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EFFECT OF DIETARY SUPPLEMENTATION OF CORIANDER SEED (*Coriandrum sativum* L.) ON GUT MORPHOLOGY IN BROILER CHICKENS

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ABSTRACT: Several herbal plants have demonstrated remarkable efficacy in modulating the morphology of the gut, leading to improved nutrients absorption, enhanced growth, and reduced susceptibility to diseases. Aim of this study was to investigate the effects of different levels of coriander seed powder (CSP; 0% as T1, 1.5% as T2 and 3.5% as T3) in modulating broiler chickens gut morphology. A total of 180 one-day-old broiler chicks were randomly allocated into 3 treatment groups 60 chick/group in 3 replicates. The trial was designed according to a completely randomized design for 45 days. The histomorphology of duodenum, jejunum and ileum [villus height (VH), villus width, crypt depth (CD) and villus height to crypt depth; VH:CD ratio] were investigated. The result showed a significant increase ($P<0.01$) of villus height in two treatments (1.5% and 3.5%) as compared to control in all segments. Moreover, the significant increase ($P<0.01$) on VH:CD ratio is observed between treatments as compared to control in ileum and dietary use of 3.5% CSP had significant effects on the jejunum and duodenum as compared to the control group. In conclusion, the application of CSP at 1.5% and 3.5% had a positive effect on villus height and VH:CD ratio of all segments. However, further research is required to understand the precise mechanisms underlying medicine plant effects as well as what the ideal percentage for each plant will be added for a best positive effect on performance.

Keywords: Broiler chicken, Coriander Sativum, Gastrointestinal functions, Gut Morphology Herbal additives.

INTRODUCTION

The poultry production industry at a global scale has experienced significant growth and fluctuations in order to meet the increasing demand in recent years. Conversely, there has been a notable rise in both public demand and scientific interest for poultry production, specifically in relation to feeding practices involving medicinal botanicals (Jyotsana and Berwal, 2019). Apart from individual herbal plants, herbal blends have also emerged as promising alternatives for gut health modulation (Stefanello et al., 2020; Pham et al., 2022). The synergistic effects of herbal blends/mixtures can lead to even more pronounced improvements in gut morphology and overall broiler (Abudabos et al., 2018; Giannenas et al., 2018). This effect duo to multiple properties of these plants as anti-inflammatory, antioxidant, and antimicrobial activities (Windisch et al., 2008; Momin et al., 2012; Ulrikh et al., 2022).

One such botanical of interest is coriander (*Coriandrum sativum* L.), is an umbelliferous annual plant of parsley family, native of eastern Mediterranean and Southern Europe, but is extensively cultivated in North Africa (Ahmad et al., 2016). The whole dried seeds are ground and widely used as condiment or spice in the Mediterranean region and known as medicinal plants (Stefanaki and van Ande, 2022). Seeds are also employed to flavor foods like fish and meat, bakery and confectionery products due to antioxidant effects (Lin et al., 2022). The therapeutic properties and nutritional values of coriander seeds are due to the presence of many bioactive compounds such as monounsaturated fatty acids, especially of petroselinic and linolenic acids, flavonoids, β-carotene, phenolic compounds and volatile compounds (Bhat et al., 2014). These constituents play a crucial role in modulating the gastrointestinal environment of broiler chickens, thereby enhancing their feed digestion and overall utilization lead to increased growth performance (Ahmad et al., 2016). A study conducted by Khubeiz and Shirif (2020) has enhanced the increased immunity and dressing without skin percentage by adding seed powder 150g /1kg basal diet.

Since the small intestine has an essential role in the nutrient absorption and assimilation; therefore, the proper structure and function of the intestine is critical for poultry health and performance (Montagne et al., 2003; Othman et al., 2022). Based on these reports, the objective of the present study was to investigate the effects of application of three levels of coriander seed powder in various gastrointestinal morphometric. A specific emphasis is placed on the utilization of herbal plants as a supplement in poultry feed.

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MATERIAL AND METHOD

Chickens and experimental designs

The trial designed according to a completely randomized design to determine the effect of dietary use of coriander seed powder (CSP) on growth performance and the morphological changes of the intestinal parts parameters of (duodenum, jejunum and ileum) of broiler chickens reared in clean pens fitted with deep litter under a standard hygienic condition. One hundred sixty Ross 308 chickens were allocated in three different treatments/experimental groups; 0.0%T1, 1.5%T2, and 3.5%T3 plus the basal diet. Experimental diets (starter and finisher) were used in this trial according to the National Research Council (NRC) regulations (1994) and standard to meet the chickens' daily requirements. The ingredients and chemical composition of the experimental diets are presented in Table 1. Each treatment group involves 60 chickens in three replicate and each replicate has 20 chickens.

Samples collection

On the day 45, 6 chicks from each treatment were slaughtered, then, 3 cm lengths of duodenum (midpoint of the pancreatic loop), jejunum (midpoint of jejunum) and ileum (5 cm after *diverticulum vitellinum*) immediately after sample were cut the physiological saline was used to flush the sample in order to remove the lumen content. All samples were placed in individually labeled flasks containing 10% buffered formalin for fixation. Samples for histology were dehydrated in graded concentrations of ethyl alcohol (70%, 80%, 95%, 96% and 100%), cleared in xylene, and embedded in paraffin. After trimming, 5µm thick section of the samples was cut using a rotary microtome machine, each sample was placed onto a glass slide and dried then stained with hematoxylin-eosin and examined by Semi-light microscopy (2000) according to method of Hashemi et al. (2014). The intestinal morphometric variables, villus height, crypt depth and villus height: crypt depth ratio was evaluated in the duodenum, jejunum and ileum. Histological examinations were carried out according to the method of Iji et al. (2001). Histological sections were examined under magnification 2.5 X of light microscope and software for image analysis (Java image processing program inspired by NIH Image for the Macintosh) (Perić et al., 2015). Villus height was measured from the tip of the villi to the base between individual villi, and crypt depth measurements were taken from the valley between individual villi to the basal membrane.

Statistical analysis

Calculations and statistical analyses were carried out for all data by using Microsoft Excel (spreadsheet) and Minitab 21 version and significance was considered at $P<0.05$ and $P<0.01$ for analysis of variance. Preliminary analysis of data has been done by using a general linear model. Normality test was applied on all data residuals. Subsequent test used by Tukey's for comparing mean values of the variables (for more than two means).

Table 1 - Ingredients and chemical analyses composition of the starter and finisher diets

Ingredients (kg/1000kg)	Starter	Finisher
Yelow corn	470	522
Wheat	150	150
Soyabean (CP 47%)	322	265
Corn oil	10	15
Ground limestone	7.2	7.2
Salt	2.8	2.8
Vitamin and mineral premix	38	38
Total	1000	1000
Calculateded Chemical analysis of diet (%)		
Metabolizable energy (ME)	2930	2996
Crude protein (CP)	21.6	20
Ether extract (E E)	3	3
Crude fiber (CF)	3	3
Calcium	1	1
P (available)	0.4	0.40
Lysin	1.25	1
Methionin	0.50	0.46
Threonine	0.76	0.64
Tryptophan	0.25	0.23
Argenin	1.42	1.29
Valin	1.08	0.99

*Source: Two experimental diets (starter and finisher) were set by Al-Maraie Company according to the National Research Council (NRC) regulations (1994) and standard to meet the chickens' daily requirements.

RESULTS

In the study conducted by Khubeiz and Shirif (2020), the findings indicated that the addition of coriander seed powder at various levels did not have a significant effect (P>0.05) on the growth performance or mortality rates of the chickens throughout the experimental period. In the present study, the effect of coriander seed powder was evaluated on gut morphology, as completive work.

The mean villus height, crypt depth and villus height/crypt depth ratio of intestinal gut (duodenum, jejunum and ileum) of different groups are presented in Tables 2, 3 and 4 respectively. Representative intestinal histomorphology of different groups is shown in Figure 1.

The villus heights and villus width of duodenum were significantly (P<0.01) improved with the application of CSP at the two levels (1.5% and 3.5%) as compared to the control. Moreover, the villus heights/crypt depth ratio were significantly (P<0.05) increased only at the level of 3.5% as compared to the control. The Crypt depth of duodenum was significantly (P<0.01) increased only when the application rate of CSP at 1.5% as compared to 3.5% and the control as shown in Table 2.

The villus height of jejunum was significantly (P<0.01) increased as the application of CSP levels were increased and the rate of increases were similar for the both levels (1.5% and 3.5%). Moreover, the villus height/crypt depth ratio was significantly (P<0.01) augmented when the rate of CSP was applied at 3.5% as compared to the control. Whereas, the crypt depth of jejunum and the villi width of jejunum were not significantly affected (P>0.05) with the application of CSP at the two treatment levels as compared to the control as illustrated in Table 3.

The villus heights of ileum were remarkably (P<0.01) improved when the diet was fortified with CSP at 1.5% and 3.5% and the great improvement was observed at 1.5% as compared to 3.5% and control. Moreover, the villus width of ileum was significantly (P<0.01) increased at 1.5% as compared to 3.5% and the control. Whereas, the villus height/crypt depth ratio was significantly (P<0.01) increased at 1.5% and 3.5% where the rate of increases was similar for both treatment levels (1.5% and 3.5%). However, the crypt depth of ileum was not changed (P>0.05) in all treatment levels (0%, 1.5% and 3.5%) respectively as presented in Table 4.

Table 2 - Effect of the additional different levels of CSP to the broiler chicken diets on duodenum at 45 days of age.

Dependent variable (µm)	Control	1.5% CSP	3.5% CSP	SEM	*P*-Value
Villus height of duodenum	1150.2^{b}	1448.3^{a}	1459.8^{a}	15.0	**
Crypt depth of duodenum	194.9^{c}	235.1^{a}	215.3^{b}	2.90	**
Villus width of duodenum	189.6^{b}	233.3^{a}	228.2^{a}	3.47	**
Villus height/crypt depth ratio	6.5^{b}	6.8^{ab}	7.2^{a}	0.127	*

a, b and c: Means with different superscripts in the same row were significantly different at <0.05. **: (P<0.01). SEM: standard error of means. CSP: coriander seed powder

Table 3 - Effect of offering different levels of CSP to the broiler chicken diets on jejunum at 45 days of age.

Dependent variable (µm)	Control	1.5% CSP	3.5% CSP	SEM	*P*-Value
Villus height of jejunum	601.9^{b}	833.3^{a}	817.2^{a}	10.9	**
Crypt depth of jejunum	157.4^{a}	174.6^{a}	175.8^{a}	2.92	NS
Villus width of jejunum	221.6^{a}	208.0^{a}	198.8^{a}	3.55	NS
Villus height/crypt depth ratio J	4.3^{b}	4.9^{ab}	5.3^{a}	0.10	**

a, b and c: Means with different superscripts in the same row were significantly different at <0.05. **: (P<0.01). SEM: standard error of means. CSP: coriander seed powder

Table 4 - Effect of application of different levels of CSP to the broiler chicken diets on ileum at 45 days of age.

Dependent variable (µm)	Control	1.5% CSP	3.5% CSP	SEM	*P*-Value
Villus heights of ileum	369.3^{c}	750.0 ^{a}	599.5^{b}	13.7	**
Crypt depth of ileum	148.0^{a}	159.1^{a}	145.4^{a}	2.39	NS
Villus width of ileum	189.4^{b}	226.1^{a}	167.5^{b}	4.84	**
Villus height/crypt depth ratio I	2.6^{b}	5.0^{a}	5.0^{a}	0.12	**

a, b and c: Means with different superscripts in the same row were significantly different at <0.05. **: (P<0.01). SEM: standard error of means. CSP: coriander seed powder.

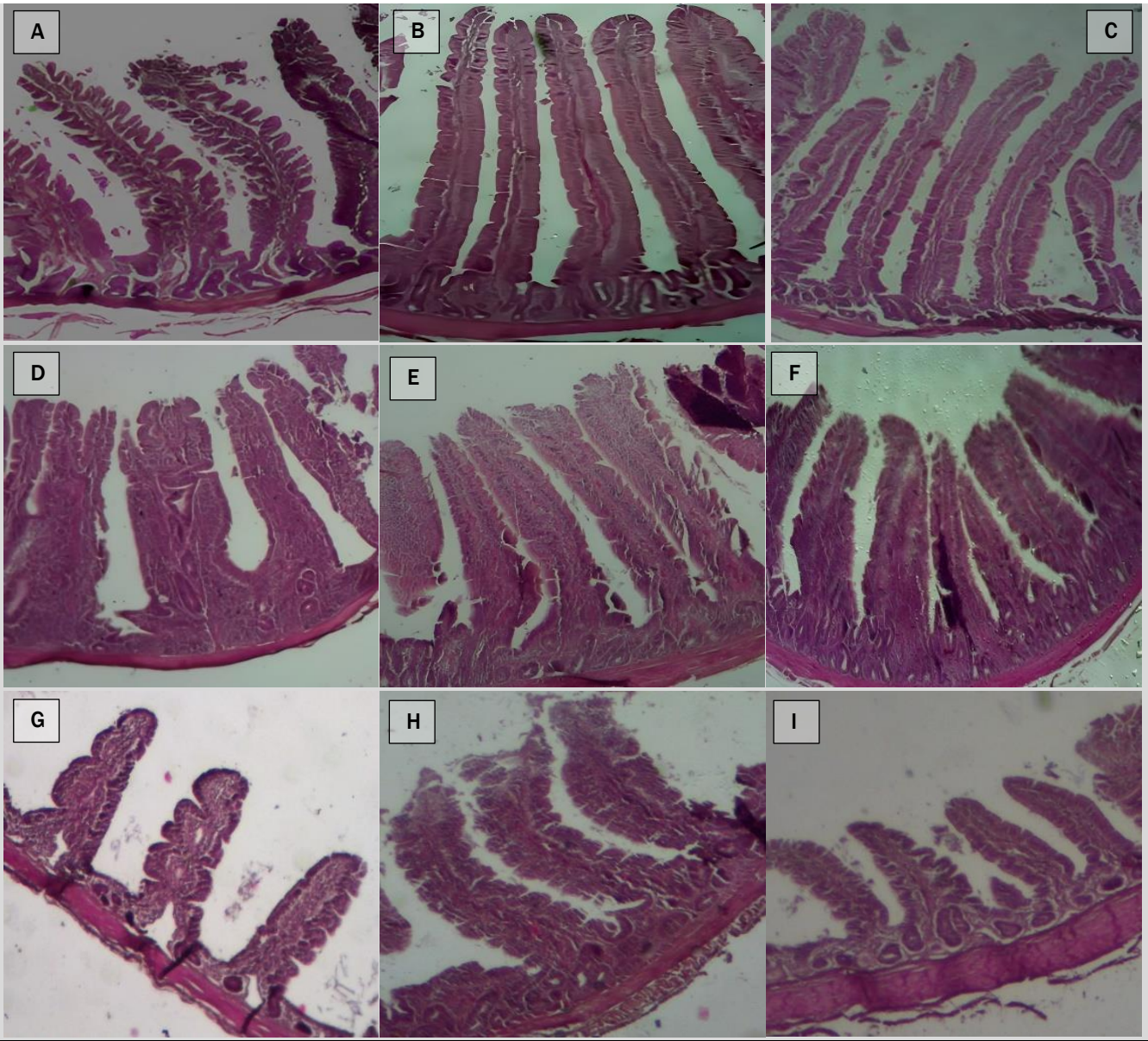

Figure 1 – Effect of coriander seed powder (CSP) on gut morphology of duodenum villi (A= 3.5% treatment: B= 1.5%, treatment; C= 0% treatment). Morphology of jejenum villi (D= 3.5% treatment; E= 1.5% treatment; F= 0% treatment). Morphology of ileum villi, G= 3.5% treatment; H= 1.5% treatment; I= 0% treatment). Histological sections were examined under magnification 2.5 X by Stemi light microscope.

DISCUSSION

The application of coriander seed powder at 1.5% and 3.5% pulse the basal diet showed great augmentation of villus heights of the duodenum, jejunum and ileum as compared to control, which was in same line (Al-Tememy et al., 2011; Ghazanfari et al., 2015; Gurram et al., 2022). These results, in agreement with other studies, revealed the significant increase of jejunum villus height and villus height to crypt depth (VH: CD) ratio (Reuben et al., 2021; Othman et al., 2022) by adding herbal plants. This finding confirms the intestinal gut influence by active compounds present in diet. The main component of coriander oil, linalool, promotes increase in broiler villi height, and therefore, may enhance the activity of digestive enzymes, leading to change of its morphology (Misharina, 2001). Longer villi are associated with activated cell mitosis. It is assumed that increased villus height is paralleled by enhanced digestive and absorptive functions of the intestine due to larger absorptive surface area and higher expression of brush border enzymes and nutrient transport systems, which could influence intestinal morphology (Yamauchi, 2002). This result of increasing height of villus by adding fermented herbal plants was supported by Lokaewmanee et al. (2012) findings. Whereas there were no significant effect on jejunum crypt depth and these results were in agreement with other studies (Reuben et al., 2021; Gurram et al., 2022; Othman et al., 2022) by supplement with medical plant that opposite to finding revealed by Sholiha et al. (2023) added coriander to basal diet. Short villus and deep crypts may lead to poor nutrient absorption, increased toxin secretion in the gastrointestinal tract, and worse performance (Montagne et al., 2003) this could be attributed to either the

concentration levels added of herbs to the diet or due to chemical composition of basal diet, which contain anti nutritive factor as lignin, trypsin or phytates lead to reduce digestibility of other important nutrient (Brenes and Roura, 2010). In contrast, this result revealed that increases in VH: CD ratio is an indicator of the likely digestive capacity of the small intestine, which correlated with improved epithelial cell turnover this result was corresponding with Amad et al. (2013); Ghazanfari et al. (2015); Khan et al. (2020); Adegbeye et al. (2020); Reuben et al. (2021); Gurram et al. (2022). So, the increase in this ratio corresponds to an increase in digestion and absorption as well as reduced levels of pathogenic bacteria and may enhance immune status. The significant effect on VH: CD ratio may be related to antimicrobial and immune-modulating activities of coriander (Taha et al., 2019; Ulrikh et al., 2022). This result supported by Oso et al. (2019) that adding phytogenic blend to chicken diet. On the other hand, a non-significant effect in VH: CD ratio was agreed by Sholiha et al. (2023) which is indicative of a higher rate of enterocyte-cell migration from the crypt to the villus and poor absorption of nutrients. It is related to stress factor as ambient temperature leads to reduced growth performance of chickens (Welay et al., 2023) or due to secondary metabolites. A Recent study by Lin et al. (2022) revealed that the light quality and intensity influenced plant growth and secondary metabolites. These findings suggest that coriander has a positive impact on intestinal morphology in poultry, potentially contributing to improved gut health and overall performance.

CONCLUSION

The summarized conclusion of the current study revealed that the application of CSP at 1.5% and 3.5% had a positive effect on villus height of duodenum, jejunum and for the ileum was observed at 1.5% as compared with control and 3.5%. Moreover, the villus height/crypt depth ratio of duodenum and jejunum was at 3.5% and in the ileum were at 1.5% and 3.5% respectively. The dietary supplementation of coriander seed had a significantly positive effect on gut morphology in all segments of intestinal gut which this effect may enhance growth performance in broiler chickens. Future research should focus on exploring potential mechanisms underlying the observed change, as well as investigating the impact of coriander additives on other aspects of poultry health and performance.

DECLARATIONS

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Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Authors' contributions

M.M. khubeiz, collected data and samples, conducted laboratory analysis and prepared the original draft. O.A. Algriany, provided equipment and programming software. W. M. Elmghirbi, managed the fund of this research. G.R. Bilkhayr, provided chemicals for histological procedure. A. M. Shirif, designed and reviewed the writing. All the authors approved the final revision.

Ethical committee approval

This study was approved by the Graduate School of the University of Tripoli, Faculty of Veterinary Medicine, Department of Physiology, Biochemistry and Nutrition. All animal welfare protocols were followed.

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Competing interests

The authors have declared no conflict of interest

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