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EFFECT OF FEEDING DIETS CONTAINING IRRADIATED OLIVE CAKE ON GROWTH PERFORMANCE OF GROWING RABBITS

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SUMMARY

A total of eighty male New Zealand White (NZW) rabbits weaned at 5 weeks of age, were divided into 4 equal groups (20 rabbits/ group) according to their initial live body weight (~ 740 g), to evaluate the possibility of feeding rabbits on diets containing irradiated (20 or 60 kGy) olive cake (OC) and their response on growth performance, nutrients digestibility as well as economical efficiency. The growing rabbits were fed the control diet (diet without olive cake), or the diet containing 15 % either non- or irradiated olive cake, at 20 or 60 kGy. Accordingly, a total of 4 experimental diets were used. The experimental diets were formulated to be iso-nitrogenous (~ 17% CP) and iso-caloric (~ 2500 Kcal DE/kg diet). At the end of the experimental period (16 weeks of age), a digestibility trial and coprophagy test were performed to determine the digestibility of feed nutrients and feeding values of the experimental diets. The experimental diets were fed to growing rabbits for 11 weeks post-weaning period. The results revealed that the OC contained 1783 Kcal digestible energy/Kg, 7.35% crude protein, 35.85% crude fiber, 7.48 % ether extract and 8.40% ash. Glucosinolates as hydrocyanic acid (HCN mg/g of sample) in raw and irradiated OC at 20 or 60 kGy of the present study were 5.5, 3.78 and 2.67mg/g, respectively, being reduced by 31.27% or 51.45% respectively compared to the raw OC. The lowest live body weight and body weight gain values, in general, were recorded for rabbits fed the control diet (without olive cake). While, the best values were for 15% dietary OC, either with or without gamma irradiation (20 or 60 kGy) instead of clover hay. Including 15% dietary OC irradiated at 20 kGy scored better body weight and body weight gain values, besides it has no adverse effect on feed intake; while improved feed conversion values insignificantly and performance index almost significantly. There were no adverse effects on nutrients digestibility of un-collared or collared rabbits due to the inclusion of 15% OC, either with or without gamma irradiation (20 or 60 kGy). However, digestibility coefficients of CF, EE and nutritive value as TDN % were improved by all dietary treatments. The results showed that 15% OC, with gamma irradiation at 20 kGy can be used in rabbit diet, to get better net revenue and economical efficiency. The above mentioned results suggested that irradiation processing of OC at 20 kGy can eliminate the harmful effect of its glucosinolates on rabbit performance and achieved better net revenue and economical efficiency.

Keywords: New Zealand White rabbits, olive cake, irradiation, growth performance, digestibility, economical efficiency.

INTRODUCTION

In Egypt, animals suffer from shortage of feeds that are continuously increasing in their costs. At the same time, many thousand tons of wastes are produced yearly from processing of vegetables and fruits (Awad, 1978). Fruit and vegetable by-products from the human food industry may offer inexpensive alternatives to the expensive feedstuffs. Fibers from fruits and vegetables contain several bioactive compounds, flavonoids and carotenoids, which increase their nutritional value in animal feeds. Fruit and vegetable fibers contain a good balance of soluble and insoluble fibers which promotes gastrointestinal health (Saura-Calixto and Larrauri, 1996). These wastes can be used as feedstuffs for rabbits as a partial substitute for the conventional grains and forages or as a primary source.

In the tropical environmental areas, whereas olive is cultivated and olive cake is left after extraction of oil, this by-product is available at a relatively low-price, rich in soluble, non-soluble and total crude protein contents (Latif *et al.*, 1976). The crude olive cake is the residue which remains after the first pressing of the olives through traditional and continuous machines. There is still a small amount of oil in this cake. If not going on for further processing, this cake is often used for heating, for animal feeding or returned to the olive grove as a mulch. Olive pulp is the residual paste which produced if the whole olive seeds are removed from the paste prior to processing. This residual paste has a very high water content and is difficult to store or dispose of.

Cultivation of olive in Egypt has been increased in the newly reclaimed land in the desert during the last three decades. According to the estimate of Agricultural Income of Ministry of Agriculture and Land Reclamation (Agriculture Economics Bull., EAT, 1990), there are 44,457 fedan cultivated with olive in Egypt and produce about 62,242 ton of olive valued 49,792,000 LE. Production of olive oil is the main goal of cultivating the olive accompanied with unwanted residues of olive pulp and cake. The residues of extraction as olive cake or olive pulp are estimated to be 40% of the original quantity (Nefzaoui, 1983). Incorporation of olive cake as an energy source in animal and poultry diets may participate in solving the problem of feed shortage and alleviate the pollution problems (Al-Shanti, 2003). The percentage of olive cake that can be used in animal feeding differed according to variety, degree of maturity of fruits and methods of oil extraction process (Nassar, 2002).

The main target of the present study was to evaluate and improve the utilization of olive cake and the possibility of replacing part of clover hay either treated or untreated with gamma irradiation in rabbit diets.

MATERIALS AND METHODS

The present work was designed and carried out during the period from January to March 2007 at Food Irradiation Research Department, National Center for Radiation Research and Technology (NCRRT), Nasr City, Cairo, Egypt, in co-operation with the Faculty of Agriculture at Moshtohor, Benha University, Egypt. Olive cake was provided

by a private factory of olive squeeze in Al-Salhyia City, Sharkia Governorate, Egypt. Olive cake was sun-air dried for seven days, ground in a hummer mill and then packed in polyethylene bags (1000 gauge, 0.25 mm thickness), and sealed by heat. Each polyethylene bag contained about 2 kg.

Radiation Treatment:

Packed olive cake was subjected at ambient temperature to gamma irradiation from Co-60 source at NCRRT. The irradiation facility used was Egypt's Mega Gamma-1 type "J-6500". The applied doses were 0, 20 and 60 kGy. Radiation dose was calibrated using small pieces of the radiochromic film (McLaughlin *et al.*, 1985), at the time of experimentation. The raw and processed samples were stored at conditioned room (at about 18 °C) until used. The biological evaluation was carried out by executing feeding experiments using diets containing the studied level of olive cake irradiated at 20 and 60 kGy.

Experimental Animals and Diets:

Eighty male New Zealand White (NZW) rabbits weaned at 5 weeks of age were used in this experiment. Rabbits were divided into 4 equal groups (20 rabbits/ group) according to their initial live body weight (~740 g). The experimental period, extended from 5 to16 weeks of age. The growing rabbits were fed the control diet (diet without olive cake), or fed diet containing 15% either non or irradiated olive cake at 20 or 60 kGy. Accordingly, a total of 4 experimental diets were used in this study. The experimental diets were formulated to be iso-nitrogenous (~ 17% CP) and iso-caloric (~ 2500 Kcal DE/Kg diet). All diets were pelleted and contained adequate levels of nutrients to satisfy the nutrients requirements of growing rabbits according to Agriculture Ministry Decree (1996). The composition and calculated analysis of the experimental diets are shown in Table (1).

Housing and Feeding System:

Rabbits of each of the four experimental groups were housed individually in galvanized wire batteries (30×35×40 cm) in a well ventilated building (natural through the window) and offered the experimental diets *ad libitum*. Fresh water was available all the time from automatic drinkers with nipples for each cage. Urine and feces dropped from cages on the floor were cleaned every day in the morning. All rabbits were observed daily, kept under the same managerial, hygienic and environmental conditions, and vaccinated against common diseases. All rabbits were individually weighed at the beginning of the experiment, then weekly before offering the morning meal until marketing age (16 weeks of age). Feed intake was weekly recorded during the experimental period. The following parameters were recorded: Live body weight (g), weight gain (g), feed intake (g), feed conversion (g feed/g gain), performance index % (final live body weight (Kg) / feed conversion*100) according to North (1981), viability% and economical efficiency.

Digestibility Trial:

At the end of the experimental period (16 weeks of age), a digestibility trial and coprophagy test were performed to determine the digestibility of feed nutrients and feeding values of the experimental diets. A total number of 24 male rabbits were taken randomly (6 within each treatment, 3 without collar and 3 with collar to prevent coprophagy) and allotted to meet the different treatments. Rabbits were housed individually in metabolic

cage to facilitate the collection of all droppings throughout the digestibility trial. The same feeding regimes used during the feeding trial (5 to16 weeks of age) were also followed during the digestibility trial. Feed intake was daily recorded. Quantitative collection of feces was started 24 hours after offering the daily feed. Feces of each rabbit were collected every day in the morning for a collection period of 7 days, sprayed with sulphuric acid 10% and toluene for trapping any ammonia released, dried at 70°C for 72 hours, finally ground and kept for chemical analysis.

Table (1): Composition and calculated analysis of the experimental diets (as fed).

Ingredients %	Control diet	Olive cake diet
Clover hay (12% CP)	30.00	0.0
Olive cake[1]	0.0	15.00
Yellow corn	21.00	12.57
Barely	2.20	13.50
Soybean meal (44%CP)	18.00	20.00
Wheat bran	22.37	27.00
Wheat straw	-	5.50
Molasses	3.50	3.50
DL-Methionine	0.13	0.13
Vit. & Min. mix.[2]	0.30	0.30
Common salt (NaCl)	0.45	0.45
Dicalcium phosphate	1.70	1.70
Limestone	0.35	0.35
Calculated analysis[3]		
Crude protein (CP), %	16.98	16.93
Ether extract (EE), %	2.64	3.32
Nitrogen free extract (NFE), %	49.18	49.46
Ash, %	5.84	5.45
Organic matter (OM), %	82.16	82.80
Digestible energy, (Kcal/Kg)	2505.30	2500.00
Crude fiber (CF), %	13.36	13.09
NDF, %	47.03	30.18
ADF, %	17.10	15.85
Lignin ,%	3.72	6.55
Calcium, %	1.07	0.934
Total phosphorus, %	0.76	0.76
Methionine, %	0.40	0.37
Lysine, %	0.75	0.85

1-Incoroporated at the same level for those irradiated at 20 and 60 kGy.
2-Supplied per kg. of diet: Vit. A 2000000 IU; Vit. D3 150000 IU; Vit. E 8.33g, Vit. K 0.33g, Vit. B1 0.33g, Vit. B_2 1.0g, Vit. B6 0.33g, Vit. B12 1.7mg, Vit. B_5 8.33g, Pantothenic acid 3.33g, Zn 11.79, Fe 12.5, Cu 0.5g,, Co 1.33mg, Se 16.6 mg, Mg 66.79mg, Niacin 8.33mg, Biotin 33mg, Folic acid 0.83g, Choline chloride 200g,, Mn 5g.
3-According to Feed Composition Tables for Animal and Poultry Feedstuffs Used in Egypt (2001).

Table (2): Chemical composition of olive cake (as fed).

Item	Olive cake			Clover hay[2]
	0 kGy	20 kGy	60 kGy	
Dry matter (DM%)	90.25	90.36	90.50	90.00
Crude protein (CP%)	7.35	7.61	7.07	12.00
Ether extract (EE%)	7.48	7.98	7.60	2.10
Ash (%)	8.40	8.90	8.57	8.80
Organic matter (OM%)	81.85	81.46	81.93	81.20
Nitrogen free extract (NFE%)	31.17	30.62	31.81	37.10
DE (kcal / kg)[1]	1783.00	1802.00	1796.00	1780.00
Crude fiber (CF%)	35.85	35.25	35.45	30.00
Neutral detergent fiber(NDF%)[1]	62.60	24.08	23.62	56.00
Acid detergent fiber (ADF%)	43.12	9.76	7.85	40.00
Lignin (ADL%)	29.80	4.10	5.51	8.20
Cellulose (%)[1]	13.32	5.66	2.34	32.50
Hemicellulose (%)[1]	19.48	14.32	15.77	16.00

1- Calculated according to Cheeke (1987). DE (Kcal/g) = 4.36 – 0.0491 (%NDF).
%NDF = 28.924 + 0.657 (%CF). Cellulose= ADF- lignin. Hemicellulose (%) = NDF – ADF
NDF =cellulose + hemicellulose + lignin ADF = cellulose + lignin.
2- According to Feed Composition Tables for Animal and Poultry Feedstuffs Used in Egypt (2001).

Table (3): Total glucosinolates represented as hydrocyanic acid (HCN mg/g of sample) in raw and irradiated olive cake.

Irradiation dose (kGy)	Total glucosinolates (mg g-1)	Destruction (%)
0.0	5.50	0.0
20	3.78	31.27
60	2.67	51.45

The following equation describes the main effects of irradiation treatment on glucosinolates content:
Y = 5.16 - 0.0444 X
Where: Y = predicated content of total glucosinolates (mg/ g). X = the dose level in kGy.

Digestion coefficients of DM, OM, CP, CF, EE and NFE were estimated and nutritive values as digestible crude protein (DCP %) and total digestible nutrients (TDN %) were calculated according to classic formula reported by Cheeke *et al.* (1982).

Economical Efficiency:

Economical efficiency was calculated as the ratio between income (price of weight gain) and cost of feed consumed at the different experimental periods (5-8, 5-12 and 5-16 weeks of age).

Chemical Analysis:

Chemical analysis of representative samples of raw and irradiated olive cake, experimental diets and dried feces were carried out to determine dry matter (DM), crude protein (CP), N x 6.25, ether extract (EE), crude fiber (CF) and ash according to the methods of the AOAC (1998). Nitrogen free extract (NFE) was calculated by difference, i.e., by deducting the sum of the percentages of moisture, CP, EE, CF and ash from 100. Digestible energy (DE) was calculated according to Cheeke *et al.* (1982). The anti-

nutritional factors of olive cake (glucosinolate) content were determined according the procedure of McGhee *et al.* (1965).

Statistical Analysis:

Data were analyzed for all variables using the general linear models procedure to establish the differences between means using SAS software version 9.1 (SAS Institute, 2004). The model used was: $Yij = \mu + Ti + E ij$

Where: Yij = the observation of ij. μ = the overall mean.

Ti = the effect of i (treatments). Eij = the experimental random error.

Data of percentages were subjected to arc-sin transformation to approximate normal distribution before being analyzed. Variables having a significant F- test were compared using Duncan's multiple rang test (Duncan, 1955). All statements of statistical significance were based on probability ($P<0.05$).

RESULTS AND DISCUSSION

Effect of Gamma Irradiation on:

Chemical Composition of Olive Cake:

The nutrients composition of the raw and irradiated samples of olive cake is given in Table (2). The raw olive cake (OC) contained 90.25% DM; 7.35% CP; 7.48% EE; 8.40% ash; 81.85% OM; 31.17% NFE and 35.85% CF. Nearly similar results were obtained by Abo-Baker (2000), Nassar (2002) and Al-Shanti (2003). The chemical composition of OC, in relation to the applied irradiation dose (20 or 60 kGy) revealed that the chemical constituents of olive cake (DM, CP, EE, ash, OM, NFE and CF) were not significantly affected by gamma irradiation up to 60 kGy but NDF, ADF and ADL were significantly affected by gamma irradiation up to 60 kGy. This can be attributed to, that olive cake contained limited amount of water (about 9.75%) which would not be easily influenced to be radiolyzed by irradiation to produce enough free radicals that could induced significant changes in gross composition of these materials. The present results are in good agreement with those of Farag (1998).

Total Glucosinolate Compounds of Olive Cake:

Raw olive cake was found to contain 5.50 mg/g total glucosinolates (as hydrocyanic acid). Regression analysis of glucosinolates content (Table 3) in relation to the applied irradiation dose indicates that there were significant effects of irradiation process on total glucosinolates. The linear effect was significant at ($P<0.038$). The glucosinolates level was reduced by 31.27% or 51.45%, respectively when olive cake received 20 or 60 kGy (Table 3).

Glucosinolates has long been implicated as toxic factors when feeding olive cake meal to rabbit. Also, Johnson and Reuber (1994) and Ali (1997) reported that glucosinolates and their breakdown products (nitrites) have long been implicated as toxic factors when feeding rapeseed meals to poultry. The results exhibited that the antinutritional factors of raw olive cake was found to contain total glucosianolates (5.50mg/g). After irradiation

treatment at dose level 20 or 60 kGy, total glucosianolates had decreased to 3.78 and 2.67, respectively. The marked reduction in glucosianolates content in response to irradiation treatments might be due to the degradation of total glucosianolates. These results are in good agreement with those reported by Farag *et al.*, (2000) and Ali (1997).

Growth Performance:

Data presented in Table (4) showed no significant differences in live body weight, except at 12 and 16 weeks of age and total weight gain, except from 8-12 and 5-12 weeks of age, among the four experimental treatments.

The lowest live body weight and body weight gain values at 16 weeks of age were for rabbits fed the control diet. The rate of 15% olive cake with 20 kGy gamma irradiation in rabbit diets recorded the higher values of final live body weight at 12 and 16 weeks of age and total body weight gain from 8-12, 5-12 and 5-16 weeks of age when compared with the control diet. The previous results indicated that, addition of 15% olive cake with 20 kGy irradiation had in general better live body weight and weight gain values than those fed 15% olive cake with 60 kGy gamma irradiation. These results may be due to that olive cake irradiated at 60 kGy may induce certain changes in the content of unsaturated fatty acids of olive cake that induces lipid peroxidation through the production of free radicals which attack the fatty acid chain primarily at the unsaturated positions. Consequently, the unsaturated fatty acids must undergo a decrease upon irradiation and a corresponding increase in peroxidation products (EL-Niely, 2001 and Osman, 2002). These results are in agreement with those of Tortuero *et al.* (1989), Ben-Rayana *et al.* (1994) and El-Kerdawy (1997).

Feed Intake, Feed Conversion and Performance Index (%):

The effect of 15% olive cake in rabbit diets, as a replacement for all clover hay during the growing period (5 to 16 weeks of age) on feed intake, feed conversion and performance index (%) are presented in Table (4). The inclusion of olive cake had insignificant effect on feed intake when comparing feed intake of rabbits consuming the control diet and those fed the diet containing 15% olive cake without irradiation during all experimental periods. Similar results were observed for feed conversion (Table 4). However, feed intake was slightly higher and feed conversion was somewhat better for rabbits fed the 15% olive cake diet (0 kGy) than for those fed the control diet during most experimental periods.

Results in Table (4) showed that inclusion of olive cake without or with radiation (20 and 60 kGy) in rabbit diets, in general had no adverse effect on feed intake during the experimental periods from 5-16 weeks of age. However, during most experimental periods from 5-16 weeks of age, all levels of olive cake with irradiation, almost decreased, non-significantly, feed intake as compared to the control and olive cake diets without irradiation. Data presented in Table (4) indicated that feed conversion values (feed/gain) were not significantly affected by the treatments through all the experimental periods except at 8-12 and 5-12 weeks of age. However, 15% olive cake (with 20 kGy) had significantly (8-12 and 5-12 weeks of age) and insignificantly (12-16 and 5-16 weeks of age) better feed conversion values than all other treatments. Values of feed intake and feed conversion obtained in this study are within the ranges reported by El-Husseiny *et al.* (1997); Chaabane *et al.* (1997); El-Kerdawy (1997) and Mousa and Abdel-Samee (2002) for rabbits.

Table (4): Effect of the experimental diets on live body weight, weight gain, feed intake, feed conversion (mean± SE) and performance index (%) of rabbits at different ages of the experimental period (5-16 weeks of age).

Item	Control diet	15% Olive cake diets		
		0 kGy	20 kGy	60 kGy
Average live body weight (g)				
5 weeks	737.5±22.46	740.5±22.07	736.5±24.63	748.0±20.34
8 weeks	1125.0±29.75	1097.5±27.16	1073.5±35.05	1105.3±29.88
12 weeks	1570.7^{ab}±48.39	1529.4^{b}±33.05	1644.1^{a}±53.82	1560.6^{ab}±40.02
16 weeks	2205.2^{b}±38.73	2242.9^{ab}±22.99	2356.3^{a}±66.17	2231.2^{ab}±49.67
Average weight gain (g)				
5-8 weeks	387.5±13.50	357.0±8.52	337.0±13.06	357.3±12.71
8-12 weeks	445.7^{b}± 19.46	431.9^{b}±15.06	570.6^{a}±18.15	455.3^{b}±17.19
12-16 weeks	634.5±44.02	713.5±21.87	712.2±27.34	670.6±39.37
5-12 weeks	833.2^{ab}±26.46	788.9^{b}±17.55	907.6^{a}±28.46	812.6^{b}±23.80
5-16 weeks	1467.7±38.27	1502.4±21.71	1619.8±47.39	1483.2±40.51
Average feed intake (g)				
5-8 weeks	1012.5±20.42	1077.7±22.82	1015.6±29.00	1021.6±18.46
8-12 weeks	2284.2±73.32	2230.7±62.07	2138.2±62.74	2252.8±47.51
12-16 weeks	3818.2±101.15	3886.8±98.39	3725.3±133.63	3635.0±92.87
5-12 weeks	3296.7±98.13	3308.4±84.35	3153.8±87.31	3274.4±67.16
5-16 weeks	7114.9±178.27	7195.2±165.30	6879.1±144.61	6909.4±141.05
Average feed conversion (g feed/g gain)				
5-8 weeks	2.61±0.105	3.01±0.072	3.01±0.094	2.85±0.115
8-12 weeks	5.12^{a} ±0.129	5.16^{a}±0.166	3.74^{b}±3.89	4.94^{a}±0.268
12-16 weeks	6.01±0.482	5.44±0.179	5.23±0.233	5.42±0.367
5-12 weeks	3.95^{a} ±0.099	4.19^{a}±0.096	3.47^{b}±0.122	4.02^{a}±0.101
5-16 weeks	4.84±0.182	4.78±0.085	4.24±0.147	4.65±0.111
Average performance index (%)[1]				
5-8 weeks	43.10	36.46	35.66	38.78
8-12 weeks	30.67^{b}	29.63^{b}	43.95^{a}	31.59^{b}
12-16 weeks	36.69	41.22	45.05	41.16
5-12 weeks	39.76^{b}	36.50^{b}	47.38^{a}	38.82^{b}
5-16 weeks	45.56^{b}	46.92^{b}	55.57^{a}	47.98^{b}

a and b means in the same column with different superscripts are significantly (P= 0.05) different.
SE = Standard error.
[1]Calculated according to North (1981): Performance index % = final live body weight (Kg) / feed conversion*100

The inclusion of olive cake as a replacement for all clover hay in rabbit diets had significant effect on performance index at (8-12, 5-12 and 5-16 weeks of age). It is clear that, 15% olive cake (with 20 kGy) in rabbit diets as a replacement for clover hay, significantly increased performance index at (8-12, 5-12 and 5-16 weeks of age) and insignificantly increased performance index of rabbits at 12-16 weeks of age. The previous results indicated that, addition of 15% olive cake with 20 kGy irradiation had in general better performance index values than all other treatments (Table 4). In this concern, Mousa and Abdel-Samee (2002) found that up to 20% olive pulp may be included in the diet of

growing New Zealand White rabbits (5 weeks old) without adverse effects on performance index.

Table (5): Effect of the experimental diets on nutrients digestibility and nutritive values of uncollared and collared rabbits.

Item	Control diet	15% Olive cake diets		
		0 kGy	20 kGy	60 kGy
Uncollared rabbits:				
Digestibility %				
DM	71.12	69.39	71.08	69.76
OM	73.36	72.50	74.57	73.19
CP	82.31	80.79	81.12	82.52
CF	21.09	21.45	27.87	23.19
EE	91.31	93.31	93.89	92.58
NFE	83.48	81.93	83.11	81.71
Nutritive values %				
TDN	71.74	72.40	74.59	73.17
DCP	15.83	15.56	15.57	15.95
Collared rabbits:				
Digestibility %				
DM	70.11	67.94	70.84	69.66
OM	73.10	70.95	73.97	73.09
CP	82.41	76.53	81.30	77.84
CF	25.90	16.82	25.18	21.98
EE	89.92	94.22	91.44	91.23
NFE	81.78	81.97	82.97	83.58
Nutritive values %				
TDN	71.45	70.99	73.92	73.02
DCP	15.85	14.74	15.60	15.04

Digestibility and Nutritive Values:

Digestibility of different nutrients and nutritive values of the experimental diets with un-collared and collared rabbits were determined at the end of the experimental period (at 16 weeks of age). Results in Table (5) cleared that the inclusion of olive cake (15% without irradiation) as a replacement for all clover hay in the control diet had no significant effect on digestibility of all nutrients (DM, OM, CP, CF, EE and NFE%) and nutritive values (TDN and DCP). Similarly, irradiation process (20 or 60 kGy) had no significant effect on either nutrients digestibility or feeding values of the experimental diets. However, it was observed that some parameters were improved by 15% olive cake, with or without irradiation, especially OM, CF, EE and TDN. Nutrients digestibility and feeding values of the experimental diets for uncollared rabbits showed the same trend observed with collarad rabbits for both the effect of replacing all clover hay of the control diet by 15% olive or irradiation at 20 or 60 kGy (Table 5). In this connection, Al-Masri and Gunther (1993) reported that the improvement in nutrients digestibility of olive cake containing diets may be related to fibers of olive cake and also, to irradiation which increased the digestion of

Table (6): Effect of the experimental diets on economical efficiency* and viability rate of rabbits.

Item	Control diet	15% Olive cake diets		
		0 kGy	20 kGy	60 kGy
5-8 weeks of age:				
Price / Kg diet (LE)	0.956	0.859	0.861	0.868
Total feed intake/rabbit (g)	1012.5	1077.7	1015.6	1021.6
Total feed cost/rabbit (LE)	0.968	0.926	0.874	0.887
Total weight gain/rabbit (g)	387.5	357.0	337.0	357.3
Feed cost / Kg gain (LE)	2.50	2.59	2.59	2.48
Total revenue/ rabbit (LE)	4.65	4.28	4.04	4.29
Net revenue/rabbit (LE)	3.68	3.35	3.17	3.40
Economical efficiency (E Ef)	3.80	3.62	3.63	3.83
Relative E Ef%	100	95	96	101
No. of dead rabbits	2	-	-	1
Viability %	90	100	100	95
5-12 weeks of age:				
Price / Kg diet (LE)	0.956	0.859	0.861	0.868
Total feed intake/rabbit (g)	3296.7	3308.4	3153.8	3274.4
Total feed cost/rabbit (LE)	3.15	2.84	2.72	2.84
Total weight gain/rabbit (g)	833.2	788.9	907.6	812.6
Feed cost / Kg gain (LE)	3.78	3.60	3.00	3.49
Total revenue/ rabbit (LE)	10.00	9.47	10.89	9.75
Net revenue/rabbit (LE)	6.85	6.63	8.17	6.91
Economical efficiency (E Ef)	2.17	2.33	3.00	2.43
Relative E Ef%	100	107	138	112
No. of dead rabbits	6	4	3	5
Viability %	70	80	85	75
5-16 weeks of age:				
Price / Kg diet (LE)	0.956	0.859	0.861	0.868
Total feed intake/rabbit (g)	7114.9	7195.2	6879.1	6909.4
Total feed cost/rabbit (LE)	6.80	6.18	5.92	6.00
Total weight gain/rabbit (g)	1467.7	1502.4	1619.8	1483.2
Feed cost / Kg gain (LE)	4.63	4.11	3.65	4.05
Total revenue/ rabbit (LE)	17.61	18.03	19.44	17.80
Net revenue/rabbit (LE)	10.81	11.85	13.52	11.80
Economical efficiency (E Ef)	1.59	1.92	2.28	1.97
Relative E Ef%	100	121	143	124
No. of dead rabbits	7	4	7	6
Viability %	65	80	65	70

* Based on prices of the Egyptian market during the experimental period (2007).

The price of one ton of clover hay (12%CP), yellow corn, barely, soybean meal (44%CP), wheat bran, wheat straw, molasses, methionine, vitamins & minerals mix., salt, lime stone and Di-cal. phosphate were 800, 950, 1800, 1700, 800, 320, 1000, 30000, 2000, 140, 170 and 1250 LE, respectively.

Initial price of rabbit 12 LE.

The prices of one ton untreated olive cake, treated olive cake (20 and 60 KGY) and body weight on selling were 50, (64 and 122) and 12 LE, respectively.

Net revenue / rabbit (LE) = (Total revenue / rabbit (LE)) – (Total feed cost / rabbit (LE)).

Economical efficiency= (Net revenue/rabbit (LE)) / (Total feed cost/rabbit (LE). Feed cost / kg gain= Total feed cost/rabbit (LE) *1000 / Total weight gain/rabbit (g).

Viability% =number of live rabbits at certain interval / initial number of rabbits at the same interval * 100.

organic and dry matter at the dose of 50 kGy. Organic matter digestibility increased ($P<0.05$) for all irradiated agricultural residues, compared with non-irradiated by-products (Al-Masri and Gunther, 1995).

Economical Efficiency and Viability Rate:

The economical efficiency of the present study was calculated based on input-output analysis of the total feeding cost and the prevailing selling price of live body weight gain. The effect of the control diet and diets containing 15% olive cake either raw or irradiated at 20 and 60 kGy on the economical efficiency and viability rate of rabbits are summarized in Table (6). The results showed that 15% dietary olive cake with 20 kGy gave the best economical efficiency, relative economical efficiency and least feed cost/ kg body gain (LE) from 5-12 and 5-16 weeks of age as compared to the control. Also, the 15% dietary olive cake with 20 kGy gave the best viability rate from 5-12 weeks of age, whereas this treatment showed a viability rate similar to that recorded by the control diet from 5-16 weeks of age. These findings are in agreement with those obtained by El-Kerdawy (1997) who found that from the economical point of view, incorporation of growing rabbit diets from (5-13 weeks) of age with 5,10 or 15% olive pulp as a partial substitution of barley decreased feed cost for kg gain by about 9.23, 14.87 and 15.90%. However the economical efficiency values of the diets increased by 13.42, 22.85 and 24.94%, respectively relative to those fed the commercial pelleted diets. Also, Mousa and Abdel-Samee (2002) showed that from the economical point of view, rabbits fed diets containing 10 or 20% olive pulp recorded lower feed cost for one kg gain in weight by about 5.6 and 18.3%, while the economical efficiency values of the diets were raised by 8.05 and 29.03%, respectively, relative to rabbits fed the commercial control diet.

From this study it could be concluded that, irradiation processing of 15% OC at 20 kGy can eliminate the harmful effect of its glucosinolates on rabbit performance and achieved better net revenue and economical efficiency.

REFERENCES

Abo-Baker, Z. Somaya. (2000). Chemical changes induced by radiation in some by-products of oil seeds. Ph.D. Thesis, Biochemistry Department, Fac. of Agric., Ain Shams Univ., Egypt.

Agriculture Economics Bull., EAT (1990). Central Department of Agriculture, Economics, Cairo, Egypt.

Agriculture Ministry Decree (1996). The standard properties for ingredients, feed additives and feed manufactured for animal and poultry. El-Wakaee El-Masria, No. 192 (1997), p. 95. Amirria Press, Cairo, Egypt.

Ali, S.T. (1997). Effect of irradiation of some plant feedstuffs on some nutritive and physiological parameters in chickens. M. Sc. Thesis, Animal Production Dept., Fac. of Agric., Al-Azhar Univ., Egypt.

Al-Masri, M.R. and K.D. Guenther (1993). The effect of gamma irradiation on in vitro digestible energy of some agricultural residues. Atomic Energy Commission. Damascus (Syrian Arab Republic).

Al-Masri, M.R. and K.D. Guenther (1995). The effect of gamma irradiation on in vitro digestible energy of some agricultural residues. Wirtschaftseigene-Futter, 41(1): 61-68.

Al-Shanti, H.A. (2003). Effect of using olive cake or extruded full fat soybean in broiler chicks diets. Egypt. Poult. Sci., 23 (I): 1-13.

Association of Official Methods of Analysis, AOAC (1998). Official methods of analysis. 18th Edition, Revision 1, Published by the AOAC, Washington, D. C., USA

Awad, M.A.A. (1978). Nutritive value of some agro-industrial by-products. M. Sc. Thesis, Fac. Agric., Alex. Univ., Egypt.

Ben-Rayana, A.; R. Bergaoui; M. Ben-Hamouda and C. Kayouli (1994). Olive oil cake incorporation for young rabbit feeding. World Rabbit Science, 2(4): 127-134.

Chaabane, K.; R. Bergaoui and M.B. Hammouda (1997). Use of different olive oil cakes in young rabbit feeding. World Rabbit Science, 5(1): 17-21.

Cheeke, P.R. (1987). Rabbit feeding and nutrition. Academic Press. Orlando, Florida, U. S.A.

Cheeke, P.R.; N. Patton and G.S. Templton (1982). Rabbit Production. 5th Edition. The Interstate Printers and Publishers Inc., Danville. Illinois, USA.

Duncan, D.B. (1955). Multiple ranges and multiple F-Test. Biometrics 11: 42.

El-Husseiny, O.M.; M.A. Hanafy; M.A.H. Radwan and H.M.M. Azouz (1997). Evaluation of traditional and untraditional protein sources in rabbit diets. Egyptian J. Anim. Prod., 34(1): 57-66.

El-Kerdawy, D. M.A. (1997). Olive pulp as a new energy source for growing rabbits. Egyptian J. of Rabbit Sci., 7(1): 1-12

El-Niely, H.F. (2001). Biochemical and nutritional studies on radiation processed peanuts. Ph.D. Thesis, Department of Biochemistry and Nutrition, Women's College, Ain Shams University, Cairo, Egypt.

Farag, M. Diaa El-Din H. (1998). The nutritive value for chicks of full-fat soybeans irradiated at up to 60 kGy. Animal Feed Sci. Tech., 73, 319-328.

Farag, M. Diaa El-Din H., A.S. Nabil and H.M. El-Shennawy (2000). Radiation detoxification of full-fat rapeseed for better health performance of feeding rats. Egypt. J. Rad.Sci, Applic., 13(1): 77-93.

Feed Composition Tables for Animal and Poultry Feedstuff Used in Egypt (2001). Technical bulletin No.1, Central Lab for Feed and Food; Ministry of Agriculture, Egypt.

Johnson, L. and M. Reuber (1994). Efficacy of feeding glucosinolate extracted canola meal to broiler chicks. Poultry Sci., 73: 1542-1551.

Latif, A.; A.G. Salib; G.S. Abdel-Malak and H. Abdel-Gabbar (1976). Bio-chemical studies on olive cakes. Egypt of Food Sci., 4(1-2): 73.

McGhee, J.E; D. Kirk and G.C. Mustakas (1965). Methods for Determining Thioglucosides in Crambe abyssinica. J. the American Oil Chemists' Society ,42,889-891.

Mc Laughlin, W.I.; Chen H. Jia Wenziu and J.C. Humphreys (1985). Response of radiochromic film dosimeter to gamma rays in different atmospheres. Radiat. Phys. Chem., 25: 793-812.

Mousa, M.R.M. and A.M. Abdel-Samee (2002). Effect of olive pulp feeding on the growth performance and some related blood biochemical changes of growing rabbits under semi-arid conditions. Egyptian J. of Rabbit Sci., 12(1): 59-68.

Nassar, M.S.M. (2002). Utilization of some agro-industrial by-products in fattening on the natural ranges in the south of vally. Ph.D. Thesis, Fac. of Agric., Zagazig Univ., Egypt.

Nefzaoui, A. (1983). Etude de Iutilisation des sous-produits de Lolivier en alimenation animale en tumisia. Animal Production and Health Division, FAO, Rome.

North, M.O. (1981). Commercial chicken production manual. 3rd Ed, Avi., publishing company. I.N.C. Westport Connecticut, USA.

Osman, N.N. (2002). Biochemical effects of feeding irradiated high and low fat diet in rabbits. Ph. D. Thesis, Faculty of Science, Ain Shams University.

SAS Institute Inc., (2004). SAS/STAT 9.1 User's Guide. SAS Institute Inc., Cary, NC, USA.

Saura-Calixto, Y. and J.A. Larrauri (1996). Nuevos tipos de fibras dieteticas de alta calidad [New type of high quality dietary fibers]. Rev. Alim. Equip. Technol., 1: 71-74.

Tortuero, F.; J. Rioperez and M.L. Rodriguez (1989). Nutritional value for rabbits of olive pulp and the effects on their visceral organs. Animal-Feed Science and Technology, 25(1-2): 79-87.

تأثير التغذية علي علائق تحتوي علي تفل الزيتون المشبع على أداء الأرانب النامية

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تم توزيع ٨٠ أرنب ذكر نيوزيلندي أبيض مفطومة عند عمر ٥ أسابيع عشوائيا إلي ٤مجموعات (٢٠ أرنب لكل مجموعة) بمتوسط وزن ٧٤٠ جم تقريبا وذلك لدراسة امكانية تغذية الأرانب علي علائق تحتوى علي تفل زيتون غير معامل أو معامل بالأشعاع (٢٠ أو٦٠ كيلو جراى) ومدي تأثير ذلك علي أداء النمو و الهضم للأرانب بالاضافه الي الكفاءة الاقتصادية. تم تكوين العلائق التجريبية بحيث تحتوي علي ١٥% تفل زيتون غير معامل أو معامل بالأشعاع (٢٠ أو٦٠ كيلو جراى) بالإضافه إلي عليقه المقارنه الخاليه من تفل الزيتون (الكنترول) وكانت العلائق الأربع المستخدمه متساوية تقريبا في البروتين (حوالي١٧٪) والطاقة المهضومة (حوالي ٢٥٠٠ كيلو كالورى/ كجم عليقة) بحيث تغطي الاحتياجات الغذائية للأرانب الناميه تبعا لمقررات وزارة الزراعة. وفى نهاية مدة التجربة (عند عمر١٦أسبوع) أجريت تجربة هضم وإختبار للكبروفاجي لتقدير معاملات الهضم والقيمة الغذائية لعلائق التجربة. وقد تم تغذية الأرانب النامية على العلائق التجريبية لمدة ١١ إسبوع بعد الفطام.

أوضحت النتائج أن تفل الزيتون يحتوى علي ١٧٨٣ كيلو كالورى طاقة مهضومة / كجم ٧,٣٥٪ بروتين خام , ٣٥,٨٥٪ الياف خام , ٧,٤٨٪ دهن خام ٨,٤٠٪ رماد ، كما احتوى تفل الزيتون غير المعامل و المعامل (٢٠ أو٦٠ كيلو جراي) على ٥,٥٠ ، ٣,٧٨ ، ٢,٦٧ ملى جرام جلوكوسينولات/ جرام علي التوالي. وقد أدت المعالجة الاشعاعية لتفل الزيتون (٢٠ أو٦٠ كيلو جراي) الى تكسير الجلوكوسينولات بمعدل ٣١,٢٧% ، ٥١,٤٥% على الترتيب. وعموما سجلت عليقة الكنترول أقل قيم لوزن الجسم والزيادة في وزن الجسم, في حين أن العلائق التي إحتوت علي تفل الزيتون سجلت أفضل القيم سواء على حالتها الخام أو بعد معالجتها إشعاعيا , وقد حققت العلائق التي إحتوت علي تفل الزيتون المعامل (٢٠ كيلو جراي) أفضل قيم لوزن الجسم والزيادة في وزن الجسم وكذلك كميه الغذاء المأكول ومعامل التحويل الغذائي ودليل الأداء الإنتاجي (معنويا). كذلك لم يكن هناك تأثير ضار علي معاملات الهضم نتيجة احتواء العلائق علي تفل الزيتون غير المعامل والمعامل بالجرعات ٢٠ أو٦٠ كيلو جراي بل تحسنت معاملات هضم كل من الألياف الخام والدهن الخام وكذلك المركبات الكلية المهضومة مع جميع معاملات تفل الزيتون. كذلك أظهرت النتائج أنه يمكن استخدام تفل الزيتون المعامل بالجرعة ٢٠ كيلو جراي فى علائق الأرانب النامية للحصول علي أفضل كفاءة اقتصادية وصافي ربح مقارنة بالعليقة الكنترول خلال فترات التجربة.

ويخلص من هذة الدراسة أن المعالجة الإشعاعية بجرعة مقدارها ٢٠ كيلو جراى لتفل الزيتون قد أدت الى خفض محتواة من الجلوكوسينولات الضارة وأن إحلاله محل الدريس فى علائق الارانب بمستوي ١٥% لم يكن له أى تأثير ضار على أداء الأرانب فضلا عن تحقيق كفاءة إنتاجية وإقتصادية عالية.