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DIETARY α-LINOLENIC ACID ALTERS N-3 FATTY ACID METABOLISM, IMMUNITY AND CHOLESTEROL LEVEL IN LAYING HENS AND THEIR PROGENY

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Abstract: *The aim of this study was to evaluate effects of α-linolenic acid (18:3n-3) supplemented diet on fats and fatty acid (FA) metabolism and immune response in the maternal hens and their hatched chicks. One hundred fifty of 30 wks old EL-Salam breeder hens were divided into three groups (5 replicate pens of 10 hens each) and housed in metallic batteries. Three levels (0, 2.5, 5%) of linseed oil (LO) were incorporated, replacing of commercial vegetable oils blend, into practical corn-soybean meal basal diet to provide 3 levels (12.1, 29.4, 47.5%) of 18:3n-3. After 10 wks of the experiment, fertilized eggs were incubated. The hatched chicks from each group were fed a commercial starter diet to estimate immune response and FA profile at 7-d old. The results obtained indicated that feeding LO diets for 12 wks did not affected hens productive performance traits. Lipids and cholesterol levels in hens (yolk, serum, liver) and cholesterol level in chicks liver were reduced (P<.05) with raising dietary LO level. Total n-3 polyun-saturated FA (PUFA, g/100g fat) were gradually increased (P<.01) to constitute in egg yolk 3.5, 9.3 and 17.5%, and in the chicks liver 4.9, 9.7 and 16.6% for 0, 2.5 and 5% LO groups, respectively. Linolenic was the major n-3family in yolks but not in the chicks liver. Long–chain n-3PUFA (20:5n-3, 22:5n-3, 22:6n-3) were, higher values (especially 22:6n-3) in the chicks liver than yolks, gradually increased (P<.01) to constitute in egg yolk 1.3, 2.3 and 4.7% and in the chicks liver 3.1, 6.1 and 10.8% for 0, 2.5 and 5% LO groups, respectively. There was insignificant reductions in saturated (SFA), monounsaturated (MUFA) and n-6PUFA with concomitant increases (P<.01) of n-3PUFA. Immune response of hens or hatched chicks was increased with raising dietary LO level. This study indicates that dietary 18:3n-3 raises n-3PUFA synthesis and immune response and reduces cholesterol level in the maternal hens and their newly hatched chicks.*

INTRODUCTION

The importance of yolk lipids as a source of energy and essential FA: linolenic (18:3n-3) and linoleic (18:2n-6) for the developing avian embryo has been well documented. α-linolenic is the precursor of long-chain n-3 PUFA such as eicosapentaenoic acid (EPA,20:5n-3), docosapentaenoic acid (DPA,22:5n-3) and docosahexaenoic acid (DHA,22:6n-3) through the desaturation and elongation pathway. The immunomodulatory functions of dietary PUFA have been widely studied in mammals, research in poultry is limited. However, an understanding of the effects and mechanisms by which nutrition influences the immune system is necessary to appreciate the complex interactions between diet and infectious diseases and to aid in maintaining chicken health and profitability (Klasing, 1998). In animal tissues, α-linolenic is converted to EPA and DHA. Linoleic acid (18:2n-6) is the precursor of n-6PUFA including arachidonic acid (AA,20:4n-6) which is the dominant precursor for eicosanoids in poultry. When diets are rich in n-3PUFA,20:5n-3 competes with 20:4n-6 as the substrate for cyclooxygenase enzyme inhibiting the production of thromboxane A2 (Kinsella *et al.*, 1990). By altering availability of AA in the membrane, a change in production of eicasanoids and eicosanoid–dependent cellular function may be produced. Arachidonic is precursor of 2-series prostaglandins and 4-series leukotrienes while EPA is precursor of 3-series prostaglandins and 5-series leukotrienes. These eicosanoids are important regulators of various immune response (Kinsella, 1993). Developmental events important for immunocompetence in chicks are initiated in the pre- and early 2 wks posthatch periods (Gobel, 1996; Ratcliff *et al.*, 1996). The early posthatch period sees a rapid increase in leukocyte populations and formation of unique clones of lymphocytes that will mediate immunity later in life (Klasing, 1998). Therefore, the supply of n-3PUFA during the embryonic and posthatch periods may impact the development and function of the immune system. The present study was designed to investigate effects of maternal dietary 18:3n-3 on FA profile, immune response and cholesterol level in maternal hens and hatched chicks.

MATERIALS AND METHODS

The present study was carried out at Sakha Animal Production Research Station, APRI, ARC, Egypt during January–March 2006 to study the effects of maternal dietary 18:3n-3 on fats and FA syntheses and immune response in maternal hens and hatched chicks. One hundred fifty breeder hens from EL-Salam strain (Nicolas×Mamourah) of 30 wks old were randomly divided into three groups (5 replicate pens of 10 hens each) and housed in

metallic batteries. Practical corn-soybean meal basal diet was formulated to meet nutrient requirements using Egyptian Feed Composition Tables (2001). Three levels (0, 2.5, 5%) of LO were incorporated, replacing of commercial vegetable oils blend, into basal diet to provide 3 levels (12.1, 29.4, 47.5%) of 18:3n-3 and fed for 12 wks as experimental period (Tables 1,2). Body weight, feed intake, egg number, egg weight and feed:egg mass ratio were measured weekly. Egg quality (Amer, 1972) and yolk color (Vuilleumier, 1969) were estimated 3 times (4 week intervals) using 50 eggs /group/time.

Table1: Composition of the experimental laying hen diets (30-42wks old)

Ingredient	Dietary linseed oil		
	Cont. 0 %	2.5 %	5 %
Yellow corn	49.41	49.41	49.41
Soybean meal, 44%	25.66	25.66	25.66
Wheat bran	8.50	8.50	8.50
Vegetable oils blend	5.00	2.50	0.00
Linseed oil	0.00	2.50	5.00
Limestone	8.55	8.55	8.55
Dicalcium phosphate	2.07	2.07	2.07
Vit.+Min. Mix[1]	0.30	0.30	0.30
NaCl	0.35	0.35	0.35
Dl-Methionine	0.15	0.15	0.15
Antioxidant	0.01	0.01	0.01
Calculated values[2]			
ME, Kcal/kg	2794	2794	2794
Lysine, %	0.96	0.96	0.96
Meth.+ Cys., %	0.70	0.70	0.70
Calcium, %	3.61	3.61	3.61
Av. Phosphorus, %	0.46	0.46	0.46
Determined analysis[3]			
DM, %	89.64	89.67	89.63
CP, %	16.61	16.63	16.62
EE, %	6.96	6.93	6.95
CF, %	3.67	3.68	3.64
Ash, %	9.83	9.79	9.86

(1) Vitamins and minerals premix provides per 3kg vit A 10 000 000 IU,vit D_3 2000 000IU, vit E 10000mg, vit $K_3$1000mg, vit B_1 1000mg, vit B_2 5000mg, vit B_6 1500, vit B_{12} 10mg, Pantothenic acid 10000mg, Nicin 30000mg, Biotin50mg, Folic acid 1000mg, Choline250 mg, Selenium 100mg, Copper 4000 mg, Iron 30000 mg, Manganese 60000mg, Zanic 50000mg, Iodine 1000mg, Cobalt 100mg and $CaCo_3$ to 3000g.
(2) According to Egyptian Feed Composition Tables (2001).
(3)According to AOAC(1990).

Hens were artificially inseminated once a week. During the last 2 wks of the experimental period, fertilized eggs were collected, stored for 5d at 18°C,

incubated, and the hatched chicks for each group were wing banded and fed a commercial starter diet. At the end of the experiment, five hens and twenty 7-d old hatched chicks from each group were slaughtered for liver and serum analyses. Lipids were extracted from yolk, liver, tested oils and feed samples according to Folch, *et al.* (1957), while serum lipids were estimated by Chabrol and Charonnat (1973). Cholesterol in liver, yolk and serum samples were determined according to Charles and Richmond (1974). For FA estimation, extracted lipids from samples of diets, tested oils, yolk and

Table 2: Analyzed fatty acid composition of oils and diets (g/100g fat)

Fatty acid[1]	Oils		Dietary linseed oil		
	Vegetable blend	linseed	Cont. 0 %	2.5 %	5 %
C14:0	0.19	0.09	0.48	0.39	0.29
C16:0	14.84	5.49	13.93	10.46	7.03
C18:0	4.95	3.81	5.92	5.15	4.23
C16:1	0.23	0.06	0.88	0.57	0.30
C18:1	27.71	18.47	27.36	23.41	19.48
C18:2n-6	38.71	20.02	38.01	29.40	20.05
C18:3n-3	12.09	50.82	12.13	29.35	47.50
Others	1.28	1.24	1.29	1.27	1.22
SFA	19.98	9.39	20.33	16.00	11.55
USA	78.74	89.37	78.38	82.73	87.23
MUFA	27.94	18.53	28.24	23.98	19.86
PUFA	50.80	70.84	50.14	58.75	67.55
n-6	38.71	20.02	38.01	29.40	20.05
n-3	12.09	50.82	12.13	29.35	47.50
n-6:n-3	3.20	0.39	3.13	1.00	0.42

Values are means of five determinations

[1]SFA=Saturated fatty acids; UFA=Unsaturated fatty acids; MUFA=Monounsaturated fatty acids; PUFA= Polyunsaturated fatty acids

liver tissues were transmethylated using methanolic KOH (Morrison and Smith, 1964). Fatty acid profile was determined using an automated GC_4 (HP5980 series ll, Hewlett Packard, Wilmington, DE 19808-1610), equipped with an automatic injector. Aliquots of 2 µl were injected into a capillary column (30m × 250µm) with cyanopropyl methyl silicone as stationary phase. Helium was used as conductor gas at a flow rate of 0.5 ml/min in column. The Split relationship was 1/200. The operating conditions of the GC were as follows: Initial temperature was 130°C, increasing 3.5°C per minute to 150°C. This temperature was maintained for 25 min and then increased to 210°C by 10°C per minute. After 7.5 min , the temperature was increased 10°C per minute to 250°C and maintained for 5 min. Total time of the chromatogram was 53.2 min. Detector temperature

(flame ionization detector) was 250°C. Fatty acid peaks were identified by comparison with retention times of FA methyl ester standards (Long-chain n-3FA standards were obtained from Sigma-Aldrich Quimica S.A. Madrid 28100, Spain). Immunological test using Sheep Red Blood Cells (SRBC's) was carried out by 10 breeder hens, and 20 1-d old hatched chicks of each group after 11 wks of feeding diets. The SRBC's (prepared by centrifuging sheep blood then washing 4 times using phosphate buffer saline, PH 7.2) were used as indicator cells for antibody producing cells. One ml of SRBC's (10^8 cells/ml) was intraperitoneally injected into each hen and the half dose was used with 1-d old hatched chicks. Seven-day later (Yamamoto and Glick, 1982), blood sample was collected from each bird and clotted to separate serum for antibody titration as described by Bachman and Mashaly (1986) and kai *et al.* (1988). Data were statistically analyzed using one–way ANOVA of GLM procedure of Statistical Analysis Software (SAS,1994). Significant differences among treatment means were separated by Duncan's new multiple range test (Duncan, 1955) with 5% level of probability.

RESULTS AND DISCUSSIONS

Fatty acid profile in diets and oils, and hen performance:

The commercial vegetable oils blend used in the basal diet contained 19.98, 27.94, 38.71 and 12.09 g/100g fat for SFA, MUFA, n-6PUFA and n-3PUFA, respectively, and they were almost similar to those of the practical corn-soybean meal diet lipids (Table2). Linseed oil contained, in addition to different FA concentrations, a higher 18:3n-3 value (50.8%). Experimental diets were formulated to cover the nutrient requirements for tested birds and contained 12.13, 29.35 and 47.5% 18:3n-3 (Tables 1,2). Results of laying performance showed that incorporation of LO in their diets for 12 wks had no significant effect on body weight, feed intake and conversion, egg weight and number, yolk color, shell thickness and shell and albumin weights (Table3). While yolk weight was gradually reduced ($P<.05$) by increasing dietary LO level. Similarly, Gonzalez-Esquerra and Leeson (2000) and Grobas *et al.* (2001) showed that laying hen performance traits were not affected by dietary n-3FA. Changes in yolk weight associated with dietary n-3PUFA have been reported previously (Whitehead *et al.*,1993; Marshall and Van Elswyk,1994; Ayerza and Coates,1999). Formulating diets to be isocaloric-isonitrogenous and contains similar values from minerals and vitamins may explain the unaffected productive traits of the present study. Regarding yolk weight decrease with LO diets, may explain that, since cholesterol is converted to pregnenolone which is the pivotal steroid from which all the other steroid hormones are produced (Grodsky, 1977), it is probable that LO may alter yolk weight indirectly through its inhibitory

effect on cholesterol biosynthesis and consequently the formation of steroid hormones which are involved in the general control of ovarian function either directly specially androgens or indirectly via their effect on pituitary.

Lipids and cholesterol levels in the maternal hens and hatched chicks:

Incorporation of 2.5 and 5% LO into hen diets for 11 wks gradually reduced (P<.05) lipids and cholesterol levels in maternal hens (yolk, serum, liver) (Table 3) and cholesterol level in hatched chicks liver (Table5) compared with control diet. There were significant differences between LO

Table 3: Performance, fresh tissue analysis and immune response of El-Salam breeder hens fed dietary linseed oil from 30 to 42 wks old.

Item	Dietary linseed oil			ANOVA	
	Cont 0 %	2.5 %	5 %	P value	SEM
Initial BW, g	1568	1579	1557	0.657	5.36
Final BW, g	1681	1667	1662	0.548	4.91
Feed intake, g	109	112	107	0.487	5.36
Feed: egg mass ratio	3.39	3.48	3.43	0.248	0.08
Egg production, %	61.25	62.12	60.83	0.654	1.81
Egg weight, g	52.54	51.81	51.23	0.234	0.92
Yolk weight, g	16.67[a]	15.55[b]	14.48[c]	0.024	0.34
Albumin weight, g	30.81	31.04	31.45	0.062	0.87
Shell weight, g	5.05	5.21	5.31	0.079	0.26
Shell thickness, mm	0.33	0.35	0.37	0.452	0.02
Yolk color	5.67	6.13	5.33	0.624	0.23
Yolk lipids, mg/g	346.4[a]	339.5[b]	323.7[c]	0.031	3.46
Yolk cholest., mg/g	14.45[a]	12.82[b]	10.14[c]	0.022	0.71
Liver lipids, mg/g	57.73[a]	56.22[b]	54.71[c]	0.042	1.16
Liver cholest., mg/100g	96.51[a]	89.36[b]	84.74[c]	0.032	2.29
Serum lipids, g/l	6.76[a]	6.15[b]	5.94 [c]	0.041	0.13
Serum cholest,mg/100ml	168.1[a]	159.5[b]	148.3[c]	0.032	4.21
Antibody titer	4.11[c]	5.03[b]	6.87[a]	0.013	0.26

Values are means of five determinations.
[a-c] Values followed by different letters within rows are significantly different (P<.05).

levels for lipid or cholesterol. This effect was found by Schumann *et al* (2000), who fed laying hens with LO and found a reduction in yolk and liver lipids and cholesterol levels. Also with broiler chicks, Maroschiello *et al* (1998) and Crespo and Esteve–Garcia (2001,2002) found similar reduction in lipids and cholesterol by dietary LO. Previous studies with birds and mammals suggest that, n-3PUFA inhibit lipid synthesis (Wilson *et al,* 1990; Blake and Clarke, 1990; Sanz *et al.,* 2000) and increase FA oxidation (Cunnane and Anderson, 1997; Madsen *et al.,* 1999; Sanz *et al.,* 2000) and

diet–induced thermogenesis (Takeuchi *et al.,* 1995). Reduction lipid lipogenesis with dietary 18:3n-3 was suggested with rats (Lambert *et al.*, 1998). These effects could explain why dietary 18:n-3 reduces tissue lipids.

Fatty acid composition of egg-yolk and liver of hatched chicks:

Data of FA composition (g/100g fat) showed great increases in n-3 PUFA concentration in egg yolk as the percentage of LO level increased in the diet (Table 4). Table 5 presents the data of liver FA, cholesterol level and immune response of 7-day old hatched chicks from breeder hens fed LO in their diets. Total n-3PUFA were gradually increased (P<.01) in yolk to

Table 4: Egg-yolk fatty acid composition (g/100g fat) of El-Salam breeder hens fed dietary linseed oil from 30 to 42 wks old.

Fatty acid[1]	Dietary linseed oil			ANOVA	
	Cont. 0 %	2.5 %	5 %	P value	SEM
C14:0	0.28	0.25	0.23	0.867	0.021
C16:0	24.58	23.98	22.35	0.154	2.813
C18:0	9.78	9.55	8.69	0.557	1.171
C14:1	0.17	0.15	0.16	0.987	0.004
C16:1	3.32	3.15	3.02	0.762	0.003
C18:1	38.57	36.94	33.23	0.089	3.251
C18:2n-6	17.86	15.86	13.04	0.07	1.273
C20:4n-6	0.48	0.46	0.45	0.06	0.031
C18:3n-3	2.25[c]	6.98[b]	12.71[a]	0.004	1.313
C20:5n-3	0.26[c]	0.43[b]	0.88[a]	0.007	0.012
C22:5n-3	0.20[c]	0.55[b]	0.96[a]	0.006	0.021
C22:6n-3	0.81[c]	1.34[b]	2.90[a]	0.008	0.137
Others	1.44	1.36	1.38	0.957	0.105
SFA	34.64	33.78	31.27	0.097	0.105
USA	63.92	64.86	67.35	0.087	3.174
MUFA	42.06	39.24	36.41	0.08	2.564
PUFA	21.86	25.62	30.94	0.068	2.870
n-6	18.34	16.32	13.49	0.07	1.273
n-3	3.52[c]	9.30[b]	17.45[a]	0.008	0.875
n-6:n-3	5.21[a]	1.76[b]	0.77[c]	0.009	0.621

Values are means of five determinations.
[a-c] Values followed by different letters within rows are significantly different (P<.05).
[1]SFA=Saturated fatty acids; UFA=Unsaturated fatty acids; MUFA=Monounsaturated fatty acids; PUFA= Polyunsaturated fatty acids.

constitute 3.5, 9.3, and 17.5% (Table 4), and in chicks liver to constitute 4.9, 9.7 and 16.6% (Table 5), for 0, 2.5, and 5% LO groups, respectively. Linolenic acid was the major n-3PUFA being 6.98 and 12.7% in LO yolk

lipids. This majority was not the case with chick liver, as the levels were lower being 3.57 and 5.75% at LO supplement diet levels of 2.5 and 5%. Long-chain n-3PUFA, especially 22:6n-3 were deposited in hatched chicks liver by higher values. Total long–chain n-3PUFA (20:5n-3, 22:5n-3, 22:6n-3) were gradually increased in yolk (P<.01) to constitute 1.3, 2.3, and 4.7%, and in chicks liver (P<.05) to constitute 3.1, 6.1 and 10.8% for 0, 2.5, and 5% LO groups, respectively (Table 5). Ratio of n-6:n-3 FA was decreased (P<.01) as a result of increasing n-3FA and decreasing n-6 FA in tested tissues. There was insignificant decrease in percentages of SFA, MUFA and n-6PUFA with a concomitant increases of n-3PUFA in yolk and chick liver lipids (Table 4,5). Palmetic (16:0), oleic (18:1) and lionoleic (18:2n-6)

Table 5: Liver fatty acid composition (g/100g fat) and cholesterol level (mg/100g) and immune response of 7-d old hatched chicks from breeder hens fed linseed oil diets from 30 to 42 wks old.

Item[1]	Dietary linseed oil			ANOVA	
	Cont. 0 %	2.5 %	5 %	P value	SEM
C14:0	0.85	0.82	0.68	0.738	0.084
C16:0	24.62	23.68	21.78	0.114	2.631
C18:0	14.83	13.92	13.06	0.573	1.083
C14:1	0.35	0.23	0.22	0.690	0.007
C16:1	4.78	4.00	3.18	0.371	0.138
C18:1	31.93	30.91	29.72	0.391	3.207
C18:2n-6	15.57	14.52	13.04	0.164	1.630
C20:4n-6	0.71	0.65	0.53	0.112	0.011
C18:3n-3	1.78^{c}	3.57^{b}	5.75^{a}	0.031	0.831
C20:5n-3	0.81^{c}	1.35^{b}	2.47^{a}	0.014	0.524
C22:5n-3	0.40^{c}	1.33^{b}	2.55^{a}	0.011	0.617
C22:6n-3	1.87^{c}	3.46^{b}	5.82^{a}	0.012	0.824
Others	1.50	1.46	1.20	0.624	0.163
SFA	40.30	38.42	35.52	0.097	3.241
UFA	58.20	60.12	63.28	0.087	4.786
MUFA	37.06	35.24	33.12	0.076	2.542
PUFA	21.14	24.88	30.16	0.063	2.129
n-6	16.28	15.17	13.57	0.067	1.427
n-3	4.86^{c}	9.71^{b}	16.59^{a}	0.013	1.734
n-6:n-3	3.35^{a}	1.56^{b}	0.82^{c}	0.014	0.043
liver cholesterol	68.31^{a}	54.83^{b}	41.96^{c}	0.034	0.826
Antibody titer	4.01^{c}	4.83^{b}	5.96^{a}	0.042	0.826

Values are means of five determinations.

[a-c] Values followed by different letters within rows are significantly different (P<.05).

[1]SFA=Saturated fatty acids; UFA=Unsaturated fatty acids; MUFA=Monounsaturated fatty acids; PUFA= Polyunsaturated fatty acids.

recorded the majors for SFA, MUFA and n-6PUFA, respectively, in tested tissues. Cherian and Sim (1991) and Cherian *et al*. (1997) showed similar alteration of FA composition by dietary n-3FA. Converting 18:3n-3 into 20:5n-3 and 22:6n-3 during desaturation and elongation pathway (Noble and Cocchi, 1989) may explain the increase of long–chain n-3PUFA in the present study. The enzyme desaturase is the rate limiting-step in the synthesis of 20:5n-3 from 18:3n-3. The FA composition of chick livers reflected yolk FA, which is not surprising, because during the 21-d developmental period, there is a large accumulation of yolk lipids in embryo liver (Noble and Cocchi, 1990). Extensive removal of yolk lipids and FA during the 3rd week of incubation is associated with a marked increase of PUFA in embryonic tissues (Cherian *et al*, 1997). The high levels of long–chain n-3FA, such as 22:6n-3, reflect a unique of embryonic liver in supplying long–chain n-3 to the developing chicks. An emphasis by the developing embryo for higher levels of C20 and C22 FA is clearly indicated by preferential incorporation of C20 and C22 FA into the embryo brain and liver (Noble and Cocchi, 1989; Cherian and Sim, 1993) .The net transfer of long–chain n-3FA, during incubation of eggs enriched with 18:3n-3, was shown by Cherian and Sim (1993) who found significant increases in the incorporateion of 20:5n-3, 22:5n-3 and 22:6n-3 in the heptic and brain tissues of hatched chicks.

Antibody response to SRBC's:

Results of antibody titer (AT) by both breeder hens (Table 3) and their newly hatched chicks (Table 5) showed similar trend with dietary LO. Incorporation of LO in laying hens diets for 11 wks increased (P<.01) AT to SRBC's by breeder hens from 4.11 for control to 5.03 and 6.87 for 2.5 and 5% LO hens, respectively, (Table 3). Similarly, AT to SRBC's in7-d old hatched chicks were increased (P<.05) from 4.01 for control to 4.83 and 5.96 for 2.5 and 5% LO groups, respectively (Table 5). There was a significant difference between the two LO groups for AT of hens and chicks (Tables 3,5). The present results confirmed those of Sijben *et al* (2001) and Wang *et al* (2002) who showed that incorporation of 18:3n-3 in laying hen diets increases immune response by hens and their hatched chicks. Wang *et al* (2000) found with laying hens that the immune responses of progeny can be affected by maternal and neonatal dietary n-3FA. Increasing immune response by dietary 18:3n-3 was observed by broiler chicks (Fritsche *et al*, 1991). When diets are rich in n-3FA, 20:5n-3 competes with 20:4n-6 as the substrate for cyclooxygenase enzyme inhibiting the production of thromboxane A2 (Kinsella *et al.*, 1990). By altering availability of AA in the membrane, a change in the production of eicasanoids and eicosanoid–

dependent cellular function may be produced. Arachidonic is the precursor of 2-series prostaglandins and 4-series leukotrienes, while EPA is precursor of 3-series prostaglandins and 5-series leukotrienes. These eicosanoids are important regulators of immune response (Kinsella, 1993). One may speculate that the effect of dietary 18:3n-3 on lymphocyte stimulation is caused by the increased competition of n-3 and n-6 FA on the binding sites of cyclooxygenase to produce prostaglandins. Immunoregulatory effects of maternal dietary n-3FA on progeny immune response could be adopted into health–promotion strategies of the broiler industry. For practical purposes, further studies are recommended to determine appropriate levels of maternal dietary n-3FA for optimizing immune response, disease resistance and resilience. The present study indicates that dietary 18:3n-3 raises n-3PUFA levels, immune response and reduces cholesterol level in the maternal hens and their newly hatched chicks.

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الملخص العربي

حامض ألفا اللينولينك بالعلف يغير تمثيل الأحماض الدهنية اوميجا-3 والمناعة ومستوى الكولسترول في الدجاج البياض ونسله

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اجري هذا البحث بهدف دراسة تأثير حامض ألفا اللينولينك في علف دجاج التربية على تخليق الدهون والأحماض الدهنية والاستجابة المناعية في كل من دجاج الأم وكتاكيتها الفاقسة . استخدم في هذه الدراسة 150 دجاجة في قمة إنتاج البيض عمر 30 أسبوعا من سلالة السلام قسمت عشوائيا إلى ثلاثة مجموعات متماثلة موزعة على 5 مكررات وربيت في بطاريات جماعية بعدد 10 دجاجات كمكررة في كل قفص وغذيت لمدة 12 أسبوعا على 3 علائق تم تكوينها من علف الأساس المكون من المواد النباتية الشائعة (ذرة-كسب فول الصويا) وذلك بإحلال زيت الكتان بمستويات صفر، 2.5، 5% محل مخلوط الزيوت النباتية التجاري المستخدم في علف الأساس لتعطي 3 مستويات من حامض ألفا اللينولينك هي 12,1، 29,4، 47,5% كنسبة مئوية من دهون العلف مع تساوي باقي العناصر الغذائية وتغطي احتياجات الطيور. وفي الأسبوع العاشر للتجربة تم تفريخ البيض المخصب وترقيم الكتاكيت الفاقسة بعدد 50 كتكوت/مجموعه موزعة على 5مكررات(10كتاكيت/مكررة) وغذيت جميعهاعلى علف بادي تجاري. واجري اختبار تحدي المناعة بحقن كرات الدم الحمراء للغنم في كل من دجاج التربية عند الأسبوع العاشر للتجربة والكتاكيت الفاقسة عمر يوم . وقيست كل من الأحماض الدهنية في صفار البيض وكبد الكتاكيت الفاقسة عند عمر 7 أيام وكذا الدهون والكولسترول في صفار البيض وسيرم الدجاج وكبد الكتاكيت ودجاج التربية فى نهاية التجربة. وأشارت أهم النتائج إلى أن استخدام زيت الكتان لم يؤثر معنويا على أداء دجاج التربية من حيث وزن الجسم واستهلاك العلف وكفاءة تحويله إلى بيض وإنتاج البيض وجودتة ، أما مستوى الدهون والكولسترول في

صفار البيض وسيرم دجاج الام وكبد كل من الكتاكيت الفاقسة والدجاج فقد انخفض تدريجيا بزيادة زيت الكتان في العلف. أظهرت الأحماض الدهنية متعددة عدم التشبع اوميجا–3 ارتفاعا تدريجيا معنويا في مجموعتي الطيور التي غذيت على أعلاف معززة بزيت الكتان مع اختلافهما معنويا مسجلتا 9.3، 17.5% في دهون الصفار و 9.7 ، 16.6% في دهون كبد الكتاكيت الفاقسة حديثا وذلك بالمقارنة بمجموعة الكنترول في دهون الصفار(3.5%) والكبد(4.9%) وسجل حامض اللينولينك أعلى قيم أفراد اوميجا–3 بالصفار مسجلا 7، 12.7% في مجموعتي زيت الكتان بينما تلاشت هذه السيادة في كبد الكتاكيت الفاقسة. ظهرت أفراد مجموعة الأحماض الدهنية اوميجا–3 ذات السلسة الطويلة وهم ك–20:5 اوميجا–3، ك–22:5 اوميجا–3، ك–22:6 اوميجا–3 بمستوي أعلى (خاصة ك–22 :6) في دهون كبد الكتاكيت القاقسه لتسجيل فى مجموعها3.1، 6.1، 10.8 % بالمقارنة بمستواها فى الصفار لتسجل1.3، 2.3، 4.7 % وذلك فى المجاميع صفر، 2,5، 5 % زيت الكتان على التوالي. أما الأحماض الدهنية المشبعة وأحادية عدم التشبع ومتعددة عدم التشبع اوميجا–6 فإنها لم تتأثر معنويا برغم وجود انخفاضات طفيفة غير معنوية في كل منهم مصاحبة للزيادة المعنوية في الأحماض الدهنية عديدة عدم التشبع اوميجا–3. كما اظهر اختبار تحدي المناعة بواسطة كل من دجاج التربية والكتاكيت الفاقسة زيادة إنتاج الأجسام المناعية تدريجيا بزيادة مستوي زيت الكتان فى علائق دجاج التربية. وتوصى هذه الدراسة بأن استخدام حامض اللينولينك في علف دجاج التربية يزيد تخليق الأحماض الدهنية اوميجا–3 وكذا الاستجابة المناعية ويخفض مستوى الدهون والكولستيرول ليس فقط في دجاج الأم بل أيضا في كتاكيتها الفاقسة حديثا.