

EFFECT OF *NIGELLA SATIVA* CAKE SUPPLEMENTATION ON CLINICAL PICTURE, RUMEN LIQUOR PARAMETERS, BLOOD BIOCHEMICAL CONSTITUENTS AND HAEMATOLOGICAL FINDINGS IN GOATS

I.A. SALEH*, G.H. RAKHA* and M. TAWFIK**

* Department of Vet. Int. Med. and Infectious Diseases, Fac. Vet. Med., Cairo University, Giza, Egypt. 12211.

** Animal Reproduction Research Institute, Agriculture Research Center, Giza, Egypt..

Received: 15-10-2001.

Accepted: 5-12-2001.

SUMMARY

Twelve females baladi goats were used in this study which carried out for five months at the Department of Internal Medicine and Infectious Diseases, Faculty of Vet. Med., Cairo University, Giza. The immature females weighed 8 - 12 kg were randomly allotted into two groups, the control group (N = 4) fed on 750 g maintenance ration/head/daily, and the tested group (N=8) given the same basal ration supplemented with 100 g/animal of *Nigella sativa* cake (NSC). Careful clinical examination of goats throughout the experiment revealed that the tested group was improved in general health and body weight in comparison to the control group. The final body weight and body weight gain were significantly higher ($P < 0.01$) in does with NSC group than the control group. Analysis of rumen liquor revealed that the total volatile fatty acids

(TVFAs) was significantly increased ($P < 0.05$) in NSC group than control, while the values of pH and ammonia were not changed. Supplementation with *Nigella sativa* cake (NSC) increase significantly the molar proportion of propionate ($P < 0.01$), decrease significantly the molar proportion of acetate ($P < 0.01$) and not affect the molar proportion of butyrate and isovalerate. The plasma proteinogram profile showed non significant decrease in total proteins and albumin while the globulin was non significantly increased in NSC group versus the control. The plasma lipogram profile revealed significant decrease in cholesterol ($P < 0.01$) and insignificant decrease of total lipids and triglycerides in NSC group. The erythron showed significant increase of haemoglobin ($P < 0.01$), haematocrite ($P < 0.05$) and RBCs count ($P < 0.05$) in the tested group (NSC) in comparison to the control. The leucon revealed significant

increase of lymphocytes (%) ($P < 0.05$), insignificant increase in total leucocytic count (TLC) and insignificant changes in segmented neutrophils, band neutrophils, eosinophils and monocytes percentages in the NSC group in comparison to the control group. It can be concluded that *Nigella sativa* cake (NSC) can be successfully used as a cheap energy and protein source for goats to increase body weight, improved rumen fermentation, accelerate proteinogram, lipogram and immune status.

INTRODUCTION

Nigella sativa cake (NSC) is an industrial by product, obtained after oil extraction from *Nigella sativa* seeds. It is considered a good protein resource for ruminants of economical importance in reducing the costs of feeding (Gabr et al., 1998 and Allam et al., 1999).

Nigella sativa seeds (black cumin, black seeds, Kalonji and is known in arabic as Habet El Barakah) is a herbaceous plant which is a member of family-Ranunculaceae. It is a spicy plant and also used as a flavoring agent for bakery products (Hekal and Omar, 1988).

In arab folk medicine, *Nigella sativa* seeds or oil used for treatment of hepatobiliary diseases, cough, bronchial asthma and also used as a carminative (Hekal and Omar, 1988).

In human medicine, *Nigella sativa* seeds or oil were used with success in the treatment of atrophic rhinitis (Abdel-Ghany, 1996), bronchial asthma (Ahmad, 1995), irritable bowel syndrome (El-Gamil, 1999) and cestodes (Akhtar and Rif-fat, 1991).

Recently, the use of *Nigella sativa* showed many pharmaceutical effects, for example, bronchodilator, spasmolytic (Gilani et al., 2001), anti-inflammatory, analgesic (Al-Ghamdi, 2001), antioxidant (Turkdogan et al., 2001), diuretic and hypotensive (Zaoui, et al., 2000).

Nigella sativa oil has a protective effect against ethanol induced gastric ulcers { El-Dakhakhny et al., 2000 ^(A) } and carbon tetrachloride induced hepatotoxicity { El-Dakhakhny et al., 2000 ^(B) } . Also, It has a radioprotective capacity against radiation impairment of hepatic function and structure (Karaweya, 1994 and El-Deghidi et al., 1995). Moreover, the *Nigella sativa* oil showed favourable effect on the serum lipid pattern where the administration of the oil orally caused a significant decrease in serum total cholesterol, low density lipoprotein, triglycerides and a significant elevation of serum high density lipoprotein level (El-Bawwab, 1998 and El-Dakhakhny et al., 2000 ^(B)).

Previous studies investigated the effects of feeding diets containing *Nigella sativa* cake on

productive performance of sheep (Awadalla, 1997 and Gabr et al., 1998), buffaloes (Youssef et al., 1998), and poultry (El-Ghamry et al., 1997), they recorded improved feed conversion, quantity and quality of produced meat and increased economic efficiency. These beneficial positive effects make it important to fully investigate the possible effects of *Nigella sativa* cake on goats. This work was planned to elucidate the effect of *Nigella sativa* cake supplementation on the clinical picture, rumen liquor parameters, some blood biochemical constituents and some haematological findings in goats.

MATERIALS AND METHODS

Animals, body weight gain and rations:

Twelve females baladi goats were used in this study. These immature females, weighed 8-12 kg. This study was carried out for five months at the Department of Vet. Internal Medicine and infectious diseases, Fac. of Vet. Med., Cairo University. These animals were divided into 2 groups: the first comprised 4 healthy goats (based upon clinical and laboratory examinations) and was regarded as a control group. The second, included 8 goats (test group). Clinical examination was done before and throughout the study according to the standard method described by Kelly (1984). The control group fed on 750 g ration/head daily as recommended by NRC (1985), and the tested group given the same basal ration supplemented with 100 g/

animal of *Nigella sativa* cake (NSC). The chemical composition of the rations, the daily intake of the ration by goats and the daily body weight gain of goats are illustrated in Table (1).

Rumen liquor and blood samples

At the end of five months of the present study, from three females from each group rumen liquor and blood samples with EDTA were collected. Rumen liquor samples examined for pH using digital pH meter, ammonia, total and individual volatile fatty acids (VFAs) and protozoal activity according to Badawy (1992). Blood plasma samples were used for estimation of total protein, albumin, globulin, urea, total lipids, cholesterol and triglycerides by standard chemical kits. Whole blood samples with EDTA were used for estimation of haemoglobin, haematocrite, red blood cells and white blood cells total and differential according to Coles (1986).

Statistical analysis:

The obtained data were statically analysed according to Stell and Torrie (1980) by computer programs.

RESULTS AND DISCUSSION:

Clinical findings:

Careful clinical examination of goats throughout the five months of study revealed that the tested group (NSC) was improved in general health and body weight in comparison to the control

group. Concerning the body weight gain Table (1) the initial body weight was not significantly different between groups. However, the final body weight was increased significantly in does of (NSC) group (15.04 ± 0.82 kg) than controls (12.5 ± 0.50). Consequently the body weight gain was significantly higher in (NSC) group than control (4.58 ± 0.8 and 1.50 ± 0.30 kg respectively). This result coincide with those obtained by Zaid (1998) in goats, El-Ekhnawy et al., (1999) in ewes and Sharobeem (1996) in the albino rats, however, other investigators (Zeweil, 1996, Awadalla, 1997 and El-Gouhary, 1997) observed no effect of Nigella

sativa cake on body weight and growth rate. Increased body weight and growth rate of (NSC) group might be attributed to high nutrient content and antimicrobial effect of Nigella sativa cake which act as a growth promotor agent (Rathee et al., 1982 and Nasr et al., 1998).

Many reports and articles have been written indicating the significant role of Nigella sativa seeds from which Nigella sativa cake (NSC) was produced in increasing immunity and maintaining good health (Mandour and Amal Rady, 1997), antifungal properties (Rathee et al., 1982), antihelmintic activity against tape worms (Agar-

Table (1): Ingredients (%), chemical compositions and daily intake of basal (control) and Nigella sativa cake (NSC) supplemented rations in addition to the body weight (mean values \pm standard errors) of control and tested goats.

Items	Control ration and goats	Tested ration and goats
Ingredients (%)		
Concentrate mixture	42.86	40.54
wheat straw	57.14	54.06
Nigella sativa cake	-	5.40
Total	100	100
Chemical compositions		
Dry matter (DM) (%)	92.30	91.95
Crude protein (CP) (%)	8.47	9.34
Total digestible nutrients (TDN) (%)	52.86	54.06
Ether extract (EE) (%)	1.470	2.299
Daily intake/head		
Dry matter intake (DM) (g)	1560	1660
Crude protein (CP)(g)	132.13	155.04
Total digestible nutrients (TDN) (kg)	82.46	87.74
Ether extract (EE) (g)	22.93	38.16
Body weight		
Initial weight (kg)	11.0 ± 0.76	10.46 ± 0.59
Final weight (kg)	12.5 ± 0.50	$15.04 \pm 0.82^{**}$
Body weight gain (kg)	1.50 ± 0.3	$4.58 \pm 0.8^{**}$

* $P < 0.05$

** $P < 0.01$

Table (2): Rumen liquor parameters of baladi goats in control and *Nigella sativa* cake (NSC) supplemented groups (mean values \pm standard errors)

Items	Control goats	Tested goats
pH	6.45 \pm 0.40	6.23 \pm 0.41
Ammonia (mg/dl)	14.35 \pm 1.48	12.55 \pm 1.76
TVFAs (meq/dl)	9.13 \pm 5.16	11.57 \pm 7.53 *
Individual VFAs (%)		
Acetic (%)	48.77 \pm 7.52 **	34.17 \pm 5.89
Propionic (%)	34.04 \pm 3.16	42.27 \pm 4.47 **
A/P ratio	1.43 \pm 0.12 **	0.80 \pm 0.15
Butyric (%)	14.78 \pm 2.11	20.99 \pm 2.75
Isovaleric (%)	2.45 \pm 0.15	2.57 \pm 0.11
Protozoal activity		
Number	+++	+++
Motility	+++	+++
Viability	75 %	80 %

*P<0.05

**P<0.01

wal et al., 1979, Akhtar and Joved, 1991), trematode worms (paramphistomum) in sheep (Korshom et al., 1998) and chloretic action (Mahfouz et al., 1992). Moreover, *Nigella sativa* seeds contain materials that show to possess both antimicrobial as well as immunostimulant effects (Hanafy and Hatem, 1991 and Hedaya, 1995 and Abdel Azim, 1996). Recently, *Nigella sativa* oil has an antitumour activity (Badary et al., 1999) and antiviral effect against murine cytomegalovirus infection (MCMV) (Salem and Hossain, 2000).

Rumen liquor parameters:

Rumen liquor parameters of baladi goats supplemented with *Nigella sativa* cake was represented in Table (2). Analysis of rumen liquor revealed that the total volatile fatty acids (TVFAs) was significantly increased in (NSC) group than control, while the values of pH and ammonia were not changed. Supplementation with *Nigella sativa* cake increase the molar proportion of propionate, decrease the molar proportion of acetate, and accordingly decrease the A/P ratio, but not affect the molar proportion of butyrate and isovalerate (%). Similar results were reported by El-Ayck et al., (1998) and El-Ayck (1999) who concluded

that *Nigella sativa* meal (cake) could be used as a relatively good source of energy and protein supplement in the diets of ruminants since it is characterized by low degradation rate in the rumen and low prices. The protozoal activity in the pattern of number, motility and viability are not affected by the addition of *Nigella sativa* cake.

Rumen liquor analysis revealed that TVFAs had a significant increase in (NSC) group, which could be attributed to the high organic matter content (90.5 %) of *Nigella sativa* cake (Youssef et al., 1998). The low level of ammonia due to *Nigella sativa* cake supplementation indicated slow release of protein degradation in spite of the relative high level of crude protein content of *Nigella sativa* cake (27.87 %).

The present study revealed that the most con-

sistent action of *Nigella sativa* cake on rumen fermentation is its ability to increase the molar proportion of propionate at the expense of acetate, and thus theoretically increased the efficiency of converting feed energy available to the animal. The concept that the propionic acid fermentation was energetically more efficient than either the acetic acid or butyric acid fermentations based on many factors. Smith (1971) reported that, propionate was utilized by the ruminants tissue more efficiently than acetate. Another possible advantage of propionate was that it was more flexible as an energy source than acetate. Propionate enjoyed the luxury of having the potential to be used for gluconeogenesis in addition to direct oxidation by the citric acid cycle (Badawy, 1992). Moreover, the efficiency of microbial protein synthesis was markedly higher with the propionate as opposed to the acetate fermentation pattern as recorded by Ishaque et al. (1971).

Table (3) : Blood plasma biochemical constituents of baladi goats in control and *Nigella sativa* cake (NSC) supplemented groups (mean values \pm standard errors)

Constituents	Control goats	<i>Nigella sativa</i> cake goats
Total protein (g/dl)	8.85 \pm 0.30	8.78 \pm 0.15
Albumin (g/dl)	6.54 \pm 0.19	6.21 \pm 0.12
Globulin (g/dl)	2.31 \pm 0.19	2.57 \pm 0.12
Urea (mg/dl)	22.1 \pm 3.1 **	13.4 \pm 1.3
Total lipids (g/dl)	386.5 \pm 11.07	378.1 \pm 6.1
Cholesterol (mg/dl)	145.3 \pm 4.5 **	127.6 \pm 4.2
Triglycerides (mg/dl)	99.6 \pm 5.5	98.8 \pm 6.6

*P<0.05

**P<0.01

Blood plasma biochemical constituents:

The statistical analysis showed that supplementation of baladi goats with *Nigella sativa* cake had no effect on plasma total protein, albumin however, there was non significant increase in globulin (Table 3). This results agrees with those obtained by Korshom et al. (1998) and El-Ekhnawy et al. (1999). Other investigators (Abdel Aal et al., 1993, Khodary et al., 1996, Nassar, 1997 and Youssef et al., 1998) who used *Nigella sativa* seeds and found a significant increase in the

plasma total proteins, which might be due to the increase in the globulins level. Otherwise, Nasar (1997) reported non significant changes in plasma albumin level on feeding of different forms of *Nigella sativa* in the ration of balady cockerels.

Our data regarding plasma urea showed significant decrease ($P < 0.01$) between the *Nigella sativa* cake supplemented balady goats and the control group (Table 3). This results disagrees with Refaei and Ahmad (1993) in rabbits and El-Ekhnawy et al., (1999) in ewes who found significant increase in urea on feeding of *Nigella sativa* seeds and cake respectively. However, Youssef et al. (1998) reported non significant increase in blood urea in buffaloes on feeding of *Nigella sativa* cake.

Concerning the plasma lipogram profile, total lipids and triglycerides were not affected, while plasma cholesterol was significantly decreased on supplementation with *Nigella sativa* cake (Table 3). This results agree with decreased Hedaya (1995) and Youssef et al., (1998) and disagree with El-Ekhnawy et al., (1999) who reported significant increase in total lipids, cholesterol and triglycerides. The significant decrease in plasma cholesterol level may be attributed to the high content of unsaturated fatty acids, mainly linolinic in *Nigella sativa* cake (Al-Gaby, 1992).

Haematological findings:

The erythron of the *Nigella sativa* cake supple-

mented balady goats showed significant increase in haemoglobin, haematocrite and RBCs count in comparison with the control goats (Table 4). This Results were in agreement with Hedaya (1995). The leucon of the supplemented balady goats with *Nigella sativa* cake, showed significant increase in lymphocyte (%), insignificant increase in total leucocytic count and insignificant changes in segmented neutrophils, band neutrophils, eosinophils and monocytes percentages in comparison with the control goats (Table 4). Similar results were reported by Hedaya (1995), this significant increase in lymphocyte (%) which cause insignificant increase in WBC count, indicates the immunostimulant effect of *Nigella sativa* cake. This immunostimulant effect was reported previously by Abdel Aal and Attia (1993), Hedaya, (1995), Abdel Azim, (1996) and El-Ekhnawy, (1999) who stated that, low doses of *Nigella sativa* seeds extract caused an increase in the immunity of the body through increasing the lymphocytes (%) and globulins. It is worth to mention that, in our study, there was non significant increase in globulin (Table 3). The intake of *Nigella sativa* may enhance T-cell mediated immunity through improvement of $T_4 : T_3$ ratios (El-Khadi et al. 1987) and significantly increase in the C₃ complement concentration as well as in % of NK-cells to total lymphocytes (Mahdy, 1993).

The nutritive value of *Nigella sativa* cake (29.7 % CP) lies in the intermediate site between cotton seed cake (24 % CP) and line seed cake (33

Table (4) : Haematological findings (mean values \pm standard errors) of both healthy and *Nigella sativa* cake (NSC) supplemented goats (mean values \pm standard errors)

Parameters	Healthy goats	<i>Nigella sativa</i> cake goats
Haemoglobin (g %)	9.27 \pm 0.23	10.48 \pm 0.25 **
Haematocrite (vol %)	29.33 \pm 1.20	33.80 \pm 1.05 *
RBCs (X 10 ⁶ /μl)	3.77 \pm 0.15	4.40 \pm 0.22*
WBCs (X 10 ³ /μl)	6.37 \pm 0.38	7.1 \pm 0.43
Lymphocytes (%)	52.50 \pm 2.1	60.50 \pm 2.70 *
Segmented neutrophils (%)	37.00 \pm 1.5	33.00 \pm 1.9
Band neutrophils (%)	3.50 \pm 1.50	2.00 \pm 1.25
Eosinophils (%)	2.00 \pm 0.40	1.00 \pm 0.40
Monocytes (%)	5.00 \pm 0.63	4.00 \pm 0.50

*P<0.05

**P<0.01

% CP). From the economical point of view and according to the current cost of tonne, *Nigella sativa* cake as an industrial by product is cheaper (300 EP/tonne) than cotton seed cake (500 EP/tonne) or line seed cake (750 EP/tonne) (El-Ekhnawy et al., 1999).

Finally, from this study, it can be concluded that, *Nigella sativa* cake can be successfully used as a cheap energy and protein supplement for goats to increase body weight, improve rumen fermentation, accelerate proteinogram, lipogram and immune status.

REFERENCES

- Abdel Aal, S.M. and Attia, R.S. (1993): Characterization of black cumin (*Nigella sativa*) seeds. Alex. Sci. Exch., 14 (4): 467-481.
- Abdel-Azim, S.A. (1996): Some biochemical studies on *Nigella sativa* with special reference to its effect on blood. Thesis in pharmacology, Fac. Vet. Med., Zagazig University, Egypt.
- Abdel-Ghany, Suaad (1996): Clinical, pathological, biochemical and immunological effects of *Nigella sativa* L seed oil on the treatment of atrophic rhinitis. Assiut Medical Journal, 20 (1): 63-73.
- Agarwal, R.R., Kharya, M.D. and Shrivastava, R. (1979): Antimicrobial and anthelmintic activities of the essential oil of *Nigella sativa*. Indian J. Exp. Biol., 1: 1264-1265.

ad. Azza M. (1995): The role of *Nigella sativa* in management of bronchial asthma. M.Sc. Thesis (Chest diseases), Fac. of Med., Assiut University, Assiut, Egypt.

htar, M.S. and Javed, I. (1991): Efficacy of *Nigella sativa* Linn. Seeds against *Moniezia* infection in sheep. *Indian Vet. J.*, 68 (8): 726-729.

htar, M. and Riffat, S. (1991): Field trial of *Saussurea lappa* roots against nematodes and *Nigella sativa* seeds against cestodes in children. *J. Pak. Med. Assoc.*, 41 (8): 185-187.

I-Gaby, A.M. (1992): Biochemical studies on Egyptian *Nigella sativa* L. oils. *Egyptian J. Appl. Sci.*, 5: 739-748.

al-Ghamdi, M.S. (2001): The anti-inflammatory, analgesic and antipyretic activity of *Nigella sativa* J. *Ethnopharmacol.*, 76 (1): 45-48.

Allam, M.S., El-Hosseiny, H.M., Abdel-Gawad, A.M. El-Saadany, S.A. and Zeid, A.M.M. (1999): Medicinal herbs and plants as feed additives for ruminants. I- Effect of using some medicinal herbs and plants as feed additives on zaraibi goat performance. Proceedings of the 7th scientific conference on animal nutrition (ruminants, poultry and fish), 19-21 October, El-Arish, Egypt. Part I. *Egyptian J. of Nutrition and Feeds*, 2: 349-365 (Special Issue).

Awadalla, L.M. (1997): The use of black cumin seed (*Nigella sativa*) cake in rations of growing sheep. *Egypt. J. Nutr. and feeds*, 1: 243-249.

Badary, O.A., Al-Shabanah, O.A., Nagi, M.N., Al-Rikabi, A.C. and Elmazar, M.M. (1999): Inhibition of benzo (a) pyrene-induced forestomach carcinogenesis in mice by thymoquinone. *Eur. J. Cancer Prev.*, 8 (5):

435-440.

Badawy, S.A. (1992): Some biological effects of rumen fermentation modifier (monensin) on buffalo-heifers with special reference to sexual puberty. Ph.D. Vet. Thesis, Fac. of Vet. Med., Cairo University, Egypt.

Coles, E.H. (1986): *Veterinary clinical pathology*, 4th ed., W.B. Saunders Company, London.

El-Ayck, M.Y. (1999): Influence of substituting concentrate feed mixture by *Nigella sativa* meal on: I- voluntary intake, digestability, some rumen parameters and microbial protein yield with sheep. Proceedings of the 7th scientific conference on animal nutrition (ruminants, poultry and fish), 19-21 October, El-Arish, Egypt. Part I. *Egyptian J. of Nutrition and Feeds*, 2: 279-296 (Special Issue).

El-Ayck, M.Y., Gabr, A.A., Mehrez, A.Z., Abdel-Samee, A.M. (ed.), Marai, I.F.M., Metwally, M.K. (1998): Utilization of diets supplemented with untreated or formaldehyde treated soybean, *Nigella sativa* meals and concentrate fed mixture by sheep. First international conference on animal production and health in semi-arid areas, El-Arish, Egypt, 1-3 September: 273-281.

El-Bawwab, E.M.E. (1998): Effect of *Nigella sativa* on pituitary testicular axis hormones and blood lipids. M.D. Thesis (Medical biochemistry), Fac. of Med., Al-Azhar Univ., Cairo, Egypt.

El-Dakhkhny, M., Barakat, M., El-Halim, M.A. and Aly, S.M. (2000) (A): Effects of *Nigella sativa* oil on gastric secretion and ethanol induced ulcer in rats. *J. Ethnopharmacol.*, 72 (1-2): 299-304.

El-Dakhkhny, M., Mady, N.I. and Halim, M.A. (2000) (B): *Nigella sativa* L. oil protects against induced hepatotoxicity and improves serum lipid profile in rats. *Arzneimittelforschung*, 50 (9): 832-836.

- El-Ekhnawy, K.E., Otteifa, A.M., Ezza, Omaina H. and Hegazy, M.A. (1999): Post-weaning reproductive activity of Barki ewes lambing in spring fed *Nigella sativa* oil seed meal. *Assiut vet. Med. J.*, 40 (80): 292-309.
- El-Dighladi, Eglal A.M., Bakshwan, Safinaz B., El-Qadhi, Maha H. (1995): Prophylactic action of *Nigella sativa* oil against radiation impairment of hepatic function and structure in male albino rats. *The Egyptian J. of Histology*, 18 (37): 37-47.
- El-Gamil, K.A.H. (1999): Evaluation of *Nigella sativa* seeds effect on bacterial flora in irritable bowel syndrome. M.Sc. Thesis (Internal Medicine), Fac. of Medicine, Ain-Shams Univ., Cairo, Egypt.
- El-Ghamry, L.D., Abdel-Samee, L.D. and Ibrahim, M. (1997): Effect of feeding black cumin (*Nigella sativa*) meal and rice polishing at different levels in the laying performance and some blood plasma constituents. *Egypt. J. Nutrition and Feeds*, 1: 311-320.
- El-Gouhari, E.S.H.E (1997): Studies on sheep feeding under Egyptian conditions: Performance of lambs fed on diets containing *Nigella sativa* meal. M.Sc. Thesis (animal nutrition), Fac. of Agri., Mansoura University, Egypt.
- El-Khadi, A., Kandel, O. and Tabuni, AM (1987): *Nigella sativa* and cell mediated immunity. *Arch. AIDS Res.*, 1:232.
- Gabr, A.A.El-Ayouty, S.A., Zaki, A.A., Abou-Ammo, F.F. and El-Gohary, E.S.I. (1998): Productive performance of lambs fed diets containing *Nigella sativa* meal. *Egyptian J. of Nutrition and Feeds*, 1 (2): 97-107.
- Gilani, A.H., Aziz, N., Khurram, I.M., Chaudhary, K.S. and Iqbal, A. (2001): Bronchodilator, spasmolytic and calcium antagonist activities of *Nigella sativa* seed (Kalonji): A traditional herbal product with multiple medicinal uses. *J. Pak. Med. Assoc.*, 51 (3): 115-120.
- Hanafy, M.S. and Hatem, M.E. (1991): Studies on antimicrobial activity of *Nigella sativa* seed (Black cumin) I. *Ethnopharmacol.*, 34 (2-3): 275-278.
- Hedaya, S.A. (1995): Effect of *Nigella sativa* seeds (black seeds) extract on some haematological and biochemical parameters in rats. *Alex. J. Vet. Sci.*, 11 (2): 95-99.
- Hekal, ME and Omar, A.A. (1988): Medicinal plants chemistry, production and benefits. Manshat Al-Maref, Alexandria (in arabic).
- Ishaque, M., Thomas, P.C. and Rook, J.A.F. (1971): Consequences to the host of changes in rumen microbial activity. *Nature (London) New biol.* 231-253.
- Karaweya, M.S. (1994): Essential oil and lipids of *Nigella sativa* seed and their biological activity. *Zagazig J. of Pharmaceutical Science*, 3 (2): 49-57.
- Kelly W.R. (1984): Veterinary clinical diagnosis. 3rd ed. Bailliere Tindall, London.
- Khodary, R.M., El-Ezzawy, M.H and Hamdy, I.R. (1996): Effect of *Nigella sativa* on egg production, hatchability percentage and some biochemical values in laying hens with reference to fertility in cockerels. 7th Sci. Cong. Fac. Vet. Med., Assiut Univ., 17-19 Nov., Assiut, Egypt.
- Korshom, A., Moghney, A.A. Mandour A. (1998): Biochemical and parasitological evaluation of *Nigella sativa* against rumen fluke (paramphistomum) in sheep compared with trematocide (Hapadex). *Assiut Med. J.*, 39 (78): 238-244.
- Mahdy, E.A. (1993): Effect of *Nigella sativa* L. on the immune systems in cirrhotic patients. M.D. Thesis Int. Med., Fac. Med., El-Azhar Univ., Egypt.

- Mahfouz, M., El-Dakhkhny, M., Gemel, A. and Mousa, H. (1992): Chloretic action of *Nigella sativa* seed oil. *Egyptian Pharmac. Bull.*, 44: 225-229.
- Mandour, A.A., Rady, Amal A. (1997): The effect of *Nigella sativa* (black seeds) on the amino acid patterns and some metabolic constituents in the serum of Pekin ducklings. *Assiut Vet. Med. J.*, 37 (74): 43-50.
- Nasr, A.S., Attia, A.I., Abdel-Samee, A.M. (ed.), Marai, H.M (ed.), Metwally, M.K. (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: 451-462.
- Nassar, H.M. (1997): Pharmacological and toxicological studies on *Nigella sativa*. Ph.D. Vet. Thesis, Alex. Univ., Egypt.
- N.R.C. (1985): National agriculture research council. Nutritional requirements of goats. Washington DC, National academy of science.
- Rathee, P.S., Mishra, S.H and Haushal, R. (1982): Antimicrobial activity of essential oil fixed and unsaponifiable matter of *Nigella sativa*. *Indian J. Pharm. Sci.*, 44:8.
- Refaei, Fawzeya M. and Ahmad, M.B. (1993): Possible renal dysfunction effect of *Nigella sativa* seeds in rabbits. *J. of Biomedical Sciences & Therapeutics*, 9 (3): 19-25.
- Salem, M.L. and Hossain, M.S. (2000): Protective effect of black seed oil from *Nigella sativa* against murine cytomegalovirus infection. *Int. J. Immunopharmacol.*, 22 (9): 729-740.
- Sharobeem, S.F. (1996): Chemical characterization of *Nigella sativa* cake protein and its biological effects on albino rats. *Zagazig J. Agric. Res.*, 3: 355-368.
- Smith, G.E. (1971): Energy metabolism. Cited from Badawy (1992).
- Steel, R.G.D. and Torrie, J.H. (1980): Principals and procedures of statistics. McGraw-Hill, New York.
- Turkdogan, M.K., Agaoglu, Z., Yener, Z., Sekeroglu, R., Akkanm H.A. and Avcı, M.E. (2001): The role of antioxidant vitamins (C and E), selenium and *Nigella sativa* in the prevention of liver fibrosis and cirrhosis in rabbits. *New hopes. Dtsch. Tierarztl. Wochenschr.*, 108 (2): 71-73.
- Youssef, M.M., Abdiene, A.M., Khattab, R.M., Darwish, S.A. (1998): Effect of feeding *Nigella sativa* cake on productive and reproductive performance of buffaloes. *Egyptian J. of Nutrition and Feeds.*, 1 (2): 73-85.
- Zaid, A.M.M. (1998): Effect of medicinal plants on goat performance. Ph.D. Thesis (animal nutrition), Fac. of Agric., Cairo University, Giza, Egypt.
- Zaoui, A., Cherrah, Y., Lacaille-Dubois M.A., Settaf, A., Amarouch, H. and Hassar, M. (2000): Diuretic and hypotensive effects of *Nigella sativa* in spontaneously hypertensive rat. *Therapie*, 55 (3): 379-382.
- Zeweil, H.S. (1996): Evaluation of substituting *Nigella sativa* oil seed meal for soyabean meal on the performance of growing and laying Japanese quails. *Egypt. Poult. Sci.*, 11: 451-477.