Egypt. Poult. Sci. Vol. (40) (IV): (819-829) (2020) **(2009-1117)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

FATTY ACID PATTERN AND PRODUCTIVE PERFORMANCE OF LAYING HENS FED DIETARY FLAXSEED OIL

Naglaa K. Soliman and Sh. F. El-Afifi

Poult. Prod. Dep., Fac. of Agric., Ain Shams Uni., Cairo 11241, Egypt

Corresponding author: Naglaa K. Soliman E. mail: naglaa_elsayed@agr.asu.edu.eg

Received: 04/10/2020 Accepted: 25 /10/2020

ABSTRACT: The current study aimed to validate the effect of adding flaxseed oil into diets Saudi local strain laying hens, on their performance, cholesterol, and fatty acid profile of egg yolk. The study used 80 layers of Hager one local Saudi strain at 31 weeks of age. The hens were allocated into four treatment groups for 12 weeks experimental period. The four groups of hens were fed isocaloric corn-soy basal diet supplemented with, 3% palm oil (T1,control), 2% palm oil + 1% flaxseed oil (T2), 1% palm oil + 2% flaxseed oil (T3) or 3% flaxseed oil (T4). The main results indicated that, egg production percentage and average egg mass increased significantly due to adding 3% flaxseed oil into laying hen diets. The values of egg yolk (%), yolk color index, egg albumin (%) and eggshell (%) were not affected significantly due to adding flaxseed oil into diets. Flaxseed supplementation significantly reduced plasma and yolk content of cholesterol and plasma triglycerides, while egg triglycerides level was not affected. Inclusion of flaxseed oil into laying hen diets decreased yolk content of saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA). Egg content of polyunsaturated fatty acids (PUFA) increased clearly. There is a slight increment in linoleic (18:2) fatty acid ratios due to treatment. The increment in linoleic fatty acid was slight because it may be used for synthesis longer chain fatty acids. The ratio of omega3 α-Linolenic fatty acid (C18:3), was multiplied due to adding 3% flaxseed oil into laying hen diets. The study concluded that, enriched flaxseed oil into laying hen diets improve egg quality. However, feasibility study is still needed for evaluating the production of this type of egg economically.

Key wards: Laying hens, Flaxseed oil, GO 3 fatty acids, egg fatty acids

INTRODUCTION

Due to its physiological roles in protecting humans from chronic heart diseases, Linoleic (18:2 ῳ -6) and Linolenic (18:3 ῳ-3) fatty acids have been received great consideration recently (Yandy *et al.*, 2020). Human nutrition organizations recommended that, insert 5% of daily caloric intake from omega 6 (18:2) and omega 3 (18:3) poly unsaturated fatty acids (PUFA) can reduce plasma concentration of LDL cholesterol which promote vascular inflammation. In addition, it can suppress the production of adhesion molecules responsible for atherosclerotic process development (Harris *et al.*, 2009). In spite of, the modern style of human foods is mainly deficient in PUFA and rich in saturated fatty acids (SFA) which have more favorable taste inherent with low price (Simopoulos, 2002). There are two ways for increasing omega 3 and omega 6 (PUFA) in human diets, first by inclusion the natural oil rich in these fatty acids such as fish oil or flaxseed oil which have undesirable taste (Gonz-alez and Leeson, 2000).The second way via consumption the functional foods enriched with omega 6 Linoleic acid and omega 3 α linoleic acid (Yandy *et al.*, 2020). In this concern poultry eggs are one of the most popular food in human meal due to its high nutritive value with suitable price. It can increase PUFA content in human diets by eating eggs enriched with these types of fatty acids (Stehle and Grimble, 1998). Producing high PUFA eggs can be achieved by enriched laying hen diets with flaxseed oil (Gonz-alez and Leeson, 2000; 2001). Flaxseed oil is plant origin oil rich in PUFA and contains 31% and 37% linoleic (18:2 ῳ-6) and α linolenic (18:3 ῳ-3) fatty acids respectively (Herkel *et al.*, 2016). Flaxseed oil has been used successfully for producing low cholesterol eggs with modifying fatty acids patterns of egg yolk previously (Beheshti Moghadam et al, 2019 and Herkel *et al.*, 2016**)**. However, most of previous studies indicated to contradictory results concerning the effect of feeding flaxseed oils on productive performance of laying hens. As well, the effect on local Saudi strains is still lacking. Therefore, the current study aimed to validate the effect of adding flaxseed oil into diets of Hager one Saudi local strain layers, on their performance, fatty acid profile and cholesterol content of eggs.

MATERIALS AND METHODS

Birds, housing, and experimental diets

The current study conducted at the experimental poultry farm, Animal Production Department, Faculty of Agriculture Sciences and Nutrition, King Faisal University, Saudi Arabia kingdom.

The study used 80 laying hens of Hager one local Saudi strain at 31 weeks of age. The hens were randomly sited in battery cages located in close sided laying house. The hens were allocated into four treatment groups with 5 replicates of 4 layers per cage. For 12 weeks experimental period the four groups of layers were fed four isocaloric corn-soy diets (Table 1) containing all nutrients needed according to NRC (1994). Flaxseed oil is used as rich source of omega 3 and omega 6 fatty acids and substituted by palm oil to keep isocaloric diet. The four experimental treatments were, T1 (control): corn – soy basal diet supplemented with 3% palm oil, T2: basal diet enriched with 2% palm oil + 1% flaxseed oil, T3: basal diet enriched with 1% palm oil + 2% flaxseed oil, and T4: basal diet supplemented with 3% flaxseed oil. Palm oil was purchased from Saudi local market while flaxseed was purchased and squeezed in Egyptian oil press. Fatty acid profiles of two oils are listed in Table 2.

Performance parameters: Egg weight in grams was recorded daily for each cage and calculated for each hen throughout the experimental period. Average egg weight, egg production percentage were calculated for each hen and treatment group. Feed

consumption in grams per cage was recorded weekly and average daily feed consumption per layer was calculated. Feed conversion ratio was calculated as gram feed per gram egg produced (g. feed/g. egg). Body weight gain was calculated for each hen and treatment group by subtracting individual body weight of hen at 31 weeks from that at 43 weeks of age. Egg components percentages were assessed at 40 weeks of age by using 15 eggs per treatment representing three consecutive eggs from each cage. Eggs were individually weighted, broken, yolk and albumin were separated, weighed, and calculated as percentage to whole egg weight. Egg shell with membrane were cleaned, weighed, and related as percentage to the whole egg. Yolk color index was determined by matching yolk color with the bands of the Roche yolk color fan.

Blood and egg yolk analysis: At the end of the experiment blood samples were obtained from wing vein of 5 hens per treatments represents the five replicates. Plasma was separated and used for different determination. Plasma triglyceride and cholesterol was measured as mg/dl using special kits (United Diagnostic industry, Dammam, Saudi Arabia kingdom).

For yolk fat extraction three grams of egg yolk was homogenized in 15 ml, 2: 1 of chloroform: methanol mixture and yolk fat was isolated according to methods of (Folch *et al.,* 1957). Yolk concentration of triglycerides and cholesterol (mg/g) was determined by ultraviolet spectrophotometer using commercial kits (United Diagnostic industry, Dammam, Saudi Arabia kingdom).

Fatty acids content of tested oils and Egg yolk were determined by preparing fatty acid methyl esters from lipid extracts according to the method of Metcalfe *et al.,* (1961). Gas liquid chromatography (G.L.C.) was used to determine fatty acid content.

Statistical analysis: Data were analysed by the GLM procedure statistical analysis system (SAS, 1998) using one-way ANOVA with the following model:

$Y_{ijk} = \mu + T_i + e_{ijk}$,

Where: Y = dependent variable; μ = general mean; T = treatment effect; e = random error.

The differences among means were determined using Duncan's multiple range tests (Duncan,1955) at $P \leq 0.05$.

RESULTS AND DISCUSSION

Productive performance: Productive characteristics of laying hens are shown in Table 3. It is clear that egg production percentage and average egg mass increased significantly due to adding 3% flaxseed oil into laying hen diets. The current results are in harmony with those of Beynen, (2004) and Beheshti *et al.,* (2019) who observed an increment in egg production due to adding heated flaxseed oil into commercial strain layers. The improvement in egg production may be related to, high PUFA content of linseed oil which improve the digestibility of dietary fats, hence improve dietary energy utilization (Scott *et al.,*1982). On the other hand, some studies did not record any improvement in egg production due to adding flaxseed oil into diets (Promila and Saurabh Baloda, 2018; Jovo Perić *et al.,* 2019). This disagreement may be related to the laying hen strain (commercial against local strain) in addition to the differences in birds' age and experimental conditions. Feed efficiency ratio (g. feed/g. egg) improved significantly due to including 3% flaxseed oil into diets (Table 3). Similar results were obtained by Ansari *et al.* (2006) and Ahmad *et al.* (2013) who observed an improvement in feed conversion ratio due to adding flaxseed oil into laying hen diets. The improvement in feed efficiency ratios may be due to feeding unsaturated fats which improve feed and energy utilization (Alagawany *et al.,* 2019). There is a significant increment in feed intake by adding 3% flaxseed oil into diets. The current results disagree with those of Crespo and Esteve-Garcia (2001) who recorded

that, feed intake decreased due to adding flaxseed oil by 5 to 10% into their diets. This disagreement may be related to high level (10%) of flaxseed oil which may negatively affect the taste and odor of diets compared with 3% level in the present study. Body weight gains of birds fed different levels of flaxseed oil were significantly lower than those fed control diets. The negative effects of flaxseed cake and oil on body weight gain of layers have been recorded early (Ayerza and Coates, 2001).

Egg components percentage : Egg components percentage and yolk color index are presented in Table 4. Egg yolk percentages were not affected by enriched flaxseed oil into diets. Similar results were noted by Jovo Perić *et al.* (2019) who did not find any effect of flaxseed oil on egg yolk proportion. However, Scheideler and Froning (1996) observed a reduction in yolk size of layers fed 15% flaxseed illustrating that low yolk size may be due to the effect of PUFA on estrogen activity of the hen. Yolk color index did not differ significantly due to treatments. Promila and Saurabh Baloda (2018) did not indicate the differences in yolk color index of layers fed flaxseed oil. Egg albumin percentages were significantly similar and not affected by adding flaxseed oil into laying hen diets. Raes *et al.,* (2002), did not record any differences in albumin weight percentage due to adding linseed oil into laying hen diets. Egg shell quality in forms of shell weight percentages were not affected significantly by included flaxseed oil into laying hen diets. Previous studies did not indicate to any visible change in eggshell percentage or thickness due to adding flaxseed oil into laying hen diets (Grobas, *et al.,* 2001; Raes, *et al.,* 2002).

Egg and plasma cholesterol: cholesterol content of plasma and egg yolk reduced significantly due to adding flaxseed oil into laying hen diets (Table 5). These results are in a good agreement with those of Celebi and Utlu (2006) and Svedova,´ *et al.* (2008) who observed a significant reduction in plasma total cholesterol of laying hens fed diets supplemented with 4% or 3% of flaxseed oil respectively. As well, Ansari *et al.* (2006) observed a linear reduction in egg yolk cholesterol due to feeding graded levels of linseed oil. Harris *et al.* (1984) suggested that, PUFA may inhibit the synthesis of apoprotein B and very low-density lipoproteins which are responsible for cholesterol transport in the blood. Plasma triglycerides decreased significantly by adding 3% flaxseed oil into diets, while the values egg triglycerides were not affected (Table ٥). These results are in harmony with the suggestion of Harris *et al.* (1984) who showed that, feeding ῳ-3 PUFA able to suppress the triglycerides synthesis in laying hens.

Fatty acid pattern in egg yolk: Fatty acids content of egg yolk is listed in Table 6 as percentage of total fatty acids. The total ratio of saturated fatty acids (SFA) decreased with inclusion flaxseed oil into layers diets. Palmitic fatty acid is the most predominant SFA in egg yolk followed by stearic fatty acid and myristic fatty acid. Yalçyn *et al.* (2007) observed a reduction in total SFA content in egg yolk as a result of inclusion flaxseed oil into laying hen diets. Low SFA ratio in flaxseed oil and diets may be responsible for the reduction in egg yolk content of FSA. Scheideler and Froning (1996) stated that, fatty acid profile of egg yolk is influenced by fatty acid composition of the hen diets.

Monounsaturated fatty acids (MUFA) % reduced due to adding different levels of flaxseed oil. Oleic (18:1) fatty acid was the major MUFA in egg yolk, as well palmitoleic (16:1) and myristoleic (14:1) fatty acid was presented in egg yolk with small ratios. Several studies showed that, oleic fatty acid is the major MUSF in egg yolk (Yalçyn *et al.* 2007). The reduction in

MUFA in egg yolk due to including flaxseed oil into laying hen diets has been reported early. Ayerza and Coates, (2001) showed that, MUFA was significantly lower in egg yolk from layers fed linolenic acid enriched diets. On the other hand, Yalçyn *et al.* (2007) did not record any significant differences in egg MUFA due to adding flaxseed oil into hen diets; they prove that, laying hens have narrow ability to change MUSF in egg yolk.

The ratio of polyunsaturated fatty acids (PUFA) in egg yolk increased clearly by adding 3% flaxseed oil into laying hen diet. This result is in harmony with the finding of Ayerza and Coates, (2001) who found that hens feeding flaxseed oil content diets increase PUFA in egg yolk. Omega 6 (GƆ6) fatty acids were calculated as a summation of Linoleic (18:2), Eicosadienoic (C20:2) and Arachidonic (C20:4 GƆ6) fatty acids. There is a slight increment in yolk content of linoleic fatty acid ratios due feeding flaxseed oil. Hargis *et al.* (1991) indicated that the linoleic acid (GƆ-6) content was reduced in eggs due to feeding fish oil rich in omega 3 fatty acids. The slight increment in linoleic acid compared with linolenic acid may be related to using linoleic for synthesis the longer chain Arachidonic and Eicosadienoic fatty acids that are completely absence in egg yolk of control group (*Scott et al.*, 1982).

Omega3 (GƆ3) fatty acids ratio was negligible (0.026%) in egg yolk of layers fed control diet free of flaxseed oil. In contrary the ratio of omega3 fatty acid was 5.52% in egg yolk of birds fed diets with 3% flaxseed oil. α-Linolenic acid (C18:3) is the major omega3 fatty acids, its ratio in egg yolk was multiplied due to adding 3% flaxseed oil into laying hen diets. Scheideler *et al.* (1998) stated that, flaxseed oil is one of the most concentrated sources of linolenic fatty acid which can be deposited in egg yolk as results of adding flaxseed oil into laying hen diets. The current results indicated that, supplemented laying hen diets with 3% flaxseed oil, can increase egg content of PUFA inherent with high ratio of α-Linolenic acid. Feeding eggs with high content of PUFA and α-Linolenic can supply human with its daily needs and protect him from coronary heart diseases , prostate and breast cancer, delay the loss of immunological functions (Fernandes, 1995; Ferrier, *et al.* 1995 and Simopoulos, 1999).

CONCLUSION

It can be concluded that, addition of 3% flaxseed oil into local laying hen strain can improve egg production percentage. As well, it improves egg quality via increase its content of omega 3 α-Linolenic and omega 6 of Linoleic acid both have a beneficial effect for protecting human from coronary heart disease. Feasibility study is still needed for evaluating the production of this type of egg economically.

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

Ingredients	**T1 3% Palm oil (Control)**	**T2 1% flax+2% palm oil**	**T3 2% flax+1% palm oil**	**T4 3% Flax seed oil**
Yellow corn	54.57	54.57	54.57	54.57
Soybean meal (4٨%)	٢٥	٢٥	٢٥	٢٥
Palm oil	3	2	1	0
Flaxseed oil	0	1	2	3
Wheat bran	٥	5	٥	٥
Di Calcium phosphate	1.98	1.98	1.98	1.98
Limestone	9.4	9.4	9.4	9.4
DL. Methionine	0.٢	0.٢	0.٢	0.٢
Vit. & min. premix*	0.٤٥	0.٤٥	0.٤٥	0.٤٥
Common salt	0.3	0.3	0.3	0.3
L. Lysine	0.1	0.1	0.1	0.1
‘Total	100	100	100	100
Calculated analysis				
Crude protein%	17.43	17.43	17.43	17.43
M.E. Kcal/kg	٢٧٦٧	٢٧٦٧	٢٧٦٧	٢٧٦٧
% Calcium	4.١	4.١	4.١	4.١
%Available phosphorus	0.4٩	0.4٩	0.4٩	0.4٩
%Methionine + cysteine	0.78	0.78	0.78	0.78
%Lysine	1.1	1.1	1.1	1.1

*Composition of vitamin and mineral premix. Each 2.5kg of vitamin and mineral mixture contains: 12000000IU

vitamin A; 2000000 IU D_3; 10g E; 1g K; 1 g B_1; 5gB_2; 1500mg B_6; 10mg B_{12};10g Pantothenic acid; 20g Nicotinic

acid;1g Folic acid; 50mg Biotin; 500g Choline Chloride; 4 g Copper; 300 mg Iodine; 30g Iron; 60g Manganese; 50g

Zinc and 100mg Selenium.

Table (2): Fatty acids composition of palm and flaxseed oils.

Fatty acids	Palm oil	Flaxseed oil
Myristic acid (C14:0)	1.1	0.09
Palmitic acid (C16:0)	39.2	6.82
Palmitoleic acid (C16:1)	0.20	0.07
Stearic acid (C18:0)	3.70	3.78
Oleic acid (C18:1c)	44.70	20.47
Linoleic acid (C18:2 ω6)	10.40	13.69
α-Linolenic acid (C18:3 ω3)	0.30	54.38
Arachidic acid (C20:0)	0.01	0.16
11-Eicosenoic acid (C20:1)	0.10	0.13
Behenic acid (C22:0)	0.20	0.13
Total SFA %	44.21	10.98
Total MUFA%	45	20.67
Total PUFA%	10.7	68.07

SFA = Saturated fatty acids, MUFA = Monounsaturated fatty acids,
PUFA = Poly unsaturated fatty acids

Table (3): Effect of feeding flaxseed oil on productive performance of local strain layers**.**

Treatment	T1 3% Palm oil (Control)	T2 1% flax+2% palm oil	T3 2% flax+1% palm oil	T4 3% Flax seed oil
% Egg Production	42.52^{b}± 0.39	47.94^{a}± 2.36	41.59^{b}± 1.40	51.90^{a}± 1.18
Egg mass (g. egg/hen/day)	20.95^{b}± 0.70	21.92^{b}± 0.61	18.50^{c}± 0.57	24.16^{a}± 0.72
Egg Weight (g.)	46.06^{a}± 0.87	45.70^{a}± 0.70	44.58^{a}± 0.47	46.52^{a}± 0.68
Feed Intake(g./hen/day)	76.28^{b}± 2.38	77.58^{ab}± 0.80	69.70^{c}± 1.46	81.60^{a}± 0.89
Feed efficiency (g. feed/g. egg)	3.89^{a}± 0.21	3.62^{ab}± 0.12	3.78^{ab}± 0.04	3.43± 0.14
Body gain (g.)	128.5^{a}± 11.25	42.00^{b}± 13.19	81.30^{b}± 18.27	65.50^{b}± 4.43

Means ± (Standard error)
Values within a raw with different superscripts are significantly different (P≤0.05)

Table (4): Effect of feeding flaxseed oil on egg composition of local strain layers.

Treatment	T1 3% Palm oil (Control)	T2 1% flax+2% palm oil	T3 2% flax+1% palm oil	T4 3% Flax seed oil
Egg Yolk %	31.77± 0.75	32.12± 0.59	32.26± 0.68	31.41± 0.38
Yolk Colour Index	11.57± 0.43	11.21± 0.45	11.53± 0.44	11.50± 0.36
Egg Albumin %	56.32± 0.75	56.19± 0.57	56.15± 0.62	56.70± 0.38
Egg Shell%	11.91± 0.27	11.69± 0.14	11.58± 0.18	11.90± 0.25

Means ± (Standard error)

Table (5): Effect of feeding flaxseed oil on plasma and egg content (mg/dl) cholesterol and triglycerides in local strain layers.

Treatment	T1 3% Palm oil (Control)	T2 1% flax+2% palm oil	T3 2% flax+1% palm oil	T4 3% Flax seed oil
Cholesterol in blood	201.4^{a}± 2.15	186.7^{c}± 2.65	194.7^{b}± 2.25	183.1^{c}± 1.70
Triglyceride in blood	240.7^{a}± 3.97	223.7^{b}± 2.29	245.8^{a}± 3.66	210.3^{c}± 5.33
Cholesterol in egg	9.16^{a}± 0.12	8.45^{b}± 0.11	8.93^{a}± 0.11	8.08^{c}± 0.12
Triglyceride in egg	9.78^{a}± 0.18	9.87^{a}± 0.18	9.75^{a}± 0.07	9.59^{a}± 0.17

Means ± (Standard error)

Values within a raw with different superscripts are significantly different (P≤0.05)

Table (6): Effect of feeding flaxseed oil on egg yolk content of fatty acids.

Fatty acid	T1 3% Palm oil (Control)	T2 1% flax+2% palm oil	T3 2% flax+1% palm oil	T4 3% Flax seed oil
Myristic acid (C14:0)	0.186	0.207	0.208	0.157
Myristoleic acid (C14:1)	0.058	0.060	0.069	0.064
Palmitic acid (C16:0)	27.11	26.59	24.53	22.74
Palmitoleic acid (C16:1)	0.099	2.566	3.367	3.011
Stearic acid (C18:0)	8.42	3.48	6.95	3.178
Oleic acid (C18:1)	46.97	42.541	40.698	40.68
Linoleaidic acid (C18:2 ω6)	9.33	11.586	10.831	11.74
α-Linolenic acid (C18:3 ω3)	0.026	0.912	1.913	5.028
Arachidic acid (C20:0)	0.227	0.211	0.421	0.158
11-Eicosenoic acid (C20:1)	0.109	0.064	0.157	0.059
Eicosadienoic acid (C20:2)	-	-	0.150-	3.077
Eicosatrienoic acid (C20:3 ω6)	0.088	0.290	0.364	1.498
Arachidonic acid (C20:4 ω6)	-	0.327	0.266	0.055
Eicosapentaenoic acid (C20:5 ω3)		0.190	-	0.224
Behenic acid (C22:0)	0.692	0.301	1.708	0.240
Erucic acid (C22:1)	0.168	-	0.070	-
Total SFA %	36.64	30.79	33.8	26.47
Total MUFA%	47.40	45.2	44.36	43.81
Total PUFA%	9.44	13.31	13.52	21.62
Total ω3 fatty acids%	0.026	1.10	1.91	5.52
Total ω6 fatty acids%	9.418	12.2	11.46	13.29
SFA /PUFA ratio	64.5%	52.63	58.39	40.46
PUSF / MUFA ratio	19.91%	29.45	30.48	49.36

SFA = Saturated fatty acids, MUFA = Monounsaturated fatty acids,

PUFA = Poly unsaturated fatty acids

REFERENCES

Ahmad, S.; Yousaf, M.; Kamran, Z.; Soheil, M.U.; 2013. Effect of feeding whole linseed as a source of polyunsaturated fatty acids on performance and egg characteristics of laying hens kept at high ambient temperature. Revista Brasileira de Ciência Avícola. 15(1):21-5.

Alagawany, M.; Elnesr, Sh. S.; Mayada, R. F.; Abd El-Hack, M. E.; Asmaa, F. K.; Taha, A. E.; Ruchi, T. M.; Iqbal, Yatoo, P. B.; Sandip, K. K. and Kuldeep, D.; 2019. Omega-3 and omega-6 fatty acids in poultry nutrition: effect on production performance and health. Animals 9, 573 2 of 19

Ansari, R.; Azarbayejani, A.; Ansari, S.; Asgari, S.; Gheisari, A.; **2010.** Production of egg enriched with omega-3 fatty acids in laying hens. ARYA Atheroscler, 1(4).

Ayerza, R.; Coates, W.; 2000. Dietary levels of chia: influence on yolk cholesterol, lipid content and fatty acid composition for two strains of hens. Poultry science. 2000; 79(5):724-39.

Beheshti, M.; Shehab, M. H.; and Cherian, G.; 2019. Production Performance, Quality and Lipid Composition of Eggs from Laying Hens Fed Heated Flaxseed with Carbohydrase Enzymes. J. Appl. Poult. Res. 29:121–129

Beynen, A. C.; 2004. Fatty acid composition of eggs produced by hens fed diets containing groundnut, soya bean or linseed. NJAS-Wageningen Journal of Life Sciences. 52(1):3-10.

Celebi, S.; and Utlu, N.; 2006. Influence of animal and vegetable oil in layer diets on performance and serum lipid profile. Int. J. Poult. Sci., 5, 370– 373.

Crespo, N.; Esteve-Garcia, E.; 2001. Dietary fatty acid profile modifies abdominal fat deposition in broiler chickens. Poultry science. 80(1):71-8.

Duncan,D. B.; 1955. Multiple range and Multiple F tests. Biometrics, 11: 1-42.

Fernandes, G.; 1995. Effects of calorie restriction and omega-3fatty acids on autoimmunity and aging. Nutr. Rev., 53, 72–79.

Ferrier, L. K.; Caston, L. J.; Leeson, S.; Squires, J.; Weaver, B. J.; Holub, B. J.; 1995. alpha-Linolenic acid-and docosahexaenoic acid-enriched eggs from hens fed flaxseed: influence on blood lipids and platelet phospholipid fatty acids in humans. The American journal of clinical nutrition. 62(1):81-6.

Folch, J.; Lees, M.; Sloane Stanley, G. H.; 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226, 497–509.

Gonz_alez, E. R.; Leeson, S.; 2000. Effect of feeding hens regular or deodorized menhaden oil on production parameters, yolk fatty acid profile, and sensory quality of eggs. Poultry Sci https://doi.org/10.1093/ps/79.11.1597.

Gonz_alez, E. R.; Leeson, S.; 2001. Alternative for enrichment of eggs and chicken meat with omega-3 fatty acids. Can J Anim Sci 2001. https://doi.org/10.4141/A00-092.

Grobas, S.; Mendez, J.; Lazaro, R.; De Blas, C.; Mateo, G. G.; 2001. Influence of source and percentage of fat added to diet on performance and fatty acid composition of egg yolks of two strains of laying hens. Poultry Science. 80 (8):1171-9.

Hargis, P. S.; Van Elswyk, M. E.; and Hargis, B. M.; 1991. Dietary modification of yolk lipids with menhaden oil. Poult. Sci.,70, 874– 883.

Harris, W.S.; Mozaffarian, D.; Rimm, E.; Kris-Etherton, P.; Rudel, L. L.; Appel, L.J.; 2009. Omega- 6 fatty acids and risk

for cardiovascular disease: a science advisory from the American heart association nutrition subcommittee of the Council on nutrition, physical activity, and metabolism; Council on Cardiovascular nursing; and Council on epidemiology and prevention. Circulation. https://doi.org/10.1161/circulationaha.108.191627.

Harris, W. S.; Connor, W. E.; Inkeles, S.B. and Illingworth, D. R.; 1984. Dietary omega-3 fatty acids prevent carbohydrateinduced hypertriglyceridemia. Metabolism, 33, 1016– 1019.

Herkel, R.; Branislav, G.; Henrieta, A.; Daniel, B.; Miroslav, J.; Milan, S.; Michal, R.; 2016. Fatty acid profile and nutritional composition of table eggs after supplementation by pumpkin and flaxseed oils. ACTA VET. BRNO 85: 277-283; doi:10.2754/avb201685030277.

Jovo Perić1, Milanka Drinić1, and Nenad Mićić. 2019. Fatty acids in feed of laying hens on the production parameters and the ratio of omega-6 and omega-3 fatty acids. Biotechnology in Animal Husbandry 35 (4), 377-386.

Metcalfe, L. D.; Smitz, A.; and Pelka, C.; 1961. The rapid preparation of fatty acid esters for gas chromatography. Ann. Chem., 33: 363-364.

NRC, National Research Council; 1994. Nutrient requirements of poultry. Nat Acad. Sci., Washington, D. C.

Promila and Saurabh, B.; 2018. A review: Effect of linseed oil supplementation on internal and external quality of hen's egg. The Pharma Innovation Journal 7(4): 990-995.

Raes, K.; Huyghebaert, G.; De Smet, S.; Nollet, L.; Arnouts, S.; Demeyer, D.; 2002. The deposition of conjugated linoleic acids in eggs of laying hens fed diets varying in fat level and fatty acid profile. The Journal of nutrition. 132(2):182-9.

S.A.S. Institute, SAS user's Guide. 1988. SAS inst. Inc. Cary. N.C.

Scheideler, S. E.; Jaroni, D.; and Froning, G. W.; 1998. Strain and age effects on egg composition from hens fed diet rich in n-3 fatty acids. Poult. Sci., 77, 192– 196.

Scheideler, S. E.; Froning, G. W.; 1996. The combined influence of dietary flaxseed variety, level, form, and storage conditions on egg production and composition among vitamin E-supplemented hens. Poultry Science. 75(10):1221-6.

Scott, M. L.; Nesheim, M. C.; and Young, R. J.; 1982. Nutrition of the chicken. M.L. Scott & associates. Ihaco, Ny.

Simopoulos, A. P.; 2002. The importance of the ratio of omega-6/omega-3 essential fatty acids. Biomed Pharmacother https://doi.org/10.1016/S0753-3322(02)002253-6.

Simopoulos, A. P.; 1999. Essential fatty acids in health and chronic disease. Am. J. Clin. Nutr., 70, 560–569.

Stehle, P.; Grimble, R. F.; 1998. Nutraceutics: a novel approach in nutrition prevention and therapy. Curr Opin Clin Nutr Metab Care 1:525e6.

Svedova, M.; Vasˇko, L.; Trebunova, A.; Kasˇtel, R.; Tucˇkova, M.; and Certık, M.; 2008. Influence of linseed and fish oil on metabolic and immunological indicators of laying hens. Acta Vet. Brno., 77, 39– 44.

Yalcyn, H.; U¨ nal, M. K.; and Basmacyoolu, H.; 2007. The fatty acid and cholesterol composition of enriched egg yolk lipids obtained by modifying hens' diets with fish oil and linseed. Grasas Y. Aceites., 58(4), 372– 378.

Yandy, J.; Aguill, o. P.; Laura, A.; Romero, Gonzalo J. D.; 2020. Effect of full-fat sunflower or flaxseed seeds dietary inclusion on performance, egg yolk fatty acid profile and egg quality in laying hens. Animal Nutrition 6, 179-18.

Laying hens, Flaxseed oil, GƆ 3 fatty acids, egg fatty acids

الملخص العربى

محتوى البيض من الأحماض الدهنية والأداء الإنتاجي لدجاجات البيض المغذاة على زيت الكتان

نجلاء كمال سليمان السيد – شعبان فتوح العفيفى

كلية الزراعة جامعة عين شمس- قسم إنتاج الدواجن

تهدف الدراسة الحالية لمعرفة تأثير إضافة زيت بذور الكتان الى علائق الدجاج البياض من السلالة المحلية السعودية هجر واحد، على الأداء الأنتاجى، ومستوى الكوليسترول والأحماض الدهنية في صفار البيض.
استخدمت الدراسة ٨٠ دجاجة بياضة من السلالة هجر واحد عمر ٣١ أسبوعًا. تم تقسيم الدجاجات إلى أربع مجموعات لمدة ١٢ أسبوعًا فترة التجربة. تمت تغذية المجموعات الأربع من الدجاجات على ٤ علائق من الذرة وفول الصويا وتتساوى فى محتواها من الطاقة والبروتين مع أضافة
٣٪ زيت نخيل (T1 ، مجموعة الكونترول) ، ٢٪ زيت نخيل + ١٪ زيت بذور الكتان ((T2) ، 1٪ زيت نخيل + ٢٪ زيت بذور الكتان (T3)) أو ٣٪ زيت بذور الكتان (T4).
أشارت النتائج إلى زيادة معنوية في إنتاج البيض ومتوسط كتلة البيض نتيجة إضافة ٣٪ زيت بذور الكتان إلى علائق الدجاج البياض. لم تتأثر النسبة المئوية لصفار البيض ، مؤشر لون الصفار ، %للألبيومين أو %لقشرة البيضة معنويا نتيجة إضافة زيت بذور الكتان إلى العلائق. أضافة زيت بذور الكتان أدت إلى انخفاض معنوي في محتوى البلازما والصفار من الكوليسترول والدهون الثلاثية في البلازما ، بينما لم تتأثر الدهون الثلاثية في البيض. كذلك اشارت النتائج الى أنخفاض محتوى الصفار من الأحماض الدهنية المشبعة والأحماض الدهنية أحادية عدم التشبع. بينما زاد محتوى البيض من الأحماض الدهنية المتعددة عدم التشبع بشكل واضح نتيجة لأضافة زيت الكتان.
الحامض الدهنيى اللينوليك (١٨: ٢) أزدادت نسبته بشكل طفيف وهذا قد يرجع الى أستنفاذ جزء منه فى بناء الأحماض الدهنية الأطول فى السلسلة الكربونية. نسبة الحامض الدهنى أوميغا ٣ ألفا لينولينيك (C18: 3) تضاعفت نتيجة إضافة ٣٪ زيت بذور الكتان إلى علائق الدجاج البياض.