Effect of diet supplemented with pumpkin (*Cucurbita moschata*) and black seed (*Nigella sativa*) oils on performance of rabbits: 1- Growth performance, blood haematology and carcass traits of growing rabbits

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Abstract: Eighty NZW weaned rabbits (40 males and 40 females at 5 weeks of age and 535.19±14.73 g LBW) were used in a complete randomized design of four treatments during feeding period from 5 to 12 weeks of age. Rabbits in the 1st group were fed commercial pelleted diet without additive (control, G1). Rabbits in the 2nd, 3rd and 4th groups were fed the control diet supplemented with 5 g pumpkin seed (PS) oil/kg diet (G2), 5 g nigella sativa seed (NS) oil/kg diet (G3) and 2.5 g PS oil plus 2.5 g NS oil /kg diet (G4), respectively. Results showed that dietary supplementation did not affect nutrients digestibility coefficients and nutritive values. Cecal pH value and NH_3-N concentration were higher (P<0.05) in G1 than in supplemented groups (G2-G4). Concentration of TVFAs was lower in G1 and the highest concentration was in G4 (P<0.05). Haemoglobin concentration, PCV%, counts of red and white blood cells, percentage of differential white blood cells, concentrations of total proteins, albumin and globulin in blood serum were nearly similar in all groups. In blood serum, concentration of glucose increased (P<0.05), total lipids, triglycerides, total cholesterol, HDL and LDL as well as activity of AST and ALT decreased (P<0.05) by supplementation of PS, NS or their combination. Mortality rate decreased (P<0.05) in supplemented groups. Final body weight was higher (P<0.05) as compared to G1, G2 and G3. Total and daily weight gain were higher (P<0.05) for G4 compared with the other groups. Rabbits in G2 and G3 showed the highest (P<0.05) feed intake followed by G1, while G4 had the lowest intake (P<0.05). Rabbits in G4 recorded the best (P<0.05) feed conversion ratio and performance index compared with other groups. Group 4 recorded the highest net revenue (P<0.05), followed by G1, while G2 and G3 had the lowest revenue (P<0.05). Groups 3 showed the highest (P<0.05) slaughter and carcass weights as well as dressing percentage. Groups 3 and 4 had (P<0.05) the highest abdominal and shoulder fat weight. Weight of liver, kidneys, heart, lungs, spleen, head and bile, physical characteristics, moisture and ash contents in meat were nearly similar in all groups. Group 4 showed the highest (P<0.05) protein content in meat, G1 showed the highest (P<0.05) fat content in meat. In conclusion, rabbits fed diet supplemented with combination of pumpkin and black seeds oils (2.5 g PS and 2.5 g NS /kg diet) showed the best results concerning digestibility coefficients, cecal fermentation, blood parameters, growth performance, carcass quality and economic efficiency.

[Gaafar, H.M.A.; Ayat A. Ragab and K.F.A. El-Reidy. **Effect of diet supplemented with pumpkin (*Cucurbita moschata*) and black seed (*Nigella sativa*) oils on performance of rabbits: 1- Growth performance, blood haematology and carcass traits of growing rabbits.** *Rep Opinion* 2014;6(1):52-59]. (ISSN: 1553-9873). http://www.sciencepub.net/report. 10

Keywords: Rabbits, pumpkin, *Nigella sativa*, digestibility, haematology, growth performance, carcass.

1. Introduction

Aromatic plants and their extracted essential oils are becoming more important due to their antimicrobial effects and the stimulating effect on animal digestive systems (Ciftci *et al*., 2005). Beneficial effects of botanical additives in farm animal may arise from activation of feed intake and digestive secretions, immune stimulation, antibacterial, coccidiostatical, antihelmintical, antiviral or antiinflamatory activities. In plant tissues, pH values are dependent on the presence of poly-carboxylic acids, phosphate salts, fiber and proteins (Al-Dabbas *et al*., 2010).

The chemical composition of the extracted fixed oil (total fatty acid composition) and volatile oil of *Nigella sativa* (NS) L. seeds included eight fatty acids (99.5%) and thirty-two compounds (86.7%) have been identified in the fixed and volatile oils, respectively. The main fatty acids of the fixed oil were linoleic acid (55.6%), oleic acid (23.4%), and palmitic acid (12.5%). The major compounds of the volatile oil were trans-anethole (38.3%), p-cymene (14.8%), limonene (4.3%), and carvone (4.0%) are reported by Nickavar *et al*. (2003). Concerning the effect of NS on animal performance, Omar *et al.* (2002) stated that use of diet supplemented with NS seed oil improved the growth performance and increased, feed conversion efficiency, immune response and increased economic return of chickens. Meral *et al.* (2004) found that oral treatment of *Nigella sativa* L. might decrease the diabetes-induced disturbances of heart rate and some haematological parameters of alloxan-induced diabetic rabbits.

The saturated fatty acid content was 27.73% and comprises of 16.41% palmitic acid and 11.14% stearic

acid. The unsaturated fatty acid value was 73.03% and consisting mainly of 18.14% oleic acid and 52.69% linoleic acid. The oil obtained from the pumpkin seed kernels had a refractive index of 1.4656, specific gravity of 0.913, iodine value of 105.12 (g I2/100g oil), saponification value of 185.20 (mg KOH/g oil), acid value of 0.53 (mg KOH/g oil), and peroxide value of 0.85 (meq peroxide/kg oil) as reported by Alfawaz (2004). Up to 60.8%, of the pumpkin seed (PS) oil is from the fatty acids, oleic (up to 46.9%), linolenic (up to 40.5%) and palmitic and stearic up to 17.4%, while the ratio of monounsaturated to polyunsaturated acids from 0.60 to 0.75 g (Nakiae *et al*., 2006). Regarding the effect of PS on animal performance, Hajati *et al.* (2011) indicated that supplementation of diets with 5 g PS/kg DM in corn-soybean meal-wheat based diet can be profitable because it reduced broiler chicken's mortality and it did not have any adverse effect on bird's performance.

Therefore, the objective of this study was to investigate the effect of dietary supplementation of pumpkin and black seed oils on digestibility, cecual activity, blood parameters, growth performance, carcass traits and economic efficiency of growing New Zealand white rabbits (NZW).

2. Materials and methods

The current work was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture during the period from November to December 2012.

2.1. Experimental rabbits and diets:

Total of 80 weaned NZW rabbits (40 males and 40 females at 5 weeks of age and 535.19±14.73 g LBW) were used in a complete randomized design of four treatments during feeding period from 5 to 12 weeks of age. Rabbits in the 1st group were fed commercial pelleted diet without additive (control, G1). Rabbits in the 2nd, 3rd and 4th groups were fed the control diet supplemented with 5 g pumpkin seed (PS) oil/kg diet (G2), 5 g nigella sativa seed (NS) oil/kg diet (G3) and 2.5 g PS oil plus 2.5 g NS oil /kg diet (G4), respectively. The experimental feeding period lasted 5 weeks up to 12 weeks of age. Rabbits in all groups were fed to cover their requirements according to NRC (1977). Ingredients and chemical composition of the control diet are presented in Table (1).

Table 1. Formulation and composition of commercial rabbit diet

Ingredient	%	Composition	%
Berseem hay	30	DM	88.06
Wheat bran	16	OM	90.57
Soybean meal	20	CP	16.54
Yellow corn	20	CF	12.33
Barley grain	10	EE	2.25
molasses	2	NFE	59.45
limestone	1	Ash	9.43
Common salt	0.5		
Premix*	0.5		
Total	100		

* Each one kg of premix (minerals and vitamins mixture) contains vit. A, 20000 IU; vit. D3, 15000 IU; vit. E, 8.33 g; vit. K, 0.33 g; vit. B1, 0.33; vit. B2, 1.0 g; vit. B6, 0.33 g; vit. B5, 8.33 g; vit. B12, 1.7 mg; pantothenic acid, 3.33 g; biotine, 33 mg; folic acid, 0.83 g; choline chloride, 200 mg.

2.2. Housing and management:

Rabbits were housed in galvanized wire cages (40 x 50 x 60 cm) and fresh water was automatically available at all time. All rabbits were kept under the same managerial, hygienic and environmental conditions.

2.3. Experimental procedures:

Live body weight and feed intake weekly were recorded throughout the experimental feeding period. Then, daily weight gain, feed conversion ratio and economic efficiency were calculated. Also, performance index (PI) was calculated according to North (1981) as given below:

PI = [final body weight (kg) / feed conversion ratio] × 100

2.4. Digestibility trials:

Digestibility trial was undertaken at the end week of the experimental period (12 weeks of age) on four animals from each group. Rabbits were housed individually in metabolism cages. The experimental diets were offered daily and fresh water was provided all the time. Individual feed intake was accurately determined and feces were collected for 5 days as a collection period. Feces of each animal was mixed, dried at 60 °C for 24 hours, then representative samples were ground for chemical analysis. Chemical analysis of different diets and feces was determined according

to AOAC (1995). Then nutritive values as TDN, DCP or energy were calculated for the experimental diets.

2.5. Cecal activity:

Cecal contents of slaughtered rabbits were taken for determination of pH using Bechman pH meter. However, samples from cecal contents were taken for determination of NH_3-N concentration according to the method of AOAC (1995) and TVFAs concentration according to Warner (1964).

2.6. Blood sampling:

At the end of experimental period, blood was collected from sacrificed rabbits (6 animals in each group) in two clean sterile tubes for each animal immediately after slaughtering. The 1st blood samples were let to coagulate and centrifuged at 3500 rpm for 15 minutes and then serum was separated and stored at -20 °C till analysis. concentration of total proteins, albumin, glucose, total lipids, triglyceride, total cholesterol, high density lipoproteins (HDL). However, concentration of globulin and low density lipoproteins (LDL) were obtained by difference. Also, activity of Aspartate (AST) and Alanine (ALT) aminotransferases was determined. All biochemical were determined using spectrophotometer (Spectronic 21 DUSA) and commercial diagnostic kits (Combination, Pasteur Lap.).

The 2nd blood samples were collected in heparinized tubes to obtain whole blood samples for determined haematological parameters including packed cell volume (PCV%) using microhaematocrit centrifuge (Mitruka and Rawnsley, 1977), haemoglobin concentration using cyanmethemoglobin echnique (Mitruka and Rawnsley, 1977). Also, count of red blood cells (RBC) and white blood cells (WBC) was determined based on the dilution of obtained blood with diluting fluids (Hayem & Turk) using haemocytometer according to Mitruka and Rawnsley (1977). Giemsa staining method was used for the differential count of WBC.

2.7. Carcass traits:

At the end of experiment, 3 rabbits were taken randomly from each group. Animals were fasted for 18 hours before slaughtering, weighed and manually slaughtered. Weight of carcass plus head, kidneys, liver and heart was determined according to Blasco *et al.* (1993). pH value was determined in fresh meat samples using Orian digital pH meter. Tenderness and water holding capacity of meat and color intensity of meat extract were determined according to Yamazake (1981). Meat samples were subjected to chemical analysis of moisture, crude protein, ether extract and ash (AOAC, 1995).

2.8. Statistical analysis:

Data were statistically analyzed using general linear models (GLM) procedures adapted by SPSS (2008) for user's guide with one-way ANOVA. Duncan test within SPSS program was done to determine the degree of significance among means.

3. Results and discussions

3.1. Nutrients digestibility and nutritive values:

Nutrients digestibility and nutritive values of the experimental diets are shown in Table (2). Results showed that the effect of dietary treatments (PS, NS or their combination oils) on nutrients digestibility coefficients and nutritive values was not significant. However, there was a slight increase in the digestibility of DM, OM, CP, CF, EE and NFE and subsequently nutritive values in terms of TDN, DCP and DE in treatment groups (G2-G4) as compared to the control one (G1).

3.2. Cecal activity:

Cecal activity in terms of pH value and concentration of VFAs and NH_3-N of rabbits in the different groups is presented in Table (3). Cecal pH value was significantly ($P<0.05$) lower in all treatment groups than in control group. Concentration of TVFAs was the lowest in G1 and G3 (8.60 and 8.76 meq/dl) and the highest in G4 (9.05 meq/dl), while G2 did not differ significantly from that in both G1 and G4. However, concentration of NH_3-N showed an opposite trend to pH values.

3.3. Blood parameters:

Results of all haematological parameters in whole blood presented in Table (4) showed significant effect of dietary treatments on al parameters studied. Concerning the biochemical concentration in blood serum, the differences in concentration of total protein, albumin and globulin among groups were not significant. Meanwhile, serum glucose concentration significantly ($P<0.05$) increased in treatment groups as compared to the control, being the highest in G2. However, concentration of total lipids, triglycerides, total cholesterol, HDL and LDL as well as the activity of AST and ALT significantly ($P<0.05$) decreased in treatment groups as compared to the control one.

3.4. Growth performance, mortality rate, feed and economic efficiency:

Data in Table (5) revealed that rabbits in G4 fed diet supplemented with PS and NS combination showed significantly ($P<0.05$) the heaviest final LBW, the highest gain (total and daily) with the lowest feed intake (total and daily), which reflected in the best feed conversion ratio, the highest performance index and the lowest mortality rate as compared to dietary supplementation of PS or NS and the control diet.

Economic efficiency expressed as total feed cost, price of total weight gain and net revenue was affected significantly ($P<0.05$) by dietary supplementation (Table 5). Rabbits in G2 showed significantly ($P<0.05$) the highest total feed cost followed by G3 and G4, while G1 had the lowest cost. However, feed cost

per kg weight gain was significantly (P<0.05) higher in G2 and G3 as compared to G1 and G4.

The price of total weight gain was significantly (P<0.05) higher in G4 compared with other groups. Also, G4 recorded significantly (P<0.05) the highest net revenue followed by G1, while G2 and G3 had the lowest revenue (Table 5).

Table 2: Nutrients digestibility and nutritive values of the experimental diets.

Item	Experimental group				MSE
	G1	G2	G3	G4	
Digestibility coefficients %:					
DM	69.45	70.14	69.94	70.49	0.36
OM	70.80	71.51	71.30	71.86	0.37
CP	71.20	71.70	71.91	72.27	0.37
CF	64.65	65.30	65.10	65.62	0.34
EE	76.90	77.60	78.75	79.15	0.47
NFE	72.50	73.23	73.01	73.59	0.38
Nutritive values %:					
TDN	66.74	67.89	67.84	68.33	0.38
DCP	11.78	11.80	11.84	11.90	0.06
DE (Kcal/kg)	2942.70	2993.20	2991.20	3012.80	16.64

Table 3: Cecal fermentation activity in the experimental groups.

Item	Experimental group				MSE
	G1	G2	G3	G4	
pH value	6.73^{a}	6.33^{b}	6.27^{b}	6.43^{b}	0.08
TVFAs (meq/dl)	8.60^{b}	8.83^{ab}	8.76^{b}	9.05^{a}	0.06
NH3-N (mg/dl)	16.08^{a}	15.77^{b}	15.73^{b}	15.65^{b}	0.06

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Table 4: Haematological and biochemical parameters in blood serum of rabbits in the experimental groups.

Item	Experimental groups				MSE
	G1	G2	G3	G4	
Haematological parameters in whole blood:					
Haemoglobin (g/dl)	8.90	9.43	8.97	8.87	0.28
PCV %	28.33	30.00	28.67	28.33	0.79
Red blood cells (10^{6}/mm^{3})	3.43	3.67	3.47	3.49	0.10
White blood cells (10^{3}/ mm^{3})	7.38	7.33	6.22	6.87	0.36
Segmented neutrophils (%)	48.33	47.67	45.33	48.33	0.84
Lymphocytes (%)	43.33	43.67	45.33	41.67	0.88
Monocytes (%)	3.67	4.00	4.67	5.00	0.28
Eosinophils (%)	3.33	3.67	4.00	3.67	0.22
Basophils (%)	0.67	0.33	1.00	0.67	0.14
Steff (%)	0.67	0.67	0.67	1.00	0.24
Blood biochemical:					
Total proteins (g/dl)	7.10	7.19	6.95	7.28	0.21
Albumin (g/dl)	3.11	3.12	3.04	3.25	0.09
Globulin (g/dl)	3.99	4.07	3.92	4.04	0.21
Glucose (g/dl)	70.00^{c}	104.76^{a}	101.32^{a}	84.13^{b}	4.58
Total lipids (mg/dl)	393.65^{a}	371.43^{b}	357.14^{c}	307.94^{d}	35.63
Triglycerides (mg/dl)	69.32^{a}	59.16^{b}	47.73^{c}	68.54^{a}	6.36
Total cholesterol (mg/dl)	79.01^{a}	62.61^{c}	52.73^{d}	67.55^{b}	6.62
HDL (mg/dl)	52.18^{a}	43.95^{b}	35.21^{c}	45.27^{b}	4.77
LDL (mg/dl)	26.83^{a}	18.66^{c}	17.53^{c}	22.28^{b}	3.54
Activity of AST (IU/ml)	44.58^{a}	41.39^{ab}	36.18^{c}	40.53^{b}	1.01
Activity of ALT (IU/ml)	37.74^{a}	29.07^{b}	29.58^{b}	31.37^{ab}	1.37

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).

Table 5: Growth performance parameters, mortality rate and economic feed efficiency of rabbits in the experimental groups.

Item	Experimental group				MSE
	G1	G2	G3	G4	
Initial weight (g)	540.50	542.25	544.75	533.25	9.73
Final weight (g)	1518.05^{b}	1558.51^{ab}	1531.12^{b}	1672.99^{a}	22.87
Total weight gain (g)	977.55^{b}	1016.26^{b}	986.37^{b}	1139.74^{a}	21.20
Average daily gain (g)	19.96^{b}	20.74^{b}	20.13^{b}	23.26^{a}	0.43
Total feed intake (g)	3365.94^{b}	3562.74^{a}	3492.90^{a}	3267.75^{c}	20.85
Average daily feed intake (g)	68.69^{b}	72.71^{a}	71.28^{a}	66.69^{c}	0.43
Feed conversion ratio (kg/kg) gain)	3.44^{a}	3.51^{a}	3.54^{a}	2.87^{b}	0.10
Performance index %	44.13^{b}	44.40^{b}	43.25^{b}	58.29^{a}	1.42
Mortality rate %	15^{a}	5^{ab}	0^{b}	0^{b}	2.45
Total feed cost (L.E.)	8.41^{c}	10.51^{a}	9.78^{b}	9.39^{b}	0.10
Feed cost(L.E.)/kg weight gain	8.60^{b}	10.34^{a}	9.92^{a}	8.24^{b}	0.11
Price of total weight gain (L.E.)	19.55^{b}	20.33^{b}	19.73^{b}	22.79^{a}	0.42
Net revenue (L.E.)	11.14^{ab}	9.82^{b}	9.95^{b}	13.40^{a}	0.43

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Table 6: Carcass traits of rabbits in the experimental groups.

Item	Experimental group				MSE
	G1	G2	G3	G4	
Slaughter weight (g)	1520^{ab}	1445^{b}	1613^{a}	1540^{ab}	35
Carcass weight (g)	693^{b}	782^{ab}	913^{a}	836^{ab}	34
Liver (g)	56.00	57.77	59.63	53.33	1.57
Kidneys (g)	12.20	11.97	12.87	12.30	0.61
Heart (g)	7.17	6.93	7.90	5.77	0.43
Lungs (g)	10.40	10.90	11.87	10.70	0.52
Spleen (g)	1.23	1.47	1.20	1.33	0.24
Head (g)	104.03	103.37	96.70	105.80	1.66
Bile (g)	1.23	1.43	1.30	1.30	0.25
Abdominal fat (g)	7.90^{b}	6.47^{b}	12.70^{a}	11.93^{a}	0.43
Shoulder fat (g)	1.20^{d}	1.80^{c}	3.40^{a}	2.80$_{b}$	0.16
Dressing %*	50.58^{b}	59.73^{ab}	61.56^{a}	58.81^{ab}	1.78

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).
* Dressing % = [Weight (g) of carcass + liver + kidneys + heart / preslaughter weight (g)] x 100

Table 7: Physical characteristics and chemical composition of meat for different groups

Item	Experimental group				MSE
	G1	G2	G3	G4	
Physical characteristics:					
pH	5.50	5.56	5.60	5.53	0.03
Color intensity	0.310	0.307	0.313	0.320	0.004
Tenderness (cm)	2.50	2.53	2.60	2.47	0.03
Water holding capacity (cm)	5.83	5.80	5.70	5.73	0.04
Chemical composition:					
Moisture	76.53	76.23	75.57	74.54	0.37
Protein	18.93^{b}	20.05^{ab}	20.41^{ab}	21.29^{a}	0.33
Ether extract	2.79^{a}	1.90^{c}	2.16^{bc}	2.37^{b}	0.37
Ash	1.52	1.57	1.62	1.55	0.03

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

3.5. Carcass traits:

Carcass traits of rabbits in the experimental groups are shown in Table (6). Results revealed significant (P<0.05) differences in slaughter and carcass weights among groups. Rabbits in G3 showed the highest slaughter and carcass weights (1613 and 913 g, respectively), but G2 had the lowest slaughter weight (1445 g) and G1 had the lowest carcass weight (693 g).

Weights of liver, kidneys, heart, lungs, spleen, head and bile were nearly similar for different groups. However, dietary supplementation of NS oil in G3 or in combination with PS resulted in significant (P<0.05) increase in abdominal fat weight (12.70 and 11.93 g, respectively) and shoulder fat weight (3.40 and 2.80 g, respectively).

Finally, in association with preslaughter weight of rabbits in all groups, rabbits in G3 showed significantly (P<0.05) the highest dressing percentage, followed by G2 and G4, while G1 had the lowest percentage.

3.6. Physical characteristics of meat:

Results in Table (7) showed that the differences in physical characteristics of rabbit meat including pH value, color, tenderness and water holding capacity were not significant among the experimental groups. These findings indicated that dietary supplementation of PS, NS or their combination had no effect on characteristics of rabbit meat because pH value represents a key role in the maintenance of the meat quality during storage and depends on the balance of muscle energy metabolism.

3.7. Chemical composition of meat:

Chemical composition of meat (Table 7) showed that moisture and ash contents were nearly similar for all groups. However, there were significant differences (P<0.05) in the contents of protein and ether extract in meat among the different groups. in this respect, G4 showed significantly (P<0.05) the highest protein content (21.29%), followed by G2 and G3, while G1 had the lowest content (18.93%). While, ether extract content was significantly (P<0.05) the highest in G1 (2.79%) and the lowest content (1.90%) in G2.

4. Discussion

The results of nutrients digestibility coefficients and nutritive values of this study agreed with those obtained by Ferreira *et al*. (2011) who found that soybean oil additive for growing rabbit had no effect on the coefficients of digestibility of DM, OM, CP and GE.

Results of cecal activity indicated that dietary supplementation of PS, NS or their combination improved the microbial fermentation by increasing utilizing ammonia nitrogen and FVAs and reducing pH values as compared to the control diet. Cecal pH value is one of the most important factors which affect bacterial fermentation. Cecal pH value depends on many factors such as the amount and composition of the diet. Fluctuations in pH value reflect the changes of organic acids accumulated in the ingesta.

In rabbits, the use of organic acids appears interesting, even though scientific data concerning their effect on microflora population, mucosal immunity and growth performance are few and often contradictory (Falcao - e - Cunra *et al*., 2007). The mode of action of these products (PS or NS) on caecal microflora is not also completely understood, although it is demonstrated that organic acids play a direct action on the bacterial cell integrity (Maertens *et al*., 2006).

The obtained haematological and biochemical parameters of rabbits in this study are nearly similar to those reported by several authors who analyzed the blood profile of young rabbits (Olayemi and Nottidge, 2007; Archetti *et al*., 2008).

Based on the present study, dietary supplementation of PS, NS or their combination had no adversely effects on the health status of growing rabbits. Differential white cell counts were typical and comparable to the findings of Archetti *et al*. (2008). Also, Miraghaee *et al.* (2011) reported that count of RBC and WBC were not affected by diet supplemented with NS.

In accordance with the present results, Hassan *et al.* (2007) and Al-Beitawi *et al.* (2009) recorded that *N. sativa* significantly decreased serum levels of total cholesterol and triglycerides. Also, Hajati *et al*. (2011) and Miraghaee *et al*. (2011) found that PS oil supplementation in broiler chicken diet decreased cholesterol and triglycerides concentrations in plasma and serum.

The results of growth performance agreed with those obtained by Abou El-Soud (2000), who found that feed conversion was better for quails receiving diet supplemented with NS seeds. Also, Miraghaee *et al.* (2011) showed that supplementing 1% of NS improved feed conversion ratio of broilers. However, Nworgu (2007) reported that birds served fluted pumpkin leaf extract stimulate feed intake.

In agreement with the present results, Abou-Egla *et al*. (2001) reported that mortality was lower in quails feed diets containing NS meal. Hajati *et al.* (2011) found that PS oil supplementation decreased mortality rate of birds.

These results agreed with those obtained by Nworgu (2007), who reported that the cost of feed out of the total cost of production was least for birds served fluted pumpkin leaf extract unlike control. He added that the net profit and cost of feed per kilogram live weight gain were higher for the birds served fluted pumpkin leaf extract compared to control.

Results of carcass traits agreed with the results of Fernandez and Fraga (1996), who reported that the

increase in slaughter weight improved all the desirable carcass characteristics measured and increased fat depots.

The pH of meat determines the environmental microbial balance, because of the bacteriostatic effect of low pH on meat (Dalle Zotte, 2002).

Also, pH value of meat affects many its properties such as water holding capacity, muscle fat content and carcass color (brightness). Losses of water in meat decreases pH value, because of the muscle proteins are closer to the isolelectric point which results in a lower hydration level (Dalle Zotte *et al.* 1995).

Meat color is one of most parameters which are strictly related to pH value, influencing muscle texture and the oxidation of haempigments. At high pH levels, oxymyoglobin is rapidly turned into reduced myoglobin with dark red color (Ouhayoun and Dalle Zotte, 1993). It is known, that meat lightness increases with muscle myofibrillar protein shrinkage, which is itself negatively correlated to pH value, e.g. the lower pH, the higher lightness (Dalle Zotte and Ouhayoun, 1998).

Generally, values of meat composition are within those obtained by Pla *et al*. (2004), who found that meat of rabbits had 70-76% moisture, 18-22% protein and 1.5-3% fat. Also, Baiomy and Hassanien (2011) reported that rabbit meat had high protein and low fat contents.

Conclusion

Based on the foregoing results, it could be concluded that rabbits fed diets supplemented with combination of pumpkin and black seeds oils (2.5 and 2.5 g/kg diet) showed the best results concerning digestibility coefficients, cecal fermentation, blood parameters, body weight gain, feed conversion, economic efficiency and carcass traits in addition to the lowest mortality rate.

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1/25/2014