

The Effect of Coriander on the Histological Structure of the Intestine and Liver in Broilers

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Abstract

Medicinal plants are used in poultry feed due to their beneficial effects on the intestinal microflora, digestibility of nutrients, intestinal morphology, aspects that are found in the quality of meat and eggs. Currently, due to its characteristics, coriander is widely used in the food, pharmaceutical and medical industry, in the cosmetics and perfume industry, but also in the zootechnical field, as an alternative to antibiotics, in raising young animals and birds. In this context, the aim of this study was to evaluate the additional effects of the diet of chickens with coriander powder on intestinal and liver morphology. The study was performed on a number of 24 broilers (ROS 308 hybrids), male, divided into two groups, each group with two replications, 6 individuals / group: Control group (CG) fed only by the basic diet and the experimental group (CoG) in which the basic diet was supplemented with 1% coriander powder. The duration of the experiment was 42 days. Supplementation of the basic diet of chickens with 1% coriander powder led to an increase in the analyzed histomorphometric parameters, the differences compared to the control group (CG) being significant ($p < 0.05$; $p < 0.001$; $p < 0.001$) for height and surface of the intestinal villi and the depth of the crypts and, respectively, insignificant ($p > 0.05$) for the width of the villi.

In addition, at the hepatic level, dietary supplementation with coriander powder led to vascular hypertrophy, the presence of perivascular leukocyte infiltrates and the manifestation of cytoplasmic vacuolation of hepatocytes in the perilobular territories. Histomorphometric analysis of the data obtained in this study and histological changes in the liver provide new information on the use of coriander seed powder in broiler feed, as a potential promoter of their growth.

Key words: *Coriandrum sativum*, intestinal morphology, liver

1. Introduction

Poultry and egg production has proven to be a major and growing problem cereals are used preferentially in the diet of birds around the world. Although there is a wide range of anti-nutritional compounds present in their food, some such as

non-starch polysaccharides (NSP) [1], are commonly found in the composition of barley, rye, wheat and corn, inhibiting the action of digestive enzymes and thus increasing the viscosity of the intestinal content. The increase in viscosity causes serious digestive and health problems by prolonging the retention time of feed, an aspect that facilitates the development and colonization of the digestive tract with pathogenic microorganisms, of which the most abundant are bacteria [2]. Because different bacterial species

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have different substrate preferences and growth requirements, the chemical composition of the diet greatly influences the composition of the microbial community, and the interaction between them and the gastrointestinal epithelium leads to various structural and functional changes of the digestive tract [3, 4]. For these reasons, over the years antibiotics have traditionally been administered in the diet of birds, to combat the main pathogens, but also to increase the number of beneficial microorganisms in the intestinal microflora. Recently, the World Health Organization (WHO) identified antibiotic resistance as the main problem for the health of the population, due to the accumulation of residues in the carcass of these species [5].

It must, therefore, the urgency of finding alternative methods to the use of antibiotics and increasing the interest of scientists in the nutrition and diet of birds [6, 7]. Numerous studies have shown that a number of medicinal plants, in the form of extracts or essential oils, can be introduced into broiler feed due to their beneficial effects on intestinal microflora, nutrient digestibility, intestinal morphology, aspects that are found in the quality of meat and eggs [8-14]. Of these, Coriander (*Coriandrum sativum*) is documented as having a long culinary and medical history of thousands of years. Due to the numerous compounds such as linalool (67.70%), α -pinene (10.5%), γ -terpinene (9.0%), geranyl acetate (4.0%), camphor (3.0%); and geraniol (1.9%) contained in both the leaves and seeds of the plant [15], coriander is currently widely used in the form of extracts, powders and essential oils (EO), with antifungal effect [16], antioxidant [17], hypolipidemic [18], antimicrobial [19], hypocholesterolemic [18] and anticonvulsant [20]. Recently, the World Health Organization (WHO) identified antibiotic resistance as the main problem for the health of the population, due to the accumulation of residues in the carcass of these species [5].

Currently, due to its characteristics, coriander is widely used in the food industry (for flavoring and preservation), in the pharmaceutical and medical industry (therapeutic action), in the cosmetics and perfume industry (lotions) [21].

In addition, the powder and essential oils extracted from coriander plants are also used in the zootechnical field, as an alternative to antibiotics, in increasing the youth of animals and birds,

helping to reduce pathogenic bacteria in the digestive tract and improve intestinal health. Thus, numerous studies conducted by some researchers at the University of Portugal, have shown a negative impact of oils extracted from coriander seeds on the development in the intestine of 12 bacterial strains, including *E. coli*, *Salmonella* and *Bacillus cereus* [6]. In addition, some results have shown that the addition of coriander powder to the chicken diet has led to improved performance indices and a positive immune response [14].

Although most studies are related to the effect of phytochemical compounds contained in coriander essential oils, the literature presents insufficient and limited evidence, both in birds and mammals, on the effect of solid forms extracted from the plant on blood parameters, intestinal microflora, immune system and gastrointestinal tract morphology.

For these reasons, the purpose of our research was to evaluate the effects of dietary supplementation of chicken meat with coriander powder on intestinal and liver morphology.

2. Materials and methods

The study was conducted on a number of 24 one-day-old male ROS 308 hybrids provided by a local broiler breeding company. The hybrids were randomly assigned to two groups, the control group (CG) and the experimental group (CoG), each group with two replications, of six individuals each, and were bred under controlled environmental conditions, respecting the optimal temperature parameters and humidity, according to the growth technology. The basic diet was combined feed. The administration of water and fodder was done ad libitum, and the lighting program was 24 hours.

Throughout the experiment (1-42 days), the chicks of the control group were fed only with the basic diet represented by the combined feed, while the individuals of the experimental group with the basic diet in which 1% coriander powder was incorporated, obtained by grinding dried seeds (at a humidity level of 9%).

Immediately after slaughtering the hybrids, at 42 days of age, by the stunning method, small intestine and liver samples were taken and fixed in neutral formalin (10%). After the fixation operation, the anatomical parts were included in

histological paraffin, were sectioned with the Leica RM 2125 RT manual rotating microtome, at a thickness of 5µ and, then, were stained by the Mallory trichrome method.

Using the Olympus Cx41 optical microscope, equipped with an eyepiece with magnification power of 10x, optically corrected lenses with magnification powers of: 10x, 40x and 100x and Quick Photo Micro 2.2 software, the following histomorphometric parameters were studied: height of intestinal villi, the width of the villi, the surface of the villi and the depth of the crypts, as

well as a series of possible histological changes noticed in the liver tissue.

3. Results and discussion

Analysis of histological and histomorphometric results shows that in the individuals in the control group (CG), fed only with the basic diet represented by the combined feed, there were no changes in the intestinal mucosa (Figure 1A, B).

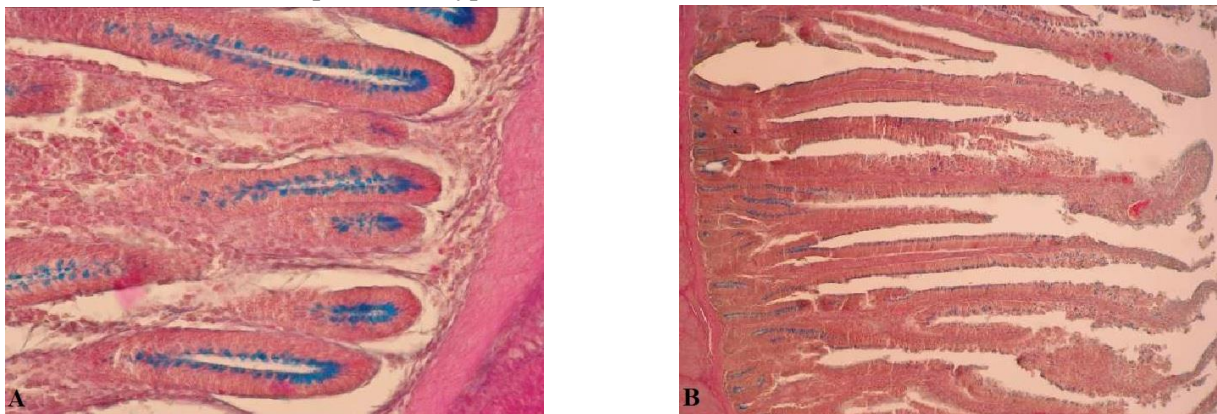


Figure 1. CG - intestinal mucosa (Mallory trichrome staining). A. intestinal villi (10x); B. intestinal glands (20x)

The intestinal villi had an average height of 1245.825 µm, an average width of about 105.385 µm, an area of 108554.025 µm², and the average depth of the crypts was about 262.450 µm (Tables 1-4).

In our study, the supplementation of the basic diet with 1% coriander powder, led to the increase of the histomorphometric parameters followed, in the

experimental group (LCo), compared to the control group (LC). Thus, in the chickens from the experimental group, the height of the intestinal villi was 1329.25 µm, with an average area of 125590.150 µm², between the individuals in this group and the control group there were significant differences (p<0.05; p<0.001) (Tables 1 and 2).

Table 1. Effect of dietary coriander powder supplementation on the intestinal villus height (µm) of birds on 42 days of age

Specification	N	Mean (µm)	Std. error	Std. deviation	Values	
					Min.	Max.
CG	40	1245.825 ^a	24.04696	152.08633	690.00	1507.00
CoG	40	1329.25 ^b	20.34194	128.65373	1078.00	1575.00

a-b p<0.05

Table 2. Effect of dietary coriander powder supplementation on the intestinal villus area (µm²) of birds on 42 days of age

Specification	N	Mean (µm ²)	Std. error	Std. deviation	Values	
					Min.	Max.
CG	40	108554.025 ^a	4231.36119	26761.47791	69157.00	204649.00
CoG	40	125590.150 ^b	2779.93155	17581.83086	100930.00	160166.00

a-b p<0.001

The villi have a rectangular appearance, with an average width of 109.300 μm , the differences being insignificant compared to the control group ($p>0.05$) (Table 3). In addition, the introduction of coriander seed powder in the basic diet led to an

increase in the depth of the crypts, whose average value was 296.2000 μm , thus being, even in the case of this parameter, significant differences between the experimental group and the control group ($p<0.001$) (Table 4).

Table 3. Effect of dietary coriander powder supplementation on the intestinal villus width (μm) of birds on 42 days of age

Specification	N	Mean (μm)	Std. error	Std. deviation	Values	
					Min.	Max.
CG	40	105.3850 ^a	1.97149	12.46881	82.00	132.00
CoG	40	109.300 ^b	3.10319	19.62625	79.00	167.00

^{a-b} $p>0.05$

Table 4. Effect of dietary coriander powder supplementation on the crypt depth (μm) of birds on 42 days of age

Specification	N	Mean (μm)	Std. error	Std. deviation	Values	
					Min.	Max.
CG	40	262.4250 ^a	8.75968	55.40105	156.00	431.00
CoG	40	296.2000 ^b	7.28884	46.09867	215.00	394.00

^{a-b} $p<0.001$

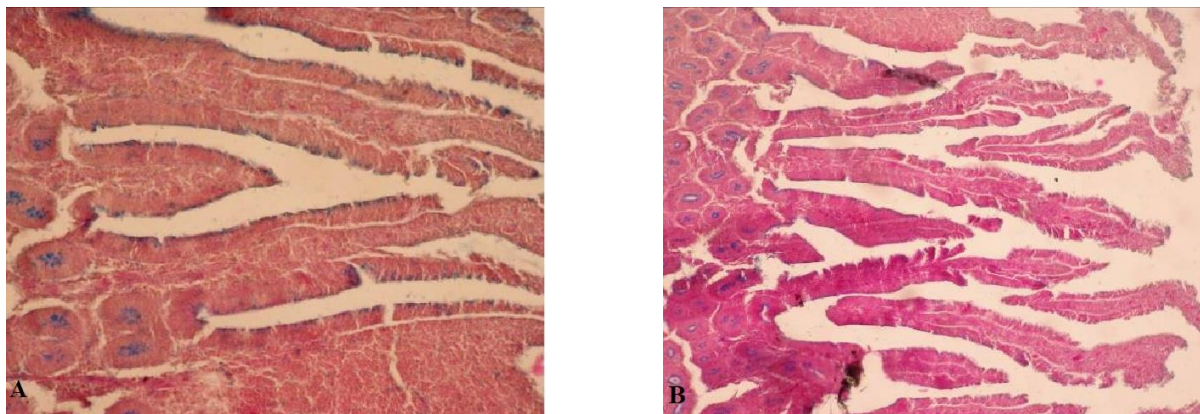


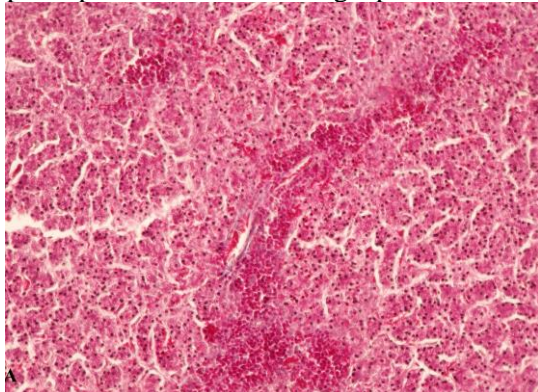
Figure 2. CoG - intestinal mucosa (Mallory trichromatic staining) - intestinal villi: A. 10x; B. 20x

Studies performed by us on histological preparations show that, in the case of individuals in the control group (LC), there are no alterations in the liver parenchyma, hepatocyte cords, sinusoidal capillaries and centrilobular vein having a normal appearance (Figure 3A). Hepatocytes have a fine-grained cytoplasm and a spheroidal nucleus.

In the case of individuals in the experimental group (LCo), in the perilobular territories, hepatocytes frequently show cytoplasmic vacuolations and nuclear degenerations. In addition, vascular hypertrophy and numerous perivascular leukocyte infiltrates are reported (Figure 3B).

The health and microscopic structure of the intestinal mucosa is a good indicator of the response of the intestinal tract to a number of active substances present in feed and intestinal contents [22]. Many studies have confirmed that the intestine can react morphologically and can adapt by increasing length and/or by increasing height or decreasing villi, in response to external factors related to dietary changes [23, 24]. The increase in intestinal villi in height, as well as the ratio between villi height and crypt depth are directly correlated with increased intestinal absorbent cell turnover and, implicitly, with mitosis activation in stem cells located at the base of villi [25, 26]. As the villi increase in height, the absorption capacity of the intestinal mucosa

increases, as a consequence of the increase of the absorption surface, of the microvilli expression at the apical pole of the absorbing epithelial cells



and, implicitly, of the nutrient transport systems at their level [27].

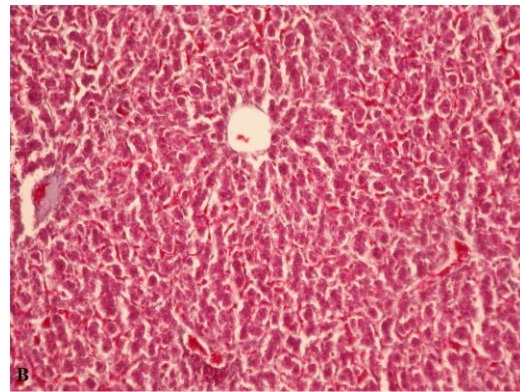


Figure 3. Histological section through the liver (20x; Mallory trichrome staining). A. CG - hepatocyte cords; centrilobular vein and sinusoidal capillaries; B. CoG - leukocyte infiltrates

On the contrary, a low height of intestinal villi and the presence of deep crypts can lead, on the one hand, to a reduced absorption of nutrients and, on the other hand, to increased secretion of toxins in the intestinal mucosa but also to poorer performance [28].

In the present study, supplementing the basic diet of chickens with 1% coriander powder led to an increase in all histomorphometric parameters studied, namely the height of the villi ($p < 0.05$) and their surface ($p < 0.001$), the width of the villi ($p > 0.05$) and the depth of the crypts ($p < 0.001$). Similar results have been reported by Ghazanfari, et al. (2015) [7], which investigated the effects of supplementation of the basic diet of coriander oil on broiler growth performance, blood parameters, microbiota and small bowel morphology. Supplementing the diet with coriander oil has led to both increased intestinal villi and the depth of the crypts, but has also influenced the decrease in height of enterocytes and the numerical reduction of goblet cells. It also Maha et al. (2016) [29] demonstrates the beneficial effect of fodder phytoadditives such as coriander, turmeric and thyme on jejunal morphology and shows a significant increase ($p < 0.05$) in intestinal villi, crypt depth, and improved broiler production performance. Studies performed by Cabuk et al. (2003) [30] have shown an increase in amylase concentration, following the dietary supplementation with coriander oil and the increase in villi in height is due to amylase. Improving the intestinal absorption process by adding coriander seed powder to the basic diet

could be due to essential oils and their main component, linalool, from coriander seeds. Linalool has an appetizing effect in diets and stimulates the digestive process in animals. Coriander (*Coriandrum sativum*) is one of the most commonly used plants in the treatment of several physiological disorders [31, 32], being known that, in recent years, plant-derived compounds have aroused much interest as natural alternatives to synthetic compounds.

The liver is an organ with an essential role in the metabolism of various types of compounds that enter the body, therefore, it is an important organ in any toxicological study. Microscopic analysis performed by us on liver tissue shows that, in the case of individuals in the control group (LC), there are no changes in the liver parenchyma, hepatocyte cords, sinusoidal capillaries and centrilobular vein with normal appearance (Figure 3A). Hepatocytes have a finely granular cytoplasm and a spheroidal nucleus.

In the case of individuals from experimental group 2 (LCo), supplementation of the basic diet of chickens with 1% coriander powder, led to vascular hypertrophy, the presence of perivascular leukocyte infiltrates and the manifestation of cytoplasmic vacuolation of hepatocytes in perilobular territories. Jothy et al. (2011) [33] suggests that, although bioactive herbal products are recognized for their beneficial effects on the body, further studies are needed to identify optimal doses that could be used later.

4. Conclusions

Supplementation of the basic diet of chickens with 1% coriander powder led to an increase in all studied histomorphometric parameters, but also

References

- Iji, P. A., The impact of cereal non-starch polysaccharides on intestinal development and function in broiler chickens, *World's Poult. Sci. J.*, 1999, 55, 375–387.
- Waldenstedt, L., Elwinger, K., Lunden, A., Thebo, P., Bedford, M. R., Ugglå, A., Intestinal digesta viscosity decreases during coccidial infection in broilers, *Br. Poult. Sci.*, 2000, 41, 459–464.
- Apajalahti, J., Kettunen, A., Graham, H., Characteristics of the gastro-intestinal microbial communities with special reference to the chicken, *World's Poult. Sci. J.*, 2004, 60, 223–232.
- Yegani, M., Korver, D. M., Factors Affecting Intestinal Health in Poultry, *Poultry Science*, 2008, 87, 2052–2063.
- Khaligh, F., Sadeghi, G., Karimi, A., Evaluation of different medicinal plants blends in diets for broiler chickens, *Journal of Medicinal Plants Research*, 2011, 5(10), 1971–1977.
- Esteghamat, O., An Investigation on Dietary Supplementation of Coriander (*Coriandrum sativum*) Seeds on the Food Intake and Microbial Populations of the ceca of Japanese quail (*Coturnix japonica*), *Biological Forum-An International Journal*, 2014, 6(2), 53–56.
- Ghazanfari, S., Mohammadi, Z., Adib Moradi, M., Effects of Coriander Essential Oil on the Performance, Blood Characteristics, Intestinal Microbiota and Histological of Broilers, *Brazilian Journal of Poultry Science*, 2015, 17(4), 419–426
- Langhout, P., New additives for broiler chickens, *World Poultry*, 2000, 16(3), 22–27.
- Taylor, D. J., Effects of antimicrobials and their alternatives, *British Poultry Science*, 2001, 42 (1), 67–68.
- Bolukbasi, S., Erhan M., Effect of dietary Thyme (*Thymus vulgaris*) on laying hens performance and *Escherichia coli* (*E. coli*) concentration in feces. Atatürk University, the Faculty of Agriculture, Department of Animal Science, 25240, Erzurum, Turkey, 2007.
- Soltan, M. A., Shewita, R. S., El-Katcha, M. I., Effect of dietary anise seeds supplementation on growth performance, immune response, carcass traits and some blood parameters of broiler chickens, *Int. J. Poult. Sci.*, 2008, 7, 1078–1088.
- Dalkılıç, B., Güler, T., The Effects of clove extract supplementation on performance and digestibility of vascular hypertrophy in the liver. Histological changes and histomorphometric analysis of the data obtained in this study provide new information on the use of coriander seed powder in broiler feed, as a potential promoter of their growth. *Nutrients in broilers, F.Ü.Sağ. Bil. Vet. Derg.*, 2009, 23, 161–166.
- Cross, D. E., Mcdevitt, R. M., Acamovic, T., Herbs, thyme essential oil and condensed tannin extracts as dietary supplements for broilers, and their effects on performance, digestibility, volatile fatty acids and organoleptic properties, *Br. Poult. Sci.*, 2011, 52, 227–237.
- Hosseinzadeh, H., Qotbi, A. A. A., Seidavi, A., Norris, Brown, D., Effects of Different Levels of Coriander (*Coriandrum sativum*) Seed Powder and Extract on Serum Biochemical Parameters, Microbiota, and Immunity in Broiler Chicks, Hindawi Publishing Corporation, The Scientific World Journal, 2014, Article ID 628979, 11.
- Nadeem, M., Anjum, F. M., Khan, M. I., Tehseen, S., El-Ghorab, A., Sultan, J. I., Nutritional and medicinal aspects of coriander (*Coriandrum sativum* L.): a review," *British Food Journal*, 2013, 115(5), 743–755.
- Bas'ílico, M. Z., Bas'ílico, J. C., Inhibitory effects of some spice essential oils on *Aspergillus ochraceus* NRRL 3174 growth and ochratoxin A production," *Letters in Applied Microbiology*, 1999, 29(4), 238–241.
- Chithra, V., Leelamma, S., 1999, *Coriandrum sativum* changes the levels of lipid peroxides and activity of antioxidant enzymes in experimental animals," *Indian Journal of Biochemistry and Biophysics*, 36(1), 59–61.
- Chithra, V., Leelamma, S., Coriandrum sativum-effect on lipid metabolism in 1, 2-dimethyl hydrazine induced coloncancer," *Journal of Ethnopharmacology*, 2000, 71(3), 457–463.
- Singh, G., Kapoor, I. P. S., Pandey, S. K., Singh, U. K., Singh, R. K., Studies on essential oils: part 10; antibacterial activity of volatile oils of some spices, *Phytotherapy Research*, 2002, 16(7), 680–682.
- Hossein, H., Mohammad, M., 2000, Anticonvulsant effects of *Coriandrum sativum* L. seed extracts in mice, *Archives of Iranian Medicine*, 3(4), 81–84.
- Mandal, S., Mandal, M., Coriander (*Coriandrum sativum* L.) essential oil: Chemistry and biological activity, *Asian Pacific Journal of Tropical Biomedicine*, 2015, 5(6), 421–428.
- Viveros A., Chamorro S., Pizarro M., Arija I., Centeno C, Brenes A., Effects of dietary polyphenol-rich grape products on intestinal microflora and gut morphology in broiler chicks. *Poultry Science*, 2011, 90, 566–578.
- Žikić, D., L Perić, G Ušćebrka, S.Stojanović, D. Milić and L Nollet, "Effect of prebiotics in broiler breeder and broiler diets on performance and jejunum morphology of broiler chickens," 1st Mediterranean

Summit of WPSA, Book of Proceedings, Porto Carras, Greece, 2008, 879-82.

24. Perić, L., N., Milkšević, D., Žikić, S., Bjedov, D., Cvetković, S., Markov, M., Mohnl and Steiner, T., Effect of probiotic and phytogetic products on performance, gut morphology and ceacal microflora of broiler chickens," *Archiv Tierzucht* , 2010, 53, 350-359.

25. Fan Y., Croom J., Christensen V., Blank B., Bird A., Daniel L, et al., Jejunal glucose uptake and oxygenconsumption in turkey poults selected for rapid growth. *Poultry Science*, 1997, 76, 1738-1745

26. Samanya M., Yamauchi K., Histological alterations of intestinal villi in chickens fed dried *Bacillus subtilis*var, 2002, 133, 95-104.

27. Pluske, J. R., Tompson, M. J., Atwood, C. S., Bird, P. H, Williams I. H, Hartmann, P. E., Maintenance of villus height and crypt depth, and enhancement of disaccharide digestion and monosaccharide absorption, in piglets fed on cows' whole milk after weaning, *British Journal Nutrition*1996, 76, 409-422.

28. Xu, Z. R., Hu, C. H., Xia, M. S., Zhan, X. A., Wang, M. Q., Effects of dietary fructooligosaccharides on digestive enzyme activities, intestinal microflora and morphology of male broilers. *Poultry Science*, 2003, 82, 1030-1036.

29. Maha, M., Hady, M. M., Zaki, Wafaa Abd EL-Ghany and Reda, M. S., Korany, Assessment of the broilers performance, gut healthiness and carcass characteristics in response to dietary inclusion of dried coriander, turmeric and thyme, *International Journal of Environmental & Agriculture Research (IJOEAR)*, 2016, 2(6), 153-159.

30. Cabuk, M., Alcicek, A., Bozkurt, M., İmre, N., Antimicrobial properties of the essential oils isolated from aromatic plants and using possibility as alternative feed additives. *Proceedings of the 2nd National Animal Nutrition Congress*; Sep 8-20; Konya, Turquia, 2003, 184-187.

31. Rana, H. K. Al-Rubaye, Effect of Aqueous Leaves Extract of *Coriandrum sativum* on Histological Structure and Liver Function of Male Albino mice, *Ibn Al-Haitham J. for Pure & Appl. Sci.*, 2016, 29(1), 16-24.

32. Nicula, M., Dumitrescu, G., Păcală, N., Tulcan, C., Dragomirescu M., Ștef, L., Dronca D., Gherbon, A., Petculescu Ciochină, L., Garlic, cilantro and chlorella's effect on gill histoarchitecture changes in Cd-intoxicated Prussian carp (*Carassius gibelio*), *Romanian Biotechnological Letters*, 2016, 21, 5, 11932-11940.

33. Jothy, S. L., Zakaria, Z., Chen, Y., Lau, Y. L., Latha, L. Y. and Sasidharan, S., Acute oral toxicity of methanolic seed extract of cassia fistula in mice, *Molecules*, 2011, 16(6), 5268-5282.