

## REVIEW ARTICLE

BLACK SEEDS (*NIGELLA SATIVA* LINN.) AS NATURAL FEED ALTERNATIVE IN POULTRY PRODUCTIONMohammed A. Al-Sanabani<sup>1,\*</sup>, Shaif A. Al-Hothaify<sup>2</sup><sup>1</sup> Dept. of Animal Production, Faculty of Agriculture, University of Sana'a, Yemen<sup>2</sup> Dept. of Livestock Research, Agriculture Research and Extension Authority, Yemen

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## Abstract

A black seeds (*Nigella sativa* Linn.) is a medicinal and herbal plant with a rich historical background that has attracted many investigators to study and explore its potential effects. BSs contain essential components for the growth such as amino acids, vitamins and minerals and active substances. The main active ingredients are volatile oils, alkaloids, saponin and sterols. The major components of volatile oils are thymoquinone followed by dithymoquinone, thymohydroquinone and thymol. It has a great medicinal properties including, antioxidant, anti-inflammatory, immune-modulatory, antibacterial, appetite stimulant, anti-diarrheal, and as a parasitic remedy. BSs have been used as feed additive in livestock feeding program as a replacement for antibiotic drugs and numerous studies have been carried out to examine the effects of BSs on broiler and layer birds and the results indicated to potential effects to stimulate immunity and upgrade the production performance and economic efficiency of the birds.

**Keywords:** Black seed, Feed additive, Poultry, Production performance, Immunity.

## 1. Introduction

Antibiotics as a chemotherapeutic drug have been used in animal diets for decades to enhance their productivity and health [1]. Using antibiotics as feed additives in animal production has some disadvantage to escalate the risk of residues in their products and tissues that may cause health problem on human through the development of bacterial resistance to specific product [2]. Antibiotic growth promoters (AGPs) prohibition has led to deteriorate in animal performance, and outbreak of certain animal diseases, such as necrotic enteritis some disease syndrome in the European Union broiler industry due to the ban of AGP [3]. For that, there are voices around the world calling for eliminating the application of antibiotics in the diets of animal and looking for natural products as an alternative to chemotherapy drugs in healing and prevention of various diseases.

Black seeds (*Nigella sativa* Linn.) is one of the medicinal plants and could be used as natural feed alternatives in the livestock and poultry production to enhance performance and reduce the incidence of developing antibiotic resistant bacteria in human and animals [4]. BSs could be the most suitable substitute to antibiotics in

livestock and poultry nutrition as beside promoting bird's health and production performance, it also plays a significant role as a natural antioxidant and immune - stimulant (5). Additionally, BSs have anti-bacterial and antiviral effects (6). Feeding BSs improved performance and egg quality of layer chickens [7]. A recent study suggested that using BSs is effective at improving broiler performance and meat quality by enhancing antioxidant activities and suppressing lipid per-oxidation in meat [8].

The objective of this review study is to evaluate the different effects of black seeds (BSs) as natural feed additives on poultry birds and performance through numerous of previous studies.

## 2. Black Seeds Definition

A black seed (*Nigella sativa*) is an annual flowering and herbal plant with a rich historical and religious background that has witnessed the attention of many investigators to explore the beneficial effects of this plant. It belongs to the family *Renanunculaceae*, grows in Asia and Mediterranean countries [9]. It was mentioned in the Holly Hadith by the prophet Mohammed (S.A.W) as a healing power, it is cultivated in small areas in

Yemen. BSs used for two purposes for health treatment also as spices to improve the sensory taste and flavor of many foods and deserts.

### 3. The Composition and Properties of Black Seeds

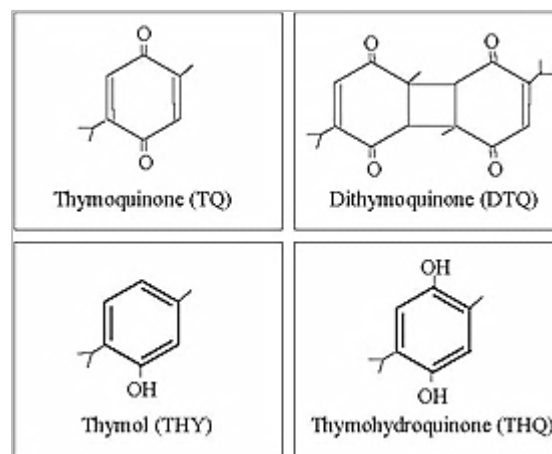
The chemical composition of BSs consists of crude protein, carbohydrates, lipids, ash and moisture. It was reported that black seed cultivated in Yemen contains proteins, fats, carbohydrates and ash [10].

BSs also contain essential components for the growth such as amino acids, vitamins and minerals and active substances. According to [11] who cleared that the major amino acids of BSs are glutamic and aspartic acid in addition some essential amino acids such as leucine, valine, tyrosine, iso-leucine and methionine.

Black seed oil (BSso) contains of fixed oil and volatile oil, the major unsaturated fatty acids of fixed oil is linoleic acid, followed by oleic acid [12]. In addition BSso contains myristic, palmitic and stearic acid. BSs contain vitamin E tocopherol and carotene, which is converted by the liver to vitamin A retinol. Also, BSs contains a satisfied amount of some minerals like calcium, iron, potassium, zinc, magnesium and sodium [13].

The main active ingredients are volatile oils, alkaloids, saponin and sterols. The major components of volatile oils are thymoquinone followed by dithymoquinone, thymohydroquinone and thymol (Figure). Volatile oil is considered the most active compound of BSs and thymoquinone represent the major compound of its components [13]. There are some sorts of alkaloids like nigelicine, nigellidine, nigellimine and nigellimine-oxide [14]. The compound Glycoside  $\alpha$ -hederin or helixin is the main saponine of BSs [15].

BSso contains a large amount of sterols particularly  $\beta$ -Sitosterol (54% of total sterols) and Stigma sterol, that may inhibit the absorption of dietary cholesterol [16]. It has also some antioxidant compounds such as Trans retinol, DL- $\gamma$ -tocopherol, DL- $\alpha$ -tocopherol and selenium [17], in addition to phenols as a source of taste for several sorts of foods.



Chemical structures of the active ingredients in the oil of black seeds [9].

### 4. Application of Black Seeds

The seeds and its oil extracts have been used in traditional medicine for centuries in Yemen, Middle East, Northern Africa, Far East, and Asia for prevention and treatment of many diseases in addition to the basic use of the seeds as a flavoring of food and deserts [18].

### 5. The Effects of Black Seeds as Antimicrobial and Antioxidant

It has a great medicinal properties including, antioxidant, anti-inflammatory, immunomodulatory and antibacterial [19].

BSs have been widely used in traditional medicine as antihypertensive, liver tonics, diuretics, digestive and appetite stimulant, anti-diarrheal, analgesics, in skin disorders [13], as a parasitic remedy [18], and as antiasthma [20].

Previous in vitro study by [21] proved that BSso has a vital effect against fungal activity and the reason attributed to the volatile oil. With the same trend, it has a strong anti-fungal effect against *Candida albicans* infections. Therefore, BSs may have suspension or minimize the negative effects of aflatoxines [22].

Additionally, many investigators documented that the antimicrobial activity of BSs and most of its pharmacological properties are due to the presence of Thymoquinone, which represent the major active compound of the essential oil of the seeds [23]. It was also found that Thymoquinone reduced translocation of bacterial and improved intestinal function in rats [24]. Additionally, BSs decreased *E. coli* numeration and improved intestinal health of broiler chicks [7]. Moreover, the seeds and its extracts have great effects against many species of bacteria, including gram positive and gram negative in addition to drug resistant strains of bacteria in animal, poultry and human [25].

## 6. Effects of Black Seeds Supplementation on Broiler Performance

Recently, numerous studies have been carried out to examine the effects of BSs as natural feed additives on broiler birds and the results were promising [10]. [26] studied the effects of feeding different levels of BSs (1, 1.5 and 2%) on broiler performance for the experiment period 4-8 weeks, and the results showed that the levels 1% and 1.5% supplemented to diets achieved significant increases ( $P<0.05$ ) in live body weight, also decreased ( $P<0.05$ ), Feed conversion ratio FCR while, increase the level of the seeds up to 2% caused a significant decreasing ( $P<0.05$ ) in broiler performance. Also, [27] showed that the use of different levels of black seeds (0.75%, 1%, 1.5% and 2%) had significant effects ( $P<0.05$ ) on performance of broilers and the highest level of weight gain was in the group that was received 2% BSs.

According to [28] BSs with a level 1% in the diets of broiler chicks significantly improved broiler health and performance. Supplementation of black seeds (0.5%) to the diet of broilers resulted in significantly higher live body weight and body weight gain [29]. Likewise, [30] found that allocation of black seed in the diet of broilers at the level 1% improved the body weight gain and FCR, they also found that the feed intake of broilers was higher ( $P<0.01$ ) in black seed treatment groups compared with the control.

On contrary to the above research, the findings by [31] indicated the absence of any significant effects on body weight gain and, Feed conversion ratio FCR when adding BSs (1%) in broilers. According to [32] found that on broiler chickens stated a decrease in body weight gain and feed intake, whereas there was no significant impact on Feed conversion ratio. As indicated by [33] supplementation of BSs (0.5%) to broiler ration had a better result as increased the weight gain of broiler birds as compared with garlic and turmeric treatments, but the difference was not significant. However, Feed conversion ratio FCR of broiler chickens was improved after 6 weeks by diets containing 1% BSs [34]. Furthermore, supplementation of BSs (1 up to 2%) as a natural growth promoter in chickens resulted in a tendency to increase body weight gain and daily feed intake linearly with increasing concentrations of BSs in the diets [35].

[36] showed that the lowest feed conversion ratio for the period 1 to 21 days was recorded in 15 g/kg BSs group, but the group supplemented with 5 g/kg BSs achieved the lowest FCR at 42 days to evaluate the effects of supplementing black seeds (5, 10 and 15 g/kg) in broiler diets. Although, the highest feed intake was recorded for the group supplemented with 10 g/kg BSs but were not significant [36]. Also, [10] indicated that the addition of BSs up to 1% in the diets enhanced linearly growth

performance, birds fed diets containing 1% BSs achieved a higher ( $P<0.05$ ) body weight and weight gain and it recorded a better ( $P<0.05$ ) Feed conversion ratio. Another study was conducted by [37] showed that broiler birds treated with black seeds (1.5%) and curcumin (400 mg/kg) had an increase in body weight.

In the fact, several studies were carried out to identify the potential influence of BSs on production performance and health in layer birds. According to [38] continuous supplementation of BSs with a level of 0.75 % for 12 weeks to layer chickens had a significant increase in final live body weight, and egg weight, also had improved Feed conversion ratio compared with control and the diet fed 1.5% BSs. This result is supported by [39] who showed that using BSs in layer diets in average 10 and 15 g/kg feed led to a significant improvement in Feed conversion ratio and egg weight when compared with the control. Another study by [40] concluded that using BSs and dry parsley as together in the layer quail diets as feed additives have a positive effect on egg production and hatchability.

## 7. The Effects of Black Seeds on Carcass Traits

Last investigations referred to controversial results of carcass indicators in poultry, [31] reported that BSs (1%) increased the average of breast percentage. Additionally, [41] observed an increased in carcass traits (carcass yield, liver, abdominal fat, breast, thigh, wing and neck weights) in broilers by feeding a diet containing 1% BSs.

Another investigation by [42] found that using 1% BSs in broiler diets increased ( $P<0.05$ ) the carcass weight as compared to the control group, while, there were no significant effects of dietary BSs or BSs extract were observed in the dressing percentage, edible inner organs, abdominal fat, full gut weight, gut length of broilers.

According to [43] the mean dressing percentage of negative control birds at 28 and 42 day of age was significantly ( $P<0.05$ ) lower than the birds fed diets containing BSs and antibiotic, in addition, there was no significant effect between BSs treatments and antibiotic. Another study by [44] who indicated to no significant differences in the weight percentage of gizzard, proventriculus, intestine and rectum, while the weight of the liver and caecum were significantly increased compared with the control group, when feeding broilers with different forms and levels of BSs (1, 2% BSs and 0.5, 1% BSs) under heating stress in summer. On the contrary, [45] indicated to no diets of black seeds (4 or 8 g/kg) affected carcass characteristics and internal organs weight.

In a recent study conducted on broiler chicks, [8] revealed that the dietary BSs (1% and 2%) supplementation resulted in a significant increase in crude protein content

and decrease in crude fat content compared to the control ( $P < 0.05$ ). Further study detailed that protein deposition in the thigh and breast muscles was increased and nitrogen excretion was reduced by supplementing (0.5, 1 and 2%) BSs to broiler diets compared with the control [46].

In a study to identify the effects of BSs (0.25, 0.5, 1 and 2%) on carcass traits of broiler birds, the results showed that the dietary treatment 1% BSs recorded the best ( $P < 0.05$ ) carcass dressing, breast and thigh percentage compared with the control group [10].

## 8. The Effects of Black Seeds on some Blood Constituents

Serum globulin proteins reflect the immune status of birds, as any changes in immunoglobulin may affect serum protein globulin. Broiler birds fed diets contain 2.5 and 5% BSs showed an increase ( $P < 0.05$ ) in total protein values as compared with birds fed diets contain 1.25% BSs, antibiotic or the control diet group [43]. In this experiment [47] found that supplementation of BSs (1%) in the diet of broilers improved ( $P < 0.05$ ) serum total protein and albumin.

According to [48] who found that feeding rabbit with a diet containing BSs (0.2%) led to increase the plasma total proteins, albumin and globulin. However, [49] showed that BSs additives (0.5%) in growing rabbits diet did not significantly ( $P > 0.05$ ) affected on hemoglobin concentration, hematocrit, the counts of red and white blood cells and the percentages of white blood cells and the concentrations of total protein, albumin and globulin in blood serum were nearly similar for the different groups.

In terms of the effects of black seeds on cholesterol, many factors may affect the content of serum cholesterol like nutrition, climate, disease, toxins and stress, for example, the rate of serum cholesterol may increase due to the stress or disease infection, [50].

For health concerns, some researchers revealed the decrease in total cholesterol of chicken yellow eggs in return, it can be more healthy and acceptable for a large of consumers, according to [51] who showed that BSs at level of 2 or 3% would positively influence egg production, egg weight, shell quality and decrease the concentration of cholesterol in the egg yolk. [38] indicated that supplementation of 0.75% and 1.5% crushed BSs to layer diets significantly decreased the total triglycerides and cholesterol in both serum blood and yellow egg compared with the control treatment.

According to [39] application of 10 and 15 g/kg feed of BSs in the chicken's diet led to a decrease ( $P < 0.05$ ) in the value of cholesterol and saturated fatty acids in yellow eggs of those birds as compared with treatments free of that feed additives. Also, [42] who observed a reduction

in egg cholesterol concentrates and improvement in egg quality of laying hens. Similarly, [7] indicated that regardless of supplementation level, dietary inclusion of black seeds (1%, 2% and 3%) improved serum lipid profile of laying hens as dietary treatments decreased ( $p < 0.05$ ) the concentration of serum cholesterol and triglycerides and increased ( $p < 0.05$ ) serum high density lipoprotein (HDL) concentration and relative weight of pancreas.

Also, [52] indicated that rabbits affected of high blood cholesterol, which, feeding diets treated with BSs or BSs for 8 weeks led to a significant decrease ( $P < 0.05$ ) in the levels of total cholesterol and low density lipoprotein, while the high density lipoprotein of serum blood was increased ( $P < 0.05$ ). They concluded that treatment of rabbits with BSs or BSs showed hypocholesterolemic and anti-atherogenic cardio-protective properties.

With the same line, A research study [45] found that feeding broiler birds on diets supplemented with 0.8% BSs resulted a significant lower effect on total cholesterol and low-density (LDL) in serum blood as compared with birds fed with no additives. Although, [53] observed the cholesterol level in the serum was not affected as a result of feeding BSs (2%) to broiler chicks for one, two and three weeks.

## 9. The Effects of Black Seeds on Immunity and Immune Responses

It is commonly whispered that the immune system represents the main defense against infectious diseases, and it is well known that any deficiencies of its characteristics would be submitted to these infectious diseases. There are two types of specific responses; the humoral response and the cellular response and both responses are intermediated through the lymphocyte [54]. Humoral responses are antibodies produced in response to an antigen, and these antibodies are proteins, have similar structures, and can be divided into several classes of immunoglobulin, cellular responses are established by cells and can only be transmitted by cells [55].

Natural products can help and improve the immunological status, according to [56] found that the antibody response of commercial broilers against infectious bronchitis (IB), Newcastle disease (ND), and Infectious bursal disease (IBD) following vaccination had a more significant beneficial effect of a combined of natural feed supplementation as compared with control and *E. coli* infected groups. The *E. coli* infected group had the lowest antibody titers to IB, ND, and IBD ( $P < 0.01$ ), when compared with other groups. A recent study by [37] indicated that treatment with BSs and curcumin decreased the risk of exposure to Infectious bursal disease vaccine, improved general health condition and

immune status of chicks. With the same line, [57] was observed the highest value of the antibody titer of chicks against ND in the treatment feeding 0.5% BSso.

In another study conducted by [58] concluded that black seed at the level of 2% would increase antibody response to ND vaccine and duration of supplementation had a positive influence on immune response and reduced coliform count in the gut. Similarly, [59] showed that supplementation of black seeds at the level of 1% or 1.4 % improved the immune responsiveness in broiler chickens. With the same trends, [60] found that antibody titers against ND virus and IBD virus were significantly enhanced by application of BSs in broiler chicks feed instead of the antibiotic Bacitracin Methylene Disalicylate.

Concerning the effects of BSs on Lymphoid organs, the bursa of Fabricius and thymus are two primary or central lymphoid organs of the immune system. Thymus creates T- cells and bursa produces B- cells and plays a vital role in cellular and humoral immunity, and the spleen, consider also another lymphoid organ of immunity system in birds and plays an important role in disease resistance and prevention [61].

According to [62] showed that adding BSs in broiler diets had non-significant effects on the relative weight of bursa, thymus and spleen organs under the normal and heating stress conditions. On the other hand, the mean weight percentage of lymphoid organs of the BSs and antibiotic dietary groups (broiler chicks) was significantly higher than the control group [31].

According to [44] adding of different levels of BSs to broiler diets in the high temperature conditions in summer, significantly increasing in the weight percentages of spleen and thymus gland.

[43] observed improvement in the immune response of broiler birds and the mean lymphoid organs (bursa of fabricious, thymus and spleen) weight ratio of the birds fed diets containing BSs was significantly higher compared with the negative control birds. Additionally, [41] found that the weights of lymphoid organs were significantly higher for broiler birds fed diets supplemented with BSs. Similarly, there was significantly increased lymphoid organs ratio with increasing BSs levels in broiler diets [63]. [64] showed a significant decrease in mortality rate of broiler groups treated with different doses of the BSs extract (2.5, 5 and 7.5 ml/kg) compared with bird groups provided with 0.1% Flavomycin. Additionally, [65] indicated that BSs at the rate of 1% in feed has an antibacterial effect against induced a airsacculitis caused by *Escherichia coli* in a similar manner as Enro- floxacin treatment in water, in addition it reduced heating stress and improved immune response of birds.

The positive effect of BSs on immunity was attributed to BSso by increasing the phagocytic activity, and the potential immunity mechanism is mediated through stimulation activity of macrophage phagocytic or by activation of lymphocytes [66].

## Conclusion

Several studies documented the positive effect of using BSs as natural feed additives in poultry industry and most of its pharmacological properties are attributed to the presence of Thymoquinone, which represent the major active compound of the BSso. Despite the controversial results, most studies confirmed that BSs could be used in the diets of poultry with a level up to 1% - 2 % to significantly improve broiler health and performance. Some researchers revealed the decrease in total cholesterol of chicken yellow eggs; in return, it can be more healthy and acceptable for a large of consumers. BSs as natural products can help and improve the immunological status by increasing immune responses and resistance to infectious diseases.

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## مقالة بحثية

## استخدام الحبة السوداء كإضافة غذائية طبيعية في إنتاج الدواجن

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## المُلخَص

الحبة السوداء (*Nigella sativa* Linn.) نبات عشبي طبي غنية بمدلولاتها التاريخية والتي لفتت أنظار العديد من الباحثين للكشف عن تأثيراتها المختلفة. تحتوي البذور على مكونات أساسية للنمو مثل الأحماض الامينية والفيتامينات والأملاح المعدنية والعديد من المواد الفعالة، وتعتبر الزيوت الطيارة والقلويدات والصابونيين والاسترولولات من أهم العناصر الفعالة ويمثل مركب الثيموكينون غالبية الزيت الطيار. تمتلك بذور الحبة السوداء خصائص طبية عديدة منها التأثير المضاد للأكسدة والالتهابات والبكتريا والتأثير المنظم للمناعة. ويمكن أن تستخدم الحبة السوداء ومستخلصاتها في برامج تغذية الثروة الحيوانية كبديل لاستخدام المضادات الحيوية، حيث أثبتت العديد من الدراسات التي أجريت مؤخراً أن استخدام البذور كإضافة غذائية طبيعية أدت إلى حدوث تأثيرات إيجابية في الجانب المناعي والصحي ورفع كفاءة الأداء الإنتاجي والاقتصادي للطيور.

الكلمات المفتاحية: الحبة السوداء، الإضافات الغذائية، الدواجن، الأداء الإنتاجي، المناعة.

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