Islam S, Islam Sh and Hossain E.

Online J. Anim. Feed Res., 12(4): 179-186, 2022; pii: S222877012200024-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.24

Abstract



The study aimed to investigate the comparative profitability of raising different breeds of small- scale free range domestic pigeon in the Chattogram metropolitan area of Bangladesh. A cross-sectional survey was carried out for a period of three months from July to September 2021 using a structured questionnaire. Results indicated that there were no differences among the performance parameters of the non-descriptive, Gola and Giribaz breeds of pigeon. However, the non-descriptive breeds produced more eggs and thus squabs per year than the Gola and Giribaz. Similarly, the average pause size, and feed supply per day and market age were lower in the local breeds compared with Gola and Giribaz. Hatchability percentage of the local breed was higher than the other breeds. Average mortality was moderately higher in the Giribaz. The average flock size was 4.9±0.70 pair. The average annual egg and squab productions were 20.6±1.10 and 10.7±1.00 pairs, respectively. The average daily feed supply was 37.8±1.5 g/bird. The average clutch and pause sizes were 2.0 and 17.3 day, respectively. Average market age, hatchability and mortality were 30.6±0.90 day, 51.4±2.20% and 7.6±1.6%, respectively. Mean feed and housing cost were 1008±24.7 and 443±42.8 Bangladeshi taka (BDT) per pair/year, respectively. Mean market price per pair adult and per squab was BDT 365±18.6 and 130±4.9, respectively. Flock size and pause size had strong positive and negative correlations with annual squab production. There were no significant differences between the net profit of the farms rearing different breeds of pigeon.

However, farms raising local breeds had the highest annual net profit (BDT 823/pair) compared with other farms raising Giribaz (BDT 478/pair) and Gola breeds (BDT 319.70/pair). Principal component analysis identified annual egg production and feed cost as the principal eigenvector determining net profit. It was concluded that despite marginal profit, small-scale free range domestic pigeon farming was economically viable for the subsistence of the rural livelihoods.
Keywords: Free range, Giribaz, Gola, Pigeon, Profitability.

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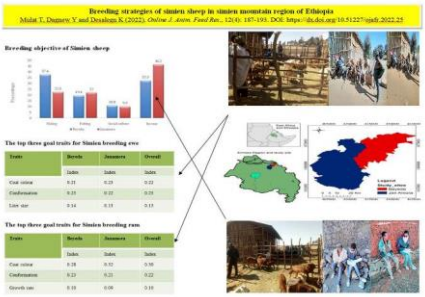
Research Paper

Breeding strategies of Simien sheep in Simien mountain region of Ethiopia

Mulat T, Dagnew Y and Desalegn K.



Online J. Anim. Feed Res., 12(4): 187-193, 2022; pii: S222877012200025-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.25

Abstract
This study was conducted to characterize the existing sheep breeding strategies as an essential step in designing a breeding program for linking sheep production in the Simien mountain region of Ethiopia. Interview with sheep keepers, direct ranking method of traits, and field observations were carried out in selected districts of Simien mountain region. Sheep kept mainly as a source of income, saving and meat with an index value of 0.27, 0.21, and 0.20 in the Beyeda district whereas the corresponding value for Janamora was 0.26, 0.22, and 0.19, respectively. Mean sheep flock sizes were 14.9 and 16.2 in Beyeda and Janamora districts of Ethiopia. Natural and uncontrolled breeding was common in the Simien mountain region of Ethiopia. Coat color, body conformation, and fast growth rate were important traits in selecting breeding rams in both study districts. Coat color and appearance were selection criteria for breeding ewes in both study districts. It is observed that Simien sheep is highly valued for its tasty meat and produce under low input conditions. However, the survival of Simien sheep is endangered due to uncontrolled breeding, intervention failures in livelihood, and market-oriented agricultural systems. In conclusion, the main breeding objective for sheep production have been defined as increasing meat production and marketed animals and this is driven by market demands. Compared with other local sheep types, Simien was rated highly by both producers and consumers in their tasty meat. These characteristics make the Simien sheep economically more important. Yet Simien sheep need to be conserved as they could serve as a source of safe and tasty products for consumption.
Keywords: Breeding practice, Livestock population, Mountain region, Sheep flocks, Simien sheep.

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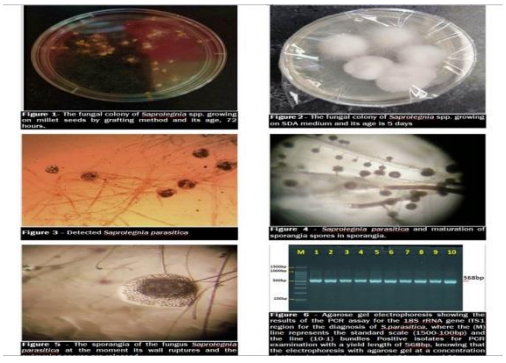
Research Paper

The spreading and molecular characterization of the fungus *Saprolegnia parasitica* in the water of Al-Diwaniyah river of Iraq

Muataz MAA and Majid KA.



Online J. Anim. Feed Res., 12(4): 194-199, 2022; pii: S222877012200026-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.26

Abstract
The water mold *Saprolegnia parasitica* is a chief species of oomycetes that affects a wide range of plant, natural ecosystems, fish and the aquaculture industry. The current study aimed to investigate the isolation and identification of some aquatic fungi like *Saprolegnia* spp. and also molecular characterization of *Saprolegnia parasitica* in the water of Al-Diwaniyah river of Iraq using the baiting method for isolation and PCR polymerase chain reaction for molecular diagnosis of fungi. A total of 60 samples were taken from three study sites of river: 25 samples of Al-Shafi'iah city bridge (Najaf road) as first site (S1); 25 samples of Hawly Al-Jamiah road bridge, Umm Al-Khail area, as second site (S2); and 10 samples of Al-Orouba bridge as the third site (S3). Molecular diagnosis was carried out by PCR examination using primers for the rDNA gene and its presence in *Saprolegnia parasitica*, as DNA was obtained at a concentration of 685.4-99.4 µg/µl and a purity of 1.92-1.8. The samples from the first site gave the highest number of 18 isolates (45%), followed by samples from the second site with 14 isolates (35%). The samples from the third site showed a number of 10 isolates (20%). The species *S. parasitica* was more visible during February 2020 with a number of 17 isolates, and less visible in April 2021, with a number of 3 isolates. In conclusion, the variation in the presence of the types of infectious aquatic fungi *Saprolegnia* spp. in the Al-Diwaniyah river of Iraq in different sites and months of 2021 showed a high percentage of isolates for Al-Shafi'iah city bridge (Najaf road) site and the highest number of *Saprolegnia parasitica in* February 2020. There is a need for further examination of oomycetes in different sites of rivers of Iraq in different months.
Keywords: Aquatic fungi, Fish, Fungal disease, Molecular characterization, *Saprolegnia parasitica.*

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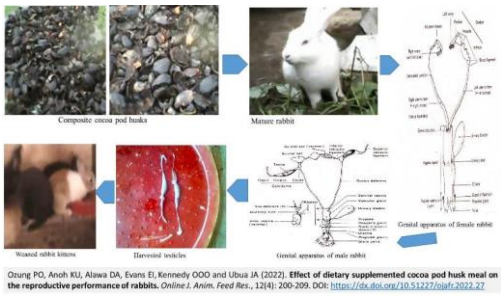
Research Paper

Effect of dietary supplemented cocoa pod husk meal on the reproductive performance of rabbits

Ozung PO, Anoh KU, Alawa DA, Evans EI, Kennedy OOO and Ubua JA.

Online J. Anim. Feed Res., 12(4): 200-209, 2022; pii: S222877012200027-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.27

Abstract
This study determined the dietary effect of cocoa pod husk meal (CPHM) on the reproductive performance of rabbits. Twelve iso-nitrogenous (16.05% CP) and iso–caloric (2500.12 Kcal kg^{-1} ME) diets were formulated. The CPHM was included at 0, 12.5, 25 and 37.5% levels for T_1, T_2, T_3, and T_4 raw; T_5, T_6, T_7, T_8 fermented and T_9, T_{10}, T_{11}, T_{12} hot–water treated CPHM. Sixty weaned rabbits between 5 and 6 weeks old of both sexes (30 males and 30 females) with mean initial body weight of 606.42±1.30g were used. The rabbits were randomly distributed using a completely randomized design (CRD). The animals were crossed at maturity for reproductive performance evaluation. Total protein concentrations of reproductive parts were determined. Result showed no significant dietary effect on reproductive performance. The 37.5% level recorded zero pregnancy in the raw and hot–water groups. Average gestation period ranged between 30 and 31 days. Average litter size at birth ranged 1 – 4 kittens. Average weaning weight ranged between 475 and 580.25g with the least weight in the raw group. Milk yield ranged between 205.46 and 262.94g. The sperm volume and gonadal sperm reserve recorded significant effect (P<0.05). In the raw and hot–water groups, the sperm volume decreased marginally. The protein concentration in the testes recorded higher significant (P<0.05) values in the control diet and the least value in raw group. The study concluded that fermented CPHM diets performed best at 37.5% level in terms of reproductive performance of rabbits.
Keywords: Cocoa, Gonadal sperm reserve, Kindling, Milking, Sperm volume.



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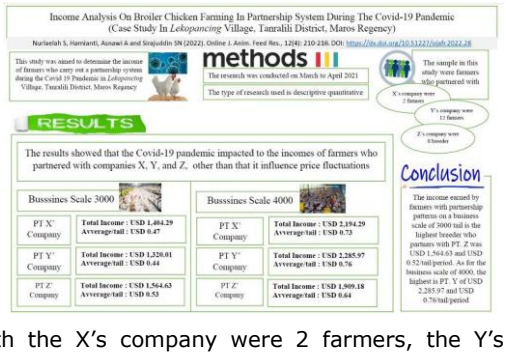
Research Paper

Income analysis on broiler chicken farming in partnership system during the COVID-19 pandemic in Tanralili district, Indonesia

Nurlaelah S, Harnianti, Asnawi A and Sirajuddin SN.

Online J. Anim. Feed Res., 12(4): 210-216, 2022; pii: S222877012200028-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.28

Abstract
This study was aimed to determine the income of farmers who carry out a partnership system during the COVID-19 Pandemic in Lekopancing Village, Tanralili District, Maros Regency. The research was conducted on March to April 2021. The type of research used is descriptive quantitative. The sample in this study were farmers who partnered with the X's company were 2 farmers, the Y's company were 12 farmers and the Z's company were 8 breeder. Data was collected through interviews with the help of a questionnaire as the research instrument. The results showed that the COVID-19 pandemic impacted to the incomes of farmers who partnered with companies X, Y, and Z, other than that it influence price fluctuations. The income earned by farmers with partnership patterns on a business scale of 3000 tail is the highest breeder who partners with PT. Z was USD 1,564.63 and USD 0.52/tail/period. As for the business scale of 4000, the highest is PT. Y of USD 2,285.97 and USD 0.76/tail/period.
Keywords: Agricultural management, Broiler chicken, Income, Partnership system, Poultry farming.



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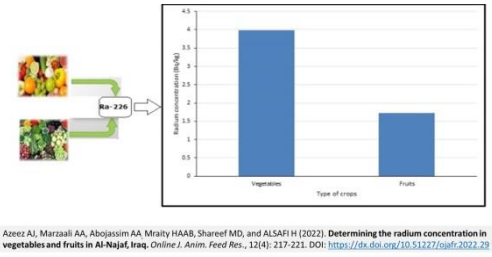
Research Paper

Determining the radium concentration in vegetables and fruits in Al-Najaf, Iraq

Azeez AJ, Marzaali AA, Abojassim AA, Mraity HAAB, Shareef MD, and ALSAFI H.

Online J. Anim. Feed Res., 12(4): 217-221, 2022; pii: S222877012200029-12

DOI: https://dx.doi.org/10.51227/ojafr.2022.29



Azeez AJ, Marzaali AA, Abojassim AA Mraity HAAB, Shareef MD, and ALSAFI H (2022). **Determining the radium concentration in vegetables and fruits in Al-Najaf, Iraq.** *Online J. Anim. Feed Res.*, 12(4): 217-221. DOI: https://dx.doi.org/10.51227/ojafr.2022.29

Abstract
Amount of pollution radiation in foodstuffs and feedstuffs are very necessary to measure because it is a direct contact with human and animal health. Therefore, the present investigation is useful for the health and environmental data base. The study included measurement of effective radium-226 content (C_{Ra}) in some chosen samples of vegetables and fruits (local and imported) in Najaf governorate. The C_{Ra} were measured in samples of vegetables and fruits using Solid State Nuclear Track Detectors (LR-115 Type II). Also, the annual effective dose (AED) associated with the exposure due to annual intake of ^{226}Ra were calculated from ingestion of vegetables and fruits samples for adults. The results were revealed that the average value of C_{Ra} in vegetables and fruits samples in the present study was 3.98±1.08 Bq/kg and 1.73±0.11 Bq/kg, respectively. While, the average of AED (mSv/y) for vegetables and fruits samples was 0.067±0.018 and 0.082±0.005, respectively. Also, the results showed that the average value of AED from fruits consumption is larger than in vegetables, but the result is not significant. All results of the C_{Ra} and AED of the studied samples had been compared with the worldwide reported value (median). Accordingly, it was found that all findings were lower than that of the recommended limits of the UNSCEAR 2000. Finally, based on present investigations, no health risk expected when considering eating vegetables and fruits of Al-Najaf of Iraq.
Keywords: Alpha emitters, Food contamination, Radium-226, Herbal samples, Al-Najaf.

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Research Paper

Performance of blackhead Ogaden sheep fed different grasses (*Chloris gayana, Pennisetum purpureum, Panicum maximum* and *Cynodon dactylon*) basal diets and the same concentrate mixture

Ahmed M, Animut G, Hassen G, and Abdimahad K.

Online J. Anim. Feed Res., 12(4): 222-231, 2022; pii: S222877012200030-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.30

Abstract
A study was conducted to determine the effect of feeding Rhodes grass (RG; *Chloris gayana*) as treatment 1 (T1), elephant grass (EG; *Pennisetum purpureum* as T2), guinea grass (GG; *Panicum maximum* as T3) and bermuda grass (BG; *Cynodon dactylon* as T4) supplemented with a similar amount of concentrate mixture (CM; wheat bran (WB) and Noug seed cake (NSC) at 67:33 ratio) on performance and economy of fattening of Blackhead Ogaden sheep. The study consisted of a feeding and digestibility trials of 90 and 7 days long, respectively. Twenty-four intact yearling Blackhead Ogaden sheep with an initial body weight (BW) of 15.83±0.04 kg (mean±SD) were used in a randomized complete block design based on their initial BW with four treatments and six replications. All animals received 300 g dry matter (DM) of CM. Nutrient concentration of RG, EG, GG, BG, NSC and WB were 5.5, 8.8, 7.6, 7.9, 24.3 and 14.0% crude protein (CP), and 83.3, 74.5, 75.4, 81.5, 39.0 and 45% neutral detergent fiber, respectively on DM basis. Intake of DM was 696, 700, 719 and 716 g/day (SEM = 0.004) for T1, T2, T3 and T4, respectively and was lowest for T1 and highest for T3. The CP intake was also lowest for T1 (89 g/day), and similar among the other 3 treatments (99-103 g/day). Digestibility of CP and organic matter were highest for T2, intermediate for T3 and T4 and lowest for T1. Average daily gain was in the order of T2 > T3 = T4 > T1 (27, 63, 50 and 45 g/day (SEM = 13.1) for T1, T2, T3 and T4, respectively); whereas hot carcass weight did not significantly differ among treatments (5.7, 6.4, 6.1 and 6.3 kg (SEM = 0.36) for T1, T2, T3 and T4, respectively). Total return, net income and marginal rate of return were all in the order of T2 > T4 > T3 > T1. Therefore, based on biological performance as well as economic return, sheep fed elephant grass perform better. However, variations in performance and economic return among the four grass species needs to be taken cautiously as part of the difference might have attributed to differences in the stage of maturity of the grasses up on harvest for feeding the lambs.
Keywords: Blackhead Ogaden sheep, Digestibility, Feed intake, Performance, Weight gain.

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Research Paper

Application of international committee for animal recording (ICAR) methodology in dairy herd management in south of Russia

Oleinik S, Skripkin V, Ershov A, Shlykov S, and Omarov R.

Online J. Anim. Feed Res., 12(4): 232-239, 2022; pii: S222877012200031-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.31

Abstract
This experiment was conducted to determine the advantages of introducing modern innovative approaches to dairy herd management based on the study and implementation of the methodological of International Committee for Animal Recording (ICAR). This research shows the main directions for introduction to new breeding and the technological model of interaction with breeding farms for breeding dairy cattle. This interaction occurs through the services provision for breeding farms, the control-assistant and expert-boniter services, as well as laboratories for selection control of milk quality and genetic control. The tasks of the control-assistant service included participation in the control milking of cows and individual milk samples picking from each cow and its delivery to the laboratory in a chilled form. Using as the example dairy herd of the black and white breed by studying the dynamics of somatic cells has been showing the effectiveness of different methods for assessing the quality of milk. Implementation of the milk quality regular monitoring during 1-2 months allows bringing the main parameters of milk quality in line with the requirements of national and international ICAR standards. The cow's conformation assessment by animals' linear assessment allows revealing the bull's prepotent abilities and choosing the right strategy for improving the cow's conformation in the herd. Genetic well-being assessment of cows makes it possible to exclude unwanted individuals with genetic abnormalities and use only healthy animals in breeding. The research purpose was studying the possibility of applying the ICAR method in Russian breeding livestock to improve the dairy herd management system. The research results showed that Implementation of individual veterinary measures for two months allowed reducing the average somatic cell count by 1.85 times and reaching the level recommended by ICAR. The spread of individual indicators also significantly decreased. Therefore, Using the individual monitoring of dairy raw materials quality assessment makes it possible to study the influence of para-typical (climatic) factors on the content of dairy components, as well as to stabilize the quality parameters in terms of the level of somatic cells not higher than 200 thousand cells/cm3.
Keywords: Breeding, Dairy cattle breeding, Dairy herd, Genetic resources, Milk quality.

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Research Paper

Nutrient content and quality of soybean meal waste fermented by *Aspergillus ficuum* and *Neurospora crassa*

Ciptaan G, Mirnawati M, Aini Q and Makmur M.

Online J. Anim. Feed Res., 12(4): 240-245, 2022; pii: S222877012200032-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.32

Abstract
Present research aimed to increase soybean meal waste quality and nutrient by fermentation using different ratio of mixed fungus inoculum (*Aspergillus ficuum* and *Neurospora crassa*) and fermentation time. The primary materials were soybean meal waste (SMW), fungus *Aspergillus ficuum* and *Neurospora crassa*. The experiment applied a completely randomized design (CRD) with a 3 × 3 factorial pattern and three replications. Two treatments were given in this study, factor A (combination of *A. ficuum* and *N. crassa*), comprising of A1 (3:1), A2 (3:2), and A3 (3:3). Factor B (fermentation time) comprising of B1 (5 days), B2 (7 days), and B3 (9 days). The variance analysis exposed a highly significant interaction between factor A and factor B, and those factors also exposed a highly significant effect. The correlation between SMW crude protein and broiler nitrogen retention showed a positive trend, contrary SMW crude fiber content negatively affected crude fiber digestibility. In conclusion, the combination of *A. ficuum* and *N. crassa* (3:2) and seven days fermentation period showed optimal results as seen from 28.25% crude protein, 13.77% crude fibre, 61.16 nitrogen retention and 58.76% crude fibre digestibility of fermented SMW.
Keywords: *Aspergillus ficuum*, Crude protein, Digestibility, Fermentation, *Neurospora crassa*.

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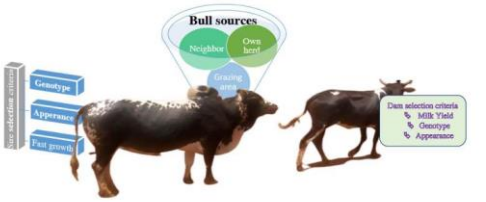
Research Paper

Breeding practices and traits preference in dairy cattle in Gedeo agroforestry of Ethiopia

Haile D and Tesfahun B.

Online J. Anim. Feed Res., 12(4): 246-254, 2022; pii: S222877012200033-12
DOI: https://dx.doi.org/10.51227/ojafr.2022.33

Abstract
The study was conducted to identify breeding practices and traits preferences of the dairy cattle producers in the southern part of Ethiopia. Representative sample households were selected by SRS (Simple Random Sampling) techniques. A cross-sectional survey with a structured questionnaire was used to collect the data on the purpose of keeping dairy cattle, herd composition, source of dairy cattle, trait preference, and breeding practices performed by the farmers. The data were analyzed using statistical software SPSS 27, and chi-square was used to compare categorical variables. The herd composition of the Bule district is significantly different from the rest of the districts in the mean number of calves, heifers, and bulls. The Yirgachefe district significantly differs in the mean number of cows compared to other districts. The breed preference of most farmers (81.67%) is cross-bred bulls (Jersey and Holstein Frisian). There are not enough bulls on the farms; only 21.7% of them have a breeding bull, and the primary sources of bulls in the study community are the grazing areas and the neighbors. Respondents preferred artificial insemination (96.1%) to natural mating. Milk yield, appearance, and genotype were important traits in selecting a dam, whereas genotype, appearance, and fast growth rate were the most preferred traits in sire ranking. The farmers' breeding objectives were to improve milk production and increase cash income. Therefore, establishing a village-based mating program for the genetic improvement of dairy cattle in the study area is recommended to overcome the shortage of bulls.
Keywords: Artificial Insemination, Breeding, Genetic improvement, Selection criteria, Sire.



Haile D and Tesfahun B (2022). **Breeding practices and traits preference in dairy cattle in Gedeo agroforestry of Ethiopia.** *Online J. Anim. Feed Res.*, 12(4): 246-254. DOI: https://dx.doi.org/10.51227/ojafr.2022.33

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EDIBLE COATINGS AND THE NEED FOR BIODEGRADABLE POLYMERS WITH FOCUS ON DAIRY PRODUCTS

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ABSTRACT: Natural polymers are non-toxic, affordable, and abundantly accessible; hence they're often used in edible coatings. Covering vegetables with edible coatings that include antimicrobials, browning inhibitors, and nutraceuticals is a unique way to increase their nutritional value. Natural polymers are non-toxic, affordable, and abundantly accessible; hence they're often used in edible coatings. Covering vegetables with edible coatings that include antimicrobials, browning inhibitors, and nutraceuticals is a unique way to increase their nutritional value. Most edible coatings employ non-toxic, inexpensive, readily accessible natural polymers. Using biodegradable synthetic polymers and liquid and solid lipids, nano systems may be built at room temperature. To minimise food waste, edible food packaging utilises high-quality, low-impact packaging materials. Dairy consumer goods are among the industries targeted by the attack. Polymer nanocomposites, a kind of nano reinforcement, may act as a small gas barrier by increasing the difficulty of passing through the material. To put it simply, we now have the ability to accurately estimate the shelf life of our products thanks to developments in packaging technology, as well as biodegradable packaging and several other advantages. Packaging nanotechnology applications are categorised by their principal function. In conclusion, biodegradable synthetic polymers and liquid and solid lipids may also be used to create nano systems at ambient temperature. It is argued that recent advances in the usage of nano systems such nanoparticles, nanotubes, composites, and emulsions, are reviewed critically in this study. For food preservation purposes, nano dispersions may be supported by polymers, although the main focus of this article was on providing information on nano systems and how they can be used in various food substrates.

Keywords: Biodegradable, Dairy products, Edible coating, Food industry, Nanotechnology.

INTRODUCTION

Nanotechnology is a rapidly expanding field that draws from a wide range of scientific and engineering disciplines. Nanotechnology has been applied to the fields of biology, chemistry, engineering, and physics in order to create new types of materials. Because of the changes in their physical, chemical, and biological properties that occur as they are scaled down to the nanoscale range, nanomaterials are finding new uses in a variety of fields. Nanoparticles (10-9 m) have the potential to be used in a wide variety of applications due to their singular qualities, which include their unusually small particle size and enormous surface area (Duran and Marcato, 2013; Patil et al., 2019). In the food industry and processing industry, potential applications of nanotechnology include the detection of pathogens, the administration of drugs, the packaging of food, and the distribution of bioactive components. Utilizing nanotechnology within food systems enables a fresh approach to the protection of food and the enhancement of its nutritional content (Rashidi and Khosravi-Darani, 2011; Kiss, 2020). It is common practice in the manufacturing of edible coatings to make use of natural polymers because they are non-toxic, inexpensive, and widely available. Covering vegetables with edible coatings that contain active compounds such as antimicrobials, browning inhibitors, and nutraceuticals is a novel method for increasing the nutritional content of the produce that is being consumed (Dholariya et al., 2021).

The production of modern food and agriculture has profited significantly from considerable breakthroughs in nanotechnology due to the advent of smart and active packages, nano sensors, nano insecticides, and also nano fertilizer. Numerous innovative nanomaterials have been emerged in recent years with the goals of enhancing the quality and safety of food, as well as monitoring crops and the environment (He et al., 2019). Edible coatings are a type of food coating that refers to food products that have been coated with an edible polymer layer that possesses both biological and chemical capabilities. Plants and animals both contain reservoirs of biopolymers such as resins, oleoresins, gums, lipids, polysaccharides, proteins, and other resinous compounds.

It is possible to recover and purify these compounds from their raw sources by employing the appropriate processing methods and procedures. Resins, oleoresins, gums, lipids, polysaccharides, and proteins are examples of biopolymers. Because plants have a high polyphenolic chemical content, which may serve as probable antioxidants and antibacterial agents, it is common practice for edible coatings to be obtained from plants. This is due to the fact that polyphenols are found in high concentrations in plants (Bhagath and Manjula, 2019). It is absolutely necessary for nanocomposites to have increased stability in order to keep their antibacterial action intact and stop the migration of metal ions in preserved

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foods. Polymers are primarily developed for the development of nanocomposites in the culinary industry that contain metal or metal oxide nanoparticles (He and Hwang, 2016). Utilizing nanoparticles such as nano chitosan, which have distinct physical and chemical qualities (small size, high surface area, and positive surface charge) that make them a viable alternative, it is possible to protect fruits from diseases (Melo et al., 2020). It is well knowledge that nanotechnology can be utilized to increase the amount of time that food can be stored. When compared to bigger systems, the smaller particle size that may be achieved in nanometric systems results in materials with distinct and better properties. It is now possible for hydrophilic and lipophilic compounds, such as antimicrobials and antioxidants, to extend the shelf life of a wide range of products, such as whole and freshly cut fruits and vegetables, nuts, seeds, cheese, and so on. The majority of edible coatings make use of natural polymers, which are often non-toxic, inexpensive, and easily accessible. On the other hand, biodegradable synthetic polymers as well as liquid and solid lipids can be employed to build nano systems even when the temperature is room temperature (Zambrano-Zaragoza et al., 2018). The improvements that have been made possible by nanotechnology have made it feasible to create a wide variety of brand-new structure, materials, and systems. These include those in the fields of agriculture, food, and medicine (Singh et al., 2017).

POTENTIAL APPLICATION IN FOOD INDUSTRY

There is a possibility that nanotechnology will have an effect on a diverse variety of food and agricultural production methods. In the fields of agriculture and food systems research and engineering, nanotechnology has a wide range of applications, some of which include food security, new methods for the delivery of disease treatments, new tools for molecular and cellular biology, innovative materials for the detection of pathogens, and environmental protection. The following are some of the ways in which the application of nanotechnology can benefit the food industry:

- Manufacturing, processing, and shipping of food has become more secure thanks to pathogen and contamination detecting sensors.
- It is important to have devices that can track particular shipments and retain environmental data for a specific product.
- Intelligent/smart systems that incorporate sensors, location, reporting and remotely maintenance of food products can increase the efficiency and stability of food processing as well as transportation.
- Food ingredients can be transported, preserved, and distributed to their designated sites of action using encapsulation and tracking system to accomplish these tasks. Biosciences and engineering applications are the primary focus of nanotechnological research. Table 1 shows a variety of uses.

Table 1 - Application matrix of nanoscience and nanotechnology in main areas of food science and technology (Hamad et al., 2018; Kumari and Yadav, 2014; Rashidi and Khosravi-Darani, 2011; Santeramo et al., 2018)

Area of application	Purpose and fact	Approaches
Design of nanomaterial	Nanoparticles, Nano emulsions, Nanocomposites, and Nanobiocomposites are all forms of nanotechnology (nano biopolymeric starch)	Self-assembling, self-healing, and modifying attributes in a novel specified material.
Nano sensors and nano biosensors	Nanolaminates Quality control and food safety	Monitoring and labeling of food items; detection of extremely trace amounts of chemical contaminants by the use of a sensor assessment system that incorporates an electronic nose and tongue The identification of food-borne pathogens can be accomplished by using nucleic acid, protein, or any other metabolite produced by microbes.
Processing	Nanofiltration Nanoscale enzymatic reactor Heat transmission and mass exchange Nanofabrication Nano capsules designed to alter the way substances are absorbed	By using a nanoceramic pan, it was possible to cut down on the amount of time needed to roast the food, the amount of oil used, and the amount of trans fatty acids produced by using plant oil rather than hydrogenated oil. Because of this, scientists were able to create nutrient-delivering nano capsules for food that are safe to ingest and may be put into food in order to facilitate greater absorption.
New products	Packaging Delivery Formulation Evaluation DNA recombinant technology	Barrier properties (mechanical, thermal, chemical, and microbial) are improved with the use of nanocomposites as coatings, release devices, and novel packaging. Mechanical and thermal properties are gotten better; effective antibacterial surfaces are developed; microbial contamination and biochemical changes can be detected and signalled; and dirt repellent coatings for packaging are developed. • Targeted delivery of nourishment by nanomycells (nutrition nano therapy) • Sustained - release of nutrients, proteins, antioxidants, and tastes with nano capsules • Development of a new product by the use of a nanoscale enzymatic reactor • Omega-3 fatty acid, haemoglobin, lycopene, beta-craton, phytosterols, and DHA/EPA fortification of food As a nano biological system for the creation of new goods, enzyme and protein evaluation • Nano porous medium for the manufacture of recombinant enzymes with a wide range of applications.

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It is possible to design novel structures out of functional nanostructures and give food products new functionality by employing these nanostructures as building blocks. Nanoliposomes, nano emulsions, nanoparticles, and nanofibers are only a few examples of the various types of nanomaterials. Weiss has provided specific information about a few of these buildings, in addition to their past, present, and potential future applications in the food sector. According to the most recent information available, nanomaterials employed in applications related to food preparation can be either inorganic or organic. Inorganic, surface-functionalized, and organic engineered nanomaterials (ENMs) are the types of designed nanomaterials that can be discovered in nanofood items (Sekhon, 2010).

Sensors that operate on the nanoscale Biosensors on food, for instance, might make use of biological molecules like sugars or proteins in order to determine the presence of infections and other impure chemicals. The use of sensors that can detect illness and contaminants in food nano sensors would make food production, processing, and shipping significantly safer. It is feasible to compensate for the shortcomings of the sensors that are currently in use by employing nano sensors because of their tiny size and portability as well as their rapid processing and specialized nature (Sharon et al., 2010). Active food packaging adds preservatives such as antimicrobials to food at the beginning of the rotting process, whereas intelligent food packaging can warn the user to the food breakdown. By utilizing nano-composites in food packaging, it is feasible to protect food against contamination such as illnesses, gas leaks, and other potentially harmful substances. In addition to preventing the growth of bacteria, fungi, and other pathogens, bio-nanoparticles such as silver titanium oxide, zinc oxide, and other bio-nanoparticles function as a barrier to the exchange of gases. Enhancing a product's barrier capabilities can assist maintain food quality and increase its shelf life, even in the absence of the application of artificial or chemical preservatives. Nano-composites are a type of reinforcing material that has a size less than 100 nanometres and is classified as a polymer with a single dispersion phase that can either be organic or inorganic (Sharma and Dhanjal, 2016). It is possible to utilize coatings and films to communicate food contents, restrict the movement of moisture and other things such as carbon dioxide and aromas, and improve the mechanical qualities of the meal. This can be done by preventing the flow of moisture and other substances. Starch, chitosan, cellulose, and galactomannans are some of the compounds that can be used to make edible or biodegradable coatings and films. Other possible substances include galactomannans (Zhang et al., 2014).

Biopolymers such as polysaccharides, proteins, lipids and waxes, plasticizers, and additives can all be utilized in edible food packaging. Other types of biopolymers include cellulose, hemicellulose, and cellulose acetate. Edible food packaging relies on high-quality and environmentally friendly packaging in order to reduce the amount of food that is wasted. The dairy industry, the fruit and vegetable industry, the grain and cereal industry, fisheries, the meat and poultry industry, as well as consumer food products and other fields are among those that are being targeted. It is also feasible to improve food qualities by combining established methods of food preservation with edible packaging. These methods include thermal treatments and cold processing, preservatives and water management, and non-thermal processing, among others. Consumables that have been wrapped in a variety of secondary and tertiary packing materials are able to be exported and transported with relative ease (Ghosh and Katiyar, 2021).

The primary idea behind this method is to change the atmosphere that is surrounding the fruits by either eliminating or adjusting the quantity of chemicals that are necessary for respiration. Some examples of these chemicals are oxygen, carbon dioxide, and ethylene. The application of edible coatings as a means of protecting the quality of fruit has revealed some encouraging outcomes. Agents, either biological or chemical, are placed to the surface of the product and left there in order to put a stop to the ripening process. The term "edible coating" refers to a thin layer of fruit that acts as a barrier between the fruit itself and the environment around it. This layer can be consumed by humans. The coating solution is either dipped onto the fruits or sprayed onto them in order to apply the edible coating to fresh or freshly cut fruits. An edible coating can act as a barrier to the interchange of gases, which in turn can lower the amount of water that is lost from the surface of the fruit and alter the atmosphere around it, leading to an improvement in the flavour of the fruit. In addition to reducing the rate of fungal development and enhancing the overall appearance of the fruit, this also stops anaerobic respiration and the aging process (Maringgal et al., 2020). Bioactive peptides are encapsulated in lipid bilayers. Compound encapsulation shields a delicate component from the potentially harmful effects of the surrounding environment by hermetically sealing the capsule. Because of this barrier, it is feasible to protect a chemical from oxygen, water, and light while yet allowing for regulated release and limiting contact with other components in a combination. This is made possible by the barrier's structure. Bioactive peptides are pieces of proteins that have the potential to improve the health and well-being of living creatures. The nitrogenous components that are biologically active are found in abundance in marine creatures. Limiting hypertension, decreasing cholesterol, controlling hunger, and inhibiting the growth of germs are just a few of the actions that have been associated to this chemical.

In addition, this substance possesses antibacterial, anticoagulant, and antidiabetic effects. With the assistance of these peptide-loaded nanocapsules, it would be feasible to stop the putrefaction of food and the development of potentially harmful microbes. When astaxanthin and maybe other carotenoid pigments are micro- or nano-encapsulated in food matrices, they may be more stable and have a greater therapeutic effect (Neves et al., 2015).

NANOTECHNOLOGY IN FOOD INDUSTRY

Food processing

Through the process of food processing, raw ingredients are converted into food and other forms that may be marketed and have a longer shelf life. These products can also be stored for longer. The elimination of toxins, the

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prevention and treatment of illness, and the conservation of materials are all examples of processing. Another example would be improving the consistency of the meal so that it can be distributed more easily. When it comes to transporting goods across great distances, processed meals are preferable to fresh foods since they are less likely to go bad than fresh foods. The application of nanotechnology has made each of these far more efficient. When foods are encapsulated with straightforward solutions like colloids, emulsions, biopolymers, and others, the food's functional characteristics are maintained. It is possible to use structural lipids, often known as "nanodrops," as a liquid transporter for beneficial components that are difficult to dissolve in water or fat (Ali et al., 2019; Giaconia et al., 2020). This is possible because structural lipids have a very small molecular size. They accomplish this by preventing cholesterol from being absorbed in the gastrointestinal tract and instead delivering it directly to the bloodstream where it may be used.

Food packaging

Food packaging is required to fulfil a number of requirements, including those pertaining to safety, resistance to tampering, and particular requirements for its chemical, biological, or physical makeup (King et al., 2017). Because of this label, you will be able to view any and all nutritional information that pertains to the food that you are about to consume. The viability of the food's business depends heavily on the packaging, which plays an important part in the preservation of the product. As a result of advances in packaging technology, we now have quality packaging, a means of estimating shelf life that is user-friendly for consumers, biodegradable packaging, and a plethora of other benefits. The various applications of packaging nanotechnology are broken down according to their primary purpose.

Barrier protection

It is important to keep food in an atmosphere that is low in oxygen and inert in order to prevent the growth of microbes and the subsequent rotting of the food. When nanocomposites are introduced into a polymer matrix, the increased surface area of the nanocomposites provides for improved filler-matrix interactions as well as performance (Bustamante-Torres et al., 2021). Nano reinforcement, which is also known as polymer nanocomposites, can function as a tiny gas barrier since it increases the difficulty of the material's passage through the material. Complex metallic ores are used in the production of nano clays, which are materials that are composite in nature. In order to enhance the quality of food packaging and provide a barrier against the permeability of gases contained within the container, polymer clays produced from nylons, polyolefins, PET, PA, epoxy resins, and poly methane are frequently utilized. In contrast, Durethan, Imperm, and Aegis nano clay, all of which are composed of nano clay based on polyamide, have undergone extensive development and are now available for commercial use. It has been praised for both its longevity and its level of protection. Due to the fact that packaging is such an essential component of the marketing of a product, numerous studies on cell-and-carbon nanotube nanocomposites have been conducted.

Antimicrobial packaging

Utilizing natural nanoparticles as a preventative measure against infections and spoilage brought on by the proliferation of microbes is possible (Saleh and Abu-Dieyeh, 2021). Silver nanoparticles can be found in a wide variety of products, including bio textiles, electrical appliances, refrigerators, and kitchenware, to name just a few of these categories. Its ions, in addition to silver nanoparticles in bulk, have the ability to obstruct a wide variety of biological processes that bacteria engage in. Zinc oxide is found in a variety of polymers, including polypropylene, and these properties become more pronounced as the particle size decreases. Zinc oxide has the ability to be activated by light and has antimicrobial properties; also, it can be activated by light. Titanium dioxide can be used as a coating on packages to prevent *E. coli* contamination of the contents. In order to help the disinfecting process along, silver is added to the solution. Recent research has shown that an antibacterial property can be discovered in a biopolymer called Chitosan, which is formed from chitin. Chitosan is also a great encapsulating material. Both the consumer and the manufacturer would stand to gain a great deal in terms of health and convenience from the use of antimicrobial packaging (Sreekumar et al., 2007; Abd El-Hack et al., 2020).

Biodegradable

The greatest concerning contributor to overall changes in environmental characteristics is pollution. The production of non-biodegradable plastics contributes to the emission of harmful gases into the environment, which in turn contributes to global warming. The production of a biodegradable polymer resulted in the material having a low mechanical strength and a high permeability to both water and gases (Moustafa et al., 2019; Zhang et al., 2022). Materials for packaging that are based on nanotechnology and possess qualities such as biodegradability, mechanical strength, and renewable resources can be developed to solve these concerns. Other sources of nanoparticles besides metal oxide nanoparticles and carbon nanotubes include animal and plant proteins, carbohydrates, and lipids. Nanoparticles can also be found in carbon nanotubes. Collagen nanofibers, zein nanofibers, and corn cellulose nanofibers all have a porous structure on their own. In the production of comfort packaging, these nanoparticles, in conjunction with nanoclays, are utilized. In addition to this, they have the capability to operate as biocatalysts, sensors, and they also have the potential to inhibit the growth of bacteria.

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CONCLUSION

Biodegradable synthetic polymers and liquid and solid lipids may also be used to create nano systems at ambient temperature. It is argued that recent advances in the usage of nano systems such nanoparticles, nanotubes, composites, and emulsions, are reviewed critically in this study. For food preservation purposes, nano dispersions may be supported by polymers, although the main focus of this article was on providing information on nano systems and how they can be used in various food substrates.

DECLARATIONS

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Authors' contribution

Nikitha R shalom designed and wrote the review.

Conflict of interests

The authors declare no conflict of interest

REFERENCES

Abd El-Hack ME, El-Saadony MT, Shafi ME, Zabermawi NM, Arif M, Batiha GE, Khafaga AF, Abd El-Hakim YM, and Al-Sagheer AA (2020). Antimicrobial and antioxidant properties of chitosan and its derivatives and their applications: A review. International Journal of Biological Macromolecules, 164: 2726-2744. https://doi.org/10.1016/j.ijbiomac.2020.08.153

Ali A, Ahmad U, Akhtar J, and Khan MM (2019). Engineered nano scale formulation strategies to augment efficiency of nutraceuticals. Journal of Functional Foods, 62:103554. https://doi.org/10.1016/j.jff.2019.103554

Bhagath Y and Manjula KJ (2019). Influence of composite edible coating systems on preservation of fresh meat cuts and products: a brief review on their trends and applications. International Food Research Journal, 26(2): 377-392. http://www.ifrj.upm.edu.my/26%20(02)%202019/(03).pdf

Bustamante-Torres M, Romero-Fierro D, Arcentales-Vera B, Pardo S and Bucio E, (2021). Interaction between filler and polymeric matrix in nanocomposites: Magnetic approach and applications. Polymers, 13(17): 2998. DOI: https://doi.org/10.3390/polym13172998

Dholariya PK, Borkar S, Borah A (2021). Prospect of nanotechnology in food and edible packaging: A review. Pharma Innovation, 10(5):197-203. DOI: https://doi.org/10.22271/tpi.2021.v10.i5c.6202

Duran N, and Marcato PD (2013). Nanobiotechnology perspectives. Role of nanotechnology in the food industry: a review. International Journal of Food Science & Technology, 48(6): 1127-1134. DOI: https://doi.org/10.1111/ijfs.12027

Giaconia MA, dos Passos Ramos S, Pereira CF, Lemes AC, De Rosso VV, Braga AR (2020). Overcoming restrictions of bioactive compounds biological effects in food using nanometer-sized structures. Food Hydrocolloids, 107:105939. DOI: https://doi.org/10.1016/j.foodhyd.2020.105939

Ghosh T and Katiyar V (2021). Edible food packaging: An introduction. Nanotechnology in Edible Food Packaging. Springer, Singapore, pp.1-23. DOI: https://doi.org/10.1007/978-981-33-6169-0_1

Hamad AF, Han JH, Kim BC and Rather IA (2018). The intertwine of nanotechnology with the food industry. Saudi journal of biological sciences, 25(1): 27-30. DOI: https://doi.org/10.1016/j.sjbs.2017.09.004

He X, Deng H and Hwang H-m (2019). The current application of nanotechnology in food and agriculture. Journal of Food and Drug Analysis, 27(1): 1-21. DOI: https://doi.org/10.1016/j.jfda.2018.12.002

He X and Hwang H-M (2016). Nanotechnology in food science: Functionality, applicability, and safety assessment. Journal of Food and Drug Analysis, 24(4): 671-681. DOI: https://doi.org/10.1016/j.jfda.2016.06.001

King T, Cole M, Farber JM, Eisenbrand G, Zabaras D, Fox EM, and Hill JP (2017). Food safety for food security: Relationship between global megatrends and developments in food safety. Trends in Food Science & Technology, 68:160-175. DOI: https://doi.org/10.1016/j.jff.2019.103554

Kiss É (2020). Nanotechnology in food systems: A review. Acta Alimentaria, 49(4): 460-474. DOI: https://doi.org/10.1556/066.2020.49.4.12

Kumari A and Yadav SK (2014). Nanotechnology in agri-food sector. Critical reviews in food science and nutrition, 54(8): 975-984. DOI: https://doi.org/10.1080/10408398.2011.621095

Maringgal B, Hashim N, Tawakkal ISMA, Mohamed MTMJTiFS and Technology (2020). Recent advance in edible coating and its effect on fresh/fresh-cut fruits quality. Trends in Food Science & Technology, 96: 253-267. DOI: https://doi.org/10.1016/j.tifs.2019.12.024

Melo NFCB, de Lima MAB, Stamford TLM, Galembeck A, Flores MA, de Campos Takaki GM, da Costa Medeiros JA, Stamford-Arnaud TM, Montenegro Stamford TCJIJoFS and Technology (2020). In vivo and in vitro antifungal effect of fungal chitosan nanocomposite edible coating against strawberry phytopathogenic fungi. International Journal of Food Science & Technology, 55(11): 3381-3391. DOI: https://doi.org/10.1111/ijfs.14669

Moustafa H, Youssef AM, Darwish NA, Abou-Kandil AI (2019). Eco-friendly polymer composites for green packaging: Future vision and challenges. Composites Part B: Engineering, 172:16-25. DOI: https://doi.org/10.1016/j.compositesb.2019.05.048

Neves MA, Hashemi J and Prentice CJCO (2015). Development of novel bioactives delivery systems by micro/nanotechnology. Current Opinion in Food Science, 1: 7-12. DOI: https://doi.org/10.1016/j.cofs.2014.09.002

Patil A, Mishra V, Thakur S, Riyaz B, Kaur A, Khursheed R, Patil K, and Sathe B (2019). Nanotechnology derived nanotools in biomedical perspectives: An update. Current Nanoscience, 15(2):137-146. DOI: https://doi.org/10.2174/1573413714666180426112851

Rashidi L and Khosravi-Darani K (2011). The applications of nanotechnology in food industry. Critical reviews in food science and nutrition, 51(8): 723-730. DOI: https://doi.org/10.1080/10408391003785417

Saleh I, and Abu-Dieyeh MH (2021). Novel Prosopis juliflora leaf ethanolic extract as natural antimicrobial agent against food spoiling microorganisms. Scientific Reports, 11(1):1-7. DOI: https://doi.org/10.1038/s41598-021-86509-3

Santeramo FG, Carlucci D, De Devitiis B, Seccia A, Stasi A, Viscecchia R and Nardone G (2018). Emerging trends in European food, diets and food industry. Food research international (Ottawa, Ont.), 104: 39-47. DOI: 10.1016/j.foodres.2017.10.039

Sekhon B (2010). Food nanotechnology–an overview. Nanotechnology, Science and Applications, 2010: 1-15. DOI: https://doi.org/10.2147/NSA.S8677

Sharma D and Dhanjal DSJJ (2016). Bio-nanotechnology for active food packaging. Journal of Applied Pharmaceutical Science, 6(09): 220-226. DOI: http://dx.doi.org/10.7324/JAPS.2016.60933

Sharon M, Choudhary AK and Kumar RJJoP (2010). Nanotechnology in agricultural diseases and food safety. Journal of Phytology, 2(4): 78-82. https://www.cabdirect.org/cabdirect/abstract/20113034565

Singh T, Shukla S, Kumar P, Wahla V, Bajpai VK and Rather IAJ (2017). Application of nanotechnology in food science: perception and overview. Frontiers in Microbiology, 8: 1501. DOI: https://doi.org/10.3389/fmicb.2017.01501

Sreekumar S, Lemke P, Moerschbacher BM, Torres-Giner S, and Lagaron JM (2017). Preparation and optimization of submicron chitosan capsules by water-based electrospraying for food and bioactive packaging applications. Food Additives & Contaminants: Part A, 34(10):1795-1806. DOI: https://doi.org/10.1080/19440049.2017.1347284

Zambrano-Zaragoza ML, González-Reza R, Mendoza-Muñoz N, Miranda-Linares V, Bernal-Couoh TF, Mendoza-Elvira S and Quintanar-Guerrero DJIjoms (2018). Nanosystems in edible coatings: A novel strategy for food preservation. International journal of Molecular Sciences, 19(3): 705. DOI: https://doi.org/10.3390/ijms19030705

Zhang Y, Rempel C and Mclaren DJIFP (2014). Edible coating and film materials: Carbohydrates. Innovations in Food Packaging (2nd Edition), Elsevier Ltd. pp.305-323. DOI: https://doi.org/10.1016/B978-0-12-394601-0.00012-6

Zhang M, Biesold GM, Choi W, Yu J, Deng Y, Silvestre C, Lin Z (2022). Recent advances in polymers and polymer composites for food packaging. Materials Today, 53: 134-161. DOI: https://doi.org/10.1016/j.mattod.2022.01.022

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A RESPONSE SURFACE MODEL TO PREDICT THE PROFITABILITY OF RAISING SMALL-SCALE FREE RANGE DOMESTIC PIGEON

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ABSTRACT: The study aimed to investigate the comparative profitability of raising different breeds of small-scale free range domestic pigeon in the Chattogram metropolitan area of Bangladesh. A cross-sectional survey was carried out for a period of three months from July to September 2021 using a structured questionnaire. Results indicated that there were no differences among the performance parameters of the non-descriptive, Gola and Giribaz breeds of pigeon. However, the non-descriptive breeds produced more eggs and thus squabs per year than the Gola and Giribaz. Similarly, the average pause size, feed supply per day and market age were lower in the local breeds compared with Gola and Giribaz. Hatchability percentage of the local breed was higher than the other breeds. Average mortality was moderately higher in the Giribaz. The average flock size was 4.9±0.70 pair. The average annual egg and squab productions were 20.6±1.10 and 10.7±1.00 pairs, respectively. The average daily feed supply was 37.8±1.5 g/bird. The average clutch and pause sizes were 2.0 and 17.3 day, respectively. Average market age, hatchability and mortality were 30.6±0.90 day, 51.4±2.20% and 7.6±1.6%, respectively. Mean feed and housing cost were 1008±24.7 and 443±42.8 Bangladeshi taka (BDT) per pair/year, respectively. Mean market price per pair adult and per squab was BDT 365±18.6 and 130±4.9, respectively. Flock size and pause size had strong positive and negative correlations with annual squab production. There were no significant differences between the net profit of the farms rearing different breeds of pigeon. However, farms raising local breeds had the highest annual net profit (BDT 823/pair) compared with other farms raising Giribaz (BDT 478/pair) and Gola breeds (BDT 319.70/pair). Principal component analysis identified annual egg production and feed cost as the principal eigenvector determining net profit. It was concluded that despite marginal profit, small-scale free range domestic pigeon farming was economically viable for the subsistence of the rural livelihoods.

Keywords: Free range, Giribaz, Gola, Pigeon, Profitability.

INTRODUCTION

The pigeon is a common title for the individuals of the expensive family 'Columbidae' characterized by strong body, long neck, little head and thick overwhelming plumage pattern (El-Haroun et al., 2008) who are related to human being since ancient time. They are the most common type of birds found almost everywhere on the planet (Marques et al., 2007). Pigeons are monogamous, extremely intelligent and complicated creatures of all the avian species (Silver et al., 1985). They coexist with humans as a source of food, hobby, income and research purposes (Levi, 2020). The 'squab', i.e., the young pigeon is a unique source of appetizing, delectable, easily digestible and elegant quality animal protein for human being. They are popular among the people of all faiths. The squab meat is low in cholesterol and high in protein, minerals and vitamins (Kokoszyński et al., 2020) which is thought to have therapeutic properties (Bu et al., 2018). The droppings of pigeon act as a source of bio-fertilizer for home gardening. Moreover, they are used in genetic and hormonal studies (Asaduzzaman et al., 2009). Rearing pigeon as a pet for recreation is becoming popular day by day. Hence, raising pigeon has been one of the popular businesses among the young generations (Maity et al., 2020; Ahamed et al., 2021).

Bangladesh has a long tradition of raising different backyard poultry species (Bhowmik et al., 2014) because of extensive tracts of croplands and housing facilities (Asaduzzaman et al., 2009). More than 60% of the rural households that raise poultry are also found to raise pigeons either commercially or as a hobby (Asaduzzaman et al., 2009). There are several popular breeds of pigeons, i.e., the King, Runt, Red Carneau, French Mondaine and Giant Homers used for squab production while the Fantail, Crowned, Jacobin, Pouter, Swallow, Bokhara trumpeter and Frill back are raised as

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ornamental breed in all over the world including Bangladesh. Flying or homer breeds, i.e., the Racing Homers, Rollers and Tumblers are possibly the most famous breeds used for endurance flying (Kabir, 2014). In Bangladesh, Giribaz is one of the subcontinent's oldest pigeon breeds. The other local breeds of pigeon available are Gola, Siraji, Serting and Mayouri (Islam, 2010).

Pigeon farming requires minimal capital investment, low feed and housing cost and simple husbandry practices. They have rapid reproductive turnover with minimum disease incidence. They can simply eat grains, i.e., mustard, wheat, rice, sorghum, corn, soy bean, peanut, fruits, insects, vegetables and grits (Canova, 2005; ChunQi et al., 2016). They can also rely on mixed crumble or blends of cereals, minerals, grits and water. Although small-scale domestic pigeon provides an alternative source of high-quality animal protein and household income generation, their contribution in family income has not yet been estimated through systematic studies. Therefore, we aimed to elucidate the comparative profitability of raising different breeds of pigeon in the Chattogram Metropolitan area of Bangladesh.

MATERIALS AND METHODS

Study design, area and duration

A cross-sectional survey was carried out for a period of three months from July to September 2021 using a structured questionnaire in the Chattogram Metropolitan area which is one of the epicenters of pigeon farming in Bangladesh.

Farm selection

Total 10 different pigeon farms were selected where the main selection criteria were minimum one year of farming experience, availability of pigeon house, currently having at least 02 pairs of pigeon reared in backyard system, free family labor and no objection of the family members for keeping the pigeons.

Farmer's interview

Farmers were interviewed in their own premises by one DVM intern of Chattogram Veterinary and Animal Sciences University (CVASU). In order to get detailed information, interviewer interviewed only one farmer a day. It took around two hours to interview a respondent. An observation list was completed during the farm visit. Institutional approval for conducting interviews with the pigeon farmers was obtained from CVASU.

Data collection

Before, the field survey, a structured questionnaire and a survey protocol were developed to achieve targeted objectives of the study. After briefing the objectives of the interview, verbal and written consents of the respondents were taken. At least one week before starting the interview, the interviewer was given printed materials as guidelines for the survey. The questionnaire included data related to farmer's personal information (age, educational level, farming experience), breed, housing, feeding, management, egg and squab production, disease control, marketing and health of pigeon. Data were collected for 100 pigeons.

Statistical analysis

Raw data were compiled into Microsoft excel professional 2019 (Microsoft corporation, USA). Outliers and multi-collinearity in the data set were tested by inter quartile range test and variance inflation factors. Normality of the response variable was checked by Shapiro Wilk test. Profile plots were used to measure the interactions of the covariates. The data were analyzed by generalized linear model (GLM). Heatmap of multiple orthogonal contrasts were produced to check the dimensionality and strengths of the co-variates. Kaiser-Meyer-Olkin measures of sampling adequacy and Bartlett's test of sphericity were applied to test the suitability of the dataset for the principal component analysis. The linear regression and response surface models were fitted using SAS 16.2 (SAS Institute Inc.). When statistical effects were deemed significant ($P<0.05$), the Duncan's New Multiple Range Test (DMRT) was used to compare the means. All statistical tests were performed by using Stata 14.1 SE (Stata Corp LP, College Station, Texas, USA). The following model was used to estimate the effects of the predictors on dependent variables:

$$Y_{ijkln} = \mu_0 + \alpha_{ij} + \beta_{ik} + \gamma_{il} + \ldots\ldots \omega_{in} + \varepsilon_{ijlkn}$$

Where,

Y_{ijkln} = The observed effect of the trait 'i' at the 'j^{th}' level of the predictor 'α', the 'k^{th}' level of the predictor 'β', 'l^{th}' level of the predictor 'γ'.....and the 'n^{th}' level of the predictor 'ω';

μ_0 = The intercept of the regression model;

α_{ij} = The slope of the regression model for the trait 'i' at 'j^{th}' level of the predictor 'α' observed on Y_{ijkln};

β_{ik} = The slope of the regression model for the trait 'i' at 'k^{th}' level of the predictor 'β' observed on Y_{ijkln};

γ_{il} = The slope of the regression model for the trait 'i' at 'l^{th}' level of the predictor 'γ' observed on Y_{ijkln};

ω_{in} = The slope of the regression model for the trait 'i' at 'n^{th}' level of the predictor 'ω' observed on Y_{ijkln};

ε_{ijkln} = The random sampling error of the trait 'i' at the 'j^{th}' level of the predictor 'α', the 'k^{th}' level of the predictor 'β', 'l^{th}' of the predictor 'γ'.....the 'n^{th}' level of the predictor 'ω' which is distributed as $\varepsilon_i \sim NID(0,\sigma^2)$.

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RESULTS

Socio-economy

Age of the pigeon farmers ranged from 27 to 50 year in the study areas. The farmers were classified into two age groups, i.e., the young (25-40 year) and middle aged (41-55 year). It was evident that 90% of the farmers belonged to young group and only 10% of them were middle aged. Accordingly, based on educational qualification the farmers were further divided into three categories where 30% of them were graduate and above while another 30% received only primary education. Unfortunately, remaining 40% of the farmers were illiterate who belonged to middle-class family with annual income ranging from 12000-15000 Bangladeshi Taka (BDT).

Comparative indices

There were no differences (P>0.05) in the performance parameter of the non-descriptive, Gola and Giribaz breeds. However, the non-descriptive breed produced more eggs and thus squabs per year than the Gola and Giribaz although the differences were statistically not-significant (P>0.05). Similarly, the average pause size, feed supply per day and average market age were lower in the local breeds than the Gola and Giribaz (Table 1). Hatchability percentage of the local breed was higher (P>0.05) than the other breeds. Average mortality (%) was higher (P>0.05) in the Giribaz (Table 1).

Table 1 - Comparative performance of the three different breeds of pigeon in the Chattogram metropolitan area (N=100)

Variables \ Breeds	Local	Gola	Giribaz	SEM[1]	P-value
Flock size (pair)	3.00	5.60	5.00	0.67	0.388
Annual egg production (no/pair/y)	22.0	20.6	19.7	1.13	0.814
Annual squab production (no/pair)	12.3	10.6	10.0	1.02	0.779
Average clutch size (d)	2.00	2.00	2.00	0.00	-
Average pause size (d)	16.0	17.2	18.3	0.79	0.644
Feed supply (g/bird/d)	35.5	38.2	38.7	1.50	0.785
Average market age (d)	29.0	30.8	31.3	0.88	0.696
Hatchability (%)	55.7	50.3	50.5	2.24	0.687
Average mortality (%)	8.00	6.00	10.0	1.60	0.609

[1]SEM = Standard error of the means

Overall indices

The mean farming experience of the pigeon farmers was 2.6±0.06 year (CI=1.3-3.9) which ranged from 1-5 years (Table 2). The average flock size was 4.9±0.70 pair (CI=3.4-6.4). The average annual egg and squab productions were 20.6±1.10 (CI=18.0-23.2) and 10.7±1.00 (CI=8.4-13) pair, respectively. The mean quantity of the supplied feed to the pigeon was 37.8±1.5 g/bird/day (CI=34.4-41.2). The average clutch and pause sizes were 2.00 day and 17.3±0.80 day (CI=15.5-19.1), respectively. The average market age, hatchability and mortality were 30.6±0.90 day (CI=28.6-32.6), 51.4±2.20% (CI=46.3-56.5) and 7.6±1.6% (CI=4.0-11.2), respectively. The mean annual feed and housing costs were BDT 1008±24.7 (CI=949-1068) and 443±42.8 (CI=346-540) per pair, respectively, where market prices per pair adult and per squab were BDT 365±18.6 (CI=323-407) and 130±4.9 (CI=119-141), respectively. The heatmap showed the orthogonal correlation between different descriptive parameters (Figure 1). Strong positive correlations were evident among flock size, feed supply, hatchability and annual squab production (Figure 1). On the other hand, pause size had a strong negative correlation with the annual squab production. Despite maximum pause size, net profit was maximum while squab production reached at peak (Figure 2). Overall, annual egg production, flock size, farming experience and squab production contributed maximum net profit (Figures 1-5; Table 2-3).

Table 2 - Least square means of the common variables for the small-scale free range domestic pigeon farming (N=100)

Variables \ Descriptive statistics[1]	Min.	Max.	Mean	SEM	95% CI	
					Min.	Max.
Farming experience (y)	1.00	5.00	2.60	0.60	1.30	3.90
Flock size (pair)	2.00	9.00	4.90	0.70	3.40	6.40
Annual egg production (pair)	15.0	28.0	20.6	1.10	18.0	23.2
Annual squab production (pair)	8.00	18.5	10.7	1.00	8.40	13.0
Feed supply (g/bird/d)	32.0	47.0	37.8	1.50	34.4	41.2
Average clutch size (d)	2.00	2.00	2.00	-	-	-
Average pause size (d)	14.0	22.0	17.3	0.80	15.5	19.1
Average market age (d)	28.0	36.0	30.6	0.90	28.6	32.6
Hatchability (%)	42.0	66.1	51.4	2.20	46.3	56.5
Annual feed cost/pair (BDT)	864	1152	1008	24.7	949	1068
Market price per squab (BDT)	110	150	130	4.90	119	141
Market price per pair adult (BDT)	280	450	365	18.6	323	407
Average mortality (%)	2.00	18.0	7.60	1.60	4.00	11.2
Housing cost/pair/y	305	700	443	42.8	346	540

[1]Min= Minimum; Max= Maximum; SEM= Standard error of the means; CI= Confidence interval; [2]BDT = Bangladeshi taka (1 $USD=93.0 BDT)

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Table 3 - Component score of the intra and inter cluster regression co-efficient of the principal component analysis for the small-scale free range domestic pigeon farming (N=100)

Cluster	Members	R^2 with own cluster	R^2 with next closest	1-R^2 ratio
1	Annual egg production (no)	0.91	0.02	0.09
1	No. of pigeons (pair)	0.89	0.03	0.11
1	Farming experience (y)	0.86	0.01	0.15
1	Annual squab production (no)	0.84	0.04	0.17
1	Mortality (%)	0.39	0.08	0.66
2	Price per squab (BDT)	0.77	0.00	0.23
2	Market age (d)	0.77	0.01	0.23
2	Cost of feed (BDT)	0.74	0.13	0.29
2	Feed supply (g/bird/d)	0.56	0.08	0.48
2	Cost of housing (BDT)	0.32	0.07	0.73
3	Pause size (d)	0.83	0.08	0.19
3	Price per adult pair (BDT)	0.63	0.12	0.43
3	Hatchability (%)	0.59	0.25	0.54

[2]BDT = Bangladeshi taka (1 $USD = 93.0 BDT)

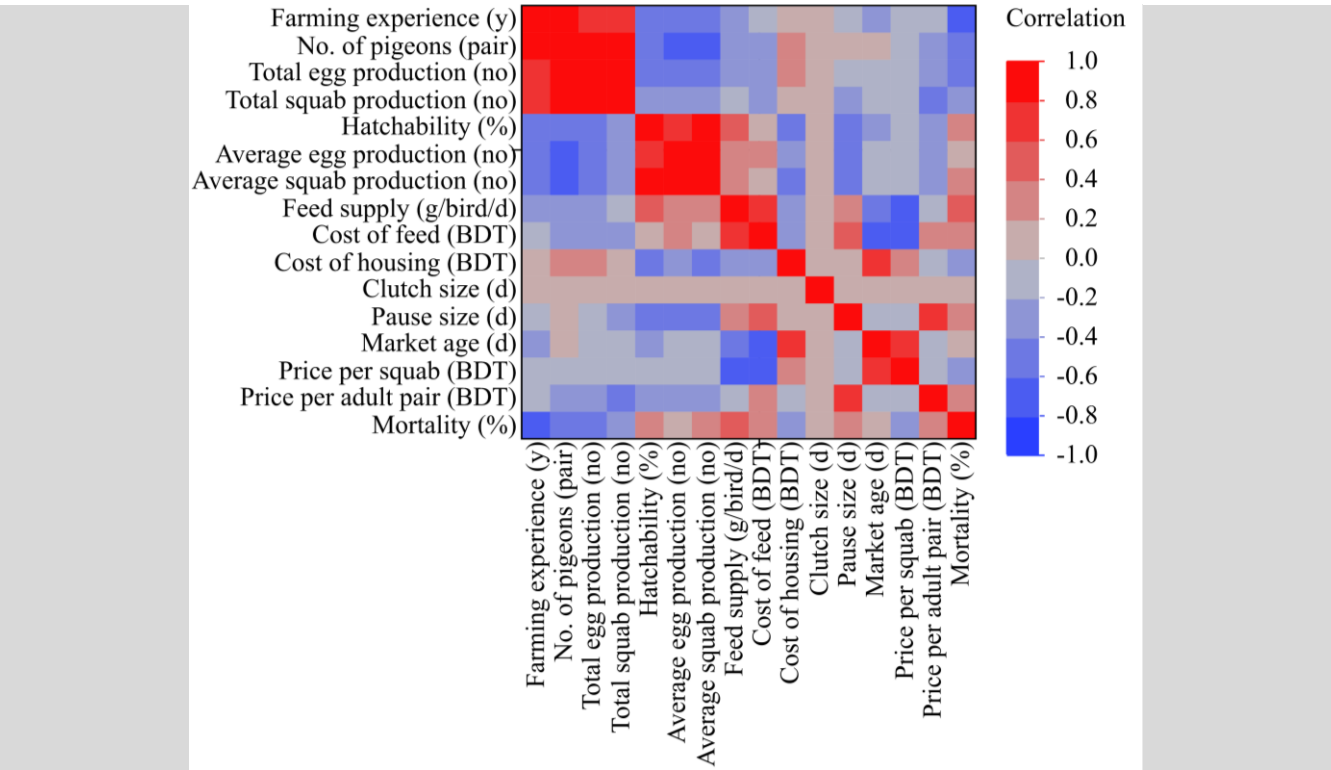

Figure 1 - Heatmap showing orthogonal contrasts of the production indices for the small-scale free range domestic pigeon farming in the Chattogram metropolitan area, Bangladesh (N=100)

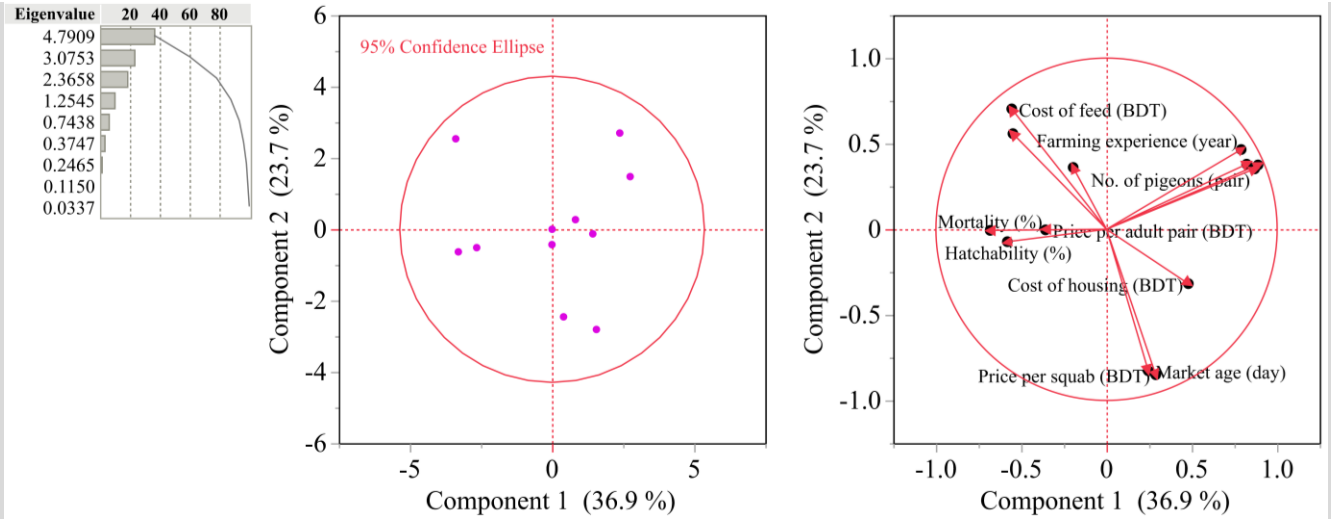

Figure 2 - Principal component analysis showing influence of the predictors on principal component 1 (36.9%; 'y' axis) and component 2 component 1 (23.7%; 'x' axis) for the small-scale free range domestic pigeon farming

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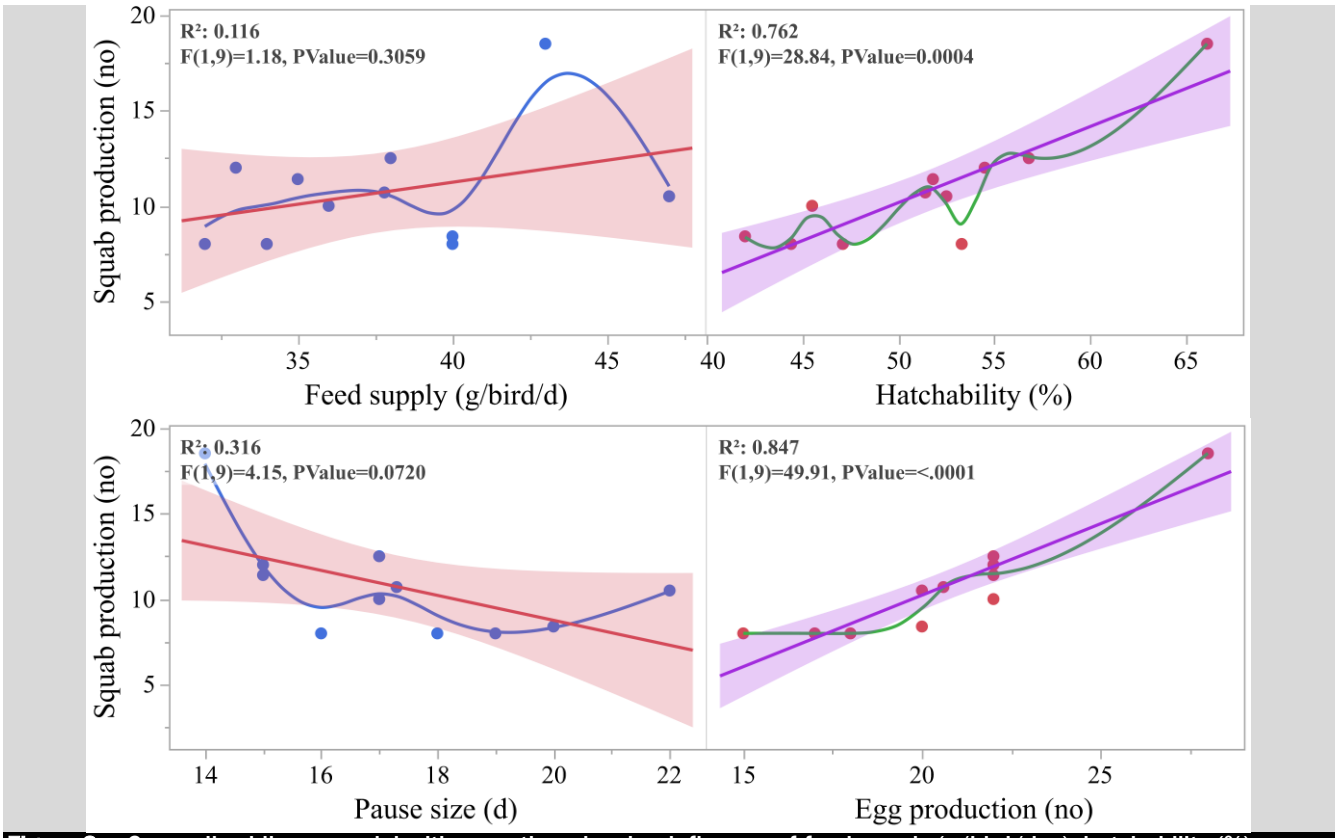

Figure 3 – Generalized linear model with smoother showing influence of feed supply (g/bird/day), hatchability (%), pause size (day) and egg production (no) on annual squab production (pair/couple) for the small-scale free range domestic pigeon farming in the Chattogram metropolitan area, Bangladesh (N=100).

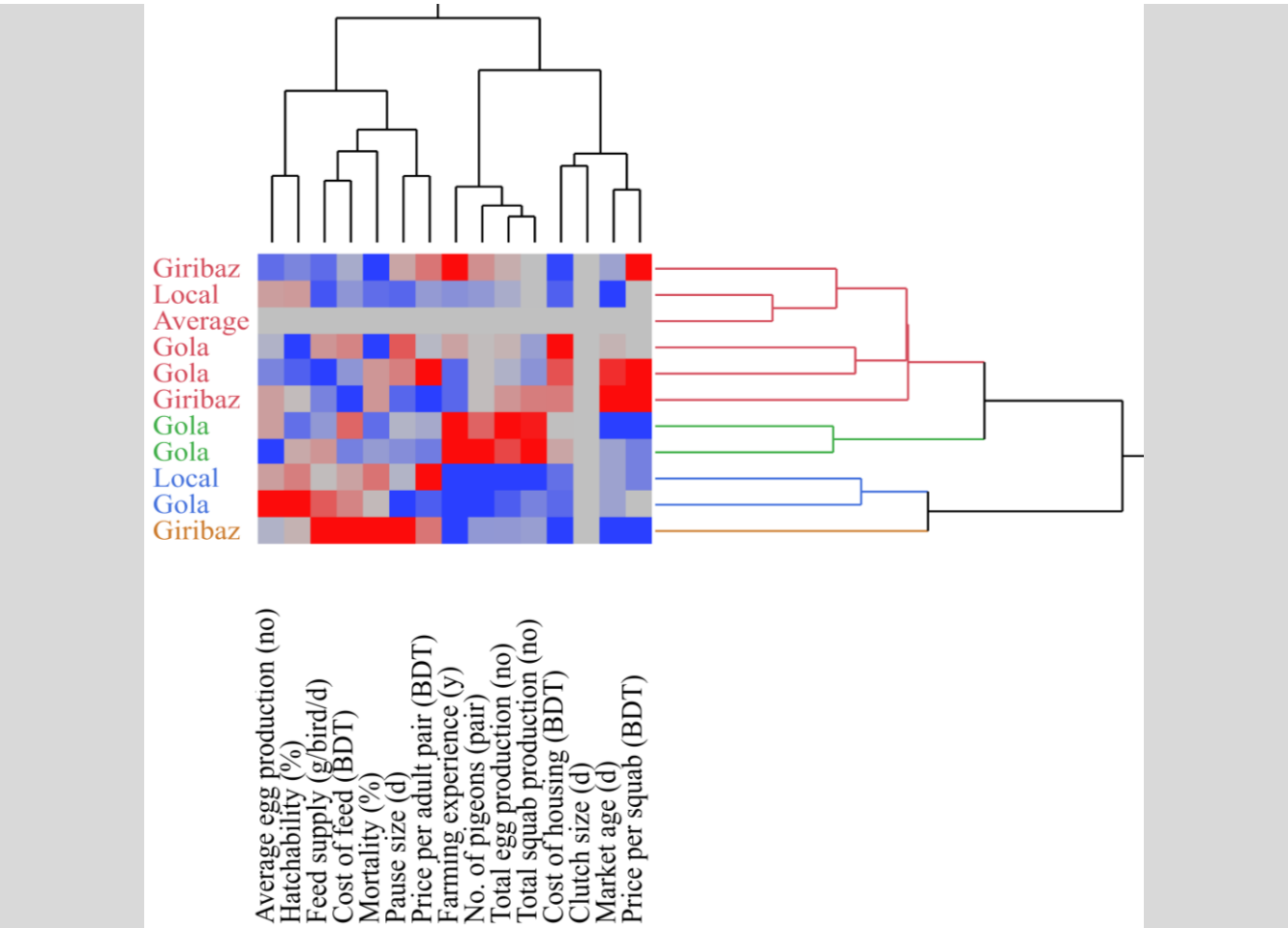

Figure 4 - Hierarchical cluster analysis showing group similar cluster of the performance indices for the small-scale free range domestic pigeon farming (N=100).

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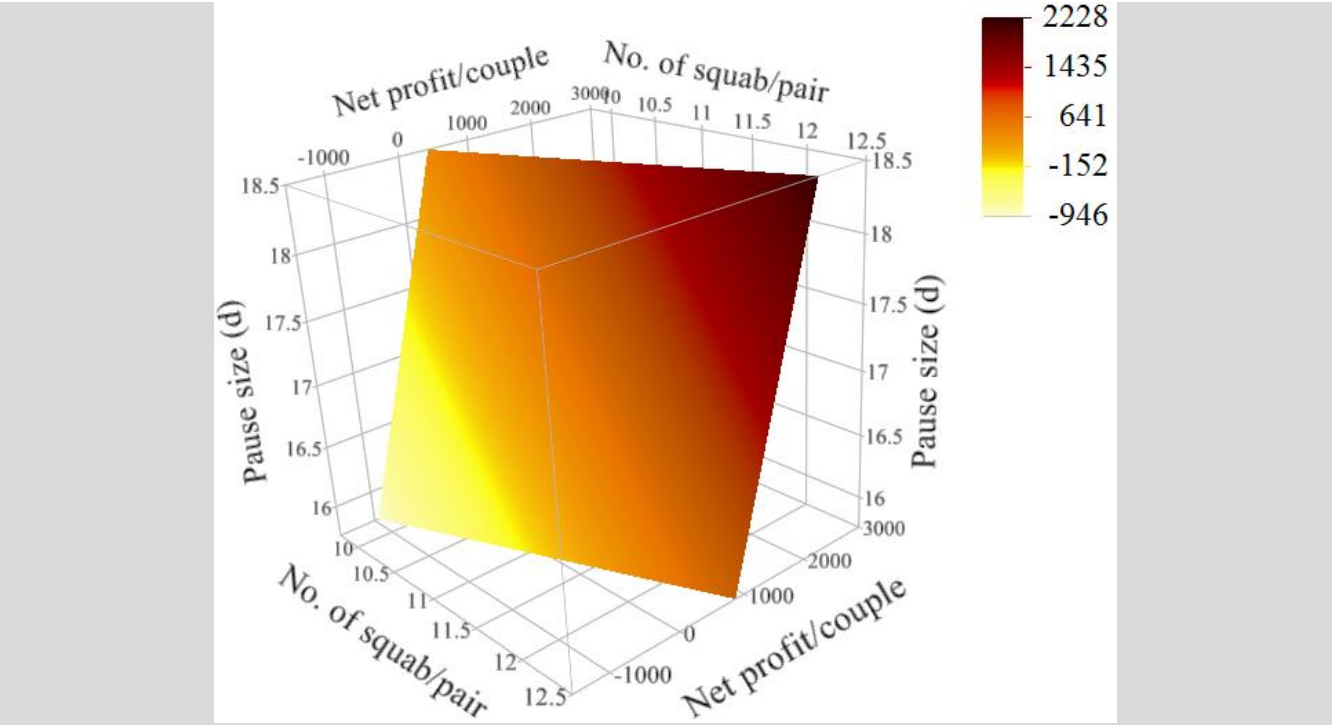

Figure 5 - A response surface model to predict the influence of average pause size (day) and annual squab production (no) on net profit (BDT; 1 USD=93.5 BDT) for the small-scale free range domestic pigeon farming (N=100)

Cost-benefit analysis

The net profit of rearing different breeds of pigeon significantly (P<0.01) differed. The farms raising local breed of pigeon obtained the highest annual net profit (BDT 823/pair) compared with other farms rearing Giribaz (BDT 478/pair) and Gola breeds (BDT 319.70/pair) of pigeon (Table 4). Although, hierarchical clustering clearly stood out Gola, principal component analysis identified annual egg production and feed cost as the principal eigenvector determining net profit.

Table 4 - Cost-benefit analysis of the different breeds of pigeon for the small-scale free range domestic pigeon farming (N=100)

Variables \ Breeds	Local	Gola	Giribaz	SEM[1]	P-value
Feed cost/pair/year (BDT[2])	996.0	1018	1000	1.10	0.948
Housing cost/pair/year (BDT)	348.5	515.2	385.7	42.8	0.250
Market price per breeding pair (BDT)	395.0	356.0	360.0	18.6	0.767
Other costs/pair/year (BDT)	500.0	500.0	500.0	-	-
Total costs (BDT)	2240	2389	2246	51.6	0.675
Market price/pair squab (BDT)	250.0	256.0	273.3	4.94	0.712
Total income from squab sale (BDT)	3063	2709	2724	65.3	0.374
Net profit/adult couple (BDT)	823.0[a]	319.7[c]	478.6[b]	46.3	0.001

[1]SEM = Standard error of the mean; [2]BDT = Bangladeshi taka (1 $USD = 93.0 BDT)

DISCUSSION

Socio-economy

In the present study, most of the pigeon farmers were literate, young to midddle aged who socially belonged to middle class. Age of the pigeon farmers observed in our study although corresponds with Rahman (2002) but contradicts with the findings of Asaduzzaman et al. (2009). Accordingly, the majority of the pigeon farmers were literate in our study which further opposes a previous study (Asaduzzaman et al., 2009) where 53.3% of the pigeon farmers were illiterate. The differences could possibly be explained for the location of study area. Our study was conducted in the Chattogram Metropolitan whereas the above study was held in the Gouripur upazilla of Mymensingh district. Chattogram being the divisional district has far more literacy level and per capita income of the pigeon farmer compared with mymensingh district.

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Comparative indices

In our study, local non-descriptive breeds of pigeon produced more eggs and squabs per year than the Gola and Giribaz although the results were not statistically significant. On the other hand, average pause size, feed supply per day and average market age were pretty lower in the local breeds than the Gola and Giribaz which ultimately helped in increasing productivity of the local breeds (Kabir, 2013). Interestingly, hatchability percentage of the local breed was higher than the other breeds and average mortality was slightly higher in Giribaz. The differences could have possibly been arisen in our study since pigeons were reared in scavenging system whereas in other studies the pigeons were reared in confinement (Abdel et al., 2019).

Overall indices

In our study, most of the backyard pigeon farmers had an average flock size of 4.9 pairs. The average annual egg and squab productions were 20.6 and 10.7 pairs, respectively. Squab production peaked at 18.5 pairs per year. According to Levi (2020), a successful commercial pigeon couple may produce 18 to 20 squabs per year although Abd el azeem et al. (2016) reported 11.4 squabs/pair/year. This discrepancy in squab production could be attributable to the genotype and geographical variables as well as the absence of one or both parents. In our study, the mean quantity of the supplied feed to the pigeon was 37.8 g/bird/day. ChunQi et al. (2016) reported that feed intake per pigeon per day was 47.4 g which was slightly higher than the present study. The differences could have possibly been because the pigeons were reared in scavenging system and farmers provided only supplementary feeding. Whereas, in other studies the pigeons were reared in confinement. The usual market age, hatchability and mortality were 30.6 day, 51.4% and 7.6%, respectively which is aligned with the report of Levi (2020) where marketing age was reported to be 25 to 35 day with an average of 30 day. The mean feed and housing cost were BDT 1008 and 443/pairs/year, respectively where market price per pair adult and per squab were BDT 36 and 130, respectively. In a previous study, maximum construction cost of pigeon house was Tk.150, minimum cost was Tk. 70 and the average cost was Tk. 113 (Asaduzzaman et al., 2009). These variations of construction materials may be due to day by day increasing market price.

Cost-benefit analysis

We estimated that farms rearing local pigeons obtained highest profit (BDT 823/pair) than the farms raising Giribaz (BDT 478/pair) and Gola (BDT 319.70/pair). The reasoning could be the lower feed and housing cost/pair/year and better squab producing capacity of the local breed than the other commercial breeds. This study further demonstrated that the free range domestic pigeon raising can be a good source of domestic income for small scale sustainable farmers. The productivity and profitability of pigeon can be increased if the vaccinations, medications and balanced feed formulations can be ensured at farm level.

CONCLUSION

The non-descriptive local breeds of pigeon produce more eggs and thus squabs per year exhibiting higher hatchability, better survivability, lower pause size, average daily feed intake, market age and mortality than the Gola and Giribaz breeds under traditional low-cost management systems. The local breeds of pigeons are economically more viable than the Gola and Giribaz breeds, hence, more preferable for subsistence rural livelihood. The small-scale free range domestic pigeon farming plays a potential role for the consistent income generation of the unemployed young people in Bangladesh.

DECLARATIONS

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Authors' contribution

Dr. Partha Samanta - Questionnaire preparation, baseline survey, data collection and preparation of initial draft. Dr. Nasima Akter-Conceptualization, project administration, questionnaire preparation and initial draft. Dr. Saiful Islam - Conceptualization and questionnaire preparation. Dr. Emran Hossain - Data curation, GLM, principal component analysis, hierarchical clustering, response surface modelling, result interpretation and finalization of the draft. All authors read and approved the final draft.

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Conflict of interests

None.

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REFERENCES

Abd el Azeem A, Amir A, Shama T and Abas W (2016). Early weaning of pigeon squabs. Egyptian Poultry Science Journal, 36: 205–232. https://epsj.journals.ekb.eg/article_33249_414292439937dfc324a59cfafeb41d06.pdf

Abdel AF, Roushdy ESM, Tukur HA, Saadeldin IM and Kishawy ATY (2019). Comparing the effect of dietary management and rearing systems on pigeon squab welfare and performance after the loss of one or both parents. Animals, 9: 165. DOI: https://doi.org/10.3390/ani9040165

Ahamed AS, Nusrathali N, Mufeeth M, Ranaweera K, Majeed UA (2021). Breeds Distribution and Management Practices of Pigeon Farming in Sri Lanka. Journal of the Bangladesh Agricultural University, 19(4):477-485. DOI: https://doi.org/10.5455/JBAU.97504

Asaduzzaman M, Mahiuddin M, Howlider M, Hossain M and Yeasmin T (2009). Pigeon farming in Gouripur upazilla of Mymensingh district. Bangladesh Journal of Animal Science, 38: 142–150. https://www.banglajol.info/index.php/BJAS/article/view/9923

Bhowmik N, Mia M and Rahman MA (2014). Morphometric, productive and reproductive performance of Jalali pigeon. International Journal of Development Research, 4: 908–911. http://www.asp.zut.edu.pl/ 2016/15_1/asp-2016-15-1-04.pdf

Bu Z, Chang L, Tang Q, Song C, Zhang R, Fu S, Mu C (2018). Comparative study of meat quality, conventional nutrition composition and muscle fibre characteristics of White King pigeons between different age and gender. Journal of Food Safety and Quality, 9(1):13-18. https://www.cabdirect.org/cabdirect/abstract/20183046223

Canova J (2005). Monuments to the birds: Dovecotes and pigeon eating in the land of fields. Gastronomica: The Journal of Food and Culture, 5: 50–59. DOI: https://doi.org/10.1525/gfc.2005.5.2.50

Chunqi GAO, Xiaohui W, Xiaochao HU, Huichao YAN and Xiuqi W (2016). Effects of dietary crude protein levels on growth performance carcass characteristics meat quality of squabs and laying performance of breeding pigeons. Journal of South China Agricultural University, 37: 1–6. https://www.cabdirect.org/cabdirect/abstract/20163333898

El-Haroun AHJ, Hassanein MNF and Sabra ZAM (2008). Studies on native pigeons under Egyptian village Nile delta conditions. Egyptians Poultry Science Journal, 28: 883–900. http://www.ijramr.com/sites/default/files/issues-pdf/2533.pdf

Islam MR (2010). Pigeon farming and meat yield of some genetic groups in Mymensingh district. MSc Thesis, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. Google Scholar

Kabir MA (2013). Productivity, Management and cost-benefit analyses of pigeons in pet shop of Bangladesh. Case Studies Journal, 2:18–19. DOI: https://ssrn.com/abstract=2868293

Kabir MA (2014). Grading system of ten common fancy pigeons of Bangladesh. Integrated Journal of British, 13: 19–26. https://www.academia.edu/download/56646433/grading_system.pdf

Kokoszyński D, Stęczny K, Żochowska-Kujawska J, Sobczak M, Kotowicz M, Saleh M, et al. (2020). Carcass characteristics, physicochemical properties, and texture and microstructure of the meat and internal organs of carrier and king pigeons. Animals, 10(8):1315. DOI: https://doi.org/ 10.3390/ani10081315

Levi WM (2020). Making Pigeons Pay-A manual of practical information on the management, selection, breeding, feeding, and marketing of pigeons. Pierce Press, Arlington, MA02476. https://www.amazon.com/Making-Pigeons-Pay-Information-Management/dp/B00POFEIPY

Maity B, Das TK, Ganguly B, Pradhan K (2020). Pigeon rearing-an investment analysis for secondary income generation to farm women, landless, marginal and small farmers. Asian Journal of Agricultural Extension, Economics & Sociology, 38(6):1-6. DOI: https://doi.org/10.9734/ajaees/2020/v38i630354

Marques SMT, De Quadros RM, Da Silva CJ and Baldo M (2007). Parasites of pigeons (Columba livia) in urban areas of lages, Southern Brazil. Parasitologia Latinoamericana, 62: 183–187. DOI: http://dx.doi.org/10.4067/S0717-77122007000200014

Murdoch J (2005). The Food of China. The Gardners Book, Eastbourne, United Kingdom. https://www.abebooks.co.uk/book-search/title/food-of-china/author/murdoch/

Rahman MW (2002). Consumption of poultry and poultry products by the rural families in selected villages of sadar upazila under Mymensingh. MS thesis, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. Google Scholar

Silver R, Andrews H and Ball GF (1985). Parental Care in an Ecological Perspective: A quantitative analysis of avian subfamilies. Integrative and Comparative Biology, 25: 823–840. DOI: https://doi.org/10.1093/icb/25.3.823

Citation: Samanta P, Akter N, Islam S, Islam Sh and Hossain E (2022). A response surface model to predict the profitability of raising small-scale free range domestic pigeon. *Online J. Anim. Feed Res.*, 12(4): 179-186. DOI: https://dx.doi.org/10.51227/ojafr.2022.24

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BREEDING STRATEGIES OF SIMIEN SHEEP IN SIMIEN MOUNTAIN REGION OF ETHIOPIA

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ABSTRACT: This study was conducted to characterize the existing sheep breeding strategies as an essential step in designing a breeding program for linking sheep production in the Simien mountain region of Ethiopia. Interview with sheep keepers, direct ranking method of traits, and field observations were carried out in selected districts of Simien mountain region. Sheep kept mainly as a source of income, saving and meat with an index value of 0.27, 0.21, and 0.20 in the Beyeda district whereas the corresponding value for Janamora was 0.26, 0.22, and 0.19, respectively. Mean sheep flock sizes were 14.9 and 16.2 in Beyeda and Janamora districts of Ethiopia. Natural and uncontrolled breeding was common in the Simien mountain region of Ethiopia. Coat color, body conformation, and fast growth rate were important traits in selecting breeding rams in both study districts. Coat color and appearance were selection criteria for breeding ewes in both study districts. It is observed that Simien sheep is highly valued for its tasty meat and produce under low input conditions. However, the survival of Simien sheep is endangered due to uncontrolled breeding, intervention failures in livelihood, and market-oriented agricultural systems. In conclusion, the main breeding objective for sheep production have been defined as increasing meat production and marketed animals and this is driven by market demands. Compared with other local sheep types, Simien was rated highly by both producers and consumers in their tasty meat. These characteristics make the Simien sheep economically more important. Yet Simien sheep need to be conserved as they could serve as a source of safe and tasty products for consumption.

Keywords: Breeding practice, Livestock population, Mountain region, Sheep flocks, Simien sheep.

INTRODUCTION

Amhara region is believed to have the largest livestock population in Ethiopia with 11 million of sheep population (CSA, 2020). It is about 73 to 75% of the sheep population is located in the highland areas of the country. Sheep are economically important for the national economy and the farm household. It accounts for about 15 to 17% of national GDP and 35 to 49% of agricultural GDP (CSA, 2018). Sheep contribute about 37 to 87% of household incomes, providing food and non-food products. Though Ethiopia is known for its huge sheep population, livestock production systems are generally subsistence-oriented and productivity is very low (Belachew and Jemberu, 2003).

The present productivity of sheep has frequently been reported to be low when compared to other countries in the world or Africa (ILRI, 2011; Yohannes et al., 2018). Getahun et al. (2014) also revealed that the productivity of indigenous sheep in terms of meat has been limited by poor genetic potential. In Ethiopia, there are about 14 traditional sheep breeds (Solomon, 2008), among which Simien sheep is highly valued for its delectable meat and adaptation to the harsh and low-input production environment (Surafel et al., 2012). Sheep products in the form of meat have great importance and provide different nutrient that contributes to the improvement of the nutritional status of the rural poor in the region (Habtamu, 2015; Birara, 2016).

These subsistence sheep farming are also key sources of income and employment. Hence, the current drive for rapid livestock development through linking sheep production with tourism requires research to design and implement suitable breeding strategies so as to improve productivity and conserve indigenous breeds. Among the various factors, the absence of planned genetic improvement programs for local breeds is one of the causes for losing their competitive advantage, especially where production systems or external conditions are subject to change (Hiemstra et al., 2007). Therefore, improvement and conservation of Simien sheep genetic resources could be imperative as it has been contributing to sheep genetic diversity in Ethiopia (Hailu et al., 2020; Desalegn et al., 2022). There is a need to design and implement appropriate breeding strategies to improve the productivity of Simien sheep to utilize and increase its contribution to its keepers and thereby enhance its conservation by the community. However, the lack of detailed information about the existing breed management, traditional breeding practice, and identification of important traits, are perceived to be the most important hindrance for genetic improvement and the development of conservation programs. Lack of such information is a serious constraint to effective prioritization and planning of breed conservation measures including sustainable breeding strategies (Solomon et al., 2013).

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Thus, characterization of breeding practices and identification of breeding objective traits would help to ensure sustainable use and development of sheep genetic resources. Hence, the aim of this study was to characterize the existing sheep breeding practices and identify traits in relation to the breeding objectives of the community for designing a sustainable selective breeding program to improve productivity and conservation of Simien sheep breed.

MATERIALS AND METHODS

Study area description

The study was carried out in Janamora and Beyeda districts of the Simien Gondar Zone of the Amhara region. Both districts are found in the Simien mountain and Ras Dejen mountain, the highest point in Ethiopia. The Simien mountain found between 13° 11'N latitude and 38° 04'E longitude. The areas have an altitude range of 2000-3900 m.a.s.l and the mean annual temperature and rainfall of 12.4°C and 974 mm (Surafel et al., 2012). The production system of both districts is characterized as small-scale barley-dominated mixed crop-livestock system. Sheep production is a common practice. The map of the study areas is presented in Figure 1.

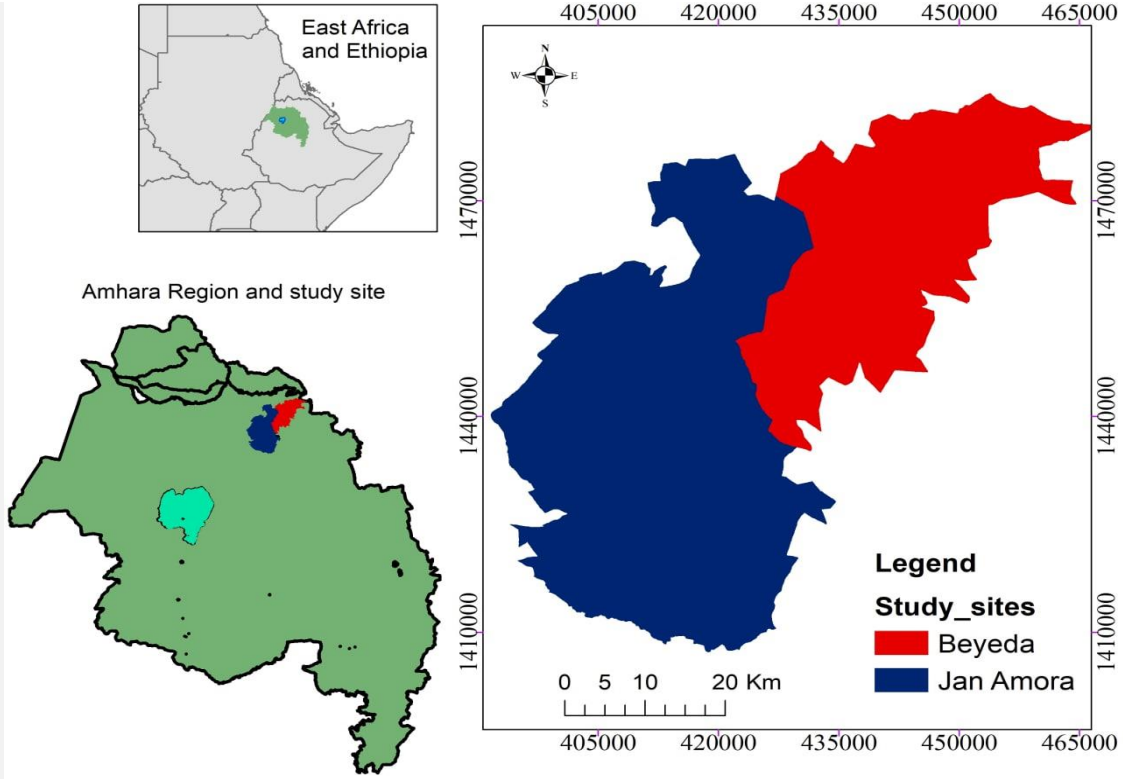

Figure 1 - Map of the study areas

Study approach

Participatory rural appraisals were conducted on characterizing indigenous breeding practices and trait preferences. This was done in rural kebeles by individual interviews, focused group discussions (FGDs) and direct flock ranking. Field surveys were carried out in three randomly selected rural kebeles. For field survey a total 184 of sheep owners were randomly selected (92 sheep owners from each district). The participant sheep owners were selected based on their indigenous knowledge. A purposive sampling was undertaken to target sheep owners in the study areas who were believed to possess more indigenous knowledge and experiences about Simien sheep. Among the recommended rural participatory approach, direct ranking experiment adopted from (Solomon et al., 2010; Yohannes et al., 2017) was used to identify trait preferences and selection criteria of sheep owners. Traits of rams and ewes were identified through an in-depth interview and discussion with sheep owners to rank the traits in order of importance. Focus group discussions were held with development agents, key informants and elders. These discussions were used to obtain information about farmers' reasons for keeping Simien sheep, breeding practice and trait preferences.

Data analysis

The statistical software SPSS Ver. 20.0 (2012) was used to analyze the data from field survey and participatory identification of trait preferences. Farmer's preference rankings were summarized into index as weighted averages. The index was computed using the following formula as suggested by Kosgey et al. (2008). Index = Sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) given for an individual reason, criteria or preference divided by the sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third for overall reasons, criteria or preferences.

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RESULTS AND DISCUSSION

Sheep production objectives

Finding out the purpose keeping for sheep of the farmer gives an indication of their breeding objectives (Solomon et al., 2013). The reasons for keeping sheep are rational and related to the farmers' needs in the long or short term. Table 1 presents the sheep production objectives of farmers in the Simien mountain region. The result shows that sheep play multi-functional roles in both study districts with similar production objectives whereby their income, saving and meat consumption function ranked as paramount importance. While functions like skin and wealth were received lower ranking, respectively. The multipurpose functions of sheep in low-input traditional systems were reported in Ethiopia (Tesfaye et al., 2010; Desalegn, 2019) and elsewhere in Africa (Wurzinger et al., 2011; Zonabend et al., 2015). This implies that multiple functional roles are particularly important in low and medium-input-out sheep production systems in developing countries. Thus, a successful breeding program could be mainly achieved through including the cultural, social, and environmental benefits in the breeding objectives for sheep under smallholder production systems in the tropics. Therefore, considering the different socio-cultural perspectives of the sheep owners is important in the adoption of any breeding program.

Flock characteristics

The study of flock characteristics helps in the design of breeding programs. As indicated in Table 2, the flock size of sheep was higher in Janamora than Beyeda district. The mean flock size in the present study was comparable to reports of Solomon et al. (2007), Yohannes et al. (2017) and Desalegn (2019) for Gumuz and Simien sheep. In Beyeda, 51.3%, 24%, 17.3 %, and 3.7% of the flock are ewes, young, lamb, and rams, respectively. Similar trends are observed In Janamora (42.1%, 32.9%, 20.2 % and 3.54%). The larger proportion of breeding ewe obtained was comparable with previous results reported 46.80% for Menz sheep and 49.2% for Afar sheep (Tesfaye et al., 2010), and 38.9% for central Tigray sheep (Hagos et al., 2015). The proportion of higher breeding ewe in both districts would imply the production of a larger number of lambs (selection candidates) which in turn might increase the intensity of selection and thus ensure the effectiveness of selective breeding. The low proportion of breeding rams in both study districts indicated the tradition of marketing young ram lambs because of the greater dependence on sheep production.

Table 1 - Ranking of the sheep production objectives by smallholder farmers

Study districts / Production objectives	Beyeda (N=92)				Janamora (N=92)			
	R1	R2	R3	Index	R1	R2	R3	Index
Income	29	23	16	0.27	28	22	17	0.26
Meat	17	20	18	0.20	17	19	17	0.19
Saving	21	20	15	0.21	22	20	14	0.22
Manure	11	12	22	0.14	10	11	21	0.13
Skin	5	9	5	0.07	5	8	6	0.06
Wealth	10	9	17	0.12	9	11	16	0.11

Index = [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for each objective]/ [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 ×number of households ranking as third) for all purposes of keeping sheep].

Table 2 - Flock size and structure of Simien sheep

Mean flock size and size of each age class as a proportion of the total flock								
Class of animal	Beyeda(N=92)				Janamora(N=92)			
	N	Mean± SD	Range	%	N	Mean± SD	Range	%
Lamb < sex month	241	2.54±1.95	0-10	17.3	266	2.85±1.59	0-8	17.82
Ram 6-12 month	97	1.04±0.83	0-3	6.98	190	2.09±1.47	0-7	12.74
Ewe 6-12 month	239	2.57±1.57	0-10	17.2	301	3.29±1.67	0-7	20.18
Breeding ewe > 1yr	713	7.67±5.17	0-24	51.3	629	6.80±4.42	0-20	42.1
Breeding ram>1yr	51	0.56±0.93	0-5	3.7	24	0.26±0.49	0-2	3.54
Castrated	49	0.53±0.74	0-5	3.54	83	0.91±0.77	0-3	5.56
Total	1390	14.91±4.8	1-50	100.0	1493	16.2±7.24	2-50	100.0

N = Number of households; % = percentage of each age class; SD = standard deviation.

Breeding managements

The flock herding practices of farmers reflect their breeding management and have serious implications for the design of controlled breeding activities. As indicated in Table 3, all sheep type of more than one household was herded together as a flock, as reported by 76% of sheep owners. As a result, there is a possibility of mixing. A similar finding is

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also reported by Tesfaye et al. (2010) and Girma et al. (2013) in the central highlands of Ethiopia. This flock mixing practice would be a good opportunity for implementing the community-based breeding program and it facilitates ram exchange which is one of the major components of the community-based breeding program.The migration of children and youth to zonal and regional cities for house servants and daily laborers has also forced them to keep sheep with other livestock. Yohannes et al. (2017), Desalegn et al. (2019) and Kiflay et al. (2019) also confirmed that sheep were herded together with other livestock species in northwestern Ethiopia.

As presented in Table 4, pure breeding of Simien sheep was practiced in the Simien mountain region. This implies the importance of pure breeding strategies for the conservation and improvement of Simien sheep. 91.4% for the Beyeda farmers and 84.6% of Janamora farmers confirmed that ram use and breeding are generally natural and uncontrolled in the Simien mountain region. Solomon et al. (2011), Surafel et al. (2012), Hayelom (2013), Yohannes et al. (2017) and Desalegn et al. (2019) reported that uncontrolled mating occurred predominantly in most traditional production systems. The primary reason for uncontrolled mating was the use of communal grazing areas, which is followed by a lack of awareness and sailing of male lambs at an early age. This may be contributed to the inbreeding, early breeding of females, and decrease genetic diversity resulting in low conception rate, low birth weight, low survival rates, and the gene pool narrows. This has to be taken into consideration when implementing a breeding program for Simien sheep.

Very few numbers of sheep owners practiced controlled breeding in which a group of ewes is left with one or more rams to mate due to strong extension services to ensure that rams are used efficiently to maximize the benefit (Zewdu et al., 2012). The reason for controlled mating was primarily to get the best animals for market. Previous studies also indicated that controlled mating is crucial for the successful implementation of genetic improvement and conservation programs (Solomon et al., 2010; Yohannes et al., 2018). This study also confirmed that few proportions of rams are used for breeding purposes. When rams were not available in their flocks, owners got the service from neighbors. These results are in line with the report of Zewdu et al. (2012), Tesfaye et al. (2016), Yohannes et al. (2017) and Kiflay et al. (2019) elsewhere in Ethiopia.

Table 3 - Herd management of Simien sheep

Herding practices \ Respondents (%)	Beyeda		Janamora	
	N	%	N	%
Sheep together with cattle	24	26.9	23	23.1
Sheep together with goat	13	10.8	12	16.5
Sheep together with equine	10	9.7	11	14.3
All herded together	40	45.2	39	40.7
Sheep herded separately	6	7.5	6	5.5
Household sheep herding system				
Sheep of a household run as a flock	23	24.7	22	24.2
Sheep of more than one household run like a flock	70	75.3	69	75.8

N =number of observations, % = percentage of proportions

Table 4 - Breeding management of Simien sheep

Breeding type practices \ Proportion (%)		Beyeda		Janamora	
		N	%	N	%
Breeding type	Pure breeding	93	100	91	100
	Crossbreeding	-	-	-	-
Mating system	Uncontrolled	83	91.4	80	84.6
	Controlled	10	8.6	11	15.4
Source of ram	Born	66	78.5	65	63.7
	Purchase	27	21.5	26	36.3

N =number of observations, % = percentage of proportions

Selection criteria for breeding ram and ewes

Within their herds, the majority of responders chose potential breeding rams and ewes. Selection practices, including selection criteria used in the Simien mountain region, but the selection of rams was more frequent than for ewes as it has been recorded previously in other districts of SNRS (Fekerte, 2008). In Beyeda, males are selected at 6-7 months, while in Janamora they are 5-6 months. This figure is comparable to the report of Tesfaye et al. (2010) but longer than Zewdu et al. (2012) who reported 4.39 ± 2.24 months for Horro rams.

Based on the reasons for keeping sheep, the breeding goals of farmers can be defined. The main breeding goal of farmers in the Simien mountain region for Simien sheep is to improve their market value through increased meat production. Selection criteria for selecting breeding rams are presented in Table 5. Among the selection criteria

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considered, coat color was an important selection criterion. Its index varied with districts and red, white, or mixed colors were more preferred in the study areas. It is ranked first by sheep owners in Beyeda and Janamora with an index value of 0.28 and 0.32, respectively. In Beyeda physical appearance and growth rate were ranked second and third with an index of 0.23 and, 0.10 respectively. Similarly, appearance and, growth rate, were ranked the second and, third selection criteria in Janamora with an index value of 0.21 and 0.09, respectively. This might be due to the association of good physical appearance of the ram with high carcass output and fetch premium price. Across districts, physically observable traits such as coat color, appearance, and horn should be considered alongside production traits in decision making to define breeding objectives of sheep owners in the sheep barley-dominated production system and to emphasize in selecting breeding rams, as their index values differed among districts.

Selection criteria for selecting breeding ewes are presented in Table 6. However, their index value differed among districts; appearance and coat color were two of the most important breeding ewe selection criteria in both study districts. In Beyeda, sheep owners have given attention primarily to appearance (index=0.21) while coat color and appearance were ranked as the first and second selection criteria for breeding ewes in Janamora district. Similar selection criteria were reported by Tesfaye et al. (2010) and Helene et al. (2013) in the Menz district and eastern Ethiopia respectively. Twining ability was ranked as the third selection criteria for ewes in Beyeda and Janamora with an index of 0.14 and 0.13, respectively.

Table 5 - Breeding objective traits for the Simien breeding ram

Breeding objective traits	Rank indexes of breeding objective traits								
	Beyeda				Janamora				Overall
	R1	R2	R3	Index	R1	R2	R3	Index	Index
Coat color	24	32	21	0.28	23	32	21	0.32	0.3
Appearance	25	11	22	0.23	25	10	21	0.21	0.22
Breeding efficiency	2	7	3	0.04	3	6	3	0.04	0.04
Paternal history	5	13	2	0.08	5	13	2	0.07	0.08
Maternal history	5	8	3	0.06	5	7	3	0.05	0.05
Libido	0	0	6	0.01	0	0	6	0.01	0.01
Growth rate	10	8	10	0.10	9	8	9	0.09	0.1
Meat yield	0	0	5	0.008	0	0	5	0.09	0.05
Temperament	0	0	2	0.003	0	0	2	0.004	0.003
Adaptability	7	6	1	0.06	7	7	1	0.07	0.06
Tolerance	4	0	6	0.03	4	0	7	0.03	0.03
Walkability	3	0	4	0.02	2	0	4	0.01	0.01
Horn	8	8	8	0.09	8	7	7	0.08	0.08

R =Rank, Index = [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for each selection criteria]/[(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for all selection criteria for all traits].

Table 6 - Breeding objective traits for the Simien breeding ewe

Breeding objective traits	Rank indexes of breeding objective traits								
	Beyeda				Janamora				Overall
	R1	R2	R3	Index	R1	R2	R3	Index	Index
Coat color	21	20	18	0.21	21	19	17	0.23	0.22
Appearance	21	22	21	0.23	20	21	19	0.22	0.23
Lamb survival	12	12	7	0.12	12	12	8	0.12	0.12
Paternal history	3	1	2	0.02	3	2	2	0.03	0.025
Maternal history	4	1	0	0.03	4	1	0	0.02	0.025
Age at first sexual maturity	3	2	2	0.02	3	2	3	0.03	0.025
Lambing interval	3	7	6	0.05	3	6	6	0.05	0.05
Litter size\twinning	13	13	11	0.14	12	13	11	0.13	0.13
Meat yield	0	0	0	0	0	0	0	0	0
Temperament	0	0	3	0.05	0	0	3	0.05	0.05
Mothering ability	13	11	11	0.13	13	11	10	0.13	0.13
Walkability	0	0	0	0	0	0	0	0	0
Adaptability	0	5	5	0.08	0	0	5	0.09	0.09
Tolerance	0	7	7	0.01	0	4	7	0.03	0.19

R =Rank, Index = [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for each selection criteria]/[(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for all selection criteria for all traits].

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CONCLUSION

Sheep production is an important component of the farming activity in the Simien mountain region through providing organic sheep meat to the local communities. The main breeding objective for sheep production have been defined as increasing meat production and marketed animals and this is driven by market demands. Compared with other local sheep types, Simien was rated highly by both producers and consumers in their tasty meat. These characteristics make the Simien sheep economically more important. Participatory identification of breeding objective traits indicated observable traits were preferred for selecting breeding animals. This implies that designing sheep improvement strategies in the area should primarily target meat production traits. The current information from breeding practices and participatory identification of breeding objective traits provided baseline information to design effective and sustainable genetic improvement and conservation programs for the Simien sheep breed. Conservation of Simien sheep genetic resources could be imperative as these have been contributing most to the sheep genetic diversity in Ethiopia.

DECLARATIONS

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Authors' contribution
All of the authors contribute to idea conception, data collection and analysis, and the write-up of the manuscript.

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

REFERENCES

Belachew H and Jemberu E (2003).Challenges and opportunities of livestock trade in Ethiopia. Challenges and opportunities of livestock marketing in Ethiopia. Proceedings of 10th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 22–24, 2002. ESAP, Addis Ababa, Ethiopia. pp. 1–14. DOI: https://doi.org/10.1.1.468.8506&rep=rep1&type=pdf

Birara E and Zemen A (2016). Assessment of the Role of Livestock in Ethiopia : A Review. American-Eurasian Journal of Scientific Research, 11(5):405–410. DOI: https://doi.org/10.5829/idosi.aejsr.2016.11.5.22464

Central Statistics Agency of Ethiopia (CSA) (2018). Agricultural Sample Survey 2017/18 [2010 E.C.]. Volume II report on livestock and livestock characteristics (Private peasant holdings). Central Statistics Agency (CSA): Addis Ababa, Ethiopia. https://www.statsethiopia.gov.et/agriculture/livestock-and-livestock-characteristicsprivate-peasant-holdings-2017-2018-2012-e-c/

Central Statistical Agency of Ethiopia (CSA) (2020).Agricultural Sample Survey 2019/20 [2012 E.C.]. Volume II report on livestock and livestock characteristics (private peasant holdings). Central Statistical Agency (CSA): Addis Ababa, Ethiopia. https://www.statsethiopia.gov.et/agriculture/livestock-and-livestock-characteristicsprivate-peasant-holdings-2020-2021-2013-e-c/

Desalegn A (2022). Alternative Village Based-Breeding Schemes for Simien and Gumuz Sheep Breeds in Northwestern Ethiopia. Iranian Journal of Applied Animal Science, 12(2):287-294. https://journals.iau.ir/article_691727_ed32fc31504f9baff53f33948efedb29.pdf

Fekerte F (2008). On-farm Characterization of Blackhead Somali Sheep Breed and Its Production System in Shinile and Erer Districts of Shinile Zone. MSc Thesis, Haramaya University, Haramaya, Ethiopia. PP. 1-134. https://cgspace.cgiar.org/handle/10568/68875

Gebregziabhear E, Urge M, Animut G and Ketema M (2019). Characterization of Sheep Production Practices in Mixed Crop-livestock and Agro-pastoral Systems of Central and Eastern Ethiopia. East African Journal of Veterinary and Animal Sciences, 3(1): 27-38. https://haramayajournals.org/index.php/EAJVAS/article/download/914/450/

Getahun L, Aynalem H, Duncan AJ, Tadelle D, Solomon G and Rischkowsky B (2014). Sheep and Goat Value Chains in Ethiopia: A Synthesis of Opportunities and Constraints. ICARDA/ILRI Project Report, International Center for Agricultural Research in the Dry Areas/International Livestock Research Institute, Nairobi, Kenya. https://www.ilri.org/publications/sheep-and-goat-value-chains-ethiopia-synthesis-opportunities-and-constraints

Girma D, Mieso G, Feyisa H and Misgana D (2013). Assessment of farmers' management practices and factors affecting goats' production system in Adami Tulu Jido kombolcha district of East Shawa Zone, Ethiopia. Agriculture and Biology Journal of North America, 4(5): 520-526. DOI: https://doi.org/10.5251/abjna.2013.4.5.520.526

Citation: Mulat T, Dagnew Y and Desalegn K (2022). Breeding strategies of Simien sheep in Simien mountain region of Ethiopia. *Online J. Anim. Feed Res*., 12(4): 187-193. DOI: https://dx.doi.org/10.51227/ojafr.2022.25

Habtamu L (2015). The contribution of livestock in meeting food production and nutrition in Ethiopia. Journal of Food Science and Quality Management, 2(3): 020-043. http://www.springjournals.net/full-articles/springjournals.netgifstarticleshabtamu.pdf?view=inline

Hagos B, Alemayehu K and Mekuriaw Z (2015). Traditional Management Practices, Breeding Objectives and Trait Preference for Indigenous Sheep in Northern Ethiopia. International Journal of Livestock Production Research, 9(6): 151-159. DOI: https://doi.org/10.5897/IJLP2017.0425

Hailu A, Mustefa A, Asegede T, Assefa A, Sinkie S and Tsewene S (2020). Phenotypic characterization of sheep populations in Tahtay Maichew district, Northern Ethiopia. Genetic Resources, 1(2):12–22. DOI: https://doi.org/10.46265/genresj.SHBD3744

Hayelom M (2013). Management practice and constraints of sheep production in southern, south eastern and eastern zones of Tigray, northern Ethiopia. World Journal of Animal Science Research, 1(1): 1-17. http://www.wjasr.com/WJASR_Vol.%201,%20No.%201,%20December%202013/MANAGEMENT%20PRACTICE.pdf

Helen N, Yoseph M, Kefelegn K, Solomon A and Sanjoy KP (2013). Production objectives, breeding practices, and selection criteria of indigenous sheep in eastern Ethiopia. Livestock Research for Rural Development, 25 (9). https://www.lrrd.cipav.org.co/lrrd25/9/nigu25157.htm

Hiemstra SJ, Drucker AG, Tvedt MW, Louwaars N, Oldenbroek JK, Awgichew K, Abegaz KS, Bhat PN and Da Mariante S A (2007). Options for strengthening the policy and regulatory framework for the exchange, use and conservation of animal genetic resources. Animal Genetic Resources Information, 41:65–74. https://www.fao.org/3/a1250e/annexes/Thematic%20Studies/Exchange_use_and_conservation.pdf

International Livestock Research Institutes (ILRI) (2011). Livestock policy analysis: ILRI Training Manual 2, ILRI, Nairobi, Kenya. http://dlc.dlib.indiana.edu/dlc/bitstream/10535/34/1/Livestock_policy_analysis.pdf

Kiflay W, Mengistu U and Solomon A (2019). Sheep Production Systems and Breeding Practices for Selected Zones of Tigray, Northern Ethiopia. Open Journal of Animal Sciences, 9: 135-140. DOI: https://doi.org/10.4236/ojas.2019.91012

Kosgey IS, Rowlands GJ, van Arendonk JAM and Baker RL (2008). Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. Small Ruminant Research, 7:11–24. DOI: https://doi.org/10.1016/j.smallrumres.2008.02.005

Solomon A, Girma A and Kassahun A (2008). Sheep and Goat Production Systems in Ethiopia. In: Alemu Yami and R.C. Merkel (Eds.), Ethiopia sheep and goat productivity improvement program (ESGPIP), Branna Printing Interprise. Addis Ababa, Ethiopia, pp: 27-32. https://agris.fao.org/agris-search/search.do?recordID=ET2008000090

Solomon A, Hegde BP and Taye M (2011). Growth and Physical Body Characteristics of Gumuz Sheep under Traditional Management Systems in Amhara Regional State, Ethiopia. Livestock Research for Rural Development, 23: 117. http://www.lrrd.org/lrrd23/5/abeg23117.htm

Solomon G (2008). Sheep resources of Ethiopia: Genetic diversity and breeding strategy. PhD thesis, Wageningen University, Netherlands. 2008. https://edepot.wur.nl/122006

Solomon G, Azage T, Berhanu G and Dirk H (2010). Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement Jido kombolcha district of east Shoa zone, Ethiopia. Working Paper No. 23. https://cgspace.cgiar.org/bitstream/handle/10568/2238/IPMS_Working_Paper_23.pdf

Solomon G, Tesfaye G, Zewdu E, Tadele M, Gemeda D, Markos T, Rischkowsky B, Mwai O, Tadelle D, Wurzinger M, Solkner J and Aynalem H (2013). Characterization of indigenous breeding strategies of the sheep farming communities of Ethiopia. A basis for designing community-based breeding programs. International Center for Agricultural Research in the Dry Areas (ICARDA). 40 pp. DOI: http://doi.org/10.22004/ag.econ.253826

Surafel M, Zeleke M, Solomon G and Mengiste T (2012). Community-based characterization of Simien sheep based on growth characteristics and farmers' breeding objectives in Simien Mountain region, Ethiopia. Research Journal of Animal Sciences, 6(3):47–55. DOI: http://doi.org/10.3923/rjnasci.2012.47.55

Tesfaye G, Ayinalem H, Markos T, Sharma AK, Sölkner J and Wurzinger M (2010). Herd Management and Breeding Practices of Sheep Owners in a Mixed Crop-Livestock and a Pastoral System of Ethiopia. African Journal of Agricultural Research, 5: 685-691. DOI: http://doi.org/10.5897/AJAR10.392

Tesfaye G, Ayinalem H, Wurzinger M, Rischkowsky B, Solomon G, Abebe A and Sölkner J (2016). Review of sheep crossbreeding based on the exotic sire and among indigenous breeds in the tropics: An Ethiopian perspective. African Journal of Agricultural Research, 11(11):901-911. DOI: http://doi.org/10.5897/AJAR2013.10626

Wurzinger M, Sölkner J and Iniguez L (2011). Important aspects and limitations in considering community-based breeding programs for low-input smallholder livestock systems. Small Ruminant Research, 98:170–175. DOI: https://doi.org/10.1016/j.smallrumres.2011.03.035

Yohannes D, Mengistu U, Tadesse Y and Solomon G (2017). Sheep Production and Breeding Systems in North Western Lowlands of Amhara Region, Ethiopia: Implication for Conservation and Improvement of Gumz Sheep Breed. Open Journal of Animal Sciences, 7(2): 179-197. DOI: https://doi.org/10.4236/ojas.2017.72015

Yohannes D, Urge M, Tadesse Y and Gizaw S (2018). Conservation-based breeding program design for genetic improvement in Gumz sheep in the western lowlands of Ethiopia. Agriculture & food security, 7(1): 34. DOI: https://doi.org/10.1186/s40066-018-0173-5

Zewdu E, Markos T, Sharma AK, Solkner J and Wurzinger M (2012). Sheep Production Systems and Breeding Practices of Smallholders in Western and South-Western Ethiopia: Implications for Designing Community-Based Breeding Strategies. Livestock Research for Rural Development, 24: Article #117. http://www.lrrd.org/lrrd24/7/edea24117.htm

Zonabend KE, Mirkena T, Strandberg E, Audho J, Ojango J, Malmfors B, Okeyo AM and Philipsson J (2016). Participatory definition of breeding objectives for sheep breeds under pastoral systems—the case of Red Maasai and Dorper sheep in Kenya. Tropical Animal Health and Production, 48(1): 9-20. DOI: http://doi.org/10.1007/s11250-015-0911-7

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THE SPREADING AND MOLECULAR CHARACTERIZATION OF THE WATER MOULD *Saprolegnia parasitica* IN AL-DIWANIYAH RIVER OF IRAQ

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ABSTRACT: The water mold *Saprolegnia parasitica* is a chief species of oomycetes that affects a wide range of plant, natural ecosystems, fish and the aquaculture industry. The current study aimed to investigate the isolation and identification of some aquatic fungi like *Saprolegnia* spp. and also molecular characterization of *Saprolegnia parasitica* in the water of Al-Diwaniyah river of Iraq using the baiting method for isolation and PCR polymerase chain reaction for molecular diagnosis of fungi. A total of 60 samples were taken from three study sites of river: 25 samples of Al-Shafi'iah city bridge (Najaf road) as first site (S1); 25 samples of Hawly Al-Jamiah road bridge, Umm Al-Khail area, as second site (S2); and 10 samples of Al-Orouba bridge as the third site (S3). Molecular diagnosis was carried out by PCR examination using primers for the rDNA gene and its presence in *Saprolegnia parasitica*, as DNA was obtained at a concentration of 685.4-99.4 µg/µl and a purity of 1.92-1.8. The samples from the first site gave the highest number of 18 isolates (45%), followed by samples from the second site with 14 isolates (35%). The samples from the third site showed a number of 10 isolates (20%). The species *S. parasitica* was more visible during February 2020 with a number of 17 isolates, and less visible in April 2021, with a number of 3 isolates. In conclusion, the variation in the presence of the types of infectious aquatic fungi *Saprolegnia* spp. in the Al-Diwaniyah river of Iraq in different sites and months of 2021 showed a high percentage of isolates for Al-Shafi'iah city bridge (Najaf road) site and the highest number of *Saprolegnia parasitica in* February 2020. There is a need for further examination of oomycetes in different sites of rivers of Iraq in different months.

Keywords: Aquatic fungi, Fish, Fungal disease, Molecular characterization, *Saprolegnia parasitica.*

INTRODUCTION

Water is the necessary factor for the life of living organisms, and it is one of the most important basic elements of the environment on which animal and human life and all his activities are based. Fresh water constitutes the remaining area, and rivers constitute a suitable environment for the growth of several biological communities of micro-organisms such as fungi, bacteria, parasites and viruses (Frenken et al., 2019; Al-Maliki et al., 2021).

Oomycetes is one of those organisms that spread in the aquatic environment, as it plays an important role in the balance of the aquatic environment, especially fresh water, as it analyzes many pollutants and substances through its enzymes that secrete them. They are very sensitive to the efficacy of toxic substances in water (Tsui et al., 2015).

Saprolegnia parasitica is a species that infect a wide range of plant and also cause economically important diseases in animals especially in aquatic animals (Earle and Hintz, 2014). This fungus is characterized by the ability to infect fish and their eggs. So, researchers are recently focused on new methods for controlling this important infection agent (Tedesco et al., 2019; Mostafa et al., 2020; Zhang et al., 2021). Some relative studies have been conducted in Iraq for detection of possible problems in rivers and also its effect on fish health (Touhali and Al-uguali, 2018; Ali et al., 2020; Al-Hassani and Mustafa, 2022).

Mustafa et al. (2019) had reported that presence and concentration of hydrogen peroxide can be useful for controlling *Saprolegnia*sis in fish (common carp). Ali et al. (2020) stated that *Saprolegnia* can have economic hazards due to lethal infection of fish, based on their studies on samples taken from Mosul, Iraq.

With attention to importance of these infectious agents in water health and also aquatic health, the purpose of the study was to survey of aquatic fungi, especially *Saprolegnia parasitica* in the water of Al-Diwaniyah River, and to conduct a phenotypic and molecular diagnosis of the fungus.

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MATERIALS AND METHODS

Samples collection

Water samples were collected monthly for the period from December 2020 to May 2021 at ten samples in the morning from the study sites represented by the Al-Diwaniyah River in three sites represented in the first site (S1) Al-Shafi'iah City Bridge (Najaf Road), and the second site (S2) (Hawly Al-Jamaa Road Bridge, Umm District, Horses), and the third site (S3) (Al-Orouba Bridge). Water samples were taken from all areas of the river from its sides and middle, i.e. square, during the above-mentioned period, i.e. in winter, spring and early summer. Under the surface of the water, at a depth of 20-30 cm, after filling, it was sealed tightly while it was under the surface of the water and was then transferred to the laboratory for laboratory tests.

Fungi isolate

Baitting method

The aquatic fungi were isolated in the current study by the baiting method according to what was mentioned by Al-Rekabi et al. (1996) and Pennisetum spicatum seeds were used as baits for this purpose.

Purification and maintenance of pure cultures

After the emergence of fungal growths, the purification process was carried out by cutting one fungal thread near the top with sterile metal forceps, and transferred under sterile conditions to SDA medium. A piece of culture medium containing the fungal ends was transferred with a 6 mm or 5 cork borer to sterile Petri dishes containing three millet seeds, 15 µl sterile distilled water and one ml of anti-chloramphenicol (Kiziewics, 2006).

Diagnosis of aquatic fungi

The isolated and developing fungi were diagnosed by grafting method based on the phenotypic and agricultural characteristics of the developing colonies and this includes the shape, color and nature of colony growth, as well as using the microscopic phenotypic characteristics of fungal hyphae and sexual and asexual reproductive structures and based on the taxonomic keys mentioned by Watanabe (2002).

Diagnostic method using PCR polymerase chain reaction

A PCR assay was performed to investigate the fungus *Saprolegnia* parasitica, by using the primers of the 18S rDNA gene to diagnose the fungus, according to the manufacturer's instructions which is similar to the methods of Paul et al. (2015) and Al-Maliki et al. (2021).

Fungus DNA Extraction

DNA extraction was carried out from fungi colonies samples using the EZ-10 Spin Column Fungal Genomic DNA Mini-Preps Kit from the Korean company Bioneer. The extraction was carried out according to the company's instructions, which are: 1- About 200 mg of fungal growth colonies were transferred to a sterile ceramic container using liquid nitrogen at a temperature of -169°C (below zero). Then the fungal colonies were crushed and then transferred to sterile 1.5 µl tubes; 2- After that, 180 µl of Universal Digestion Buffer and 20 µl of Proteinase K were added to each sample and then mixed well with the Vortex mixer and then the samples were incubated at 56°C for 30 minutes; 3- Then 100 µl of Universal Buffer PF solution was added and mixed by inverting and then the tubes were incubated at -20°C for 30 minutes; 4- The samples were placed in a centrifuge at a speed of 10000 rpm for 5 minutes. Then transfer the supernatant to a new 1.5 µl tube; 5- Then 100 µl of Universal Buffer BD solution was added and mixed well with a mixture; 6- After that, Absolute ethanol 96% was added to all samples and mixed well with a mixture; 7- The mixture was transferred to special tubes containing a DNA extraction filter equipped with the EZ-10 column kit, which were placed inside university collection tubes with a capacity of 2 µl, and then placed in a centrifuge at 12000 rpm for one minute, and then the precipitate was disposed of; 8- Then 500 µl of Universal PW Solution was added and the tubes were placed in a centrifuge at 12000 rpm for 1 minute and then the precipitate was discarded; 9- Then again 500 µl of Universal Wash Solution was added and then the tubes were placed in a centrifuge at 12000 rpm for 1 minute and then the precipitate was discarded; 10- The DNA-containing EZ-10 column was placed in sterile 1.5 µl tubes and the tubes were then placed in a centrifuge at 12000 rpm for 2 min to dry the EZ-10 column membrane from alcohol and then the precipitate was discarded; 11- After that 50 µl of TE Buffer solution was added to dissolve the DNA inside the EZ-10 filter column and then incubated at room temperature for one minute and then all tubes were placed in a centrifuge at 12000 rpm for one minute to collect the DNA and then transferred to storage At -20°C in the refrigerator until use in the PCR test.

DNA profile assay

The DNA is extracted from the fungal samples through the use of the Nanodrop spectrophotometer (THERMO, USA) to detect and measure the concentration of nucleic acids (DNA and RNA), where the DNA is detected by determining the concentration of DNA (ng\µl DNA). The purity of DNA was measured by reading the absorbance at a wavelength ranging between (260-280 nm) and the device was used as follows: 1) After turning on the Nanodrop device, the DNA measurement program was selected; 2) Sweep the scale substrate twice using blotting paper for the device by placing 1

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µl of ddH2O using a sterile micropipette on the surface of the scale substrate, zeroing and then cleaning the substrate for measuring samples; Press the start button to start the process of measuring the concentration of DNA, using 1 microliter of each sample of the extracted DNA, and then the substrate of the scale device was cleaned again to measure the other samples; The purity of the extracted DNA samples was determined when the absorbance ratio was 1.8, then the extracted DNA is pure.

Analysis of the results of the PCR examination

Agarose gel electrophoresis was carried out using 1.5% agarose gel, reading the PCR product analysis result as follows: 1- Dissolve 1 g of agarose gel in 100 µl of TBE buffer (Tris-borate-EDTA) at 1X concentration using a Microwave device for 5 minutes; 2- The gel was left to cool at 50°C. Then 3 microliters of radioactive DNA dye Ethidium bromide were added and mixed well with the gel; 3- The agarose gel poured into the Tray containing the comb to locate the PCR samples, then the gel were left to solidify at room temperature for 15 minutes and then the comb removed from the gel carefully; 4- The samples that are the result of the PCR product were carried and placed in the gel pits, and then a 100 DNA Marker ladder was added to measure the PCR product in the first hole; 5- After the loading process was completed, the agarose gel was immersed in a buffer TBE Buffer solution at a concentration of 1X, the relay cover was closed, and then the relay was operated using a current of 100 volts and 80 amps for one hour; 6- After the migration process is completed, examine the gel containing the PCR product using a U.V light source to determine the product with the measurement unit.

Statistical analysis

The results were subjected to statistical analysis to find out the significant differences between the studied sites. The significant differences were determined at a probability level of 5% using the least significant difference (LSD) test and the Chi-square test. The percentage of the appearance of fungi in the studied sites was calculated through the following equation:

Percentage = (Number of isolates x 100 / The number of samples examined) x 100%

RESULTS AND DISCUSSION

Isolation and identification

Isolation of the fungus Saprolegnia parasitica

Table 1 shows the numbers of Fungi isolated in this study and the percentage of their appearance using saproide dextrose agar medium and using the grafting method. One species of *Saprolegnia* spp. was isolated and diagnosed. It is the type *S.parasitica* being the most visible in the study areas in terms of its accessibility, where the current study was conducted on the Al-Diwaniyah river in three locations represented in the first site (S1) Al-Shafi'i city bridge (Najaf road), and the second site (S2) (University of Road Bridge, Hawalli, Umm Al-Khail area), and the third site (S3) (Al-Orouba bridge), as it appears from the table below that the total number of samples was 60 samples distributed by 25 samples from the first site, 25 samples from the second site, and 10 samples from the third site. The first site had the highest number of isolates, amounting to 18 isolates, with a percentage of 45%, followed by samples from the second site, with 14 isolates, and with a percentage of 35%. The samples for the third site were 10 isolates and with a percentage of 20%.

This was represented during the study that started from December of the year 2020 until the month of May 2021, and it appeared that there was a significant difference ($P<0.05$) in the numbers of these fungi from one site to another during the study period for the purpose of isolating and diagnosing the aforementioned types of fungi, as rivers represent a suitable environment for the growth of these fungi. Fungi species *Saprolegnia* spp. due to the availability of appropriate ambient conditions such as temperature, acid function, appropriate concentration of dissolved oxygen, lighting, flow velocity and surface tension property, and the variation in the proportions of fungal isolates in the studied sites can be attributed to the difference in the characteristics mentioned, which is consistent with what was reported by Olegovich Bokov et al. (2020) which mentioned that it can be The variation in the fungi that live in Iraqi water in general is attributed to the pollution occurring therein and the difference in physical and chemical properties and other environmental influences that have a direct impact on the presence of these fungi.

Monthly distribution of the fungus *Saprolegnia* parasitica and the effect of its chemical and physical properties

Table 2 shows the monthly distribution and temperature range of *Saprolegnia* parasitica. And the total number of isolates, as the lowest temperature was recorded and was from 12-13 °C at the beginning of the study in December of the year 2020, and the maximum was in May of the year 2021, where the temperature range was from 28-27 °C or less than that by one or two degrees This is consistent with what was mentioned by Watanabe, (2002) and Hafsan et al. (2022), in their study on the types of Fungi *Saprolegnia* in the water of the Shatt al-Arab and their pathogenicity examination, as the temperatures recorded in that region were close to the sites of the current study. The best month in which fungal isolates were obtained in abundance is February 2021, where 17 isolates of *S.parasitica* were isolated, where the temperature range was measured from 14-16°C, and the least number of isolates obtained was in the month of April 2021, as 3 isolates of the aforementioned fungus were isolated, and the temperature range was measured from 20-22°C, and no isolation was obtained in May 2021, which is the last month of the isolation and diagnosis phase, where the temperature

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range was measured from 27-28°C, and the following pictures, the Fungi *Saprolegnia* spp. during the period of isolation and diagnosis, by the appearance of fungal growths on sterilized millet seeds and on SDA culture media in the laboratory (Figures 1 and 2).

Saprolegnia fungi species isolated during the current study

Type I Saprolegnia parasitica Coker

The diameter of the colony of this fungus, after two weeks of growth on millet seeds, ranged 1-1.5 cm. The diameter of the fungal thread at the base reached 25-45 microns. The fungal threads are less branched. The gametes were abundant with different shapes, often regular and sometimes irregular in shape, terminal or inter-site and they exist in the form of chains. The boards are longitudinal or cylindrical, their dimensions range between 35-60 × 250-950 microns, the diameter of the sintered boards is 12 microns, the boards are spherical or pear-shaped, and they are terminal or sideways. With antheridia, cylindrical straight clipboard holders with dimensions 15-30 × 50-200 microns, eccentric oval boards 10-25 microns in diameter, and 2-40 in one capsule filling the cavity (Figures 3-5). Antheridia fungus is characterized by the ability to infect fish and their eggs, which is identical to what Mentioned by Kiziewics (2006) and Hafsan et al. (2022) and its forms are:

Diagnosis of the fungus *Saprolegnia parasitica* PCR technique

The PCR examination was carried out using primers for the rDNA gene to diagnose the fungus *S.parasitica*. The results showed the efficiency of the method in extraction, as DNA was obtained in *S.parasitica* at concentrations of 685.4-99.4 µg/µl and with a purity of 1.80-1.92, noting that the percentage of purity adopted for the reaction is 1.8, as it shows in Table 3.

PCR assay for *Saprolegnia parasitica*

Through what appeared in the electrophoresis on agarose gel at a concentration of 1%, it was observed when examining the gel under ultraviolet rays that light orange bands appeared resulting from the replication process, in reference to the link of the initiator with its complementary sequence in the template DNA. It appeared that the sizes of the pieces of DNA compared with the product size from the measurement of the size of the DNA bundle of *S.parasitica* is 568 bp, all isolates of this species gave a positive result, which numbered 10 pure isolates, and these values were confirmed according to what is found in the NCBI Gene Bank as well as what was confirmed by Sparrow (1960) and through what appeared in the photography after the end of the electrical relay process (Figures 4-6).

Table 1 - The sites of isolates of Fungi, the number of isolates on the Sabouraud agar medium and their percentage.

Sample location	Number of samples examined	Number of isolates	Percentage
S1	25 [a]	18 [a]	45
S2	25 [a]	14 [b]	35
S3	10 [b]	8 [c]	20
Total	60	40	100

*Similar letters: indicate no significant differences. The different letters: indicate the presence of significant differences.

Table 2 - Monthly distribution and water temperature ranges of *Saprolegnia parasitica* and the total number of isolates.

Months	Temperature range (°C)	Number of isolates
December 2020	12-13	5
January 2021	10-11	8
February 2021	14-16	17
March 2021	17-19	7
April 2021	20-22	3
May 2021	28-27	0
Total	40	

Table 3 - Samples of S. parasitica, their concentrations and purity in PCR assay using a Nanodrop spectrophotometer.

Sample	Concentration (ng/ml)	Purity (1.8)
S.parasitica 1	99.4	1.80
S.parasitica 2	238.2	1.82
S.parasitica 3	239.9	1.82
S.parasitica 4	317.6	1.84
S.parasitica 5	320.5	1.84
S.parasitica 6	351.6	1.85
S.parasitica 7	429.3	1.86
S.parasitica 8	493.7	1.88
S.parasitica 9	667.1	1.90
S.parasitica 10	685.4	1.92

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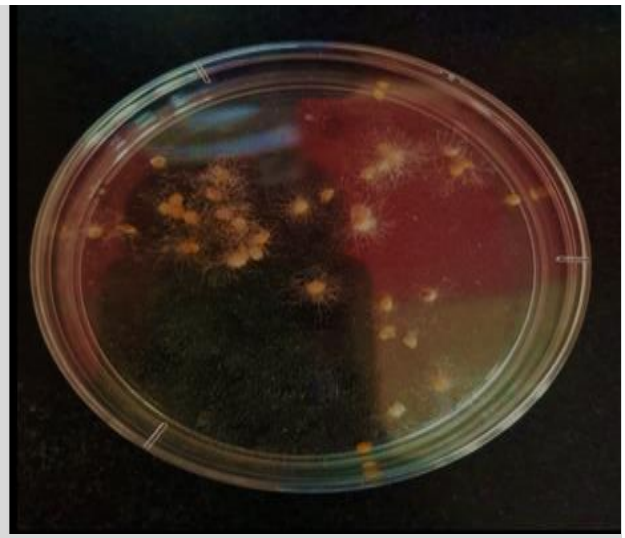

Figure 1- The fungal colony of *Saprolegnia* spp. growing on millet seeds by grafting method and its age, 72 hours.

Figure 2 - The fungal colony of *Saprolegnia* spp. growing on SDA medium and its age is 5 days.

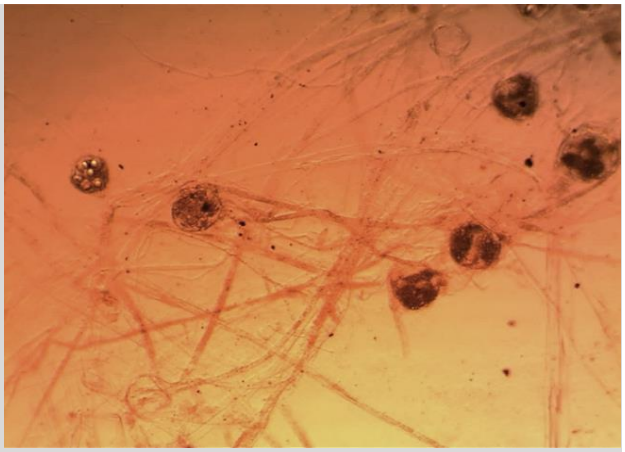

Figure 3 - Detected *Saprolegnia parasitica.*

Figure 4 - *Saprolegnia parasitica* and maturation of sporangia spores in sporangia.

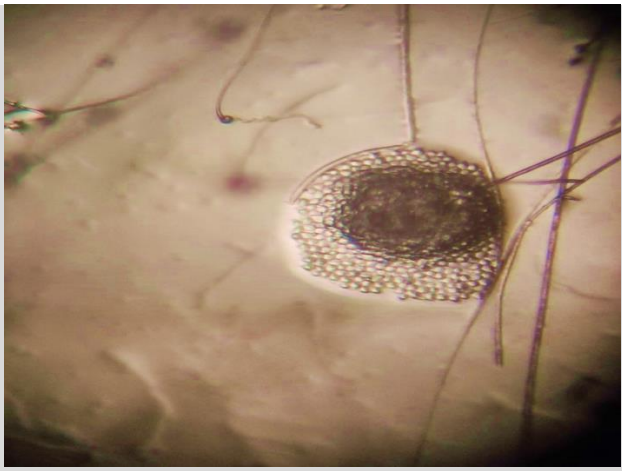

Figure 5 - The sporangia of the fungus *Saprolegnia parasitica* at the moment its wall ruptures and the swimming spores are released.

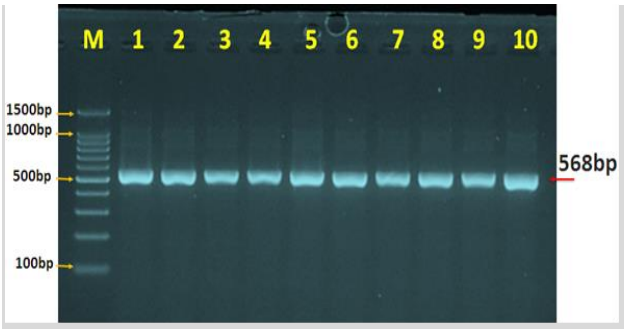

Figure 6 - Agarose gel electrophoresis showing the results of the PCR assay for the 18S rRNA gene ITS1 region for the diagnosis of *S.parasitica*, where the (M) line represents the standard scale (1500-100bp) and the line (10-1) bundles Positive isolates for PCR examination with a yield length of 568bp, knowing that the electrophoresis with agarose gel at a concentration of 1% and an electric current of 100 volts and 80 amps.

CONCLUSION

In conclusion, the variation in the presence of the type of aquatic fungi *Saprolegnia* spp. in the Al-Diwaniyah river of Iraq was evaluated and reported. Also the application of the PCR examination in the molecular diagnosis of the type of fungus is efficient for further studies in different regions.

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DECLARATIONS

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Authors' contribution
Both authors contributed equally to this work.

Conflict of interests
The authors declared that there is no conflict of interest in this study.

REFERENCES

Al-Hassani ST, Mustafa SA (2022). Efficiency of synbiotic as feed additives on growth performance, survival rate and health status in common carp challenged with *Saprolegnia* spp. Iraqi Journal of Agricultural Sciences, 53(2):397-405. DOI: https://doi.org/10.36103/ijas.v53i2.1548

Ali FF, Al-Taee SK, Al-Jumaa ZM (2020). Isolation, molecular identification, and pathological lesions of *Saprolegnia* spp. isolated from common carp, Cyprinus carpio in floating cages in Mosul, Iraq. Veterinary World, 13(12):2759. DOI: https://dx.doi.org/10.14202%2Fvetworld.2020.2759-2764

Al-Maliki LA, Farhan SL, Jasim IA, Al-Mamoori SK, Al-Ansari N (2021). Perceptions about water pollution among university students: A case study from Iraq. Cogent Engineering, 8(1):1895473. DOI: https://doi.org/10.1080/23311916.2021.1895473

Al-Rekabi SA, Naeem RA, and Butty KN (1996). Specificity of Baits in isolation *Saprolegnia*ceae. Al-Mustansiriyah Journal of Science, 7(1):20-22. Google Scholar

Earle G, and Hintz W (2014). New Approaches for Controlling *Saprolegnia* parasitica, the Causal Agent of a Devastating Fish Disease. Tropical Life Sciences Research, 25(2):101-109. http://www.tlsr.usm.my/tlsr25022014/25022014_07.pdf

Frenken T, Agha R, Schmeller DS, van West P, Wolinska J (2019). Biological concepts for the control of aquatic zoosporic diseases. Trends in parasitology, 35(7):571-382. DOI: https://doi.org/10.1016/j.pt.2019.04.003

Hafsan H, Dmitry Bokov,Walid Kamal Abdelbasset,Mustafa M. Kadhim,Wanich Suksatan,Hasan Sh. Majdi, et al. (2022). Dietary Dracocephalum kotschyi essential oil improved growth, haematology, immunity and resistance to Aeromonas hydrophila in rainbow trout (Oncorhynchus mykiss). Aquaculture Research, 53(8): 3164-3175. DOI: https://doi.org/10.1111/are.15829

Kiziewicz B (2006). Water Fungi and Fungus-like Organisms Isolated from Surface Waters Situated in the Białowieża Primeval Forest Using the Liver Fluke Fasciola Hepatica L. of European Bison Bonasus L. as Bait. Polish Journal of Environmental Studies, 15(2):277–281. http://www.pjoes.com/pdf-87868-21727?filename=Water%20Fungi%20and.pdf

Mostafa AA, Al-Askar AA, Yassin MT (2020). Anti-*Saprolegnia* potency of some plant extracts against *Saprolegnia* diclina, the causative agent of saprolengiasis. Saudi Journal of Biological Sciences, 27(6):1482-1487. DOI: https://dx.doi.org/10.1016%2Fj.sjbs.2020.04.008

Mustafa SA, Al-Rudainy AJ, and Al-Faragi JK (2019). Assessment of hydrogen peroxide on histopathology and survival rate in common carp, Cyprinus carpio l. infected with *Saprolegnia*sis. The Iraqi Journal of Agricultural Science, 50(2):697-704. DOI: https://doi.org/10.36103/ijas.v2i50.669

Olegovich Bokov D, Jalil AT, Alsultany FH, Mahmoud MZ, Suksatan W, Chupradit S, Qasim MT, Delir Kheirollahi Nezhad P (2022). Ir-decorated gallium nitride nanotubes as a chemical sensor for recognition of mesalamine drug: a DFT study. Molecular Simulation, 48(5): 438-447. DOI: https://doi.org/10.1080/08927022.2021.2025234

Paul Y, Leung WL, and Hintz WE (2015). Species composition of the genus *Saprolegnia* in fin fish aquaculture environments, as determined by nucleotide sequence analysis of the nuclear rDNA ITS regions. Fungal biology, 119(1):27-43. DOI: https://doi.org/10.1016/j.funbio.2014.10.006

Sparrow FK (1960). Aquatic phycomycetes. 2nd edition, Ann Arbor: The University of Michigan Press, USA. pp. 1187. Google Scholar

Tedesco P, Fioravanti ML, and Galuppi R (2019). In vitro activity of chemicals and commercial products against *Saprolegnia* parasitica and *Saprolegnia* delica strains. Journal of Fish Diseases, 42(2):237-248. DOI: https://doi.org/10.1111/jfd.12923

Touhali IS, and Al-uguali IS (2018). Isolation and identification of *Saprolegnia* parasitica and other fungi from farms fishes in the province of Wasit/Iraq. Journal of Global Pharma Technology, 10(05):135-142. Google Scholar

Tsui CK, Baschien C, and Goh TK (2016). Biology and ecology of freshwater fungi. In Biology of Microfungi Springer, Cham, pp. 285-313. DOI: https://doi.org/10.1007/978-3-319-29137-6_13

Watanabe, T (2002). Pictorial Atlas of Soil and seed fungi morphologies of cultured fungi and key to species, Boca Raton London New York Washington, D.C. DOI: https://doi.org/10.1201/9781420040821

Zhang J, Chen J, Huang Q, MacKinnon B, Nekouei O, Liu H, Jia P, Wang J, Li N, Huang L, Yang Y (2021). Copper/carbon core/shell nanoparticles: a potential material to control the fish pathogen *Saprolegnia* parasitica. Frontiers in Veterinary Science, 8:798. DOI: https://doi.org/10.3389/fvets.2021.689085

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EFFECT OF DIETARY SUPPLEMENTED COCOA POD HUSK MEAL ON THE REPRODUCTIVE PERFORMANCE OF RABBITS

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ABSTRACT: This study determined the dietary effect of cocoa pod husk meal (CPHM) on the reproductive performance of rabbits. Twelve iso-nitrogenous (16.05% CP) and iso–caloric (2500.12 Kcal kg^{-1} ME) diets were formulated. The CPHM was included at 0, 12.5, 25 and 37.5% levels for T_1, T_2, T_3, and T_4 raw; T_5, T_6, T_7, T_8 fermented and T_9, T_{10}, T_{11}, T_{12} hot–water treated CPHM. Sixty weaned rabbits between 5 and 6 weeks old of both sexes (30 males and 30 females) with mean initial body weight of 606.42±1.30g were used. The rabbits were randomly distributed using a completely randomized design (CRD). The animals were crossed at maturity for reproductive performance evaluation. Total protein concentrations of reproductive parts were determined. Result showed no significant dietary effect on reproductive performance. The 37.5% level recorded zero pregnancy in the raw and hot–water groups. Average gestation period ranged between 30 and 31 days. Average litter size at birth ranged 1 – 4 kittens. Average weaning weight ranged between 475 and 580.25g with the least weight in the raw group. Milk yield ranged between 205.46 and 262.94g. The sperm volume and gonadal sperm reserve recorded significant effect ($P<0.05$). In the raw and hot–water groups, the sperm volume decreased marginally. The protein concentration in the testes recorded higher significant ($P<0.05$) values in the control diet and the least value in raw group. The study concluded that fermented CPHM diets performed best at 37.5% level in terms of reproductive performance of rabbits.

Keywords: Cocoa, Gonadal sperm reserve, Kindling, Milking, Sperm volume.

INTRODUCTION

Rabbits are prolific animals that can contribute significantly to food security in sub- Saharan Africa. Currently, we are living in a world with over 925 million food insecure people (FAO, 2010) and majority of these hungry people live in poor, rural communities of Asia and African continents with crop and livestock production as their primary occupations (FAO, 2011). The present hunger and malnutrition can partly be solved through intensive rabbit production, as a means of boosting animal protein intake (Ozung, 2021) and enhancing livelihood security (Halberg and Muller, 2013). Rabbits are short cycle animals with a gestation period of one month, making them suitable for multiplication during periods of food crisis. Rabbit production can yield enormous meat and cheap animal protein. Rabbit meat is healthy as it is low in cholesterol (50g 100^{-1}g); fat (4g 100^{-1}g); energy (124Kcal 100^{-1}g) but high in protein (22g 100^{-1}g) (Aduku and Olukosi, 1990). The meat has complete amino acid profile; it has good flavour, rich in minerals and other essential nutrients as well as easily digestible.

However, rabbit farming like other livestock production enterprises is facing feeding challenges in view of the high cost of conventional feed ingredients. This development has necessitated the search for alternative feed resources in rabbit nutrition. The domestic rabbit is a pseudo-ruminant (monogastric–herbivore or hind gut fermentor) that feeds on forages, grains/ concentrates, kitchen wastes, yam and cassava peels, hay and agro by - products (Mutsami et al., 2019; Gbenge, 2022). One of the promising agro by - products that can be utilized in rabbit feeding is the cocoa pod husk. Cocoa husk is a by-product from cocoa pods obtains from cacao trees grown in the tropics. According to Olubamiwa and Akinwale (2000), 25% cocoa pod husk meal (CPHM) can partially replace maize in layers' diet with no adverse effects on egg parameters. Untreated CPHM has been added in the diets of growing swine up to 300g Kg^{-1} without deleterious signs on body characteristics (Oddoye et al., 2010). The practice of incorporating cocoa pod husk meal in animal diets (pigs, broilers, layers, rabbits) has been reported by various researchers in previous studies (Adomako et al. 1999; Agyente - Badu and Oddoye 2005, Akanbi, 2019; Ozung, 2021).

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Extant literature has reported that sun-dried cocoa beans contain 0.7% sugar, 0.7% starch, 1.7% theobromine (an alkaloid), 6.70% protein and 50-55% pale yellow, non - drying fat known as cocoa butter. The cocoa bean testa has been used successfully in feeding trials for small ruminants without adverse effects on performance characteristics in some countries. According to Adomako et al. (1999), cocoa pod husks constitute 75% of the entire cocoa fruit on fresh weight basis. Adomako (1991) reported that cocoa beans account for less than 2.55% of the whole fruit. Cocoa pod husks contain 6-7% crude protein, 9-10% total ash, 1-8% crude fat (ether extract) and 23-33% crude fibre. Furthermore, Sobamiwa and Longe (1994) reported that metabolizable energy of cocoa pod husk is moderate and ranges from 2000–2100Kcal Kg^{-1}; which is comparable to that of palm kernel cake, soybean meal, rice bran and brewers dried grain. The chemical composition of cocoa pod husk meal shows that it contains total dry matter (42.25%), crude protein (9.69%), fatty substances (0.15%), ash (SiO_2 free) (10.80%), crude fibre (33.90%), Nitrogen free extract (42.21%), glucose (1.16%), sucrose (0.18%), pectin (5.30%) and theobromine (0.20%). The processed cocoa pod husks have been reported to have low theobromine content. The crude fibre is easily digestible. It is reported that cocoa pod husk is digestible by all classes of livestock, especially ruminants. However, the high crude fibre content (21.49-34.82%) hinders its effective utilization by monogastrics (Abiola and Tewe, 1991). The constraint of high fibre content and associated poor digestibility calls for the processing of the cocoa pod husks by various methods (fermentation, hot-water treatment, urea, enzyme, fungal treatment and microbial detheobromination), so as to promote digestibility and biodegradability in animals. Furthermore, some research studies with cocoa by-products have shown that at higher levels of dietary inclusion; the alkaloids (theobromine and caffeine) have adverse effects on the reproductive potential of animals (Adomako et al., 1999). According to Ozung et al. (2019), these alkaloids have been reported to penetrate the placenta and blood vessels, thereby causing foetal abnormality. Therefore, this study was designed to determine the effect of different forms of cocoa pod husk meal on the reproductive performance of rabbits.

MATERIAL AND METHODS

Study location

The study was carried out at the Rabbitry Unit of the Teaching and Research Farm, University of Calabar, Calabar, Cross River State, Nigeria, West Africa. According to the GeoNames geographical database Google Earth-2021; Calabar is located at 4.9517^0 latitude and 8.322^0 longitude (in decimal degrees) with an average elevation/ altitude of 42 metres. Other workers, Akpan et al. (2006) reported that Calabar is located at latitude 3^0N of the equator and longitude 7^0E of the Greenwich meridian, with a land mass of 233.2 sq. miles (604 km^2). The annual rainfall ranges between 3000 and 3500mm (average of 1,830 mm) per annum and the average daily temperature is 25^0 C/77^0 F which increases to 30^0 C (86^0 F) in August. The relative humidity is between 70 and 80%.

Collection and handling of cocoa pod husk meal (CPHM)

Freshly broken composite and discarded cocoa pod husks were obtained from the fermentation units of cocoa plantations at the rainforest zone of Etomi, Ikom, Cross River State, Nigeria. The pods were collected during the main production season in West Africa (September – March). The broken pods were washed and sun - dried to constant weight, bulked and milled with hammer mill (Model 912, Winona Attrition Mill Co., Winona, MN) to produce cocoa pod husk meal (CPHM). The resultant meal was shared into three (3) portions: The raw CPHM (RCPHM), Fermented CPHM (FCPHM) and hot-water treated CPHM (HCPHM), respectively. CPHM for the fermented treatment was thoroughly mixed with 60% water, relative to its weight as ascertained by Bello et al. (2015) and bagged in an air tight polythene bag. This was allowed to stay for three days under room temperature, thereafter, it was opened and shade dried to constant weight; before being packed, bagged and stored in a cool dry place until it was used for diet formulation. The final portion of CPHM was treated with hot-water that was boiled to 100^0 C for 15 minutes (Adeyina et al., 2010) which was later drained, shade dried and stored for later use in feed formulation.

Experimental diets

Twelve iso-nitrogenous (16.05% CP) and iso–caloric (2500.12 Kcal kg^{-1}ME) diets were formulated in line with the nutrient needs of rabbits recommended by Aduku and Olukosi (1990). Each treated form of CPHM was included at 0, 12.5, 25 and 37.5% levels for T_1, T_2, T_3, and T_4 (Raw CPHM), T_5, T_6, T_7, T_8 (Fermented CPHM) and T_9, T_{10}, T_{11}, T_{12} (Hot – water treated CPHM), respectively in the experimental diets. Diet without CPHM (0%) served as control in the experiment.

Experimental rabbits and management

A total of 60 weaned mixed breed rabbits between 5 and 6 weeks old of both sexes (30 bucks and 30 does) (mating ratio of male: female was 1:1), (mean initial body weight of 606.42±1.30 g) were used in this study. The rabbits were purchased from Domino farms, Useh-Offot in Uyo, Akwa Ibom State, Nigeria. They were managed based on standard experimental protocols. On arrival at the rabbitry facility, the animals were provided with anti–stress vitalyte at 0.5 g per 75 litres of chlorine - free water. The experimental animals were housed individually in double tier wooden hutches (with wire mesh floor) measuring 65 × 65 × 65 cm (L × H × W) and raised 25cm from the ground and placed in a standard rabbitry with half walls to allow for cross ventilation.

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Concrete drinking troughs and fabricated feeding troughs were provided in each cage. The rabbits adjusted for two weeks before the actual commencement of the feeding trial and within this period; they were placed on commercial pelleted grower mash and screened against ecto and endo parasites via subcutaneous injection of Ivermectin (Kepromec) at the recommended level (0.2 ml per rabbit). Thereafter, the animals were subjected to 21 weeks feeding trial and at maturity (5 months), they were crossed for reproductive performance evaluation.

Animal welfare and ethical approval

In this study, ethical approval on Animal Welfare and Rights was obtained from the University of Calabar Committee on Animal Care and Welfare based on the Australian Code for the Care and Use of Animals for Scientific Purposes, 8th Edition (National Health and Medical Research Council; Canberra 2013).

Experimental design

The rabbits were randomly distributed to the diets in a simple Completely Randomized Design (CRD) experiment with three processed forms of CPHM. They were twelve (12) dietary treatments with five (5) rabbits per treatment. The rabbits were distributed to the treatments after equalizing for body weight and sex.

Reproductive performance and gonadal sperm reserves

During mating, a buck and doe in a particular treatment/diet were kept together (paired) until successful mating was observed to ensure that pregnancy is achieved. The mating ratio of 1:1 (buck: doe) was maintained throughout the duration of this study. Successful mating took place when the buck summersaulted and screamed, after which they were separated. Pregnancy was diagnosed after 14 days by combining abdominal palpation with observation of body weight changes (size and weight of does) (Oguike et al., 2011). Kindling boxes were provided at the 3rd week of gestation. The following reproductive parameters were determined for the does: pregnancy rate, litter size, average birth weight, average weaning weight (at 6 weeks) and mortality. Milk yield (g^{-1}day) was estimated from the equation reported by Nguyen et al. (2000) as 1.18 × [live weight of litter at 21days - live weight at birth]. Reproductive parameters determined in bucks included: weights of testes and epididymes (caput, corpus and cauda). Gonadal sperm reserves were determined haemocytometrically by homogenate technique, using a modified method as described by Adejumo (2006). Daily sperm production (DSP) was obtained by dividing Gonadal sperm reserve by 3.56 (time in days of the duration of the seminiferous epithelium cycle) while total sperm reserve was calculated by multiplying semen volume by the concentration (Bitto and Egbunike, 2006; Zahraddeen et al., 2007).

Statistical analysis

Data obtained in this study were subjected to one–way ANOVA using General Linear Model for a completely randomized design (CRD). Significant means were separated using the Least Significance Difference (LSD) method (Steel and Torrie, 1980).

The experimental model used was as follows: $Y_{ij} = \mu + T_i + E_{ij}$

Where:

Y_{ij}: Observed value; μ: Overall mean value; T_i: Random effect of the i^{th} processing method of CPHM; and E_{ij}: Random residual error

RESULTS

Reproductive performance characteristics of rabbits

The reproductive performance of rabbits fed cocoa pod husk meal-based diets is summarized in Table 1. The pregnancy rate ranges from 0 - 100%. The highest inclusion level of CPHM (37.5%) recorded zero pregnancy rates in the raw and hot – water treated cocoa pod husk meal. The average gestation period ranged between 30 and 31 days across the dietary treatments. The average litter size at birth ranged from 1-4 kittens. Results further revealed that the average birth weight per kitten decreased marginally (< 2%) across dietary treatments as the levels of CPHM increased in the diets; values for kittens fed the raw CPHM were 27.85, 26.47, 25.48 and 0.00 g for 0, 12.50, 25.00 and 37.50% inclusion levels, respectively. While the fermented and hot-water treated CPHM recorded 30.51, 31.22, 29.27 and 27.17g, respectively and 30.01, 28.12, 27.98 and 0.00 g for 0, 12.50, 25.00 and 37.50 percent inclusion levels, respectively. The average weaning weight ranged between 475.00 and 580.25g across dietary treatments, with the least weight recorded in the raw CPHM group with 25.00 % inclusion level. The average weight of kittens at 21 days decreased across dietary treatments in the raw CPHM, that is; 225.25, 220.40, 200.00 and 0.00 g respectively, for diets with 0, 12.50, 25.00 and 37.50 % levels. The trend was reversed in the other processed forms of CPHM with average weight values of 212.50, 220.00, 240.00 and 250.00g for 0, 12.50, 25.00 and 37.50 % levels and 225.00, 240.00, 245.00 g for diets with 0, 12.50, 25.00 % levels, respectively with no value in 37.50%. The milk yield ranged between 205.46 and 262.94g across dietary treatments. The mortality of kittens ranged from 0.00 - 25.00%.

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Table 1 - Reproductive performance of rabbits fed cocoa pod husk meal (CPHM) based diets

Parameter	Raw CPHM				Fermented CPHM				Hot-water treated CPHM				
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	
	0%	12.50%	25.00%	37.50%	0%	12.50%	25.00%	37.50%	0%	12.50%	25.00%	37.50%	SEM
No. of Does bred	2.00	3.00	3.00	3.00	3.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	0.11
Pregnant does (day 14)	2.00	3.00	1.00	0	3.00	1.00	1.00	2.00	2.00	1.00	1.00	0	0.29
Pregnancy rate (%)	100.00	100.00	33.33	0	100.00	50.00	33.33	66.67	66.67	33.33	33.33	0	10.36
Av. Gestation length (days)	30.50	30.50	31.00	0	30.33	30.00	31.00	30.00	30.50	30.00	30.50	0	3.43
Av. Litter size at birth	4.00	3.33	1.00	0	3.00	1.00	3.00	3.50	2.00	4.00	2.00	0	0.42
Av. Birth weight (g)	27.85	26.47	25.48	0	30.51	31.22	29.27	27.17	30.01	28.12	27.98	0	3.23
Av. Wt. of kittens (g) at	225.25	220.40	200.00	0	212.50	220.00	240.00	250.00	225.00	240.00	245.00	0	25.96
21 days													
No. alive at weaning	3.00	8.00	1.00	0	9.00	1.00	3.00	2.00	4.00	4.00	2.00	0	0.83
6 weeks													
Av. Weaning wt. (g)	520.00	480.00	475.00	0	580.25	570.20	566.67	560.10	512.50	510.00	520.00	0	60.38
Milk yield (g)	232.93	228.84	205.93	0	214.75	222.76	205.46	262.94	230.09	250.02	256.08	0	26.51
Mortality (%)	25.00	20.00	0	0	0	0	0	0	0	0	0	0	2.55

*Milk yield = 1.18 x [Live wt. of litter at 21 days - Live wt. at birth], equation reported by Nguyen et al. (2000)

Table 2 - Semen volume and gonadal sperm reserve characteristics of rabbit bucks fed cocoa pod husk meal based diets

Parameter	T_1 0%	T_2 12.50%	T_3 25.00%	T_4 37.50%	T_5 0%	T_6 12.50%	T_7 25.00%	T_8 37.50%	T_9 0%	T_{10} 12.50%	T_{11} 25.00%	T_{12} 37.50%	SEM
Semen volume (ml)	0.87^{a}	0.53^{c}	0.50^{c}	0.47^{c}	0.67^{b}	0.57^{c}	0.43^{c}	0.47^{c}	0.57^{c}	0.47^{c}	0.37^{d}	0.33^{d}	0.08
Gonadal sperm reserve ($\times 10^6$ ml^{-1})	611.00^{a}	575.67^{b}	510.67^{c}	498.00^{c}	520.33^{b}	558.00^{b}	401.33^{d}	369.00^{e}	313.00^{e}	390.33^{d}	377.00^{d}	366.00^{e}	19.91
Total sperm reserve ($\times 10^6$ ml^{-1})	531.57	305.11	255.34	234.06	348.62	318.06	172.57	173.43	178.41	183.46	139.49	120.78	33.43
Daily Sperm Production ($\times 10^6$ ml^{-1})	171.63	161.71	143.45	139.89	146.16	156.74	112.73	103.65	87.92	109.64	105.90	102.81	8.02

$^{a,b,c...e}$ means on the same row with different superscripts are significantly different ($P<0.05$); SEM: Standard Error of Mean

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Table 3 - Total protein concentrations in testicular and tubal fluids of rabbits fed Cocoa pod husk meal-based diets

Parameter	Raw CPHM				Fermented CPHM				Hot- water treated CPHM				
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	
	0%	12.50%	25.00%	37.50%	0%	12.50%	25.00%	37.50%	0%	12.50%	25.00%	37.50%	SEM
Bucks (g per 100 ml)													
Testes	0.73 ^{c}	0.76^{c}	0.82 ^{b}	0.54^{d}	1.39 ^{a}	1.38^{a}	1.04 ^{b}	0.83^{b}	0.74 ^{c}	0.63^{c}	0.65^{c}	0.72^{c}	0.08
Epididymis	0.89^{a}	0.64^{c}	0.53^{d}	0.32^{e}	0.76^{b}	0.64^{c}	0.70^{b}	0.72^{b}	0.68^{b}	0.58^{d}	0.56 ^{d}	0.34^{e}	0.05
Paired caput	0.55^{c}	0.61^{c}	0.48^{c}	0.51^{c}	1.05^{a}	1.14^{a}	0.80^{b}	0.73^{b}	0.30^{d}	0.26 ^{d}	0.27 ^{d}	0.90^{b}	0.09
Paired corpus	0.72^{c}	0.78^{c}	0.37^{d}	0.40 ^{d}	0.96^{b}	0.95^{b}	1.10^{a}	0.55^{d}	0.56^{d}	0.49^{d}	0.43 ^{d}	0.42 ^{d}	0.07
Paired cauda	0.85^{a}	0.71^{b}	0.83^{a}	0.29 ^{d}	0.88 ^{a}	0.90^{a}	0.34 ^{d}	0.39^{d}	0.43 ^{c}	0.73^{b}	0.47^{c}	0.48 ^{c}	0.07
Does (g per 100 ml)													
Ovary	0.50	0.48	0.42	0.28	2.17	1.52	0.46	0.43	0.61	0.60	0.59	0.55	0.16
Oviduct	1.04^{c}	1.01^{b}	0.68^{d}	0.60 ^{d}	0.91^{c}	0.73^{c}	0.56^{d}	0.58 ^{d}	1.72^{a}	1.71 ^{a}	1.25^{b}	1.27^{b}	0.12
Uterine horns	0.60	0.58	0.55	0.49	0.52	0.70	0.69	0.50	0.61	0.59	0.64	0.88	0.03
Cervix	0.29	0.22	0.37	0.27	0.63	0.69	0.72	0.59	0.95	0.83	0.83	0.85	0.07
Vagina	0.78	0.81	0.52	0.39	1.10	0.72	0.12	0.15	0.57	0.54	0.63	0.71	0.08

$^{a, b,c,d}$ Means on the same row with different superscripts are significantly different ($p < 0.05$)

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Semen volume and gonadal sperm reserves of rabbit bucks

Table 2 shows the result of sperm volume and gonadal sperm reserve characteristics of rabbit bucks fed cocoa pod husk meal-based diets. The sperm volume (SV) and gonadal sperm reserve (GSR) recorded significant effect ($P<0.05$) of dietary treatments; while results for total sperm reserve (TSR) and daily sperm production (DSP) were statistically similar. In the raw and hot-water treated cocoa pod husk meal groups, the sperm volume decreased marginally as the level of inclusion of cocoa pod husk meal increased across the diets. The values obtained for SV were 0.87, 0.53, 0.50 and 0.47ml in the raw cocoa pod husk meal group; while the fermented and hot – water treated cocoa pod husk meal groups recorded SV values of 0.67, 0.57, 0.43, 0.47ml and 0.57, 0.47, 0.37 and 0.33ml, respectively for control, 12.50, 25.00 and 37.50 % diets. Results obtained for the GSR were 611.00, 575.67, 510.67 and 498.00 ($\times 10^6$ ml^{-1}) in the raw cocoa pod husk meal; 520.33, 558.00, 401.33 and 369.00 ($\times 10^6$ ml^{-1}) in the fermented cocoa pod husk meal and 313.00, 390.33, 377.00 and 366.00 ($\times 10^6$ ml^{-1}) in the hot-water treated cocoa pod husk meal, respectively for diets 0, 12.50, 25.00 and 37.50 % inclusion levels. Results for TSR were 531.57, 305.11, 255.34 and 234.06 ($\times 10^6$ ml^{-1}) in raw cocoa pod husk meal; 348.62, 318.06, 172.57 and 173.43 ($\times 10^6$ ml^{-1}) in fermented cocoa pod husk meal; 178.41, 183.46, 139.49 and 120.78 ($\times 10^6$ ml^{-1}) in hot – water treated cocoa pod husk meal, respectively for 0, 12.50, 25.00 and 37.50 % inclusion levels. The values obtained for the DSP were 171.63, 161.71, 143.45 and 139.89 ($\times 10^6$ ml^{-1}) in raw cocoa pod husk meal; 146.16, 156.74, 112.73 and 103.65 ($\times 10^6$ ml^{-1}) in fermented cocoa pod husk meal; as well as 87.92, 109.64, 105.90 and 102.81 ($\times 10^6$ ml^{-1}) in hot-water treated cocoa pod husk meal, respectively for diets containing 0, 12.50, 25.00 and 37.50 % inclusion levels.

Total protein concentrations in testicular and tubal fluids of rabbits

Result of the total protein concentrations in testicular and tubal fluids of rabbits fed experimental diets is summarized in Table 3. All parameters in the bucks were significantly different between dietary groups. The protein concentrations in the testes recorded higher values in the control diets across the three processing methods and the least values in the 37.50% inclusion level in the raw and fermented CPHM groups. Total protein concentrations in the testes were 0.73, 0.76, 0.82 and 0.54g 100^{-1}ml; 1.39, 1.38, 1.04 and 0.83g 100^{-1}ml as well as 0.74, 0.63, 0.65 and 0.72g 100^{-1}ml in diets containing 0, 12.50, 25.00 and 37.50% levels, respectively for the raw, fermented and hot-water treated CPHM. The epididymis recorded total protein concentrations as 0.89, 0.64, 0.53 and 0.32g 100^{-1}ml; 0.76, 0.64, 0.70 and 0.72g 100^{-1}ml as well as 0.68, 0.58, 0.56 and 0.34g 100^{-1}ml for 0, 12.50, 25.00 and 37.50% levels, respectively in the raw, fermented and hot-water treated CPHM. Total protein concentrations in paired caput, corpus and cauda epididymis recorded fluctuating trends across dietary treatments as the levels of CPHM increased. In the tubal fluids, the total protein concentrations recorded in the ovary decreased as the inclusion of CPHM increased in the differently processed forms of dietary treatments. Values obtained were 0.50, 0.48, 0.42 and 0.28g 100^{-1}ml in the raw CPHM; 2.17, 1.52, 0.46 and 0.43g $100ml^{-1}$ in the fermented CPHM as well as 0.61, 0.60, 0.59 and 0.55g 100^{-1}ml in the hot-water treated CPHM for diets containing 0, 12.50, 25.00 and 37.50% inclusion levels, respectively. Total protein concentrations in the oviduct recorded significant effect ($P<0.05$) while the uterine horns, cervix and vagina were statistically similar and did not record particular trends among the processing methods. However, higher values were recorded in the fermented and hot-water groups compared to the raw CPHM group.

DISCUSSION

Reproductive performance of rabbits

The reproductive performance of different rabbit breeds has been reported to be an important feature that determines their efficiency in production (Fadare and Fatoba, 2018). The reproductive performance of rabbits fed cocoa pod husk meal based diets (Table 1) revealed an average pregnancy rate that dropped from 100 to 33.33% in both raw and fermented cocoa pod husk meal groups as well as 66.67 to 33.33% in hot-water treated cocoa pod husk meal group as the levels of inclusion increased up to 25.00% level across dietary treatments. The highest level of inclusion (37.50%) of cocoa pod husk meal in the raw and hot-water treated groups recorded zero pregnancy rate, while the fermented group recorded 66.67%. The pregnancy rate obtained in this study ranges from 0.00 –100%, while Ewuola and Egbunike (2010) reported 87.50-100% who fed fumonisin B_1 to male rabbits. The difference could be attributed to the age at puberty and effect of diet on the two separate studies. The litter size at birth, weight of kittens and weaning weight followed the same trend recorded for pregnancy rates in this study.

The average litter size at birth in the experimental rabbits was from 1 to 4 kittens across dietary treatments in all the processed forms of cocoa pod husk meal (CPHM). The raw CPHM group showed a regular declining trend, while the fermented and hot-water treated groups fluctuated as the levels of inclusion increased. The declining trend in reproductive performance characteristics has revealed that cocoa pod husk meal has adverse effects on the reproductive performance of rabbits. This assertion confirms the findings of EPSA (2008) on contaminants in the food chain that theobromine induces reproductive problem affecting the gonads, delayed ossifications in mice and skeletal variations in kittens of rabbits. Furthermore, the average litter size at birth recorded in this study fell below the average value (4.27-5.33) reported for New Zealand and Dutch rabbits (Akanno et al., 2004; Oseni et al., 2006) and (6.50-7.25) in cross bred rabbits reported by Ewuola and Egbunike (2010) as well as (4.23 – 6.75) reported by Fadare and Fatoba (2018) for New Zealand White, California and Palomino brown rabbits. This difference in litter size is attributable to breed or strain influence, age

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at first parity (young female rabbits tend to have smaller litter than older dams), quality of feed, re – mating interval, environmental conditions and other management practices. This agrees with the findings of Fielding (1991) and Olateju and Chineke (2022) that litter size at birth is affected by genetic composition of the doe among other factors. Experimental findings by other workers show that the New Zealand breed recorded a higher mean litter size at birth (5.03) than the Dutch breed (4.67); (Omole et al., 2007). The control diets in this study had an average litter size at birth of 2 to 4 kittens, this range was closed to the average value (4.77) reported by Fayeye and Ayorinde (2003) for the New Zealand breed in the derived savanna zone. Also, a value of 5.33 for the same trait in California and Havana black rabbits has been reported in the humid tropical region of Nigeria (Fadare and Fatoba, 2018). Other workers have reported average litter size at birth of 6 and 7 kittens for the Japanese white and New Zealand white rabbits, respectively; with an average litter size of 8 kittens (Casady et al., 1996) as well as 6-8 kittens (Henry et al. 2018). The average gestation length observed in this study was between 30 and 31 days across dietary treatments. This fell within the normal gestation length (30 ±2 days) for rabbits (Aduku and Olukosi, 1990, Omole et al., 2007, Ozung et al., 2019). The normal gestation length recorded in this study suggests low neonatal loss that usually accompanies longer gestation periods. This is confirmed in the low mortality of kittens (20-25%) in the raw CPHM group and absence of mortality in the fermented and hot-water treated groups in this study. The finding confirms the submission of previous works that small litters are associated with long gestation period (33-34 days) accompanied by high mortality of kittens. The workers had suggested the use of prostaglandin $F_2\alpha$ as a cost-effective means of reducing the observed mortality in pregnant does having longer gestation periods. A correlation between gestation length and litter size has been suggested (Fayeye and Ayorinde, 2003).

The average birth weight of kittens obtained in this study declined as the CPHM increased in the dietary treatments; implying cocoa pod husk meal with the associated theobromine has an adverse effect on the birth weight of rabbit kittens. The values for the raw CPHM group were between 25.48 and 27.85g kitten^{-1}; while values in the fermented and hot–water treated groups were 27.17 and 31.22g kitten^{-1}; 27.98 and 30.01g kitten^{-1}, respectively. However, these values were within the range (15–30g kitten^{-1}) for birth weight reported by Omole et al. (2007). The average weaning weight of kittens at six weeks when compared to the values in the control diets decreased marginally across dietary treatments as the levels of CPHM increased in the raw, fermented and hot–water treated groups. The weaning weight was highest in the fermented CPHM, higher in the hot–water treated CPHM and high in the raw CPHM groups. The results have confirmed that fermentation and hot–water treatment of CPHM lower the theobromine content, which translates to better weaning weight compared to the raw CPHM with higher theobromine content and lower weaning weight. Theobromine has been reported to have negative effects on the reproductive parameters of rabbits (EFSA, 2008). The litter size recorded in this study did not adversely influence the weaning weight of kittens. This corroborates the report by Orunmuyi et al. (2006) that litter size at birth does not exert significant effect on weaning weight of animals. However, the mothering ability of the female rabbit (doe) decreases with increased litter size (Fayeye and Ayorinde, 2003). The milk yield of lactating does in this study ranges from 205.46-256.08g. The milk yield is a good indicator of the mothering ability of rabbit does. However, the milking ability is breed dependent with the Californian white reported to have the best milking ability compared to other breeds like the New Zealand white, Havana black, Palomino brown and Chinchilla (Fadare and Fatoba, 2018).

Semen volume and gonadal sperm reserve characteristics of rabbit bucks

The semen volume (SV) and gonadal sperm reserve (GSR) in this study had significant reduction in values with increasing levels of CPHM across treatments (Table 2). Both parameters recorded lowest values at the highest inclusion level (37.50%) of each processed form (raw, fermented and hot–water treated) of CPHM. Total sperm reserve (TSR) and daily sperm production (DSP) were statistically similar across dietary treatments, but showed gradual decline in values as the levels of CPHM inclusion increased. These observations affirmed that residual theobromine from differently processed forms of cocoa pod husk meal (especially the raw form and followed by the hot-water treated form) has deleterious effects on gonads (testes) and associated physiological processes like spermatogenesis. This observation agrees with the findings of EFSA (2008) that theobromine from cocoa products induces reproductive dysfunction targeting the gonads (testes) in rodents and dogs. However, the semen volume in the control diet for raw, fermented and hot-water treated CPHM was comparable to range of values (0.73-0.74ml) earlier reported by Ewuola and Egbunike (2010). Equally, the SV and GSR were similar in values with those earlier given by Adams and Singh (1981). The GSR was also comparable with the values published by Castellini (2008); while the TSR values were fairly higher than those reported by Abu et al. (2013). Also, GSR and DSP were fairly higher than the values reported by Amao et al. (2011). Differences in TSR, GSR and DSP could be attributed to effect of nutrition/ diet (different test materials) and age of bucks in the separate studies.

Total protein concentrations in testicular and tubal fluids

Total protein concentrations in the testicular fluids of rabbit bucks fed cocoa pod husk meal (Table 3) revealed significant ($P<0.05$) effect of dietary treatments in the fluids from testes, epididymis, paired caput and paired corpus. The total protein concentrations in the tubular fluids of female rabbits (does) were statistically similar except for the Oviduct. The fermented CPHM group recorded higher total protein concentrations in both testicular and tubular fluids. The total protein concentrations in fluids from the testes were of the range 0.54 -0.82g per 100ml, 0.83–1.39g per 100 ml and 0.63–0.74g per 100 ml, respectively in the raw, fermented and hot-water treated cocoa pod husk meal diets. Total protein

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concentrations in the testes were least in value in the highest inclusion level (37.50%) of CPHM in the raw and fermented groups compared with the hot-water treated group. The fermented group recorded a gradual declining trend across dietary treatments as the levels of CPHM increased. The findings in this study affirmed that cocoa pod husk meal, especially the raw form with higher content of theobromine has negative effect on the total protein concentrations in the testes. This could lead to poor spermatogenesis, oligospermia and abnormal sperm cells in rabbit bucks. The total protein concentrations in the epididymis showed a marginal declining trend across dietary treatments in the raw CPHM (0.89–0.32g per 100 ml) and hot-water treated CPHM (0.68–0.34g per 100 ml), respectively while the fermented CPHM recorded a fluctuating trend that could not be ascribed to experimental diets. The total protein concentrations in the paired caput, corpus and cauda epididymis recorded fluctuating trends across dietary treatments. The testicular fluids total protein concentrations in this study are higher than the values for paired testes, paired caput, corpus and cauda epididymes reported by Bitto (2010) who fed kapok - forage combinations to rabbit bucks. These slight differences are obviously due to age (the bucks in this study were slightly older) and diet as different test ingredients were utilized in the separate studies.

The total protein concentrations in the tubal fluids of female rabbits recorded significant effect on the oviduct only, while fluids from the ovary, uterine horns, cervix and vagina showed statistically similar results in total protein concentrations. The range of values obtained in this study for fluids from the oviduct (0.56 –1.72g per 100 ml), uterine horns (0.49– 0.88g per 100 ml), cervix (0.22–0.95g per 100 ml) and vagina (0.12–1.10g per 100 ml) were fairly lower than the range of values for tubular fluids from the oviduct (0.97–1.81g per 100 ml), uterine horns (1.67–2.95g per 100 ml), cervix (0.76–0.99g per 100 ml) and vagina (0.52–1.19g per 100 ml) reported by Ozung et al. (2011) who fed varying dietary levels of cassava peel meal as replacement for maize to female rabbits. These differences in tubal fluid protein concentrations could be attributed to the effect of anti–nutrients in the diets, as it is obvious that theobromine in this study had severe adverse effects compared to cyanide in the earlier study in the total protein concentrations of tubal fluids.

CONCLUSION AND RECOMMENDATION

This study concluded that different forms of cocoa pod husk meal (CPHM) at 37.5% level of inclusion could negatively affect the reproductive performance of rabbits. The order of preference is the fermented CPHM, followed by the hot – water treated CPHM and lastly the raw CPHM, respectively. The fermented cocoa pod husk meal based diets performed best compared to other forms in terms of reproductive performance and semen characteristics as well as total protein concentrations in testicular fluids of bucks and tubal fluids of does. The study recommended that cocoa pod husk meal should be fermented before it can be incorporated in diets meant for rabbits. Hence, fermentation is the preferred method of detheobromination. The optimum level of inclusion of fermented CPHM could be up to 37.5% in the diets. Farmers using raw and hot – water treated CPHM should not exceed 25% inclusion level for fear of adverse effects of residual theobromine on reproductive performance of rabbits and semen characteristics of bucks.

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Authors' contribution

P.O. Ozung and E.I. Evans: Conceptualization, laboratory investigation, sampling, research methodology and writing of original draft; K.U. Anoh and J.A. Ubua: Feeding trial, data collection as well as statistical analysis and table presentations; O.O.O. Kennedy and D.A. Alawa: Conceptualization, literature review, editing of manuscript and confirmation of all references.

Conflict of interests

The authors hereby declare that there is no conflict of interests in this research work.

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REFERENCES

Abiola SS, and Tewe OO (1991). Chemical evaluation of cocoa by – products. Tropical Agriculture, 68: 335–336. https://agris.fao.org/agris-search/search.do?recordID=XG19940093278

Abu AH, Ahemen T and Ikpechukwu P (2013). The testicular morphometry and sperm quality of rabbit bucks fed graded levels of *Moringa oleifera* leaf meal (MOLM). Agro search, 13 (1): 49–56. DOI: https://doi.org/10.4314/agrosh.v13i1.5

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Adams CE and Singh MM (1981). Semen characteristics and fertility of rabbits subjected to exhaustive use. Laboratory Animals 15: 157–161. DOI: https://doi.org/10.1258%2F002367781780958856

Adejumo DO (2006). Effects of supplemental cocoa husk on testicular characteristics of pigs. Nigerian Journal of Animal Production 33: 151–156. DOI: https://doi.org/10.51791/njap.v33i1.2226

Adeyina AO, Apata DF, Annongu AA, Olatunde OA, Alli OI, and Okukpe KM (2010). Performance and physiological response of weaner rabbits fed hot – water treated cocoa bean shell-based diets. Research Journal of Animal and Veterinary Science 5: 53–57. www.aensiweb.net/AENSIWEB/rjavs/rjavs/2010/53-57.pdf

Adomako D (1991). Processing of cocoa pod husk into animal feed. Proceedings of the International Conference on Tree Crops, Owerri, Nigeria, March, Pp. 40 – 43.

Adomako, Osei-Amaning E and Asante EG (1999). Compounded animal feed based on cocoa pod husk. Tropical Science, 39: 120–123. https://agris.fao.org/agris-search/search.do?recordID=US201302908530

Aduku AO and Olukosi JO (1990). Rabbit Management in the Tropics: production, processing, utilization, marketing, economics, practical training, research and prospects Living Books GU Publication, Abuja, FCT, 150Pp.

Akanbi OM (2019). Performance and health implication of feeding Fungi treated cocoa pod husk meal on broiler. Bulletin of the National Research Centre, 43(1):55. DOI: https://doi.org/10.1186/s42269-019-0097-7

Akanno EC, Ibe SN and Ogundu UE (2004). Reproductive and pre- weaning litter performance of different genotypes of locally adapted rabbit breeds. In: Ariyo, O.J., Ikeobi, C. O. N., Ozoje, M. O., Omoniyi, I. T. and Kehinde, O. B. (eds.). Genetics and Improvement in the Quality of life. Proceedings of the 29th Annual Conference of the Genetics Society of Nigeria, University of Agriculture, Abeokuta, October 11–14, 2004, Pp. 10–106. Google Scholar

Akpan ER, Offem JO and Nya AE (2006). Baseline ecological studies of the great Qua River, Nigeria 'Physico-chemical studies' Eco serve, retrieved 21 July 2021. Google Scholar

Bello KO, Bode-Kaseem TS, Lala AO, Oladele SO, Irekhore O, Ilori B (2015). Selected welfare parameters of broiler chickens on different feed quantity and time. Journal of Agricultural Science and Environment, 15(2): 57-67. DOI: https://doi.org/10.51406/jagse.v15i2.1976

Bitto II (1989). Seasonal changes in the physiological and reproductive responses of the West African Dwarf bucks in Ibadan. Ph.D. Thesis, Department of Animal Science, University of Ibadan, Ibadan, Nigeria. Google Scholar

Bitto II (2010). Protein concentrations of testicular spermatozoa and fluids during sperm maturation in male rabbits fed concentrate to kapok (Ceiba pentandra) forage combinations. Proceedings of the 15th Annual Conference of Animal Science Association of Nigeria (ASAN), 13th – 15th September, held at the University of Uyo, Nigeria. Pp. 206– 208.

Bitto II and Egbunike GN (2006). Seasonal variations in sperm production, gonadal and extra gonadal reserves in pubertal WAD bucks in their native tropical environment. Livestock Research for Rural Development, 18: Article #134 http://www.lrrd.org/lrrd18/9/bitt18134.htm

Casady RB, Sawin PB and Vendan J (1996). Commercial Rabbit Raising, USDA Handbook Number 309, Washington, D.C.

Castellini C (2008). Semen production and management of rabbit bucks. Proceedings of the 9th World Rabbit Congress June 10 – 13, Verona, Italy, Pp. 265–278. http://www.cuniculture.info/Docs/Magazine/Magazine2008/FiguresMag2008/Congres-2008-Verone/Papers/R0-Castellini.pdf

EFSA (2008). European Food Safety Authority. Scientific Opinion of the Panel on contaminants in the food chain on a request from the European Commission on theobromine as undesirable substance in animal feed. The EFSA Journal, 725: 1-66. DOI: https://doi.org/10.2903/j.efsa.2008.725

Ewuola EO and Egbunike GN (2010). Effects of dietary fumonisin B_1 on the onset of puberty, semen quality, fertility rates and testicular morphology in male rabbits. Reproduction, 139: 439 – 445. https://pubmed.ncbi.nlm.nih.gov/19917669/

Fadare AO and Fatoba JJ (2018). Reproductive performance of four breeds of rabbits in the humid tropics. Livestock Research for Rural Development, 30: Article #114. http://www.lrrd.org/lrrd30/7/delod30114.html

FAO (2010). Food and Agriculture Organization of the United Nations, Rome. The State of Food Insecurity in the World 2010, Addressing Food insecurity in protracted crises. www.fao.org/docrep/013/i1683e/i1683e00.htm , retrieved 14 February 2022.

FAO (2011). The State of Food Insecurity in the World 2011, How does international price volatility affect domestic economies and food security? Food and Agriculture Organization of the United Nations, Rome. www.fao.org/docrep/014/i2330e/i2330e00.htm

Fayeye TR and Ayorinde KL (2003). Correlations between some weaning traits in domestic rabbits in Nigeria. Nigerian Journal of Genetics, 18: 63–67. DOI: https://doi.org/10.4314/njg.v18i1.42293

Fielding D (1991). Rabbits. The Tropical Agriculturist, CTA Netherlands, Macmillan Publishers, 103pp. https://www.cabdirect.org/cabdirect/abstract/19920196773

Gbenge AA (2022). Nutrient digestibility of rabbits fed yam-cassava peel composite meal as replacement for maize. Nigerian Journal of Animal Science and Technology 5(1): 10 – 20. http://njast.com.ng/index.php/home/article/view/182

Halberg N and Muller A (2013). Organic Agriculture for Sustainable Livelihoods. Taylor and Francis Group, Routledge Publishers, Milton Park, Abingdon, Pp. 280. Google Scholar

Henry AJ, Udie GU, Ozung PO and Anya MI (2018). Hormonal assay and reproductive performance of rabbits fed pawpaw (*Carica papaya*) leaves as feed supplement. Annual Research and Review in Biology 25(3): 1–9. https://journalarrb.com/index.php/ARRB/article/view/25086

Mutsami C, Mburu J, Wanyoike M. and Ochieng S (2019). The rabbit value chain in Kenya: A framework for food policy and research. Livestock Research for Rural Development, 31: Article #71. http://www.lrrd.org/lrrd31/5/ckhal31071.html

Citation: Ozung PO, Anoh KU, Alawa DA, Evans EI, Kennedy OOO and Ubua JA (2022). Effect of dietary supplemented cocoa pod husk meal on the reproductive performance of rabbits. *Online J. Anim. Feed Res.*, 12(4): 200-209. DOI: https://dx.doi.org/10.51227/ojafr.2022.27

National Health and Medical Research Council; Canberra (2013). Australian Code for the Care and Use of Animals for Scientific Purposes, 8th Edition, Ref. No. N55. https://www.nhmrc.gov.au/about-us/publications/australian-code-care-and-use-animals-scientific-purposes

Nguyen QS, Ly TL and Dinh B (2000). Feeding systems for tropical rabbit production emphasizing root and bananas in the Workshop 'making better use of local feed resources' SAREE UAF, January, 2000, Vietnam. https://agris.fao.org/agris-search/search.do?recordID=XF9325341

Oddoye EOK, Rhule SWA, Agyente – Badu AV and Owusu Ansah F (2010). Fresh cocoa pod husk as an ingredient in the diets of growing pigs. Scientific Research and Essays, 5 (10): 1141–1144. https://academicjournals.org/article/article1380626448_Oddoye%20et%20al.pdf

Oguike MA, Igwe CO, Odika IE and Onyekweodiri EO (2011). Effect of *Aspilia africana* leaves on the reproductive potentials of rabbit bucks. Proceedings of the British Society of Animal Science and the Association of Veterinary Teaching and Research Work, Cambridge University Press, April. P. 179.

Olateju IS, and Chineke CA (2022). Effects of genotype, gestation length and litter size on the birth weight, litter weight, pre- and post-weaning weight of crossbred kits. Bulletin of the National Research Centre, 46: 166. DOI: https://doi.org/10.1186/s42269-022-00843-8

Olubamiwa O. and Akinwale TO (2000). Partial placement of maize with cocoa husk meals in layers' mash: An on – farm experience. The Journal of Food Technology in Africa, 5: 62 – 63. https://www.ajol.info/index.php/jfta/article/view/19260

Omole AJ, Ajasin FO, Oluokun JA and Tiamiyu AK (2007). Rabbit Farming without tears. Back to Agric. Series (7). Green Choice Agric. Publications, MAC – B Ventures, Ibadan, Nigeria, Pp. 41. Google Scholar

Orunmuyi M, Adeyinka IA, Ojo OA and Adeyinka FD (2006). Genetic parameter estimates for pre – weaning litter traits in rabbits. Pakistan Journal of Biological Sciences, 9 (15): 2909–2911. DOI: https://dx.doi.org/10.3923/pjbs.2006.2909.2911

Oseni SO, Odubote IK and Akinokun O (2006). Evaluation of purebred and crossbred rabbits for fertility and pre –weaning litter performance in the humid tropics. Proceeding of the 24th Annual Conference of the Nigerian Society for Animal Production (NSAP), held at the University of Ilorin, Kwara State, Nigeria, March 22–25, Pp. 186–188.

Ozung PO (2021). Temperature – Humidity Index (THI) of rabbits in a tropical environment as influenced by dietary cocoa pod husk meal. Sumerianz Journal of Agriculture and Veterinary, 4: 97-102. DOI: https://doi.org/10.47752/sjav.44.97.102

Ozung PO, Bitto II and Ikurior SA (2011). Carcass yield, gut morphology, reproductive tract morphometry and some biochemical characteristics of serum in female rabbits fed cassava peel meal-based diets. Continental Journal of Animal and Veterinary Research 3: 22–32. www.core.ac.uk and http://www.wiloludjournal.com

Ozung PO, Kennedy OOO, Ubua JA and Agiang EA (2019). Dietary cocoa pod husk meal could influence the reproductive tract morphometry of rabbits. East African Scholars Journal of Agriculture and Life Sciences, 2 (1): 26 - 30. https://www.easpublisher.com/get-articles/1549

Steel RGD and Torrie JH (1980). Principles and Procedures of Statistics. A Biometric Approach. 2nd edition, McGraw Hill Book Co. Inc. New York, USA. Pp. 481. Google Scholar

Zahraddeen D, Buswat ISR and Mbap ST (2007). Influence of collection period on semen characteristics of two breeds of rabbit (Oryctolagus cuniculus) raised in a tropical environment. Proceedings of the 32nd Annual Conference of Nigerian Society for Animal Production (NSAP), March 18 - 21, University of Calabar, Calabar, Nigeria. Pp. 69–72.

Citation: Ozung PO, Anoh KU, Alawa DA, Evans EI, Kennedy OOO and Ubua JA (2022). Effect of dietary supplemented cocoa pod husk meal on the reproductive performance of rabbits. *Online J. Anim. Feed Res.*, 12(4): 200-209. DOI: https://dx.doi.org/10.51227/ojafr.2022.27

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INCOME ANALYSIS ON BROILER CHICKEN FARMING IN PARTNERSHIP SYSTEM DURING THE COVID-19 PANDEMIC IN TANRALILI DISTRICT, INDONESIA

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ABSTRACT: This study was aimed to determine the income of farmers who carry out a partnership system during the COVID-19 Pandemic in Lekopancing Village, Tanralili District, Maros Regency. The research was conducted on March to April 2021. The type of research used is descriptive quantitative. The sample in this study were farmers who partnered with the X's company were 2 farmers, the Y's company were 12 farmers and the Z's company were 8 breeder. Data was collected through interviews with the help of a questionnaire as the research instrument. The results showed that the COVID-19 pandemic impacted to the incomes of farmers who partnered with companies X, Y, and Z, other than that it influence price fluctuations. The income earned by farmers with partnership patterns on a business scale of 3000 tail is the highest breeder who partners with PT. Z was USD 1,564.63 and USD 0.52/tail/period. As for the business scale of 4000, the highest is PT. Y of USD 2,285.97 and USD 0.76/tail/period.

Keywords: Agricultural management, Broiler chicken, Income, Partnership system, Poultry farming.

INTRODUCTION

The development of the broiler chicken business in Indonesia is relatively more advanced than in other livestock businesses (Coyne et al., 2019, 2020). Broiler chicken is one of the poultry commodities that contributes significantly to meeting the protein needs of animal origin for the people of Indonesia (Coyne et al., 2020). Broiler chickens have fast meat growth in a relatively short time and the genetic advantages of broiler chickens and good feeding can display optimal production performance (Wahyono and Utami, 2018; Baxter et al., 2021).

Investment opportunities in broiler agribusiness are enough to attract people to open a business. This can be seen from the population of broiler chickens which continues to increase yearly, and its contribution is quite broad in expanding employment opportunities. A partnership pattern is a form of cooperation between entrepreneurs and farmers in terms of managing the livestock business for a certain period to achieve mutual benefits. Plasma farmers who follow the partnership pattern are sufficient to provide cages, labor, equipment, electricity, and water, while seeds (DOC), feed and medicines, technical guidance, and marketing are provided by the core company (Riwukore and Habaora, 2020).

The COVID-19 pandemic began in early 2020 with the implementation of Large-Scale Social Restrictions, impacted all economic industries, including the broiler farming business. The results of research by Sain et al. (2021) stated that this pandemic affected broiler chicken farmers, disrupting the supply chain of seeds, feed, and medicines. Other impacts that farmers also feel are a decrease in income, a decrease in the population of livestock kept, a decrease in consumers, and an increase in production costs. Therefore, the sustainability of the meat farming business can be threatened given the decline in business productivity and farmer income.

The broiler chicken business's sustainability indirectly impacts both the company (core) and farmers (plasma). The purpose of income analysis is to describe the current situation and measure a business's succss (Budiraharjo and Handayani, 2008; Geo et al., 2020). Based on these facts, it has aroused interest in conducting further investigations on farmers' income with a partnership system during the COVID-19 pandemic in Lekopancing Village, Tanralili District, Maros Regency. The problem in this study is the income of farmers who carry out a partnership system during the COVID-19 Pandemic in Lekopancing Village, Tanralili District, Maros Regency.

This study aimed to determine the income of farmers who carried out a partnership system during the COVID-19 Pandemic in Lekopancing Village, Tanralili District, Maros Regency. The information from this research is expected to be useful as consideration for companies and farmers to increase income for companies and farmers, for farmers as information or consideration in running their business and as material for further research as well as reference material for researchers who will conduct the similar study at a later time.

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MATERIALS AND METHODS

Time and place

Research on income analysis in a partnership system broiler farming business during the COVID-19 pandemic (a case study of Lekopancing Village, Tanralili District, Maros Regency) was carried out in March-April 2021. This research was conducted in this area because it is one of the areas where many farmers keep broiler chickens and are affected by COVID-19.

Types of research

This type of research was quantitative descriptive, namely research that describes the condition of the variable, namely the income of farmers who collaborate with companies in Lekopancing Village, Tanralili District, Maros Regency.

Data types and sources

The type of data used in this study was quantitative data, namely data in the form of numbers that can be obtained based on the results of questionnaires from farmers or respondent information. The sources of data used in this study were as follows:

Primary data was obtained directly from the source without going through an intermediary. Primary data was data sourced from interviews with broiler farmers who have partnerships. This data includes data during the COVID-19 pandemic from May 2020-December 2020 (3 maintenance periods), respondent identities, and data on cost analysis used by farmers. Secondary data is obtained indirectly but through intermediaries (obtained and recorded by other parties). This data was in the form of records or archive reports that are published or not published. The data includes the general condition of the location, including a description of the location.

Method of collecting data

The process of collecting data in this study used field study techniques and literature studies. The field studies consisted of A) Observation was data collection which is done through direct observation of research locations and activities of broiler farmers with a partnership system in Lekopancing Village, Tanralili District, Maros Regency; B) Interviews were data collection which was conducted through direct interviews with broiler farmers with a partnership system in Lekopancing Village, Tanralili District, Maros Regency; C) Questionnaires or questionnaires were methods or techniques used by a researcher to collect data by distributing some sheets of paper containing questions that respondents must answer; E) Documentation is looking for data in the form of notes, reports, and tables, photos, and so on related to the object of research. In this study, the data obtained were photos with partnered farmers in Lekopancing Village, Tanralili District, Maros Regency.

Population and sample

The population was the farmers who have partnerships with the core company as many as 22 farmers are also the sample in this study (saturated sample). These 22 farmers were partnered with 3 core companies, namely X, Y, and Z companies. The distribution can be seen in Table 1.

Table 1 - Distribution of research samples

Scale enterprises	Company X	Company Y	Company Z	Amount
3,000 tails	1	4	4	9
4,000 tails	1	8	4	13

Data analysis

The data used in this research is a descriptive analysis to describe the production costs, revenues, and income obtained by broiler farmers in the partnership system in Lekopancing Village, Tanralili District, Maros Regency. The calculation of total costs, revenues, and income, according to Soekartaw (2002), are as follows:

Total Production Costs (TC) are composed of all expenses during the production process due to fixed and variable costs.

TC = TFC + TVC

Where

TC = Total Production Cost (*Total Cost*) (USD/Period); TFC = Total Fixed Cost (USD/Period); TVC = Total Variable Cost (USD/Period)

Revenue is the amount of revenue minus the total cost of production

$$TR = Q \times P$$

TR = Total Revenue (Total Revenue) (USD/Period; ; Q = Number of Products (Kg); P = Price/ Unit of Product (USD/Kg)

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Analysis of Revenue/Cost ratio (R/C)

$$\frac{R}{C} = \frac{Pq}{TFC - TVC}$$

R = Revenue; C = Cost; Pq = Price and Quantities; TVC = Total Variable Cost; TFC = Total Fixed Cost

RESULTS AND DISCUSSION

Income from broiler farming is the difference between revenue and total costs incurred. The income received by farmers is determined by the size of the costs used in the production process because production costs are one of the most important factors.

Production cost

Cost is the basis for determining prices because a price level that cannot cover costs will result in losses. Conversely, if a price level exceeds all costs, production, operating and non-operating costs will generate profits (Soekartawi, 2002). Production costs are classified into 2, namely fixed costs, which are types of costs incurred by farmers that do not depend on the size of the volume of production, for example, expenses of property tax, depreciation of cages, and depreciation of equipment. Meanwhile, variable costs vary according to the size of the production volume, such as DOC, feed, medicine, and operational costs (labor, electricity, husk, and LPG gas).

Fixed cost

Fixed costs are costs incurred for procuring components supporting the production process where these components can be used in several production processes (Joshua Olorunwa, 2018). For example, fixed costs on each farm of each company in Lekopancing Village, Tanralili District, can be seen in Table 2.

Table 2 - Fixed costs of broiler chicken business in Lekopancing village per period (USD)

No	Fixed Cost	Business Scale 3000			Business Scale 4000		
		PT.X	PT.Y	PT.Z	PT.X	PT.Y	PT.Z
1	Cage Shrinking	100.20	137.06	127.45	234.01	178.23	221.48
2	Equipment Depreciation	40.04	44.62	37.09	40.99	51.62	48.98
3	Land and Building Tax Cost	0.05	0.21	0.19	0.47	0.34	0.40
	Sub Total	140.29	181.89	164.73	275.47	230.19	270.86

Cage shrinking

The difference in the shrinkage of the cage in each scale is the difference in the area of the cage. For example, the average cage area on a scale of 3000 tails for X's company is 600 m^2, Y's company is 420 m^2 and Z's company is 340 m^2 while the average cage area is on a scale of 4000 tails for X's company is 720 m^2, Y's company is 710 m^2 and Z's company is 805 m^2. The number of depreciation costs of the cage depends on the costs incurred to make the cage. The wider or better the cage, the more costs incurred to make the cage. This is following the opinion of Kalangi et al. (2021), that the coops of partner farmers who cooperate with the company must meet company standards so that the chickens do not experience stress. The size of the cage area depends on the density of the kept livestock population.

The broiler chicken coop has the ideal size cage. There is even an ideal standard for broiler chicken coop sizes that will be kept in the tropics so that chicken growth remains good. In determining the size of the ideal broiler chicken coop, one must pay attention to the level of broiler population density based on age, namely one day – one week 40-50 birds per m^2, Age 2 weeks 20-25 birds per m^2, and Age more than 2 weeks 8-12 birds per m^2. More than this number, the temperature of the cage quickly increases, especially during the day at adult age which causes feed consumption to decrease, chickens tend to drink a lot, stress, stunted growth, and are susceptible to disease (Nadzir et al., 2015; Rahman et al., 2020).

The amount of equipment depreciation costs incurred by 3000 business-scale farmers are the highest at Y's company of USD 44,62 and the lowest is at Z's company USD 37,09 while the cost of equipment depreciation incurred by business-scale farmers of 4000 tails is the highest at Y's company USD 51,62 and the lowest is at X's company amounting to USD 40,99. The equipment used by farmers includes feeders, drinking containers, heaters, shovels, water dynamos, machetes, buckets, basins, and ropes. Equipment depreciation costs incurred by each breeder vary greatly, this is following the scale of the farmer's business, the price, and the number of tools used. This follows the opinion of Naradhipa et al. (2020) which states that the need for a place to feed and drink depends on the number of chickens kept and the age of the chickens. Tube-shaped feed container (diameter 38 cm) or a capacity of 5 kg, one tube feed content can be used for 30-35 chickens. The cost of depreciation of cage equipment is the same as the cost of depreciation of cages, the size of the depreciation cost of cage equipment that is borne each period is influenced by the scale of business.

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Variable cost

Variable costs, referred to as variable costs, are costs incurred for the procurement of supporting components during the production period, the size of which is influenced by the scale or amount of productionsed up in one production process (Kamruzzaman et al., 2021). The variables included in the costs incurred by farmers include DOC, feed, labor, medicine, electricity, gas, and husks. Variable costs on each company's farm in Lekopancing Village, Tanralili District can be seen in Table 3.

Table 3 - Average variable costs per period of business scale 3000 and 4000 tails (USD).

No.	Description	PT.X		PT.Y		PT.Z	
		Business Scale 3000	Business Scale 4000	Business Scale 3000	Business Scale 4000	Business Scale 3000	Business Scale 4000
1	Seeds	1,534.26	2,045.68	1,599.27	2,132.36	1,492.00	1,989.34
2	Feed	4,720.83	5,853.22	4,761.14	5,997.03	4,944.27	6,928.47
3	Labor	137.82	179.86	141.51	173.85	140.56	173.42
4	OVK	103.57	113.21	108.16	119.56	106.29	94.5
5	Electricity	23.84	19.50	24.11	24.24	20.37	29.6
6	Gas	56.34	49.84	42.26	73.35	47.95	75.85
7	Husk	18.64	31.96	25.46	53.88	26.82	40.74
	Sub Total	6,595.30	8,293.27	6,701.91	8,574.27	6,778.26	9,331.92

Seeds

The average cost of seeds for business scale 3000 the highest is at Y's company of USD 1,599.27 and the lowest at Z's company is USD 1,492.00. For Expenditures of the cost of seeds, the highest X's company occurred in the third period, was USD 1,560.27, for Y's company in the second period was USD 1,638.28, while for Z's company in the third period was USD 1,536.86. Likewise, for a business scale of 4000, the highest average cost of seeds is also at Y's company was USD 2,132.36 and the lowest at Z's company was USD 1,989.34. The difference in the cost of seeds is due to the difference in the price of seeds for each company and the cost of seeds incurred by the breeder and each company following the contract previously agreed by both parties. The cost of seeds (DOC) is a fairly large production cost in a broiler farming business with a portion between 10-16% of the total production cost (Sani et al., 2015; Kalangi et al., 2021). The size of the business scale can determine the level of income and profits of the actors involved in running it.

The availability of DOC is also one of the factors in determining the number of chickens to be produced. This is following the opinion of Ningsih and Prabowo (2017) which states that the availability and price of day-old chick (DOC) affect the broiler production process. The availability of DOC at the farmer level, there is no decrease in the number of populations being kept during the COVID-19 pandemic, but resulted in a delay in the distribution of DOC to farmers. This is due to the implementation of Large-Scale Social Restrictions which have been implemented in every region in Indonesia.

The average cost of feed on a business scale of 3000 is the highest at Z's company was USD 4,944.27 and the lowest at X's company was amounting to USD 4,720.83. Expenditures for the cost of feed at X's company and the highest in Y's company was occurred in the second period, was USD 5,217.62 and USD 4,868.68, and for the cost highest in Z's company in the third period was USD 5,356.49. On a business scale of 4000, the highest average cost of feed is also at Z's company was USD 6,928.47 and the lowest at X's company is amount to USD 5,853.22. This difference is because each company's feed cost is different and each period will change. This is following the opinion of Sani et al. (2015) which states that the cost of feed has a portion of 70-80% of the total production cost. Thus, feed greatly affects the success of a broiler farming business.

During COVID-19 the availability of feed at the farmer level in Lekopancing Village, Tanralili Subdistrict is sufficient, however, the maintenance period for broiler chickens during the COVID-19 pandemic is longer than before, resulting in more total feed requirements. There is no impact from the implementation of Large-Scale Social Restrictions on the availability of animal feed. It's just that the transportation/distribution of feed is slightly disrupted due to inspections at the border area because all areas are on lockdown. This condition directly affects expedition drivers who do not want to travel and prefer to rest or stay at home.

The average amount of labor costs incurred by farmers on a business scale of 3000 at X's company was USD 137.82, Y's company was USD 141.51 and Z's company was USD 140.56 while the labor costs for business scale farmers are 4000 X's company as much as USD 179.86, Y's company was USD 173.85 and for Z's company was USD 173.42. The workforce is divided into 2, namely production workers who work when the chickens come in until harvest, and daily labor is needed only at harvest. This is following the opinion of Yusuf et al. (2016) which states that the labor used by farmers is grouped into two major groups, namely production workers and external (wage) workers. The salary distribution system for production workers is in the form of money with a nominal value of USD 130.02 for a population of 3000 individuals and USD 0.16.

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Revenue

Revenue is the sum of the components of production revenue expressed in rupiahs, namely sales of chickens and sales of the production process for one period. The income obtained by farmers is then used to cover the total costs that have been incurred (Iskayani et al., 2016). Revenue from each farm of each company in Lekopancing Village, Tanralili District can be seen in Table 4.

The income of plasma farmers fluctuates every period. This fluctuation in revenue is due to the mortality rate, FCR rate, average weight of the harvested chickens, and the contract price of chickens. The income fluctuates every period as a result of the high risk of weather and disease risk in the livestock business. The largest total revenue on a business scale of 3000 and 4000 tails were Z's company was USD 8,503.06 and USD 11,641.80 and the lowest at X's company was USD 8,136.50, and USD 10,755.42. Livestock business revenue is the result of efforts to sell the main livestock business carried out, while the capital used for the business is not included in it. The selling price determined in the market multiplied by the amount of business production is the gross revenue obtained through the livestock business. This is following the opinion of Geo et al., 2020; Yusuf et al., 2016) which states that the number of chicken sales will depend on body weight gain and the price per kilogram of chicken. The price is determined based on the live weight of the chicken. The price continues to fluctuate in line with market demand and supply. The amount of a farmer's income can be analyzed using a predetermined product price multiplied by the amount of business production.

Total Revenue at companies X, Y, and X fluctuated during the COVID-19 pandemic. This was due to the unstable selling price of live chicken due to weak market demand the rest of the price decline was also due to Large-Scale Social Restrictions due to the COVID-19 pandemic so that there is a buildup of live chickens at the farmer level. This resulted in the condition of the average weight of chickens and different levels of mortality. Mortality affects the number of healthy chickens ready to harvest in the coop.

Table 4 - Average revenue per period of business scale 3000 and 4000 Tails (USD)

Description	Business Scale 3000			Business Scale 4000		
	PT.X	PT.Y	PT.Z	PT.X	PT.Y	PT.Z
Chicken	8,086.22	8,163.68	8,472.35	10,695.61	11,046.00	11,608.04
Phase	50.28	35.11	30.71	59.81	38.13	33.76
Total Receipt	8,136.50	8,198.79	8,503.06	10,755.42	11,084.13	11,641.80

Income analysis

Income is the goal of every type of business. Income can be achieved if the amount of revenue obtained from the results of the operation is greater than the total expenditure. The higher the difference, the higher the profit that can be obtained. The income of farmers in Lekopancing Village, Tanralili District can be seen in Table 5.

The income earned by broiler farmers in partnership pattern in Lekopancing Village on a business scale of 3000 tails, the highest is farmers who partner with Z's company with a total was USD 1,564.63 and USD 0.52/tail/period. As for the business scale of 4000, the highest was Y's company was USD 2,285.97 and USD 0.76/tail/period. The difference in income earned by farmers who partner with X and Y companies and farmers who partner with Z's company with a business scale of 3000 and 4000 tails is caused by differences in production costs incurred, for example, the cost of seeds and feed costs. In addition to differences in production costs, differences in income earned by farmers in partnership with X and Y companies and farmers who partner with Z's company is also due to the different selling prices of chicken meat.

The COVID-19 pandemic has resulted in the income of farmers who partner with companies of X, Y, and X experiencing fluctuations in input-output prices every period. This is due to the implementation of social distancing, so it becomes an obstacle for brokers to take live chickens from farmers. This again becomes a production burden, namely increasing harvest age and then automatically followed by an increase in production or maintenance and of course increasing production costs, in this case following the very popular farm production triangle law, namely breed, feed and management where it is said that 70 % production costs are feed costs.

The results showed that the broiler farming business was profitable during the COVID-19 pandemic, although at the beginning of the COVID-19 pandemic there was a decline in income but did not cause losses for farmers. This is not following the opinion of Sain et al. (2021) stating that the losses from the COVID19 pandemic include supply chain disruptions due to disruption of DOC distribution, feed, and medicines as well as operational activities. Therefore, the sustainability of the meat farming business can be threatened given the decline in business productivity and livestock income. The distribution of sales profits in pandemic has not changed much, still according to the contract between farmers (plasma) and companies (core). However, there was a change in the amount of income in a year due to the reduced number of maintenance periods due to the constraints faced during the pandemic, namely movement restrictions, resulting in hampered feed distribution and decreased sales. This causes some companies (core) to slow down or delay the collection of chicken from farmers even though it is ready to be marketed.

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Table 5 - Average income per period of business scale 3000 and 4000 Tails (USD)

Description	Business Scale 3000			Business Scale 4000		
	PT.X	PT. Y	PT. Z	PT.X	PT. Y	PT. Z
Reception	8,136.49	8,198.78	8,503.07	10,755.42	11,084.06	11,504.45
Production Cost	6,732.20	6,878.78	6,938.44	8,561.13	8,798.09	9,595.28
Total Income	1,404.29	1,320.01	1,564.63	2,194.29	2,285.97	1,909.18
Average/Tail	0.47	0.44	0.52	0.73	0.76	0.64

CONCLUSION

The results of research that have been carried out in Lekopancing Village Tanralili Subdistrict, Maros Regency, it can be concluded that the COVID-19 pandemic has resulted in the income of farmers who partner with companies X, Y, and X experiencing production price fluctuations. The income earned by broiler farmers with partnership patterns on a business scale of 3000 heads is the highest breeder who partners with Z's company was USD 1,564.63 and USD 0.52/tail/period. As for the business scale of 4000, the highest of Y's company was USD 2,285.97 and USD 0.76/tail/period.

DECLARATIONS

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Authors' contribution

S.Nurlaelah led and fully managed the research project and was responsible for data collection and script writing; H.Husbnar contributed to data processing and interpreting field data; A.Asnawi contributed to the data processing and provision of library resources; and Dr S.Nurani Sirajuddin contributed to the article writing process, publication process and translation process

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Conflict of Interest

None

REFERENCES

Baxter M, Richmond A, Lavery U, and O'Connell NE (2021). A comparison of fast growing broiler chickens with a slower-growing breed type reared on Higher Welfare commercial farms. Plos One, 16(11):e0259333. Doi: https://doi.org/10.1371/journal.pone.0259333

Budiraharjo K, Handayani M (2008). Profitability and Financial Feasibility Analysis of Duck Livestock Business in Pagerbarang District, Tegal Regency. Research Report. Faculty of Animal Husbandry. Diponegoro University. Semarang. https://www.researchgate.net/publication/277733132

Coyne L, Arief R, Benigno C, Giang VN, Huong LQ, Jeamsripong S, Kalpravidh W, McGrane J, Padungtod P, Patrick I, Schoonman L (2019). Characterizing antimicrobial use in the livestock sector in three South East Asian countries (Indonesia, Thailand, and Vietnam). Antibiotics, 8(1):33. https://doi.org/10.3390/antibiotics8010033

Coyne L, Patrick I, Arief R, Benigno C, Kalpravidh W, McGrane J, Schoonman L, Harja Sukarno A, Rushton J (2020). The costs, benefits and human behaviours for antimicrobial use in small commercial broiler chicken systems in Indonesia. Antibiotics, 9(4):154. https://doi.org/10.3390/antibiotics9040154

Geo L, Saediman H, Ariani WOR (2020). Profit and Financial Feasibility Analysis of Broiler Chicken Livestock in South Konawe District, Indonesia. IOP Conference Series: Earth and Environmental Science, 465:012059. https://doi.org/10.1088/1755-1315/465/1/012059

Iskayani, Lestari VS, Pakiding W (2016). Income Analysis of Broiler Breeders with Partnership Patterns in Bontomatene Village, Marusu District, Maros Regency. Journal of Science - Animal Science, 2(2):122–132. https://doi.org/10.24252/jiip.v2i2.1565

Joshua Olorunwa O (2018). Economic Analysis of Broiler Production in Lagos State Poultry Estate, Nigeria. Journal of Investment and Management, 7(1): 35-44. https://doi.org/10.11648/j.jim.20180701.15

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Kalangi LS, Lombogia SOB, Regar MN (2021). Analysis of Income on the Partnership Program-based Broiler Business in Regency of North Minahasa, North Sulawesi, Indonesia. International Journal of Applied Business and International Management, 6(1): 14-24. https://doi.org/10.32535/ijabim.v6i1.937

Kamruzzaman M, Islam S, Rana MJ (2021). Financial and factor demand analysis of broiler production in Bangladesh. Heliyon, 7(5): e07152. https://doi.org/10.1016/j.heliyon.2021.e07152

Nadzir, Tusi A, Haryanto A (2015). Evaluation of broiler chicken coop design in Rejo Binangun Village, North Raman District, East Lampung Regency. Lampung Agricultural Engineering Journal, 4(4):255–266. https://jurnal.fp.unila.ac.id/index.php/JTP/article/view/998

Naradhipa AR, Syaifudin, Sari S (2020). Knowledge management system for broiler and laying cultivation. International Journal of Scientific and Technology Research, 9(3):1373-1378. https://www.ijstr.org/final-print/mar2020/Knowledge-Management-System-For-Broiler-And-Laying-Cultivation.pdf

Ningsih R, Prabowo DW (2017). Level of Broiler Market Integration in Main Production Centers: A Case Study of East Java and West Java. Trade R&D Scientific Bulletin, 11(2): 247–270. https://doi.org/10.30908/bilp.v11i2.231

Rahman NU, Mehmood S, Ahmad S, Javid A, Mahmud, Hussain J, Shaheen M S, Usman M, Mohayud Din Hashmi S G (2020). Production analysis of broiler farming in central Punjab, Pakistan. Tropical Animal Health and Production, 52: 1125–1131. https://doi.org/10.1007/s11250-019-02107-6

Riwukore JR, and Habaora F (2020). Aspect And Impact Of The Existence Of Breeding Companies Of Racial Chicken In The Nusa Tenggara Timur Province. International Journal of Creative Research Thoughts, 8(7): 2242-2250. https://ijcrt.org/papers/IJCRT2007204.pdf

Sain F A, Asnawi A, Nurlaelah S (2021). The impact of the COVID-19 pandemic on broiler farms in Moncongloe District, Maros Regency South Sulawesi. IOP Conference Series: Earth and Environmental Science, 788(1). https://doi.org/10.1088/1755-1315/788/1/012226

Wahyono ND, and Utami MMD (2018). A Review of the Poultry Meat Production Industry for Food Safety in Indonesia. Journal of Physics: Conference Series, 953(1): 012125. https://doi.org/10.1088/1742-6596/953/1/012125

Yusuf TM, Tiamiyu SA, Aliu RO (2016). Financial analysis of poultry production in Kwara State, Nigeria. African Journal of Agricultural Research, 11(8): 718-723. https://doi.org/10.5897/ajar2015.10690

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DETERMINING THE RADIUM CONCENTRATION IN VEGETABLES AND FRUITS IN Al-NAJAF, IRAQ

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ABSTRACT: Amount of pollution radiation in foodstuffs and feedstuffs are very necessary to measure because it is a direct contact with human and animal health. Therefore, the present investigation is useful for the health and environmental data base. The study included measurement of effective radium-226 content (C_{Ra}) in some chosen samples of vegetables and fruits (local and imported) in Najaf governorate. The C_{Ra} were measured in samples of vegetables and fruits using Solid State Nuclear Track Detectors (LR-115 Type II). Also, the annual effective dose (AED) associated with the exposure due to annual intake of ^{226}Ra were calculated from ingestion of vegetables and fruits samples for adults. The results were revealed that the average value of C_{Ra} in vegetables and fruits samples in the present study was 3.98±1.08 Bq/kg and 1.73±0.11 Bq/kg, respectively. While, the average of AED (mSv/y) for vegetables and fruits samples was 0.067±0.018 and 0.082±0.005, respectively. Also, the results showed that the average value of AED from fruits consumption is larger than in vegetables, but the result is not significant. All results of the C_{Ra} and AED of the studied samples had been compared with the worldwide reported value (median). Accordingly, it was found that all findings were lower than that of the recommended limits of the UNSCEAR 2000. Finally, based on present investigations, no health risk expected when considering eating vegetables and fruits of Al-Najaf of Iraq.

Keywords: Alpha emitters, Food contamination, Radium-226, Herbal samples, Al-Najaf.

INTRODUCTION

It is customary that people are exposing to natural radiation in everyday life. The basic components that support human beings' continuous life is sought from the soil, water, air and vegetation. In this regard, some of the latter components are either inhaled or ingested into the body where they contain measurable amount of radioactivity (Abojassim et al., 2021). It should be noted that the specific metabolism of different plants types might lead to an accumulation of radio-nuclides that depends upon the physico-chemical characteristics of the soil (Engelbrecht, 2020). Fertilizers affect the increase in the concentrations of nuclides that occur naturally in the soil and therefore in plants at higher rates in agricultural areas (Ba et al., 2022; Najam et al., 2022).

Thus, the naturally occurring and man-made nuclides are transmitted to crops through the soil as one of the steps of the plant food chain through the roots, which is the initial step of this chain (Mukherjee, 2022). There may be an increase in the amount of risk that the human population might expose to via food chain (Shaw, 2018). Some of the aforementioned radiations are originated from natural sources, while others are from artificial sources. To illustrate, the natural sources of radiation include cosmic, terrestrial and internal radiations. By contrast, the artificial sources include medical radiation-based procedures, commercial radioactive materials-based products, and finally the fallout from nuclear testing (Abojassim et al., 2021). The major terrestrial elements of radioactivity include uranium, thorium, potassium and together with their corresponding decay products namely: 'radium and radon' (Shaw, 2018). Radium deposits in the bones up to 20%, causing necrosis and decomposition of the bones due to its radioactive activity that repels calcium from them. The danger of internal and external exposure to it lies in the alpha emitters that kill and mutate cells, and an isotope Radium-226 (^{226}Ra) is the most toxic. The radium is a natural radioactive element. It is existed in the uranium and thorium series of the crust of the earth. In this context, the radium was used in many applications such as its use as a self-illuminating material in dial clocks, medical diagnoses and therapy (radiation therapy and brachytherapy) (Abojassim et al., 2021). The most abundant of the radium isotopes is ^{226}Ra that is a natural arises as a decay product of uranium-238 (^{238}U). ^{226}Ra is an alkaline earth metal with physiological and environmental qualities similar to calcium and barium, making it an important radiotoxic radionuclide (L'annunziata, 2016). ^{226}Ra being an alpha-emitter and having a half-life about 1620 years, it is of utmost interest because when deposited in internal organs of humans, it is known to

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cause severe radiation damage resulting from the alpha particles and short-lived daughter radionuclides of high specific activity emitted in its decay process (Zimmermann, 2007).

Such severe radiation damage may cause cancer as in the case of the early radium dial painters. Groundwater and Ra-bearing interact of components like rocks, soil, ore bodies, and other materials are natural sources of radium in groundwater then in some foods. Currently, chemical based agricultural fertilizers are key for the purpose of agricultural activity. They can help in increasing the production of crops and therefore improving the nutrient lands characteristics. Nevertheless, it is possible to encounter the negative impact of aforementioned fertilizers. For example, it includes the contamination of the agricultural lands by trace elements, and certain types of the naturally occurring radioactive materials (NORM) (Azeez et al., 2020).

Consequently, the latter argument can highlight that the usage of the fertilizers may involve certain types of hazards due to radiation to the farmers and then to general public (Abojassim, 2021). In this regard, the radium can result in some carcinogenic diseases to include lung, bone, skull, and nasal passage cancers when it is being inhaled. In case of internal exposure to large amounts of radiation, the radium has been reported to induce the cancer of bone cancer in animals as well as humans. In Iraq, animals become contaminants when they feed on radium-226 contaminated plants (vegetables and fruits) and water; those radionuclides are transferred to their bodies and products such as milk and dairy products, eggs, meat. As a result, contamination occurs primarily because of animals' ingestion of contaminants. The monitoring of the concentrations of radium in either sample (i.e., vegetables and fruits) had been the research focus for many published studies worldwide (Hashim and Najam, 2015; Girault et al., 2021; Hassan and Rashid, 2022).

This research was focused on investigating the radium-226's concentrations in samples of vegetables and fruits which are consumed in Najaf, Iraq utilizing the technique of nuclear track detectors (e.g., LR-115 type-II).

MATERIALS AND METHODS

Sample collection and preparation

Nine samples of vegetables together with nine samples of fruits were collected from the local markets of Najaf, Iraq as shown in Tables 1 and 2, respectively. After the collection of the required samples decided for this research from markets, they were cleaned and dried using electric oven at 60 Co for one day. Next, the samples were crushed via utilizing an electric mill. To reach the homogeneity of the samples, they were sieved using a 0.8 mm-pore-size sieve. Then, the resulted sample powder was placed in a plastic cup whose dimensions: 5 cm diameter, 7 cm length and 130 ml volume). The samples were labeled using a code and the country of origin. The corresponding net were determined and recorded utilizing digital balance with high accuracy. Finally, the plastic cups were stored for around one month before the counting process begins. This is in order to reach the secular equilibrium among the isotopes of natural decay series (Abojassim et al., 2016).

Table 1 - Samples of vegetables under study.

No.	Name of vegetables	Code	Country of origin
1	Celery	V1	Iraq
2	Parsley	V2	
3	Watercress	V3	
4	Onion	V4	Iran
5	Lettuce	V5	
6	Zucchini	V6	
7	Bell Pepper	V7	
8	Chili Pepper	V8	India
9	Garlic	V9	China

Table 2 - Samples of fruits under study.

No.	Name of fruits	Code	Country of origin
1	Rearrange	F1	Iraq
2	Pomegranate	F2	
3	Pear	F3	
4	Watermelon	F4	Iran
5	Apple	F5	
6	Banana	F6	Egypt
7	Orange	F7	
8	Lemon	F8	Turkey
9	Apricot	F9	

Methods of measurement

After end time equilibrium, A piece of LR–115 type-II a sensitive cellulose nitrate (C_6-H_8O_8-N_2) detector with area 1x1 cm^2 and thickness of 12mm was placed at the bottom of each cylinder cover, with samples at the bottom of cylinder and then sealed for exposure of 90 days. Detectors were etched with sodium hydroxide (NaOH) solution of 2.5 (which is prepared by dissolving 40gm of NaOH in 0.4 Litter of distilled water) normality in temperature at 60˚C within 90min in order to show the tracks (Hady et al., 2016). The tracks count per unit area of the studied samples were counted using an optical microscope (Novel N-120A, 400X magnification power).

Statistical analysis

In this work, the statistical analysis has been carried out by using the statistics software package SPSS version 23.0 for windows.

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Theoretical equations

Track density (ρ) of each sample (track/cm2) was measured using equation (1) as follows (Abojassim, 2021):

$$\rho\left(\frac{Track}{c^2}\right) = \frac{No.Tracks}{Area\ of\ view} \quad (1)$$

The equation (2) was used to determine effective radium-226 content (C_{Ra}) in samples, as following (Ibrahim et al., 2021; Hashim et al., 2021):

$$C_{Ra}(\mathrm{Bq}.kg^{-1}) = \left(\frac{\rho}{KT_e}\right)\left(\frac{hA}{M}\right) \quad (2)$$

where, h: refers to the height of the sample inside the plastic cup (5 cm), A: refers to the area of plastic cup, M: refers to the mass of sample, K: represents the calibration factor which is equal to (0.256 tracks.cm^{-2}. d^{-1}/ Bq.m^{-3}) and T_{eff} represents the time of actual exposure which was calculated using equation (3) (Oleiwi et al., 2021):

$$T_{eff}=\left[T - \lambda_{Rn}^{-1}\left(1 - e^{-\lambda_{Rn}T}\right)\right] \quad (3)$$

where λ_{Rn} represents the decay constant for ^{222}Rn.

Annual effective dose (AED) based on specific activity ^{226}Ra in unit Bq/kg (C_{Ra}) were calculated using (4), as following (Abojassim and Lawi, 2018):

$$AED\left(\frac{nSv}{y}\right) = C_{Ra} \times I \times CF \quad (4)$$

where, I is consumption rate of samples which it is equal 60 kg/y for vegetables samples and 170 kg/y for fruits samples, and CF is conversion dose factor which it is equal 280 nSv/Bq (UNSCEAR, 2000).

RESULTS AND DISCUSSIONS

The results of C_{Ra} in Bq/kg for vegetables samples in the present study as well as results of annual effective dose in mSv/y are given in Table 3. From Table 3, it is show that, the highest value of C_{Ra} was 10.291 Bq/kg in sample V4 (Onion, made in Iran), while the lowest value was 1.667 Bq/kg in sample V2 (Parsley, made in Iraq) with an average value of 3.98±1.08 Bq/kg. Also, from same Table 3, it is show that, the range values of annual effective dose due to ^{226}Ra concentrations were ranged from 0.028 mSv/y to 0.173 mSv/y, with an average value of 0.067±0.018 mSv/y. Table 4 illustrates the results of C_{Ra} in fruits samples of the present study. Table 4 show that the range of C_{Ra} in fruits samples in the present study varies from 1.232 Bq/kg in sample F5 (Apple, made in Iran) to 2.174 in sample F6 (Banana, made in Egypt), with an average value of 1.73±0.11 Bq/kg. The annual effective dose due to ^{226}Ra concentrations were determined for various samples of fruits which ranged from 0.059 mSv/y to 0.103 mSv/y with an average of 0.082±0.005 mSv/y. The results of ^{226}Ra concentrations in the collected vegetables and fruits samples under study were lower than the world median according to UNSCEAR 2000 (UNSCEAR, 2000) which is 32 Bq/kg. Also, this indicates that the annual effective dose in all vegetables and fruits samples was lower than the permissible limit of internal exposure due to ingestion which equal 0.3 mSv recommended by UNSCEAR 2000 (UNSCEAR, 2000). From results in Tables 3 and 4, it was found that there was a significant difference across all samples when considering the values of radium concentrations in vegetables and fruits samples due to geochemical composition and origin of soil cultivation kinds in this location which is taken of samples.

Table 3 - Results of C_{Ra} and AED in vegetables

No.	Code	C_{Ra} (Bq/kg)	AED (mSv/y)
1	V1	1.884	0.032
2	V2	1.667	0.028
3	V3	2.029	0.034
4	V4	10.291	0.173
5	V5	3.189	0.054
6	V6	9.711	0.163
7	V7	2.319	0.039
8	V8	1.957	0.033
9	V9	2.826	0.047
Average ± S.E		3.98±1.08	0.067±0.018

C_{Ra}= Effective radium-226 content; AED= Annual effective dose; V= vegetables sample.

Table 4 - Results of C_{Ra} and AED in fruits.

No.	Code	C_{Ra} (Bq/kg)	AED (mSv/y)
1	F1	1.449	0.069
2	F2	1.739	0.083
3	F3	1.594	0.076
4	F4	2.029	0.097
5	F5	1.232	0.059
6	F6	2.174	0.103
7	F7	2.102	0.100
8	F8	1.305	0.062
9	F9	1.957	0.093
Average ± S.E		1.73±0.11	0.082±0.005

C_{Ra}= Effective radium-226 content; AED= Annual effective dose; F= fruits sample.

The comparison of the average value of C_{Ra} and AED between vegetables and fruits samples in the current research can be seen in Figures 1 and 2, respectively. There are two ways to transfer natural radionuclides to plants and one of these two methods of natural radionuclides transmitted method of absorption indirectly from the soil via the roots. While the crops are growing up in a given contaminated soil, the radioactivity is driven from the soil to the plant roots and from there into the plant stem, and then into leaves of the fruit tree (Hussain and Rani, 2010). That is why the emergence of radium concentrations in vegetables are higher than in the fruit (Figure 1), because most vegetables have roots and

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leaves while the fruits have few roots. Regarding the annual effective doses, it had been found that for the fruits the value was larger than the dose in vegetables (Figure 2). This larger value for fruits is due to the high consumption rate of samples by adult. Finally, we can say the vegetables and fruits in the present study are no health hazards due to radium-226 concentrations.

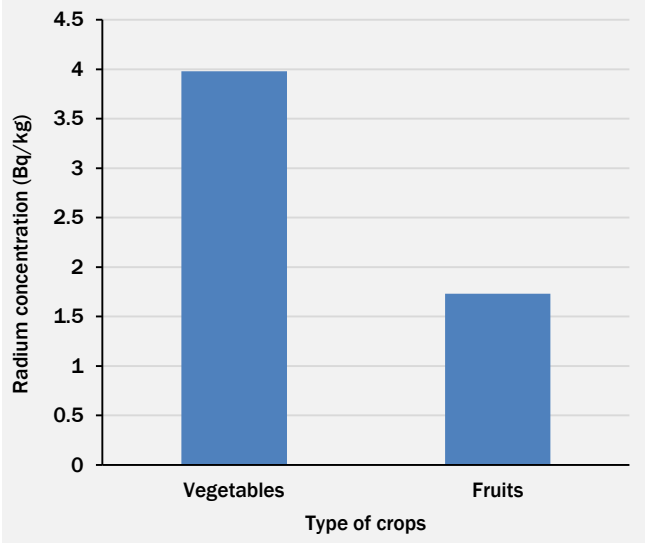

Figure 1 - Compering of the average value of ^{226}Ra concentrations between vegetables and fruits samples in the present study.

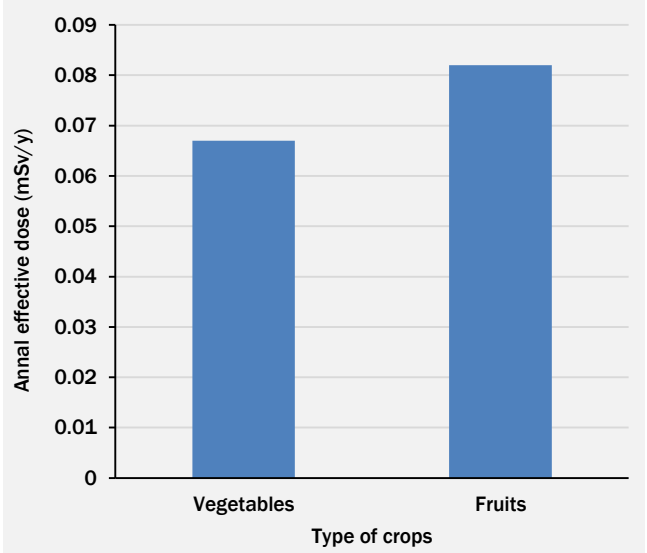

Figure 2 - Compering of the average of AED between vegetables and fruits samples in the present study.

CONCLUSION

According to the findings obtained by this research, one can conclude that the radium-226 concentrations values together with annual effective dose for eighteen samples of vegetables and fruits were noticed to be below the worldwide median value (i.e., 32 Bq/kg and 0.3 mSv/y) which were reported by UNSCEAR 2000. It was also found that the average concentration value of ^{226}Ra in vegetables samples was seen to be larger than in the fruit's samples. Concerning the annual effective dose resulted from the fruits samples was noticed to be larger than in vegetables samples. The findings of this work, however, demonstrate that vegetables and fruits (local and imported) in the Iraqi market in Najaf governorate consumption does not pose any severe health risks to humans and animal. Animals receive radium-226 through their food (such as vegetables and fruits) and water. Therefore, we must recommend the necessity of detection on the contamination occurs primarily as a result of animals' ingestion of this food.

DECLARATIONS

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Authors' contribution
All authors are contributed to the present work.

Conflict of interests
There is no conflict of interests.

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Data availability statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

Abojassim AA, and Lawi DJ (2018). Alpha particles emissions in some samples of medical drugs (capsule) derived from medical plants in Iraq. Plant archives, 18 (1): 1137-1143. https://www.cabdirect.org/cabdirect/abstract/20183312460

Abojassim AA, Dahir DM, Alaboodi AS and Abonasria AH (2016). Annual effective dose of gamma emitters in adults and children for some types of rice consumed in Iraq. Journal of food protection, 79 (12): 2174-2178. https://doi:10.4315/0362-028X.JFP-16-242

Citation: Azeez AJ, Marzaali AA, Abojassim AA, Mraity HAAB, Shareef MD, and ALSAFI H (2022). Determining the radium concentration in vegetables and fruits in Al-Najaf, Iraq. *Online J. Anim. Feed Res.*, 12(4): 217-221. DOI: https://dx.doi.org/10.51227/ojafr.2022.29

Abojassim AA, Hashim RH, and Mahdi NS (2021). Basics of nuclear radiation. Basics of Nuclear Radiation, B P International, India. pp.1-86. Link: https://stm.bookpi.org/BNR/article/view/4269

Abojassim AA (2021). Radiological risk assessment of radon gas in bricks samples in Iraq. Journal of Nuclear Engineering and Radiation Science, 7(3). https://doi.org/10.1115/1.4049051

Azeez HH, Mansour HH, and Ahmad ST (2020). Effect of Using Chemical Fertilizers on Natural Radioactivity Levels in Agricultural Soil in the Iraqi Kurdistan Region. Polish Journal of Environmental Studies, 29 (2): 1059–1068. https://doi.org/10.15244/pjoes/106032

Ba VN, Thien BN, and Loan TT (2022). The effect of fertilizers on transfer factors in plant, the topsoil environment and the risk of ingestion. Environmental Earth Sciences, 81(13):1-4. Doi: https://doi.org/10.1007/s12665-022-10474-x

Engelbrecht R (2020). Environmental radioactivity monitoring. In Handbook of Radioactivity Analysis: Vol. 2 pp.1-40. Academic Press, USA. https://doi.org/10.1016/C2017-0-01513-6

Girault F, Perrier F, Ourcival JM, FerryR, Gaudemer Y, Bourges F and Didon-Lescot JF (2021). Substratum influences uptake of radium-226 by plants. Science of the Total Environment, 766:142655. https://doi.org/10.1016/j.scitotenv.2020.142655

Hady HN, Abojassim AA and Mohammed ZB (2016). Study of radon levels in fruits samples using LR-115 type II detector. Journal of Environmental Science and Technology, 9(6): 446-451. https://doi.org/10.3923/jest.2016.446.451

Hashim AK and Najam LA (2015). Radium and uranium concentrations measurements in vegetables samples of Iraq. Detection, 3(04): 21-28. http://dx.doi.org/10.4236/detection.2015.34004

Hashim AK, Mezher HA, Kadhim SH and Abojasim AA (2021). Annual average internal dose based on alpha emitters in milk sample. In Journal of Physics: Conference Series, 1829(1): 012027. https://doi.org/10.1088/1742-6596/1829/1/012027

Hassan SJ and Rashid JM (2022). Determination of natural radioactivity material concentrations consumed widely during Corona pandemic in Thi-Qar province. Materials Today: Proceedings, 49: 2636-2640. https://doi.org/10.1016/j.matpr.2021.08.243

Hussain MY and Rani M (2010). Quantitative measurement of natural radioactivity in vegetable and meat before and after cooking. Pakistan Journal of Agricultural Sciences, 47(2): 153-156. https://pakjas.com.pk/papers/28.pdf

Ibrahim AA, Hashim AK, and Abojassim AA (2021). Determination of alpha radioactivity in soil samples collected from University of Kerbala, Iraq. International Journal of Nuclear Energy Science and Technology, 15(1): 1-15. https://doi.org/10.1504/IJNEST.2021.120126

L'annunziata MF (2016). Radioactivity: introduction and history, from the quantum to quarks. Elsevier. USA https://www.elsevier.com/books/radioactivity/lannunziata/978-0-444-63489-4

Mukherjee S (2022). Soil Pollution. In Current Topics in Soil Science. Springer, Cham, pp. 249-261. Doi: https://doi.org/10.1007/978-3-030-92669-4_25

Najam LA, Mahmmod RH, Albanna OM (2022). Evaluation of Natural Radionuclides in Samples of Plant Fertilizers Used in Iraq and Radiation Hazard Indicators. Iranian Journal of Science and Technology, Transactions A: Science, 11:1-9. Doi: https://doi.org/10.1007/s40995-022-01306-5

Oleiwi MH, Ibrahem SH and Abojassim AA (2021). Natural Alpha Emitters in Some Types of Medical of Parenteral Solutions (Domestic and Imported) Samples in Iraqi Hospitals. NeuroQuantology, 19(5): 139-144. https://doi.org/10.14704/nq.2021.19.5.NQ21058.

Shaw IC (2018). Food safety: the science of keeping food safe. John Wiley & Sons, UK. https://www.perlego.com/book/992564/food-safety-the-science-of-keeping-food-safe-pdf.

UNSCEAR, (2000). Sources and effects of ionizing radiation. Report to general assembly, with scientific annexes. United Nations. https://www.unscear.org/docs/publications/2000/UNSCEAR_2000_Report_Vol.I.pdf

Zimmermann R (2007). Nuclear Medicine Radioactivity for Diagnosis and Therapy. France: Editions EDP Sciences, France. https://inis.iaea.org/search/search.aspx?orig_q=RN:41081844

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PERFORMANCE OF BLACKHEAD OGADEN SHEEP FED DIFFERENT GRASSES (*Chloris gayana*, *Pennisetum purpureum*, *Panicum maximum* AND *Cynodon dactylon*) BASAL DIETS AND THE SAME CONCENTRATE MIXTURE

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ABSTRACT: A study was conducted to determine the effect of feeding Rhodes grass (RG; *Chloris gayana*) as treatment 1 (T1), elephant grass (EG; *Pennisetum purpureum* as T2), guinea grass (GG; *Panicum maximum* as T3) and bermuda grass (BG; *Cynodon dactylon* as T4) supplemented with a similar amount of concentrate mixture (CM; wheat bran (WB) and Noug seed cake (NSC) at 67:33 ratio) on performance and economy of fattening of Blackhead Ogaden sheep. The study consisted of a feeding and digestibility trials of 90 and 7 days long, respectively. Twenty-four intact yearling Blackhead Ogaden sheep with an initial body weight (BW) of 15.83±0.04 kg (mean±SD) were used in a randomized complete block design based on their initial BW with four treatments and six replications. All animals received 300 g dry matter (DM) of CM. Nutrient concentration of RG, EG, GG, BG, NSC and WB were 5.5, 8.8, 7.6, 7.9, 24.3 and 14.0% crude protein (CP), and 83.3, 74.5, 75.4, 81.5, 39.0 and 45% neutral detergent fiber, respectively on DM basis. Intake of DM was 696, 700, 719 and 716 g/day (SEM = 0.004) for T1, T2, T3 and T4, respectively and was lowest for T1 and highest for T3. The CP intake was also lowest for T1 (89 g/day), and similar among the other 3 treatments (99-103 g/day). Digestibility of CP and organic matter were highest for T2, intermediate for T3 and T4 and lowest for T1. Average daily gain was in the order of T2 > T3 = T4 > T1 (27, 63, 50 and 45 g/day (SEM = 13.1) for T1, T2, T3 and T4, respectively); whereas hot carcass weight did not significantly differ among treatments (5.7, 6.4, 6.1 and 6.3 kg (SEM = 0.36) for T1, T2, T3 and T4, respectively). Total return, net income and marginal rate of return were all in the order of T2 > T4 > T3 > T1. Therefore, based on biological performance as well as economic return, sheep fed elephant grass perform better. However, variations in performance and economic return among the four grass species needs to be taken cautiously as part of the difference might have attributed to differences in the stage of maturity of the grasses up on harvest for feeding the lambs.

Keywords: Blackhead Ogaden sheep, Digestibility, Feed intake, Performance, Weight gain.

INTRODUCTION

Sheep contributes to a substantial amount to the farm household income, mutton and non-food products (manure, skin and coarse wool). In addition to many other socioeconomic and cultural functions, they are a source of risk mitigation during crop failures, property security, and monetary saving and investment (Dossa et al., 2008). The productivity of indigenous sheep breed is low as compared to temperate breeds due to limited genetic capacity and diverse environmental factors. Among environmental factors, the main bottleneck for poor animal production in many African and Asian countries is an insufficient supply and low level of feeding due to a severe feedstuff shortage. Ben Salem et al. (2003) reported that there is a wide gap between the requirements and supplies of nutrients for small ruminants in numerous African and Asian countries. Higher animal density in relation to grazing areas, unreliable rainfall, increasing human population, small land holdings, and declining land productivity are all contributing factors to this gap. In addition to scarcity of feed, sheep productivity is constrained by diseases, lack of infrastructure, market information and trained personnel (Chikwanha et al., 2021; Mengistu et al., 2021).

The major feed resources for small ruminants in Ethiopia are forage from natural pastures, crop residues and agro-industrial byproducts (Duguma and Janssens, 2021; Bayissa et al., 2022). The availability of the major feed resources, however, fluctuates seasonally. The scenario holds true in Somali Region where natural pasture and crop residues are the dominant feed resources for small ruminants and feed shortage is faced during dry seasons (Maleko et al., 2018; Habte et al., 2022). Sheep production in Somali Region is constrained not only by the quantity of available feeds but also by the poor quality of the feed resources (Kenfo et al., 2018). Sheep in the area depend predominantly on high fiber feeds that are deficient in nutrients essential for microbial proliferation and nutrient supply to the animal (Xin et al., 2021; Yang et al., 2021). The implications of such poor nutritional values are slow growth rates, poor fertility, and high rates of mortality and consequently reduced production of livestock (Walsh et al., 2011).

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In Ethiopia, even though poor quality and quantity of feed constrained sheep productivity, most sheep are slaughtered at about 12 months of age with body weights (BW) of 18-20 kg. This shows that there is a scope for improvement by improving the feeding and reproductive management practices and health care management (Kassahun, 2000). One of a feeding management practice is improving the nutritive value of low quality feed resources. In crop livestock production system, the strategy used to upgrade the feeding value of animal feed is feed supplementation. These involve the use of fodder banks, fodder trees, by-products such as oil seed cakes and meals, and urea/ molasses licks. Hay from various species of grasses along with appropriate supplementation can also make sheep perform well. Such a feeding strategy can be a feasible approach for agro-pastoral areas so long as awareness is created. In Fafan area of the Somali Regional State, there are an ongoing works on improved forage grass selection and development, including Rhodes grass (*Chloris gayana*), elephant grass (*Pennisetum purpureum*), guinea grass (*Panicum maximum*) and Bermuda grass (*Cynodon dactylon*). However, the potential of these grass species for sheep performance has not been tested in the area. This study was therefore, aimed to determine the effect of feeding Rhodes grass, Elephant grass, Guinea grass, and Bermuda grass hay supplemented with a similar amount of concentrate mixture on intake, digestibility, growth rate and carcass characteristics of Blackhead Ogaden sheep and evaluate the economics of the feeding regime through partial budget analysis.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at Fafan Agricultural Research Center of the Somali Region Pastoral and Agro Pastoral Research Institute (SoRPARI) located in Somali Regional State, Ethiopia. Fafan is located at 9.08^{0}N and 42^{o}21 E and has an elevation 1600-1700 meters above sea level. The area has a mean annual temperature of 21 ^{o}C and an annual rainfall of 750 mm.

Experimental feeds and feeding

The four basal diets used in this experiment were prepared from Rhodes grass (*Chloris gayana*), elephant grass (*Pennisetum purpureum*), guinea grass (*Panicum maximum*) and local grass (*Cynodon dactylon*). All animals were offered the basal diet *ad libitum* at a refusal rate of 20%. Basal feed offered were adjust once every week ensuring a refusal of at least 20% based on previous week's intake of an individual animal. Each animal received a 300 g DM concentrate mixture per day. The concentrate mixture was composed of Noug seed cake (NSC) and wheat bran (WB) at a ratio of 33:67, respectively. Throughout the experiment, all animals had free access to water and mineral licks.

Experimental animals and management

Twenty-four intact yearling Blackhead Ogaden sheep with an initial body weight of 15.83 ±0.04 kg (mean±SD) were purchased from Jigjiga market. The age of the animals was determined by dentition and by asking the owners. The animals were then quarantined for 21 days in order to observe their health condition. During this time, the experimental animals were dewormed and sprayed against internal and external parasite and vaccinated against common diseases of the area, and animals were ear tagged for identification. Following the quarantine period, the animals were kept in individual pens and fed the experimental ration for another fifteen days as an acclimatization period. The animals were used in a feeding trial of 90 days and digestibility trial of 10 days and carcass evaluation at the end. Throughout the experiment, the animals were closely monitored for any signs of illness or disorders.

Animal care

The experiment was carried out in accordance with the European Union directive 2010/63/EU (2010) on the care and use of animals in experimental and scientific purposes.

Experimental design and treatments

The experiment was conducted in a randomized complete block design (RCBD) with four treatments and six replications. The sheep were blocked based on their initial BW into six blocks and animals within each block were randomly assigned to one of the four dietary treatments. The four dietary treatments were the four basal diets used in this study, and all animals received 300 g concentrate mixture (67% WB and 33% NSC). Therefore, treatments were:

T_1: Rhodes grass (*Chloris gayana*) hay *ad libitum* + 300 g DM concentrate mixture
T_2: Elephant grass (*Penniesetum purpureum*) hay *ad libitum* + 300 g DM concentrate mixture
T_3: Guinea grass (*Panicum maximum*) hay *ad libitum* + 300 g DM concentrate mixture
T_4: Bermuda grass (*Cynodon dactylon*) hay *ad libitum* + 300 g DM concentrate mixture

Digestibility trial

The digestibility trial was conducted before the feeding trial. All sheep were kept in individual metabolism cage that was equipped with feeder and waterer. Feces were collected into a fecal collection bag carried by the animal. The animals were adapted to carrying fecal bags for three days, which was follow by total collection of feces for seven consecutive days. During this period, daily feed intake per sheep was recorded. After thorough mixing, twenty percent of the feces

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voided daily was taken and kept in a deep freezer at -20°C. The samples were bulk per animal over the collection period. Samples of feeds refusal were taken daily and the latter was pooled per treatment. The sampled feeds were bulked over the seven days of digestibility trial. At the end of the collection period, sub-samples of feces and feeds were taken and transported in ice box fill with chill ice bags, to laboratory for chemical analysis. The apparent digestibility co-efficient (DC) of nutrients were estimated as:

$$DC = \frac{\text{Total amount of nutrients in feed-nutrients in feces}}{\text{Total amount of nutrients in feed}} \times 100$$

Feeding trial

After the digestibility trial, animals were placed in the feeding trial that lasted 90 days. The amount of feed offered and refusal was recorded daily for each experimental animal to determine daily feed intake of individual animals. Daily feed intake was calculated as a difference between the feed offered and feed refused. Feed samples were taken on batches of feed offered and that of the refusal were taken for each animal daily and pooled per treatment. Feed offer were bulked over the experimental period and sub-samples were taken for chemical composition. Body weights of animals were taken initially and every ten days after overnight fasting to account for differences in gut fill. The average daily body weight gain (ADG) during the experimental period was determined by regressing body weight (BW) of each animal measured at 10 days interval on days of feeding. Feed conversion efficiency (FCE) was calculated as a proportion of ADG to daily feed DM intake.

Chemical analysis

The sample of feed offered, refusal and feces were analyzed for DM, ash and nitrogen, neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) and crude protein. The dry matter (DM), ash and nitrogen contents of the samples were analyzed following the methods of AOAC (2005). The nitrogen contents were determined using the micro-Kjeldahl method (AOAC, 2005) and the CP content was estimated by multiplying the N content by 6.25. The neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL) were analyzed according to Van Soest et al. (1991).

Carcass parameters

At the end of the feeding trial, all the sheep was fasted overnight, weighed and slaughtered. On slaughtering, the animals were killed by severing the jugular vein and the carotid artery with knife. Blood, skin, head, tongue, hot carcass, liver with gall bladder, heart, kidneys, lung with trachea, tail, testis, penis, spleen, fat (omental, intestinal and kidney), feet, gut fill, total and empty gut were recorded. Empty body weight (EBW) was calculated as the difference between slaughter weight (SW) and gut content. Total edible offal components (TEOC) was taken as the sum total weight of blood, heart, liver with gall bladder, empty gut, kidney, tongue, tail, testis and fat (omental, intestinal and kidney). Total non-edible offal components (TNEOC) were considered as the sum of the weight of head without tongue, lung with trachea, skin, penis, spleen, feet and gut content. Dressing percentage was calculated as proportion of hot carcass weight (HCW) to SW and EBW. Regarding the rib eye muscle area (REA), both the right and left halves were cut between the 11^{th} and 12^{th} ribs perpendicular to the backbone to measure the cross-section of the rib-eye muscle. The rib-eye muscles were traced first on transparency paper then on graph paper and the area was measured by using mechanical polar planimeter.

Partial budget analysis

Partial budget analysis was performed to evaluate the profitability of feeding the sheep with a basal diet of hay prepared from the different grasses supplemented with same level of concentrate mix. It was done by considering the main cost components of sheep price and feed prices. Before slaughtering, three experienced animal dealers estimated the selling price of each experimental sheep. The difference in sale and purchase price was considered as total return (TR) in the analysis. The calculation was done according to Upton (1979). Net return (NR) was calculated as NR= TR-TVC (total variable cost). Marginal rate of return (MRR) was determined as MRR= NR/ TVC.

Data analysis

The data were subjected to analysis of variance (ANOVA) using the general linear model procedures of SAS (2011). Tukey test was used for mean separation that was found to be statistically different at the 5% significant level. The statistical model used for the analysis of data was: $Yij= \mu + Ti + Bj + Eij$

Where, Yij= the response variable, μ= overall mean, Ti = treatment effect), Bj = block effect, Eij= random error

RESULTS AND DISCUSSION

Chemical analysis of the experimental feeds

The result of chemical analysis of feeds used in the study is shown in Table 1. The CP content of the hay used in this study ranged 5.5% for Rhodes grass to 8.9% for elephant grass. While the CP content of Bermuda, elephant and guinea grass was above 7.5%, the content of Rhodes grass was far below the 7% level required to support the maintenance

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requirements of sheep and for normal microbial function (Bonsi et al., 1996; Ftiwi and Tadess, 2018). Thus, the basal feeds in this study might have a nutritional potential to satisfy the maintenance requirement of the animals except for Rhodes grass.

Information on Feedipedia (2015) indicated range of CP content of 4.4-16.6% for Rhodes grass, 5.5-15.1% for elephant grass, 2.4-5.8 for guinea grass and 6.3-14.7% for Bermuda grass. It appears that the protein content of guinea grass reported in this study is higher than the ranges of values reported. On the other hand, the CP content of the hay from the other three grasses was within the reported ranges. From the same source, the NDF and ADF contents ranges 70.5-80.8 and 37-50% for Rhodes grass hay, 55-75% and 33-50% for elephant grass hay, 69-79% and 37-54% for guinea grass hay and 69-79% and 28-44% for Bermuda grass hay, respectively.

The NDF and ADF content of the hay used in this experiment were relatively high. The NDF and ADF contents of the hay used in the present study were indicators of the fact that the hay was prepared from grasses harvested at a relatively matured stage. Advance in maturity of plants was reported to be associated with low CP and high cell wall content (McDonald et al., 2002).

The CP content of Noug seed cake (NSC) used in this study was relatively high, although many other reports noted values greater than 33% (Dessie et al., 2019; Mamo et al., 2021). It is obvious that NSC is a good source of protein that could be used to supplement low quality roughages. The amount and quality of NDF in a diet can either enhance or limit intake. At lower NDF concentrations (7.5%-35.5%), DM intakes increased with increasing dietary NDF concentration, but DM intakes decreased sharply as NDF concentration increased over the range of 22.2%–45.8% in high-producing animals (Harper and McNeill, 2015). Thus, the level of NDF in NSC observed in the present study is expected to have little negative impact on consumption and/or digestibility of the diets by the animals.

Wheat bran is one of the major agro-industrial by-products commonly used in the feeding of livestock. The CP content of wheat bran noted in this study was within the range of 13.4-21% reported before (Feedipedia, 2015). The NDF, ADF and ash values of wheat bran used in this study were also within the reported range of values. On average wheat bran contains 18.9 MJ/kg DM gross energy (Feedipedia, 2015), and is a good supplemental energy for ruminants. Though, the chemical analysis may not give full information regarding availability of the nutrients present in the feedstuffs to animals, it is a good indicator about the quality of the feedstuffs. Thus, based on the chemical analysis results, NSC and WB are good sources of nutrients. Feeds that contain 20% or more CP are classified as protein supplements that NSC qualifies (Kellems and Church, 2002).

Table 1 –Chemical composition of the experimental feeds (%DM)

Feed offered	DM (%)	CP	NDF	ADF	ADL	Ash
Rhodes grass	91.5	5.50	83.3	49.9	10.6	9.64
Elephant grass	91.4	8.88	74.5	41.5	8.5	14.9
Guinea grass	90.6	7.56	75.4	44.2	10.6	11.1
Bermuda grass	91.5	7.90	81.5	49.3	11.4	9.3
NSC	92.5	38.75	24.3	15.5	4.2	7.56
WB	90.3	14.25	45.1	12.5	4.1	4.75

ADF = acid detergent fiber; ADL = acid detergent lignin; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; NSC=Noug seed cake; WB=wheat bran.

Dry matter and nutrients intake

The DM and nutrient intakes of Blackhead Ogaden sheep during the feeding trial are presented in Table 2. The supplemental concentrate mixtures supplied to the animals were entirely consumed. Therefore, any difference among treatments in the intake of DM and nutrients was a result of variations in the intake and nutrient content of grass hays made from the four grass species.

Hay DM intake differed among treatments ($P<0.05$) and was in the order of Guinea grass hay > Bermuda grass hay > Elephant grass hay > Rhodes grass hay. Consequently, total DM intake took a similar trend like that of hay DM intake, values being in the order of T3 > T4 > T2 > T1 ($P<0.05$). However, numerical differences in hay and total DM intake was not so high, indicating that differences observed in the chemical composition of the hay was either not big enough to result to a wider impact on intake of DM or the supplement might have played in supplying sufficient additional nutrients to balance nutrient deficiencies in the hay so as to bring comparable level of hay or total DM intake. McDonald et al. (2002) indicated feed intake to be maximized if the feed provides all nutrients required by rumen microbes and by the tissue of the animal. Therefore, the higher hay and total DM intake in treatments with concentrate mixture (combinations of the two supplements WB and NSC) could as well be due to the better nutrient balance supplied to the animals when supplemented to the grass hay.

Although, there were statistical variations among treatments in the total OM intake ($P<0.05$), numerical variations on the total OM intake among treatments were not very high which was consistent with the total DM intake. Intake of total crude protein was lowest for T1 ($P<0.05$) as compared to the other treatments that had a similar level of crude protein intake ($P>0.05$). Differences in CP intake among treatments appears to be in line with the low level of CP of Rhodes grass noted in this study as compared to the other grass species used in this experiment.

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Intake of NDF and ADF varied among treatments ($P<0.05$) and was in the order of T4 > T1 > T3 > T2. This appears to be in line with differences in the NDF and ADF content of the hays from the four grass species. Generally, the NDF contents of the hays from the four grass species used in this study was high, which might imply that intake of basal diet may be limited since a major factor regulating forage intake is NDF content, as it is the major component limiting rumen fill and directly correlated with rumination or chewing time (Gebreegziabher, 2016). However, the supplement might have played a role in reducing the negative effect of high NDF content of the hays on intake. According to Roche et al. (2008), dietary fiber content, its digestibility and rate of degradation in the rumen are the most important forage characteristics that determine DMI. Therefore, the neutral detergent fiber (NDF), which is a measure cell wall content, determines the rate of digestion and has negative correlation with the rate at which the feed is digested (McDonald et al., 2002).

Previous studies (Solomon et al., 2004a; Solomon et al., 2004b) indicated that supplementation of protein rich feed to poor quality basal diets improved total DM intake, and intake of some nutrients. In general, Martinez et al. (2022) and Ali (2019) indicated that supplementation to low quality feeds increase feed intake because the supplements stimulate the rumen microbial function and thereby reduce digesta retention time. Riveros (1992) indicated that intake of elephant grass (*Pennisetum purupureum*) by sheep was improved by supplemental concentrated mix. Dietary deficiency of nutrients, especially CP for rumen microbes was noted to reduce voluntary feed intake (Cheeke, 1999).

Table 2 – Daily dry matter and nutrient intakes of Blackhead Ogaden sheep fed Rhodes grass, elephant grass, guinea grass and bermuda grass hay supplemented with concentrate mix

Feed offered \ Treatments	T1	T2	T3	T4	SEM
Hay DM	396^{d}	400^{c}	419^{a}	416^{b}	0.003
Supplement DM	300	300	300	300	-
Total DM	696^{d}	700^{c}	719^{a}	716^{b}	0.004
Total OM	641^{c}	624^{d}	656^{b}	660^{a}	0.003
Total CP	89^{b}	103^{a}	99^{a}	100^{a}	0.019
Total NDF	444^{b}	413^{d}	431^{c}	453^{a}	0.021
Total ADF	238^{b}	207^{d}	226^{c}	245^{a}	0.011

$^{a-d}$Means with different superscripts in a row are significantly different ($P<0.05$); SEM=standard error of the mean; ADF = acid detergent fiber; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; OM = organic matter; CM = concentrate mixture (67% wheat bran + 33% noug seed cake); T1 = Rhodes grass hay ad libitum + 300 g DM of CM; T2 = Elephant grass hay ad libitum + 300 g DM of CM; T3 = Guinea grass hay ad libitum + 300 g DM of CM; T4 = Bermuda grass hay ad libitum + 300 g DM of CM

Dry matter and nutrient digestibility

The apparent digestibility coefficients of DM and nutrients for Blackhead Ogaden sheep fed hay of the four grass species supplemented with a similar 300 g DM amount of concentrate mixture is shown in Table 3. In the current study, treatments had a significant effect on DM, OM, CP, NDF and ADF digestibility. This is presumably due to the slight variations in the chemical composition of the different species of grasses used in the current study. This is also an indicative that improvements in digestibility of roughage diets due to supplementation with concentrate feed (McDonald et al., 2002) might not bring the different roughages to a similar level of digestibility, which is a sign of the presence of additive effect in digestibility when roughages are mixed with protein rich concentrates.

The utilization of nutrients contained in feeds is determined by the amount of dry matter intake and digestibility. A primary consideration concerning DM intake is digestibility. Digestibility of feedstuff is affected by many factors such as stage of maturity of the crop, botanical composition, dry matter intake, processing and chemical treatment and dietary supplements. Ammerman et al. (1972) found that nitrogen intake was a major factor influencing the intake and digestibility of low quality roughages by ruminants. Similarly, Banamana et al. (1990) indicated that increasing CP in concentrates increased the digestibility of DM. Therefore, the lower DM digestibility of T1 as compared to the other treatments might be associated to the lower CP level in Rhodes grass as compared to the other three grass species used in this study. This slightly lower level of digestibility for T1 was reflected in lower intake of T1 diet as compared to the other treatments.

The apparent digestibility of CP in this study was in the order of T2 > T3 = T4 > T1 ($P<0.05$). This appears to be consistent with variations in the CP content of the four grass species used in this study and was also in line with differences in CP intake among treatments. This might suggest the possible additive effect of the grass hays when supplemented with concentrate mixture in the digestibility of the total diet. Generally, the digestibility of the different nutrients in this study followed a similar trend to that of CP intake. McDonald et al. (2002) remarked that concentrate feed rich in protein promotes high microbial population which in turn facilitates rumen fermentation. According to Robert (2011), the amount of protein in a feed affects its digestibility. As the level of protein in the feed increased, the apparent protein digestibility would be improved. If protein rich feeds are added to balance low protein roughages, the activities of microorganisms are increased and nutrient digestibility consequently be improved (Ranjihan, 2001). Supplementation of low quality roughage with moderate levels of protein source has been known to stimulate higher digestibility and therefore, improved feed intake (Fonseca et al., 2001; Sawal et al., 2004). Furthermore, ARC (1980) indicated that digestibility is much reduced when a ration has too little protein.

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Table 3 – Apparent digestibility coefficients of dry matter and nutrients of Blackhead Ogaden sheep fed Rhodes grass, elephant grass, guinea grass and bermuda grass hay supplemented with concentrate mix

Digestibility coefficient (%) \ Treatments	T1	T2	T3	T4	SEM
DM	66.8^{b}	68.1^{a}	67.9^{a}	67.9^{a}	0.078
OM	66.2^{c}	66.8^{a}	66.4^{b}	66.4^{b}	0.001
CP	67.9^{c}	70.4^{a}	68.4^{b}	68.3^{b}	0.007
NDF	65.4^{c}	68.5^{a}	66.8^{b}	66.4^{bc}	0.008
ADF	64.5^{d}	67.5^{a}	66.4^{b}	65.2^{c}	0.039
DM	66.8^{b}	68.1^{a}	67.9^{a}	67.9^{a}	0.078

$^{a-d}$Means with different superscripts in a row are significantly different (P<0.05); SEM=standard error of the mean; ADF = acid detergent fiber; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; OM = organic matter; CM = concentrate mixture (67% wheat bran + 33% noug seed cake); T1 = Rhodes grass hay ad libitum + 300 g DM of CM; T2 = Elephant grass hay ad libitum + 300 g DM of CM; T3 = Guinea grass hay ad libitum + 300 g DM of CM; T4 = Bermuda grass hay ad libitum + 300 g DM of CM

Body weight gain and feed conversion efficiency

The initial and final body weights, daily live weight change and feed conversion efficiency of the experimental sheep are presented in Table 4. Sheep fed Rhodes grass hay basal diet had the lowest and those fed elephant grass hay basal diet had the highest final body weights. Body weight change, daily body weight gain (ADG) and feed conversion efficiency followed a similar trend like that of final body weight and were in the order of T2 > T3 = T4 > T1 (P<0.05). Feeding the four species of grass hay supplemented with a concentrate mixture made of noug seed cake and wheat bran resulted to positive ADG in this study. The positive gain in body weight of sheep in this study obviously indicates that the animals were getting nutrients above their maintenance requirements partly due to the supplemental regime employed in this study. Previous studies (Solomon et al., 2004a; Solomon et al., 2004b) indicated that supplementation of protein rich feed to poor quality basal diets improved body weight gains.

Growth and hence body weight gain is a consequence of the level of feed intake and the concentrations of nutrients in the diet. AS such animal performance is the product of nutrient concentration, intake, digestibility, and metabolic efficiency of absorbed nutrients. Since all animals were supplemented similar amount of the same concentrate mixture, any variation in the growth rate of sheep among treatments will unquestionably be a consequence of the variation in the chemical composition of the basal diets and their subsequent effect on intake, digestibility and nutrient supply. Therefore, differences in ADG among treatments in the current study was in line with differences in CP content, DM and CP intake and digestibility of DM and nutrients observed in the current study. Therefore, differences in chemical composition especially of the protein content of hays can lead to a significant effect on the overall productivity of growing animals. This variation could be associated with between species variation of may be a result of management and utilization such as growing condition and harvesting time and conservation practice.

Table 4 – Body weight, average daily gain and feed conversion efficiency of Blackhead Ogaden sheep fed Rhodes grass, elephant grass, guinea grass and bermuda grass hay supplemented with concentrate mix

Parameters \ Treatments	T1	T2	T3	T4	SEM
Initial BW (Kg)	16.13	16.08	15.7	15.4	1.67
Final BW(Kg)	18.55^{c}	21.73^{a}	20.23^{b}	19.43^{bc}	1.79
BW change (Kg)	2.42^{c}	5.65^{a}	4.53^{b}	4.03^{b}	1.39
ADG (g/day)	26.85^{c}	62.78^{a}	50.37^{b}	44.82^{b}	13.11
FCE (g ADG/g DMI)	0.035^{c}	0.081^{a}	0.063^{b}	0.056^{b}	0.273

$^{a-c}$Means with different superscripts in a row are significantly different (P<0.05); SEM = standard error of the mean; ADG = average daily body weight gain; BW = body weight; FCE = feed conversion efficiency; DMI = dry matter intake; CM = concentrate mixture (67% wheat bran + 33% noug seed cake); T1 = Rhodes grass hay ad libitum + 300 g DM of CM; T2 = Elephant grass hay ad libitum + 300 g DM of CM; T3 = Guinea grass hay ad libitum + 300 g DM of CM; T4 = Bermuda grass hay ad libitum + 300 g DM of CM

Carcass

Carcass components

Empty BW was lowest (P<0.05) for T1 highest for T2 and intermediate for the other two treatments (Table 5). The trend in variation among treatments in empty body weight is consistent with that of differences in final body weight among treatments. Although hot carcass weight was slightly lower for T1 as compared to the other treatments, differences were not significant (P>0.05). Similarly, dressing percentage and rib eye area did not differ (P>0.05) among treatments. This happens despite significant differences among treatments in DM and CP intake and digestibility as well as variations among treatments in body weight gain and empty body weight. The reason for such observation is not apparent although numerical differences in aspects like intake and digestibility on DM and nutrients were not high.

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Table 5 – Carcass parameters, dressing percentage and rib eye muscle area of Blackhead Ogaden sheep fed Rhodes grass, elephant grass, guinea grass and bermuda grass hay supplemented with concentrate mix

Parameters \ Treatments	T1	T2	T3	T4	SEM
Slaughter BW (kg)	18.54^{c}	21.73^{a}	20.23^{b}	19.43^{bc}	1.79
Empty BW (kg)	13.04^{c}	15.72^{a}	14.69^{b}	14.70^{b}	1.28
HCW (kg)	5.66	6.38	6.07	6.29	0.36
Dressing percentage (% Slaughter BW)	30.07	29.43	29.97	32.38	4.24
Rib eye area (cm^2)	9.51	12.64	11.15	9.67	6.00

$^{a-d}$Means with different superscripts in a row are significantly different (P<0.05); SEM=standard error of the mean; ADF = acid detergent fiber; CP = crude protein; DM = dry matter; NDF = neutral detergent fiber; OM = organic matter; CM = concentrate mixture (67% wheat bran + 33% noug seed cake); T1 = Rhodes grass hay ad libitum + 300 g DM of CM; T2 = elephant grass hay ad libitum + 300 g DM of CM; T3 = guinea grass hay ad libitum + 300 g DM of CM; T4 = Bermuda grass hay ad libitum + 300 g DM of CM

Non carcass parameters (edible and non-edible offals)

Non carcass parameters of Blackhead Ogaden sheep fed Rhodes grass, elephant grass, guinea grass and bermuda grass hay supplemented with concentrate mix is shown in Table 6. All edible offal components except empty gut were significantly affected by treatment (P<0.05). For all of the edible offals where significant effect of treatment was noted, the highest value was observed for sheep fed the basal diet of Elephant grass and the lowest value was for animal fed the basal diet of Rhodes grass, while values for the other two treatments were intermediate. Consequently, the weight of total edible offal components was in the order of T2 > T3 > T4 > T1 (P< 0.05).

It appears that differences in body weight change or ADG observed among treatments in this study to be more reflected in the weight of edible offals than in the weight of hot carcass component. This might be attributed to the young age of the animals used in this study, which might have drained nutrients towards the development of organs associated with nutrient metabolism and utilization. Moreover, the growth of certain edible carcass components might be positively associated with nutrient intake. Kidney, kidney fat, and abdominal fat were also significantly higher (P<0.001) for sheep in T_2 compared to other supplemented groups associated with the relatively more DM and nutrient intakes. The higher amount of visceral fat in accordance to DM and nutrient intake in this study substantiates that animals supplied with better nutrient can store more fat in the viscera. This is in agreement with the view of Khan et al. (2009) who stated that animals fed on poor feed that could not fulfill their maintenance requirement loses weight since body reserves are used up and vice versa. Hagos and Melaku (2009) also reported relatively lower TEO which were 2.8 kg for the un-supplemented and 4.32 kg for 350g DM/day supplemented group. Generally, supplementation affects positively the weights of visceral and other edible offal component.

All of the non-edible offals and the total non-edible offal components were significantly different among treatments (Table 6). Gut contents was greater for Rhodes grass fed sheep as compared to the other treatments, a reflection of the lower digestibility and greater ruminal retention time of Rhodes grass possibly associated with the lower CP content of Rhodes grass as compared to other grass species used in the current study. This resulted to consequent higher total non-edible offal components for T1 as compared to T2 and numerical differences as compared to T3 and T4. Other non-edible offal components were relatively greater for T2 as compared to other treatments.

Table 6 – Non carcass components of Blackhead Ogaden sheep fed Rhodes grass, elephant grass, guinea grass and bermuda grass hay supplemented with concentrate mix

Parameters (g) \ Treatments		T1	T2	T3	T4	SEM
Edible offal	Empty gut	1686.2^{a}	1545.0^{b}	1654.0^{ab}	1662.0^{ab}	27.84
	Heart	51.0^{c}	79.0^{a}	74.0^{ab}	68.0^{b}	2.63
	Liver with bile	195.0^{c}	298.2^{a}	278.0 ^{b}	272.2^{b}	9.05
	Kidney	61.0^{c}	90.4^{a}	78.0^{b}	76.0^{b}	2.72
	Kidney fat	30.0^{c}	112.0^{a}	98.0^{b}	94.0^{b}	7.37
	Tail	680.40^{d}	1026.0^{a}	894.2^{b}	773.9^{c}	2.45
	Abdominal fat	58.0^{d}	142.0^{a}	121.2^{b}	92.0^{c}	7.30
	Tongue	72.0^{b}	86.0^{a}	76.6^{b}	74.0^{b}	1.92
	Testis	112.0^{c}	220.4^{a}	220.0^{a}	172.0^{b}	4.63
	Blood	852.0 ^{d}	1118.0^{a}	1100.0^{b}	946.0^{c}	4.18
	TEO	3758.20^{c}	4704.0^{a}	4579.0^{b}	4318.2^{c}	21.13
Non-edible offal	Skin with feet	1742.0^{b}	1878.0^{a}	1790.0^{b}	1774.0^{b}	17.84
	LTE	230.0^{c}	258.0^{a}	252.0^{ab}	246.0^{b}	2.90
	Spleen	28.3^{c}	44.2^{a}	38.3^{b}	36.2^{b}	1.51
	Head without tongue	826.0^{b}	910.0^{a}	904.0^{a}	820.0^{b}	11.64
	Penis	112.0^{c}	156.0^{a}	149.2^{ab}	144.0^{b}	4.02
	Gut fill	5120.1^{a}	3986.0^{c}	4810.0^{b}	4986.0^{ab}	82.93
	TNEO	8082.1^{a}	7212.0^{b}	7938.0^{a}	7987.0^{a}	104.83

$^{a-d}$ Means with different superscripts in a row are significantly different (P<0.05); SEM=standard error of the mean; TEOC = total edible offal; TNEO = total nonedible offal; LTE = lung, trachea and esophagus; CM = concentrate mixture (67% wheat bran + 33% noug seed cake); T1 = Rhodes grass hay ad libtum + 300 g DM of CM; T2 = Elephant grass hay ad libtum + 300 g DM of CM; T3 = Guinea grass hay ad libtum + 300 g DM of CM; T4 = Bermuda grass hay ad libtum + 300 g DM of CM

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Partial budget analysis

The partial budget analysis of the experiment is given in Table 7. Despite a similar purchasing price of sheep used for the different treatments, estimated selling price of lambs vary among treatments. This appears to be consistent with variations in the live weight gain, feed conversion efficiency and consequently difference in body weight and body conditions of sheep. Total return, net income and marginal rate of return were all in the order T2 > T4 > T3 > T1. Therefore, based on biological performance as well as economic return (net income and marginal rate of return), sheep fed elephant grass perform better. However, variations in performance and economic return among the four grass species needs to be translated cautiously as part of the difference might have attributed to differences in the stage of maturity of the grasses up on harvest for feeding the lambs. Thus, further work is needed to substantiate the results by synchronizing harvesting of the grasses at a similar stage of maturity.

Table 7 – Partial budget analysis of Blackhead Ogaden sheep fed Rhodes grass, elephant grass, guinea grass and bermuda grass hay supplemented with concentrate mix

Parameters \ Treatments	T1	T2	T3	T4
Purchasing price of sheep (ETB/head)	550	550	550	550
Estimated selling price of sheep (ETB/head)	1610	1830	1700	1715
Total cost of hay (kg/head)	142.45	144.0	151.1	130.8
Total cost of supplement	121.5	121.5	121.5	121.5
Total feed cost VC (ETB)	263.95	265.5	272.6	252.3
Total variable cost	813.95	815.5	822.6	802.3
Total return (TR)	1060	1280	1150	1165
Net income (NI)	246.05	464.50	327.40	362.7
MRR	0.30	0.57	0.40	0.45

ETB = Ethiopian birr; ΔNI = change in net income; ΔTR = change in total return; ΔTVC = change in total variable cost; MRR = marginal rate of return; CM = concentrate mixture (67% wheat bran + 33% noug seed cake); T1 = Rhodes grass hay ad libtum + 300 g DM CM; T2 = elephant grass hay ad libtum + 300 g DM of CM; T3 = guinea grass hay ad libtum + 300 g DM of CM; T4 = Bermuda grass hay ad libtum + 300 g DM of CM

CONCLUSION

The crude protein (CP) and neutral detergent fiber (NDF) contents of Rhodes grass, elephant grass, Guinea grass and Bermuda grass were 5.5 and 83.3, 8.8 and 74.5, 7.6 and 75.4, and 7.9 and 81.5, respectively indicating that Rhodes grass CP content was below the limit to support maintenance requirement of ruminants. Noug seed cake had 39% CP and 24% NDF, and that of wheat bran contained 14.0% CP and 45.1% NDF. Hay DM intake differed among treatments (P<0.05) and was in the order of Guinea grass hay (419 g/day) > Bermuda grass hay (416 g/day) > Elephant grass hay (400 g/day) > Rhodes grass hay (396 g/day). Total DM intake was 696, 700, 719 and 716 g/day (SEM = 0.004) for T1, T2, T3 and T4, respectively and followed a similar trend like that of hay DM intake being lowest for T1 and highest for T3. The CP intake was also lowest for T1 (89 g/day), and similar among the other 3 treatments (99-103 g/day). Intake of NDF and ADF vary among treatments (P<0.05) and was in the order of T4 > T1 > T3 > T2 (NDF intake: 444, 413, 431 and 453 (SEM = 0.02); ADF intake: 238, 207, 226 and 245 (SEM = 0.01 for T1, T2, T3, T4, respectively).

The apparent digestibility of organic matter (OM) and CP in this study was in the order of T2 > T3 = T4 > T1 (P< 0.05) (OM digestibility: 66.2, 66.8, 66.4 and 66.4 (SEM = 0.001); CP digestibility: 67.9, 70.4, 68.4 and 68.3 (SEM = 0.007 for T1, T2, T3, T4, respectively). Average daily gain was in the order of T2 > T3 = T4 > T1 (27, 63, 50 and 45 g/ day (SEM = 13.1) for T1, T2, T3 and T4, respectively); whereas hot carcass weight did not significantly differ among treatments (5.7, 6.4, 6.1 and 6.3 kg (SEM = 0.36) for T1, T2, T3 and T4, respectively).

Partial budget analysis result showed that net return in the current study to be 1060, 1280, 1150 and 1165 ETB, indicating that net return was in the order of T2 > T4 > T3 > T1. The difference in the net return among treatments was due to the difference in feed cost and selling price of the animals. Therefore, based on biological performance as well as economic return, sheep fed elephant grass perform better. However, variations in performance and economic return among the four grass species needs to be translated cautiously as part of the difference might have attributed to differences in the stage of maturity of the grasses up on harvest for feeding the lambs. In addition, further work is needed to substantiate the results by synchronizing harvesting of the grasses used in the current study at a similar stage of maturity.

DECLARATIONS

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Authors' contribution

I contributed on data collection, analysis and the write up of the manuscript.

Conflict of interests

The authors have not declared any conflict of interests.

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REFERENCES

Ali AIM, Wassie SE, Korir D, Merbold L, Goopy JP, Butterbach-Bahl K, Dickhoefer U, and Schlecht E (2019). Supplementing Tropical Cattle for Improved Nutrient Utilization and Reduced Enteric Methane Emissions. Animals, 9(5):210. https://doi.org/10.3390/ani9050210

Ammerman CB, Verde GJ, Moore JE, Burns WC and Chicco CF (1972). Biuret, urea and natural proteins as nitrogen supplements for low quality roughage for sheep. Journal of Animal Science, 35(1): 121-127. https://doi.org/10.2527/jas1972.351121x

AOAC (2005) Official method of Analysis. 18th Edition, Association of Officiating Analytical Chemists, Washington DC, Method 935.14 and 992.24. https://www.aoac.org/

ARC (Agricultural Research Council) (1980). The nutrient requirements of ruminant livestock. Technical Review by an Agricultural Research Council Working Party, Common wealth Agricultural Bureaux, Farnham Royal, UK. pp. 341-390. https://www.arc.agric.za/

Banamana MS, Oldham JD and Mowlem A. (1990). The effect of amount of protein in the concentrate on hay intake and rate of passage, diet digestibility and milk production in British Saanen goat. Journal of Animal Production, 51: 333-342. https://www.cabdirect.org/cabdirect/abstract/19901426970

Bayissa T, Dugumaa B, and Desalegn K (2022). Chemical composition of major livestock feed resources in the medium and low agroecological zones in the mixed farming system of Haru District, Ethiopia. Heliyon, 8(2): e09012. https://doi.org/10.1016/j.heliyon.2022.e09012

Ben Salem H, Nefzaoui A, and Makkar HP (2004). Towards better u utilization of non-conventional feed sources by sheep and goats in some African and Asian countries. In: Ben Salem H. (ed.), Nefzaoui A. (ed.), Morand-Fehr P. (ed.). Nutrition and feeding strategies of sheep and goats under harsh climates. Zaragoza: CIHEAM, pp. 177-187. http://om.ciheam.org/article.php?IDPDF=4600026

Beyene C. (1977). Laboratory evaluation and estimation of nutritive value of some Ethiopian feedstuffs and formulae plus animal evaluation of noug seed cake. A PhD Thesis Cornell University Ethaca, New York. Pp.135. https://agris.fao.org/agris-search/search.do?recordID=US19810638555

Bonsi, ML., Tuah, AK, Osuji, PO, Nsahlai, VI. and Umunna, NN. (1996). The effect of protein supplement source or supply pattern on the intake, digestibility, rumen kinetics, nitrogen utilization and growth of Ethiopian Menz sheep fed teff straw. *Animal Feed Science and Technology*, *64*(1): 11-25. https://doi.org/10.1016/S0377-8401(96)01048-6

Cheeke PR (1999). Applied of Animal Nutrition. Feed and Feeding. Macmillan publishing company, New York. Pp. 525. https://www.worldcat.org/title/applied-animal-nutrition-feeds-and-feeding/oclc/245700358

Chikwanha OC, Mupfiga S, Olagbegi BR, Katiyatiya CL, Molotsi AH, Abiodun BJ, and Mapiye C (2021). Impact of water scarcity on dryland sheep meat production and quality: Key recovery and resilience strategies. Journal of Arid Environments, 190: 104511. https://doi.org/10.1016/j.jaridenv.2021.104511

Dessie Y, Berhanu A, and Asnakew A (2019). Effect of Different Levels of Lentil (*Lens culinaries*) Hull and Noug Seed (*Guizotia abyssinica*) Cake Mixture Supplementation on Feed Intake, Digestibility and Body Weight Change of Farta Sheep Fed Hay as Basal Diet. Academic Research Journal of Agricultural Science and Research, 7(2): 75-86. http://www.academicresearchjournals.org/ARJASR/Index.htm

Dossa LH, Rischkowsky B, Birner R, and Wollny C. (2008). Socio-economic determinants of keeping goats and sheep by rural people in southern Benin. Agriculture and human values, 25(4): 581-92. https://doi.org/10.1007/s10460-008-9138-9

Duguma B, and Janssens GP (2021). Assessment of Livestock Feed Resources and Coping Strategies with Dry Season Feed Scarcity in Mixed Crop–Livestock Farming Systems around the Gilgel Gibe Catchment, Southwest Ethiopia. *Sustainability*, 13(19):10713. https://doi.org/10.3390/su131910713

Feedipedia (2015). Animal feed resources information system. INRA, CIRAD AFZ and FAO. www.feedipedia.org

Fonseca AJ, Dias-da-Silava AA and Laurenco AL (2001). Effect of maize and citrus pulp supplementation of urea-treated wheat straw on intake and productivity in female lambs. Journal of British Society of Animal Science, 73: 123-136. https://ur.booksc.me/book/64154774/e67a15

Ftiwi, M., and Tadess, G. (2018). Nutrient Intake, Digestibility and Growth Performance of Local Sheep in western Tigray, Ethiopia. *ARC Journal of Animal and Veterinary Sciences*, *4*(3): 48-59. http://45.113.122.54/journal-of-animal-and-veterinary-sciences/volume-4-issue-3/4

Gebreegziabher Z (2016). Factors Affecting Feed Intake and Its Regulation Mechanisms in Ruminants -A Review. International Journal of Livestock Research, 6(4): 19- 40. http://dx.doi.org/10.5455/ijlr.20160328085909

Habte M, Eshetu M, Maryo M, Andualem D, and Legesse A (2022). Effects of climate variability on livestock productivity and pastoralists perception: The case of drought resilience in Southeastern Ethiopia. Veterinary and Animal Science, 16:100240. https://doi.org/10.1016/j.vas.2022.100240

Hagos T and Melaku S (2009). Feed intake, digestibility, body weight and carcass parameters of Afar rams fed tef (Eragrostis tef) straw supplemented with graded levels of concentrate mix. Tropical Animal Health and Production, 41(4): 599-606. https://doi.org/10.1007/s11250-008-9230-6

Harper JK and McNeill DM (2015). The Role iNDF in the Regulation of Feed Intake and the Importance of Its Assessment in Subtropical Ruminant Systems (the Role of iNDF in the Regulation of Forage Intake). Agriculture, 5: 778-790. https://doi.org/10.3390/agriculture5030778

Kassahun A (2000). Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and Intensive feeding conditions. Ph.D. Dissertation. Animal Science, University of Wales, UK. 173p. https://edoc.hu-berlin.de/bitstream/handle/18452/15243/Awgichew.pdf?sequence=1

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Kellems RO and Church DC (2002). Feedstuffs. p. 39- 54. In R.O Kellems, and D.C. Church (ed.) Livestock Feeds and Feeding. 5th ed. Prentice Hall. New Jersey. https://www.worldcat.org/title/livestock-feeds-and-feeding/oclc/248198121?referer=di&ht=edition

Kenfo H, Mekasha Y, and Tadesse Y (2018). A study on sheep farming practices in relation to future production strategies in Bensa district of Southern Ethiopia. Tropical Animal Health and Production, 50(4): 865-874. https://doi.org/10.1007/s11250-017-1509-z

Khan, MJ., Peters, KJ., and Uddin, MM. (2009). Feeding strategy for improving dairy cattle productivity in small holder farm in Bangladesh. *Bangladesh Journal of Animal Science*, *38*(1-2): 67-85. https://www.banglajol.info/index.php/BJAS/article/view/9914

Maleko D, Ng WT, Msalya G, Mwilawa A, Pasape L, and Mtei K. (2018). Seasonal Variations in the Availability of Fodder Resources and Practices of Dairy Cattle Feeding among the Smallholder Farmers in Western Usambara Highlands, Tanzania. Tropical Animal Health Production, 50: 1653-1664. https://doi.org/10.1007/s11250-018-1609-4

Mamo M, Seman U, and Yigrem M (2021). Effect of Different Proportions of Wheat Bran and Noug Seed Cake Mixture Supplementation on Feed Intake, Digestibility and Body Weight Change of Salale Sheep Type Fed Natural Grass Hay as Basal Diet. Journal of Fisheries & Livestock Production, 9: 297. https://www.omicsonline.org/open-access-pdfs/effect-of-different-proportions-of-wheat-bran-and-noug-seed-cakemixture-supplementation-on-feed-intake-digestibility-and.pdf

Martinez JJ, Löest CA, McCuistion KC, Wester DB, and Bell NL (2022). Effects of monensin and protein supplementation on intake, digestion, and ruminal fermentation in beef cattle consuming low-quality forage. Applied Animal Science, 38(1): 13-21. https://doi.org/10.15232/aas.2021-02219

McDonald P, Edward RA, Green Halgh J.F.D and Morgan GA (2002). Animal Nutrition 7th Pearson Educational limited. Edinburgh, Great Britain. Pp 544. http://gohardanehco.com/wp-content/uploads/2014/02/Animal-Nutrition.pdf

Mengistu S, Nurfeta A, Tolera A, Bezabih M, Adie A, Wolde-meskel E, and Zenebe M (2021). Livestock Production Challenges and Improved Forage Production Efforts in the Damot Gale District of Wolaita Zone, Ethiopia. Advances in Agriculture, 2021: Article ID 5553659, 10 pages, https://doi.org/10.1155/2021/5553659

Ranjihan SK (2001). Animal nutrition in the tropics. 4th eds. Vikas publishing House P. Ltd. New Delhi, India. Pp.557. https://www.cabdirect.org/cabdirect/abstract/20023023598

Riveros F (1992). The genus Prosopis and its potential to improve livestock production in arid and semi-arid regions. Legume Trees and Other Fodder Trees as Protein Sources for Livestock. FAO, Roma, pp.257-276. https://www.fao.org/waicent/FAOINFO/AGRICULT/aga/AGAP/FRG/AHPP102/102-257.pdf

Robert WW (2011). Nutrient Composition and Nutritional Quality of Oats and Comparisons with Other Cereals. Editor(s): Francis H. Webster, Peter J. Wood, In American Associate of Cereal Chemists International, Oats (Second Edition), AACC International Press, 2011, Pp 95-107. https://doi.org/10.1016/B978-1-891127-64-9.50011-7

Roche JR, Blache D, Kay JK, Miller DR, Sheahan AJ and Miller DW (2008). Neuroendocrine and physiological regulation of intake with particular reference to domesticated ruminant animals. Nutrition Research Reviews, 21: 207–234. https://doi.org/10.1017/s0954422408138744

Sawal RK, Ratan R, and Yadav SB (2004). Mesquite (*Prosopis juliflora*) pods as a feed resource for livestock-A review. Asian-Australasian Journal of Animal Sciences, 17(5): 719-725. https://doi.org/10.5713/ajas.2004.719

Solomon M, Peters KJ and Azage T (2004b). Feed intake digestive kinetics and rumen volatile fatty acids in Menz rams supplemented with *Lablab purpureus* or graded levels of *Leucaena pallida* and *Sesbania sesban*. Journal of Animal Feed Science and Technology, 117: 61-73. DOI: http://dx.doi.org/10.1016/j.anifeedsci.2004.07.016

Solomon M., Peters, KJ. and Azage T (2004a). Effect of supplementation with foliages of selected multi-purpose trees, their mixtures or wheat bran on feed intake, plasma enzyme activities, live weight and scrotal circumference gains of Menz sheep. Journal of Livestock Production Science, 89: 253-264. DOI: http://dx.doi.org/10.1016%2Fj.livprodsci.2004.01.003

Upton M. (1979). The Unproductive Production Function. Journal of Agricultural Economics, 30(2): 179-194. https://doi.org/10.1111/j.1477-9552.1979.tb01494.x

Van Soest PJ, Robertson JB, and Lewis BA (1991). Methods for Dietary Fiber, Neutral Detergent Fiber, and Non-Starch Polysaccharides in Relation to Animal Nutrition. Journal of Dairy Science, 74(10): 3583-3597. https://doi.org/10.3168/jds.S0022-0302(91)78551-2

Walsh SW, Williams EJ, and Evans AC (2011). A review of the causes of poor fertility in high milk producing dairy cows. Animal Reproduction Science, 123(3-4): 127-138. https://doi.org/10.1016/j.anireprosci.2010.12.001

Xin H, Khan NA, and Yu P (2021). Evaluation of the nutritional value of faba beans with high and low tannin content for use as feed for ruminants. Journal of the Science of Food and Agriculture, 102 (7): 3047-3056. https://doi.org/10.1002/jsfa.11646

Yang K, Yiqing Q, Qifang Y, Xiaopeng T, Gang C, Rejun F, and Hu L (2021). By-Product Feeds: Current Understanding and Future Perspectives. Agriculture, 11 (3): 207. https://doi.org/10.3390/agriculture11030207

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APPLICATION OF INTERNATIONAL COMMITTEE FOR ANIMAL RECORDING (ICAR) METHODOLOGY IN DAIRY HERD MANAGEMENT IN SOUTH OF RUSSIA

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ABSTRACT: This experiment was conducted to determine the advantages of introducing modern innovative approaches to dairy herd management based on the study and implementation of the methodological of International Committee for Animal Recording (ICAR). This research shows the main directions for introduction to new breeding and the technological model of interaction with breeding farms for breeding dairy cattle. This interaction occurs through the services provision for breeding farms, the control-assistant and expert-boniter services, as well as laboratories for selection control of milk quality and genetic control. The tasks of the control-assistant service included participation in the control milking of cows and individual milk samples picking from each cow and its delivery to the laboratory in a chilled form. Using as the example dairy herd of the black and white breed by studying the dynamics of somatic cells has been showing the effectiveness of different methods for assessing the quality of milk. Implementation of the milk quality regular monitoring during 1-2 months allows bringing the main parameters of milk quality in line with the requirements of national and international ICAR standards. The cow's conformation assessment by animals' linear assessment allows revealing the bull's prepotent abilities and choosing the right strategy for improving the cow's conformation in the herd. Genetic well-being assessment of cows makes it possible to exclude unwanted individuals with genetic abnormalities and use only healthy animals in breeding. The research purpose was studying the possibility of applying the ICAR method in Russian breeding livestock to improve the dairy herd management system. The research results showed that Implementation of individual veterinary measures for two months allowed reducing the average somatic cell count by 1.85 times and reaching the level recommended by ICAR. The spread of individual indicators also significantly decreased. Therefore, Using the individual monitoring of dairy raw materials quality assessment makes it possible to study the influence of para-typical (climatic) factors on the content of dairy components, as well as to stabilize the quality parameters in terms of the level of somatic cells not higher than 200 thousand cells/cm3.

Keywords: Breeding, Dairy cattle breeding, Dairy herd, Genetic resources, Milk quality.

INTRODUCTION

Dairy cattle breeding is one of the basic branches of agriculture that ensures the national security of the Russian Federation. In most regions of Russia, the main shares of livestock products and milk have been producing in personal subsidiary farms and farms (Galiev and Ahrens, 2018). That leads to the small-scale nature of production processes and the insufficient ability to effectively control the quality and safety of products. Currently, in the domestic Russian market, have been producing about 22.5 million tons of marketable milk, which is approximately 236-237kg/person per year or at the level of 70% of the biological requirement (Melnikova and Bogdanova, 2021). The shortage of raw milk in Russia is almost 100kg per person per year, or 30.7% of the need (Melnikova and Bogdanova, 2021).

The regulatory requirements for food security regulate the production of raw milk in the domestic market for at least 90% of the needs for the population. It could reach by introducing current dairy herd management systems developed based on classical studies (Crowe et al., 2018; Guinn et al., 2019; Cockburn, 2020). To increase the efficiency of the development of national dairy farming, it is necessary to develop and implement an integrated approach to managing a dairy herd, considering the proven accounting practices of the International Committee for Animal Registration (ICAR) for accounting for the milk production of lactating cows (Ferris et al., 2020).

Reproduction of the herd of dairy cattle is one of the major factors that ensure the preservation of the dairy herd and stable milk production. There had been revealing the negative impact of various genetic anomalies in cattle. That often inherited in a recessive form and under certain conditions, upon transition to a dominant form. It causes significant damage to both the health of animals and the reproduction of the herd (Cartwright et al., 2017; Nowicki et al., 2017; Schuster et al., 2020).

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An analysis of the official accounting data in the breeding dairy farming of Russia shows that if in 2014 the average age of all breeding dairy cows calving was 2.79, and the withdrawal of animals from the herd for various reasons were at 3.48. Then, there had been observing the so-called "rejuvenation" of cows when they had retired from the herd. Since the average age of all breeding dairy cows calving was 2.52 and disposal occurs already at 3.11 calving. Thus, it could have assumed that during 2014-2019, at the national level, it was not possible to find an organizational and technological solution to ensure a longer period of economic use of highly productive dairy cattle (Yurchenko et al., 2018; Nikitin et al., 2021; Khabipov et al., 2021).

Considering the fact that the level of reproduction of a herd of dairy cattle, according to official data, is on average at the level of 80%, and the duration of the service period is 130-140 days (for Holstein, Ayrshire, black and white breeds), it will no longer be possible to provide annual replenishment of uterine resources, respectively, and the full reproduction of the dairy herd. Thus, there remains a need to replenish uterine resources in dairy cattle breeding only by importing livestock from abroad. The dairy business is also talking about this with concern.

The current situation in pedigree dairy cattle breeding raises concerns about actually achieving the criteria indicators outlined in the current Food Security Doctrine and causes the search for new breeding and technological solutions (Ananiev et al., 2019; Muzalev and Reshetov, 2020).

In addition, the significant dependence of the national dairy cattle breeding on the import of genetic resources (bull semen, embryos, and heifers) does not allow to fully monitoring the genetic usefulness and well-being of incoming materials. Over the past 40-50 years, in Russian market are being intensive delivered the genetic material from the leading countries of the world. That, of course, led to the creation of a highly productive array of Holsteinized cattle from the leading lines of sires (Hladiy et al., 2018).

Using a limited contingent of Holstein and Ayrshire bulls in the breeding system led to the appearance of newborn calves with various physiological and anatomical abnormalities that have a genetic basis because of gene mutation. There had known about two hundred types of such anomalies, including about 80 in Holstein black and white cattle, and about 20 in Ayrshire cattle. This is physiological abnormalities of organs and tissues because of genetic disorders. These deviations had been inheriting in a recessive form. Therefore, they are an undesirable hidden genetic load in the herd. In the event of an increase in inbreeding under conditions of large-scale selection, a significant change in the dynamics of their inheritance frequencies can occur (Zinovieva, 2016; Gladiy et al., 2018).

Therefore, in order to reduce import dependence on the supply of genetic materials, as well as to develop national breeding resources in dairy cattle breeding, it is necessary to develop a modern innovative dairy herd management system that allows you to consider and meet the needs of dairy cattle, ensure high efficiency of production processes, and purposefully form animals with the desired physique type.

The purpose of the research is to study the possibility of a comprehensive application of the methodological approaches recommended by ICAR to assess phenotypic (yield, milk quality) and genotypic (presence of genetic abnormalities) traits to improve the efficiency of managing a herd of highly productive dairy cattle.

MATERIALS AND METHODS

For this research, methodological recommendations for the application of the ICAR method was developed in dairy cattle breeding. For this reason had created the control-assistant and expert-boniter services and laboratories for milk selection control quality and genetic control. Cattle phenotypic and genotypic characteristics studying were in herds of breeding black and white (1275 cows) and Holstein (1100 cows) cattle of the South of Russia. Average milk productivity of these herds was 8.2 and 9.8 thousand kg of milk per cow per year. The raw milk quality studying had conducted in the milk quality selection control laboratory. Fluorescence microscopy carried somatic cells determination in milk by a somatic cell analyzer DCC, Delavale. The essence of the method lies in the somatic cells cytoplasmic membrane destruction under the lysogenic buffer, while the cell nuclei become available for the action of a fluorescent dye, which is propidium iodide. This reagent binds to the double-stranded DNA of somatic cells, and forms a fluorescent substance that absorbs green light and emits red, with the help of the latter, the somatic cell is identified. The system gives an image of the cells, and the computer built into the analyzer, using software, counts the number of white dots, which corresponds to the number of somatic cells. Cell analyzer DCC, working on the principle of fluorescence microscopy, equipped with a cassette receiver (removable mandrel), backlit LCD display, complete with cassettes (Nudeo cassette), sample flasks.

There was monitored a wide range of genetic abnormalities associated with impaired fertility: Leukocyte adhesion deficiency (BLAD); uridine monophosphate synthase deficiency (DUMPS); Complex spinal malformation (CVM); citrullinemia (BC); Brachispin (BY); Blood factor XI (eleven) deficiency (FXID); Axonopathy (DS); Subfertility of bulls (BMS); Chediak-Higashi Syndrome (CHS); Congenital muscular dystonia type 1 (CMD1); Congenital muscular dystonia type 2 (CMD2); Crooked Tail Syndrome (CTS); Bulldog dwarfism (BD); Epidermolysis bullosa (EB); Factor VIII deficiency (eight); hemophilia A (FVIIID); Idiopathic congenital megaesophagus (ICM), a-mannosidosis (a-MAN), β-mannosidosis (b-MAN); Mucopolysaccharidosis (MPSIIIB); maple syrup disease (valinoleucinuria) (MSU); Syndactyly, mule hoof (Mulefoot); Neuronal ceroid lipofuscinosis (NCL), Osteopetrosis (OS); bloated calf syndrome (PCS); Congenital pseudomyotonia (PMT); Congenital erythropoietic protoporphyria (PT); Arachnomyelia and arthrogryposis syndrome (SAA); spinal demyelination (SDM); spinal muscular atrophy (SMA); thrombopathy (TP); Weaver (Weaver Syndrome) (Weaver). Haplotypes associated

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with impaired fertility - according to 12 indicators: Holstein haplotype 1 (HH1); Holstein haplotype 2 (HH2); Holstein haplotype 3 (HH3); Holstein haplotype 4 (HH4); Holstein haplotype 5 (HH5); Holstein haplotype associated with cholesterol deficiency (HCD).

Work on monitoring genetic diseases and DNA diagnostics of the productive qualities of dairy cattle were carried out in a certified genetic laboratory. The monogenic diseases carriage studied by selecting biological material as a skin pluck, from which genomic DNA was isolated using Qiagen columns, the Netherlands called QIAamp DNA Blood Mini Kit based on silicon membrane technology under the manufacturer's protocol.

The carrier status of monogenic recessive diseases determination and lethal haplotypes of cattle was using the polymerase chain reaction method with further electrophoretic analysis of the amplicon, the method of polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP), the method of sequencing target regions of the bovine genome or the method of whole genome genotyping using technology from Illumina, USA.

Polymerase chain reaction method with further electrophoretic analysis of the amplicon: within the framework of this technique, the polymerase chain reaction was in a volume of 10 ml containing 10 ng of DNA, 2 ml of the 5X MasCFETaqMIX PCR buffer (Dialat, Moscow) and 0.4 ml of primer (concentration 2.5 pmol/100 ml). The polymerase chain reaction was on a C1000™ ThermalCycler instrument (BioRad, USA). PCR products separated on a 2% agarose gel, visualized in an ultraviolet transilluminator, and detected using a gel documentation system. Carrier status was determined based on the identification of bands in the agarose gel, which corresponded to DNA fragments of a certain length.

Polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP). The polymerase chain reaction carried out in a volume of 10 ml containing 10 ng of DNA, 2 ml of PCR buffer 5X MasCFETaqMIX (Dialat, Moscow) and 0.4 ml of primer (concentration 2.5 pmol/100 ml). The polymerase chain reaction was carried out on a C1000™ ThermalCycler instrument (BioRad, USA). Next, 10 ml of the restriction mixture containing 0.7 ml of restriction endonuclease, 1.3 ml of 10x buffer for the selected restriction endonuclease, and 8 ml of water was added to 10 ml of the got amplicon. The resulting mixture incubated according to the restriction endonuclease manufacturer's protocol on a C1000™ ThermalCycler instrument (BioRad, USA). The incubated restriction mixture separated on a 4% agarose gel, visualized in an ultraviolet transilluminator and detected using a gel documentation system. The definition of carrier status established based on the identification of bands in the agarose gel, which corresponds to DNA fragments of a certain length. Method for sequencing target sections of the bovine genome: within the framework of this technique, a polymerase chain reaction performed in a volume of 10 ml containing 10 ng of DNA, 2 ml of PCR buffer 5X MasCFETaqMIX (Dialat, Moscow) and 0.4 ml of primer (concentration 2.5 pmol/100 ml). The resulting amplicons were purified by alcohol (ethanol) reprecipitation. Next, the purified amplicon was sequenced on an ABI PRISM 3730 capillary sequencer according to the protocol of the manufacturer. Carrier status was determined based on the determination of the genotype of the casual mutation associated with the disease.

Whole genome genotyping method using technology from Illumina, USA: Whole genome genotyping was performed using standardized protocols from Illumina, USA. Mathematical processing of primary data was by Statsoft and MS Excel. Changes were significant at $p<0.05$.

RESULTS AND DISCUSSION

The organization of individual sampling of raw milk with the involvement of the control-assistant service made it possible to study the seasonal dynamics of the main dairy components, including milk fat, which is the most important element for providing good nutrition to consumers.

Statistical processing of the actual material made it possible to establish a high dependence between the parameters of the temperature factor throughout the seasons of the year and the average concentrations of the main dairy components in cows of the studied breeds - milk fat and protein (Figures 1 and 2). The results showed that in the breeding stock of the Holstein breed, the correlation coefficient between the temperature dynamics and the fat content in milk was $r = - 0.74$. Similarly, for protein, this indicator was, respectively, $r = - 0.77$. In the breeding stock of the black and white breed, the showed correlative relationship was also high. The correlation index between changes in ambient temperature and the concentration of fat in raw milk was $r = - 0.71$, and for protein, respectively, $r = - 0.80$. Carrying out individual sampling of milk from breeding cows, prompt delivery of milk samples in compliance with the temperature during transportation not higher than +4...+ 6ºC and the study of the content of dairy components using modern methods made it possible to record high negative relationship between changes in the temperature factor and the concentration of milk components - fat and protein. The established high influence of the temperature factor on the indicators of the content of dairy components causes the development of modern feeding and housing systems for highly productive dairy cattle to ensure more stable microclimate parameters throughout the seasons of the year, which is also emphasized by the increasing global climate trends associated with warming. The study of the dynamics of changes in the content of fat and protein in milk over the seasons of the year shows that the studied raw milk meets the established breed requirements and corresponds to the category of high-quality milk, because changes in milk fat were between 3.92...4.18%, and milk protein, respectively, 3.24-3.40%, which correspond to national requirements, and also exceed them by 10-15%.

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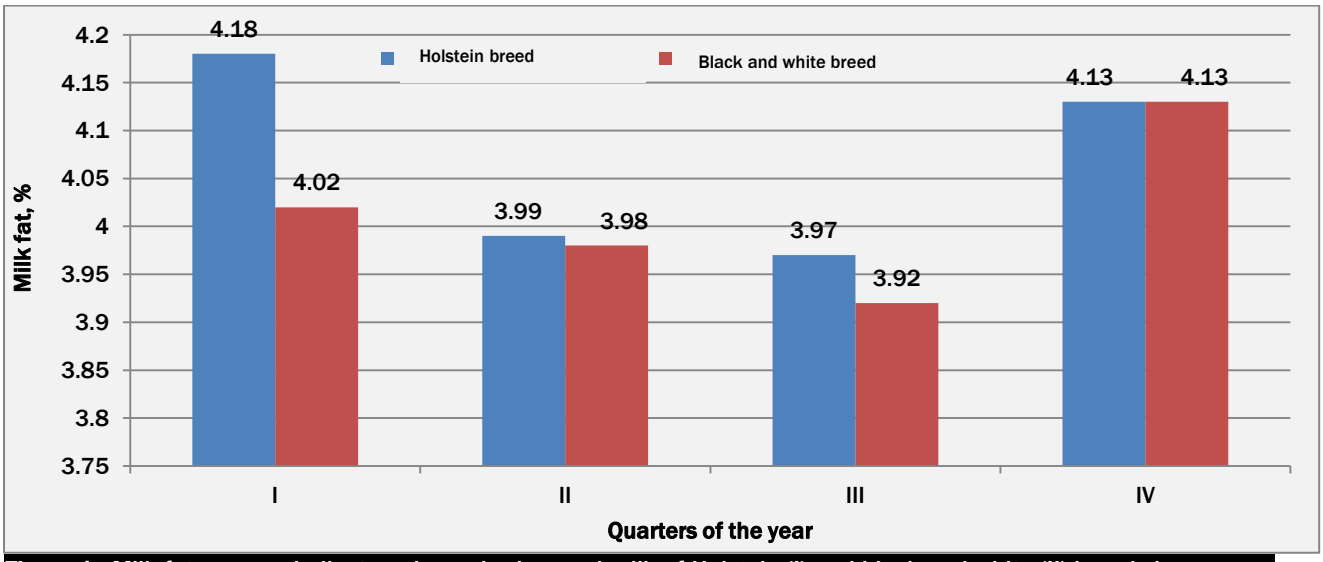

Figure 1 - Milk fat average indicators dynamics in cows' milk of Holstein (I) and black and white (II) breeds by seasons

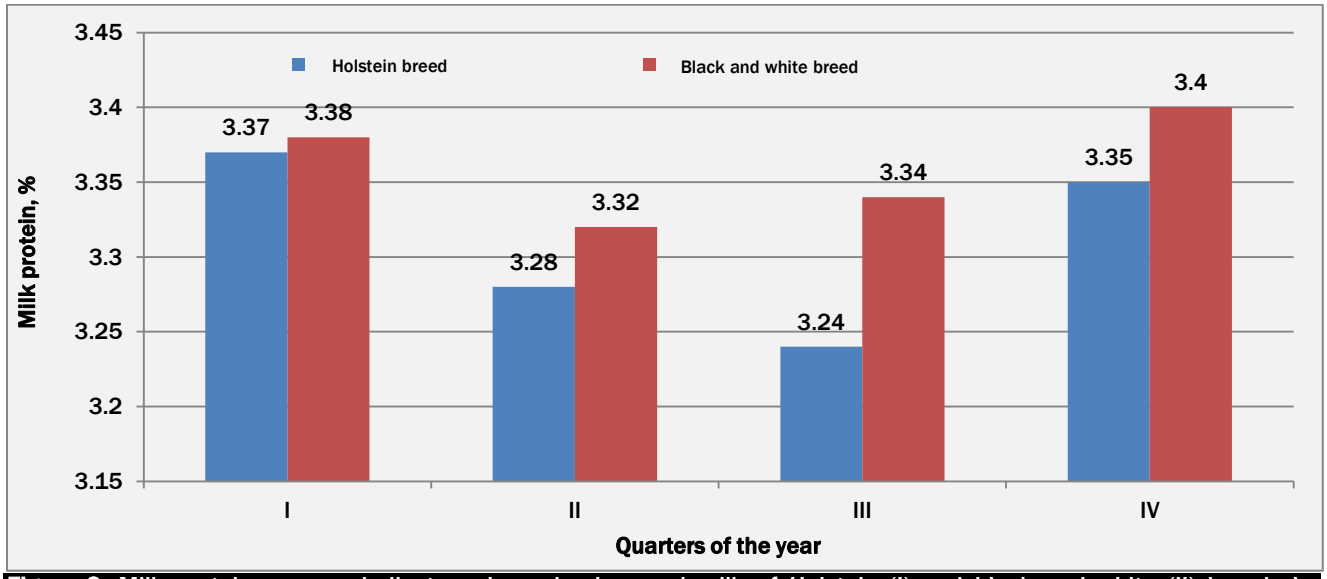

Figure 2- Milk protein average indicators dynamics in cows' milk of Holstein (I) and black and white (II) breeds by seasons

The technological factor, the system of keeping animals, of course, affects the parameters of the microclimate and the ability of animals to realize the genetically determined potential of milk production. In the farms under study, the maintenance of black and white breed cows is tethered, and the milking of cows is linear. While the cows of the Holstein black and white breed are kept loose and their milking is carried out in the milking parlour. The dynamics of milk components in cows of the studied genotypes are similar, despite the different systems of feeding and keeping animals in the studied enterprises. There had known that industrial milk production by tethered housing system, animals are in stress. Cows deprived the possibility for free movement and may have reduced immunity (Sawa and Bogucki, 2011). In the conditions of a loose system of keeping animals, labor costs for servicing livestock are significantly reduced. However, because of problems with monitoring the individual condition of the breeding stock, the herd reproduction parameters often deteriorate and the only way out is the widespread use of hormonal stimulation (Lambertz et al., 2014; Kobek-Kjeldager et al., 2020).

Undoubtedly, the achievement of high milk yields in modern dairy cattle genotypes is an important result of selection and breeding work in the breeding herds of dairy cattle (Oltenacu and Broom, 2010). There is obvious fact that massive using the hormonal drugs to ensure the desired herd reproduction indicators cannot be recognized as justified. For example, the duration of the inter-calving period is not over 400 days, as practiced in many countries around the world. It is necessary to conduct an in-depth study of the influence of the genetic characteristics of modern dairy cattle in combination with the development of an adequate system of feeding and keeping animals to minimize the use of veterinary drugs in implementing the natural need of cows - the birth of a calf (Ladyka et al., 2021). This work has begun in the countries of the Eurasian Economic Union. Carrying out individual sampling of milk also allows you to quickly respond to a decrease in the quality of milk because of an increase in somatic cells. Because of the influence of seasonal factors, we studied the possibility of improving the quality of raw milk by interacting with a separate "problem" farm by

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monthly monitoring of milk quality for the content of somatic cells. The results of the study of the content of somatic cells in the milk of the controlled group of cows (Table 1) show that in the first period of lactation, there was a slight excess of this parameter compared to the level of somatic cells recommended by ICAR (up to 200 thousand cells/cm^3), although these parameters correspond to the current regulatory document in the EAEU countries. The individual scatter of data on the content of somatic cells both visually (Figure 3) and mathematical characteristics was quite large. The standard deviation is 6.67% of the mean value. Using individual veterinary measures, there had observed significant improvement in the situation regarding milk quality within two months (Table 1 and Figure 4). Thus, the average value of somatic cells decreased by 1.85 times and reached the level recommended by ICAR. The spread of individual indicators also significantly decreased. The standard deviation was 3.63% of the average value for the herd.

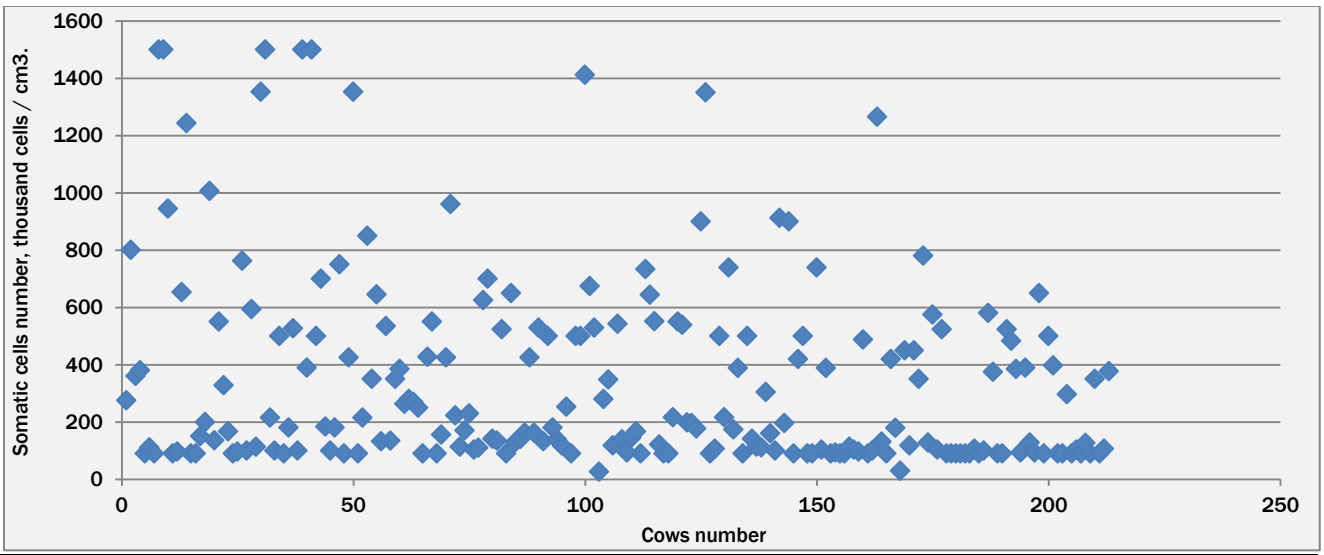

Figure 3 - Distribution of individual indicators of the content of somatic cells in raw milk of a herd of black and white cows before monitoring

Table 1 - Dynamics of the content of somatic cells in raw milk in black and white cows during monitoring

Control group of cows	Number of cows in the group	The content of somatic cells, thousand cells/cm3	Individual minimum level of somatic cells, thousand cells/cm3	Individual maximum level of somatic cells, thousand cells/cm3
Up to 100 days of lactation	213	346 ± 23.1	26	1500
During the period of 100-200 days of lactation	213	187 ± 6.8*	25	414

P<0.05

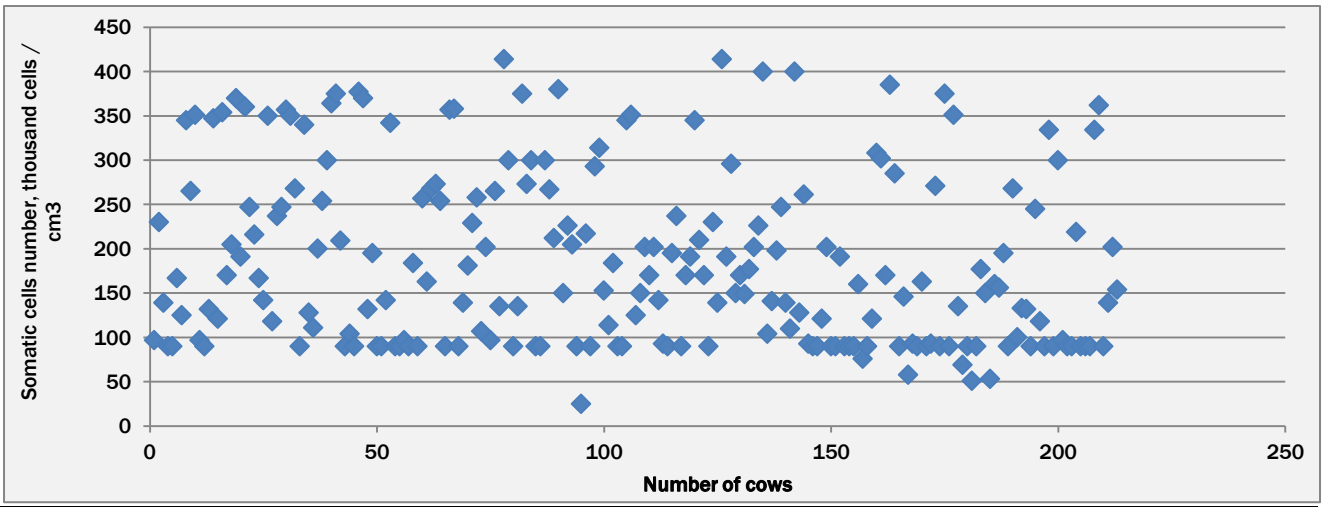

Figure 4 - Somatic cells distribution in raw milk of black and white cows after monitoring

According to the results of genetic studies (65 heads) were determined cows with reproductive problems. There were 2 cows carriers of the monogenic recessive disease BLAD, 1 - carrier of the monogenic recessive disease CVM and 1 - carrier of the recessive monogenic disease BY, 2 - carriers of the lethal HCD haplotype, 1 - carrier of the lethal HH1 haplotype, 2 - carriers of the lethal HH3 haplotype and 1 - carrier of the lethal HH5 haplotype. The isolation percentage of

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animals with genetic abnormalities did not exceed 3% of the study group. These genetic abnormalities emphasize the need for widespread genetic monitoring to ensure the effective development of the dairy cattle industry. The results of the research allow us to conclude that implementing the ICAR method in the practical field of livestock breeding in Russia is promising. As mentioned above, the organization of breeding work in dairy farming was under the Order of the Ministry of Agriculture of the Russian Federation of October 28, 2010 No. 379. These documents regulate the selection and breeding work in breeding enterprises, mainly with the involvement of full-time veterinary specialists of these enterprises. The modern practice of organizing dairy herd management, developed in ICAR member countries and presented in the public domain, involves the involvement of specialists from an independent control-assistant service. Also, it should conduct milk quality assessment in an independent, specialized laboratory. It should notice that, since 2016, a regulatory document has also come into force in the breeding dairy cattle breeding of Russia. This document recommends conducting research on the quality of dairy raw materials in independent laboratories for selection control of milk quality. It is certainly a progressive step and contributes to increasing the reliability of research and improving breeding work in dairy herds. The introduction of a control-assistant service remains open, although we have already discussed this issue at the national level (Vasilchenko, 2018). Approval of the method for assessing the breeding value of farm animals in the member states of the Eurasian Economic Union of the member countries of the EAEU, which is reflected in the new developed regulatory documents of the Eurasian Economic Commission for assessing the breeding value of dairy cattle, considering the ICAR method and as mentioned above, is also progressive character. Questions regarding the assessment of the daily dynamics of milk fat and protein in breeding cows, as reflected in the works of Dineen et al. (2020), Dynko et al. (2021) and Trukhachev et al. (2021).

Using foreign standards in the practice of breeding work (ICAR, Section 7 Bovine Functional Traits, 2020) for assessing the quality of milk, which establish more stringent requirements for the permissible level of somatic cells up to 200 thousand cells/cm3, in practice allow us to ensure the production of high-quality milk raw materials and the exploitation of a healthy milking contingent, free from mastitis diseases, which certainly makes it possible to more fully realize the genetically determined potential of milk productivity. Metlytska et al. (2018), Safina, (2018), and Ladyka et al. (2021) also pointed out the achievement of the desired milk productivity. Supplementing the practice of dairy herd management with mandatory monitoring of cattle for genetic abnormalities should also have to be as a progressive requirement. There had been studying that a few parental couples carriers of recessive monogenic diseases BLAD, CVM, BY, HCD and HH1, HH3, HH5 haplotypes. It is likely that some cows have reached the dominant form of these anomalies, which is reduced, including the fertility of animals. And although at the present stage, genetic studies are quite expensive and therefore cannot recommended everywhere for the entire livestock, it is necessary to cover stud bulls as much as possible with studies. Implementation of the ICAR method in breeding dairy cattle breeding in Russia will make it possible to assess the breeding value of dairy cattle using unified methods that have already tested in ICAR member countries. A wider implementation of this method will make it possible to form an export development vector for livestock breeders in the states of the Eurasian Economic Union. It should recognize that development of national coefficients for recalculating the daily dynamics of milk fat and protein content as promising areas. That will make it possible to unify national methods for assessing the breeding value of animals with the accepted methodological approaches of ICAR.

CONCLUSION

Implementation of individual veterinary measures for two months allowed reducing the average somatic cell count by 1.85 times and reaching the level recommended by ICAR. The spread of individual indicators also significantly decreased. The standard deviation was 3.63% of the herd mean. According to the results of genetic studies of cows (65 heads), the number of animals with genetic abnormalities did not exceed 3% of the study group. But these genetic anomalies underline the need for widespread genetic monitoring to ensure the effective development of the dairy cattle industry. Therefore, introducing the ICAR method into the practice of national breeding work in dairy cattle breeding will make it possible to unify accounting practices with international principles and form the export potential. Using the individual monitoring of dairy raw materials quality assessment makes it possible to study the influence of para-typical (climatic) factors on the content of dairy components, as well as to stabilize the quality parameters in terms of the level of somatic cells not higher than 200 thousand cells/cm^3.

DECLARATIONS

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Authors' contribution

Oleinik S. conceived of the presented idea; Skripkin V. developed the theory and performed the computations; Ershov F. analyzed and interpreted the data, and edited the manuscript for important intellectual contents; Shlykov S. and Omarov R. participated with data acquisition and critically revised the manuscript for improvements. All authors discussed the results and contributed to the final manuscript.

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Conflict of interests

The authors have not declared any conflict of interests.

REFERENCES

Ananiev MA, Burlankov SP, Melnikova DM and Sedova NV (2019). Forecasting the main indicators of food security of Russia. International Journal of Recent Technology and Engineering, 8(2): 4637-4642. Link

Cartwright SL, Malchiodi F, Thompson-Crispi K, Miglior F and Mallard BA (2017). Short communication: Prevalence of digital dermatitis in Canadian dairy cattle classified as high, average, or low antibody- and cell-mediated immune responders. Journal of Dairy Science, 100(10): 8409-8413. Link

Cockburn M (2020). Review: Application and prospective discussion of machine learning for the management of dairy farms. Animals, 10(9): 1690. Link ; DOI: https://doi.org/10.3390/ani10091690

Crowe MA, Hostens M and Opsomer G (2018). Reproductive management in dairy cows - The future. Irish Veterinary Journal, 10(9): 1690. Link ; DOI: https://doi.org/10.1186/s13620-017-0112-y

Dineen M, McCarthy B, Dillon P, LaPierre PA, Fessenden S, Matthews C and Van Amburgh ME (2020). Rumen metabolism, omasal flow of nutrients, and microbial dynamics in lactating dairy cows fed fresh perennial ryegrass (Lolium perenne L.) not supplemented or supplemented with rolled barley grain. Journal of Dairy Science, 103(12): 11332-11348. Link ; DOI: https://doi.org/10.3168/jds.2020-18437

Dynko Y, Stavetska R, Babenko O, Starostenko I and Klopenko N (2021). Characteristics of economically important traits of cows depending on their body built. Tehnologìâ Virobnictva ì Pererobki Produktìv Tvarinnictva, 1: 14-24. Link ; DOI: https://doi.org/10.33245/2310-9289-2021-164-1-14-24

Ferris MC, Christensen A and Wangen SR (2020). Symposium review: Dairy Brain - Informing decisions on dairy farms using data analytics. Journal of Dairy Science, 103(4): 3874-3881. Link ; DOI: https://doi.org/10.3168/jds.2019-17199

Galiev RR, and Ahrens HD (2018). Part-time farmers in Russia: Phenomenon and social functions based on the example of the Republic of Bashkortostan. Studies on Russian Economic Development, 29(3):257-266. Link ; DOI: https://doi.org/10.1134/S107570071803005X

Gladiy MV, Polupan YP, Bazyshina IV, Pochukalyn AE, Koval TP, Bezrutchenko IM and Mikhaylenko NG (2018). Genesis and prospects of red dairy cattle in ukraine. Animal Breeding and Genetics, 51: 41-60. Link ; DOI: https://doi.org/10.31073/abg.51.06

Guinn JM, Nolan DT, Krawczel PD, Petersson-Wolfe CS, Pighetti GM, Stone AE and Costa JHC (2019). Comparing dairy farm milk yield and components, somatic cell score, and reproductive performance among United States regions using summer to winter ratios. Journal of Dairy Science, 102(12): 11777-11785. Link ; DOI: https://doi.org/10.3168/jds.2018-16170

Hladiy MV, Polupan YP, Kovtun SI, Kuzebnij SV, Vyshnevskiy LV, Kopylov KV and Shcherbak OV (2018). Scientific and organizational aspects of generation, genetics, reproduction biotechnology and protection of the genofonds in livestock breeding. Animal Breeding and Genetics, 56: 5-14. Link ; DOI: https://doi.org/10.31073/abg.56.01

Khabipov RR, Serebryakova TYu, Khmelev SA (2021). Dairy farming in the national food security infrastructure. Voprosy Regionalnoj Ekonomiki, 2(47): 148-157. Link ; DOI: https://doi.org/10.21499/2078-4023-2021-47-2-148-157

Kobek-Kjeldager C, Moustsen VA, Theil PK and Pedersen LJ (2020). Effect of litter size, milk replacer and housing on production results of hyper-prolific sows. Animal, 14(4): 824-833. Link ; DOI: https://doi.org/10.1017/S175173111900260X

Ladyka VI, Sklyarenko YI and Pavlenko YM (2021). Peculiarities of formation of genealogical structure of ukrainian black and white dairy breed in sumy region and research of its influence on the genotype of cows by capa-casein. Animal Breeding and Genetics, 61: 126-136. Link ; DOI: https://doi.org/10.31073/abg.61.14

Lambertz C, Sanker C and Gauly M (2014). Climatic effects on milk production traits and somatic cell score in lactating Holstein-Friesian cows in different housing systems. Journal of Dairy Science, 97(1): 319-329. Link. DOI:https://doi.org/10.3168/jds.2013-7217

Melnikova EI and Bogdanova EV (2021). Parameters for proteolysis of β-lactoglobulin derived from cheese whey. Food Biotechnology, 35(3): 237-251. Link. DOI:https://doi.org/10.1080/08905436.2021.1941079

Metlytska OI, Kopylov KV and Berezovsky AV (2018). Modern molecular-genetic approach to increase efficiency of selection process in animal breeding of Ukraine. Animal Breeding and Genetics, 51: 193-200. Link ; DOI: https://doi.org/10.31073/abg.51.26

Milknews (Information Agency). 2022. Soyuzmoloko: the growth of milk and dairy products production continues despite the complication of the economic situation. Russia. Link

Muzalev SV and Reshetov KY (2020). Food Security of Russia: Problems and Perspectives of Sustainable Development. In Studies in Systems, Decision and Control, 282: 495-502. Link ; DOI: https://doi.org/10.1007/978-3-030-44703-8_54

Nikitin AV, Antsiferova OYu and Fedotov AN (2021). Development of dairy cattle breeding in the Tambov region. IOP Conference Series: Earth and Environmental Science, 845: 012044. Link. DOI: https://doi.org/10.1088/1755-1315/845/1/012044

Citation: Oleinik S, Skripkin V, Ershov A, Shlykov S, and Omarov R (2022). Application of international committee for animal recording (ICAR) methodology in dairy herd management in south of Russia. *Online J. Anim. Feed Res.*, 12(4): 232-239. DOI: https://dx.doi.org/10.51227/ojafr.2022.31

Nowicki A, Barański W, Baryczka A and Janowski T (2017). OvSynch protocol and its modifications in the reproduction management of dairy cattle herds-an update. Journal of Veterinary Research (Poland), 61(3): 329-336. Link ; DOI: https://doi.org/10.1515/jvetres-2017-0043

Oltenacu PA, and Broom DM (2010). The impact of genetic selection for increased milk yield on the welfare of dairy cows. Animal welfare, (1):39-49. https://www.ingentaconnect.com/content/ufaw/aw/2010/00000019/a00102s1/art00006

Safina N (2018). Monitoring variability of leptin gene (lep) alleles of large cattle, depending on the direction of productivity. Vestnik of Kazan State Agrarian University, 12(4). DOI: https://doi.org/10.12737/article_5a5f04fdcc20d2.43676819

Sawa A and Bogucki M (2011). Effect of housing system and milk yield on cow fertility. Archives Animal Breeding, 54(3): 249-256. Link ; DOI: https://doi.org/10.5194/aab-54-249-2011

Schuster JC, Barkema HW, De Vries A, Kelton DF and Orsel K (2020). Invited review: Academic and applied approach to evaluating longevity in dairy cows. Journal of Dairy Science, 103(12): 11008-11024. Link ; DOI: https://doi.org/10.3168/jds.2020-19043

Trukhachev V, Oliinyk S, Zlydnev N, Pokotilo A and Ershov A (2021). Study of daily dynamics of cow milk quality indicators. BIO Web of Conferences, 37: 00091. Link ; DOI: https://doi.org/10.1051/bioconf/20213700091

Vasilchenko MY (2018). The innovation process development in dairy cattle breeding in Russia. Espacios, 39(14): 30. Link

Yurchenko A, Yudin N, Aitnazarov R, Plyusnina A, Brukhin V, Soloshenko V and Larkin DM (2018). Genome-wide genotyping uncovers genetic profiles and history of the Russian cattle breeds. Heredity, 120:125–137. Link ; DOI: https://doi.org/10.1038/s41437-017-0024-3

Zinovieva NA (2016). Haplotypes affecting fertility in Holstein cattle (review). Sel'skokhozyaistvennaya Biologiya [Agricultural Biology], 51(4). DOI: https://doi.org/10.15389/agrobiology.2016.4.423eng

Citation: Oleinik S, Skripkin V, Ershov A, Shlykov S, and Omarov R (2022). Application of international committee for animal recording (ICAR) methodology in dairy herd management in south of Russia. *Online J. Anim. Feed Res*., 12(4): 232-239. DOI: https://dx.doi.org/10.51227/ojafr.2022.31

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NUTRIENT CONTENT AND QUALITY OF SOYBEAN MEAL WASTE FERMENTED BY *Aspergillus ficuum* AND *Neurospora crassa*

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RESEARCH ARTICLE

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ABSTRACT: Present research aimed to increase soybean meal waste quality and nutrient by fermentation using different ratio of mixed fungus inoculum (*Aspergillus ficuum* and *Neurospora crassa*) and fermentation time. The primary materials were soybean meal waste (SMW), fungus *Aspergillus ficuum* and *Neurospora crassa*. The experiment applied a completely randomized design (CRD) with a 3 × 3 factorial pattern and three replications. Two treatments were given in this study, factor A (combination of *A. ficuum* and *N. crassa*), comprising of A1 (3:1), A2 (3:2), and A3 (3:3). Factor B (fermentation time) comprising of B1 (5 days), B2 (7 days), and B3 (9 days). The variance analysis exposed a highly significant interaction between factor A and factor B, and those factors also exposed a highly significant effect. The correlation between SMW crude protein and broiler nitrogen retention showed a positive trend, contrary SMW crude fiber content negatively affected crude fiber digestibility. In conclusion, the combination of *A. ficuum* and *N. crassa* (3:2) and seven days fermentation period showed optimal results as seen from 28.25% crude protein, 13.77% crude fibre, 61.16 nitrogen retention and 58.76% crude fibre digestibility of fermented SMW.

Keywords: *Aspergillus ficuum*, Crude protein, Digestibility, Fermentation, *Neurospora crassa*.

INTRODUCTION

The availability of soybean meal waste (SMW) is abundant in line with the mushrooming of the home industry for making soy milk due to the high public awareness of healthy living. Soy milk has high protein content and contains isoflavone compounds is a beneficial foodstuff for healthy nutrition (Jang et al., 2021; Chitisankul et al., 2022). Along with the increasing demand for soy milk, the availability of SMW is also increasing, so it is the potential to be utilised as a source of animal feed, especially for poultry feed. Nutrient content of SMW is quite high, such as crude protein 27.62%, crude fat 2.95%, non-nitrogen free extract 52.66%, crude fiber 13.81% and ash 2.96%, Ca 0.09%, P 0.04% (Mirnawati, 2011). Although the protein content of SMW is quite high, the benefits are limited. Only 6.2% are possible to be applied in broiler rations. It is due to the low palatability and quality of rations which can be seen from nitrogen retention that is also lower (Mirnawati, 2012).

Based on the previous study, it was found in the broiler that supplemented with fermented soybean milk by *Aspergillus ficuum* resulted in higher feed intake, body weight gain and feed conversion compared to control (Ciptaan et al., 2021). But it is still limited to only being used up to 25% of rations. The limiting factor of using SMW in poultry rations since it has high crude fibre content and phytic acid. Furthermore, Ciptaan and Mirnawati (2015) stated that fermented SMW with *Neurospora sitophila* gave better results than the of *Neurospora crassa* and *Neurospora* sp. saw from crude protein content and nitrogen retention are 37.68% and 55.77%. Although the crude protein content is comparatively high, nitrogen retention is still low because of the presence of phytic acid which will reduce the digestibility of the protein so that the protein becomes unavailable. *In vitro* evaluation of *N. crassa* as an oligosaccharide inoculum toward soybean pulp extract showed a safer fermentation profile with probiotic properties (Zhou et al., 2019). Biotechnology research on cellulolytic fungi and phytates to produce cellulases and phytases to degrade cellulose and phytic acid are to improve the SMW quality (Yang et al., 2019; Chen et al., 2021). So fermented soybean milk is of high quality, namely low crude fibre and phytic acid can be utilized more in poultry rations. One of the fungus that produce high cellulase and phytase is *A. ficuum*. Phytase production from potato waste fermentation using *A. ficuum* reached 5.17 U/g ds (Tian and Yuan, 2016).

Based on the above description, a study to determine the combination of *A. ficuum* with *N. crassa* with fermentation period to increase the SMW quality as local feed ingredients that can replace or reduce the imported feed ingredients in poultry rations is necessary. Besides that, it also determines of fermented SMW that can be applied in the poultry industry to provide low cholesterol meat and eggs.

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MATERIALS AND METHODS

Materials

The materials applied to conduct the study include SMW (Figure 1), *A. ficuum* (Figure 2), *N. crassa* (Figure 3), Potato Dextrose Agar (PDA), experimental chicken, distilled water, rice bran, standard mineral solution comprising of $(NH_4)_2SO_4$ 0.14%, KH_2PO_4 0.2%, $MgSO_4$ $7H_2O$ 0.03%, urea 0.03%, $CaCl_2$ 0.03%, $FeSO_4$ $7H_2O$ 0.0005%, $MnSO_4$ H_2O 0.00016%, $ZnSO_4$ $7H_2O$ 0.00014%, $CoCl_2$ 0.0002%, pepton 0.075%, ADS solution, alcohol, aceton and H_2SO_4 72%. The equipment used is an autoclave to sterilize tools and materials for 1 kg size plastic bags (polypropylene), analytical scales, incubator cabinets, electric ovens, oasis needles, bunsen, test tube, cotton, aluminium foil, and trophy cups, a set of laboratory equipment for analysis.

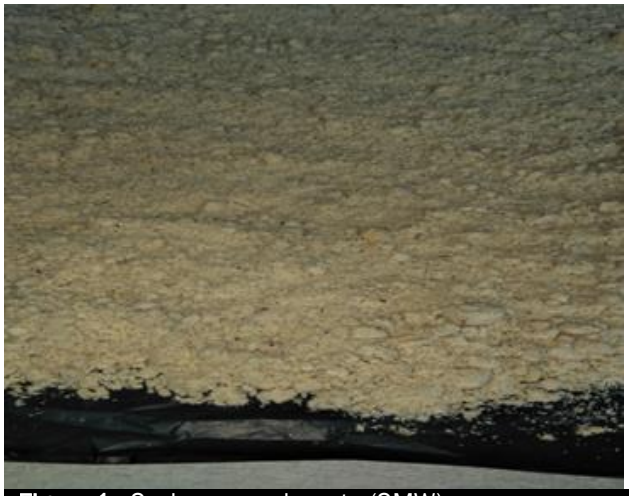

Figure 1 - Soybean meal waste (SMW)

Figure 2 - *Aspergillus ficuum*

Figure 3 - *Neurospora crassa*

Figure 4 - Fermented SMW

Methods

Soybean meal waste fermentation was processed by adding rice bran in a ratio (80:20) as a substrate while the inoculum is *A. ficuum* and *N. crassa* as much as ration treatment then placed in plastic bags as an incubator for several days. The factors for the treatment were: Factor A (ratio of inoculum): A1=3:1, A2=3:2, A3=3:3; Factor B (duration of fermentation): B1=5 day, B2=7 day, B3=9 day.

Fermented SMW was harvested (Figure 4) and dried at a temperature of 60°C and ready to be given as rations.

Determination of crude protein and crude fibre of SMW using proximate analysis

In 100 broilers, Lohmann strain at five weeks of age was prepared for nitrogen retention and crude fibre digestibility measurement. Five birds per unit cage (80 × 80 × 60 cm) supplied with *ad libitum* drinking water. Nitrogen retention and crude fibre digestibility were measured following Sibbald (1980) and Mirnawati et al. (2019). For comparison, we performed nutritional analysis and measurements of nitrogen retention unfermented SMW (Table 1). A completely randomized design applied in this experimental research with factorial patterns (3 × 3) and three replications. The data obtained will be analyzed for variance. If treatment has a significant effect on variables, then proceed with Duncan's Multiple Range Test. Pearson correlation was performed to determine the relationship between the variables using MedCalc software (version 20.110).

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Table 1 - Proximate analysis and nitrogen retention of unfermented SMW

Nutritional value (%)	Soybean meal waste
Crude protein	27.62
Ether extract	2.95
Non-nitrogen free extract	52.66
Crude fiber	13.81
Ash	2.96
Ca	0.09
P	0.04
Nitrogen retention	40

RESULTS AND DISCUSSION

Crude protein content

The results showed that there were interactions that had a highly significant effect (P<0.01) between Factor A (composition of inoculum) and Factor B (duration of fermentation) on crude protein. Each factor A (composition of inoculum) and factor B (duration of fermentation) also showed a similar effect (P<0.01) on crude protein. The interaction between inoculum composition and fermentation period is due to the mixed inoculum nutrition availability and the proper duration of fermentation.

In Table 2 the composition of the treatment inoculum A2 (3:2), it is better than A1 (3:1) and A3 (3:3). A1 (3:1) was higher than A3 (3:3). The composition of the inoculum is optimal in A2 (3:2) thus each inoculum can perform a synergistic effect that enhances enzymatic activity. *A. ficuum* can produce phytase at 37.46 U/ml for seven day incubation period (Pazla et al., 2021). Meanwhile, fermentation of soybean meal by *N. crassa* can hydrolyze protein more efficiently and increase amino acids (Li et al., 2019). *Neurospora* can produce protease enzymes that digest proteins into amino acids and lipases that digest fat, and triglycerides become free fatty acids (Kurniati, 2012). In addition, the highest crude protein content in A2B2 is because of the prominent contribution of the microbes population. Yousufi (2012) stated that the elevated in protein substance was because of the proteins supplement contributed by microbial cells as single cell protein source.

Table 2 - Nutrient content, nitrogen retention, and crude fiber digestibility of SMW.

Variables	A (ratio of inoculum)	B (duration of fermentation)		
		B1 (5 day)	B2 (7 day)	B3 (9 day)
Crude protein (%)	A1 (3:1)	21.08^{c}	25.39^{a}	23.26^{b}
	A2 (3:2)	22.51^{c}	28.25^{a}	25.18^{b}
	A3 (3:3)	19.11^{c}	24.47^{a}	22.04^{b}
Crude fiber (%)	A1 (3:1)	18.81^{a}	16.71^{c}	17.90^{b}
	A2 (3:2)	17.25^{a}	13.77^{c}	15.97^{b}
	A3 (3:3)	20.54^{a}	18.40^{c}	19.24^{b}
Nitrogen retention (%)	A1 (3:1)	45.64^{c}	55.56^{a}	51.48^{b}
	A2 (3:2)	51.25^{c}	61.16^{a}	56.43^{b}
	A3 (3:3)	42.57^{c}	49.56^{a}	47.52^{b}
Crude fibre digestibility (%)	A1 (3:1)	45.32^{c}	55.28^{a}	50.53^{b}
	A2 (3:2)	49.50^{c}	58.76^{a}	53.11^{b}
	A3 (3:3)	39.60^{c}	49.30^{a}	45.23^{b}

Different letters in different lines and uppercase letter show a highly significant effect (P <0.01)

Crude fibre content

The results of the analysis showed that treatment had a highly significant interaction (P<0.01) between factor A (composition of inoculum) and factor B (duration of fermentation) on crude fibre content. More specifically, each factor showed an eminent effect (P<0.01). The lowest crude fibre content is found in A2B2 (13.77%). Li et al. (2014) stated that *N. crassa* has peptidase enzyme activity, endoglucanase, exoglucanase, and cellobiose dehydrogenase. It is an extracellular enzyme that plays a role in the hydrolysis of cellulose and hemicellulose. Fermentation inoculum using *N. crassa* can improve nutritive value in agriculture waste and might enhance poultry production (Liu et al., 2016). This result is close to the crude fibre content of fermented palm kernel cake with *Bacillus subtilis* plus humic acid treatment with a value range of 18.05-19.96% (Mirnawati et al., 2022). In addition, the application of fermentation to palm kernel cake using *Sclerotium rolfsii* can replace commercial concentrate in quail ration without significantly affecting crude fiber content and egg production (Ciptaan et al., 2022).

Nitrogen retention

The finding has proven that there were high significant interactions (P<0.01) between factor A (composition of inoculum) and factor B (duration of fermentation) on nitrogen retention. Each factor also showed a high significant effect

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(P<0.01) on a variable. As shown in Table 2 that the highest nitrogen retention is found in A2B2 (61.16%). Since the crude protein content in A2B2 is higher than in the other treatments. In addition, during fermentation, *A. ficuum* produces a protease enzyme resulting in better nutrition quality for SMW. Malomo et al. (2013) showed that broiler nitrogen retention is positively related to dietary protein content. This also has an impact on increasing the protein efficiency ratio in diet substituted with 15% SMW (Dono et al., 2017). If the protein content is low, it will impact the animal production. However, Brink et al. (2022) showed that higher crude protein levels did not elevate broiler nitrogen retention.

Crude fibre digestibility

The variance analysis exposed that there were interactions between factors A and B that had a highly significant effect (P<0.01). Each factor also contributes to the digestibility of crude fibre SMW with a prominent effect (P<0.01). Table 2 showed the A2B2 highest crude fibre digestibility (58.76%). Since the crude fibre content in A2B2 is lower than in other treatments. Crude fibre components are degraded during the fermentation process that animals could easily digest. *N. crassa* has high cellulolytic activity and produces cellulase enzymes that enhance crude fibre digestibility and also protein availability (Mirnawati et al., 2017). Compared with the combination of *Phanerochaete chrysosporium* and *N. crassa* (4:1), the digestibility of palm oil sludge fibre was 57.66% for an incubation period of 13 days. A mixture of *A. ficuum* and *N. crassa* showed SMW in better crude fibre digestibility with a shorter incubation period (Mirnawati et al., 2019).

Relationship between nutritional value

Fermented SMW crude protein content has a highly positive correlation with broiler nitrogen retention (r=0.95, P=0.0001, Figure 5). Meanwhile, fermented SMW crude fiber and broiler crude fiber digestibility showed a highly negative correlation (r=-0.95, P=0.0001, Figure 6). The effect of reducing crude protein on a diet (maize-soybean meal) showed a downward trend in broiler nitrogen retention, but it was not significant (Chrystal et al., 2020). This difference may be due to physicochemical profile of feed ingredients. The relationship between crude fiber content and crude fiber digestibility is in accordance with the results of Ginindza et al. (2017) in indigenous breed chickens, where increased CF levels decreased feed intake as well as digestibility but this was compensated by adaptation in intestinal villi. Promising nutritional profile of fermented SMW is expected to support broiler production performance.

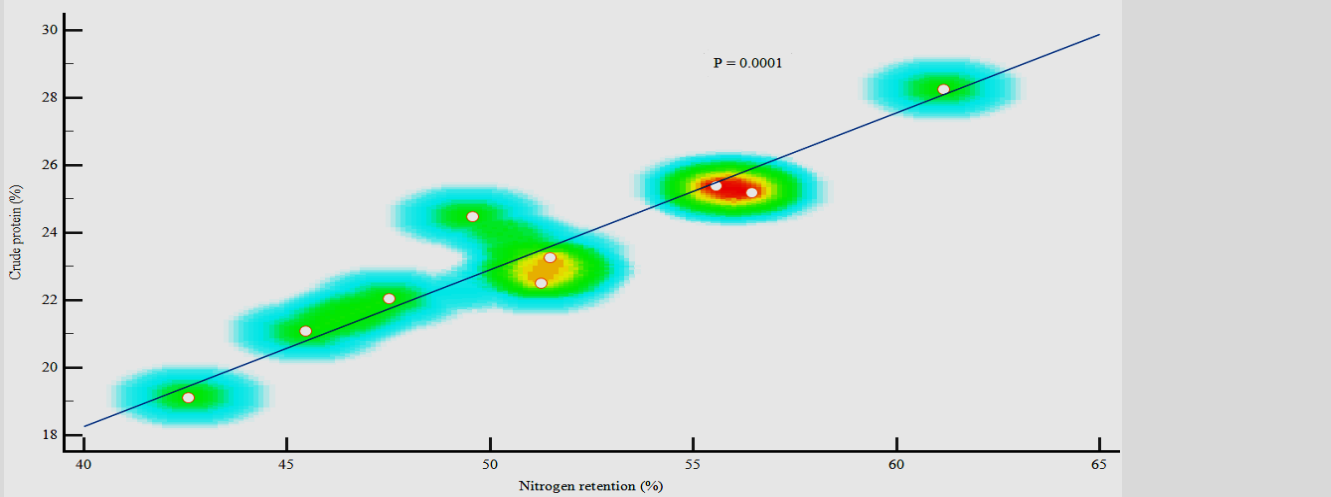

Figure 5 - Correlation between SMW crude protein and broiler nitrogen retention

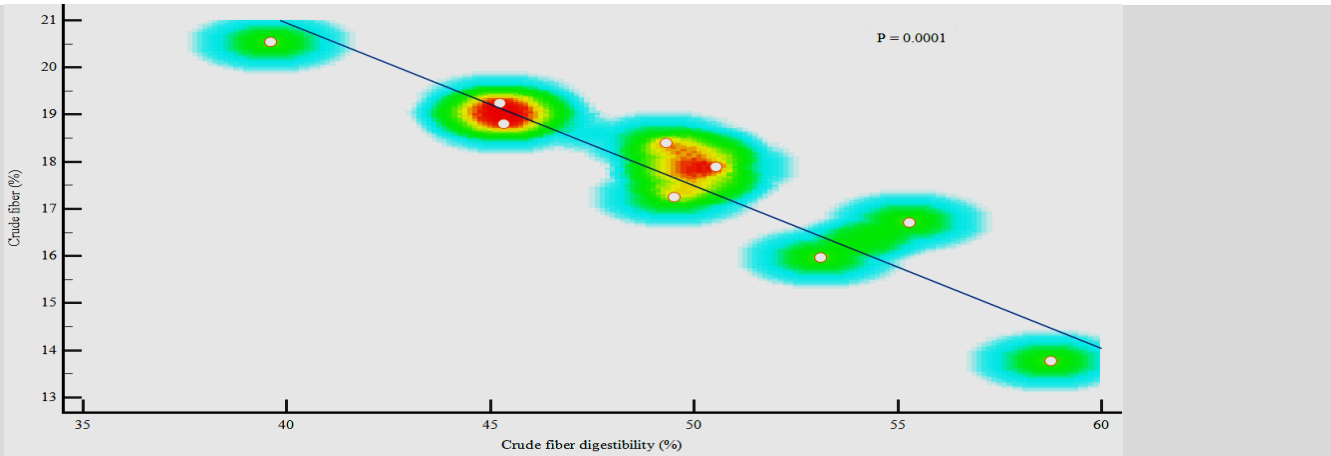

Figure 6 - Correlation between SMW crude fiber and broiler broiler crude fiber digestibility

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CONCLUSION

The mixed inoculum *A. ficuum* plus *N. crassa* (3:2) with seven days of fermentation session showed optimal results. That is shown by increased crude protein, nitrogen retention, crude fibre digestibility, and reduced crude fibre of soybean meal waste. Early indications have signified that fermented soybean meal waste has promised to be an alternative protein source for poultry feed. Further studies focused on the amino acid quality of fermented soybean meal waste.

DECLARATIONS

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Authors' contribution
Ciptaan G, Mirnawati M, Aini Q, Makmur M contribute to experiment, analysis and writing manuscript

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

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REFERENCES

Brink M, Janssens GPJ, Demeyer P, Bağci Ö and Delezie E (2022). Reduction of dietary crude protein and feed form: Impact on broiler litter quality, ammonia concentrations, excreta composition, performance, welfare, and meat quality. Animal Nutrition, 9: 291-303. DOI: https://doi.org/10.1016/j.aninu.2021.12.009

Chen L, Zhao Z, Yu W, Zheng L, Li L, Gu W, Xu H, Wei B and Yan X (2021). Nutritional quality improvement of soybean meal by *Bacillus velezensis* and *Lactobacillus plantarum* during two-stage solid-state fermentation. AMB Express, 11(1): 23. DOI: https://doi.org/10.1186/s13568-021-01184-x

Chitisankul WT, Shimada K and Tsukamoto C (2022). Antioxidative Capacity of Soyfoods and Soy Active Compounds. Polish Journal of Food and Nutrition Sciences, 72(1): 101-108. DOI: https://doi.org/10.31883/pjfns/146562

Chrystal PV, Moss AF, Khoddami A, Naranjo VD, Selle PH and Liu SY (2020). Impacts of reduced-crude protein diets on key parameters in male broiler chickens offered maize-based diets. Poultry Science, 99(1): 505-516. DOI: https://doi.org/10.3382/ps/pez573

Ciptaan G and Mirnawati (2015). Isolation of cellulolytic and carotenoid molds to increase the efficacy of soy milk dregs and their application to poultry, Fundamental Research Report of Higher Education. Link: http://repo.unand.ac.id/21893/6/DATA%20PENELITIAN%20LPPM%202016.pdf

Ciptaan G, Mirnawati and Djulardi A (2021). Utilization of fermented soy-milk waste with *Aspergillus ficuum* in broiler ration. IOP Conference Series: Earth and Environmental Science, 709 (012044). DOI: https://doi.org/10.1088/1755-1315/709/1/012044

Ciptaan G, Mirnawati, Ferawati and Makmur M (2022). The effect of fermented palm kernel cake layer quail rations on production performance and eggshell thickness. International Journal of Veterinary Science, 11(3): 400-403. https://doi.org/10.47278/journal.ijvs/2021.108

Dono ND, Indarto E and Soeparno S (2017). Soy-milk waste with soybean meal dietary substitution: effects on growth performance and meat quality of broiler chickens. Indonesian Journal of Animal Science, 19(2): 55-60. https://doi.org/10.25077/jpi.19.2.54-59.2017

Ginindza MM, Ng'Ambi JW and Norris D (2017). Effect of dietary crude fibre level on intake, digestibility and productivity of slow-growing indigenous Venda chickens aged one to 91 days. Indian Journal of Animal Research, 51(6): 1073-1079. DOI: https://doi.org/10.18805/ijar.v0iOF.7255

Jang CH, Oh J, Lim JS, Kim HJ and Kim JS (2021). Fermented soy products: Beneficial potential in neurodegenerative diseases. Foods, 10(3): 636. DOI: https://doi.org/10.3390/foods10030636

Kurniati T (2012). Detoxification through fermentation by consortium of *Aspergillus niger* and *Neurospora sitophila* towards the degree of forbol esther and nutrition value of *Jatropha curcas* L. for broiler's feed. Journal of Asian Scientific Research, 2(6): 317-324. Link: https://digilib.uinsgd.ac.id/36550/

Li J, Zhou R, Ren Z, Fan Y, Hu S, Zhou C and Deng Z (2019). Improvement of protein quality and degradation of allergen in soybean meal fermented by *Neurospora crassa*. LWT-Food Science and Technology, 101: 220-228. DOI: https://doi.org/10.1016/j.lwt.2018.10.089

Li Q, Ng WT and Wu JC (2014). Isolation, characterization and application of a cellulose-degrading strain *Neurospora crassa* S1 from oil palm empty fruit bunch. Microbial Cell Factories, 13(157): 1-8. DOI: https://doi.org/10.1186/s12934-014-0157-5

Liu P, Li J and Deng Z (2016). Bio-transformation of agri-food wastes by newly isolated *Neurospora crassa* and *Lactobacillus plantarum* for egg production. Poultry Science, 95(3): 684-693. DOI: https://doi.org/10.3382/ps/pev357

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Malomo GA, Bolu SA and Olutande SG (2013). Effects of diietary crude protein on performance and nitrogen economy of broilers. Sustainable Agriculture Research, 2(3): 52-57. DOI: http://dx.doi.org/10.5539/sar.v2n3p52

Mirnawati (2012). Utilization of soybean meal waste as a substitution for soybean meal protein in broiler ration. Poultry International Seminar. World Poultry Science Association Indonesia, Padang, Indonesia, 1: 209-214.

Mirnawati, Ciptaan G and Djulardi A (2019). The combined effects of fungi *Phanerochaete chrysosporium* and *Neurospora crassa* and fermentation time to improve the quality and nutrient content of palm oil sludge. Pakistan Journal of Nutrition, 18: 437-442. DOI: https://dx.doi.org/10.3923/pjn.2019.437.442

Mirnawati, Ciptaan G and Ferawati (2019). Improving the quality and nutrient content of palm kernel cake through fermentation with *Bacillus subtilis*. Livestock Research for Rural Development, 31 (7). Link: http://www.lrrd.org/lrrd31/7/mirna31098.html

Mirnawati, Ciptaan G, Seftiadi Y and Makmur M (2022). Effects of humic acid dosage and fermentation Time with *Bacillus subtilis* on nutrient content and quality of palm kernel cake. American Journal of Animal and Veterinary Sciences, 17(1): 35-41. DOI: https://doi.org/10.3844/ajavsp.2022.35.41

Mirnawati, Djulardi A and Ciptaan G (2017). Role of humic acid in improving the nutrient content and quality of fermented palm oil sludge. Pakistan Journal of Nutrition, 16: 538-543. DOI: https://dx.doi.org/10.3923/pjn.2017.538.543

Mirnawati, Rizal Y, Marlida Y and Kompiang IP (2011). Evaluation of palm kernel cake fermented by *Aspergillus niger* as substitute for soybean meal protein in the diet of broiler. International Journal of Poultry Science, 10 (7): 537-541. DOI: https://dx.doi.org/10.3923/ijps.2011.537.541

Pazla R, Jamarun N, Zain M, Yanti G and Chandra RK (2021). Quality evaluation of tithonia (*Tithonia diversifolia*) with fermentation using *Lactobacillus plantarum* and *Aspergillus ficuum* at different incubation times. Biodiversitas, 22(9): 3936-3942. DOI: https://doi.org/10.13057/biodiv/d220940

Sibbald IR (1980). Metabolizable energy in poultry nutrition. BioScience, 30(11): 736-741. DOI: https://doi.org/10.2307/1308333

Tian M and Yuan Q (2016). Optimization of phytase production from potato waste using *Aspergillus ficuum*. 3Biotech, 6: 256. DOI: https://doi.org/10.1007/s13205-016-0573-9

Yang J, Wu XB, Chen HL, Sun-Waterhouse D, Zhong HB and Cui C (2019). A value-added approach to improve the nutritional quality of soybean meal byproduct: enhancing its antioxidant activity through fermentation by *Bacillus amyloliquefaciens* SWJS22. Food Chemistry, 272: 396-403. DOI: https://doi.org/10.1016/j.foodchem.2018.08.037

Yousufi MK (2012). Utilization of various fruit wastes as substrates for production single cell protein using *Aspergillus oryzae* and *Rhizopus oligosporus*. International Journal of Advanced Scientific and Technical Research, 5(2): 92-95. Link: https://rspublication.com/ijst/oct12/12.pdf

Zhou R, Ren Z, Ye J, Fan Y, Liu X, Yang J, Deng Z and Li J (2019). Fermented soybean dregs by *Neurospora crassa*: a traditional prebiotic food. Applied Biochemistry and Biotechnology, 189: 608–625. DOI: https://doi.org/10.1007/s12010-018-02931-w

Citation: Ciptaan G✉, Mirnawati M, Aini Q and Makmur M (2022). Nutrient content and quality of soybean meal waste fermented by *Aspergillus ficuum* and *Neurospora crassa*. *Online J. Anim. Feed Res.*, 12(4): 240-245. DOI: https://dx.doi.org/10.51227/ojafr.2022.32

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BREEDING PRACTICES AND TRAITS PREFERENCE IN DAIRY CATTLE IN GEDEO AGROFORESTRY OF ETHIOPIA

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ABSTRACT: The study was conducted to identify breeding practices and traits preferences of the dairy cattle producers in the southern part of Ethiopia. Representative sample households were selected by SRS (Simple Random Sampling) techniques. A cross-sectional survey with a structured questionnaire was used to collect the data on the purpose of keeping dairy cattle, herd composition, source of dairy cattle, trait preference, and breeding practices performed by the farmers. The data were analyzed using statistical software SPSS 27, and chi-square was used to compare categorical variables. The herd composition of the Bule district is significantly different from the rest of the districts in the mean number of calves, heifers, and bulls. The Yirgachefe district significantly differs in the mean number of cows compared to other districts. The breed preference of most farmers (81.67%) is cross-bred bulls (Jersey and Holstein Frisian). There are not enough bulls on the farms; only 21.7% of them have a breeding bull, and the primary sources of bulls in the study community are the grazing areas and the neighbors. Respondents preferred artificial insemination (96.1%) to natural mating. Milk yield, appearance, and genotype were important traits in selecting a dam, whereas genotype, appearance, and fast growth rate were the most preferred traits in sire ranking. The farmers' breeding objectives were to improve milk production and increase cash income. Therefore, establishing a village-based mating program for the genetic improvement of dairy cattle in the study area is recommended to overcome the shortage of bulls.

Keywords: Artificial Insemination, Breeding, Genetic improvement, Selection criteria, Sire.

INTRODUCTION

Ethiopia has enormous potential for cattle in Africa and keeps about 70 million cattle population. More than half (56%) of female cattle, and the remaining 44% are male cattle. Dairy cows are estimated to be around 10.8% and dominated by local breeds and only 2.6 % are cross-bred and the exotic from the total cattle population. On average, milk production is 1.48 liters per cow per day (CSA, 2021).

The dairy sector is critical to Sub-Saharan Africa's (SSA) socioeconomic situation, particularly in Ethiopia, by providing food security and revenue generation, especially for small households (Lemaire et al., 2019; Wangu et al., 2021). Despite its importance to farmers and the economy as a whole, the cattle sector has been neglected and underutilized (Mekonnen et al., 2012)

Breeding practices of dairy farmers differ in agroecology (highland, midland and the lowland) areas of Ethiopia (Bedada et al., 2021). Trait preferences of farmers usually vary across communities, production systems, and agroecological zones (Roessler et al., 2008; Duguma et al., 2010; Zewdu et al., 2018; Aman et al., 2021). This has resulted from economically important traits influenced by livestock keepers' production environment.

The study area is found in Shashemene Dilla milkshed and, its contribution in terms of milk production to the community is high, comprehensive baseline data about breeding practices and selection criteria were not found. To enhance the productivity of the dairy sector and design dairy production improvement strategies or interventions, knowing the dairy farmers' trait preferences and breeding practices is vital (Gebremichae et al., 2015; Zewdu et al., 2018). In this regard, farmers' trait preferences and breeding practices of dairy cows are essential to study that have not been investigated in the study area. Therefore, the current study was initiated to fill this research gap by investigate the farmers' trait preferences and breeding practices of dairy cattle production in the Gedeo agroforestry production system.

MATERIALS AND METHODS

Study area description

The study was conducted in selected districts of Gedeo Zone and Abaya District of West Guji and geographically located between 5^{0}50' 19" to 6^{0}35' 56"N latitude and 37^0 50' 47" to 38^0 26'17" E longitudes (Figure 1). The selected districts from Gedeo zone were Bule, Gedeb and Yirgachefe. The elevation varies between 1450 and 3200 m.a.s.l. It is

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normal to get bimodal rainfall from March to May and August to October. The annual rainfall fluctuates between 1200 and 1800mm. The temperature is between 18 ^{0}c and 25^{0}c. The Gedeo zone is made up of 26 percent Dega (highland), 65 percent Woina Dega (middle), and 9 percent Kola (lowland) agroecologically. Abaya, the other selected district, is found in West Guji Zone in Oromiya Region. Agro-ecologically, it comprises two main agro-ecologies, namely Kolla/lowland (70 Percent) and Woina Dega/midland (30 Percent). The altitude ranges from 1200 to 2060 m.a.s.l. The temperature is between 16 ^{0}c and 28 ^{0}c. The average annual rainfall of the district is 105.5 mm, which commences in May and extends to the end of October (Mebrate et al., 2021).

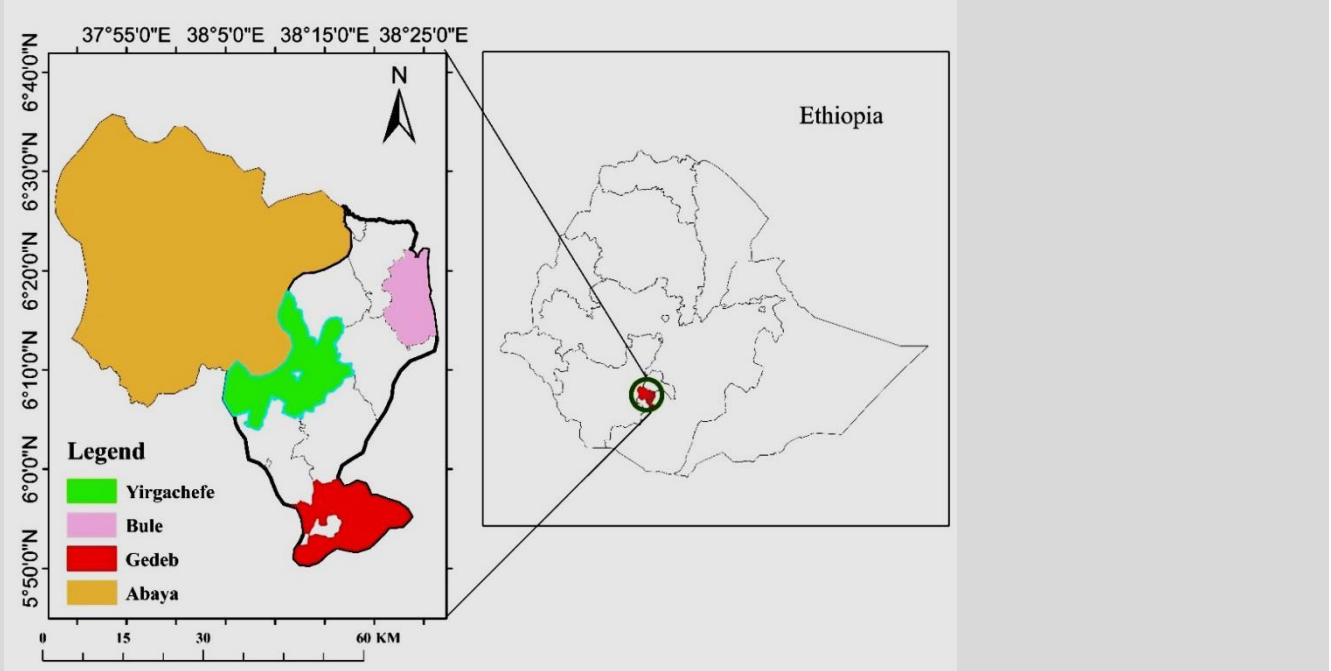

Figure 1 - Study area location map

Sampling procedures and sample size determination

A cross-sectional study design was used for the study. The study districts were purposively selected as they have a high potential for dairy cattle production with the consultation of Gedeo Zone and Abaya district livestock officers. Four potential districts (Yirgachefe, Gedeb, Bule and Abaya) were selected. Target households were selected from three kebeles (small administrative units) for each district using the same criteria that the districts were selected. Finally, the interviewed individuals were selected using simple random sampling (SRS) procedures. The sample size was determined by the formula (1) of Arsham, (2005) for the survey study.

$$N = \frac{0.25}{(SE)^2} \quad \text{..... (1)}$$

Where; N=population size and SE= standard error. Accordingly, 3.73 % of standard error with 95% CI (confidence interval), hence, the total sample households become 180.

Methods of data collection

A survey was undertaken to collect data from 180 dairy farmers in the four districts. Structured questioners were designed. Before the commencement of the actual study, a pretest was conducted to ensure the respondents understood and answered the questions correctly. The questioner used to collect general household information, herd composition, sources, and breeding practices. Secondary data was gathered from the agriculture offices in the zone and districts.

Data analysis

The collected data were summarized on Microsoft excel 2021, and using SPSS 26 (statistical package for social science) was used to analyze descriptive statistics. A chi-square ($\chi 2$) test was calculated using SAS (Statistical Analysis System) version 9.4 to see if the proportions of the different categorical variables were significantly different or not at $P \leq 0.05$. Indices were calculated to provide an overall ranking of keeping dairy cattle and the traits used for choosing sires and dams according to the formula of the index (2) developed by Kosgey et al. (2008).

$$\text{Index} = \frac{[(N*F1)+((N-1)*F2)+\cdots+(1*Fn)]}{\sum[(N*F1)+((N-1*F2)+\cdots+(1*Fn)]} \quad (2)$$

Where N maximum level of rank, F1 frequency of the 1st rank, F2 frequency of the 2nd rank, and Fn frequency of the last rank. The herd compositions of the respondent were analyzed using the GLM (general linear model) procedure of SAS 9.4. Mean comparisons were carried out using Duncan's multiple range tests, and the significant differences were declared when $P < 0.05$. The appropriate statistical model (3) used was:

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$$Yij = \mu + \mathrm{Ti} + \mathrm{eij} \quad (3)$$

Where Y_{ij}: Observed value of the herd composition, μ: Overall mean, T_i: Effect of i^{th} location (i = Abaya, Bule, Gedeb and Yirgachefe) and e_{ij}: Residual random error.

Ethical approval

The study is a survey type and did not involve humans or animals as subjects in the research. All the data collection instruments (household survey questionnaires) were reviewed for ethical clearance and approved by the Dilla University College of Agriculture and Natural Resources ethics committee.

RESULTS AND DISCUSSION

General household characteristics

General household characteristics are presented in Table 1. The differences in sex, education, and age are significant at p<0.05 using the chi-square test. In all districts, males outnumber females, with Bule (93.3%), Gedeb (82.2%), Abaya (82.2%), and Yirgachefe (80.0%). In Adama, Gurage Zone, and North Shoa, 73.5%, 81.1%, and 90.4% of the respondents were men, according to Sharew (2018), Tesfaye and Wondossen (2019), and Yohanis and Tilahun (2021) respectively.

Nearly 3/4th of the interviewed household heads from all the studied areas were found in an age category of 30-59 years. The result (Table 1) showed that the farmers still practice dairy farming when their age increases. Similarly, Yohanis and Tilahun, (2021) and Hailemariam et al. (2022) also reported similar findings in Adama and Dilla Zuriya.

The majority (85.5%) of the interviewed households were literate. The result of the present study agreed with reports of Melku, (2016), and Sharew et al. (2022). The literacy of respondents gives a better chance to apply agricultural technologies to agricultural practices and makes it easy the acceptance new technologies and efficient resources use. Assemu et al. (2013) and Gatew et al. (2018) findings support the importance of education on agricultural technology practices.

Table 1 - Household characteristics of the respondent

Descriptions		Yirgachefe N (%)	Bule N (%)	Gedeb N (%)	Abaya N (%)	Over all %	χ2	P-value
Sex	Male	36(80.0)	42(93.3)	37(82.2)	37(82.2)	84.4	85.42***	0.0001
	Female	9(20.0)	3(6.7)	8(17.8)	8(17.8)	15.6		
Education background	Illiterate	3(6.7)	11(24.4)	7(15.6)	5(11.1)	14.4	76.94***	0.0001
	Read& write	6(13.3)	6(13.3)	9(20.0)	8(17.8)	16.1		
	1-6 class	18(40.0)	19(42.2)	21(46.7)	20(44.4)	43.3		
	7-12 class	13(28.9)	9(20.0)	6(13.3)	12(26.7)	22.2		
	≥Diploma	5(11.1)	-	2(4.4)	-	3.9		
Age	20-29	5(11.1)	2(4.4)	-	1(2.2)	4.4	75.67***	0.0001
	30-39	12(26.7)	9(20.0)	6(13.3)	6(13.3)	18.3		
	40-49	15(33.3)	18(40.0)	25(55.6)	19(42.2)	42.8		
	50-59	6(13.3)	9(20.0)	11(24.4)	15(33.3)	22.8		
	≥60	7(15.6)	7(15.6)	3(6.7)	4(8.9)	11.7		

χ2 = Chi-square; *= significant if p< 0.05; ***= p < 0.001

Table 2 - Herd composition in the study area

Herd composition	Yirgachefe (Mean ±SE)	Gedeb (Mean ±SE)	Bule (Mean ±SE)	Abaya (Mean ±SE)	Overall (Mean ±SE)	P-value
Calves	1.82±0.21 ^{b}	1.45±0.10 ^{b}	2.67±0.21 ^{a}	1.69±0.13 ^{b}	1.96±0.09	0.0001***
Heifers	1.29±0.11 ^{b}	1.43±0.11 ^{b}	2.57±0.26 ^{a}	1.16±0.08 ^{b}	1.68±0.10	0.0001***
Oxen	1.00±0.00 ^{b}	1.64±0.17 ^{ab}	2.20±0.55 ^{a}	1.50±0.11 ^{ab}	1.65±0.13	0.0001***
Bulls	1.00±0.00 ^{a}	1.14±0.14 ^{a}	1.50 ±0.11 ^{a}	1.00±0.00 ^{a}	1.36±0.08	0.1444 ^{ns}
Cows	1.34±0.14 ^{b}	2.42±0.18 ^{a}	2.39±0.27 ^{a}	2.20 ±0.13 ^{a}	2.13±0.09	0.0004***

^{a,b} Means within a row with different superscripts differ significantly (P<0.05); ***= p < 0.001; NS = not significant; SE = Standard Error

Dairy cattle herd compositions

The average herd composition in the area is summarized in Table 2. On average (2.13±0.09), cows take the leading number in the herd composition. These results agree with those (Bereda et al., 2014; Tesfaye and Wondossen, 2019; Hailemariam et al., 2022) in Gurage Zone and Dilla Zuriya and Enemor districts and Hadiya respectively. The average

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number of calves and heifers Bule district significantly differs ($p<0.05$) from the remaining districts. The mean cow number in Yirgachefe district significantly differs ($p<0.05$) from the remaining three districts. There is no significant difference among bulls keeping potential across the districts in the present study. The number of bulls kept by the respondents was small compared to other herd compositions. This might be because the area is known for its agroforestry practices, and farming is less practiced than other farming systems. The lower average number of bulls could be attributed to a significant land constraint on providing sufficient feed for their animals (Bereda et al., 2014).

Breeding objectives

Choosing multiple traits for which animals are specifically bred is always a part of breeding objectives, assuming that farmers have consciously decided to improve the next generation of animals genetically. The cost of production and revenue from product sales associated with a genetic alteration in the target attribute is likely to impact the breeding objectives (Sölkner et al., 2008 and Godadaw et al., 2014). The purpose of dairy cattle keeping as ranked by the respondents in the study area is depicted in Figure 2. The first two important breeding objective stated by the sampled farmers in all study districts was obtaining better milk yield and income sources. Overall, these findings are in accordance with results reported by Endashaw et al. (2012); Banerjee et al. (2014), Debir, (2016), Woldeyohannes, (2018), and Hailemariam et al. (2022); the purpose of keeping cattle is for milk production and income source. The milk production assumption is related to increased profit with increased yield per cow per day. In addition, more milk supply also indicates better-fed calves with greater pre-and post-weaning survival rates (Godadaw et al., 2014).

The farmers reared dairy cattle as the following important functions are farming/draft power and manure. There is no special breed for a specific trait in the country, whereas cattle are used as a multipurpose role for the livestock keepers in the tropics. Adebabay (2009) also studied in Amhara Region and Bainesagn (2015) in West Shoa stated multipurpose role of cattle is common in the country.

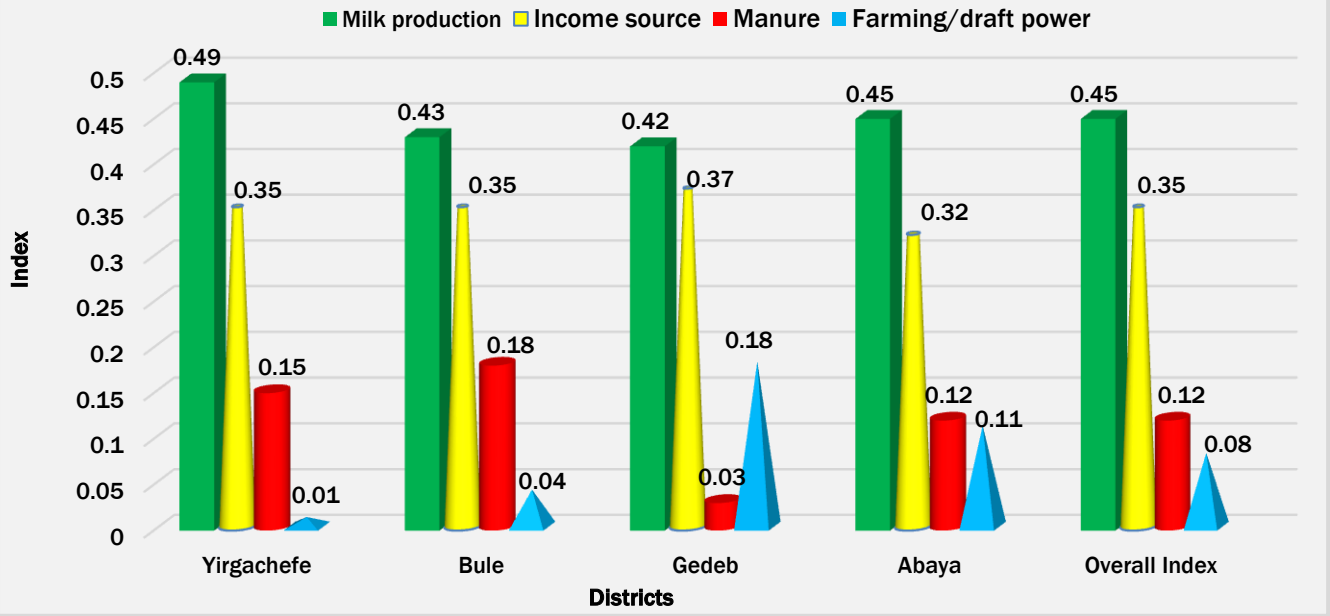

Figure 2 - Breeding objectives

Breeding practices

The breeding practices of the study districts are illustrated in Table 3. The breeding practices reported in the study area are mostly (96.1%) Artificial Insemination (AI), and natural mating was very rare. The present study confirms the findings of Destalem (2015) in the Central Zone of Tigray, AI was preferred by two-thirds of the respondent. There is a trend toward replacing natural mating with AI. The majority (81.67%) of the respondents' breed preferences were cross-bred (Jersey and HF cross) than the indigenous breeds. At the same time Hailu and Abate, (2016) also reported in North Gondar that 82.5% of the dairy farmers prefer cross-breeding.

According to individual farmer interviews, obtaining the desired type of breeding bulls has also become increasingly difficult in the area. Less than a quarter (21.7%) of the respondents have a breeding bull. This might be related to the management cost of bulls. These results agree with (Godadaw et al., 2014; Lakew et al., 2019; Duguma, 2020) findings that farmers don't have breeding bulls in different parts of the country. To overcome the problem, farmers have an additional bull source for mating. The farmers obtained breeding bulls from their neighbors and grazing areas. So, most (81.1%) farmers primarily rely on bulls from neighbors and grazing areas. The results of this study are in keeping with previous observational (Godadaw et al., 2014; Ayeneshet et al., 2017; Lakew et al., 2019), which report 55% to 81.9% of the farmers depend on mating with neighbors, grazing area in North Amhara, North Gondar, and North Shoa Zone of the country.

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Sources of dairy cattle

Sources of dairy cattle are represented in Table 4. There are different sources for dairy cattle replacement in the study area like own herd, buying, a gifts from families. Except for Gedeb, the highest percentage of the source of dairy cattle is buying, whereas in Gedeb own herd replacement is the highest percentage than the others. The buying and own herd covers 88.83% of replacement stock in the study area. Similarly, Godadaw et al. (2014) and Gebremichael et al. (2015) and reported that purchase is the highest source for foundation stock in Dembia district and Tigray highlands, respectively. Sharew (2018) also stated that owning herd replacement is the second source of foundation stock in North Shoa.

Trait preference for selection of dairy cattle

The ranking of traits for selecting breeding males and females as perceived by farmers was summarized in Table 5. The index value showed that milk yield was ranked first in the selection of breeding females with an index value of 0.3, 0.36, 0.4 & 0.21 in Yirgachefe, Bule Gedeb and Abaya districts, respectively. In accordance with the present result, previous studies by Takele (2005), Godadaw et al.(2014), Ftiwi and Tamir (2015), Girma et al. (2016), and Belay and Zeleke (2021) have demonstrated that milk yield is the primary interest of the livestock keeper in a different part of the country.

In Yirgachefe and Bule, appearance was the second most important trait in the selection of breeding females, whilst genotypes were in Gedeb and Abaya. Similarly, Ftiwi and Tamir (2015) stated that physical appearance is one of the preferred traits in the selection of breeding animals. The farmers focus on body shape, udder size and teat position as primary interests when looking at the appearance of the animals. In general, cattle owners' selection criteria are related to production traits in a different part of the country. It is assumed that large animals produce high milk yields and reach market weight sooner.

Traits like genotype, appearance, fast growth and disease resistance were the most preferred traits by the farmers in the area study areas in selecting breeding bulls (Table 5). According to Mekonnen et al. (2012) in Western Oromia, Bayou et al. (2014) in Benchi Maji, Mezgebe et al. (2017) in Northern Ethiopia and Aman et al. (2021) in mid rift valley of Oromia found, most farmers practiced selection based on appearance. Coat color and temperament were given relatively little emphasis in selecting breeding bulls. Temperament was the list preferred trait in west Tigray and the Aneded district of East Gojam (Ftiwi and Tamir, 2015; Zewdu et al., 2018).

Table 3 - Breeding practices in the study districts

Breed preference		Yirgachefe N (%)	Bule N (%)	Gedeb N (%)	Abaya N (%)	Overall (%)
Local		7(15.56)	16(35.56)	1(2.22)	9(20)	18.33
Jersey cross		17(37.78)	-	6(13.33)	13(28.89)	20.00
HF cross		21(46.67)	29(64.44)	38(84.44)	23(51.11)	61.67
Mating preference	AI	43(95.6)	40(88.9)	45(100)	45(100)	96.1
	Natural mating	2(4.4)	5(11.1)	-	-	3.9
Own breeding bull	Yes	5(11.1)	19(42.2)	7(15.6)	8(17.8)	21.7
	No	40(89.9)	26(57.8)	38(84.4)	37(82.2)	78.3
Breeds of bull	Local	3(60)	14(73.7)	5(71.4)	8(100)	76.9
	Cross	2(40)	4(21.1)	1(14.3)	-	17.2
	Both	-	1(5.3)	1(14.3)	-	5.1
Sources of bull for mating	Neighbor	22(48.9)	19(42.2)	30(66.7)	21(46.7)	51.1
	Grazing area	19(42.2)	7(15.6)	10(22.2)	18(40)	30
	Own herd	4(8.9)	19(42.2)	5(11.1)	6(13.3)	18.9

NB: HF-Holstein Frisian; AI-Artificial Insemination

Table 4 - Sources of dairy cattle

Sources	Yirgachefe N (%)	Bule N (%)	Gedeb N (%)	Abaya N (%)	Over all %
Buying	31(68.90)	26(57.80)	10(22.20)	40(88.90)	59.40%
Gift	1(2.20)	-	1(2.20)	4(8.90)	3.30%
Own herd	5(11.10)	19(42.20)	27(60.00)	1(2.20)	28.90%
Buying and own herd	8(17.80)	-	4(8.90)	-	6.70%
Buying and gift	-	-	3(6.70)	-	1.70%

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Table 5- Selection criteria of dam and sire

	Traits preferences	Yirgachefe	Bule	Gedeb	Abaya	Overall Index
Dam	Appearance	0.17	0.19	0.08	0.19	0.16
	Milk yield	0.30	0.36	0.40	0.21	0.31
	Fast Growth	0.08	0.13	0.09	0.17	0.12
	Genotype	0.16	0.19	0.19	0.19	0.18
	Temperament	0.12	0.01	0.01	0.00	0.04
	Coat color	0.01	0.03	0.03	0.01	0.02
	Disease Resistant	0.11	0.01	0.10	0.07	0.07
	Record history	0.05	0.08	0.10	0.16	0.10
	Total	1.00	1.00	1.00	1.00	1.00
Sire	Appearance	0.08	0.42	0.14	0.19	0.21
	Libido	0.10	0.07	0.11	0.18	0.11
	Genotype	0.44	0.30	0.38	0.20	0.33
	Fast Growth	0.12	0.11	0.15	0.30	0.17
	Temperament	0.02	0.01	0.05	0.02	0.02
	Coat color	0.00	0.07	0.02	0.06	0.04
	Disease resistant	0.24	0.02	0.15	0.05	0.12
	Total	1.00	1.00	1.00	1.00	1.00

CONCLUSION

Dairy cattle production plays a significant role in food security. Artificial insemination was preferred over natural mating. The grazing area and the neighbors are the sources of bulls for natural mating. The breeding objectives in each district were better milk yield, income source, and traction/draft power. According to the index value, the most preferred traits in dam selection were milk yield, appearance, and genotype. The three most useful sire selection criteria were genotype, appearance, and fast growth rate. In conclusion, farmers should use a village-based mating system since bulls are a shortage. In addition, the local administrators should think about establishing more AI centers to bring genetic improvement programs in short.

DECLARATIONS

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Authors' contribution
Both of authors contribute equally for this work.

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

REFERENCES

Adebabay KB (2009). Characterization of Milk Production Systems, Marketing and On- Farm Evaluation of the Effect of Feed Supplementation on Milk Yield and Milk Composition of Cows at Bure District, Ethiopia. M.Sc. Thesis. Bahir Dar University, Ethiopia. Link: https://hdl.handle.net/10568/621 ; DOI: https://doi.org/10.13140/RG.2.1.3353.7682

Aman G, Tadele M, Tesfaye K (2021). Traditional cattle breeding practices and rate of inbreeding in the mid rift valley of Oromia, Ethiopia. International Journal of Veterinary Science and Research, 7: 077–082. DOI: https://doi.org/10.17352/ijvsr.000084

Arsham H (2005). Questionnaire design and surveys sampling. Link: http://home.ubalt.edu/ntsbarsh/Business-stat/stat-data/Surveys.htm

Assemu T, Kerealem E, Adebabay K (2013). Assessment of Current Beekeeping Management Practice and Honey Bee Floras of Western Amhara, Ethiopia. International Journal of Agriculture and Biosciences, 2(5), 196–201. Link: http://www.ijagbio.com/volume-2-no-5-2013/

Ayeneshet B, Wondifraw Z, Abera M (2017). Production Objectives , Breeding Practices International Journal of Animal and Rate of Inbreeding in Dairy Cows at Alefa and Quara Districts of North Gondar Science. International Journal of Animal Science, 1(2), 1–7. Link: https://www.jsmcentral.org/sm-animal-science/ijas-v1-1011.pdf

Citation: Haile D and Tesfahun B (2022). Breeding practices and traits preference in dairy cattle in Gedeo agroforestry of Ethiopia. *Online J. Anim. Feed Res*., 12(4): 246-254. DOI: https://dx.doi.org/10.51227/ojafr.2022.33

Bainesagn W (2015). Assessment of Breeding Practices and Evaluation of Estrus Synchronization and Mass Insemination Technique in Dairy Cattle in West Shoa Zone. M.Sc. Thesis, Hawasa University, Ethiopia. Link: https://cgspace.cgiar.org/bitstream/handle/10568/90466/Worku.pdf?sequence=1

Banerjee S, Beyan M, Bekele H (2014). Some traditional livestock selection criteria as practiced by several indigenous communities of Southern Ethiopia. Animal Genetic Resources, 54: 153–162. DOI: https://doi.org/10.1017/S2078633614000083

Bayou E, Haile A, Gizaw S, Mekasha Y (2014). Characterizing husbandry practices and breeding objectives of Sheko cattle owners for designing conservation and improvement strategies in Ethiopia. Livestock Research for Rural Development, 26(12). Link: http://www.lrrd.org/lrrd26/12/bayo26235.html

Bedada KW, Kechero Y, Janssens GP (2021). Seasonal and agro-ecological associations with feed resource use and milk production of ranging dairy cows in the Southern Ethiopian Rift Valley. Tropical animal health and production, 53:411. DOI: https://doi.org/10.1007/s11250-021-02867-0

Belay DL, Zeleke B (2021). On-Farm Phenotypic Characterization of Indigenous Cattle in its Production Environment in Sidama, Ethiopia. Global Journal of Science Frontier Research: D Agriculture and Veterinary, 21(3). Link: https://journalofscience.org/index.php/GJSFR/article/view/2945

Bereda A, Yilma Z, Nurfeta A (2014). Dairy production system and constraints in Ezha districts of the Gurage zone, Southern Ethiopia. Global Veterinaria, 12(2): 181–186. DOI: https://doi.org/10.5829/idosi.gv.2014.12.02.81199

CSA (2021). Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural Sample Survey 2020/21 [2013 E.C.] Volume II Report on Livestock and Livestock Characteristics (Private Peasant Holdings). Link: https://www.statsethiopia.gov.et/wp-content/uploads/2021/05/REVISED_2013.LIVESTOCK-REPORT.FINAL-1.pdf

Debir L (2016). Assessment of Breeding Practice and Evaluation of Estrus Synchronization of Dairy Cattle in Sidama Zone , Assessment of Breeding Practice and Evaluation of Estrus Synchronization of Dairy Cattle in Sidama Zone. M.Sc.. Thesis, Hawasa University, Ethiopia. Link: https://hdl.handle.net/10568/76188

Destalem G (2015). Breeding Practice and Estrus Synchronization Evaluation of Dairy Cattle in Central Zone of Tigray, Northern Ethiopia. M.Sc. Thesis. Jimma University, Ethiopia. Link: https://hdl.handle.net/10568/76171

Duguma B (2020). A survey of management practices and major diseases of dairy cattle in smallholdings in selected towns of Jimma zone, south-western Ethiopia. Animal Production Science, 60(15): 1838–1849. DOI: https://doi.org/10.1071/AN19079

Duguma G, Mirkena T, Haile A, Iñiguez L, Okeyo AM, Tibbo M, Rischkowsky B, Sölkner J, Wurzinger M (2010). Participatory approaches to investigate breeding objectives of livestock keepers. Livestock Research for Rural Development, 22(4): Link: http://www.lrrd.org/lrrd22/4/dugu22064.htm

Endashaw T, Tadelle D, Aynalem H, Wudyalew M, and Okeyo M (2012). Husbandry and breeding practices of cattle in Mursi and Bodi pastoral communities in Southwest Ethiopia. African Journal of Agricultural Research, 7(45): 5986–5994. DOI: https://doi.org/10.5897/ajar12.1566

Ftiwi M, and Tamir B (2015). Phenotypic Characterization of Indigenous Cattle in Western Tigray, Northern Ethiopia. Indian Journal of Dairy Sciences, 68(2): 343–354. Link: http://journals.wsrpublishing.com/index.php/tjanrs/article/view/198

Gatew H, Zewde T, Kassa G, Chanyalew Y, and Gazu L (2018). Factors influencing the success of on-farm estrus synchronization of dairy cattle in North Shewa Zone, Amahara Region, Ethiopia. International Journal of Livestock Production, 9(1):9–16. DOI: https://doi.org/10.5897/IJLP2017.0408

Gebremichael, D, Belay B, and Tegegne A (2015). Assessment of Breeding Practice of Dairy Cattle in Central Zone of Tigray, Northern Ethiopia. Journal of Biology, 5(23): 96–105. Link: https://www.iiste.org/Journals/index.php/JBAH/article/view/27575

Girma E, Alemayehu K, Abegaze S, Kebede D (2016). Phenotypic characterization, population structure, breeding management and recommend breeding strategy for Fogera cattle (Bos indicus) in Northwestern Amhara, Ethiopia. Animal Genetic Resources, 58: 13–29. DOI: https://doi.org/10.1017/S2078633616000035

Godadaw M, Zewdu W, Workneh A (2014). Breeding practices in indigenous dairy cattle breeds in Northern Amhara, Ethiopia. Livestock Research for Rural Development, 26 (4). Link: http://www.lrrd.org/lrrd26/4/misg26062.htm

Hailemariam SE, Tezera BT, and Engidahset DH (2022). Husbandry practices and constraints of smallholder dairy production in Dilla Zuriya district, Gedeo Zone, Ethiopia. Heliyon, 8(3):E09151. Doi: https://doi.org/10.1016/j.heliyon.2022.e09151

Hailu A, and Abate M (2016). Community Breeding Practice and the Challenges in Dairy Cattle Management in North Gondar, Ethiopia. International Journal of Environmental & Agriculture Research, 2(4): 76–83. Link: https://ijoear.com/assets/articles_menuscripts/file/IJOEAR-JAN-2016-18.pdf

Kosgey IS, Rowlands GJ, Arendonk JAM Van, Baker RL. (2008). Small ruminant production in smallholder and pastoral / extensive farming systems in Kenya. Small Ruminant Research, 77: 11–24. Link: DOI: https://doi.org/10.1016/j.smallrumres.2008.02.005

Lakew A, Goshu G, Mengistu A, Mamo G, Demissie T (2019). Dairy Cattle Husbandry Practices in Selected Urban and Peri-Urban Milk Shed Areas of North Shoa Zone, Ethiopia. World Journal of Agricultural Sciences, 15(2): 86–92. Link: DOI: https://doi.org/10.5829/idosi.wjas.2019.86.92

Lemaire G, Giroud B, Bathily B, Lecomte P, Corniaux C (2019). Toward integrated crop-livestock systems in West Africa: a project for dairy production along Senegal river. In:G. Lemaire (Editor), Agroecosystem diversity, Elsevier Inc. p. 275-285 Link: DOI: https://doi.org/10.1016/B978-0-12-811050-8.00017-0

Mebrate A, Kippie T, Zeray N (2021). Determinant Factor of Plant Species Diversity in the Organic Agriculture-Dominated System of Gedeo Zone, Southern Ethiopia. International Journal of Ecology, Article ID 2919260. Link: DOI: https://doi.org/10.1155/2021/2919260

Mekonnen A, Haile A, Dessie T, Mekasha Y (2012). On farm characterization of Horro cattle breed production systems in western Oromia, Ethiopia. Livestock Research for Rural Development, 24:6-17. Link: http://www.lrrd.org/lrrd24/6/meko24100.htm

Melku MK (2016). Milk Production and Reproductive Performance of Local and Crossbreed Dairy Cows in Selected Districts of West Gojam Zone, Amhara Region, Ethiopia. M.Sc. Thesis. Bahir Dar Univrsity, Ethiopia. Link: https://hdl.handle.net/10568/77363

Mezgebe G, Gizaw S, Urge M, Chavhan A (2017). Begait cattle production systems and production performances in northern Ethiopia. International journal of Life Sciences, 5(4): 506–516. Link: https://oaji.net/articles/2017/736-1512489136.pdf

Roessler R, Drucker AG, Scarpa R, Markemann A, Lemke U, Thuy LT, Zarate AV (2008). Using choice experiments to assess smallholder farmers' preferences for pig breeding traits in different production systems in North–West Vietnam. Ecological Economics, 66(1):184-92. DOI: https://doi.org/10.1016/j.ecolecon.2007.08.023

Sharew MH (2018). Assessment of breeding practice, statues of estrus synchronization and mass insemination of dairy cattle in North Shewa zone, Ethiopia. M.Sc. Thesis. Hawasa University, Ethiopia. Google Scholar

Citation: Haile D and Tesfahun B (2022). Breeding practices and traits preference in dairy cattle in Gedeo agroforestry of Ethiopia. *Online J. Anim. Feed Res*., 12(4): 246-254. DOI: https://dx.doi.org/10.51227/ojafr.2022.33

Sharew M, Belete k, Mulugeta T (2022). Management Practice and Comparison of Reproductive and Productive Performance of Dairy Cattle between Beneficiary and None Beneficiary of Estrus Synchronization and Mass Insemination in North Shewa Zone, Amhara Region, Ethiopia. NASS Journal of Agricultural Sciences, 04(1): Article ID: 391. Link: https://ojs.nassg.org/index.php/NJAS/article/view/391

Sölkner J, Grausgruber H, Okeyo AM, Ruckenbauer P, and Wurzinger M (2008). Breeding objectives and the relative importance of traits in plant and animal breeding: a comparative review. Euphytica, 161(1): 273–282. DOI: https://doi.org/10.1007/s10681-007-9507-2

Takele T (2005). On-Farm Phenotypic Characterization of Sheko Breed of Cattle and their Habitat in Bench Maji Zone, Ethiopia. M.Sc. Thesis. Alemaya University. Google Scholar ; DOI: https://doi.org/10.13140/2.1.2101.1525

Tesfaye FA, and Wondossen A (2019). Assessment of Dairy Cattle Management in Gurage Zone, Southern Nation Nationalities and Peoples Region, Ethiopia. International Journal of Research Studies in Agricultural Sciences, 5(4): 1–10. Google Scholar ; DOI: https://doi.org/10.20431/2454-6224.0504001

Wangu J, Mangnus E, van Westen ACM (2021). Recognizing determinants to smallholders' market orientation and marketing arrangements: Building on a case of dairy farming in rural Kenya. Land, 10(6): 572. DOI: https://doi.org/10.3390/land10060572

Woldeyohannes T (2018). Production System, Morphological Characterization and Structural Indices of Indigenous Cattle in Hadiya Zone, Southern Ethiopia. M.Sc. Thesis. Mizan-Tepi University, Ethiopia. DOI: https://doi.org/10.13140/RG.2.2.35130.95686

Yohanis K, and Tilahun B (2021). Assessment of Efficiency and Major Constraint of Artificial Insemination Service in Small Holder Dairy Farmers in and around Adama Town. International Journal of Advanced Research in Biological Sciences, 8(6): 1–5. DOI: http://dx.doi.org/10.22192/ijarbs.2018.05.07.006

Zewdu A, Alemayehu K, and Wondifraw Z (2018). Breeding practices and farmers trait preferences on indigenous dairy cattle production in east Gojjam zone, Ethiopia. Asian Journal of Agriculture and Food Sciences, 6(1): 55–63. Link: https://www.ajouronline.com/index.php/AJAFS/article/view/5212

Citation: Haile D and Tesfahun B (2022). Breeding practices and traits preference in dairy cattle in Gedeo agroforestry of Ethiopia. *Online J. Anim. Feed Res*., 12(4): 246-254. DOI: https://dx.doi.org/10.51227/ojafr.2022.33

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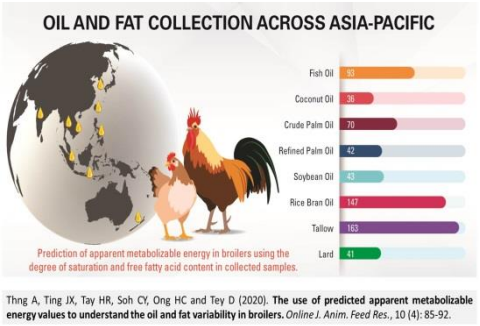

Thng A, Ting JX, Tay HR, Soh CY, Ong HC and Tey D (2020). **The use of predicted apparent metabolizable energy values to understand the oil and fat variability in broilers.** *Online J. Anim. Feed Res.*, 10 (4): 85-92.

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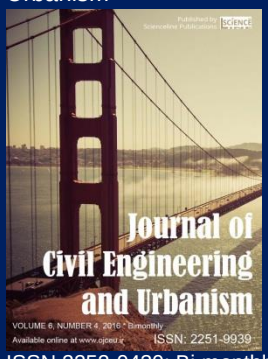

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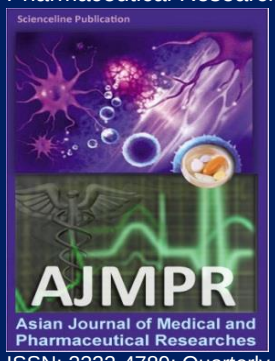

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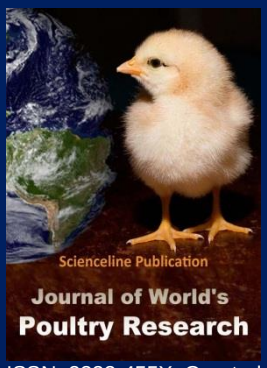

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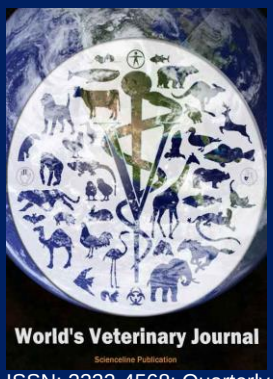

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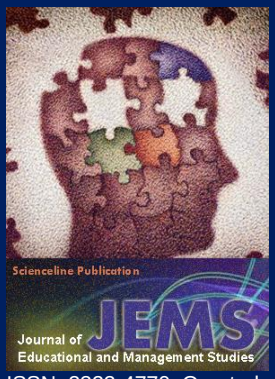

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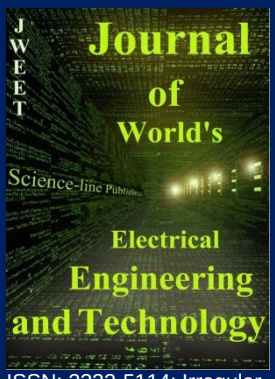

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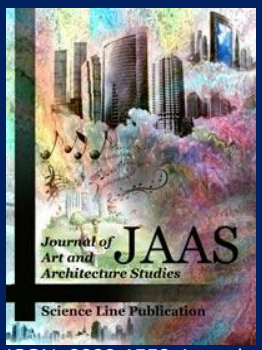

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