Egypt. Poult. Sci. Vol (29) (I): (145-172)

EFFECT OF DIETARY *NIGELLA SATIVA L.* ON PRODUCTIVE PERFORMANCE AND NUTRIENTS UTILIZATION OF BROILER CHICKS RAISED UNDER SUMMER CONDITIONS OF EGYPT

By

I.H. Hermes, Faten A.M. Attia, K.A. Ibrahim, and S.S. El-Nesr

Dep. of Animal Prod.,, Fac. of Agric, Suez Canal Univ., Ismalia

Received: **09/02/2009** Accepted: **05/03/2009**

ABSTRACT: *An experiment was designed to study the effects of feeding different forms and levels of Nigella sativa L. as natural feed additives on productive performance and nutrients utilization of broiler chicks raised under summer conditions of Egypt. A total of 280 unsexed one day old "Ross" broiler chicks was reared in batteries in an open house. Chicks were divided into 7 treatment groups of 40 chicks (4 replicates each). Ambient temperature (°C) and relative humidity (%) inside the experimental room were recorded during the experimental period. Experimental diets were formulated to be isonitrogenous and isocaloric according to the strain manual recommendation. Seven experimental diets were used; the first diet (T1) was the control, with no natural feed additives. Diets 2 and 3 (T2 and T3) contained Nigella sativa oil (NSO) at 2 levels of 0.5 and 1.0%, respectively. In diets 4 and 5 (T4 and T5), Nigella sativa seed (NSS) was added at 2 levels of 1.0 and 2.0%, respectively, while diets 6 and 7 (T6 and T7) contained Nigella sativa meal (NSM) at 2 levels of 10 and 20%, respectively. Water and feed were offered ad-libitum during the experimental period, which lasted for 49 days. At the end of the experiment, slaughter tests were performed using 6 birds per treatment. The apparent digestibility coefficients of nutrients of the experimental diets were determined using three male birds from each treatment at the end of the experiment. The trial was continued for five days after a preliminary period of three days. Results could be summarized as follows: 1)- Feeding heat stressed broiler chicks the control diet only during studied periods (0-28, 29-49 and 0-49 days of age) resulted in significantly ($P \leq 0.05$) poor growth performance (BWG ,FC, FCR, CPC, CCR), high mortality rate, low carcass characteristics, low nutrients digestibility and low relative efficiency but high relative economic efficiency compared with those fed treated groups (T2-T7). 2)- In most cases, during starting period (0-28 days) and overall period (0-49 days), feeding diets supplemented with 10% NSM (T6) or 1.0% NSS (T4) or 0.5% NSO(T2) reflected ($P \leq 0.05$) an improvement in previous studied criteria compared with* *the control and other treated groups. Contrary to that, during finishing period (29-49 days of age), results of studied criteria showed inconsistent figures and did not follow a definite trend as starting and overall periods.*

In conclusion *The results showed that addition of 10% NSM or 1.0% NSS or 0.5% NSO in broiler diets had improved the productive performance, livability, carcass characteristics, digestibility of nutrients and economic return. However, addition of Nigella sativa as natural feed additives for broiler diets reared in open houses under summer conditions of Egypt reduced the harmful effects of high temperature.*

INTRODUCTION

Under summer conditions of Egypt, poultry production (broiler intensive production) suffered from high environmental temperature which caused many troubles. Numerous studies have established the negative effects of heat stress during summer on productive performance of poultry such as reduction of feed consumption, growth rate, feed utilization and economic efficiency. Decreased rate of productive performance has been reported in broilers reared at high environmental temperatures **(Abu-Dieyeh, 2006)**.

In order to overcome the adverse effect of heat stress, a considerable amount of research has been conducted depending upon nutritional conditions, such as: feeding timing program **(Abdel-Mageid *et al.*, 2007)**, increasing dietary density **(Galal *et al.*, 2002)**, critical essential amino acids **(Abd-Elsamee, 2005)**, fat supplementation **(Abo Saq, 2004)**, minerals and vitamins **(Al-Homidan, 2000)** and feed additives and growth promoters **(Hermes and Al-Homidan, 2003)**.

It has been found that the natural feed additives like herbs and medicinal plants have some properties as growth enhancers to replace synthetic drugs. These natural feed additives are given to animals/birds to improve their productive performance under normal or stress conditions. Among natural feed additives, *Nigella sativa* seed, meal or oil showed a significant improvement of body weight gain, feed conversion ratio, mortality rate and economic efficiency **(Nofal *et al.*, 2006** with broiler; **Ghazalah and Ibrahim, 1996** with ducks; **Abou El-Soud, 2000** with Japanese quail; **and Naser and Attia, 1998** with rabbits).

In the same order, *Nigella sativa* has no harmful effects on broiler performance and could be supplemented to overcome the deleterious effects of hot climatic conditions **(Afifi, 2001 and Tollba and Hassan, 2003)**.

Generally, literatures on feeding different forms and levels of *Nigella sativa* to broiler chicks under high temperature conditions are very limited.

The present study was designed to shed some light on the effects of feeding different forms and levels of *Nigella sativa L.* as natural feed additives on productive performance and nutrients utilization of broiler chicks reared under summer conditions of Egypt.

MATERIALS AND METHODS

The experimental work was carried out at the Poultry Research Farm, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt during summer season (July and August) of 2006.

Birds and management: Two hundred and eighty one-day old unsexed "Ross" broiler chicks were reared in brooder batteries with wire mesh floors in an open house. Chicks were wing-banded, weighed individually and randomly distributed into 7 treatment groups of 40 chicks (4 replicates each). Feed was supplied *ad-libitum* and birds had free access to water. Artificial light was provided 24 hour daily through the experimental period, which lasted for 49 days. Ambient temperature (°C) and relative humidity (%) inside experimental room were recorded 4 times daily and the weekly average values during experimental period are shown in Figure (1).

Diets and Treatments: Chicks were fed two types of diets, starter from 0-28 days-old and finisher from 29-49 day-old. Experimental diets were formulated to be isonitrogenous and isocaloric according to strain manual recommendation. Seven experimental diets were used; the first diet (T1) was the control, with no natural feed additives. Diets 2 and 3 (T2 and T3), included *Nigella sativa* oil (NSO) which was added at 2 levels of 0.5 and 1.0%, respectively. In diets 4 and 5 (T4 and T5), *Nigella sativa* seed (NSS) was added at 2 levels of 1.0 and 2.0%, respectively, while in diets 6 and 7 (T6 and T7), *Nigella sativa* meal (NSM) was added at 2 levels of 10 and 20%, respectively. Chemical analysis of NSS, NSM, starter and finisher experimental diets were determined according to AOAC (1990). The starter and finisher experimental diets formulation and their chemical analyses are presented in Tables (1 and 2).

Growth performance: Birds individual live body weight (LBW) and pen feed consumption (FC) were weekly recorded and mortality was daily observed. Body weight gain (BWG), feed conversion ratio (FCR), crude protein conversion (CPC) and caloric conversion ratio (CCR) were calculated. At the end of the study, economic studies of experimental treatments were estimated using two ways: 1) Economic efficiency (EE_f) of the product which was calculated from the input-output analysis based upon the difference in both growth rate and feeding cost; 2) European productive efficiency factor (EPEF) which was calculated according to **Kamar and Sami (1982)** using the following formula:

$$\text{EPEF} = \frac{\left(\dfrac{\text{AFLBW (kg)} \times \text{TFBWS (kg)}}{\text{SNC}}\right)}{\left(\dfrac{\text{AMA (days)} \times \text{TFC (kg)}}{\text{FNC}}\right)} \times \left(\frac{10000}{2.2}\right)$$

Where:

EPEF=European productive efficiency factor

AFLBW =Average final live body weight

TFBWS = Total final live body weight sold **SNC** = Starter number of chicks

AMA = Average marketing age **TFC** = Total feed consumption

FNC = Final number of chicks $\frac{\mathbf{10000}}{\mathbf{2.2}}$ = Constant factor

Carcass parameters and chemical analysis of meat: At the end of the experiment, 6 birds were chosen from each treatment. Selected birds were individually weighted, slaughtered to complete bleeding and defeathered. Weight of each eviscerated carcass, liver, heart, empty gizzard and abdominal fat were recorded. Carcass was portioned and the right side of each carcass was deboned. Giblets, meat, bone, abdominal fat and dressing were expressed as a percentage of LBW. Meat was minced and dried in a forced air oven at 60°C for 24 hr. Chemical analysis of the representative samples of boneless meat was undertaken according (**AOAC, 1990**).

Physical characteristics of meat: Physical characteristics of meat were measured directly using fresh samples. Tenderness and water holding capacity (WHC) were measured according to the method of **Volovinskaia and Kelman (1962)**. The method of **Aitken *et al.* (1962)** was used for measuring pH value of meat using pH meter. Color attributes of meat; lightness (*L*), redness (*a*) and yellowness (*b*) were performed using a Minolta Color Reader CR-10 (**RØrå and Einen, 2003**).

The apparent digestibility coefficients of nutrients and nutritive values: At the end of the experiment, the apparent digestibility coefficients of nutrients and nutritive values of the experimental diets were determined using three male birds from each treatment. Digestion trial was extended for five days after a preliminary period of three days. Experimental diets and dried excreta analysis were carried out to determine DM, CP, EE, CF and ash contents according to the methods of **AOAC (1990)**. Fecal nitrogen was determined according to **Jakobson *et al.* (1960)**. Metabolizable Energy was calculated as 4.2 Kcal/g TDN as suggested by **Titus (1961).**

Statistical analysis: Data were statistically analyzed using the General Linear Model procedure of SAS (**SAS Institute Inc., 1998).** Least Square Means (LSM) were calculated, and differences among means were differentiated by Multiple Range Test (**Duncan, 1955**).

RESULTS AND DISSCUSION

1. Chemical analysis and calculated ME (Kcal/kg) values of *Nigella sativa* seed (NSS) and *Nigella sativa* meal (NSM): The experimental NSS and NSM contained 4.40% Moisture; 23.22% and 31.97% CP; 22.38% and 10.98% EE; 19.36% and 13.86% CF and 6.33 %, 7.41% ash; 24.31% and 31.38% NFE and calculated ME values of 3950 and 3625 Kcal ME/Kg, respectively as shown in Table (3). In this connection, **Sandak (2002)** showed that Egyptian black cumin contains: crude protein (22.37%), crude fat (35.42%), crude fiber (8.25%), ash (4.53%) and total carbohydrates (29.43%). From the previous results, it can be observed that NSS used in this study contains relatively higher CP value (23.22%) than those reported by **Sandak (2002)** and **Radwan (2003)**, which ranged from 22.37 to 20.73% and relatively lower than those reported by **Cheikh Rouhou *et al.* (2007)** being 26.7%. NSS contains relatively lower EE value (22.38%) than those reported by previous authors; they revealed that the NSS contains 28-42 % of oil.

The calculated ME (Kcal/kg) values are in good agreement with those reported by **Abdel-Mageed (2002)** and **Abdo (2004)** who reported that the NSM contains about 3552 and 3408 (Kcal ME/kg), respectively. However, **Zeweil (1996)** showed by calculation that NSM contains 3005 Kcal ME/kg.

Such variation in nutrient composition of NSS and/or NSM may be due to genetic, cultivated, geographical and climatic regions, storage conditions, maturity stage, seed quality, oil processing method, lipid extraction method and quantitative techniques (**Ramadan and Mörsel, 2002**).

2- Growth Performance:

Body weight gain (BWG), feed consumption (FC), feed conversion ratio (FCR), crude protein conversion (CPC) and caloric conversion ratio (CCR) are shown in Table (4):

Starting period (0-28 days of age): Feeding heat stressed broiler with diets supplemented with different forms and levels of *Nigella sativa* L. (NS) (T2-T7) improved ($P \leq 0.05$) BWG compared with the control. Final BWG was ($P \leq 0.05$) heavier than the control (T1) by about 33.1%, 32.0%, 26.7%, 21.7%, 15.3% and 11.9% for T6, T4, T5, T3, T2 and T7, respectively. Significant ($P \leq 0.05$) improvement in FC, FCR, CPC, and CCR were recorded when heat stressed broiler chicks fed experimental treatments T2 to T6 compared with the unsupplemented control group (T1).

Finishing period (29-49 days of age): Results of BWG showed different trends in comparison with starting period (0-28 days) and overall period (0-49 days). Final BWG ranged from 865.7g (T2) to 680.6g (T4) compared with the control (T1) 778.7g. Chicks fed diets containing 0.5% NSO (T2) had the best FCR (1.723), CPC (0.320) and CCR (5.515) compared with control (T1) and other treatments (T3-T7) and differences among treatments were significant ($P \leq 0.05$).

Overall period (0-49 days of age): Data of BWG showed the same trends as starting period except T7, in which birds recorded the lowest BWG figure. The corresponding values of the final BWG ranged from 1482.3 g (10% NSM) to 1242.9g (20% NSM) compared with the control (1280.4 g). Chicks fed diets containing 0.5% NSO recorded the lowest FC and the best ($P \leq 0.05$) FCR, CPC and CCR compared with the control and the other treatments (T3-T7).

The results reported herein are in good agreement with those found by **Tollba and Hassan (2003)** who reported that NSS had no harmful effects on broiler performance and could be supplemented to overcome the deleterious effects of hot climatic conditions and broiler chicks fed NSS showed higher ($P \leq 0.05$) BWG compared with the control. **Tollba *et al.* (2005)** illustrated that average BWG of Gimmizah or Bandarah birds (local strains) at 46 weeks of age fed diet supplemented with 2% NSS was significantly different compared with the control during summer season.

The improvement of BWG due to supplementation of *Nigella sativa* L. could be related to changes in the metabolism of the bird reared under heat stress in different ways: 1- *Nigella sativa* L. contains different components such as thymoquinone and thymohydroquinone which shown to posses antimicrobial and pharmacological activities (**Mahfouz and El-Dakhakhny, 1960**). 2- NSS acts as antibacterial, antifungal and showed protective action against hepatoxity which lead to higher utilization efficiency of nutrients in the feed (**Rathee *et al.*, 1982**). 3- The effect of NSS on thyroid hormones, which stimulates the thyroid gland directly and/or through the pituitary gland to secrete the thyroid hormones. Thyroid hormones increase metabolic rate, which lead to increase amino acids metabolism (**More *et al.*, 1980**). Furthermore, thyroid hormones accelerate cellular reactions in most organs and tissues of the body, including the liver in which amino acids are synthesized and formed (**Smith *et al.*, 1983**). **Mandour *et al.* (1998)** reported that feeding broiler chicks with diets supplemented with low doses of NSS increases thyroxin concentration. 4- The calorific effect of NSO which increases the bile flow (**Mahfouz *et al.*, 1962**). Bile is an emulsifying agent which activates pancreatic lipase that aids in the digestion, absorption of fat and the absorption of fat soluble vitamins (**Crossland, 1980**). 5- The high amount of unsaturated fatty acids in NSO (**Üstun *et al.*, 1990**), especially the primary essential fatty acid (linoleic). The improvement in BWG of chicks fed NSS containing diets may be due to that NSS contains 37.36% of EE which is rich in the unsaturated fatty acids such as oleic, linoleic and leinolenic acids that are considered essential for growth (**Murray *et al.*, 1991**).

The reduction of BWG in chicks fed diets supplemented with 20% NSM (T7) compared with other treated groups (T2-T6) may be due to the high crude fiber content of NSM as shown in Table (2). In this respect, **Simon *et al.* (1996)** concluded that the protein meals and oil seeds contain carbohydrates including polysaccharides in the cell wall specially non starch polysaccharides (NSP) such as cellulose, B-glucans, arbinoxylans and galactomannans, which cannot be hydrolyzed by enzyme produced endogenously by the birds. The high crude fiber contents and the major fractions in the NSP in broiler diets may have direct and negative effects on the performance in two ways: 1- These substances may prevent nutrients uptake through forming nutrient complex in the gastro-intestinal tract and/or they may directly inhibit the action of the endogenous enzyme which would make a nutrient available for absorption. 2- Either way, if a bird lacks the appropriate enzymes in its digestive tract to render them ineffective, their effect is anti-nutritional. The changes in the digestive tract may reduce nutrient absorption and retention with fat being affected more than starch and protein. The consequences of feeding high levels of these protein meals and oil seeds without supplementation of special enzymes resulted in relatively poor chick's performance (reduction in LBW, BWG and FCR) as well as a deterioration of barn environmental and unmanageable litter conditions due to wet sticky manure (**Lesson and Summers, 1991**).

Generally, the low growth rate in the present study may be due to the high ambient temperature inside the experimental pen as the average temperature during July–August, 2006 was 33.2°C, being higher than the suitable temperature for poultry which is ranged between 16 and 25°C (**Sahin *et al.*, 2006**). **Dawoud (1998)** found that low broiler growth rate occurred in Egyptian summer season was due to high ambient temperature (30-36°C) especially in open houses. **El-Tantawy *et al.* (1998)** exposed broiler chicks to 33.5±3.5°C and reported that the body weight at all ages reduced by about 23-37 %.

The high ambient temperature may have direct and negative effects on the organ systems of chicks and could be summarized as follows: 1- **Dale and Fuller (1980)** suggested that only 63% of growth depression in broilers due to heat stress is directly related to reduced feed intake and concluded that under high temperature, birds try to reduce energy metabolism and protect themselves through starvation (eating less feed to satisfy energy requirement). With the starvation, fewer nutrients are available to the body, which is reflected in reduction of body weight gain. 2- **Yousef (1985)** concluded that the poor growth performance was mainly due to the reduction in feed consumption, which leads to less protein biosynthesis and/or less fat deposition. Moreover, the high temperature resulted in physiological changes and reactions on the bird such as the increase of body temperature, respiration rate and heart impulse, as the birds consume more energy and accordingly the remaining net energy for growth is decreased. 3- The effect on adrenal gland, which increases the release of corticosterone that cause reduction of the chicken growth rate (**Siegel, 1985**). 4- **Bonnet *et al.* (1997)** reported that the reduction of FC in heat-exposed broilers may be caused by a direct effect on various regions of the brain acting on feed intake mechanism and induces inefficient digestion and impaired metabolism. In the same order, they found that digestibility of protein, fat, and starch nutrients was significantly reduced in heat-exposed broilers by 4.2%, 5.2% and 4.2%, respectively. In addition, the negative effect on central nervous system (CNS), in which reduces metabolic rate and feed consumption (**Dawoud, 1998**). 5- **Har *et al.* (2000)** found that the passage rate of feed residue and the expelling of digesta from the crop or small intestine of heat-exposed broilers were decreased. They suggested that this inhibition might be caused by the excitement of the sympathetic nerve or the decrease of trioiodothronine during the long-term effect of high temperature. **6- Abu-Dieyeh (2006)** reported that the activities of trypsin, chymotrypsin and amylase were reduced significantly of broilers exposed to 32°C and this reduction might be the reason for the reduction of the amino acid digestibility.

Chicks fed experimental diets (T2 to T7) consumed more feed than the control (T1) during 0-28, 29-49 and 0-49 days of age and differences among treatments were significant ($P \leq 0.05$). However, during starting period either FC or FCR was ($P \leq 0.05$) improved when chicks fed diets supplemented with different forms and levels of NS, except (T7) which showed the lowest figures. The possible explanation for the the increase in FC and the improvement in FCR may be attributed to the taste and the aromatic odor of these seeds and the suppression of harmful intestinal microflora which interfere with the absorption of nutrients such as amino and fatty acids, minerals, vitamins... etc.

Results during finishing and total periods showed inconsistent figures and did not follow a definite trend as the starting period. Chicks fed diets containing 0.5% NSO (T2) consumed the lowest FC and recorded the best FCR during 29-49 and 0-49 days of age compared with the control (T1) and the other treatments (T3 to T7) and the differences were significant ($P \leq 0.05$). Similar results were found by **Afifi (2001)** who reported that FC and FCR were ($P \leq 0.05$) improved for broiler chicks fed diets supplemented with 2 or 3% freshly crushed NSS under hot climatic condition of Upper Egypt. **Tollba and Hassan (2003)** found that adding 1% NSS to broiler diets under high temperature conditions improved ($P \leq 0.05$) FCR. On the other hand, **Osman and El-Barody (1999)** found that the high levels of NSS (0.8 and 1.0%) had an adverse effect on FC and FCR and this may be due to the strong aromatic, higher fiber content and/or to unknown factor presented in NSS which increase with the increasing level of NSS in the feed. **Radwan (2003)** found that 1 or 3% NSS had no significant effects on FC during the growing period.

3- Mortality rate: As shown in figure (2), the average percentage of mortality rate (MR) during starting period showed lower figures than finishing one (10.7% versus 12.8%). Chicks fed control diet had the highest MR (22.5%) compared with those fed treated diets (T2-T7) and differences were significant ($P \leq 0.05$). At finishing period, results of MR% showed inconsistent figures and did not follow a definite trend as starting period and corresponding values ranged from 5% (T2) to 17.5 % (T6 and T7) with no significant differences. Results indicated that the average MR% during the whole experimental period was relatively high and corresponding value was 23.6%. Feeding heat stressed broiler chicks diets supplemented with different forms and levels of NS reduced ($P \leq 0.05$) MR%. Values for the treated groups during 0-49 days ranged from 17.5% to 25% compared with the control group being 37.5%. The improvement of mortality percentage for birds fed NSS and its oil may be due to their antimicrobial effects therefore, they were used to overcome many diseases, increase body immunity and to improve the health status of the bird **(Soltan, 1999)**. These findings were in good agreement with those reported by **Tollba and Hassan (2003)** who found that adding 1% NSS into broiler diets under high temperature conditions decreased ($P \leq 0.05$) the mortality rate (8%) compared with the control (26%).

4- Carcass parameters: The data in Table (5) showed that forms and levels of NS did not significantly affect the percentage of giblets and abdominal fat %. There was a significant difference ($P \leq 0.05$) in meat % between birds fed diets supplemented with NS than control. The highest significant figures were found by feeding NSS (1 and 2%), while the lowest values were recorded for chicks fed NSM 20% and the control. Chicks fed control diet had higher ($P \leq 0.05$) bone (%) than the other treated groups. Experimental diets (T2-T6) improved ($P \leq 0.05$) dressing percentage with values ranged from 68.2 to 67.4% compared with the control group (66.6%).

These results are within the range reported by many investigators under normal condition. **Guler *et al.* (2006)** found that the highest carcass, thigh and breast weights resulted from 1% NSS treated birds compared with other levels (0.5, 2 or 3%) and the control. In the same order, **Radwan (2002)** found that addition of NSM to growing rabbit diets under hot climatic conditions caused no significant effect on either carcass or dressing % compared to the control.

Chemical composition of meat: As shown in Table (6), birds fed treated diets (T2 to T6) had significantly ($P \leq 0.05$) higher meat protein % and lower fat % on DM basis compared with the control (T1). Birds fed control diet surpass all treated groups in ash % significantly ($P \leq 0.05$). Birds fed diet supplemented with 1% NSS had significantly higher NFE % than the other treated and the control groups.

Physical characteristics of meat: As shown in Table (6), no significant differences in color values (except a), tenderness and pH were detected between chicks fed diets supplemented with different forms and levels of NS and the control. Feeding NS resulted in significantly ($P \leq 0.05$) lower WHC values compared with the control.

Literatures dealing with the effect of NS on the chemical composition and physical characteristics of meat for heat stressed broiler could not be found and therefore no comparisons were made wi'h the results of the present study.

5- Digestion trail: As shown in Table (7), digestibility coefficients of OM, CP, EE, CF and NFE significantly ($P \leq 0.05$) increased over the control as result of feeding NS treated diets. Data concerning the percentage of crude protein (CP) digestibility coefficients ranged from 86.8 - 87% for birds fed diets supplemented with 10% NSM or 1% NSS to 83.3% for chicks fed diets supplemented with 20% NSM (T7), while the lowest figure was found for chicks received the control diet (80.1%) and differences were significant ($P \leq 0.05$). The highest ($P \leq 0.05$) EE digestibility coefficients values were recorded for broiler chicks fed diet supplemented with 10% NSM (58.6%) followed by chicks fed diet supplemented·with 20% NSM (58.1%), while chicks fed control diet had the lowest figure (52%). Chicks fed T2 to T7 diets digested their CF contents in feed with higher ($P \leq 0.05$) efficiency (33.6 to 27.2%) than chicks fed control diet (17.9%).

Feeding T2 to T7 treated diets caused significant ($P \leq 0.05$) increment in TDN and ME values compared with the control group. Data of (TDN) % were ranged from 78.3% (T6) to 75.0 % (T3) and differences failed to be significant. While the lowest figure was observed for chicks received the control diets being 71.6 % and differences between treated groups and control were significant ($P \leq 0.05$). Metabolizable energy values showed the same trend. The present results are in agreement with those reported by **Radwan (2002)** who stated that digestibility coefficients of CP, EE, NFE and CF for rabbits fed diets containing NSM were increased insignificantly ($P \leq 0.05$) under hot climatic conditions.

6- Economic studies:

Economic efficiency (EE_f): As shown in Table (8), Feeding heat stressed broiler with diets supplemented with different forms and levels of NS (T2-T7) showed a negative result on economic efficiency (EE_f) compared with control (T1), because the average cost of one/ton treated diets (starter and finisher) were relatively higher than control diet by about 22.4%, 44.9%, 7.4%, 15.4%, 5.9% and 12.4% when chicks fed diets supplemented with 0.5% NSO (T2), 1.0% NSO (T3), 1.0% NSS (T4), 2.0% NSS (T5), 10% NSM (T6) and 20% NSM (T7), respectively. The highest and best figure (100%) for EE_f were reported for chicks fed control diet followed by chicks fed diets supplemented with 0.5% NSO (90.8%), 10% NSM (87.7%), 1% NSS (87.3%), 2% NSS (79.4%) and 20% NSM (72.8%), while the worst one was reported for chicks fed diet supplemented with 1% NSO (54.8%).

Generally, under experimental conditions, using EE_f which depends only on feed cost to produce 1 kg body weight is unsuitable for broiler production reared in open houses during summer months.

Unfortunately, there are no available published literatures dealing with the effects of feeding different forms and levels of NS on EE_f of broiler chicks reared under hot climatic conditions and therefore, no comparisons were made with the results of the present study.

In this respect, under normal temperature conditions, many investigators showed the following reports on EE_f of broiler chicks: **Abou El-Soud (2000)** observed that the economic efficiency was increased by using NSO at 1% level. **Abaza *et al.* (2003)** found that the use of NSS in broiler diets was more economic than the control. **Abdo (2004)** indicated that 25% NSM substitution gave the best economic efficiency and the least cost per Kg body weight as compared with the control.

European productive efficiency factor (EPEF): The highest and best figures for EPEF were 67.8, 60.3, 60.2, 54.6, 52.4 and 43.4 recorded for chicks fed 0.5% NSO, 10% NSM, 2.0% NSS, 1.0% NSO, 1.0% NSS and 20% NSM diets, respectively. The worst EPEF (39.3) was reported for chicks fed control diet (Figure 3). This means that under experimental conditions (summer months), EPEF mainly depends on feed conversion ratio (feed/gain) and mortality rate. The improvement observed in EPEF for chicks fed diets supplemented with 0.5% NSO (T2) or 10% NSM (T6) may be related to the improvement of BWG, FCR, CPC, CCR and MR%. Generally, these figures of EPEF hold true with those reported by **Kamar and Sami (1982)** and **Hermes *et al.* (1984)** who stated that the EPEF values for commercial hybrids of broiler chicks reared under normal temperatures are ranged from 47 to 68.

CONCLUSION

It could be concluded that the addition of 10% *Nigella sativa* meal (NSM) or 1.0% *Nigella sativa* seed (NSS) or 0.5% *Nigella sativa* oil (NSO) in broiler diets reared in open houses under summer conditions of Egypt has the best effect to improve their productive performance and to reduce the harmful effects of the high temperature or any stressful conditions.

Figure (1): The average weekly ambient temperature (°C) and relative Humidity (RH %) in the experimental house during the experimental period.

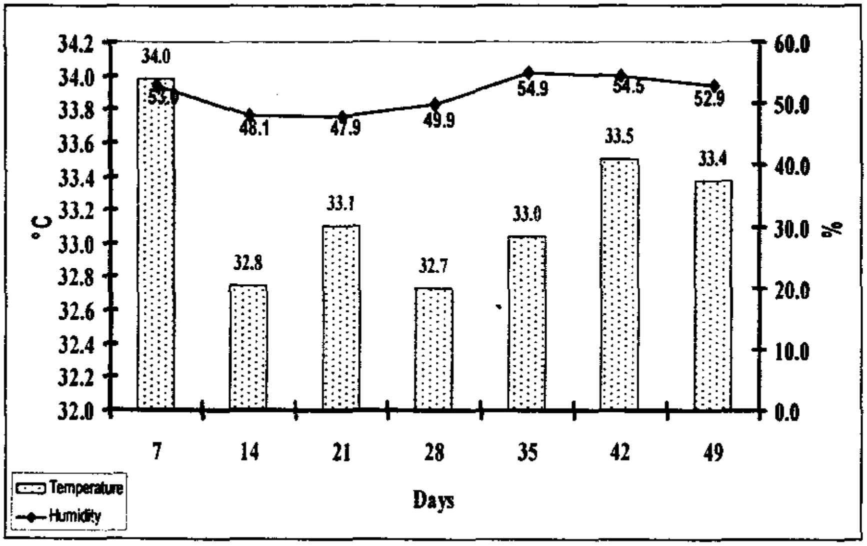

Figure (2): Effect of dietary NSO, NSS and NSM on mortality rate (MR %) of heat stressed broiler chicks.

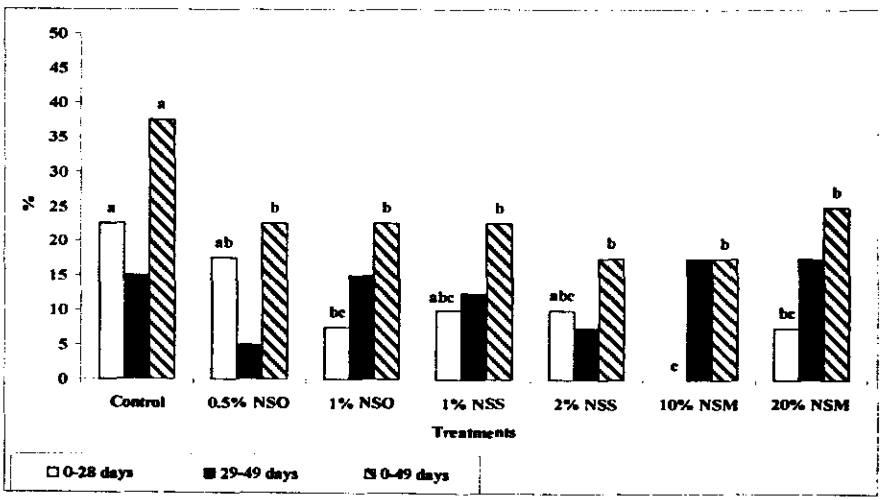

Figure (3): Effect of dietary NSO, NSS and NSM on European productive efficiency factor (EPEF) of heat stressed broiler chicks at 49 days of age.

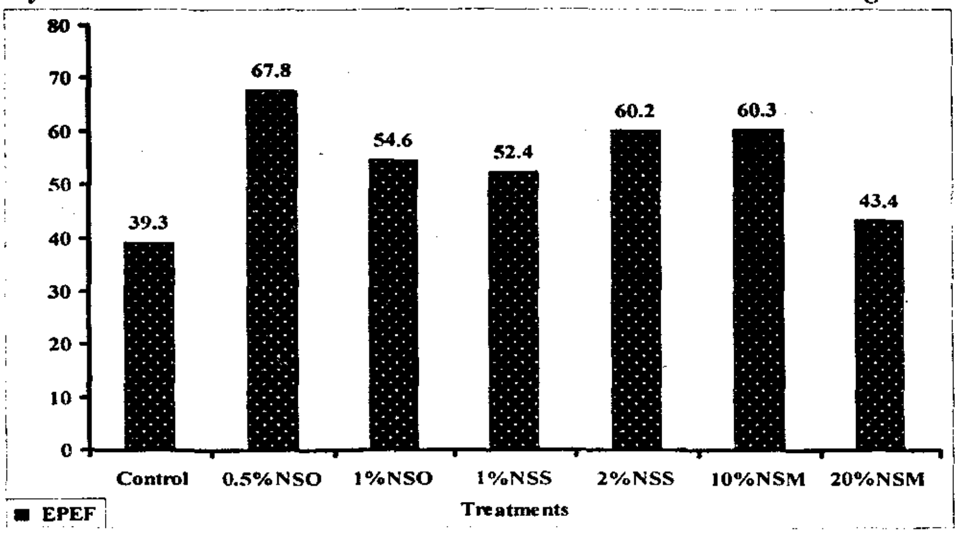

Table (1): Formulation of starter (S) and finisher (F) experimental diets.

Ingredients (%)	Experimental diets													
	Control (T1)		0.5% NSO (T2)		1% NSO (T3)		1%NSS (T4)		2% NSS (T5)		10% NSM (T6)		20% NSM (T7)	
	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Yellow corn	50	60	50	60	50	60	48	60	44	60	50	58	50	58
Corn gluten meal (60%)	8.95	0.33	8.95	0.33	8.95	0.33	8.84	0	9	0	10.92	0	12.89	2.41
Soybean meal (44%)	30	30	30	30	30	30	30	30	30	29.53	20	23.62	10	13
Nigella sativa oil (NSO)	0	0	0.5	0.5	1	1	0	0	0	0	0	0	0	0
Nigella sativa seed (NSS)	0	0	0	0	0	0	1	1	2	2	0	0	0	0
Nigella sativa meal (NSM)	0	0	0	0	0	0	0	0	0	0	10	10	20	20
Veget. oil (soybean + sunflower)	5.51	5.36	5.01	4.86	4.51	4.36	5.84	5.08	6.78	4.77	3.27	3.88	1.03	1.62
Di-calcium phosphate	1.7	1.2	1.7	1.2	1.7	1.2	1.7	1.2	1.7	1.2	1.67	1.15	1.65	1.15
Limestone	1.4	1.42	1.4	1.42	1.4	1.42	1.4	1.41	1.4	1.41	1.42	1.45	1.43	1.44
[1] Vit.+mineral premix	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
NaCl	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
DL- Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.06	0.08	0.04	0.04
L-Lysine	0.1	0.04	0.1	0.04	0.1	0.04	0.06	0.02	0.05	0.02	0.22	0.11	0.36	0.27
Choline Chloride	0.1	0.15	0.1	0.15	0.1	0.15	0.1	0.15	0.1	0.15	0.1	0.15	0.1	0.15
Sand	1.44	0.7	1.44	0.7	1.44	0.7	2.26	0.34	4.17	0.12	1.64	0.86	1.8	1.22
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100
[2]Cost /ton (LE)	1453.72	1292.38	1761.72	1600.38	2069.72	1908.38	1557.68	1391.01	1674.86	1493.19	1537.53	1370.55	1626.16	1461.48

[1] Each 3 kg of vitamin and minerals mixture contained (starter / finisher diets):
12,000,000 IU vit. A; 2,000,000 IU vit. D_3; 10,000 mg vit. E; 2,000 mg vit. K_3; 1,000 mg vit. B_1; 5,000 mg vit. B_2; 1,500 mg vit. B_6; 10 mg vit. B_{12} : 10,000 mg pantothenic acid; 30,000 mg Nicotinic acid, 1,000 mg Folic acid; 50 mg Biotin; 250,000 mg choline chloride, 10,000 mg Cu, 1,000 mg I; 30,000 mg Fe: 50,000 mg Zn, 60,000 mg Mn, 100 mg Co and 100 mg Se.

[2] According to market prices of 2006.

Table (2): Chemical analysis of starter (S) and finisher (F) experimental diets.

Items	Experimental diets													
	Control (T1)		0.5% NSO (T2)		1% NSO (T3)		1%NSS (T4)		2% NSS (T5)		10% NSM (T6)		20% NSM (T7)	
Determined analysis (%)	S	F	S	F	S	F	S	F	S	F	S	F	S	F
Moisture	8.79	8.77	8.90	8.45	8.25	8.65	8.75	8.99	8.00	8.58	8.45	8.90	8.25	8.95
Crude Protein (CP)	23.17	18.69	22.91	18.59	23.34	18.85	22.95	18.41	22.95	18.72	23.13	18.55	23.26	18.10
Crude Fiber (CF)	3.55	3.10	3.25	3.55	3.15	3.50	3.75	3.85	3.20	3.55	3.95	4.00	4.98	4.95
Ether Extract (EE)	7.65	7.92	7.50	8.05	7.45	7.90	8.00	7.80	9.10	7.75	6.17	7.54	6.15	7.95
Ash	7.83	6.83	7.64	7.31	7.90	6.55	7.55	6.85	7.60	6.95	8.50	7.01	8.79	6.75
Nitrogen Free Extract (NFE)	49.01	54.69	49.80	54.05	49.91	54.55	49.00	54.10	49.15	54.45	49.80	54.00	48,57	53.30
[1]Calculated values														
ME(Kcal/Kg)	3200.4	3200.5	3200.4	3200.5	3200.4	3200.5	3200.1	3201.1	3200.9	3200.7	3200.4	3200.8	3200.4	3201.5
Ca %	1.00	0.90	1.00	0.90	1.00	0.90	1.01	0.90	1.01	0.90	1.00	0.91	1.00	0.90
Avail. P %	0.45	0.35	0.45	0.35	0.45	0.35	0.45	0.36	0.45	0.36	0.45	0.35	0.45	0.36
Lysine %	1.13	1.01	1.13	1.01	1.13	1.01	1.10	1.00	1.10	1.01	1.11	1.00	1.10	1.01
Methionine %	0.51	0.40	0.51	0.40	0.51	0.40	0.51	0.40	0.51	0.40	0.51	0.39	0.51	0.38
Meth. +Cyst. %	0.90	0.71	0.90	0.71	0.90	0.71	0.89	0.71	0.89	0.71	0.91	0.72	0.94	0.73

1 According to NRC, 1994.

Table (3): Chemical analysis and calculated ME (Kcal/kg) values of *Nigella sativa* seed (NSS) and *Nigella sativa* meal (NSM) used in the experimental diets.

Items	*Nigella sativa* seed (NSS)		*Nigella sativa* meal (NSM)	
	%On air dried basis	%On DM basis	%On air dried basis	%On DM basis
DM	95.60	100	95.60	100
Moisture	4.40	—	4.40	—
CP	23.22	24.29	31.97	33.44
EE	22.38	23.41	10.98	11.48
CF	19.36	20.25	13.86	14.50
Ash	6.33	6.62	7.41	7.75
NFE	24.31	25.43	31.38	32.83
[1] ME(Kcal/Kg)	—	3950	—	3625

[1]ME= Metabolizable Energy values were calculated according to **Carpenter and Clegg (1956)**, on DM basis as follows:

ME (Kcal/Kg) = 35.3 × CP% +79.5 × EE% +40.6 × NFE +199

Table (4): Effect of dietary NSO, NSS and NSM on body weight gain (BWG), feed consumption (FC), feed conversion ratio (FCR), crude protein conversion (CPC) and caloric conversion ratio (CCR) of heat stressed broiler chicks (M±SE).

Traits	Age (days)	Control (T1)	0.5% NSO (T2)	1% NSO (T3)	1%NSS (T4)	2% NSS (T5)	10% NSM (T6)	20% NSM (T7)
BWG (g)	0-28	$501.7^{d} \pm 17.9$	$578.4^{bc} \pm 11.3$	$610.4^{abc} \pm 14.5$	$662.5^{a} \pm 36.0$	$635.9^{ab} \pm 10.7$	$667.8^{a} \pm 21.0$	$561.3^{c} \pm 10.5$
	29-49	$778.7^{ab} \pm 37.9$	$865.7^{a} \pm 103.3$	$767.7^{ab} \pm 69.3$	$680.6^{b} \pm 37.2$	$766.1^{ab} \pm 19.4$	$814.5^{ab} \pm 27.9$	$681.6^{b} \pm 13.2$
	0-49	$1280.4^{bc} \pm 45.8$	$1444.1^{ab} \pm 111.4$	$1378.1^{abc} \pm 56.3$	$1343.1^{abc} \pm 39.5$	$1402.0^{abc} \pm 24.3$	$1482.3^{a} \pm 19.0$	$1242.9^{c} \pm 13.6$
FC (g)	0-28	$775.4^{d} \pm 27.3$	$783.6^{d} \pm 19.0$	$849.7^{bc} \pm 24.5$	$895.6^{ab} \pm 15.2$	$826.7^{cd} \pm 8.7$	$921.2^{a} \pm 11.6$	$871.9^{abc} \pm 21.5$
	29-49	$1541.7^{b} \pm 79.3$	$1488.2^{b} \pm 170.1$	$1647.4^{ab} \pm 84.8$	$1582.6^{ab} \pm 75.6$	$1746.8^{ab} \pm 44.3$	$1847.9^{a} \pm 35.3$	$1589.8^{ab} \pm 33.7$
	0-49	$2317.1^{bc} \pm 92.6$	$2271.8^{c} \pm 174.4$	$2497.1^{abc} \pm 83.0$	$2478.3^{bc} \pm 75.1$	$2573.5^{ab} \pm 47.1$	$2769.1^{a} \pm 28.6$	$2461.6^{bc} \pm 49.0$
FCR	0-28	$1.546^{a} \pm 0.018$	$1.355^{b} \pm 0.020$	$1.393^{b} \pm 0.034$	$1.361^{b} \pm 0.055$	$1.301^{b} \pm 0.030$	$1.382^{b} \pm 0.028$	$1.553^{a} \pm 0.014$
	29-49	$1.979^{b} \pm 0.024$	$1.723^{c} \pm 0.032$	$2.169^{a} \pm 0.092$	$2.333^{a} \pm 0.083$	$2.281^{a} \pm 0.040$	$2.273^{a} \pm 0.047$	$2.333^{a} \pm 0.033$
	0-49	$1.809^{b} \pm 0.018$	$1.574^{c} \pm 0.020$	$1.815^{b} \pm 0.044$	$1.845^{b} \pm 0.008$	$1.836^{b} \pm 0.012$	$1.868^{b} \pm 0.005$	$1.980^{a} \pm 0.019$
CPC	0-28	$0.358^{a} \pm 0.004$	$0.314^{b} \pm 0.005$	$0.323^{b} \pm 0.008$	$0.315^{b} \pm 0.013$	$0.302^{b} \pm 0.007$	$0.320^{b} \pm 0.007$	$0.360^{a} \pm 0.003$
	29-49	$0.370^{b} \pm 0.005$	$0.320^{c} \pm 0.006$	$0.409^{a} \pm 0.017$	$0.429^{a} \pm 0.015$	$0.427^{a} \pm 0.007$	$0.422^{a} \pm 0.009$	$0.422^{a} \pm 0.006$
	0-49	$0.419^{b} \pm 0.004$	$0.360^{c} \pm 0.005$	$0.424^{b} \pm 0.010$	$0.423^{b} \pm 0.002$	$0.421^{b} \pm 0.003$	$0.432^{b} \pm 0.001$	$0.461^{a} \pm 0.005$
CCR	0-28	$4.947^{a} \pm 0.059$	$4.336^{b} \pm 0.064$	$4.457^{b} \pm 0.108$	$4.354^{b} \pm 0.177$	$4.164^{b} \pm 0.095$	$4.423^{b} \pm 0.091$	$4.969^{a} \pm 0.046$
	29-49	$6.336^{b} \pm 0.076$	$5.515^{c} \pm 0.104$	$6.943^{a} \pm 0.295$	$7.467^{a} \pm 0.264$	$7.302^{a} \pm 0.127$	$7.276^{a} \pm 0.151$	$7.470^{a} \pm 0.105$
	0-49	$5.789^{b} \pm 0.057$	$5.036^{c} \pm 0.065$	$5.808^{b} \pm 0.142$	$5.905^{b} \pm 0.026$	$5.876^{b} \pm 0.039$	$5.979^{b} \pm 0.015$	$6.336^{a} \pm 0.006$

$^{a-d}$ means within each row followed by different letters differ significantly ($P \leq 0.05$)

Table (5): Effect of dietary NSO, NSS and NSM on carcass parameters as a percentage of LBW of heat stressed broiler chicks at 49 days of age (M±SE).

Traits	Control (T1)	0.5% NSO (T2)	1% NSO (T3)	1%NSS (T4)	2% NSS (T5)	10% NSM (T6)	20% NSM (T7)
Live Body Weight (g)	1265.50^{d} ±32.24	1539.50^{c} ±47.29	1581.67^{bc} ±48.97	1947.33^{a} ±58.07	1753.67^{b} ±43.30	1730.00^{b} ±56.38	1329.33^{d} ±47.01
Giblets (%)	4.04 ±0.26	4.01 ±0.13	3.89 ±0.06	3.90 ±0.13	3.82 ±0.13	3.99 ±0.15	4.02 ±0.05
Meat (%)	43.30^{c} ±0.25	45.32^{b} ±0.40	45.21^{b} ±0.28	46.96^{a} ±0.13	46.74^{a} ±0.16	45.91^{b} ±0.19	43.20^{c} ±0.35
Bone (%)	15.70^{a} ±0.22	14.70^{b} ±0.28	14.79^{b} ±0.25	14.23^{b} ±0.23	14.28^{b} ±0.13	14.24^{b} ±0.16	14.74^{b} ±0.11
Abdominal fat (%)	7.55 ±0.13	7.38 ±0.55	7.50 ±0.27	6.96 ±0.24	7.13 ±0.13	7.46 ±0.06	7.63 ±0.21
Dressing (%)	66.55^{b} ±0.29	67.40^{a} ±0.17	67.51^{a} ±0.31	68.15^{a} ±0.19	68.15^{a} ±0.16	67.60^{a} ±0.28	65.54^{c} ±0.25

$^{a-d}$ means within each row followed by different letters differ significantly ($P \leq 0.05$)

Table (6): Effect of dietary NSO, NSS and NSM on chemical composition and physical characteristics of meat of heat stressed broiler chicks at 49 days of age (M±SE).

Traits		Control (T1)	0.5% NSO (T2)	1% NSO (T3)	1% NSS (T4)	2% NSS (T5)	10% NSM (T6)	20% NSM (T7)
Chemical composition (%)								
Moisture		6.01^{bc} ±0.04	6.42^{a} ±0.09	6.23^{ab} ±0.13	6.26^{ab} ±0.09	6.13^{bc} ±0.07	6.39^{a} ±0.09	5.88^{c} ±0.03
Protein		55.94^{c} ±0.13	56.54^{b} ±0.11	56.90^{a} ±0.06	56.41^{b} ±0.19	57.08^{a} ±0.04	56.32^{b} ±0.16	55.92^{c} ±0.05
Fat		35.01^{a} ±0.03	34.09^{b} ±0.06	33.99^{b} ±0.13	34.08^{b} ±0.11	33.99^{b} ±0.06	34.11^{b} ±0.06	35.18^{a} ±0.06
Ash		2.49^{a} ±0.05	2.24^{b} ±0.06	2.37^{ab} ±0.10	2.24^{b} ±0.06	2.31^{b} ±0.05	2.29^{b} ±0.05	2.29^{b} ±0.03
NFE		0.55^{b} ±0.06	0.71^{ab} ±0.15	0.51^{b} ±0.15	1.01^{a} ±0.18	0.49^{b} ±0.06	0.89^{ab} ±0.18	0.73^{ab} ±0.04
Physical characteristics								
Color	*Lightness (L)*	64.16 ±0.93	61.24 ±1.25	62.31 ±0.77	61.93 ±0.82	61.44 ±0.56	62.38 ±0.93	64.21 ±1.58
	Redness (a)	11.58^{b} ±0.33	12.98^{a} ±0.42	12.31^{ab} ±0.47	12.12^{ab} ±0.45	12.21^{ab} ±0.44	11.88^{ab} ±0.53	11.35^{b} ±0.06
	Yellowness (b)	19.52 ±0.36	18.23 ±0.12	19.30 ±0.61	18.22 ±0.37	18.28 ±0.46	18.70 ±0.63	19.52 ±0.47
Tenderness (Kg/cm^{2})		3.35 ±0.19	3.88 ±0.32	3.80 ±0.40	3.89 ±0.19	3.76 ±0.23	3.98 ±0.21	3.33 ±0.11
pH		5.75 ±0.06	5.90 ±0.06	5.76 ±0.07	5.91 ±0.05	5.89 ±0.02	5.76 ±0.06	5.75 ±0.05
WHC (cm^{2})		2.14^{ab} ±0.49	1.30^{b} ±0.09	1.95^{ab} ±0.60	2.09^{ab} ±0.32	2.08^{ab} ±0.64	1.32^{b} ±0.31	3.22^{a} ±0.71

$^{a-c}$ means within each row followed by different letters differ significantly ($P \leq 0.05$)

Table (7): Effect of dietary NSO, NSS and NSM on digestibility coefficients and nutritive values of heat stressed broiler chicks at 49 days of age (M±SE).

Traits	Control (T1)	0.5% NSO (T2)	1% NSO (T3)	1% NSS (T4)	2% NSS (T5)	10% NSM (T6)	20% NSM (T7)
DM	64.05^{c} ±0.99	69.56^{ab} ±1.46	68.07^{bc} ±2.28	68.83^{ab} ±0.50	69.69^{ab} ±0.72	72.65^{a} ±1.19	69.27^{ab} ±1.50
CP	80.14^{c} ±0.83	84.50^{ab} ±1.55	84.47^{ab} ±0.82	87.00^{a} ±0.73	83.85^{ab} ±0.82	86.77^{a} ±1.14	83.27^{b} ±0.12
CF	17.89^{b} ±1.30	28.18^{a} ±2.50	27.28^{a} ±3.98	32.12^{a} ±2.28	31.65^{a} ±2.83	33.59^{a} ±1.85	27.21^{a} ±0.71
EE	51.98^{b} ±0.90	56.24^{ab} ±1.74	52.27^{ab} ±3.31	57.12^{ab} ±0.23	54.02^{ab} ±1.24	58.58^{a} ±0.47	58.12^{ab} ±2.94
NFE	74.09^{c} ±0.61	78.16^{abc} ±1.29	77.56^{abc} ±1.58	76.97^{bc} ±0.52	78.16^{abc} ±1.74	81.44^{a} ±1.36	78.41^{ab} ±1.22
OM	66.62^{c} ±0.33	71.37^{ab} ±1.34	70.72^{b} ±2.09	71.34^{ab} ±0.29	71.09^{ab} ±1.04	75.02^{a} ±1.07	71.47^{ab} ±1.27
TDN	71.59^{b} ±0.10	75.52^{a} ±1.20	75.02^{a} ±1.77	75.73^{a} ±0.28	75.25^{a} ±1.05	78.33^{a} ±0.86	76.25^{a} ±1.32
ME (Kcal/100g diet)	300.69^{b} ±0.42	317.19^{a} ±5.06	315.10^{a} ±7.44	318.07^{a} ±1.15	316.07^{a} ±4.40	328.98^{a} ±3.60	320.25^{a} ±5.57

$^{a-c}$ means in the same row within the same item followed by different letters differ significantly ($P \leq 0.05$)

Table (8): Effect of dietary NSO, NSS and NSM on economical efficiency (EE_f) of heat stressed broiler chicks at 49 days of age.

Items	Control (T1)	0.5% NSO (T2)	1% NSO (T3)	1% NSS (T4)	2% NSS (T5)	10% NSM (T6)	20% NSM (T7)
Average feed intake (Kg/bird) Starter = a1	0.775	0.784	0.850	0.896	0.827	0.921	0.872
[1]Price / Kg starter feed (P.T.) =b1	145.37	176.17	206.97	155.77	167.49	153.75	162.62
Average feed intake (Kg/bird) Finisher =a2	1.542	1.488	1.647	1.583	1.747	1.848	1.590
[2]Price / Kg finisher feed (P.T.) b2	129.24	160.04	190.84	139.10	149.32	137.06	146.15
Total feed cost (P.T.)=(a1×b1) +(a2×b2)=c	311.95	376.26	490.24	359.77	399.38	394.89	374.18
Average BWG (Kg) = d	1.2804	1.4441	1.3781	1.3431	1.4020	1.4823	1.2429
[3]Price / Kg live weight (P.T.) = e	800	800	800	800	800	800	800
Total revenue (P.T.) =d x e = f	1024.32	1155.28	1102.48	1074.48	1121.60	1185.84	994.32
Net revenue (P.T.) = f - c = g	712.370	779.023	612.242	714.715	722.224	790.949	620.137
[4]Economic Efficiency = (g/c)	2.28	2.07	1.25	1.99	1.81	2.00	1.66
[5]Relative Efficiency	100	90.79	54.82	87.28	79.39	87.72	72.81

[1] Based on average price of starter diets during the experimental time.
[2] Based on average price of finisher diets during the experimental time.
[3] According to the local market price at the experimental time.
[4] Net revenue per unit feed cost.
[5] Assuming that economic efficiency of control group equal 100.

REFERENCES

Abaza, I.M., M.A. Asar, G.E. Elshaarrawi and M.F. Hassan (2003). *Effect of using Nigella seeds, Chamomile flowers, Thyme flowers and Harmala seeds as feed additives on performance of broiler. Egypt. J. of Agric. Res., 81(2):735-750.*

Abdel-Mageed, M.A.A. (2002). *A study of substituting soybean meal by Nigella sativa meal on the performance of broiler chicks. Ph.D. Thesis, Fac. of Agric., Fayoum, Cairo Univ.*

Abdel-Mageid, H.A., M.O. Abd-Elsamee, A.S. Abd El-Hakim and M.A. El-Manylawi (2007). *Effect of using some natural herbs through different feeding systems on the performance of broiler chicks during summer season. Egypt. J. Nutr. and Feeds. 10(2): 759-780. Special Issue.*

Abd-Elsamee, M.O. (2005). *Influence of different levels of lysine and vitamin E on broiler performance under normal or heat stress conditions. Egypt. J. Nutr. and Feeds. 8(1): 827-838. Special Issue.*

Abdo, Zeinab M.A. (2004). *Effects of phytase supplementation on the utilization of Nigella sativa seed meal in broiler diets. Egypt. Poult. Sci., 24(1): 143-162.*

Abo Saq, H.J. (2004). *Alleviating the adverse effect of heat stress on broiler performance by using natural oils in diets. M.Sc. Thesis in Agric. Sci., Fac. of Meteorology, Environment and Arid Land Agriculture, King Abdul-Aziz Univ. Kingdom of Saudi Arabia.*

Abou El-Soud, Sabria B. (2000). *Studies on some biological and immunological aspects in Japanese quail fed diets containing some Nigella sativa seeds preparations. Egypt. Poult. Sci., 20(4): 757-779.*

Abu-Dieyeh, Z.H.M. (2006). *Effect of high temperature per se on growth performance of broilers. Int. J. of Poult. Sci., 5(1): 19-21.*

Afifi, O.S. (2001). *Effect of different level of freshly crushed Nigella sativa seeds on performance, organ weights and blood constituents of broiler chickens reared under hot climatic conditions. Egypt. Poult. Sci., 21(2): 567-583.*

Aitken, A., J.C. Casey, I.F. Penny and C.A. Volys (1962). *Effects of drying temperature in the accelerated freeze drying of pork. J. Sci. Food Agri., 13: 439.*

Al-Homidan, A.A. (2000): *Effect of vitamin C addition in water for broilers raised under two different ambient temperatures on growth performance and water consumption. Egypt. Poult. Sci., 20(2):327-346.*

Association of Official Analytical Chemists, A.O.A.C. (1990). *Methods of Analysis, 15th Ed. Arlington, USA.*

Bonnet, S., P.A. Geraert, M. Lessire, B. Carre and S. Guillaumin (1997). *Effect of high ambient temperature on feed digestibility in broilers. Poult. Sci., 76:857-863.*

Carpenter, K.J. and K.M. Clegg (1956). *The metabolizable energy of poultry feeding stuffs in relation to their chemical composition. J. Sci. Food Agri., 7:45-51.*

Cheikh Rouhou, S., S. Besbes, B. Hentati, C. Blecker, C. Deroanne and H. Attia (2007). *Nigella sativa L.: chemical composition and physicochemical characteristics of lipid fraction. Food Chemistry, 101: 673-681.*

Crossland, J. (1980). *Lewis's Pharmacology. 5th Ed. Chuchill Livingstone, London and N. Y., pp. 656-657.*

Dale, N.M. and H.L. Fuller (1980). *Effect of diet composition on feed intake and growth of chicks under heat stress. II. Constant versus cycling temperatures. Poult. Sci., 59:1434-1440.*

Dawoud, A.M. (1998). *Effect of environmental conditions on body compartments of broilers. Ph.D. Thesis, Fac. of Agric., Cairo Univ.*

Duncan, D.B. (1955). *Multiple range and multiple F tests. Biometerics, 11:1-42.*

El-Tantawy, S.M.T., H.H. Khalifa, N.A. Ahmed, M.A. Kicka and A.M. Dawoud (1998). *Effect of season, dietary NaCl and heat acclimation on performance and carcass quality of broiler chicken. Egypt. J. Anim. Prod., 35: 141-155.*

Galal, A. Gh., A. M. Osman, M.A. Toson, M.A. Shehata (2002). *Effect of diet density on broiler performance during hot environment. Proc 11th European Poultry Conference, Bremen, Germany.V*

Ghazalah, A.A. and Faten A.A. Ibrahim (1996).*The possibility of using some edible and aromatic oils in the nutrition of muscovi ducks. Egypt. Poult. Sci., 16(2): 305-328.*

Guler, T., B. Dalklc, O.N. Ertas and M. Ciftci (2006). *The effect of dietary black cumin seeds (Nigella sativa L.) on the performance of broilers. Asian Australasian J. of Anim. Sci., 19(3): 425-430.*

Har, L., D. Rong and Z.Y. Zhang (2000). *The effect of thermal environment on the digestion of broilers .Anim. Physiol., 83:57-64.*

Hermes, I.H. and A.H. Al-Homidan (2003). *Effect of microbial phytase enzyme supplementation on growth performance and bone mineralization of broiler chicks reared under mild heat stress. Egypt J. Nutr. and Feeds, 6 (2): 209-224.*

Hermes, I.H., N.E. Asker and M.S. Mobarak (1984). *A comparative study among some local strains and Lohmann hybrids in meat production under two different dietary conditions. Annals Agric. Sci., Fac. of Agric., Ain- Shams Univ., 29(1): 281-298.*

Jakobson, D.E.; S.K. Gertovey and H. Nielson (1960). *Digestibility trails with poultry. Husdryrbugsudvaly-Kobengaven, 56: 1-34.*

Kamar, G.A. and M.S. Sami (1982): *Commercial broiler production. Recent book center, Kuwait. pp: 114-115. (Arabic text book).*

Lesson, S. and J.D. Summer (1991). *Commercial poultry nutrition. University Books, Gueleph, Ontario, Canada.*

Mahfouz, M. and M. El-Dakhakhny (1960). *Some chemical and pharmacological properties of the new anti asthmatic drug "Nigellone". Egypt. Pharm. Bull., 24: 411-424.*

Mahfouz, M., M. El-Dakhakhny, A. Gemel and H. Moussa (1962). *Chloretic action of Nigella sativa seed oil. Egypt. Pharm. Bull., 44: 225-229.*

Mandour, A.A., K.M. Ashry and S.A. Hedaya (1998). *Biochemical profile of serum constituents of broiler chicken supplemented with different levels of Nigella sativa (black seeds) with special reference to its effects of hormonal and mineral content rations. Egypt. Poult. Sci., 18(2): 429-439.*

More, T, A.K. Rai and M. Singh (1980). *Note on the effect of themal exposure on body fluid composition of different breeds and crosses of sheep. Ind. J. Anim. Sci., 50: 207-209.*

Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodweel (1991). *The text book of Harper's Biochemistry, 22 edition, Appleton and Large, Norwalk, Connecticut, Las Altos, California.*

Naser, A.S. and A.I. Attia (1998). *Nutritive value of Nigella sativa L. seeds and its effect on rabbit growth and reproductive performance under summer conditions of Egypt. First International Conference on Animal Production and Health in Semi-Arid Areas, El-Arish, Egypt., 1-3 September, 457-462.*

National Research Council, N.R.C. (1994). *Nutrient Requirements of Poultry 9th revised edition. National Academy Press. Washington, D.C, USA.*

Nofal. M.E, E.M. Abo-Etta and A.A. Salem (2006). *Some productive and physiological responses to dietary Nigella sativa seeds supplementation of Mamourah laying hens. Egypt. Poult. Sci., 26: 455-476.*

Osman, A.M.A. and M.A.A. El-Barody (1999). *Growth performance and immune response of broiler chicks as affected by diet density and Nigella sativa seeds supplementation. Egypt .Poult. Sci., 19(3): 619-633.*

Radwan, M.S.M. (2002). *Effects of replacing soybean meal by nigella seed meal for growing rabbits on digestibility coefficients, growth performance, carcass traits and economic efficiency under hot climatic conditions. Egypt. J. of Rabbit Sci., 12(1): 13-25.*

Radwan, Nadia L. (2003). *Effect of using some medicinal plants on performance and immunity of broiler chicks. Ph.D. Thesis, Fac. of Agric., Cairo Univ.*

Ramadan, M.F. and J.T. Mörsel (2002). *Characterization of phospholipids composition of black cumin (Nigella sativa L.) seed oil. Nahrung Food, 46: 240-244.*

Rathee, P.S., S.H. Mishra and R. Kaughal (1982). *Antimicrobial activity of essential oil, Fixed oil and unsaponifiable matter of Nigella sativa Linn. Indian. J. Pharm. Sci., 44: 8-10.*

RØrå, A.M.B. and O. Einen (2003) *Effects of freezing on quality of cold smoked Salmon based measurements of physicochemical characteristics. .J. Food Sci., 68: 2123-2128.*

Sahin, K., M. Onderci, N. Sahin, M.F. Gursu, F. Khachik and O. Kucuk (2006). *Effects of lycopene supplementation on antioxidant status, oxidative stress, performance and carcass characteristics in heat-stressed Japanese quail. J. Thermal Biol., 31: 307–312.*

Sandak, R.N. (2002). *Utilization of defatted black cumin and its extract as natural antioxidants to keeping quality of cake during storage. Egypt. J. of Agric. Res., 80(3): 1263-1275.*

SAS Institute, (1998). *SAS statistical guide for personal computer, SAS Institute Inc. Cary, NC.*

Siegel, H.S. (1985). *immunological responses as indicators of stress. World's Poultry Sci., 41:36-44.*

Simon, O., H. Gruppen, H. Classen, W. Close, N. Khan, T. Acamovic, B.V McCleary, A. Morgan and D. Cown (1996). *Enzymes in action, a feed mix special. World Poultry–Misset, 12(11): 62-71.*

Smith, E.L., R.L. Hill, I.R. Lehman, R.J. Lefkowitz, P.H. Handler and A. White (1983). *Thyroid. In: Principles of Biochemistry: Mammalian Biochemistry (7th Ed., pp. 416-440. McGraw Hill Book Co., NY.*

Soltan, M.A. (1999). Effect of diets containing *Nigella sativa* (black seeds) and or ox bile on growth and reproductive performance of Japanese quail. Alex. J. Vet. Sci., 15(3): 655-669.

Titus, H.W. (1961). *The scientific feeding of chickens. 5th Ed. Danvil, Illinois, U.S.A.*

Tollba, A.A.H. and M.S.H. Hassan (2003). *Using some natural additives to improve physiological and productive performance of broiler chicks under high temperature conditions. 2-Black cumin (Nigella sativa) or garlic (Allium sativum). Egypt. Poult. Sci., 23(2): 327-340.*

Tollba, A.A.H., M.A. Abd El-Galyl and M.H. Abd El-Samad (2005). *The effect of using some herbal additives on physiological and productive performance of two Egyptian chicken strains during winter and summer seasons. Egypt. Poult. Sci., 25(1): 107-123.*

Üstun, G., L. Kent, N. Cekin and H. Civelekoglu (1990). *Investigation of the technological properties of Nigella sativa L. (Black Cumin) seed oil. JAOCS, 67(12): 958-960.*

Volovinskaia, V.P. and B.Y. Kelman (1962). *Modification of the water holding capacity method of meat. F. D. Industry, 11 (80), Moscow.*

Yousef, M.K. (1985). *Stress physiology in livestock, Volume 111-Poultry (Feeding poultry in hot and cold climates, PP: 123-136 CRC Press, Inc. Boca Raton, 33431 Florida, USA.*

Zeweil, H.S. (1996). *Evaluation of substituting Nigella seed oil meal for soybean meal on the performance of growing and laying Japanese quails. Egypt. Poult. Sci., 16(2): 451-477.*

الملخص العربي

تأثير التغذية بحبة البركة على الأداء الإنتاجي والاستفادة من الغذاء لبدارى اللحم تحت ظروف الصيف المصرية

إسماعيل حافظ هرمس ، فاتن عبد العزيز محمود عطية ، كمال الدين عبد العزيز إبراهيم ، شعبان سعد النسر

قسم الإنتاج الحيواني - كلية الزراعة - جامعة قناة السويس

صممت التجربة لدراسة تأثير التغذية بصور ومستويات مختلفة من حبة البركة كإضافات غذائية طبيعية على الأداء الإنتاجي لكتاكيت التسمين المرباة تحت ظروف الصيف المصرية. تم تسكين ٢٨٠ كتكوت تسمين عمر يوم غير مجنس من سلالة (ROSS) في بطاريات بمسكن مفتوح وتم توزيعهم عشوائياً على ٧ مجاميع متساوية كلا منها مكونة من ٤٠ كتكوت (٤ مكررات). تم تسجيل درجات الحرارة والرطوبة النسبية داخل المسكن أثناء فترة التجربة. كانت العلائق التجريبية متساوية في الطاقة والبروتين طبقاً للتوصيات الخاصة بالسلالة . تم تكوين ٧ علائق تجريبية حيث استخدمت العليقة الأولى ككنترول (م١) أو عليقة مقارنة وبدون إضافة أي إضافات غذائية طبيعية ، وفى العليقة الثانية والثالثة (م٢ ، م٣) تم إضافة زيت حبة البركة بمستوى ٠.٥ و ١% ، وفى العليقة الرابعة والخامسة (م٤ ، م٥) تم إضافة بذور حبة البركة بمستوى ١ و ٢% ، وفى العليقة السادسة والسابعة (م٦ ، م٧) تم إضافة كسب حبة البركة بمستوى ١٠ و ٢٠% على التوالي. وتم تقديم مياه الشرب والغذاء للكتاكيت بصورة حرة خلال فترة التجربة التي استمرت ٤٩ يوم. وفى نهاية فترة التجربة تم إجراء اختبارات الذبح باختيار ٦ طيور من كل معاملة. تم تقدير معاملات هضم العناصر الغذائية للعلائق التجريبية باستخدام ٣ طيور ذكور من كل معاملة عند نهاية فترة التجربة واستمرت التجربة ٥ أيام بعد ٣ أيام دور تمهيدي.

ويمكن تلخيص النتائج في النقاط التالية:

(١) أظهرت تغذية كتاكيت التسمين تحت ظروف الإجهاد الحراري على العليقة الكنترول انخفاض معنوي في أداء النمو (الزيادة في وزن الجسم- الغذاء المستهلك- معدل تحويل الغذاء- معدل تحويل البروتين والطاقة في الغذاء) وارتفاع معدل النفوق وانخفاض خصائص الذبيحة ومعاملات الهضم وكفاءة الإنتاج ولكن ارتفعت الكفاءة الاقتصادية مقارنة بالمغذاة على المجاميع المختبرة (م٢-م٧).

(٢) في معظم الحالات، أثناء فترة البادئ (صفر- ٢٨ يوم) والفترة الكلية للتجربة (صفر-٤٩ يوم) فإن التغذية على العلائق المحتوية ١٠% كسب حبة البركة (م٦) أو ١% بذور حبة البركة (م٤) أو ٠.٥% زيت حبة البركة (م٢) أعطت تحسن معنوي في الصفات المدروسة السابقة مقارنة مع المغذاة على المجموعة الكنترول والمجاميع الأخرى. وعلى العكس في فترة الناهي (٢٩-٤٩ يوم) كانت النتائج غير ثابتة ولم تعطى نفس اتجاه فترة البادئ والفترة الكلية للتجربة.

الخلاصة: أظهرت النتائج أن إضافة ١٠% كسب حبة البركة أو ١% بذور حبة البركة أو ٠.٥% زيت حبة البركة في علائق كتاكيت التسمين لها تأثير أفضل في تحسين الأداء الإنتاجي والاستفادة من الغذاء (الزيادة في وزن الجسم- الغذاء المستهلك- معدل تحويل الغذاء- معدل تحويل البروتين والطاقة في الغذاء - الحيوية - خصائص الذبيحة - معاملات الهضم - العائد الاقتصادي) كما أن إضافة حبة البركة كإضافات غذائية في علائق كتاكيت التسمين المرباة في العنابر المفتوحة تحت ظروف الصيف المصرية قللت من التأثيرات الجانبية لدرجات الحرارة المرتفعة .