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Growth Performance of Rabbits Fed Olive Pulp in North Sinai

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ABSTRACT

Olive pulp has high nutritive value and is available in large quantities in North Sinai. The present research was designed to study the effects of partial replacement of barley grains by olive pulp in the diets of growing rabbits on their performance. Forty eight weaned New Zealand White male rabbits (1160.62±19.7 g body weight) were divided into 4 similar groups. They were assigned to receive four treatments in which olive pulp (without nucleolus) replaced 0, 20, 25 or 30% barley grains. Their effects on nutritive values, growth performance and economical efficiency were studied during 56 days. Carcass traits and blood metabolites were determined by slaughtering 3 rabbits from each group at the end of the growth trial. The digestibility of organic matter, crude protein, crude fiber and nitrogen free extract significantly ($p<0.05$) decreased with increasing olive pulp level. Nutritive value of the diets in terms of digestible crude protein, total digestible nutrients and nitrogen balance were not significantly affected by olive pulp inclusion. Final body weight and daily weight gain along with carcass traits, carcass weight, dressing percentage, head and liver weights were not significantly ($p<0.05$) affected by olive pulp inclusion. Serum total protein, albumin, globulin, glucose, cholesterol, urea-N, Glutamic-oxaloacetic Transaminase (GOT) and Glutamic-pyruvic Transaminase (GPT) were insignificantly ($p<0.05$) affected with olive pulp inclusion. Rabbits fed diets containing olive pulp recorded lower feed costs to produce one kg gain. Accordingly, olive pulp without nucleolus could be used successively and safely in feeding growing rabbits up to 25% without adverse effects on performance and carcass traits.

Key words: Rabbits, olive pulp, feed utilization, growth, carcass quality, blood metabolites, economical efficiency

INTRODUCTION

The rapid increase in human population in Egypt necessitates a corresponding increase of animal products to provide adequate quantities of animal proteins In Egypt, the shortage of feedstuffs is one of the major limiting factors for increasing animal production. However, there are large quantities of non utilized agriculture by-products such as olive cake. The available feedstuffs cover less than 60% of the total requirements of ruminants (El-Ashry *et al.,* 1996).

From 1000 kg of fresh olives 214 kg olive oil 496 kg crude olive cake, 40 kg of leaves and 1633 kg of olive mill waste are produced (Vlyssides *et al.*, 2004). The olive and olive-derived industries are of an especial importance in the Mediterranean area (Martin Garcia *et al.*, 2003).

A variety of agricultural residues and agro- industrial by products have been used in rabbit feeding (Perez, 1990; Cheeke, 1992). Feeding costs are the most significant expenses in animal production including rabbits and reaches 70% of the total costs of rabbits industry (El-Sayaad, 2002). Incorporation of the cheap untraditional feedstuffs such as the agro-industrial by products in animal diets may participate in solving the problem of feed shortage, decrease the feeding cost and alleviate the pollution problems (El-Kerdawy, 1997; Moustafa *et al*., 2008).

In North Sinai, there is a great shortage in animal feedstuffs, while olive cake represents the majority of agro-industrial by- products. About 35.000 ton of olive fruits are annually produced and about 3000 ton olive cake remain after oil extraction (Information Center of North Sinai Governorate, 2000).

Olive-pulp has been demonstrated by many investigators as an energy source for rabbits (Abd El-Galil, 2001; Abdel-Ghaffar, 2002; Mousa and Abd El-Samee, 2002; Abdel-Samee *et al.,* 2005), sheep and goats (Mousa, 1999, 2000, 2001; Abd-Alla *et al*., 2007; Moic *et al*., 2007; Abdel-Samee *et al*., 2008; Ben Salem and Znaidi, 2008; Molina-Alcaide and Yanez-Ruiz, 2008; Mustafa *et al*., 2009), growing camels (Mohamed *et al*., 1997) lactating buffaloes (Moustafa *et al*., 2008), calves (Gad *et al*., 2008) poultry (Lotfollahian and Hosseini, 2007) and Nile Tilapia (Tonsy *et al*., 2005).

Olive pulp is considered as medium grade with respect to protein content but is high in ether extract. Olive pulp contains from 6.44 to 10.20% crude protein on DM basis (Abd El-Galil, 2001; Rabayaa *et al*., 2001; Mousa, 2001; Abdel-Ghaffar, 2002; Mousa and Abd El-Samee, 2002; Mousa and Shetaewi, 2002; Lotfollahian and Hosseini, 2007; Moic *et al*., 2007; Molina-Alcaide and Yanez-Ruiz, 2008; Moustafa *et al*., 2008). While olive pulp contains from 6.32 to 24.10% ether extract (Salama *et al*., 1993; Abd El-Galil, 2001; Rabayaa *et al*., 2001; Abdel-Ghaffar, 2002; Mousa and Abd El-Samee, 2002; Lotfollahian and Hosseini, 2007; Moic *et al*., 2007; Moustafa *et al*., 2008).

The chemical composition of olive cake varies widely due to the oil extraction process, degree of extraction, year and geographical origin of olives (Moic *et al*., 2007). Production of rabbits has a potential in developing countries to supply cheap and high quality animal proteins within the shortest possible time. Rabbits are of small size, short generation interval, high reproductive potential, rapid growth rates, genetic diversity and ability to utilize forages and by-products as major diet components (El-Basiony *et al*., 2005). Rabbit meat is high in protein of excellent quality and low in total lipids, saturated fatty acids, cholesterol and sodium (Cheeke *et al*., 1987).

In light of these reports, the present study was carried out to investigate the effects of partial substitution of barley grains by olive pulp in growing rabbit's diets on digestibility, nitrogen balance, growth performance, blood biochemical changes, carcass traits and economical efficiency of growing rabbits.

MATERIAL AND METHODS

The present study was carried out at Rabbit Research Farm of Animal Production Department, Faculty of Environmental Agricultural Sciences, El-Arish, Suez Canal University, north Sinai during April to June, 2008.. The climatic characteristic of this region (Long,, 33.75 E., Lat. 31.27 N) is Semi- arid with an average annual rain fall of about 94mm and average ambient temperature of about 20.47°C (from 2000 to 2008) in El-Arish, North Sinai (CLAC, 2008).

Collection and preparation of olive pulp without nucleolus: Raw olive cake was collected from local olive pressing factory. This factory is a semi automatic one. The olive pulp was collected during the olive pressing season then transported to the Rabbit Research Farm. Olive pulp was spread on a plastic sheath for sun- drying. A few days later when the olive pulp was air-dried, separation of seeds started. A 2 mm sieve was used in this process where most of the seeds were removed. Olive pulp obtained by sieving was placed in tight plastic sacs for later use.

Growth performance and feed utilization: The experimental work of this study was carried out to study the effects of partial substitution of barley grains by olive pulp without nucleolus in growing rabbit's diets, on growth performance, feeding value some blood metabolites and carcass traits.

The growth trial lasted for 56 days (April and May, 20.15°C). A total number of 48 weaned New Zealand White male rabbits were weighed (1160.62±19.7 g) and divided into 4 equal treatment groups of 12 rabbits each. They were assigned at random to receive the four experimental treatments. The first group was given a commercial pelleted diet as a control, while groups 2, 3 and 4 were fed diets containing either 20, 25 and 30% olive pulp without nucleolus to substitute 66.67, 83.3 and 100% of the barley in the control diet in diets 2, 3 and 4, respectively.

Ingredients of the experimental diets are presented in Table 1. The rabbits were housed in galvanized with cages of two rabbits each. Cages of commercial type measured (40×40×25 cm) and raised 120 cm from the concrete floor. The cages were provided with feeders and automatic nipple drinkers. Food and water were available *ad libitum*. All rabbits were kept under the same managerial, hygienic and environmental conditions. Individual live body weight and feed consumption throughout the experimental period were weekly recorded. Body weight gain and feed conversion ratio were also calculated.

Carcass traits: At the end of the growth trial, 5 random rabbits from each group were slaughtered and carcass traits were estimated and recorded.

Blood metabolites: Blood samples were collected at slaughtering from each slaughtered animal. Within one hour of collection, the samples were centrifuged at 3000 r.p.m. for 15 min. The serum was separated and stored a-20°C until analysis. Serum total protein, albumin, glucose, cholesterol,

Table 1: Formulation of the experimental diets (% of ingredients on DM basis)

Ingredients %	Control 1	20%OP 2	25% OP 3	30% OP 4
Barley grains	30.00	10.00	5.00	-
Olive pulp without nucleolus	-	20.00	25.00	30.00
Wheat bran	25.00	25.00	25.00	25.00
Soybean meal, 44%OP	15.00	15.00	15.00	15.00
Un-decorticated cottonseed meal	5.00	5.00	5.00	5.00
Clover hay	20.00	20.00	20.00	20.00
Molasses	3.00	3.00	3.00	3.00
Limestone	1.30	1.30	1.30	1.30
Premix*	0.30	0.30	0.30	0.30
Sodium chloride	0.30	0.30	0.30	0.30
Dl-Methionine	0.10	0.10	0.10	0.10
Total	0.00	100.00	100.00	100.00

*One kg premix provided: Vit. A, 2.000.000 IU , D3 150.000 IU, E 8.33 g, Vit. K 0.33 g, Vit. B1 0.33 g, Vit. B2, 1.0 g, Vit: B6, 0.33 g, Vit. B5 8.33 g, Vit. B12, 1.70 mg, Pantothenic acid: 3.33 mg, Biotin: 0.33 g, Folic acid, 0.83 g, choline chloride: 200 g, Zn: 11.7 g, Fe: 12.5 g, Cu: 0.5 g, I: 33.3 mg, Se: 16.6 mg, Mg: 66.7 g and Mn: 5 g urea, creatinine, ALT, or GPT, AST or GOT levels were determined by a colorimeter using commercial kits (Bio-Merieus, Laboratory Reagents and Products, France. The globulin values were obtained by subtracting albumin values from total protein values.

Metabolism trials: At the end of the growth period, a metabolism trial was conducted using 12 male rabbits (3 from each group) with an average live body weight of 2.40±0.02 kg live body weight were used. Rabbits were kept in individual metabolic cages. The digestibility trial consisted of 10 day as a preliminary period followed by 7 days as a collection period. The experimental diets were offered once a day at 8.00 a.m. During the collection period, total daily excreted feces were weighed and dried in an oven at 65°C for 48 h. At the end of the collection period, dried feces of each rabbit were mixed, ground and kept in plastic vials for laboratorial analysis. Total daily urine excreted by each rabbit was collected in a Jar containing 50 mL^{-1} of 20% H_2SO_4 to prevent ammonia loss. Daily samples of 20% were taken from each animal. Samples of feeds, faces and urine were chemically analyzed according to AOAC (1995).

Economical evaluation: The economical efficiency (y) was calculated according to El-Kerdawy (1997) and Mousa and Abd El-Samee (2002).

Statistical analysis: Data were subjected to statistical analysis by the SAS (1996) computer program using the General Linear Models (GLM). The model used was:

$$Yij = \mu + Ti + Eij$$

where, Yij is the observation of ij, μ is the overall mean, Ti is the effect of i (treatments) and Eij is the experimental random error.

Significance among treatment means were tested at 5% level of probability using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition of the ingredients and the experimental rations: The chemical composition of the ingredients used to formulate the experimental rations is presented in Table 2. The CP content of olive pulp without nucleolus used to replace barley grain in the experimental ration (10.2%) was within the normal ranges published by Tortuero *et al.* (1989), Salama *et al.* (1993), Ghazalah and El-Shaat (1994), Ibrahim (1998), Rabayaa *et al.* (2001) and Mousa and Abd El-Samee (2002). However, they were higher than those reported by El-Kerdawy (1997), Mohamed *et al.* (1997), Mousa (1999, 2001), Abd El-Galil (2001), Abdel-Ghaffar (2002), Mousa and Shetaewi (2002), Lotfollahian and Hosseini (2007), Moic *et al.* (2007), Molina-Alcaide and Yanez-Ruiz (2008), Moustafa *et al.* (2008) and Mustafa *et al.* (2009). Such differences may be due to the type of olive, stage of maturity, location and methods of preparation.

The removal of seeds increases the crude protein and decreases crude fiber of the pulp (Rabayaa *et al.*, 2001).

Crude Protein (CP), Ether Extract (EE); Crude Fiber (CF) and ash were higher in olive pulp without nucleolus than barley grains while Nitrogen Free Extract (NFE) was lower than barley grains (Table 2). These results are in agreement with those reported by El-Kerdawy (1997) and Abdel-Ghaffar (2002). The proximate analyses of the consumed experimental rations are also

Table 2: Chemical composition of the ingredients and the experimental diets (% on DM basis)

		Composition of DM					
Ingredients	DM	OM	CP	EE	CF	NFE	Ash
Olive pulp without nucleolus	91.50	93.45	10.20	9.34	19.45	53.96	6.55
Barley grains	90.43	97.52	9.30	1.85	7.10	79.27	2.48
Diet 1	90.15	94.33	16.49	2.37	12.94	62.52	5.67
Diet 2	90.39	93.52	16.66	3.88	15.51	57.47	6.48
Diet 3	90.42	93.38	16.71	4.22	16.15	56.24	6.69
Diet 4	90.47	93.11	16.75	4.60	16.80	54.96	6.89

shown in Table 2. The control ration (T_1) had higher NFE (62.52%) than rations 2, 3 and 4, but lower EE (2.37%) and CF (12.94%) than other rations, because of the higher NFE (79.27%) and lower EE (1,85%) and CF (7.10%) in barley grains than olive pulp. This was a reflection of the varying replacement of barley by olive pulp in rations 3, 3 and 4.. These results are in agreement with those of El-Kerdawy (1997), Abd El-Galil (2001), Fayed *et al.* (2001), Kholif *et al.* (2001), Mostafa *et al.* (2003) and Moustafa *et al.* (2008).

Digestibility coefficients and nutritive values of the experimental diets: Digestibility coefficients of the experimental rations are presented in Table 3. Apparent digestibility coefficients of DM, OM, CP, EE, CF and NFE for the different experimental diets were significantly different ($p<0.05$). The digestibility of CP was significantly ($p<0.05$) higher in rations 1 and 2 (72.53 and 72.03%) than rations 3 and 4 (70.54 and 69.73%), respectively. In addition, CF digestibility of the control ration (40.72%) was significantly ($p<0.05$) reduced to 39.26, 36.62 and 36.64% without significant differences among them as a result of replacing barley grains with olive pulp in rations 2,3 and 4, respectively. These results indicate that the digestibility of both CP and CF olive pulp is less than those of barley grains. These results are in agreement with those of Ben Rayana *et al.* (1994), El-Kerdawy (1997), Mohamed *et al.* (1997), Abd El-Galil (2001), Fayed *et al.* (2001), Abd El-Rahman *et al.* (2003), Mostafa *et al.* (2003) and Moustafa *et al.* (2008). Ben Rayana *et al.* (1994) also reported a significant decrease in CP digestibility coefficient when rabbits were fed on a diet including 11.5% (OP). Moreover, El-Kerdawy (1997), found lower significant differences ($p<0.01$) in the digestibility coefficients of CP and CF when (OP) represented 10 or 15% compared with 0 (control) or 5% diets. Similarly, Abd El-Galil, (2001) reported lower ($p<0.01$) CP and CF digestibility coefficients when OPM represented 20% of the diet compared with 0 (control), 5, 10 or 15% diets.

Henderson (1973) reported that high lipids content in sheep ration inhibit some rumen microbes particularly the cellulolytic bacteria which reduce the CF digestibility. Van Soest (1982) also, indicated that high CF and ADL decrease the ration digestibility.

The digestion coefficient of DM was not significantly affected by dietary inclusion of olive pulp up to 25% of diet while it decreased ($p<0.05$) in rabbits received 30% olive pulp of diet. The same trend was recorded for OM digestibility which decreased by increasing dietary (OP) more than 20% of diet which are reflections of the changes of nutrients digestibilities.

Insignificant differences were observed among ration 1 and 2 in the digestibility coefficients of DM, CP and NFE but they significantly decreased when OP replaced 25 Or 30% of barley grains. However, ration 4 showed the lowest digestibility coefficients for DM, OM, CP, CF and NFE. These results are in agreement with those of Abd El-Galil (2001), Fayed *et al.* (2001), Abd El-Rahman *et al.* (2003), Mostafa *et al.* (2003) and Moustafa *et al.* (2008). They reported that the digestibility coefficients of nutrients were decreased with increasing olive pulp inclusion in the diet.

On the other hand, Aguiliera (1987) reported that the decrease in digestibility of CP and CF may be attributed to the relatively high lignin content of olive pulp and the fact that most of its total nitrogen is linked to lignocelluloses which are the two main factors limiting the digestive utilization of olive residues.

The digestibility of EE was slightly but significantly ($p<0.05$) higher in rations 2 and 3 (78.47 and 78.99%, respectively) compared to the control ration (76.14%). These results are in agreement with those reported by El-Kerdawy (1997). The digestibility of NFE (75.63) was high for ration 1 compared to other ration. These results are in agreement with those reported by Abd El-Galil (2001).

The previous results obtained on nutrients digestibility coefficients are supported by the findings of El-Kerdawy (1997) with rabbits. Also, Tortuero *et al.* (1989) found that digestibility of crude protein, neutral and acid detergent fiber were reduced with 30% olive pulp diet, however no changes were recorded with 10 or 20% OP diets compared with the control.

Ben Rayana *et al.* (1994) reported a significant decrease in CP and CF digestibility coefficients when rabbits were fed diet including 11.5% (OP), however no significant differences were observed with rabbits fed diets included 0 or 23% olive pulp. Also, Ghazalah and El-Shaat (1994) mentioned that digestibility of OM was not significantly affected by dietary inclusion of Olive Kernel Meal (OKM) up to 75% in replacement of barley while it decreased ($p<0.05$) in rabbits received a diet in which OKM completely replaced barley.

It is clear than replacing 100% of the barley by olive pulp lowered the digestible protein. This may be due to the nature of olive pulp crude protein beside its content of some anti-nutritional factors (tannins). These results are parallel to those reported by Youssef *et al.* (2001) and Moustafa *et al.* (2008).

Table 3 illustrates the nutritive values of the experimental diets expressed as TDN, DCP and DE (kcal kg^{-1}). The nutritive value expressed as TDN significantly ($p<0.05$) decreased as olive pulp inclusion rate reached 30% of the diet.

Total digestible nutrients of ration 4 (64.44%) was significantly ($p<0.05$) lower than other rations, ration 1 (68.58), ration 2 (67.88) and ration 3 (67.05). No significant differences in TDN were observed among rations 1, 2 and 3. Similar results were obtained by El-Kerdawy (1997) and Abd El-Galil (2001). Insignificant differences were observed among DCP% of rations 1, 2, 3 and 4. Ghazalah and El-Shaat (1994) also revealed that the feeding values as TDN and DE showed the same trend being decreased ($p<0.05$) by increasing dietary (OKM) more than 50% of barley. Similarly, El-Sayed *et al.* (1996) and Moustafa *et al.* (2008) found that the values of TDN and DCP for the diet contained 25 to 30% of olive pulp were lower than that containing 15 to 20% level of olive cake. Feggeros and Kalaisakres (1987) concluded that the reduction in digestibility and the nutritive value of diets with a high proportion of stoned olive pulp with sheep, may be due to the relatively their higher contents of lignin, cutin and tannins than the normal control diet.

The lowered digestibility and feeding values associated with more OP inclusion might be due to either :(1-) the negative effect of more complex of tannin types in olive cake, (2-) high content of lignin and other poorly digested components (3) fat and its high content of polyunsaturated fatty acids in olive cake (4) most of total nitrogen of olive cake is linked to lignocellulosic compound or (5) the high values of NDF, ADF and ADL (Mostafa *et al.*, 2003; Mustafa *et al.*, 2009).

Table 3: Digestion coefficients and feeding values of the experimental diets

	Levels of olive pulp			
Items	(Control) 0	20%	25%	30%
Digestion coefficient %				
DM%	66.83±0.50^{A}	66.66±0.85^{A}	65.88±0.16^{A}	62.87±0.53^{B}
OM%	71.12±0.49^{A}	70.06±1.15^{AB}	68.28±0.82^{B}	65.13±0.32^{C}
CP%	72.53±0.31^{A}	72.03±0.38^{A}	70.54±0.34^{B}	69.73±0.39^{B}
EE%	76.14±0.30^{B}	78.47±0.50^{A}	78.99±0.44^{A}	77.53±0.62^{AB}
CF%	40.72±0.44^{A}	39.26±0.26^{AB}	36.62±0.48^{B}	36.46±0.73^{B}
NFE%	75.63±0.50^{A}	74.72±0.83^{A}	73.88±0.19^{AB}	70.27±0.041^{B}
Nutritive values %				
TDN	68.58±0.39^{A}	67.88±0.48^{A}	67.05±0.38^{A}	64.44±0.23^{B}
DCP	11.96±0.05	12.00±0.06	11.79±0.06	11.68±0.06
DE (kcal kg^{-1})*	2983.82±10.63	2982.27±20.48	2932.71±4.11	2835.08±9.20

Means in the same row followed by different letters differ significantly ($p<0.054$). *DE (kcal kg^{-1}) = 5.28 (DCP, g kg^{-1}) +9.51 (DEE, g kg^{-1}) +4.2 (DCF + DNFE, g kg^{-1})

Table 4: Nitrogen balance of growing rabbits fed on different levels of olive pulp diets

	Levels of olive pulp meal			
Items	(Control) 0	20%	25%	30%
No. of animals	3	3	3	3
N- intake (g/h/d), NI	2.45±0.14	2.54±0.17	2.45±0.05	2.47±0.05
Fecal -N(g/h/d)	0.68±0.04	0.70±0.06	0.73±0.05	0.79±0.03
Urinary-N(g/h/d)	1.11±0.06	1.09±0.10	1.10±0.05	1.06±0.07
N-balance(g/h/d), NB	0.67±0.04	0.65±0.08	0.63±0.05	0.62±0.02
N-digested(g/h/d), ND	1.77±0.09	1.82±0.09	1.72±0.02	1.68±0.06
NB/NI x 100	27.22±0.91	25.67±2.15	25.63±2.47	25.10±0.04
NB/ND x 100	37.65±1.28	35.80±3.04	36.29±2.76	37.06±2.0

All differences among treatment groups were not significant

Nitrogen balance: The data of N- balance recorded for the four experimental rations are reported in Table 4. In general, all rabbits on the four experimental rations were in positive N-balance. The amounts excreted in the feces were reflected on the CP digestibility coefficients. No significant differences were observed in N-balance among rations 1, 2, 3 and 4. Similar results were obtained by El-Kerdawy (1997).

Growth performance and economical efficiency: Data of growth performance of growing rabbits when fed different levels of olive pulp without nucleolus (0, 20, 25 and 30%) are shown in Table 5. Rabbits fed conventional diet (control group) showed non significant increase final body weight and daily body weight gain in comparison with the other groups 2, 3 and 4.

Final live body weight , total body weight gain, daily body weight gain and feed efficiency (feed/gain) of growing rabbits did not differ significantly due to the difference in olive pulp percentage in the used diets. Similar results were obtained by Tortuero *et al.* (1989), Ben Rayana *et al.* (1994), El-Kerdawy (1997) and Mousa and Abd El-Samee (2002).

Tortuero *et al.* (1989) found no significant differences in body weight gain, feed intake and efficiency of rabbits fed diets which included 10 and 20% olive pulp as substitute of alfalfa meal.

Table 5: Growth performance and economical efficiency of growing rabbits as affected by dietary treatments

Items	Levels of olive pulp meal (Control) 0	20%	25%	30%
Number of rabbits	12	12	12	12
Initial body weight (g)	1176.67±51.79	1176.67±42.35	1140.0±38.24	1154.54±37.7
Final body weight (g)	2213.75±37.05	2128.75±47.52	2124.17±60.04	2105.08±37.02
Total body weight gain (g)	1037.08±58.90	952.08±32.79	984.16±50.39	950. 54±27.93
Daily body weight (g)	18.52±1.13	17.00±0.56	17.57±0.86	15.97±0.46
Daily feed intake (g)	104.87±5.04	104.33±5.01	101.14±4.53	99.78±4.63
Feed cost /kg gain(LE)	9.06	8.22	7.34	7.11
Feed efficiency ratio	5.66	6.13	5.75	5.88
Economic efficiency	175.88	204.0	240.72	251.45
Improvement %	100	115.99	136.87	142.96
Mortality %	-	-	8	-

Differences among treatments were not significant The price of diet 1,2,3 and 4 and olive pulp = 1600, 1340, 1275 and 1210 and 100L.E., respectively and price of one kg of live body weight at selling was 25.00 L.E

The same trend was reported by Ben Rayana *et al.* (1994) who reported non significant differences in daily gain and feed efficiency for rabbits fed diets containing 0, 11.5 or 23% olive cake for seven weeks from 5-11 weeks of age. In this connection, El-Kerdawy (1997) found no significant differences in live body weight and weight gain, feed consumption and feed conversion efficiency rabbits fed control diets which included 5, 10 and 15% olive pulp. The findings were in good agreement with those obtained by Mousa and Abd El-Samee (2002) who observed no significant differences in final weight, daily body weight gain and feed efficiency for rabbits fed diets containing 0, 10 and 20% olive pulp. Also, Rabayaa *et al.* (2001) reported that weight gain of chicks was the same in chicks consuming up to 7.5% of olive pulp, while weight gain of chicks fed the level of 10% olive pulp had the lowest significant ($p<0.05$) weight gain. Similar trends were observed with chicks for feed intake and feed conversion efficiency.

On the other hand, Ghazalah and El-Shaat (1994) reported a significant increase in live body weight and weight gain of rabbits when fed Olive Kernel Meal (OKM) to replace 50% of barley, while it was significantly reduced when (OKM) replaced 75 and 100% of barley. Abd El-Galil (2001) found also that body weight gain of growing rabbits decreased by increasing olive pulp meal level more than 10% during the starter (5-9 weeks of age) and 15% during the finisher (9-13 weeks of age periods).

Moreover, Abdel-Ghaffar (2002) reported a significant ($p<0.05$) increase in live body weight and daily body weight gain for California and New Zealand White growing rabbits during hot summer fed (20% olive pulp) as substitute of barley by 19.60 and 20.30 and 42.6 and 47.1 %, respectively compared with rabbits fed the conventional diet (control). Also, Abd-Alla *et al.* (2007) and Abdel-Samee *et al.* (2008) reported that feeding olive pulp during hot summer season resulted in non significant improvements in growth rate of lambs. While, Moic *et al.* (2007) reported that the high level of olive cake inclusion (30%) decreased ($p<0.01$) daily gain and final weight of lambs.

From the economical point of view, feeding growing rabbits on diets containing 20, 25 and 30% olive pulp decreased the cost of feed per kg gain by 9.30, 19 and 21.5%, while the economic efficiency values were raised with olive pulp supplementation by 15.99, 36.86 and 42.96%, respectively, compared with rabbits fed the commercial diet. The same trend was noticed for the improvement% the values were 100, 116, 137 and 143 , respectively. These findings were in good

Table 6: Carcass traits of growing rabbits fed on olive pulp diets

	Olive pulp levels			
Items	(Control) 0	20%	25%	30%
Pre-slaughter weight (g)	2160.0±57.68	2050.00±45.3	2066.0±47.5	2036.00±68.06
Carcass weight (g)	1388.57±36.04	1322.00±27.25	1322.0±21.62	1326.00±51.71
Dressing	64.31±0.74	64.50±0.60	64.04±0.86	65.11±0.89
Fur weight (g)	395.71±14.69^{A}	346.00±16.43^{B}	350.0±10.61^{B}	340.00±9.35^{B}
Liver weight	62.86±5.63	62.00±8.21	60.0±3.70	57.00±2.23
Kidney weight (g)	20.0±2.04	20.00±0.44	19.0±1.11	19.00±2.09
Empty gut weight (g)	161.43±8.63	164.00±16.04	140.0±7.07	144.00±17.53
Head weight (g)	118.57±5.08	110.33±3.16	114.2±4.1	112.10±3.74

Means bearing different superscripts within the same row are significantly different at p<0.05

agreement with those reported by El-Kerdawy (1997), Rabayaa *et al.* (2001), Mousa and Abd El-Samee (2002) and Abdel-Ghaffar (2002). In this connection, Christodoulou *et al.* (2008) observed insignificant final body weight body weight gain, DM intake or feed conversion for lambs fed diets containing 0, 5, 10 and 15% fermented olive wastes. However these results are in agreement with Mousa (2000, 2001), Fayed *et al.* (2001), Abd El-Rahman *et al.* (2003) and Mostafa *et al.* (2003) who found that the feed cost per kg gain was relatively lower than the control when lambs were fed rations contained 15-35% olive cake. Also, Moustafa *et al.* (2008) found that economical efficiency (price of the 7% fat corrected milk produced/cost of the consumed feed) was lower than the control when Egyptian lactating buffaloes were fed rations containing 10-30% olive pulp.

Carcass traits: Results of carcass traits (Table 6) show that carcass weight, dressing percentage, liver and head weights were insignificantly affected by feeding olive pulp. Pre-slaughter and carcass weights ranged from 2036 to 2160 g and from 1322 to 1388g, respectively being the highest with the control. Dressing percentages ranged within a narrow range from 64.04 to 65.11. Such small variations were reflections of the small differences in weights of kidneys heart and head. Although, fur weight of the fur in the control group was significantly (p<0.05) higher than treated groups yet the magnitude was small to be reflected on dressing. The present results are in agreement with those obtained by Tortuero *et al.* (1989), Ben Rayana *et al.* (1994), El-Kerdawy (1997), Abd El-Naby (1998), Abd El-Galil (2001), Abdel-Ghaffar (2002), Mousa and Abd El-Samee (2002) and Christodoulou *et al.* (2008).

In this connection, Tortuero *et al.* (1989) reported that carcass yield and liver weight were not affected by olive pulp inclusion. Similarly, Ben Rayana *et al.* (1994) observed no significant differences in carcass traits of rabbits fed either control or 11.5% (OP) diets. However, they found significant decrease in carcass traits for those fed diet with 23% (OP). El-Kerdawy (1997) found that carcass weight, giblets weight and dressing percentage did not differ significantly with including up to 15% OPM in rabbit diets. Also, Abd El-Naby (1998) observed no significant differences in dressed, liver, edible giblets organ percentage when rabbits were fed diets containing olive cake meal as a substitute of wheat bran. Abd El-Galil (2001) observed non significant differences in carcass traits of rabbits fed either control or 20% olive pulp meal. Mousa and Abd El-Samee (2002) found that the carcass weight, giblet weight, empty alimentary tract and dressing percentage did not differ significantly with up to 20% olive pulp meal of rabbit diets. Also,

Table 7: Some blood constituents of growing rabbits of the first period as affected by feeding diets containing different levels of olive pulp

	Levels of olive pulp			
Items	(Control) 0	20%	25%	30%
Total protein (g dL^{-1})	7.56±0.30	7.30±0.39	7.18±0.46	6.87±0.18
Albumin (g dL^{-1})	4.18±0.22	3.84±0.18	3.76±0.18	3.99±0.22
Globulin (g dL^{-1})	3.37±0.43	3.46±0.53	3.42±0.35	2.88±0.43
Glucose (mg dL^{-1})	91.67±5.71	97.00±9.30	92.60±4.94	89.71±5.71
Cholesterol (mg dL^{-1})	79.87±11.88	75.27±9.94	72.14±8.98	86.29±11.88
Urea-N (mg dL^{-1})	42.89±4.05	46.84±7.78	42.20±5.52	44.90±8.43
SGOT (μ mL^{-1})	12.00±1.79	17.40±3.25	12.80±3.36	16.67±3.08
SGPT (μ mL^{-1})	17.20±1.87	14.00±2.95	19.17±2.74	17.67±4.40

All the differences among treatment groups were not significant

Abdel-Ghaffar (2002) reported that the carcass, giblet percentage, heart and kidney weight did not differ significantly for California and New Zealand white rabbits fed either control or 20% OPM.

On the other hand, Christodoulou *et al.* (2008) found that fasting body weight cold carcass weight, carcass yield and other carcass yield traits were not affected by feeding diets with increasing fermented olive wastes inclusion for growing lambs. While, Moic *et al.* (2007) reported that the high level of olive cake inclusion (30%) decreased ($p<0.01$) empty carcass weight and ($p<0.05$) dressing percentage of lambs.

Blood constituents: Results in Table 7 indicate that concentration of serum total protein, albumin, globulin, glucose, cholesterol, urea-N, SGOT and SGPT did not differ significantly among the four experimental groups, due to olive pulp feeding. Results indicated that total protein slightly decreased with level of 30% olive pulp. This might be due to the lower digestibility of CP in the ration. Tortuero *et al.* (1989), Ben Rayana *et al.* (1994) and El-Kerdawy (1997), Abd El-Naby (1998), Abd El-Galil (2001), Abdel-Ghaffar (2002), Mousa and Abd El-Samee (2002) did not find significant differences in this respect due to feeding diets including olive pulp at different percentage varying from 5 to 20%. Similarly, El-Kerdawy (1997) reported that levels of total protein, GOT, GPT, and creatinine were not significantly affected by olive pulp inclusion. Also, Mousa and Abd El-Samee, (2002) reported that the concentration of serum globulin, total lipid, glucose, creatinine, GOT and GPT did not differ significantly among the experimental groups due to olive pulp feeding.

On the other hand, these findings were in good agreement with those reported by Mousa (2000) who observed no significant differences in serum concentrations of total protein, albumin, globulin, creatinine, urea-N, SGOT and SGPT by feeding the growing lambs 25% olive pulp. However, blood total lipids and cholesterol significantly ($p<0.05$) increased for growing lambs fed 25% olive pulp than the control group. Differences were also not significant for serum total protein, albumin, globulin, total lipids, cholesterol, creatinine, urea-N, SGOT and SGPT between ewes offered conventional diets (control) and those offered olive pulp 30% (Mousa and Shetaewi, 2002).

CONCLUSION

It could be concluded that olive pulp without nucleolus could be successively and safely included up to 25% (or to replace 83.3% of barley grains of commercial diets) in growing rabbits diets without adversely affecting nutritive value, growth performance, carcass traits and blood constituents under the conditions of North Sinai.

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