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Response of laying hens to dietary flaxseed levels on performance, egg quality criteria, fatty acid composition of egg and some blood parameters

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Abstract: *This work was performed to study the effect of providing laying hens with various levels of locally produced flaxseed (FS) on the production performance, egg quality criteria, fatty acid composition and some blood parameters. In this experiment, a total of 144 Hi-sex laying hens of 40 weeks of age were used in which divided randomly into four treatment groups and fed different diets containing 0, 5, 10 or 15% FS for twelve weeks. All birds received water and diets ad libitum and were under hygienic control. The results showed that feeding diet supplemented with FS to laying hens resulted in significant increase in egg production (EP), egg mass (EM) and feed intake (FI), whereas, egg yolk and shell percentage were not significantly different. However, albumen percentage was increased compared to the control group. But, a significant decrease in shell thickness, also egg yolk and shell percentage decreased. Adding FS to hen diets significantly increased omega-3 fatty acid in egg yolks compared to the control diet. Also, the omega-3 diets decreased the saturated the palmitic fatty acid content and increased the linolenic fatty acid content. However, FS containing diets significantly decreased the serum cholesterol and triglycerides concentrations. The serum cholesterol level of hens fed diets containing (15% FS) was lower than the control group. In conclusion, the dietary FS can be valuable additive to the layer diets, did not affect the laying performance and egg quality criteria adversely, improved unsaturated fatty acid content of the egg yolk and reduced the cholesterol of egg, so it possible to obtain yolk with amount of beneficial fatty acids by adding FS in the laying diets.*

Keywords: *Flaxseed, Fatty acid, hen performance, egg quality, egg production, blood parameters.*

1. INTRODUCTION

Recently, consumer demands for more healthy food stimulated the intestine in modifying the fatty acid profile of egg. As a result of many studies, it was stated that saturated fatty acids and trans fatty acids cause negative effects on human health but polyunsaturated fatty acids (PUFA) have a positive effect as regard to coronary heart disease (CHD) (Blanch and Grashorn, 1995 [1]; Bhatnagar and Durrington, 2003 [2]; Erkkila et al., 2003 [3]; Meyer et al.2003 [4]).

Table eggs is one of the most complete foods from a nutritional point of view, but consumers refrain from egg consumption due to relatively high cholesterol content of eggs which leads to risk factors for CHD in humans, who have high blood cholesterol levels(Zeidler,1998 [5]) . However, dietary fat type and fatty acid composition of fats consumed are more important than the amount of dietary cholesterol consumed (Leskanich and Noble, 1997 [6]; Simopoulos, 2000 [7]).

Flaxssed is one of the most concentrated sources of PUFA available in natural feedstuffs for poultry (Caston and Leeson, 1990 [7]; Jiang et al., 1991 [9]), because it contains high amount of linolenic acid (Genser, 1994 [9]). Also, flaxseed is used in the production of omega-3 enriched eggs (Hayat et al., 2009 [11]; Afaf et al., 2011 [12]). The increase in PUFA is accompanied by a decrease in saturated fatty acid resulting in a healthier fat profile to appeal to consumer's desire to increase their consumption of n-3 PUFA in the more palatable form.

Despite of the beneficial effect of using flaxseed in layer diets, there has been some concern about toxicity associated with flaxseed. Some reports showed a decrease in egg production (EP) in response to 15% flaxseed (Aymond and Elswky, 1995 [13]; Najib and Al-yousef, 2011 [14]) whereas, others reports showed an increase in EP when hens fed 5 and 10% flaxseed (Scheideler and Froning, 1996 [15]). However, many conflicting and inconsistent reports appear in the literature about using flaxseed in layer diets, some reports indicated that flaxseed reduced yolk and egg weight (Scheideler and Froning,1996 [15]; Bean and Leeson,2003 [16]) whereas, others showed that birds fed flaxseed exhibit lower feed intake (Scheideler and Froning ,1996 [15]) while others showed increased feed intake (Novak and Scheideler,2001 [17]). Due to conflicting reports on the role of flaxseed in laying diets, the question that needs to be addressed is whether flaxseed has beneficial effect when added to hen diets. Therefore, the objective of this trial was to examine the effects of flaxseed at different levels in diets of hens on performance, fatty acid composition, egg quality criteria, cholesterol and fatty acid content of egg yolk and some blood parameters.

2. METHODS

This work was performed in poultry experimental station, Nubaria, national Research Centre, Cairo, Egypt, to study the response of laying hens to different levels of locally ground produced flaxseed (FS) on the productive performance, egg quality criteria and fatty acid composition of egg. A total of 144 Hi-sex laying hens of 40 weeks of age were used in which divided randomly into four treatment groups (9 replicates of 4 birds each) and lasted 12 weeks at three intervals. The experimental diets were a control (T1) with no FS, while the other three diets were 5, 10 and 15% FS respectively. All diets were kept to be iso-nitrogenous (18%crude protein) and iso-energetic (2850 ME/kg of diet) to supply birds requirements according to NRC (1994) [18].

The ingredients and chemical composition of the experimental diets are presented in Table 1. All hens had ad-libitum access to feed and water and were under managerial and hygienic conditions. The lighting program was 16 h light: 8h darkness for the entire experimental periods. Egg weights were recorded daily per hen to calculate average egg weight. Egg production and feed consumption were calculated.

Table1. *Composition of the experimental diets.*

Item	Experimental rations			
	0% Flax seed	**5% Flax seed**	**10% Flax seed**	**7.5% Flax seed**
Yellow corn	64.0	57.0	50.0	43.0
Soybean meal	16.6	14.6	12.6	10.6
Protein concentrate	10.0	10.0	10.0	10.0
Flax seed[1]	-	5.0	10.0	15.0
Wheat bran	0.2	4.2	8.2	12.2
Di-Ca-Phosphate	1.0	1.0	1.0	1.0
Limestone	7.5	7.5	7.5	7.5
Sodium chloride	0.5	0.5	0.5	0.5
Vit. & Min. mixture[2]	0.2	0.2	0.2	0.2
Calculated CP	17.90	17.99	18.03	18.06
ME, kcal/ kg DM	2849	2859	2869	2874

[1]- *Flax seed contain 24 % crude protein; 3960 ME / kg; 0.89 % lysine; 0.44 % methionine; 0.87 % methionine + cysteine ; 0.28 % calcium; 0.55 % available phosphorus; 2.3 % sodium; 6.3 % crude fiber; 35.9 % crude fat; 5.39 % Linoleic acid; 16.8 % Linolenic acid (Ensminger et al, 1990; Vaisey – Genser, 1994 [9]).*

[2]-*Vit. & Min. mixture: Each kilogram of Vit. & Min. mixture contains: 2000.000 IU Vit. A, 150.000 IU Vita. D, 8.33 g Vit. E, 0.33 g Vit. K, 0.33 g Vit. B_1, 1.0 g Vit. B_2, 0.33g Vit. B_6, 8.33 g Vit.B_5, 1.7 mg Vit. B_{12}, 3.33 g Pantothenic acid, 33 mg Biotin, 0.83g Folic acid, 200 g Choline chloride, 11.7 g Zn, 12.5 g Fe, 16.6 mg Se, 16.6 mg Co, 66.7 g Mg and 5 g Mn.*

2.1. Productive performance

Egg weights (in grams) were recorded daily for each hen throughout the experimental period (12 weeks). Average egg weight and egg production percentage were calculated at 4 weeks intervals for each treatment group. Average egg mass was calculated as gram egg/hen/ 4weeks.

Feed consumption in grams/ hen/ 4 weeks and daily feed consumption (g/hen/day) per treatment group was calculated. Feed conversion (g feed/g egg) per each treatment group was also calculated.

2.2. Egg characteristics (egg quality)

At the end of the experiment, 2 eggs from each replicate were collected randomly for fatty acid analysis. Fatty acids in flax seeds and yolks were determined by Gas Chromatographic method using direct saponification (AOAC, 2000 [19]).

Also, blood samples were collected in heparinized tubes from the brachial vein(5 hens /group), and centrifuged at 3000rpm for 15 minutes to separate clear serum which stored at 20ºC for determination of some blood constituents as total protein, albumen, globulin, total lipids, triglyceride (TG), cholesterol, low density lipoprotein, alkaline-Phosphatase, creatinine, aspartate transaminases (AST) and alanine transaminase (ALT).

2.3. Statistical analysis

Statistical analysis was carried out using SAS (2004) [20] and Duncan's multiple range test (Duncan, 1955 [21]).

3. RESULTS AND DISCUSSION

3.1. Egg Production (EP)

Data for hen performance as affected by dietary treatments are shown in Table 2. There were minimal differences in egg production (EP).

Table2. *Productive performance of laying hens as affected by Flaxseed seed containing diets.*

Item	Treatments				
	Control	**5% flaxseed**	**10% flaxseed**	**15% flaxseed**	**Means ±SE**
1st period					
E. No./ hen	22.14	23.36	23.75	24.31	23.39 ± 0.38
Egg mass/g.	1296.31	1377.47	1415.03	1428.19	1379.25±22.54
Egg weight/g.	58.68	58.98	59.53	58.77	58.99 ± 0.24
Egg production %	79.07	83.43	84.82	86.81	83.53 ± 1.37
Feed intake g/h/d.	114.93^{b}	127.93^{a}	132.01^{a}	130.40^{a}	126.32 ± 2.39
Feed conversion	2.49	2.60	2.61	2.56	2.56 ± 0.02
2nd period					
E. No./ hen	22.56	23.61	24.00	24.31	23.62 ± 0.34
Egg mass/g.	1329.97	1406.97	1432.25	1435.25	1401.16±21.09
Egg weight/g.	59.00	59.58	59.63	59.06	59.32 ± 0.21
Egg production %	80.55	84.33	85.71	86.81	84.35 ± 1.21
Feed intake g/h/d.	120.48	128.64	131.98	129.51	127.66 ± 2.46
Feed conversion	2.53	2.56	2.58	2.53	2.55 ± 0.02
3rd period					
E. No./ hen	21.81^{b}	23.81^{a}	22.78^{ab}	23.19^{a}	22.90 ± 0.24
Egg mass/g.	1296.36^{b}	1414.92^{a}	1360.83^{ab}	1397.08^{a}	1367.30±15.23
Egg weight/g.	59.43	59.44	59.74	60.23	59.71 ± 0.15
Egg production %	77.88^{b}	85.02^{a}	81.35^{ab}	82.84^{a}	81.77 ± 0.87
Feed intake g/h/d.	115.72^{b}	129.85^{a}	120.81^{ab}	127.91^{a}	123.57 ± 1.82
Feed conversion	2.50	2.57	2.49	2.56	2.53 ± 0.02
Whole period					
E. No./ hen	22.17^{b}	23.95^{a}	23.51^{a}	23.94^{a}	23.30 ± 0.25
Egg mass/g.	1307.55^{b}	1399.79^{a}	1402.70^{a}	1420.24^{a}	1382.57±15.65
Egg weight/g.	59.04	59.33	59.63	59.36	59.34 ± 0.15
Egg production %	79.17^{b}	84.26^{a}	83.96^{a}	85.48^{a}	83.22 ± 0.89
Feed intake g/h/d.	117.04^{b}	128.81^{a}	128.67^{a}	129.27^{a}	125.85 ± 1.73
Feed conversion	2.50	2.57	2.56	2.55	2.55 ± 0.01

Feeding flaxseed had no significant effects on EP during the 1st and 2nd periods of production. Also, a comparison of EP in three periods, the control hens decreased in rate of production more rapidly than the average of FS-fed hens, which increased in production rates in all tested periods. However, EP of hens fed on T2 and T3 diets was numerically higher than T1 and the control diets during first and second period.

Significant improvement was detected on EP by adding FS in diet compered with control diet during the third and whole periods. Also, feeding 15% FS to hen diets supports good EP, while adding 10% FS to the diet depressed EP% which could be attributed to anti-nutritional factors contained in full-fat seed as reported by Scheideler et al. (1995) [22]. However, Novak and Schiedeler (2001) [17] found the addition of FS to the diet of laying hens did not have any effects on EP parameters. Similar results were reported by Jiang et al., 1991 [9]; Caston et al., 1994 [23]; Aymond and Vav Elswyk, 1995 [13];Yannakopoulos et al., 1999 [24]; Najib and Al-Yousef, 2010 [25]). Generally, EP was similar in hens from all dietary treatments compared to the control.

3.2. Egg Mass (EM)

Egg mass (EM) was higher for FS-fed hens and increased by increasing FS level tested compared to controls during first and second period (Table 2), whereas, a significant increase was observed for feeding FS (5 to 15%) on EM compared to controls during the 3rd period. It can be concluded that adding FS to layer diets significantly increased EM during the whole period. In general, FS supplement significantly ($P<0.05$) improved EM, this improvement was increased by increasing FS level. In this respect, Najib and AL-yousef (2011) [14] showed that the effect of FS inclusion on EM was not significant when used 5, 10, 15 and 20%unroasted FS in laying diets. Whereas, Novak and Scheideler (2001) [17] found no differences between phases one and two received a significant diet effect, when FS fed hens increasing slightly in EM compared to controls which decreased.

3.3. Egg Weight (EW)

Egg weight (EW) showed no significant differences among treatments at all tested periods. The present results were in agreement with those of Bean and Leeson (2003) [16] and Nain et al. (2012) [26]. On the other hand, the present results were inconsistent with those of Caston et al. (1994) [23] and Schiedeler and Froning (1996) [15] who found a decrease in EWs with FS supplementation (5 and 15% ground or whole FS diets) and they attributed the decrease in EW to hormone metabolism regulation by dietary phytoestrogens, mainly estrogen. Whereas, Novak and Scheideler (2001) [17] showed that hens consuming FS diet increased in weight than from control-fed hens. But, EW was unaffected by the dietary FS treatments or the duration of feeding, and the best level of FS in their trial was 10%.The present results confirmed those of Najib and Yousef (2011) [14].

3.4. Feed Intake (FI) and Feed Conversion (FC)

From table 2, the trial showed a significant increase of FI for hens fed FS containing diets compered to control hens which consuming less feed per day. However, there was a gradual increase in FS as level of FS increased in the diet, when calculations were based on FS consumption per bird per day as (Najib and Yousef, 2010 [25]). Although, significant differences among treatments were detected, the relationship among treatments and periods was not consistent. Regard to FC efficiency, Birds fed FS-diets showed insignificant difference and the relation among treatments was inconsistent and nearly similar during the experiment trial. Generally, It is important to note that the use of FS had no detrimental effects on production parameters during the trial.

3.5. Egg quality criteria

Egg quality criteria for hens fed FS-diets are presented in Table 3. The results showed that FS-diets (except 5%) were lower yolk percentage in relation to the control, but no significant effect among treatments. But, albumen percentage was affected by FS-diets produced eggs with higher percentage of albumen than did hens with no significant effects. Also, Haugh units did no reveal any significant effects between the tested levels of FS-diets compared to the control. However, feeding FS has been reported to reduce shell percentage when supplemented into layer diets whereas, shell thickness was significantly reduced for hens fed FS-diets compared to controls.

Table3. *Egg quality criteria of laying hens as affected by Flaxseed seed containing diets.*

Item	Treatments				
	Control	**5% flaxseed**	**10% flaxseed**	**15% flaxseed**	**Means ±SE**
Average of egg weight/g	58.00^{ab}	57.30^{b}	59.74^{a}	56.37^{b}	57.85 ± 0.35
Shell index	78.73	78.47	79.70	78.72	78.90 ± 0.27
Yolk index	44.75^{a}	42.91^{a}	40.13^{b}	37.13^{c}	41.23 ± 0.43
Hough unit	83.67	84.11	83.93	83.37	83.77 ± 0.56
Yolk colour	6.81^{a}	5.89^{b}	5.74^{b}	6.00^{b}	6.11 ± 0.07
Shell thickness/µm	36.26^{a}	34.85^{ab}	33.04^{b}	33.59^{b}	34.44 ± 0.33
Albumen %	63.49	63.43	64.97	64.61	64.12 ± 0.26
Yolk %	23.34	23.43	22.38	22.58	22.93 ± 0.19
Shell %	13.17	13.14	12.65	12.81	12.94 ± 0.16

In this respect, few trials have focused on how FS-containing diets affect egg quality parameters in layers (Novak and Scheideler, 2001 [17]; Bean and Leeson, 2003 [16] and Basmacioglu et al., 2003 [27]). The results obtained concerning to FS-diets in our study may be attributed to hormones metabolism regulation by dietary phytoestrogens, mainly estrogen. Caston et al. (1994) [23], Aydin et al. (2006) [28] and Souza et al. (2008) [29] reported that FS contain high quantity of phytoestrogens like lignin and iso-flavones which play important role in reproductive performance, egg quality and fatty acid profile of layer diets. However, the increase in percentage yolk in these eggs is important to consumers because of total cholesterol in the yolk, also, decreasing the percent of yolk and increasing albumen may impact or decrease the amount of cholesterol percent per egg consumed (Novak and Scheideler, 2001 [17]; Hazim et al.,2011 [30]).

The percent of yolk was decreased with 10 and 15% FS supplemented diets to laying hens (Caston et al. (1994) [23] and Scheideler and Froning, 1996 [15]), whereas, others have associated the decrease in yolk weight with a decrease in egg weight which is not desirable. Moreover, there were significant differences in Haugh units between FS-diets, so the lake of effect of these changes on Haugh units is consistent with the findings of Jiang et al. (1991) [9] who studied the effect of albumen thickness from feeding high amounts of linolenic acid (Dunn et al., 2011 [31]). In general, the addition of FS to diets of laying hens did not cause any negative effect on some egg quality criteria as reported by Hazim et al. (2011) [30].

3.6. Fatty acid composition of egg (FA)

The fatty acid composition of eggs listed in Table 4.The results showed that Palmitic acid (16:0) was the pre-dominant saturated fatty acid. All hens fed FS–diets significantly decreased palmitic acid compared to the control. This reduction indicates an additional health advantage for these n-3enriched eggs (Ayerza and Coates, 2000 [32]). Increasing the amount of Unroasted FS to 15% of feed addition reduced the saturated palmitic acid in the egg yolk compared to the control. However, the saturated palmitic acid was lower at 15% FS inclusion. The significant reduction in palmitic fatty acid content found for hens fed on the n-3 fatty acid enriched diets compared to control could be attributed to the high dietary intake of PUFA, since this has been shown to reduce synthesis of saturated fatty acids (Sim and Qi, 1995 [33]).

Table (4): *Fatty acids composition in egg yolk of laying hens as affected by Flaxseed seed containing diets.*

Item	**11.70^{b} Treatments**				
	Control	**5% flaxseed**	**10% flaxseed**	**15% flaxseed**	**Means ±SE**
C14 : 0	0.04	0.02	0.05	0.04	0.04 ± 0.01
C16 : 0	28.74^{a}	26.39^{b}	23.59^{c}	23.47^{c}	25.55 ± 0.60
C17 : 0	0.24^{a}	0.12^{b}	0.14 ^{b}	0.12^{b}	0.16 ± 0.02
C18 : 0	11.79	10.60	11.04	11.09	11.13 ± 0.31
C20 : 0	0.11	0.19	0.00	0.00	0.07 ± 0.05
Total Saturated F.A	40.91^{a}	37.12^{b}	34.83^{c}	34.71^{c}	36.89 ± 0.71
C16 : 1	2.70	3.16	2.77	2.90	2.88 ± 0.08
C18 : 1	37.08^{b}	42.79^{a}	41.42^{a}	39.88^{ab}	40.29 ± 0.84
C20 : 1	0.24^{b}	0.65^{ab}	0.68^{ab}	0.97^{a}	0.63 ± 0.10
C18 : 2	13.83^{a}	13.94^{a}	13.33^{a}	11.70^{b}	13.20 ± 0.25
C18 : 3	1.69^{c}	2.23^{b}	2.67^{ab}	2.98^{a}	2.42 ± 0.13
Total Unsaturated F.A	55.52^{c}	62.90^{a}	60.86^{ab}	58.42^{bc}	59.43 ± 0.86

The second major saturated fatty acid was stearic acid (18:0) which was not significantly influenced by FS-containing diets among the dietary treatments. Stearic fatty acid content was lower for hens fed –FS diets than the control with no difference. However, oleic acid (18:1) content constituted more than 90% of the mono-unsaturated fatty acid in egg lipids. The oleic content of the egg yolks found is associated with the diet having the highest content of this fatty acid. Also, the FS-diet which had the highest dietary oleic showed significantly higher oleic egg yolk contents than the control. The significant higher oleic content of the egg yolks found with levels 5 and 10% FS is associated with the diet having both the highest content of this fatty acid and the highest oleic: PUFA ratio as well. Baucells et al. (2000) [34] reported that the ability of the laying hens to change the monounsaturated fatty acid mainly as oleic acid in yolk seems limited, so, it can be observed that the proven tendency of laying hens is to keep the degree of mono-unsaturation in yolk within very narrow margins (Yalcin et al.,2007 [35]).

Linoleic acid (18:2) is the parent compound of the n-6 family, and arachidonic acid is the metabolic of the linoleic acid. The FS containing diets realized no significant difference in linoleic acid between levels of 0, 5 and 10% FS while, 15% level was significantly lower than that the control. The diet of level 5% FS (T2) yielded significantly higher linoleic content than the other levels.

As cited by Hazim et al. (2011) [30] FS is rich plant source of alpha- linolenic acid (ALA) which is an-essential fatty acid in the human diet and the parent fatty acid of the n-3 family. Also, FS is higher in omega-3fatty acid and lowers in SFAs than the other grains. ALA is converted into two main long chain fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in a series of enzymatic reactions. Dietary enriched with FS may result in an excess of ALA which is precursor of DHA and EPA in the human body. Adding FS to diets significantly increased the total omega-3 fatty acid in yolk eggs (Yalcin et al., 2007 [35]).

The linolenic (18:3) acid content of eggs was the highest in eggs of layers fed diets containing FS compared to the control. Increasing FS-diets up to 15% resulted in increases in linolenic acid concentration in the yolk lipids. For this reason, the rise in total n-3 fatty acids in eggs obtained from hens FS-containing diets may be attributed to the increase in alpha linolenic acid concentration in the yolk lipids. In general, increasing the linolenic fatty acid content of the diet produced increasing levels in yolk egg fatty acid, whereas, the lowest linolenic yolk content was found for hens fed the control diet. These findings are in accordance with those of Jiang et al. (1991) [9], Cherian and sim (1991) [36] and Beynen (2004) [37], who found a significant reduction in this fatty acid amount in the eggs of hens whose fed diet contained FS compared to controls. While, Caston et al.(1994) [23] reported that when dietary FS increased from 10% to 20% the level of alpha linolenic acid in eggs doubled, but Cherian and Sim (1991) [36] did not observed twice the alpha linolenic acid when the ratio was increased from 8% to 16%.

However, any alteration in the fatty acid composition of yolk lipids (increase in n-3 fatty acids and decrease in n-6) resulted in a large reduction in the n-3 ratio. However, the total n-3 fatty acid content was significantly greater for all diets, and the predominant change in FS containing diets was found in linolenic acid content, whereas, total saturated fatty acid was decreased while, in all diets compared to the control diet (Yalcin et al., 2007 [35]). In general, an increased in alpha linolenic fatty acid content of the diet increased the linolenic fatty acid content of the egg yolks. ALA enriched diets produced significantly lower n-6: n-3 ratios compared with the control-corn-soya diets.

3.7. Blood serum parameters

Studies with regard to the effects of omega-3fatty acids on blood parameters are lacking. Concerning the inclusion of FS in the diet the results showed that supplementing dietary FS-containing diets significantly decreased the serum cholesterol and triglycerides concentrations (Table 5). Whereas, no significant differences were noted for total lipid levels. These results are similar to those obtained by Van Elswyk et al. (1994) [38] who reported that dietary Flax oil supplementing at a 3.0% inclusion level resulted in a decreased serum cholesterol concentration in hens. Also, Hazim et al. (2011) [30] found that the omega -3 fatty acids help lower blood cholesterol and triglycerides levels. Whereas, Najib and Yousef (2011) [14] observed that feeding FS marginally increased the amount of cholesterol. The values of serum total protein and globulin for hens fed FS were significantly higher ($P<0.05$) while serum albumin and A/G ratio were significantly lower (P, 0.05) than the control group. Therefore, we need several studies about blood analysis for FS.

Table (5): *Blood parameters of laying hens as affected by Flaxseed seed containing diets.*

Item	Treatments				
	Control	**5% flaxseed**	**10% flaxseed**	**15% flaxseed**	**Means ±SE**
Total protein (g/dL)	4.72^{b}	5.23^{a}	5.64^{a}	5.24^{a}	5.21 ± 0.10
Albumin (g/dL)	1.15^{a}	0.94^{ab}	0.62^{b}	0.54^{b}	0.81 ± 0.09
Globulin (g/dL)	3.58^{b}	4.31^{a}	5.02^{a}	4.70^{a}	4.40 ± 0.16
A/G ratio	0.36^{a}	0.23^{ab}	0.13^{b}	0.11^{b}	0.21 ± 0.03
Total lipids (mg/dL)	967.57	965.23	951.90	993.68	969.60 ± 39.03
Triglycerides (mg/dL)	229.58^{a}	220.22^{ab}	218.22^{ab}	204.78^{c}	218.20 ± 3.37
Cholesterol (mg/dL)	147.15^{a}	139.23^{b}	134.33^{c}	131.80^{c}	138.13 ± 1.36
Alkaline-Pho. (mg/dL)	15.73^{b}	17.43^{a}	16.05^{b}	15.73^{b}	16.24 ± 0.25
Creatinine (mg/dL)	0.89	1.04	0.83	0.79	0.89 ± 0.05
AST (IU/L)	161.30	165.02	179.33	178.83	171.12 ± 3.73
ALT (IU/L)	24.92^{b}	26.65^{ab}	30.90^{a}	27.27^{ab}	27.43 ± 0.89

4. CONCLUSION

In conclusion, this study showed that the addition of FS in laying hen diets improved productive performance, egg quality parameters and the fatty acid content of the egg yolk. Moreover, it increased unsaturated and omega-3 fatty acids which are important in producing healthier and efficiently passed along the human food chain with the practice of using FS in feeding poultry. However, the inclusion of 15% FS would support an excellent of omega-3 fatty acids in the egg during this experiment.

REFERENCES

[1]. Blanch, A.and Grashorn, M.A. (1995). Ernahrungsphysiologische Bedeutung per Omega-3-Fettsauren und Moglichkeiten der Anreicherung in Eiern. Physiological importance of omega-3 fatty acids for human nutrition and way fore their enrichment in eggs. Archive Fur Geflugelkunde 60, 49- 58.

[2]. Bhatnagar, D. and Durrington, P.N.(2003). Omega-3 fatty acids. Their role in the prevention and treatment of atherosclerosis related risk factors and complications. InT. J. Clin. Prac. 57, 305-14.

[3]. Erkkila, A.T.; Lehto, S.; Pyorala, K. and Uusitupa, M.I. (2003). Fatty acids and 5-y risks of death and cardiovascular disease evevts in patents with coronary disease. Am. J. Clin. Nutr. 78, 65-71.

[4]. Meyer, B.J. ; Mann, N.J.; Lewis, J.L.; Milligan, G.C.; Sinclair, A.J. and Howe, P.R. (2003). Dietary intakes and food sources of omega-6 and omega-3 polyunsaturated fatty acids. Lipids 38, 391-39.

[5]. Zeidler, G.(1998). Poultry products in the 21th Century, 132-141. The poultry industry towards the 21st century, WPSA-Israel Branch 10th European Poult. Conf., Proc. Vol. Jerusalem, Israel. 502pp.

[6]. Leskanich, C.O. and Noble, R.C. (1997). Manipulation of n-3 polyunsaturated fatty acid composition of avian eggs and meat. World's Poult. Sci. 53: 157-183.

[7]. Simopoulos, A.B. (2000). Symposium: Role of poultry products in enriching the human diet with n-3 PUFA. Poult. Sci. 75: 961- 970.

[8]. Caston, L.J. and Leeson,S. (1990). Dietary flax and egg composition . Poult. Sci. 69. 1617-1620.

[9]. Jiang, Z.R.; Ahn, D.U. and Sim, J.S. (1991). Effects of feeding flax and two types of sunflower seeds on fatty acid composition of yolk lipid clsasses. Poult. Sci., 70: 2467-2475.

[10]. Genser MY (1994).Description and composition of flaxseed. Pages 914 in: Flaxseed, Health, Nutrition and Functionality.The Flax Council of Canada.

[11]. Hayat, Z.; G. Cherian; T.N. Pasha; F.M. Khattak and M.A. Jabbar (2009). Effect of feeding flax and two types of antioxidants on egg production, egg quality and lipid composition of eggs. J. Appl. Poult. Res. 18: 541- 551.

[12]. Afaf, Y. Al-Nasser; Abdul Ameer, E. Al-Saffar; Faten, K. Abdullah; Mariam, M. Al- Bahouh; Gehan Ragheb and Magdy. M. Mashaly (2011). Effect of adding flaxseed in the diet of laying hens on both production of of omega-3 enriched eggs and on production performance. International Journal of Poultry Science, 10: 825- 831.

[13]. Aymond WM, Van Elswyk ME, (1995). Yolk thiobarbituric acid reactive substances and n-3 fatty acids in response to whole and ground flaxseed, Poultry Sci, 74: 1388-1394.

[14]. Najib, H. and Y.M.AL- Yousef. (2011). Performance and essential fatty acids content of dark meat as affected by supplemting the broiler diet with different levels of flaxseed . Annual Review& Research in Biology 1: 22-32.

[15]. Scheideler, S.E. and G.W.Froning. (1996). The combined influence of dietary flaxseed variety, level, form and storage condition on egg production and composition among vitamin E-supplemented hens. Poult. Sci. 75: 1221- 1226.
[16]. Bean, L.D. and S. Leeson (2003). Long –term effects of feeding flaxseed on performance and egg fatty acid composition of brown and white hens.Poult. Sci. 82: 388-394.
[17]. Novak, C. and S. E. Scheideler (2001). Long-term effects of feeding flaxseed-based diets.1. Egg production parameters, components and egg shell quality in two strains of laying hens. Poult. Sci.80: 1480- 1489.
[18]. National Research Councel. (1994). Nutrient Requirements of Poultry 9th Revised Edition (Washington, D.C. National Academy Press).
[19]. A.O.A.C. (2000). Official Methods of Analysis. 17th Ed., Association of Official Analytical Chemists. Washington, D.C.
[20]. SAS institute (2004). SAS User'sGuide: Statistics, 2004. Edition 9,1 SAS Institute Inc.,Cary,NC.
[21]. Duncan,D.B.(1955). Multiple range and multiple F-test. Biometrics 11: 1-42
[22]. Scheideler,S.E.; Jaroni, D. and Froning, G. (1995). Strain and dietary oats effect on flax fed hen's egg production and fatty acid profile. Poult. Sci.,74: (suppl. 1)
[23]. Caston,L.J., E.S. Squires and S. Leeson (1994). Hen performance, egg quality and sensory evaluation of eggs from SCWL hens fed dietary flax. Can. J. Anim.Sci. 74: 347-353.
[24]. Yannakopoulos, A.L.; Tserveni, A.S. and Yannakakis, S. (1999). Effect of feeding flaxseed to laying hens on the performance and egg quality and fatty acid composition of eg yolk. Archive Fur Geflugelkunde 63, 260- 263.
[25]. Najib, H., and Yousef, Y. M. (2010). Essential fatty acid content of eggs and performance of layer hens fed with different levels of full-fat flaxseed. J. Cell Anim. Biol. 4(3):58-63.
[26]. Nain, S.; Renema, R.A. ; Zuidhof, M.J. and D.R. Korver (2012). Effect of metabolic efficiency and intestinal morphology on variability in n-3 polyunsaturated fatty acid enrichment of eggs. Poult. Sci. 91; 888-898.
[27]. Basmacioglu, H., M. Cabuk, K. Unal, k. Ozkan, S. Akkan and H. Yalcn (2003). Effect of dietary fish oil and flaxseed on cholesterol and fatty acid composition of egg yolk and blood parameters of laying hens. South Afr. J. Anim. Sci.33 (4): 266-273.
[28]. Aydin, R., M. Karaman, H.H.C. Toprak, A.K. Ozugar and T. Cicek (2006). The effect of long – term feeding of coniugated linolenic acid on fertility in Japanese quail. South Afr. J. Anim. Sci. 36 (2): 99-104.
[29]. Souza,J.G. F.G.P.Costa,R.C.R.E.Queioga, J.H.V. Silva, A.R. P. Sculer and C.C. Goulart (2008). Fatty acid profile of egg of semi-heavy layers fed feeds containing flaxseed oil. Barz. J. Poult. Sci. 10 (1): 37-44.
[30]. Hazim,J. Al-Daraji; Razuki, W.M.; Hayani, W.K. and Hassani, A.S. (2011). Effect of feeding diet containing flax seed on certain egg quality traits of Japanese quail. Researches of the first international conference (Babylon and Razi Universities).
[31]. Dunn-Horrcks,S.; Pichardo-Fuchs, M.; Lec, J.; Ruiz-Feria, C.; Creger, c.; Hyatt, D.; Stringfellow, K.; Sanchez, M. and M. Farnell (2011). International Journal of Poultry Science. 10:8-11.
[32]. Ayerza, R. and Coates, W. (2000). Dietary levels of chia: Influence on yolk cholesterol, lipid content and fatty acid composition for two strains of hens. Poult. Sci.79: 724-739.
[33]. Sim, J. S. and Qi, G.H. (1995). Designing Poultry products using flaxseed in : Cunnane, S.C. & Thompson, L.U. (Eds) Flaxseed in Human Nutrition, PP. 315-333. (Champaign, Il, USA, AOCS Press).
[34]. Baucells M.D, Crespo N, Barroeta, A.C., López-Ferrer,S., Grashorn, M.A.(2000). Incorporation of different polyunsaturated fatty acids into eggs. Poultry Science; 79:51-59.
[35]. Yalcin, H.; Unal, M.K. and Basmacioglu, H. (2007). The fatty acid and cholesterol composition of enriched egg yolk lipids obtained by modifying hens' diets with fish oil and flaxseed. Grasas YAceites 58 (4) 372-378.
[36]. Cherian, G. and Sim,J.S. (1991). Effect of feeding full-fat flax and canola seeds to laying hens on the fatty acid composition of eggs, embryos and newly hatched chicks. Poult. Sci. 70; 917-922.
[37]. Beynen, A.C. (2004). Fatty acid composition of eggs produced by hens fed diets containing groundnut, soya bean or linseed. Netherlands Journal of Agricultural Science, 52 (1): 3-10.
[38]. Van Elswyk, M.E.; Hargis, B.M.; Williams, J.D. and Hargis, P.S. (1994). Dietary menhaden oil contributes to hepatic lipids in laying hens . Poult. Sci.,73: 653-662.