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Evaluation of Using Different Levels and Sources of Oil in Growing Japanese Quail Diets

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Abstract: A total of 750 one day old Japanese quail were randomly divided into ten dietary treatment containing 75 birds each. Each group contained 3 replicates, of 25 qualis. The control diet contained yellow corn as a main source of energy and containing 3% poultry fat (PF), while linseed oil (LO), sunflower oil (sun O) and olive oil (OLO) were incorporating into the other diets; each of witch at a level of 1.5, 2 or 3% of the diet, to replace proportionally on equivalent amount of the poultry fat. The experiment was terminated when birds were 5 weeks old, body weight, weight gain and feed intake were recorded. Feed conversion (kg feed/ kg gain) was calculated. At the end of the experiment carcass characteristics were measured, blood samples were taken to determine some blood plasma constituents and some birds were kept for the digestibility experiments. The economic efficiency values were calculated. The data revealed that, bird fed diets contain different levels (1.5, 2 or 3%) from polyunsaturated fatty acid (PUFA) which found in (LO, Sun O or OLO) recorded the highest ($P<0.05$) body weight, body gain and feed intake, but as a result of increased feed intake the feed conversion was not improved. Replacement of different levels of (LO, Sun O or OLO) from (PF) in control diet of Japanese quail improved the digestibility of all nutrients (OM, CP, EE and NFE) while not affected on CF. No significant effect was recorded on both edible giblets (gizzard, liver and heart) and offals (blood, feather, legs, head and viscera) percentage. It is worthy to not that either LO, Sun O or OLO at the tested levels improved dressing percentage and did not increased the abdominal fat percentage. Blood plasma samples presented an improvement ($P<0.05$) in total protein, albumin and globulin, supplementation of (LO, Sun O or OLO) in different levels (1.5, 2 or 3%) did not affect ($P>0.05$) the triglyceride and HDL but decreased ($P<0.05$) plasma cholesterol values. Quail feed diets containing (LO, Sun O or OLO) in different level, (1.5, 2 or 3%) recorded the higher economic efficiency (expressed as % net revenue/ feed cost compared with control diet.

Key words: Japanese quail % Sunflower oil % Olive oil % Performance carcass

INTRODUCTION

Saturated fatty acids and trans fatty acids cause negative effects on human health, but polyunsaturated fatty acids (PUFA) have a positive effect on human health as regards coronary heart disease [1-4]. Therefore the consumption of unsaturated oils in diet is recommended both to decrease high cholesterol intake and to increase the ratio of polyunsaturated to saturated fatty acids to prevent the development of atherosclerosis [5,6]. Polyunsaturated fatty acids (PUFA) are subject to free-radical reactions leading to lipid peroxidation which is known to play a significant role in the development of cancer, aging, diabetes mellitus, atherosclerosis etc [7-9]. Over the past 20 years many studies and clinical investigations revealed that omega-3 PUFA, particularly eicosapentaenoic (EPA) and decosahexaenoic (DHA) exert beneficial effects on human health. Omega-3 (PUFA) are essential for normal growth and development and play an important role in the prevention and treatment of CHD hypertension, inflammatory, autoimmune disorders and cancer [10-12].

Olive oil was reported to offer a good protection against lipid peroxidation because of its high content of monounsaturated fatty acid (Oleic acid) and vitamin E. Oleic acid is resistant to lipid peroxidation and inhibits it perhaps by chelating free iron [13,14]. Also olive oil has been reported to decease serum cholesterol level and provide a protective effect against the development of atherosclerosis [15].

Vegetable sources such as linseed oils and rapeseed oil, may clearly increase the n-3 FA content in the form of linolenic acid (LNA), the precursor of the whole n-3 family. Several studies with diets mildly rich in LNA have failed to increase the n-3 LC-PUFA content in chicken tissues [16,17].

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Sunflower oil is the most unsaturated oil among widely consumed oil. Sunflower oil is rich in oleic, linoleic and linolenic acids. Therefore, it is easily affected by free radical reactions, which results in the formation of oxidized LDL (O-LDL). This particle has recently been shown to be another significant risk factor for atherosclerosis [18-20].

The purpose of the present study was to investigate the effects of replaced dietary levels of (Linseed oil, sunflower oil and olive oil) in equivalent amount from poultry fat in japanese quail diets on the performance, plasma lipids and cholesterol, digestibility, carcass characteristic and the economic efficiency.

MATERIALS AND METHODS

A total of 750 one-day-old Japanese quail chicks were randomly divided into ten dietary treatment containing 75 birds each. Each group contained 3 replicates of 25 quails. The birds were housed in group cages until 5 weeks of age and fed the following 10 experimental diets. The control diet (T1) contained yellow corn as a main source of energy and containing 3% poultry fat (PF), while linseed oil (LO), sunflower oil and (Sun O) olive (OLO) oil were incorporating into the other diets; each of which at a level of 1.5, 2 or 3% of the diet, to replace proportionally an equivalent amount of poultry fat (T2 to T10).

A digestion experiment was done at the end of the experiment to evaluate the nutrients digestibility of the tested diets. Five adult male birds from each treatment were housed individually and fed on the tested diets. After a 3 day preliminary period a collection period continued for 6 days. Where feed intake was measured and excreta were collected daily. Then excreta were oven dried (70°C/24 h) and ground and representative samples were used for analysis. The chemical analysis of diets and excreta for dry mattes (DM), ether extract (EE), crude protein, crude fiber (CF) and ash were conducted according to AOAC [21]. For calculating CP digestibility, fecal protein was determined according to Jakobsen *et al.* [22].

At the end of the experiment, five unsexed chicks were randomly chosen and slaughtered after 12 h fasting period. The dressing %, giblets %, edible parts % and abdominal fat were recorded.

Blood samples (10 ml) were obtained from wing vein and centrifuged at 3500 rpm for 15 minutes. The plasma produced was frozen at -20° until analysis. Plasma total protein, albumen, triglyceride, cholesterol and HDL were estimated by using commercial kits purchased from Bio-merieux (Motcyl etios charbon mierels Rains france). While globulin was calculated.

Economical efficiency: Cost of one kilogram feed was calculated based on the prices of feed replacement and the control diet.

The feed cost of kg gain was calculated based on the cost of one kilogram feed and feed conversion (kg feed/kg gain) ration. The economic efficiency was expressed as a percent of net revenue/ feed cost.

Statistical analysis: Data were statistically analysis using the general linear model for analysis of variance of SAS [23]. Test of significance for the difference between means of different levels within each classification was done by Duncun's multiple range test [24].

RESULTS AND DISCUSSION

Productive performance: The effect of different oil sources and levels on body weight, body weight gain, feed intake and feed conversion (kg feed/ kg gain) are shown in Table 2. It was observed that the performance parameter showed little difference through out the experiment period. However the increase in weight in grams per bird was higher ($P<0.05$) in quail chicks fed polyunsaturated diets (LO, Sun O and OLO) in different levels during the whole trial period than in quail chicks fed the control diet that only included (PF). Similar results were reported by Lopez-Ferrer *et al.* [25] when diets with higher fish oil (FO) content (as 4% of the added fat, also with a high amount of (PUFA) were compared to a control diet that included tallow (T) only. Therefore, higher feed intake and higher final weights ($P<0.05$) were recorded when a (PUFA) diets were used, but as a result of increased feed in take the feed efficiency was not improved, which is in agreement with those obtained by Zollitsch *et al.* [26]. An increase in the saturation of the diet decreased the weight gain and final weights, although controversial results have been reported elsewhere[16].

Digestibility coefficients: The digestibility coefficients of the different nutrients are presented in Table 3, in general, data obtained, revealed that (LO, Sun O and OLO) supplementation enhanced ($P<0.05$) the digestibility of all nutrients (OM, CP, EE and NFE) while not effected on CF. The highest ($P>0.05$) value of CP digestibility was observed when birds fed dietary 2% OLO and 3% Sun O compared with other experimental diets. However,

Table 1: Composition and calculated analysis of experimental diets:

	Treatments									
		1.5%			2%			3%		
Ingredients	Control	LO	Sun O	OLO	LO	Sun O	OLO	LO	Sun O	OLO
Yellow corn	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
Soybean meal (48%)	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00	36.00
Poultry fat	3.00	1.50	1.50	1.50	1.00	1.00	1.00	0.00	0.00	0.00
Linseed oil	-	1.50	-	-	2.00	-	-	3.00	-	-
Sunflower oil	-	-	1.50	-	-	2.00	-	-	3.00	-
Olive oil	-	-	-	1.50	-	-	2.00	-	-	3.00
Bone meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Vitamins and minerals mixture	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Chemical analysis										
Crude protein (%)	24.30	24.31	24.32	24.32	24.31	24.30	24.32	24.29	24.29	24.31
Crude fiber (%)	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
Ether extract (%)	7.50	7.48	7.45	7.49	7.50	7.49	7.50	7.46	7.49	7.49
Calculated analysis										
Metabolizable energy Kcal/kg	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000.00	3000	3000.00
Calcium	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Methionine and cystine	0.80	0.80	0.80	0.8	0.8	0.80	0.80	0.80	0.8	0.80

* Each 2.5 kg of vitamins and minerals mixture contain: 12000.000 IU vitamin A acetate; 2000.000 IU vitamin D_3; 10.000 mg vitamin E acetate; 2000 mg vitamin K_3; 100 mg vitamin B_1; 4000 mg vitamin B_2; 1500 mg vitamin B_6; 10 mg vitamin B_{12}; 10.000 mg pantothenic acid; 20.000 mg Nicotinic acid; 1000 mg Folic acid; 50 mg Biotin; 500.000 mg chorine; 10.000mg Copper; 1000 mg Iodine; 300.00mg Iron; 55.000 mg Manganese; 55.000 mg Zinc and 100 mg Selenium.

Table 2: Effect of dietary treatments on performance of growing Japanese quails

	Treatments									
		1.5%			2%			3%		
Items	Control	LO	SunO	OLO	LO	SunO	OLO	LO	SunO	OLO
Initial bodyweight	8.66±0.10	8.72±0.10	8.70±0.28	8.72±0.20	8.77±0.31	8.60±0.30	8.70±0.11	8.70±0.37	8.86±0.10	8.70±0.22
Final bodyweight	187.57±1.16^{c}	188.94±0.23^{c}	188.60±1.11^{c}	191.32±0.62^{b}	191.80±1.06^{ab}	193.09±0.80^{ab}	193.59±0.6^{ab}	193.65±1.9^{ab}	193.97±0.46^{a}	194.32±0.44^{a}
Body gain g from 1 to 5 week	178.91±1.16^{d}	180.22±3.98^{dc}	179.90±3.34^{d}	182.08±1.87^{bc}	182.03±3.25^{bc}	184.49±1.80^{ab}	184.89±1.80^{ab}	184.95±3.65^{ab}	185.11±1.38^{ab}	185.62±3.20^{a}
Feed in take (g)	590.40±2.35^{c}	594±3.32^{c}	593±2.51^{c}	600±3.37^{b}	602.16±3.47^{b}	606±3.55^{ab}	609±2.16^{a}	609±4.31^{a}	610±2.5^{a}	610±3.3^{a}
Feed conversion (kg feed/kg gain)	3.30±0.2	3.30±0.09	3.3±0.04	3.27±0.03	3.29±0.07	3.3±0.08	3.29±0.09	3.29±0.2	3.29±0.07	3.29±0.08

Data in the same row under each treatment followed by unlike letters differ significantly (P<0.05)±S.E.

Table 3: Effect of dietary treatments on digestibility coefficient of nutrients for growing Japanese quails

	Treatments									
		1.5%			2%			3%		
Items	Control	LO	Sun O	OLO	LO	Sun O	OLO	LO	SunO	OLO
Organic matter (OM)	75.36±0.32^{c}	76.10±0.41^{bc}	76.22±0.41^{bc}	76.15±0.36^{bc}	76.56±0.44^{ab}	76.60±0.54^{ab}	76.62 0.43^{ab}	76.89±0.37^{ab}	77.00±0.42^{a}	77.20±0.36^{a}
Crud protein (CP)	85.19±0.35^{b}	86.73±0.25^{a}	86.90±0.34^{a}	86.91 0.41^{a}	85.77±0.32^{b}	87.23±0.45^{a}	87.30±0.40^{a}	87.10±0.36^{a}	87.30±0.41^{a}	87.10 0.43^{a}
Ether extract (EE)	66.74±0.19^{c}	70.43±0.66^{b}	70.11±0.36^{b}	70.00±0.62^{b}	71.10±0.43^{ab}	71.15±0.62^{ab}	71.13±0.52^{ab}	72.5±0.41^{a}	72.4±0.42^{a}	72.22±0.31^{a}
Crude fiber (CF)	20.56±0.02	20.31±0.01	20.69±0.05	20.24±0.05	20.16±0.04	20.36±0.05	20.26±0.05	20.88±0.04	20.59±0.07	20.87±0.05
NFE	77.20 +0.85^{b}	78.83 +0.31^{ab}	78.97 +0.34^{ab}	79.83 + 0.32^{a}	79.87 +0.39^{a}	79.30 +0.55^{a}	79.00 +0.84^{a}	79.37 +0.50^{a}	79.47 +0.22^{a}	79.23 +0.23^{a}

Data in the same row under each treatment followed by unlike letters differ significantly (P<0.05)±S.E.

Table 4: Effect of dietary treatments on performance of growing Japanese quails

	Treatments									
		1.5%			2%			3%		
Items	Control	LO	Sun O	OLO	LO	Sun O	OLO	LO	SunO	OLO
Body weights	190.74±0.25	190.18±0.75	190.20±0.66	191.31±0.25	190.45±1.17	189.84±1.60	190.51±1.71	191.31±3.77	190.33±1.04	190.68±2.3
Dressing (%)	73.36±0.05	74.11±0.01^{a}	74.47±0.09^{a}	76.21±0.02^{a}	74.50±0.01^{a}	74.53±0.12^{a}	74.54±0.49^{a}	74.24±0.55^{a}	74.7±0.02^{a}	74.7±0.01^{a}
Edible giblets (%)	5.57±0.37	5.55±0.62	5.49±0.31	5.48±0.15	5.44±0.52	5.32±0.50	5.45±0.31	5.13±0.28	5.20±0.31	5.20±0.41
Offal (%)	7.00±1.72	6.57±0.55	7.21±0.70	6.46±0.55	6.09±0.58	6.89±0.34	6.45±0.10	6.38±0.20	6.19±0.33	6.21±0.28
Abdominal fat	1.18±0.01	1.02±0.01	1.15±0.01	1.20±0.01	1.12±0.01	1.10±0.01	1.12±0.01	10.9±0.01	1.08±0.01	1.10±0.01

Data in the same row under each treatment followed by unlike letters differ significantly (P<0.05)±S.E.

Table 5: Effect of dietary treatments some metabolic function of growing Japanese quails

	Treatments									
		1.5%			2%			3%		
Items	Control	LO	Sun O	OLO	LO	Sun O	OLO	LO	SunO	OLO
Total protein g/100m	3.49±0.05^{c}	3.65±0.04^{bc}	3.67±0.09^{bc}	3.60±0.05^{bc}	3.65±0.8^{bc}	3.75±0.10^{ab}	3.75±0.9^{ab}	3.77±0.07^{ab}	3.75±0.06^{ab}	3.82±0.07^{a}
Globulin g/100m	1.46±0.07^{c}	1.65±0.08^{ab}	1.60±0.07^{b}	1.54±0.3^{b}	1.59±0.05^{b}	1.65±0.06^{ab}	1.75±0.07^{a}	1.68±0.04^{ab}	1.75±0.06^{a}	1.75±0.07^{a}
Albumin g/100m	2.03±0.01^{c}	2.00±0.13^{c}	2.07±0.12^{b}	2.06±0.09^{b}	2.06±0.08^{b}	2.10±0.10^{a}	2.0±0.80^{c}	2.10±0.07^{a}	2.00±0.06^{c}	2.07±0.09^{b}
Triglyceride g/dl	1467±6.54	1450±8.73	1444±6.62	1430±7.21	1450±5.5	1445±6.72	1448±7.72	1470±8.21	1475±9.54	1468±10.31
Cholesterol mg/dl	130.4±0.34^{a}	125.31±0.44^{ab}	124.41±0.53^{ab}	123.21±0.45^{ab}	111.22±0.65^{b}	112.32±0.54^{b}	114.23±0.32^{b}	99.69±0.52^{c}	100.0±0.48^{c}	102±0.52^{c}
HDLmg/dl	37.5±0.35	37.8±0.45	37.74±0.47	37.77±0.44	37.32±0.46	37.73±0.48	37.49±0.37	37.51±0.38	37.61±0.45	37.41±0.43

Data in the same row under each treatment followed by unlike letters differ significantly (P<0.05)±S.E

Table 6: The economical efficiency of the experimental diet (L.E. in 2008)

	Treatments									
		1.5%			2%			3%		
Items	Control	LO	Sun O	OLO	LO	Sun O	OLO	LO	SunO	OLO
Price of 1Kg diet/L.E (a)	2.89	2.64	2.56	2.71	2.69	2.59	2.79	2.79	23.64	2.94
Feed/gain ratio(b)	3.30	3.30	3.30	3.27	3.29	3.30	3.29	3.29	3.29	3.29
Feed cost of 1kg weight gain (a,b)	8.22	8.71	8.45	8.86	8.85	8.55	9.18	9.18	8.69	9.67
Market price of 1kg live weight (c)	17.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Net revenue [(c)-(ab)],L.E.	8.78	11.29	11.55	11.14	11.15	11.45	10.82	10.82	11.31	10.33
Percent of net revenue of feed cost	1.07	1.30	1.37	1.25	1.26	1.34	1.18	1.18	1.30	1.07

L.E. = Egyptian pound

the highest (P>0.05) value of EE and OM digestibility was noticed when birds fed dietary 3% from experimental oil compared with the other levels (1.5 and 2%), the positive effect of these coefficients as affected by adding (LO, Sun O and OLO) supplementation was parlay with the enhancements in body weight, body gain (Table 2) and carcass characteristics (Table 4) and this may give approve to the critical role of these oils in improving growth performance and feed utilization.

Carcass Characteristics: The results of carcass traits of quails are tabulated in Table 4. No significant effect was recorded on both edible giblet (Gizzard, liver and heart) and offals (blood, feather, legs, head and viscera) percentage due to the dietary treatment. It's worthy to note that either LO, Sun O or OLO at the tested levels improved dressing percentage. Increasing levels in the polyunsaturation of the diet did not increased the abdominal fat percentage, as reported by Zollitsch *et al.* [26], who described similar data after using polyunsaturated fatty acids (PUFA) dietary levels ranging from 1.2 to 2.4%, however, we found lower levels (1.1 to 1.2) which could be due to slightly shorter growth period 35 days at slaughtering.

Metabolic Changes: Changes in blood plasma total protein, albumin, globulin, triglycerides, cholesterol and high density lipoprotein (HDL) as affected by different levels of LO, Sun O and OLO are listed in Table 5.

Data showed that replacement of different levels of LO, Sun O and OLO from PF in Japanese quail diet enhanced (P<0.05) plasma total protein, albumin and globulin compared with the control diet.

These results contribute with the improving of performance and digestibility coefficients (Table 2 and 3). This positive improvement of these values may be due to the inclusion of these oils on fatty acids which may affect muscle protein synthesis and protein deposition through a prostaglandin depend mechanism [27].

Inclusion of different levels of experimental oil in the diet did not affect (P>0.05) the triglyceride and HDL but decreased (P<0.05) plasma cholesterol concentration (Table 5). Our finding was similar to that obtained by Van Elswyk *et al.* [28] who demonstrated that dietary fish oil supplementation at a 3.0% inclusion level resulted in a decreased serum cholesterol concentration in hens.

Economic Efficiency: The economic efficiency for quails fed experimental diets during the growth period are summarized in Table 6. The results showed that diet containing sunflower oil at level 1.5% had the best value 137% while the control diet recorded the lowest income due to the lowest marketing price of 1 kg live weight because when (LO, Sun O and OLO) with high content of monounsaturated fatty acids were added to diets monounsaturated fatty acids content in meat increased significantly also decrease serum cholesterol and provide a protective effect against the development of a atherosclerosis (P<0.01) as reported by Ajuyah *et al.* [16] for this reason the marketing price of 1kg live weight of the other quails meat is higher than the control diet.

In general it could be recommended that the use of (PUFA) at levels 1.5, 2 and 3% in Japanese quail diet during the growth period get higher economic efficiency without adverse effects on the performance and improve the physiological parameters.

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