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Effect of *Nigella Sativa* on poultry health and production: A review

Tamoor Azeem[a], Zaib-Ur-Rehman[b], Sajid Umar[a]*, Muhammad Asif[a], Muhammad Arif[c], Abdur Rahman[c]

[a] Department of Veterinary Pathology, Faculty of Veterinary and Animals Sciences, PMAS Arid Agriculture University, Rawalpindi, Pakistan
[b] Department of poultry production, Faculty of Veterinary and Animals Sciences, PMAS Arid Agriculture University, Rawalpindi, Pakistan
[c] Department of Animal Nutrition, University of Veterinary and Animal Sciences, Lahore, Pakistan

Abstract
Incidences of antibiotic residues and drug resistance against pathogenic organism are common due to inclusion of antibiotics in poultry diet. It is the dire need of the time to use natural and effective alternative to synthetic antibiotics. *Nigella sativa* (black cumin) seed could be the most suitable alternative to antibiotics in poultry nutrition. *Nigella sativa* not only promote bird's health and production performance, but also plays a significant role as a natural antioxidant and immuno-stimulant. The poly-unsaturated fatty acids share is almost double than mono-unsaturated fatty acids in oil content of black seed, so it reduces the total cholesterol content. The bioactive compounds in black cumin are anticancerous. The present review describes the natural beneficial effect of *Nigella sativa* on poultry health and production when used in poultry diet.
Key Words: *Nigella sativa*, black cumin, poultry, nutrition.

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***Corresponding Author**: Sajid Umar; **Email**: sajncvi@gmail.com

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Introduction

Inclusion of antibiotics as a principal growth promoter in poultry feed often resulted in the incidence of cross resistance among pathogens and also a source of residues in animal body tissues [1]. Consequently, the European Union banned the use of antibiotics as a growth promoter in animal feeds in January, 2006 [2] and the scientists searched for the alternative natural growth promoting substances, essential oils and medicinal plants, which are proving more beneficial because of their antimicrobial effects [3, 4]. Such medicinal plants also possess stimulating effects on the animal digestive system [5-7].

Nigella sativa (black cumin) specie belonging to the family *Ranunculaceae* is famous for its medicinal properties. Seeds of *N. sativa* contain alkaloids, volatile as well as fixed oils and a variety of pharmacologically active substances like thymoquinone, dithymoquinone, carvacrol, thymol, nigellicine-N-oxide, nigellidine and α-hedrin [8-10]. Black cumin is also enriched with the fat content of 35.5% [11]. The seeds of *N. sativa* contain volatile oil (0.5-1.6%), fixed oil (35.6-41.6%), protein and amino acids (22.7%) [12]. So *N. sativa* seeds appear to be a multipurpose feed growth promoter and may be promising in improving broiler performance [13]. Many researchers have found encouraging results regarding the use of *N. sativa* as an alternative to antibiotics and a source of nutrition in the poultry feeds and many of them found encouraging results. This review paper digests not only the previous research done on the subject matter, but also discusses the potential benefits of *N. sativa* in poultry nutrition.

Nigella Sativa and feed intake and efficiency

Feed efficiency (FE) is the prime factor to assess feed quality. Research regarding the effect of *N. sativa* on FE is neutral as well as positive. Feed efficiency was improved by incorporating black seeds in the broiler rations [8, 14-16]. Guler et al. [17] reported no significant change in dietary intake of broiler by consuming feed containing black cumin and antibiotics. In another research it was found that diets with 4% grounded black cumin resulted in less feed intake but better FE as compared to control diet [18]. However, controversy results were reported by Abbas and Ahmed [19] as poor FE was observed in broiler chicks fed diet supplemented with 1 and 2 % black seeds. Feed intake remained unaltered by feeding diet having 1, 2 and 3% black cumin seeds [20] and 1, 2 and 3 ml/kg *N. sativa* oil [21] in 27 weeks old laying hens.

Nigella sativa and growth performance

The present commercial farming is becoming challenging for obtaining the desired weight without the use of antibiotics as growth promoters; therefore natural products capable of meeting the challenge are desired. Different studies on the effect of *N. sativa* seed on broiler performance have been carried out. El-Ghammry et al. [22] and Hassan et al. [23] reported an increased body weight by incorporating grounded *N. sativa* seed in broiler feed. Improved average daily weight gain and better feed conversion ratio (FCR) in broilers was achieved with fed 1% *N. sativa* seed in broiler diet [17, 18, 24].

Feed conversion ratio was improved by using 4g/kg black seed [2], 1.5% black cumin seeds [25] and 1.5% powdered *N. sativa* in four week old broilers [26]. The favorable effects of *N. sativa* on performance are thought to be due to high nutritive value as well as pharmacologically active substances present in the seeds. Black seeds contain mixture of essential fatty acids, particularly oleic, linoleic and linolenic acids that cannot be synthesized in the body. There are fifteen amino acids comprising the proteins of *N. sativa* out of which eight are essential [27]. Jamroz and Kamel [5] reported a stimulating effect of black seed on digestive system, resulting in better absorption and performance. Addition of *N. sativa* in feed increased bile flow rate results in increased emulsification that activates the pancreatic lipases which then aid in fat digestion and absorption of fat-soluble vitamins [28]. Black seed oil and thymoquinone have hepatoprotective effects [29], [30] so these seeds have been traditionally used in a wide range of gastrointestinal disorders [31]. The increased performance might also be due to antimicrobial effects of the active ingredients of black seed [32]. Antimicrobial activities of *N. sativa* inhibit *Shigella dysenteriae, Vibrio cholera, Shigella sonne, Escherichia coli* [33], *Bacillus pumilus, Bacillus suptilus*, *Staphylococcus lutea* [34], *Shigella flrxneri* [35] *Staphylococcus aureus* and *Pseudomonas aeruginos* [36]. The anthelmintic activity of black cumin was observed by Agarwal et al. [37] and antifungal activity against pathogenic yeast *Candida albicans* by Hanafy and Hatem [38].

Controversy findings related to the performance of broiler were reported by Nasir and Grashorn [39]; they found no significant effect on body weight gain, average daily weight gain and FCR by the addition of 1% *N. sativa* seed. The inclusion of black cumin seeds into the diet significantly decreased body weight of chickens [40, 41]. El-Bagir et al. [42] found that dietary *N. sativa* at the level of 1 and 3% significantly increased final body weight of laying hens, so caused negative impact on egg production. However, in contrast, 27 weeks old laying hens, fed diets supplemented with 1, 2, and 3% black cumin seeds, had no significant effects on body weight and FCR [20, 21]. Broiler chicks fed diet having 1 and 2 % black seeds showed a significant decreased in feed consumption, body weight gain and live body weight whereas non-significant results were obtained regarding FCR [19]. The reduced weight gain due to *N. sativa* meal was attributed to high fiber contents of the meal [43].

Heat stressed broilers fed black cumin oil (0.5, 1%), seeds (1, 2%) or meal (10, 20%) in feed showed better results than the control group. Significant improvement was observed regarding FCR, crude protein conversion (CPC), calorie conversion ratio (CCR) and feed consumption of the birds [43]. The better results of broilers by feeding *N. sativa* under heat stressed conditions can be attributed to the different ways by which black seeds exerted their effects on body metabolism. Firstly, *N. sativa* exhibits a variety of different components such as thymoquinone and thymohydroquinone and these constituents possess antimicrobial properties and are well known for their pharmacological effects [44]. Secondly, black seed also possess antibacterial and antifungal properties, so showed protective action against hepatotoxicity; all this can result in increased nutrient utilization [45]. It has been observed that *N. sativa* can stimulate thyroid gland directly or indirectly through the pituitary gland. Thyroid hormones are very important for the metabolism of the body as these hormones increase the metabolic rate that can lead to enhanced amino acid utilization by fastening their metabolism [46].

Nigella sativa and carcass traits

Guler et al. [17] and Toghyani et al. [2] reported an increased carcass yield, liver, abdominal fat, breast, thigh, wing and neck weights in broilers by feeding diet having 1% black cumin. However, non-significant values were obtained regarding heart weight. Controversy results were documented by [13] who found no improvement in carcass characteristics by feeding different levels of crushed as well as uncrushed *N. sativa* seed in broilers, however, breast percentage significantly increased [39, 47]. This increase breast weight indicated that *N. sativa* might have a good effect on protein metabolism. The greater ash percentage of the meat in the same study might be due to enhanced availability of minerals in black seeds. Fat percentage, breast meat color, shear force value and electrical conductivity revealed non-significant effects. Cooking losses were significantly greater in *N. sativa* seeds treated birds' meat. Broilers fed diet containing 1% whole grounded black cumin resulted in a significant decrease of dressing percentage as compared to the control, however, there were non-significant effects regarding liver, gizzard, heart, and abdominal fat percentage by supplementation of whole *N. sativa* seeds [19].

Hermes et al. [43] showed no significant effect on giblet and abdominal fat percentage in broilers. The bone percentage was greater in the control group

as compared to black cumin treated groups. Birds treated with *N. sativa* oil (0.5, 1%) or seeds (1, 2%) represented higher meat protein and lower fat percentage on dry matter basis. Non-significant values were obtained regarding tenderness and meat pH [81].

Nigella sativa and egg production and quality

Different scientists documented contradictory results regarding the effect of *N. sativa* on egg production in layers. Egg production markedly increased by using 1.5% powdered black cumin [40] and 3% black seeds [20] in layer diet. However, El-Bagir et al. [42] reported that supplementation of 1 and 3% black cumin in diet resulted in reduced egg production by approximately 9 and 16%, respectively without effecting egg length and width. The reduction in egg production might be due to the 10% increased final body weight of layers as energy from the black cumin oil extract was used to increase the weight gain rather than egg production. The dropped egg production might also be due to decrease in cholesterol [40], because in a study by Elkin et al. [48] it was observed that decrease in egg yolk cholesterol up to 30% by the addition of synthetic HMG-CoA reductase inhibitor in the diet resulted in reduced egg production by 20 % without effecting egg weight. So it can be inferred that cholesterol is needed for egg production and there may be a certain limit for cholesterol level, below which egg formation or production may be completely stopped.
Egg weight increased from 54 to 58g by supplementation of 1.5% black cumin in layers [40] and 1% black cumin extract increased egg weight as well as egg shell weight and thickness in quails [49]. Shell thickness and strength increased with 2 and 3% black seed in layer diets as compared to low levels i.e. 1% and without black cumin [20]. Bolukbasi et al. [21] reported that dietary supplementation of *N. sativa* oil had no significant effect on egg weight, egg production, ratio of yolk, albumen and shell. The addition of 3 ml/kg *N. sativa* oil in layer diet decreased the Haugh unit of the egg**.** Diet containing 3% black cumin seeds decreased the egg-yolk total lipids, cholesterol, phospholipids as well as triacylglycerols by 34, 45, 11 and 20%, respectively. The decrease in egg yolk cholesterol is highly desirable as efforts are being made to decrease the total cholesterol consumption in human diets because of its damaging effects on the health. The mechanism by which black cumin decreases the egg yolk cholesterol is not fully understood. However, speculations are made that the decrease in cholesterol can be related to the decreased in serum cholesterol by the black seeds. It is further assumed that seeds may inhibit the de-novo synthesis of cholesterol [42]. Albumin quality of eggs was improved by addition of black cumin in the diet [40, 41]. Non-significant results were observed regarding yolk index by supplementing diet with black cumin [41].

Nigella sativa and blood biochemistry

Badari et al. [50] reported decrease in serum triglycerides and cholesterol level with addition of *N. sativa* seeds in broiler diet. The cholesterol level of eggs was markedly decreased from 227 to 199 mg/egg yolk when diet supplemented with 1.5% black cumin [40]. The study conducted by El-Bagir et al. [42] indicated that addition of 1 or 3% black cumin in the diets of 68 weeks old layers resulted in a dose dependent decrease of serum phospholipids and cholesterol whereas a general decline in serum lipids was observed. The addition of 3% black cumin reduced the serum cholesterol and serum phospholipids by 23 and 30% respectively. The feeding of 3% crushed and non-crushed *N. sativa* seeds reduced plasma cholesterol, triglycerides concentration and increased the plasma High Density Lipoprotein (HDL) concentrations compared to 1.5, 2 and 2.5% crushed *N. sativa* seeds [13]. The reduction in the triglycerides and cholesterol level might be due to the active ingredients such as thymoquinone and compounds like monounsaturated fatty acids that lower the cholesterol synthesis by hepatocytes and decrease the fractional absorption of cholesterol from small intestine [51].

Studies conducted on broiler chicks have shown that replacing bacitracin methylene disalicylate by grounded black cumin seeds decreased serum cholesterol and triglycerides levels while HDL concentration increased [13, 35]. The decrease in serum cholesterol levels might be due to enhanced bile production as reported by El-Dakhakhny et al. [52]. EL-Kaiaty et al. [53] documented decrease in serum glucose levels up to 16% by adding the black cumin in the diet. EL-Ghammry et al. [22] found that by the incorporation of 4 g/kg black seeds, total plasma protein, albumin as well as globulin values were close to control birds. However, the addition of 2% *N. sativa* seeds in broiler diet resulted in increased total plasma protein [24]. The research on rats indicated a significant increase in RBC, WBC, PCV and Hb of *Trypanosoma brucei* infected rats when treated with black seed oil as compared to control rats [54].

Nigella sativa and bird's immunity

Black cumin bears an excellent potential as alternative to antibiotics and vaccines to improve immunity and to reduce mortality in poultry. Mortality was decreased from 16.67 to 4.17% by supplementation of layer diet with 1.5% black cumin [40] and from 3.5% in the control group to 2% in the group fed diet containing 1% powdered *N. sativa* seeds in broilers [39]. AL-Jabre et al. [55] found that volatile oils in *N. sativa* exhibit 67 constituents capable of inducing beneficial and pharmacological effects against bacteria such as *Staphylococcus* and *E. coli*. Active components of black seed possessing antibacterial, antioxidant, and anti-inflammatory activities induced positive effects on the immunity and organs involved [56, 57].

Antibody titer against Newcastle Disease (ND) and Infectious Bursal Disease (IBD) improved significantly by replacing bacitracin methylene disalicylate with grounded *N. sativa* seed in broiler diets; however, antibody titer against Infectious Bronchitis (IB) was not affected significantly. The improvement in ND and IBD titer is attributed to *N. sativa* oil components such as thymoquinone, carvacrol, nigellimine, thymol and nigellicine [13]. Increase in the lymphoid organ weight was observed when broilers fed diet supplemented with 0.2 and 0.4 % black seeds. However, incorporation of *N. sativa* seeds failed to induce any significant impact on antibody titers against Influenza and ND virus at 18 and 28 days of age. It was also noticed that heterophil to lymphocyte and albumin to globulin ratios were not statistically affected by the treatments [2].

Supplementation of broiler diet with *N. sativa* strengthened the immunity by preventing liver damage and lipid peroxidation [82]. Hermes et al. [43] found that broilers under heat stress condition behaved well with reduced mortality in black cumin treated groups as compared to control group. The reduced mortality rate was attributed to the antimicrobial effects, which helped the birds to overcome bacterial diseases, increased immunity and promote health [59]. Controversy results regarding mortality were reported by Ismail [47] who observed no effect on mortality when black cumin was added in the broiler diet.

Nigella sativa and reproductive traits

In a study carried out on male broiler breeder birds (45 weeks old) fed diet containing 0.5% and 1% *N. sativa* oil and seeds showed that the addition of either seed or oil resulted in best semen characteristics which were studied in the traits. The treated groups amazingly showed an increase ejaculation volume, sperm mass motility, progressive motility, count, and total sperm output as well as viability percentage. On the other hand, breeders exhibited a decrease in time of ejaculation and sperm abnormalities. In the second part of this study inclusion of black cumin in the diet of cocks significantly improved the fertility and hatchability of the treated cock groups, as compared to on non-back cumin diets [60].

Antioxidant effects of *Nigella sativa*

Badary et al. [61] documented the *N. sativa* as an excellent superoxide anion scavenger. The addition of black cumin ethanolic extracts to the corn oil prevented the oxidative damage of triglycerides [62]. The anti-oxidative properties are related to the inhibition of eicosanide generation, thromboxane B_2 and leukotriene B_4 because of inhibition of cyclooxigenase and 5- lipooxigenase, respectively. The antioxidant potential by capturing free radicals became evident when *N. sativa* oil was given to pentylenetatrazol induced seizure kindled mice [63]. These effects of black seeds might be due to the active constituents like thymoquinone, carvacole, anethole and 4- terepinol [64].

The study carried out on broilers showed that the *N. sativa* decreased the hepatic liver peroxidation and increased the activities of several enzymes such as glutathione-S-transferase, catalase, myeloperoxidase and adenosine deaminase all of which resulted in decreased oxidative stress on the liver using 3, 5 and 7% black cumin [58]. Methanolic extracts of black cumin showed that phenolic compounds such as syringic acid, hydroxybenzoic and pcumaric acids possess significant antioxidant properties under *in vitro* system [65].

Diet treated with 0.5 and 1% black seeds resulted in significantly decreased erythrocyte malondialdehyde (MDA) concentration, production of lipid peroxidases and increased glutathione (GSH) concentration compared to control group in chicken. The scientist concluded that *N. sativa* exhibits protective properties on the injury produced by oxidative stress by inhibiting free radical production and by regulation of glutathione preventing oxidative stress. Black seeds might decrease the production of hydrogen peroxide (H_2O_2), hydroxyl (OH) and superoxide (O_2) radicals that are produced as a result of aerobic respiration [66].

In rat and mouse models, many researchers have indicated the antioxidant effects of *N. sativa*. Nagi et

al. [67] showed that the mice treated with carbon tetrachloride (CCl_4) were protected by antioxidant mechanisms of black cumin oil. In another study, black seed oil reduced the lipid peroxidation activities of liver enzymes and contributed to the antioxidant defense system in CCl_4 treated rats [68].

Anti-cancerous effects of *Nigella sativa*

Many studies were performed on lab animals (mice and rats) regarding the anti-cancerous effects of *N. sativa*. A notable discovery was made regarding anti-cancerous activity of black seeds when researchers found an increased activity of natural killer cells (NK) up to 200-300% in advanced cancer patients who were receiving a multi-modality immunotherapy in which black seeds were a part of therapy [69]. Topical application of *N. sativa* seed extract inhibited dimethylbenz[α]anthracene/croton oil induced skin carcinogenesis in mice, delayed the onset of papilloma formation and reduced the number of papillomas per mouse [70].

In-vitro studies indicated that the *N. sativa* possess marked growth inhibiting properties of two leukemic cell lines and five solid tumor cell lines [71]. Ethanol extracts of *N. sativa* were capable of inhibiting ehrilich ascites tumor growth by reducing cell count as well as inhibit tumor development [72]. Different extracts of *N. sativa* produced different levels of cytotoxic effects on different cell lines when tested *in-vitro*, for example essential oil produced the most cytotoxic effects against the P815 cell line as compared to ethanol acetate and butanolic extracts. Whereas against the BSR line of cells, ethyl acetate extracts showed more cytotoxicity. Butanolic extract showed the greatest cytotoxic effects when ICO1 cell line was used. When treatment of solid tumor in mice was carried out with essential oil it was noted that the tumor growth significantly arrested as compared to PBS treated mice, suggesting that the cytotoxic activity of the extract particularly from day 0 to 12 of treatment and remained constant from day 12 to 30 indicated inhibition of cell growth. Furthermore, it was observed that the administration of the essential oil into the tumor site prevented the incidence of liver metastasis and improved the mouse livability [73]. Based on the findings of different research studies, it can be concluded that inclusion of *N. sativa* (black cumin) in poultry diet is beneficial regarding therapeutic and nutritional purposes. Being a good source of different nutrients it boosts up the growth rate, enhance the egg production, egg quality, dressing percentage and is effective against pathogenic organisms so the immune status of the bird. Due to exhibiting various therapeutic roles it can be used to replace antibiotics.

References

[1] Schwarz S, Kehrenberg C, Walsh TR. Use of antimicrobial agents in veterinary medicine and food animal production. Int J Antimicro 2001;17:431-437.

[2] Toghyani MA, Geisari G, Ghalamkari M, Mohammadrezaei. Growth performance, serum biochemistry and blood hematology of broiler chicks fed different levels of black seed (*Nigella sativa* L.) and peppermint (*Mentha piperita*). Livestock Sci 2010;129:173-178.

[3] Elgayyar M, Draughon FA, Golden DA, Mount JR. Antimicrobial activity of essential oils from plants against selected pathogenic and saprophytic microorganisms. J Food Prot 2001;64:1019-1024.

[4] Valero M, Salmeron MC. Antibacterial activity of 11 essential oils against *Bacillus cereus* in tyndallized carrot broth. Int J Food Microbiol 2003;85:73-81

[5] Jamroz D, Kamel C. Plant extracts enhance broiler performance. In non-ruminant nutrition; antimicrobial agents and plant extracts on immunity, health and performance. J Anim Sci 2002;80:41.

[6] Jang IS, Ko YH, Yang HY, Ha JS, Kim JY, Kang SY, Yoo DH, Nami DS, Kim DH, Lee CY. Influence of essential oil components on growth performance and the functional activity of the pancreas and small intestine in broiler chickens. Asian-Aust J Anim Sci 2004;17:394-400.

[7] Ramakrishna RR, Platel K, Srinivasan K. *In-vitro* influence of species and spice-active principles on digestive enzymes of rat pancreas and small intestine. Nahrung 2003;47:408-412.

[8] Al-homidan A, Al-qarawi AA, Al-waily SA, Adam SEI. Response of broiler chicks to dietary *Rhazya stricta* and *Nigella sativa*. Brit Poult Sci 2002;43:291-296.

[9] Ghosheh OA, Houdi AA, Crooks PA. High performance liquid chromatography analysis of the pharmacologically active quinines and related compounds in the oil of the black seed (*Nigella sativa*). J Pharm Biomed Ana 1999;19:757-762.

[10] Nasir Z, Abid AR, Hayat Z, Shakoor HI. Effect of kalongi (*Nigella sativa*) seeds on egg production and quality in white Leghorn layers. J Anim Plant Sci 2005;15:22-24.

[11] Babyan VK, Koottungal D, Halaby GA. Proximate analysis, fatty acid composition of *Nigella sativa* L. seeds. J Food Sci 1978;43:1314–1315.

[12] AL-Gaby AM. Amino acid composition and biological effects of supplementing broad bean and corn proteins with *Nigella sativa* (Black cumin) cake protein. Nahrung 1998;42:290- 294.

[13] AL-Beitawi NA, El-Ghousein SS, Nofal AH. Replacing bacitracin methylene disalicylate by crushed *Nigella sativa* seeds in broiler rations and its effects on growth, blood constituents and immunity. Livestock Sci 2009;125:304-307

[14] Halle I, Thomann R, Flachowsky G, Schubert R, Bitsch R, Jahreis G. Effect of ethereal (essential) oil and oil seeds on the growth of broilers. Sypposium Jenna-Thuringen, Germany; 1999, p. 469-472.

[15] Osman AMA, El-barody MAA. Growth performance and immune response of broiler chicks as affected by diet density and *Nigella sativa* seeds supplementation. Egypt Poult Sci 1999;19:619-633.

[16] Soliman AZM, Ghazalah AA, EL-Samra SH, Atta AM, Abdo ZMA. The synergistic effects of either black seeds or garlic with fat on broiler performance and immunity. Egypt J Nutr Feeds 1999;2:603-620.

[17] Guler T, Dalkilic B, Ertas ON, Ciftci M. The effect of dietary black cumin seeds (Nigella sativa L.) on the performance of broilers. Asian-Austr. J Anim Sci 2006;19:425-430

[18] Durrani FR, Chand N, Zaka K, Sultan A, Khattak FM, Durrani Z. Effect of different levels of feed added black seed (*Nigella*

sativa L.) on the performance of broiler chicks. Pak J Biol Sci 2007;10:4164-4167.
[19] Abbas TEE, Ahmed ME. Effect of supplementation of *Nigella sativa* seeds to the broiler chick's diet on the performance and carcass quality. Int J Agri Sci 2010;2:9-13.
[20] Aydin R, Karaman M, Cicek T, Yardibi H. Black Cumin (*Nigella sativa* L.) Supplementation into the Diet of the Laying Hen Positively Influences Egg Yield Parameters, Shell Quality, and Decreases Egg Cholesterol. Poult Sci 2008;87:2590–2595.
[21] Bolukbasi SC, Kaynar O, Erhan MK, Uruthan H. Effect of feeding *Nigella Sativa* oil on laying hen performance, cholesterol and some proteins ratio of egg yolk and *Escherichia coli* count in faeces. Archiv fur Geflugelkunde 2009;73:167-172.
[22] EL-ghammry AA, EL-Mallah GM, EL-Yamny AT. The effect of incorporation yeast culture, *Nigella sativa* seeds and fresh garlic in broiler diets on their performance. Egypt Poult Sci 2002;22:445–459.
[23] Hassan II, Askar AA, Gehan A, EL-Shourbagy A. Influence of some medicinal plants on performances; physiological and meat quality traits of broiler chicks. Egypt Poult Sci 2004;24:247-266.
[24] AL-Beitawi N, EL-Ghousein SS. Effect of feeding different levels of *Nigella sativa* seeds (black cumin) on performance, blood constituents and carcass characteristics of broiler chicks. Int J Poult Sci 2008;7:715-721.
[25] Ziad HM, Abu-Dieyeh, Abu-Darwish MS. Effect of feeding powdered black cumin seeds (*Nigella sativa* L.) on growth performance of 4-8 week-old broilers. J Anim Vet Adv 2008;7:286- 290.
[26] Abu-Dieyeh ZHM, Abu-Darwish MS. Effect of feeding powdered black cumin seeds (*Nigella sativa* L.) on growth performance of 4-8 week old broilers. J Anim Vet Adv 2008;3:286-290.
[27] Takruri HRH, Dameh MAF. Study of the national value of black cumin seeds (*Nigella sativa* L). J Sci Food Agric 1998;76:404–410.
[28] Crossland J. Lewiss Pharmacology, fifth ed. Churchill Livingston, London. 1980;656–657.
[29] Mahmoud MR, El-abhar HS, Saleh S. The effect of *Nigella sativa* oil against the liver damage induced by Schistosoma mansoni infection in mice. J Ethnopharmacol 2002;79:1-11.
[30] Mansour MA, Nagi MN, EL-Khatib AS, AL-Bekairi AM. Effects of thymoquinone on antioxidant enzyme activities, lipid peroxidation and DT- diaphorase in different tissues of mice: a possible mechanism of action. Cell Biochem Funct 2002;20:143-151.
[31] EL-Abhar HS, Abdullah DM, Saleh S. Gastroprotective activity of *Nigella sativa* oil and its constituent, thymoquinone, against gastric mucosal injury induced by ischaemia/reperfusion in rats. J Ethnopharmacol 2003;84:251-258.
[32] Gilani AH, Jabeen Q, Khan MAU. A Review of Medicinal Uses and Pharmacological Activities of *Nigella sativa*. Pakistan J Biol Sci 2004;7:441-451.
[33] Ferdous AJ, Islam SN, Ahsan M, Hasan CM, Ahmad ZU. *In vitro* antibacterial activity of the volatile oil of *Nigella sativa* seeds against multiple drug-resistant isolates of *Shigella* species and isolates of *Vibrio cholerae* and *Escherichia coli*. Phytotherpy Res 1992;6:137-140.
[34] El-Kamali HH, Ahmed AH, Mohamed AS, Yahia AAM, Eltayeb IH, ALI AA. Antibacterial properties of essential oils from *Nigella sativa* seeds, Cymbopogon citratus leaves and Pulicaria undulata aerial parts. Fitoterapia 1998;69:77-78.
[35] Chowdhury AKA, Islam A, Rashid A, Ferdous A. Therapeutic potential of the volatile oil of *Nigella sativa* seeds in monkey model with experimental shigellosis. Phytotherapy Res 1998;12:361-363.
[36] Sokmen A, Jones BM, Erturk M. The effect of black seed oil from *Nigella sativa* against murine cytomegalovirus infection. Int. J Immunopharmacol 1999;22:729-740.
[37] Agarwal R, Kharya MD, Shrivastava R. Antimicrobial and anthelmintic activities of the essential oil of *Nigella sativa*. Ind J Exp Biol 1978a;17:1264-1265.
[38] Hanafy MS, Hatem ME. Studies on the antimicrobial activity of *Nigella sativa* seed (*Black cumin*). J. Ethnopharmacol 1991;34:275-278.
[39] Nasir Z, Grashorn MA. Effects of Echinacea purpurea and *Nigella sativa* supplementation on broiler performance, carcass and meat quality. J Anim Feed Sci 2010;19:94–104.
[40] Akhtar MS, Nasir Z, Abid AR. Effect of feeding powdered *Nigella sativa* L. seeds on poultry egg production and their suitability for human consumption. Vet Arhiv 2003;73:181-190.
[41] EL-Sheikh AMA, Amin AE, Khadiga AA. The effect of feeding different levels of *Nigella sativa* seeds on layer performance and egg quality characteristics. Sudan J Vet Sci Anim Husb 1998;37:121-128.
[42] EL-Bagir NM, Hama AY, Hamed RM, EL Rahim AGA, Beynen AC. Lipid composition of egg yolk and serum in laying hens fed diets containing black cumin (*Nigella sativa*). Int J Poult Sci 2006;5:574–578.
[43] Hermes IH, Faten AM, Attia KA, Ibrahim, EL-Nesr SS. Effect of dietary *nigella sativa l.* On productive performance and Nutrients Utilization of broiler chicks raised under summer conditions of Egypt. Egypt Poult Sci J 2009;29:145-172.
[44] Mahfouz M, EL-Dakhakhny M. Some chemical and pharmacological properties of the new antiasthmatic drug "Nigellone". Egypt Pharm Bull 1960;42:411–424.
[45] Rathee PS, Mishra SH, Kaughal R. Antimicrobial activity of essential oil, Fixed oil and unsaponifiable matter of *Nigella sativa* Linn. Indian. J Pharm Sci 1982;44:8-10.
[46] More T, Rai AK, Singh M. Note on the effect of thermal exposure on body fluid composition of different breeds and crosses of sheep. Ind J Anim Sci 1980;50:207-209.
[47] Ismail ZSH. Effects of dietary black cumin growth seeds (*Nigella Sativa L.)* or its extract on performance and total coliform bacteria count on broiler chicks. Egypt Poult Sci 2011;31:139-149.
[48] Elkin RG, Freed MB, Kieft KA, Newton RS. Alteration of egg yolk cholesterol content and plasma lipoprotein profiles following administration of a totally synthetic HMG-CoA reductase inhibitor to laying hens. J Agri Food Chem 1993;41:1094-1101.
[49] Denli M, Okan F, Uluocak AN. Effect of dietary black seed (*Nigella sativa* L.) extract supplementation on laying performance and egg quality of quail (*Coturnix coturnix japonica*). J Appl Anim Res 2004;26:73-76.
[50] Badari OA, Abdel-Naim AB, Abdel-Wahab MH, Hamada FM. The influence of thymoquinone on doxorubicin-induced hyperlipidemic nephropathy in rats. Toxicol 2002;143:219–226.
[51] Brunton LL. Agents affecting gastrointestinal water flux and motility, digestants and bile acids, The Pharmacological Basis of Therapeutic, eight ed. Pregman Press. 1998.
[52] El-Dakhakhny M, Mahady NI, Halim MA. *Nigella sativa* L. oil protects against induced hepatotoxicity and improves serum lipid profile in rats. Arzneimittel Forschung 2000;50:832-836.
[53] El-Kaiaty AM, Soliman AZM, Hassan MSH. Combine effect of garlic, fenugreek and black seed on some productive and physiological response of laying hens. Egypt Poult Sci 2002;22:147–174.
[54] Justine TE, Oluwatosin KY. Some biochemical and haematological effects of black seed (*Nigella sativa*) oil on Trypanosoma brucei infected rats. Afric J Biotech 2008;7:153-157.
[55] Al-Jabre S, Al-Akloby O, AL-Qurashi A, Akhatar NA, AL-Dossary MA, Rankawa S. Thymoquinone: an active principle of *Nigella sativa*, inhibited Aspargillus niger. Pak J Med Res 2003;42:102–104.
[56] Al-Saleh IA, Billedo G, Inam IE. Level of selenium, DL-α-tocopgerol, DL-γ-tocopherol, all trans retinol, thymoquinone and

thymol in different brands of *Nigella sativa* seeds. J Food Comp Anal 2006;19:167-175.
[57] Arslan SO, Gelir E, Armutcu F, Coskun O, Gurel A, Sayan H, Celik L. The protective effect of thymoquinone on ethanol-induced acute gastric damage in the rat. Nutr Res 2005;25:673-680.
[58] Sogut B, Celik I, Tuluce Y. The effects of diet supplemented with black cumin (*Nigella sativa* L.) upon immune potential and antioxidant marker enzymes and lipid peroxidation in broiler chicks. J Anim Vet Adv 2008;7:1196-1199.
[59] Soltan MA. Effect of diets containing *Nigella sativa* (black seeds) and or ox bile on growth and reproductive performance of Japanese quail. Alex J Vet Sci 1999;15:655-669.
[60] Abdulkarim SM, Al-Sardary SY. Effects of black seed (*Nigella sativa*) on some reproductive traits in Ross broiler breeder male chickens. J Bombay Vet Colg 2009;17:19-28.
[61] Badary OA, Taha RA, Gamal-el-Din AM, Abdel-Wahab MH. Thymoquinone is a potent superoxide anion scavenger. Drug Chem Toxicol 2003;26:87-98.
[62] Bassim-Atta. M, Imaizumi. K. Antioxidant activity of Nigella (*Nigella sativa L.)* seeds extracts. J Japan Oil Chem Soc 1998;47:475-480.
[63] Ilhan A, Gurel A, Armutcu F, kamisli S, Iraz M. Antiepileptogenic and antioxidant effects of *Nigella sativa* oil against pentylenetetrazol-induced killing in mice. Neuropharmacol 2005;49:456-464.
[64] Guler T, Ertas ON, Kizil M, Dalkilic B, Ciftci M. Effect of dietary supplemental black cumin seeds on antioxidant activity in broilers. Medycyna Wet 2007;63:1060-1063.
[65] Mariod AA, Ibrahim RM, Ismail M, Ismail N. Antioxidant activity and phenolic content of phenolic rich fractions obtained from cumin (*Nigella sativa*) seed cake. Food Chem 2009;116:306-312.
[66] Tuluce YH, Ozkol B, Sogut I, Celik. Effects of *nigella sativa* on lipid peroxidation and reduced glutathione levels in erythrocytes of broiler chickens. Cell Membra Free Radi Res 2009;1:1-3.
[67] Nagi MN, Alam K, Badary OA, Al-Shabanah OA, AL-Sawaf HA, AL-bekairi AM. Thymoquinone protects against carbon tetrachloride hepatotoxicity in mice via an antioxidant mechanism. Biochem Mol Biol Int 1999;47:153-159.
[68] Kanter M, Meral I, Dede S, Gunduz H, Cemek M, Ozbek H. Effects of *Nigella sativa* L. and Urtica dioica L. on lipid peroxidation, antioxidant enzyme systems and some liver enzymes in CCl4- treated rats. J Vet Med A Physiol Pathol Clin Med 2003b;50:264-268.
[69] El-Kadi A, Kandil O. Effect of *Nigella sativa* (the black seed) on immunity. In: Proceedings of the Fourth International Conference on Islamic Medicine, 4 November, Kuwait; 1986, p. 344–348.
[70] Salomi MJ, Nair SC, Panikkar KR. Inhibitory effect of *Nigella sativa* and saffron (Crocus sativus) on chemical carcinogenesis in mice. Nutr Cancer 1991;16:67-72.
[71] Iddamaldeniya SS, Wickramsinghe N, Thabrew I, Ratnatunge N, Thammitiyagodage MG. Protection against diethylnitrosamine-induced hepatocarcinogenesis by an indigenous medicine comprised of *Nigella sativa*, Hemidesmus indicus and Smilax glabra: a preliminary study. J Carcinog 2003;18: 3-6.
[72] Musa D, Dilsiz N, Gumushan H, Ulakoglu G, Bitiren M. Antitumor activity of an ethanol extract of *Nigella sativa* seeds. Bratislava 2004;59:735-740.
[73] Mbarek LA, Mouse HA, Elabbadi N, Bensalah M, Gamouh A, Aboufatima R, Benharref A, Chait A, Kamal M, Dalal A, Zyad A. Anti-tumor properties of blackseed (*Nigella sativa* L.) extracts. Brazilian J Med Biol Res 2007;40: 839-847.