Effect of diet supplemented with pumpkin (*Cucurbita moschata*) and black seed (*Nigella sativa*) oils on performance of rabbits: 2- Productive and reproductive performance of does and their offspring.

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ABSTRACT

Thirty six New Zealand white (NZW) doe rabbits with initial body weight of 1445.2±39.4 g and aged 12 weeks were used in a complete randomized design experiment with four dietary treatments. Does were fed commercial diet without additive (control, G1), or supplemented with 5 g pumpkin seed (PS) oil/kg diet (G2), 5 g black seed (BS) oil/kg (G3), 2.5 g PS oil plus 2.5 g BS oil/kg (G4). Rabbit does in G4 showed the highest ($P<0.05$) body weight (BW) and average daily gain at the different age intervals, followed by those in G2 and G3, while does in G1 had the lowest weights. Does in G4 showed significantly ($P<0.05$) the highest values of BW at mating and parturition, the 1st service conception rate and the lowest number of services per conception, followed by those in G2 and G3, while does in G1 had the poorest values. Does in G2, G3 and G4 increased average daily milk yield (as overall for the suckling period) by 9.57, 20.00 and 27.63% compared with G1, respectively. Milk of does in G4 showed significantly ($P<0.05$) the highest percentages of fat, protein, lactose, total solids and solids not fat, followed by milk of does in G2 and G3, while milk of G1 had the lowest percentages. In blood serum of does, G4 showed significantly ($P<0.05$) the highest concentrations of total protein and globulin, while those in G2 showed significantly ($P<0.05$) the highest albumin and glucose concentrations. Does in G1 showed significantly ($P<0.05$) the highest total lipids, triglycerides, total cholesterol, HDL and LDL concentrations. Activity of AST and ALT was not affected by supplementation. The concentrations of prolactin and thyroxine (T4) hormones were higher in G4, while triiodothyroninehormone (T3) was higher in G3. The concentrations of IgG and IgM in serum of both does and their offspring were the highest in G4 as compared to other groups, but the differences were not significant. Does in G3 showed the highest litter size at birth, but those in G4 showed the highest ($P<0.05$) litter size at 7, 14, 21 and 28 days of suckling period. Bunnies of G1 showed the highest ($P<0.05$) mortality rate, followed by those in G2 and G3, while G4 had the lowest rate. Does in G2 showed the heaviest ($P<0.05$) litter weight at

birth, while G4 had the highest litter weight at 28 days of suckling period. Bunnies of G3 and G4 recorded the heaviest ($P<0.05$) litter weight gain for the whole suckling period. Bunnies in G2 showed significantly ($P<0.05$) the highest BW and weight gain during the different suckling periods, while the lowest weight gain was recorded for bunnies in G1. Pumpkin and black seeds oils supplementation improved economic efficiency of does and their offspring, which net revenue of G2, G3 and G4 increased by 9.77, 25.23 and 34.75% compared with G1, respectively. Doe rabbits fed diet supplemented with a combination of pumpkin and black seeds oils (2.5 g PS oil plus 2.5 g BS oil/kg) and their offspring showed the best results.

Keywords: NZW rabbits, pumpkin, black seed, reproduction, offspring growth.

INTRODUCTION

Rabbits can play a sigificant role in solving the problem of meat shortage in many parts of the world, due to their high potential for reproduction, rapid growth rate, short generation interval, ample nutritional spectrum, limited vital space and ease of rearing. However, pre- and post-weaning mortality until marketing limits the crope of rabbits in kilograms and a lower income would be obtained **(Rashwan and Marai, 2000).**

Eight fatty acids (99.5%) and thirty-two compounds (86.7%) have been identified in the fixed and volatile oils of *Nigella sativa* seeds, 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%) **(Nickavar *et al.*, 2003).** The use of diet supplemented with *nigella sativa* seed oil improved growth performance, feed conversion efficiency and immune response of chickens (**Omar *et al.*, 2002**). Also, oral *Nigella sativa* L. treatment might decrease the diabetes-induced disturbances of heart rate and some haematological parameters of alloxan-induced diabetic rabbits (**Meral *et al.*, 2004**).

In pumpkin seed (PS) oil, 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 and52.69% linoleic acid (**Alfawaz, 2004**). Up to 60.8% of PS oil is from the fatty acids, oleic (up to 46.9%), linolenic (up to 40.5%), palmitic and stearic (up to 17.4%), the ratio of monounsaturated to

polyunsaturated acids from 0.60 to 0.75 g **(Nakiae *et al.*, 2006).** The dietary supplementation with 5 g kg^{-1} DM from PS oil 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.

The objective of this study was to investigate the effect of pumpkin and black seeds oil on growth performance, milk yield and composition, blood parameters, immune response, and reproductive performance of doe rabbits as well as growth performance and immune response of their offspring during the suckling period.

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.

Thirty six NZW rabbits with initial body weight of 1445.2±39.4 g and aged 12 weeks were used in a complete randomized design with four dietary treatment groups. Rabbits were fed commercial growing diet without additive (control, G1), or supplemented with 5 g PS oil/kg (G2), 5 g BS oil/kg (G3), 2.5 g PS oil plus 2.5 g BS oil/kg (G4). Rabbits were fed commercial rabbit diet to cover their requirements according to **NRC (1977).** The formulation and chemical composition of commercial rabbit is shown in Table (1). Chemical analysis of diet was determined according to **AOAC (1995).**

Table (1): Ingredients and chemical composition of the control diet.

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

Rabbits were housed separately in individual wired cages (30×50×30 cm) and arranged in double tier batteries allocated in two rows till insemination. After insemination, rabbits were placed again in individual cages (50×60×35 cm) of galvanized wire net and arranged in double tier batteries allocated in two rows. Nest boxes (30×25×30 cm) were attached to the front sides of the cages five days prior to kindling and removed at 28 d of lactation (weaning age). The bucks were housed in individual cages as that of females, but without nest boxes. All cages were equipped with feeders (made of galvanized steel sheets) and nipples (automatic drinkers). The system provided animals with fresh water all over the experimental period. Rabbits in all treatment groups were kept under similar managerial system and environmental conditions.

Doe rabbits were individually weighed at the beginning of the experiment and at weekly intervals during the experimental period. Does were naturally inseminated using four NZW bucks rabbit fed the control diet. Pregnancy diagnosis was done by palpation at 10-12 days post-mating and does failed to conceive post 1st mating were reinseminated and number of services per conception was calculated. During the suckling period, milk yield was determined by the differences in LBW before and after suckling and milk composition was determined using milko-scan (Model 133 B).

Post-kindling, litter size and weight were recorded for each group at birth and at weekly intervals up to weaning at 28 days. Feed intake and weight gain during pregnancy and lactation and kindling rate of does as well as litter size and weights, stillbirths and mortality rate of bunnies were also recorded.

Blood samples were taken from does at 20 weeks of age and at 28 days of suckling period from does and their offspring. Blood samples were taken from the ear vein into clean sterile tubes. Blood samples were let to coagulate and centrifuged at 3500 rpm for 15 minutes and serum was separated and stored at 20 °C till assay. Concentrations of total protein, albumin, globulin (by difference), glucose, total cholesterol, HDL-cholesterol, LDL-cholestrol (by difference), triglycerides, total lipids and activity of aspartate aminotransferase (AST), alanine aminotransferase (ALT) as well as prolactin, T3 and T4 (one sample from each group) were determined in blood serum using spectrophotometer (Spectronic 21 DUSA) and commercial kits (Combination, Pasteur Lap.). Also, concentration of

immunoglobulins (IgG and IgM) was determined in serum of does and offspring using rabbit immunoglobulin M Elsa Kits.

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 level among means.

RESULTS AND DISCUSSIONS

Growth performance of does:

Averages of live body weight (LBW), daily gain (ADG) and total feed intake of does are presented in Table (2). Does in G4 showed significantly (P<0.05) the highest LBW and ADG at each age interval as compared to other groups versus the lowest values in G1. However, the differences in total feed intake were not significant. These results agreed with those obtained by **Awadalla and Kamal (2000)**, who found that addition of BS oil to the diet of rabbit improved growth performance. Also, **Miraghaee *et al.* (2011)** showed that supplementing 1% *Nigella sativa* improved ADG of broilers. Moreover, **Nworgu (2007)** reported that ADG of broiler chickens was significantly (P<0.05) different, which was least in control as compared to birds served fluted pumpkin leaf extract.

Table (2): Live body weight and average daily gain of does rabbit at different age interval.

Age (week)	Experimental group				MSE
	G1	G2	G3	G4	
Body weight (g)					
12	1283.60^{b}	1455.00^{ab}	1450.00^{ab}	1592.10^{a}	39.44
16	1785.40^{c}	1980.80^{bc}	2021.80^{ab}	2191.80^{a}	42.64
20	2237.00^{c}	2454.00^{b}	2536.40^{ab}	2731.50^{a}	48.28
24	2658.50^{c}	2895.70^{b}	3016.70^{ab}	3235.20^{a}	55.21
Average daily gain (g)					
12-16	17.92^{c}	18.78^{bc}	20.42^{ab}	21.42^{a}	0.46
16-20	16.13^{c}	16.90^{bc}	18.38^{ab}	19.27^{a}	0.41
20-24	15.05^{c}	15.77^{bc}	17.15^{ab}	17.99^{a}	0.38
12-24	16.37^{c}	17.15^{bc}	18.65^{ab}	19.56^{a}	0.42
Total feed intake (kg)	13.59	13.60	13.67	12.99	0.19

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

Reproductive performance of does:

Reproductive traits of doe rabbit are shown in Table (3). Results showed that does in G4 showed significantly (P<0.05) the highest LBW at mating and kindling, 1st service conception

rate (CR) and the lowest number of services per conception, followed by those in G2 and G3, while G1 had the poorest values.

However, gestation period length was nearly similar for all treatment groups, ranging from 31.3 to 32.0 days. The improvement of reproductive traits with dietary supplementation with PS and BS oils may be attributed to increasing their contents of unsaturated fatty acids mainly oleic and linoleic acids **(Nickavar *et al.*, 2003; Alfawaz, 2004)**.

Table (3): Reproductive traits of doe rabbit in experimental groups.

Age (week)	Experimental group				MSE
	G1	G2	G3	G4	
No. of does	9	9	9	9	
LBW at mating (g)	2711.70^{c}	2953.60^{b}	3077.10^{ab}	3299.90^{a}	56.31
LBW at kindling (g)	2791.40^{c}	3040.40^{b}	3167.60^{ab}	3397.00^{a}	57.97
Conception rate %					
1st service	66.67^{b}	77.78^{ab}	77.78^{ab}	88.89^{a}	6.93
2nd service	22.22^{a}	22.22^{a}	22.22^{a}	11.11^{b}	2.69
3rd service	11.11^{a}	0.00^{b}	0.00^{b}	0.00^{b}	1.50
No. service /conception	1.44^{a}	1.22^{ab}	1.22^{ab}	1.11^{b}	0.08
Gestation period (day)	32.00	31.43	31.71	31.29	0.17

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

Milk yield and composition:

Results in Table (4) showed that does in G4 recorded significantly (P<0.05) the highest average daily milk yield (ADMY) at different suckling intervals, followed by those in G2 and G3, while G1 had the lowest yield. Overall mean of daily milk yield during the suckling period significantly (P<0.05) increased by 9.57, 20.00 and 27.63% for G2, G3 and G4 compared with G1, respectively.

The significant enhancement in milk production was observed in goats fed diet supplemented with BS seeds (**Vihan and Panwar, 1987**). Lactating goats rations supplemented with garlic, cinnamon or ginger oils, significantly increased (P<0.05) milk yield (**Kholif *et al.*, 2012**). Also, **Pascual *et al.* (2003)** reported that during lactation, milk production was greater in animal fat and vegetable oil groups.

Generally, **Rashwan (1998)** working with doe rabbits, reported that milk production was improved as a results to supplementing doe diet with 12 g fenugreek or aniseed/kg diet. Improvement of nutrition (by using feed additives, antibiotics,

green fodder or natural sources) increase rabbit doe milk **(Rashwan and Marai, 2000).**

It is of interest to note that ADMY in all treatment groups increased gradually up to 21 days and decreased at 28 days of suckling period thereafter (Table 4). Similar trend of changes in milk yield of rabbits was observed by **Omara *et al.* (2004).**

Table (4): Average daily milk yield (g/day) of does rabbit at different suckling intervals.

Suckling period (day)	Experimental group				MSE
	G1	G2	G3	G4	
1	73.57^{b}	88.57^{ab}	98.57^{a}	100.71^{a}	6.57
7	88.57^{c}	105.00^{b}	117.86^{a}	122.14^{a}	7.57
14	149.29^{b}	151.43^{b}	168.57^{a}	170.71^{a}	9.59
21	159.29^{c}	178.57^{b}	182.86^{b}	212.86^{a}	12.03
28	118.57^{b}	122.14^{b}	139.29^{a}	145.71^{a}	7.11
Overall mean	117.86^{c}	129.14^{b}	141.43^{ab}	150.43^{a}	8.35

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

Milk composition of does including the percentages of fat, protein, lactose, total solids (TS), solids not fat (SNF) and ash are presented in Table (5). Results showed that diet of does in G4 significantly (P<0.05) improved milk composition in terms of the highest percentage of fat, protein, lactose, TS and SNF in milk. Does in G2 and G3 ranked the 2nd and 3rd groups, while G1 had the lowest percentages. However, ash percentage was not affected by supplementation. It is of interest to note that milk composition showed an opposite trend to milk yield. These results agreed with those obtained by **Kowalska (2008),** who indicated that fat milk increased from 18.4 to 22.2% in female rabbits receiving 3% fish oil compared to the control group. **Kholif *et al.* (2012)** found that garlic, cinnamon and ginger oils significantly increased (P<0.05) milk yield, protein and solids not fat contents compared with the control. **Santos *et al.* (2010)** reported that milk lactose percent was increased by essential oils supplementation.

Table (5): Milk composition of doe rabbits at different suckling periods.

Suckling period (day)	Experimental group				MSE
	G1	G2	G3	G4	
Fat (%):					
1	16.63^{b}	17.33^{ab}	17.83^{ab}	18.33^{a}	0.26
7	14.97^{b}	15.60^{ab}	16.05^{ab}	16.50^{a}	0.24
14	14.47^{b}	15.08^{ab}	15.52^{ab}	15.95^{a}	0.23
21	14.14^{b}	14.73^{ab}	15.16^{ab}	15.58^{a}	0.22
28	14.64^{b}	15.25^{ab}	15.69^{ab}	16.13^{a}	0.23
Protein (%):					
1	20.67^{b}	21.83^{ab}	22.17^{ab}	23.77^{a}	0.46
7	16.87^{c}	17.60^{bc}	18.93^{ab}	19.77^{a}	0.48
14	16.50^{b}	17.13^{ab}	17.77^{ab}	18.80^{a}	0.35
21	15.90^{b}	17.00^{ab}	17.70^{a}	18.67^{a}	0.39
28	17.47^{b}	18.53^{ab}	18.73^{ab}	19.67^{a}	0.32
Lactose (%):					
1	2.06^{b}	2.18^{ab}	2.20^{ab}	2.38^{a}	0.05
7	1.76^{b}	1.78^{ab}	1.81^{ab}	1.88^{a}	0.02
14	1.52^{c}	1.62^{bc}	1.72^{ab}	1.88^{a}	0.05
21	1.41^{c}	1.58^{bc}	1.64^{ab}	1.84^{a}	0.05
28	1.72^{b}	1.78^{b}	1.82^{ab}	1.98^{a}	0.04
Total solids (%):					
1	41.41^{b}	43.42^{ab}	44.30^{ab}	46.60^{a}	0.62
7	35.35^{c}	36.75^{bc}	38.58^{ab}	39.95^{a}	0.65
14	34.17^{c}	35.53^{bc}	36.73^{ab}	38.37^{a}	0.55
21	33.09^{c}	34.97^{bc}	36.19^{ab}	37.79^{a}	0.50
28	35.54^{c}	37.29^{b}	38.00^{ab}	39.56^{a}	0.54
Solids not fat (%):					
1	24.77^{c}	26.08^{b}	26.47^{b}	28.27^{a}	0.49
7	20.38^{b}	21.15^{ab}	22.53^{ab}	23.45^{a}	0.49
14	19.70^{b}	20.45^{ab}	21.21^{ab}	22.41^{a}	0.44
21	18.95^{b}	20.24^{ab}	21.03^{ab}	22.21^{a}	0.36
28	20.90^{b}	22.04^{ab}	22.31^{ab}	23.43^{a}	0.34
Ash (%):					
1	2.05	2.07	2.10	2.12	0.03
7	1.75	1.76	1.79	1.80	0.03
14	1.68	1.70	1.72	1.74	0.03
21	1.64	1.66	1.69	1.70	0.03
28	1.71	1.73	1.75	1.77	0.03

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

Blood parameters:

Blood serum parameters of does shown in Table (6) revealed significant differences ($P<0.05$) in the concentrations of total protein (TP), albumin (AL), globulin (GL), glucose, total lipids (TL), triglycerides (TG), total cholesterol (TC), HDL and LDL. Does in G4 showed significantly ($P<0.05$) the highest concentration of TP and GL, while the highest AL concentration was detected significantly ($P<0.05$) in G2. Does in G2 showed

significantly (P<0.05) the highest glucose concentration, while does in G1 showed significantly (P<0.05) the highest TL, TG, TC, HDL and LDL concentrations.

Activity of AST and ALT was nearly similar in different groups. Concentration of prolactin was insignificantly the highest in G4 and its level in different groups confirmed the differences in milk yield (Table 4). However, the differences in concentration of T3 and T4 were not significant (Table 6). These results agreed with those obtained by **Hassan *et al.* (2007)** and **Al-Beitawi *et al.* (2009),** who recorded that *N. sativa* significantly decreased serum levels of TC and TG. Also, **Hajati *et al.* (2011)** and **Miraghaee *et al.* (2011)** found that dietary PS oil supplementation decreased TC and TG concentration in plasma and serum of broilers. Moreover, **Sayed *et al.* (2007)** found that T3 concentration in blood serum of Bouscat-doe rabbit increased with fenugreek and aniseed additive.

Table (6): Blood serum parameters of does in different groups.

Item	Experimental group				MSE
	G1	G2	G3	G4	
At 20 week of age:					
Total protein (g/dl)	6.92^{b}	7.72^{a}	6.76^{b}	7.99^{a}	0.33
Albumin (g/dl)	3.17^{ab}	3.51^{a}	3.35^{ab}	3.06^{b}	0.12
Globulin (g/dl)	3.75^{c}	4.21^{b}	4.07^{bc}	4.93^{a}	0.25
Glucose (g/dl)	47.75^{c}	63.48^{a}	57.74^{b}	59.50^{ab}	3.13
Total lipids (mg/dl)	282.87^{a}	261.77^{ab}	269.30^{ab}	248.59^{b}	19.22
Triglycerides (mg/dl)	40.80^{a}	38.67^{ab}	36.80^{ab}	35.87^{b}	2.58
Total cholesterol (mg/dl)	53.26^{a}	45.94^{ab}	43.06^{b}	43.04^{b}	4.07
HDL (mg/dl)	41.93^{a}	36.15^{ab}	34.12^{ab}	33.11^{b}	3.26
LDL (mg/dl)	11.33^{a}	9.78^{ab}	8.94^{b}	9.33^{ab}	1.31
Activity of AST (IU/ml)	38.42	38.37	37.09	38.41	0.47
Activity of ALT (IU/ml)	25.69	25.07	24.62	25.17	0.44
At 28 day of suckling period:					
Prolactin (ng/ml)	5.37	5.48	6.15	6.46	
T3 (nmol/l)	1.12	1.96	2.23	1.29	
T4 (nmol/l)	15.35	17.12	31.69	60.77	

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

Immune response of does and produced bunnies:

Immunoglobulin (IgG and IgM) concentration in blood serum of does and their offspring at 28 days of suckling period are presented in Table (7). Concentrations of IgG and IgM in serum of both does and their offspring were higher in G4, followed by G2 and G3, while they were lower in G1, but the differences were not significant. Concentrations of both IgG and IgM increased in serum of offspring than of does. Concentrations of

both IgG and IgM in serum of does was associated with globulin concentration in serum of does in all groups (Table 6). These results agreed with those obtained by **Khattab *et al.* (2011),** who found that plasma immunoglobulin concentration of suckling buffalo calves was increased with supplementing 5 ml/head/day of BS oil.

Table (7): Immunoglobulin concentration in blood serum of does and their offspring for the different groups at 28 days of suckling period.

Item	Experimental group			
	G1	G2	G3	G4
Does				
IgG (ng/ml)	823	847	888	924
IgM (ng/ml)	328	422	455	589
Offspring				
IgG (ng/ml)	977	1013	1023	1140
IgM (ng/ml)	387	433	478	605

Litter performance:

Results in Table (8) showed significant differences ($P<0.05$) in litter size and mortality rate of bunnies among groups during different suckling intervals. Does in G3 showed significantly ($P<0.05$) the highest litter size (LS) at birth, while those in G4 showed significantly ($P<0.05$) the highest LS ($P<0.05$) at 7, 14, 21 and 28 days of the suckling period. Concerning the variations in mortality rate of bunnies among different groups, G1 showed significantly ($P<0.05$) the highest mortality rate, followed by G2 and G3, while G4 had the lowest rate. Mortality rate of young rabbit during suckling period decreased with increasing milk yield (Table 4) as well as with increasing immunoglobulin concentration in serum (Table 7). Mortality rate of young rabbits is of vital importance in commercial rabbit farming, since it determines the net income of the rabbitries. **Rashwan (1998)** working with doe rabbits, reported that pre-weaning mortality was decreased as a results of supplementing doe diet with 12 g fenugreek or aniseed/kg diet. The increase of pre-weaning mortality associated the increase in litter size at birth and reduction of remating interval period, although doe milk yield appeared to be the most important factor in this respect. Thus, all factors which may decrease doe rabbit milk (nutrition, management of the rabbitry, climatic conditions and doe diseases), increase pre-weaning mortality **(Rashwan and Marai, 2000).** The high mortality of young rabbits among primiparous rabbits was due to relatively low milk production.

For this reason, the lower mortality of young rabbits may be due to higher fat content of milk rather than from the higher milk yield **(Kowalska, 2008).** Also, **Sayed *et al.* (2007)** found improvement in LS at 8 week after parturition to supplement the diet of Bouscat does and their offspring with a mixture of fenugreek and aniseed at the level of 0.5%.

Table (8): Litter size/doe and mortality rate (%) in different groups during suckling period.

Age (day)	Experimental group				MSE
	G1	G2	G3	G4	
Litter size:					
1	7.14^{ab}	6.71^{b}	7.57^{a}	7.29^{ab}	0.26
7	6.29^{b}	6.29^{b}	6.86^{ab}	7.29^{a}	0.25
14	6.29^{b}	6.00^{b}	6.86^{ab}	7.29^{a}	0.27
21	5.86^{b}	5.86^{b}	6.71^{a}	7.00^{a}	0.27
28	5.57^{b}	5.43^{b}	6.29^{a}	6.43^{a}	0.31
Mortality rate (%):					
1-7	11.90^{a}	5.16^{c}	7.76^{b}	0.00^{d}	2.43
8-14	0.00^{b}	3.57^{a}	0.00^{b}	0.00^{b}	0.89
15-21	5.95^{a}	1.59^{c}	1.43^{c}	3.57^{b}	1.40
21-28	4.76^{b}	7.14^{a}	4.90^{b}	8.16^{a}	2.15
1-28	22.62^{a}	17.46^{b}	14.08^{bc}	11.73^{c}	3.66

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

Litter weight (LW) and their gain in different groups are shown in Table (9). Litter weight at birth was significantly (P<0.05) the highest in G2, while G4 had the highest LW at 28 days of age. Litter weight at birth was significantly (P<0.05) the lowest in G3, while G1 had the lowest (P<0.05) LW thereafter until weaning. During the whole suckling period, G3 and G4 recorded significantly (P<0.05) the highest LW gain, followed by G2, while G1 had the lowest gain. These results agreed with those obtained by **Rashwan (1998),** who working with doe rabbits, reported that litter gain upon weaning improved as a results of supplementing doe diet with 12 g fenugreek or aniseed/kg diet. Also, **Pascual *et al.* (2003)** reported that growth of the litter during lactation was greater in group supplemented with animal fat and vegetable oil. **Sayed *et al.* (2007)** found improve litter weight at 8 week after parturition to supplementing the diet of Bouscat-doe and their offspring with a mixture of fenugreek and aniseed.

Table (9): Litter weight and weight gain in different groups during suckling period.

Age (day)	Experimental group				MSE
	G1	G2	G3	G4	
Litter weight (g):					
1	474.71^{ab}	535.86^{a}	437.43^{b}	461.43^{ab}	25.06
7	853.57^{c}	930.00^{a}	881.43^{b}	866.43^{bc}	48.95
14	1505.70^{c}	1508.60^{c}	1564.30^{b}	1597.90^{a}	74.12
21	1890.70^{c}	2038.60^{b}	2176.40^{ab}	2251.40^{a}	93.66
28	2319.30^{c}	2755.70^{b}	2845.50^{ab}	2912.90^{a}	101.39
Litter weight gain (g):					
1-7	378.86^{b}	394.14^{ab}	444.00^{a}	405.00^{ab}	48.20
8-14	652.14^{b}	578.57^{c}	682.86^{ab}	731.43^{a}	57.13
15-21	385.00^{c}	530.00^{b}	612.14^{ab}	653.57^{a}	62.22
21-28	428.57^{c}	717.14^{a}	669.10^{b}	661.50^{b}	55.34
1-28	1844.60^{c}	2219.90^{b}	2408.07^{a}	2451.47^{a}	104.68

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

Growth performance of bunnies of different groups:

Data in Table (10) showed that bunnies of G2 were significantly (P<0.05) the heaviest weights and gains at different times of the suckling period, and this trend may be attributed to the lower litter size of does in this group. These results agreed with those obtained by **Kowalska (2008)**, who found that fat supplemented diets increased rabbit kid weight at birth, 21 days and 35 days of age.

Economic efficiency:

Results in Table (11) showed that feed cost was nearly similar for the different groups. The highest total weight gain (TWG) of does, price of total weight gain (PTWG) of does, litter weight (LW) at weaning, price of litter weight (PLW) at weaning, total revenue (TR) and net revenue (NR) were found in G4, however the lowest values were detected in G1 (P<0,05). The net revenue improvement (NRI) for G2, G3 and G4 were 9.77, 25.23 and 34.75%, respectively compared with G1. These results agreed with those obtained by **El-Diahy (2004)** who found that palm oil supplementation of Friesian cows improved economic efficiency.

Table (10): Average live body weight and gain of bunnies produced by does in different groups during suckling period.

Age (day)	Experimental group				MSE
	G1	G2	G3	G4	
Bunnies weight (g):					
1	66.32^{b}	83.52^{a}	59.18^{c}	63.24^{bc}	4.20
7	138.72^{ab}	149.66^{a}	127.66^{bc}	120.51^{c}	7.02
14	241.76^{ab}	253.69^{a}	231.81^{bc}	222.95^{c}	10.90
21	324.20^{b}	352.20^{a}	328.70^{b}	322.16^{b}	10.27
28	433.70^{c}	518.22^{a}	452.38^{b}	453.02^{b}	18.46
Bunnies weight gain (g):					
1-7	72.40^{a}	66.14^{a}	68.48^{a}	57.28^{b}	6.53
8-14	103.04	104.04	104.15	102.44	9.12
15-21	82.44^{b}	98.50^{a}	96.89^{a}	99.20^{a}	7.61
21-28	109.51^{b}	166.03^{a}	123.68^{ab}	130.86^{ab}	16.07
1-28	367.38^{c}	434.70^{a}	393.20^{b}	389.78^{b}	17.39

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

Table (11): Economic efficiency for the different groups.

Item	Experimental group				MSE
	G1	G2	G3	G4	
Total feed intake (kg)	13.59	13.60	13.67	12.99	0.19
Feed cost (LE)	33.98	33.99	34.16	32.47	0.49
Oil additives (g)	0.00	67.99	68.33	64.95	
Oil cost (LE)	0.00	6.12	4.10	4.87	
Total feed cost (LE)	33.98^{b}	40.11^{a}	38.26^{a}	37.34^{a}	0.67
TWG of does (LE)	1374.90^{c}	1440.70^{bc}	1566.70^{ab}	1643.10^{a}	34.92
PTWG of does (LE)	27.50^{c}	28.81^{bc}	31.33^{ab}	32.86^{a}	0.70
LW at weaning (LE)	2319.30^{c}	2755.70^{b}	2845.50^{ab}	2912.90^{a}	101.39
PLW (LE)	46.39^{c}	55.11^{b}	56.91^{ab}	58.26^{a}	2.03
TR (LE)	73.89^{c}	83.92^{b}	88.24^{ab}	91.12^{a}	2.31
NR (LE)	39.91^{c}	43.81^{bc}	49.98^{ab}	53.78^{a}	2.11
NRI %	0.00^{d}	9.77^{c}	25.23^{b}	34.75^{a}	5.50

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).
Price of one kg commercial rabbit diet = 2.5 LE, pumpkin seeds oil = 90 LE, black seeds oil = 60 LE and live body weight = 20 LE.

Conclusion:

Based on the foregoing results, it could be concluded that doe rabbits fed diet supplemented with a combination of pumpkin and black seeds oils (2.5 g PS oil plus 2.5 g BS oil/kg) showed the best results concerning growth performance, milk yield and composition, blood parameters, immune response, and reproductive performance of does as well as the best results regarding litter size and weight, mortality rate and growth performance of their offspring and economic efficiency.

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تأثير اضافة زيوت بذور اليقطين وحبة البركة فى العليقة على أداء الأرانب. ٢- الأداء الإنتاجى والتناسلى للأمهات ونتاجها

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استخدم فى هذه الدراسة ٣٦ أنثى أرنب نيوزيلندى متوسط وزنها ١٤٤٥،٢±٣٩،٤ جم وعمر ١٢ أسبوع فى التصميم كامل العشوائية وقسمت الى ٤ مجموعات متماثلة. غذيت الأرانب على عليقة الأرانب التجارية بدون اضافة (مجموعة المقارنة، ج١) أو مع اضافة ٥ جم زيت بذور اليقطين/كجم عليقة (ج٢)، ٥ جم زيت حبة البركة/كجم عليقة (ج٣)، ٢،٥ جم زيت بذور اليقطين + ٢،٥ جم زيت حبة البركة /كجم عليقة (ج٤).

توضح النتائج أن أمهات الأرانب فى المجموعة الرابعة أظهرت معنويا عند مستوى ٠،٠٥ أعلى وزن للجسم ومتوسط الزيادة اليومية فى الوزن فى مراحل العمر المختلفة تلتها المجموعتين الثانية والثالثة، بينما كانت أقل الأوزان فى أمهات المجموعة الأولى. كذلك حققت أمهات المجموعة الرابعة معنويا عند مستوى ٠،٠٥ أعلى وزن عند التلقيح والولادة وأعلى معدل

اخصاب للتلقيحة الأولى وأقل عدد من التلقيحات لحدوث الاخصاب تلتها المجموعتين الثانية والثالثة، بينما أظهرت أمهات المجموعة الأولى أقل القيم.

زيادة متوسط إنتاج اللبن اليومى مع اضافة زيت بذور اليقطين وحبة البركة، حيث زاد المتوسط العام لإنتاج اللبن فى المجموعات الثانية، الثالثة والرابعة (كمتوسط عام خلال فترة الرضاعة) بمقدار ٩،٥٧،٢٠،٠٠ و ٢٧،٦٣% مقارنة بالمجموعة الأولى على التوالى. أظهر لبن أمهات المجموعة الرابعة معنويا عند مستوى ٠،٠٥ أعلى نسب مئوية لكل من الدهن، البروتين، اللاكتوز، الجوامد الصلبة الكلية والجوامد الصلبة اللادهنية تلاها لبن أمهات المجموعتين الثانية والثالثة، بينما كانت أقل النسب فى لبن أمهات المجموعة الأولى.

وجد في سيرم دم الأمهات أعلى تركيز للبروتينات الكلية والجلوبيولين فى المجموعة الرابعة والألبيومين والجلوكوز فى المجموعة الثانية. بينما أظهرت المجموعة الأولى أعلى تركيزات للبيدات الكلية، الجليسريدات الثلاثية، الكوليسترول الكلى، الكوليسترول العالى والمنخفض الكثافة. ارتفاع تركيز هرمونات البرولاكتين والثيروكسين (T4) في المجموعة الرابعة وهرمون تراى أيودوثيرونين (T3) في المجموعة الثالثة. ارتفاع تركيز لجلوبيولينات المناعة (IgG and IgM) في سيرم الامهات ونتاجها في المجموعة الرابعة بالمقارنة بالمجموعات الأخرى ولكن الاختلافات كانت غير معنوية.

سجلت المجموعة الثالثة أعلى عدد للخلفات عند الولادة، بينما سجلت المجموعة الرابعة أعلى عدد للخلفات عند الأيام ٧، ١٤، ٢١، ٢٨ من فترة الرضاعة. أظهرت أرانب مجموعة المقارنة معنويا عند مستوى ٠،٠٥ أعلى معدل نفوق تلاها المجموعتين الثانية والثالثة، بينما كان أقل نفوق في المجموعة الرابعة. حققت المجموعة الثانية أعلى وزن للخلفات عند الميلاد، بينما وجد في المجموعة الرابعة أعلى وزن للخلفات عند ٢٨ يوم من فترة الرضاعة. ارتفاع الزيادة في وزن الخلفات فى المجموعتين الثالثة والرابعة خلال فترة الرضاعة. أظهرت خلفات المجموعة الثانية أعلى وزن للجسم وزيادة في الوزن خلال فترة الرضاعة، بينما أقل زيادة في الوزن كانت في خلفات المجموعة الأولى. أدت اضافة زيوت بذور اليقطين وحبة البركة الى تحسن الكفاءة الاقتصادية، حيث زاد العائد الصافى فى المجموعات الثانية، الثالثة والرابعة بمقدار ٩،٧٧، ٢٥،٢٣ و ٣٤،٧٥% مقارنة بالمجموعة الأولى على التوالى.

من هذه النتائج نستخلص أن أمهات الأرانب المغذاة على العليقة المضاف اليها مخلوط زيوت بذور اليقطين وحبة البركة (٢،٥ جم زيت بذور اليقطين + ٢،٥ جم زيت حبة البركة) أظهرت أفضل النتائج بخصوص أداء النمو، انتاج اللبن وتركيبه، مكونات الدم، الاستجابة المناعية وأداء التناسل للأمهات وكذلك أفضل النتائج بخصوص عدد ووزن الخلفات، معدل النفوق وأداء المنو لنتاجها والكفاءة الاقتصادية.