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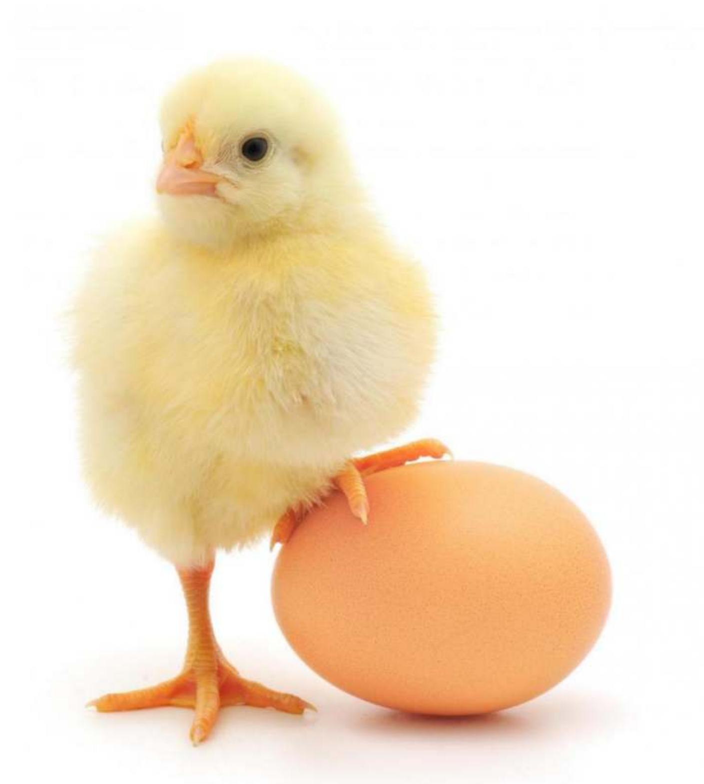

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Effect of Dietary Supplementation with Different Oils on Productive and Reproductive Performance of Quail

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Abstract: To assess the effects of dietary oil source on productive and reproductive traits, sunflower oil, flax oil, corn oil or fish oil were induced in quail diets. One hundred and sixty eight 7 weeks old Japanese quail were randomly assigned to 4 groups (12 males and 30 female each) with 3 replicates per group containing 4 males and 10 females each and fed for 13 weeks (including one week as adaptation period) on a commercial diet supplemented with 3% of sunflower oil (T1), Flax oil (T2), corn oil (T3), or fish oil (T4). The birds received water and feed *ad libitum* during the study. Results of experiment revealed that dietary supplementation with different sources of oil had no significant effect on male body weight, female body weight and feed consumption of quails. Dietary fish oil at the inclusion level of 3% (T4) recorded the best results ($p<0.05$) in regard to egg weight, hen-day egg production, egg mass, cumulative egg production, feed conversion ratio, fertility, hatchability of eggs set, hatchability of fertile eggs and embryonic livability, followed by the results of flax oil (T2), whereas the lowest values for these traits recorded for corn oil (T3) followed by the results of sunflower oil (T1) which recorded the lowest means with relation to characteristics included in this study. However, there was no significant difference between T2 and T3 in respect to feed conversion ratio during the entire period of experiment. In general it can be recommended that use of fish oil (T4) and flax oil (T2) at levels of 3% in Japanese quail diet during the laying period get higher economic efficiency without adverse effects on productive and reproductive performance. Therefore, providing fish oil or flax oil to quail throughout their laying period may be a simple means to enhance reproductive efficiency of these birds.

Key words: Different oil sources, productive and reproductive performance, quail

INTRODUCTION

Oil and fats are usually added to the diet of poultry to enhance the energy density as economic tools of producing energy-rich formulations. It was show that there was different constitution in terms of fatty acids structure, fatty acids contain carbon, oxygen and hydrogen and classified as saturated fatty acids, monounsaturated fatty acids, or polyunsaturated fatty acids. Fats of animals contain especially palmitic acid as a long chain saturated fatty acid except for fish oil. While vegetable oils contain a many quantities of long-chain unsaturated fatty acids. The fat content and the composition of fatty acids in lipids of eggs have been involved in human health (Chow, 1992). Norum (1992) found direct relationship between intake of saturated fatty acids and incidence of cardiovascular diseases. Aydin *et al.* (2006) reported that increasing the ratio of polyunsaturated fatty acids to saturated fatty acid of the diet reduced the plasma concentration of cholesterol, whereas Pappas *et al.* (2005) indicated that there were positive effects from the intake of monounsaturated fatty acids, such as oleic acid (C18:1 n-9) and of n-3 fatty acids on health, with reduced triglycerides concentration in blood. Initially, most efforts were concerned on reducing the cholesterol content of final products and were met with various results (Basmacoglu *et al.*, 2003), but recently, researches has focused on dietary change to modify the fatty acids composition of food. Modifications of the fatty acids composition of the egg yolk may improve the health image of eggs and could enhance their supplementation value. Studies have shown that type of dietary lipids of the laying hen, can drastically change the lipid profile of the egg-yolk (Yang *et al.*, 2000; Grobas *et al.*, 2001). Chekani-Azar *et al.* (2007) reported that marine oils (fish oil and certain marine algae) contain the long chain (C20 and longer) omega 3 fatty acids as being an important factor in the diet is for promote of health in man and animals than other origins. Over the past 20 years many studies and clinical investigations revealed that omega-3 PUFA, particularly Eicosapentaenoic Acid (EPA) and Decosahexaenoic Acid (DHA), which found at great amount in fish oil, exert beneficial effects on human health. Omega-3 (PUFA) are essential for normal growth and development and play important role in the prevention and treatment of CHD hypertension, inflammatory, autoimmune disorders and cancer (El-Yamany *et al.*, 2008). Vegetable sources such as flax

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seed oil may clearly increase the n-3 fatty acid content in the form of linolenic acid, the precursor of the whole n-3 family. Sunflower and corn oil are the most unsaturated oil among widely consumed oil. Sunflower and corn oil are rich in omega-6 fatty acids especially linoleic acid (Baucells *et al.*, 2000). In this study, inclusion of 4 different oil sources that differ in fatty acid profile (Sunflower, flax, corn and fish oil) in laying quail diet at the level of 3% on productive and reproductive performance was examined.

MATERIALS AND METHODS

Birds and treatments: One hundred and sixty eight 7 weeks old Japanese quail (48 males and 120 females) were used in this experiment. Following one week of adaptation period on experimental conditions and treatment diets the quail were weighed to provide an equal live weight in all groups at the beginning of the experiment. They were evenly distributed in 4 treatment groups with three replicates per group containing 4 males and 10 females each. For 13 weeks (including adaptation period) the quail were fed diets containing 3% oil from sunflower, flax, corn, or fish oil. The quail were allowed free access to food and water. The birds were housed in stainless steel wire cages with 7 quail (2 males and 5 females) for each cage. Ingredients and chemical composition of diet were shown in Table 1. However, the fatty acid composition of oils used in this experiment is presented in Table 2. A regime of 17 h constant lighting and continuous ventilation were provided and all birds were kept under uniform management conditions throughout the experimental period.

Productive and reproductive performance: Productive traits involved in this experiment were male body weights, female body weights, feed consumption, egg weight, hen-day egg production, cumulative egg number, egg mass and feed conversion ratio. A total of 120 eggs from each treatment groups at 9, 11, 13 and 15 weeks of age were collected and used to investigate reproduction parameters. Eggs were collected daily over a 7 days period and were randomly inserted into incubator after numbering. Eggs were incubated at a temperature of 37.8^{o}C with 55% relative humidity for 14 days. They were then transferred at random to hatcher trays and were maintained at 37.2^{o}C and 75% relative humidity until hatching. The numbers of hatched chicks were counted after 18 days of incubation and then fertility, hatchability of total eggs, hatchability of fertile eggs and embryonic mortality in the treatment groups were determined.

Statistical analysis: Data were statistically analysis using the general linear model for analysis of variance of SAS (2000). Test of significance for the difference between means of different levels within each classification was done by Duncan's multiple range test (Duncan, 1955).

RESULTS

Productive performance: Body weights of hens and males determined fortnightly are shown in Table 3 and 4. Hens and males body weight was not affected by dietary oil addition through the entire experimental period. The feed consumption was not affected by the oils used in this study, while egg weight, egg production, egg mass and cumulative egg production were higher ($p<0.05$) in T4 (fish oil), followed by T2 (flax oil) than in the remaining groups during the total period of experiment. The cumulative feed consumption was 215.43, 214.37, 202.47 and 201.06 gm for T1, T2, T3 and T4, respectively. However, General means for egg weight were 11.07, 11.29, 11.19 and 11.45 gm, for hen-day egg production 68.97, 77.39, 74.79 and 79.42%, for egg mass 7.63, 8.73, 8.36 and 9.09 gm and for cumulative egg number 9.65, 10.83, 10.47 and 11.11 with relation to T1, T2, T3 and T4, respectively (Table 5, 6, 7, 8 and 9). On the other hand, in this experiment the better ($p<0.05$) feed conversion ratio was obtained from hens receiving diet containing fish oil, whereas there were no significant differences between T2 and T3 and T1 group recorded the worst value as concerns this trait. The general mean of feed conversion ratio were 4.71, 4.08, 4.03 and 3.67 for T1, T2, T3 and T4, respectively (Table 10).

Reproductive performance: Results of this experiment revealed that laying quails fed the rations supplemented with fish oil (T4) excel other groups with relation to fertility, hatchability of total eggs, hatchability of fertile eggs and embryonic mortality during all hatches that done during this experiment. However, flax oil (T2) surpasses T1 and T3 groups and T3 group recorded the lowest means concerning these traits. The general means for these traits were: 81.57, 87.15, 83.96, 90.14%; 75.71, 83.38, 79.4, 88.73%; 87.67, 93.92, 90.91, 97.08%; 12.32, 6.08, 9.09 and 2.92% for T1, T2, T3 and T4, respectively (Table 11).

DISCUSSION

As noticed from Table 3 and 4 there were no significant differences between treatments groups respecting body weights of males and females during total period of experiment and respecting the general mean of these two traits. The absence of the effect of dietary inclusion of different oil sources on the body weights of quails in this experiment confirmed the findings of other researches who found no significant differences for dietary oil sources on body weight of quails (Bozkurt *et al.*, 2008; Guclu *et al.*, 2008) and laying hens (Shafey *et al.*, 2003) and broiler (Newman *et al.*, 2002). The positive results obtained in this experiment when diet of quail

Table 1: Ingredients and chemical composition of the diet fed to quails

Ingredients (%)	Sunflower oil (T1)	Flax oil (T2)	Corn oil (T3)	Fish oil (T4)
Yellow corn	12.00	12.00	8.50	10.00
Wheat	47.70	47.70	51.50	50.00
Soybean meal	20.00	20.00	19.70	19.70
Protein concentrate*	10.00	10.00	10.00	10.00
Lime stone	7.00	7.00	7.00	7 .00
Oil	3.00	3.00	3.00	3.00
Sodium chloride	0.30	0.30	0.30	0.30
Calculated content**				
Crude protein (%)	21.05	21.05	21.10	21.05
Metabolizable energy (Kcal/kg)	2888.00	2879.00	2881.00	2885.00
Total calcium (%)	3.60	3.60	3.60	3.60
Available phosphorus (%)	0.30	0.30	0.30	0.30
Methionine (%)	0.35	0.35	0.34	0.34
Lysine (%)	1.00	1.00	0.99	0.99
Cystine (%)	0.27	0.27	0.27	0.27

*Golden protein concentrate provided per kg: : 2500 ME/kg; 40% crude protein; 9% crude fat; 4.5% crude fiber; 9% calcium; 2.3% available phosphorus; 2.3% lysine; 1.25 methionine; 1.8% methionine + cystine; 100000 IU vit A; 10 mg vit B1; 100 mg vit B12; 20 mg vit K3; 50 mg copper; 700 mg manganese; 2 mg selenium; 200 mg vit E; 0.5 mg biotin; 5 mg folic acid; 200 mg niacin; 80 mg pantothenic acid; 10 mg iodine; 25000IU vit D3; 500 mg iron; 10 mg cobalt; 600 mg zinc; 10 mg vit B6.

**Calculated composition was according to NRC (1994)

Table 2: Fatty acid composition (%) of oils included in the diets of quails

Numeric name	Common name	T1	T2	T3	T4
C12:0	Lauric acid	-	-	-	0.090
C14:0	Myristic acid	0.06	0.12	0.06	5.41
C15:0	None	0.02	0.08	0.03	0.47
C16:0	Palmitic acid	6.25	6.0	11.01	14.05
C17:0	Margaric acid	0.03	0.11	0.09	1.73
C18:0	Stearic acid	3.58	2.5	1.91	2.87
C20:0	Arachidic acid	0.238	0.5	0.36	0.15
C21:0	None	0.008	0.01	0.01	0.04
C22:0	Behenic acid	0.587	0.23	0.15	0.02
C23:0	None	0.028	0.02	0.02	0.06
C24:0	Lignoceric acid	0.203	0.08	0.16	0.15
C14:1	Myristoleic acid	-	-	-	0.03
C15:1	None	0.01	0.01	-	0.19
C16:1	Palmitoleic acid	0.09	0.4	0.13	8.25
C17:1	None	0.04	0.03	0.04	0.36
C18:1 n9	Oleic acid	23.0	19.0	24.0	21.94
C20:1 n9	Gadoleic acid	0.255	0.28	0.36	11.22
C22:1 n9	Erucic acid	0.007	0.01	0.01	7.65
C24:1 n9	Nervonic acid	0.005	0.02	0.12	2.30
C18:3 n3	Alpha linolenic acid	0.108	57.29	1.26	0.50
C20:3 n3	None	0.025	0.05	0.03	0.05
C20:5 n3	Eicosapentenoic acid (EPA)	0.118	0.63	0.09	10
C22:6 n3	Docosahexaenoic acid (DHA)	0.012	0.0	0.02	10.73
C18:2 n6	Linoleic acid	65	12.18	60	1.02
C18:3 n6	Gamma linolenic acid	0.016	0.02	0.06	0.13
C20:2 n6	11, 14-Eicosadienoic acid	0.155	0.08	0.06	0.19
C22:2 n6	13, 16-Docosadienoic acid	0.155	0.003	0.001	0.38
Total of saturated fatty acids		11.0	9.65	13.8	25.04
Total of mono unsaturated fatty acids		23.40	19.75	24.66	51.94
Total of polyunsaturated fatty acids		65.58	70.55	61.52	23.0
Total of omega-3 fatty acids		0.26	58.27	1.4	21.28
Total of omega-6 fatty acids		65.32	12.28	60.12	1.72
Total of omega-6/total omega-3 fatty acids ratio		251.23	0.21	42.94	0.08

supplemented with fish oil and flax oil as compared with corn oil and sunflower oil in respect to productive and reproductive traits included in this experiment may be explained by that fish oil and flax oil contain high amount of omega-3 fatty acids and low ratio of omega-6 to omega-3 fatty acids. Dalton (2000) reported that the decrease in the ratio of omega-6 to omega-3 fatty acids in Japanese quail diet resulted in significant increase in

Table 3: Effect of different oil sources on female body weight (g) (Mean±SE) of quail

Periods	Treatments T1	T2	T3	T4
0	208.4±5.7	205.7±8.9	209.5±4.8	205.2±2.6
1	212.0±6.3	208.1±7.6	217.1±2.9	211.9±2.4
2	214.7±3.7	207.6±4.1	217.1±3.1	210.4±4.5
3	215.2±2.5	208.5±5.4	220.4±1.7	211.4±5.9
4	216.2±2.5	206.4±9.2	218.5±2.1	212.0±4.5
5	210.7±2.9	206.9±10.3	217.3±5.3	212.5±6.7
6	213.9±3.3	210.4±10.7	216.3±3.5	219.3±4.9

Each period represented 14 days. T1: Sunflower oil; T2: Flax oil; T3: Corn oil and T4: Fish oil

Table 4: Effect of different oil sources on male body weight (g) (Mean±SE) of quail

Periods	Treatments T1	T2	T3	T4
0	163.3±2.0	165.3±2.6	165.0±2.8	165.0±7.6
1	180.0±5.7	169.3±2.9	175.0±2.8	171.6±3.3
2	178.3±6.0	166.6±8.3	171.6±1.6	170.0±5.0
3	186.6±3.3	176.6±8.8	185.0±2.8	176.6±1.6
4	178.3±1.6	171.6±8.3	180.0±2.8	175.0±1.0
5	181.6±4.4	168.3±9.2	181.6±4.4	176.6±1.6
6	178.3±6.0	163.3±8.9	176.6±1.6	171.6±11.1

Each period represented 14 days. T1: Sunflower oil; T2: Flax oil; T3: Corn oil and T4: Fish oil

Table 5: Effect of different oil sources on feed consumption (g) (Mean±SE) of quail

Periods	Treatments T1	T2	T3	T4
1	35.8±1.7	35.0±2.1	32.6±1.3	32.4±1.5
2	36.5±1.8	38.9±0.8	32.9±0.9	32.3±1.4
3	34.1±1.9	33.0±1.7	34.3±1.2	31.9±2.2
4	35.0±1.8	33.7±1.1	33.8±0.9	33.1±2.6
5	35.9±1.5	36.3±2.2	34.1±1.0	34.9±1.3
6	37.8±1.3	37.1±1.7	34.44±1.9	36.2±1.7
Cum.	215.4±5.1	214.3±6.3	202.4±1.4	201.0±2.0

Each period represented 14 days. T1: Sunflower oil; T2: Flax oil; T3: Corn oil and T4: Fish oil. ^{a,b,c}Means within rows with different superscripts differ significantly at (p<0.05). Cum.=Cumulative

Table 6: Effect of different oil sources on egg weight (g) (Mean±SE) of quail

Periods	Treatments T1	T2	T3	T4
1	11.4±0.01^{d}	11.6±0.02^{b}	11.4±0.01^{c}	11.7±0.01^{a}
2	11.2±0.02^{d}	11.3±0.02^{b}	11.3±0.01^{c}	11.5±0.02^{a}
3	10.4±0.20^{d}	10.6±0.43^{b}	10.6±0.32^{c}	10.9±0.28^{a}
4	10.9±0.09^{d}	11.1±0.20^{b}	11.0±0.07^{c}	11.2±0.05^{a}
5	11.3±0.22^{d}	11.6±0.09^{b}	11.5±0.23^{c}	11.7±0.11^{a}
6	11.0±0.13^{d}	11.3±0.25^{b}	11.1±0.2^{c}	11.5±0.23^{a}
Mean	11.0±0.03^{d}	11.2±0.09^{b}	11.1±0.05^{c}	11.4±0.09^{a}

Each period represented 14 days. T1: Sunflower oil; T2: Flax oil; T3: Corn oil and T4: Fish oil. ^{a,b,c}Means within rows with different superscripts differ significantly at (p<0.05)

egg size, egg production, fertility, hatchability and decrease in early embryonic mortality. Important nutritionally-essential n-3 fatty acids are: α-Linolenic

Table 7: Effect of different oil sources on hen-day egg production (%) (Mean±SE) of quail

Periods	Treatments T1	T2	T3	T4
1	75.23±3.4	76.17±0.9	74.83±2.6	77.21±3.9
2	70.59±3.0^{b}	76.53±3.0^{a}	71.55±3.5^{b}	77.89±2.3^{a}
3	72.21±2.9^{d}	75.79±2.3^{b}	73.47±2.7^{c}	77.45±2.1^{a}
4	64.0±1.9^{d}	76.6±3.6^{b}	74.83±1.2^{c}	78.34±3.4^{a}
5	63.78±2.0^{d}	79.54±5.6^{b}	76.02±3.1^{c}	82.48±2.8^{a}
6	68.03±1.7^{d}	79.76±4.8^{b}	78.06±2.5^{c}	83.62±1.8^{a}
Mean	68.97±1.1^{d}	77.39±2.3^{b}	74.79±0.8^{c}	79.42±0.8^{a}

Each period represented 14 days. T1: Sunflower oil; T2: Flax oil; T3: Corn oil and T4: Fish oil. ^{a,b,c}Means within rows with different superscripts differ significantly at (p<0.05)

Table 8: Effect of different oil sources on egg mass (g) (Mean±SE) of quail

Periods	Treatments T1	T2	T3	T4
1	8.59±0.3^{d}	8.84±0.8^{b}	8.56±0.3^{c}	9.04±0.4^{a}
2	7.93±0.3^{d}	8.70±0.3^{b}	8.11±0.4^{c}	8.98±0.2^{a}
3	7.53±0.4^{d}	8.09±0.5^{b}	7.79±0.1^{c}	8.47±0.8^{a}
4	7.02±0.1^{d}	8.55±0.5^{b}	8.26±0.1^{c}	8.81±0.3^{a}
5	7.24±0.3^{d}	9.24±0.6^{b}	8.75±0.3^{c}	9.65±0.2^{a}
6	7.50±0.2^{d}	9.01±0.7^{b}	8.73±0.4^{c}	9.69±0.3^{a}
Mean	7.63±0.1^{d}	8.73±0.3^{b}	8.36±0.6^{c}	9.09±0.1^{a}

Each period represented 14 days. T1: Sunflower oil; T2: Flax oil; T3: Corn oil and T4: Fish oil. ^{a,b,c}Means within rows with different superscripts differ significantly at (p<0.05)

Table 9: Effect of different oil sources on cumulative egg number (Mean±SE) of quail

Periods	Treatments T1	T2	T3	T4
1	10.53±0.4^{d}	10.66±0.1^{b}	10.47±0.3^{c}	10.80±0.5^{a}
2	9.88±0.4^{d}	10.71±0.4^{b}	10.01±0.4^{c}	10.89±0.3^{a}
3	10.10±0.1^{d}	10.61±0.3^{b}	10.28±0.3^{c}	10.84±0.2^{a}
4	8.96±0.4^{d}	10.72±0.5^{b}	10.47±0.1^{c}	10.96±0.4^{a}
5	8.92±0.2^{d}	11.13±0.7^{b}	10.64±0.4^{c}	11.54±0.3^{a}
6	9.52±0.2^{d}	11.16±0.6^{b}	10.92±0.3^{c}	11.70±0.2^{a}
Total	57.93±0.9^{d}	65.0±1.9^{b}	62.82±0.6^{c}	66.71±0.7^{a}
Mean	9.65±0.1^{d}	10.83±0.3^{b}	10.47±0.1^{c}	11.11±0.1^{a}

Each period represented 14 days. T1: Sunflower oil; T2: Flax oil; T3: Corn oil and T4: Fish oil. ^{a,b,c}Means within rows with different superscripts differ significantly at (p<0.05)

Table 10: Effect of different oil sources on feed conversion ratio (g diet/g egg) (Mean±SE) of quail

Periods	Treatments T1	T2	T3	T4
1	4.17±0.11^{a}	3.96±0.29^{b}	3.81±0.21^{b}	3.59±0.11^{c}
2	4.61±0.13^{a}	4.48±0.30^{b}	4.06±0.31^{b}	3.60±0.14^{c}
3	4.53±0.27^{a}	4.08±0.35^{b}	4.41±0.18^{b}	3.77±0.16^{c}
4	4.99±0.22^{a}	3.95±0.19^{b}	4.09±0.04^{b}	3.75±0.28^{c}
5	4.96±0.12^{a}	3.93±0.05^{b}	3.90±0.10^{b}	3.62±0.19^{c}
6	5.04±0.07^{a}	4.12±0.04^{b}	3.94±0.20^{b}	3.74±0.26^{c}
Mean	4.71±0.08^{a}	4.08±0.17^{b}	4.03±0.06^{b}	3.67±0.17^{c}

Each period represented 14 days. T1: Sunflower oil; T2: Flax oil; T3: Corn oil and T4: Fish oil. ^{a,b,c}Means within rows with different superscripts differ significantly at (p<0.05)

Table 11: Effect of different oil sources on fertility and hatchability traits (Mean±SE) of quail

Traits	Treatments T1	T2	T3	T4
Fertility (%)				
Hatching 1	80.00±5.77[d]	88.33±1.67[b]	83.67±1.67[c]	91.67±3.48[a]
Hatching 2	83.33±6.01[c]	88.67±1.55[b]	84.13±2.08[c]	90.00±5.00[a]
Hatching 3	81.67±5.04[d]	88.23±4.41[b]	85.00±2.89[c]	90.00±2.81[a]
Hatching 4	81.30±2.65[d]	85.37±3.05[b]	83.06±2.66[c]	88.92±1.93[a]
Mean	81.57±4.52[d]	87.15±5.08[b]	83.96±3.95[c]	90.14±3.33[a]
Hatchability of total egg (%)				
Hatching 1	75.00±8.66[d]	83.99±2.19[b]	80.00±2.89[c]	91.01±2.37[a]
Hatching 2	80.00±3.55[d]	86.11±4.09[b]	83.27±7.66[c]	88.95±4.18[a]
Hatching 3	75.93±5.15[d]	83.25±3.29[b]	79.11±1.95[c]	88.02±3.39[a]
Hatching 4	71.91±6.08[d]	80.19±4.71[b]	75.22±6.19[c]	86.95±5.27[a]
Mean	75.71±2.58[d]	83.38±1.49[b]	79.40±2.95[c]	88.73±3.72[a]
Hatchability of fertile eggs (%)				
Hatching 1	87.52±1.97[d]	93.16±4.14[b]	90.29±4.91[c]	98.15±1.85[a]
Hatching 2	88.11±3.16[d]	94.40±3.09[b]	91.33±5.01[c]	97.33±4.87[a]
Hatching 3	87.98±3.81[d]	94.23±3.40[b]	90.99±6.09[c]	96.85±3.33[a]
Hatching 4	87.13±1.55[d]	93.90±4.20[b]	91.03±5.18[c]	96.00±4.25[a]
Mean	87.68±4.19[d]	93.92±3.87[b]	90.91±4.44[c]	97.08±5.15[a]
Embryonic mortality (%)				
Hatching 1	12.48±0.95[a]	6.48±1.11[c]	9.71±1.35[b]	1.85±0.55[d]
Hatching 2	11.89±1.03[a]	5.60±0.97[c]	8.67±1.17[b]	2.67±0.71[d]
Hatching 3	12.02±0.88[a]	5.77±0.81[c]	9.01±2.55[b]	3.15±0.93[d]
Hatching 4	12.87±0.75[a]	6.10±1.03[c]	8.97±2.48[b]	4.0±1.09[d]
Mean	12.32±1.20[a]	6.08±0.97[c]	9.09±3.01[b]	2.92±1.01[d]

T1: Sunflower oil; T2: Flax oil; T3: Corn oil; T4: Fish oil. [a,b,c]Means within rows with different superscripts differ significantly at ($p<0.05$)

Acid (ALA), Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA), all of which are polyunsaturated. The vertebrate body cannot synthesize n-3 fatty acids *de novo*, but it can form 20-carbon unsaturated n-3 fatty acids (like EPA) and 22-carbon unsaturated n-3 fatty acids (like DHA) from the 18-carbon n-3 fatty acid ALA. These conversions occur competitively with n-6 fatty acids, are essential closely related chemical analogues that are derived from Linoleic Acid (LA). Both the n-3 ALA and n-6 LA are essential nutrients which must be obtained from food. Synthesis of longer n-3 fatty acids from ALA within the body is competitively slowed by the n-6 analogues. Thus accumulation of long-chain n-3 fatty acids in tissues is more effective when they are obtained directly from food or when competing amounts of n-6 analogs do not greatly exceed the amount of n-3 (Culver, 2001; Midilli *et al.*, 2009). The 18 carbon ALA has not been shown to have the same health and cardiovascular benefits such as DHA or EPA. Currently there are many products on the market which claim to contain health promoting omega-3 but contain only ALA, not EPA or DHA. These products contain mainly higher plant oils and must be converted by the body to create DHA and therefore considered less efficient. DHA and EPA are made by micro algae that live in sea water. These are then consumed by fish and accumulate to high levels in their internal organs. Fish oil stimulate blood circulation, increase the breakdown of fibrin, a compound involved in clot and scar formation and additionally has been shown to reduce blood pressure, reduce blood triglyceride levels, regular intake reduces the risk of secondary and primary heart attack, treatment of rheumatoid arthritis and cardiac arrhythias, helpful in depression and anxiety, reduce the risk of ischemic and thrombotic stroke (Sanders *et al.*, 1997; Davidson *et al.*, 2007). Researches agree that the optimal ratio of omega-6 to omega-3 should not exceed 2:1-4:1. The dietary imbalance in fatty acids (excessive omega-6 and insufficient omega-3) is a fundamental underlying cause of many chronic disease including cardiovascular disease, many cancers, most inflammatory diseases, autoimmune diseases and many physiological disturbances (Baucells *et al.*, 2000). Hudson and Wilson (2003) found that when broiler breeder males were provided with 3% fish oil resulted in improvement in fertility, hatchability of eggs set, testis weight, sperm mobility index, sperm holes in the ovum and the number of males producing semen. However, those authors suggested that sperm from males consuming fish oil may have persisted in sperm storage tubules for longer periods. Blesbois *et al.* (1997) showed that the addition of fish oil to broiler breeder roosters resulted in significant increase in fertility, hatchability and embryonic livability compared with corn oil treatment, and concluded that the lipid composition of the diet may modify the fatty acid composition of the semen and its fertilizing ability. Bozkurt *et al.* (2008) indicated that dietary supplementation with 1.5% fish oil resulted in improvement in egg production performance, fertility, egg weight, chick weight, hatch of egg set without any adverse effect on body weight.

On the other hand, the improvement in the productive traits of laying quail when flax oil was supplemented to the diet of quail in comparison with sunflower oil and corn oil groups may be attributed to hormone metabolism regulation by dietary phytoestrogens, mainly estrogen (Caston *et al.*, 1994; Aydin *et al.*, 2006). Souza *et al.* (2008) reported that flaxseeds contain high quantity of phytoestrogens like lignans and isoflavones which play important role in regulate reproductive performance and fatty acid profile of eggs of semi-heavy layers. The lignans are group of chemical compounds found in plants, particularly in flaxseed. Lignans are one of the major classes of phytoestrogens, which are estrogen-like chemicals and also act as antioxidants. Lignans function as phytoestrogens, due the similarities the phytoestrogens from flaxseed (enterolactone and enterodiol) may impact estrogen metabolism for the better. They do this by binding to estrogen receptors on cell membranes and either block the action of the strong steroidal estrogens or act like weak estrogens when the body is deficient (Dawson, 2008). Begum *et al.* (2004) summarized the benefits of lignan for many cases as follows: Energy levels, sleep patterns, immune support, hormone health, constipation, digestion, anti-fungal, anti-viral, anti-parasitical, skin conditions and anti-carcinogenic. A rich source of minerals, omega-3 fatty acids, phytoestrogens and soluble and insoluble fiber, gave abundant evidence that supports the value of flaxseed in preventing diverse illnesses such as heart disease and cancer as well as helping to address common ailments such as digestive irregularity and enhancing reproductive performance in both males and females (Guilliams, 2000). Leskanich and Noble (1997) indicated that omega-3 fatty acids help lower blood triglycerides and cholesterol levels. However, omega-3 fatty acids are also required for normal growth and development, good production and distinguished reproductive performance. Flaxseed is higher in omega-3 fatty acids and lowers in saturated fatty acids than other grains. As a result, the eggs produced from hens on this formula are higher in omega-3 fatty acids (Pruuthi *et al.*, 2007). DaSilva *et al.* (2009) reported that supplementation the quail diet with flaxseed at levels of 1.5, 3.0, or 5.0% resulted in significant increase in n-3 fatty acid level compared to that of control group. However, the n-6/n-3 decreased from 21:30 (control group) to 4.52 (5% flaxseed group), which is a better value from the nutritional viewpoint.

Conclusion: The results of the present experiment demonstrated that different oil sources had varying effects on productive and reproductive traits of quail. This is reflected by the fatty acid composition of this oils added to the diet. Incorporation of these oils, especially fish oil and flax oil in the diet of quail may have practical value in improving the productive and reproductive traits of Japanese quail.

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