Arab Gulf J. Scient. Res., **16** (2), pp. 331-345 (1998)

Effects of Dietary Retinol and Sunflower Oil on the Performance, and on the Lipoproteins, Lipids, Cholesterol and Retinol Concentrations of Plasma and Eggs of Laying Hens

T.M. Shafey

Department of Animal Production, College of Agriculture,
King Saud University, P.O. Box 2460, Riyadh 11451,
Kingdom of Saudi Arabia

ABSTRACT. The effects of adding vitamin A supplement (0, 6 mg retinol/kg) and sunflower oil (0, 20 g/kg) on the performance and on yolk cholesterol, fatty acid and retinol and plasma lipids, lipoproteins and retinol concentrations of laying hens were studied for 13 weeks. Pullets fed the retinol supplement had a significantly ($p < 0.05$) higher egg production, egg mass, plasma retinol concentration, yolk cholesterol and retinol contents and a higher daily egg cholesterol output and a lower yolk arachidonic acid concentration than pullts fed the control diet. Weight gain, feed consumption, egg weight, yolk concentration of most fatty acids and plasma lipids and lipoproteins concentrations were not significantly affected by retinol supplementation. Sunflower oil supplementation significantly ($p < 0.01$) increased yolk concentration of stearic, linoleic and arachidonic acids and decreased yolk concentration of palmitic and oleic acids. Production performance, yolk cholesterol, linolenic acid and retinol concentrations and plasma retinol, lipid and lipoprotein concentrations were not significantly affected by sunflower oil supplementation. There was a significant interaction between dietary sunflower oil and retinol supplements on egg weight. Sunflower oil supplementation significantly reduced egg weight of pullets fed the retinol diet, whilst sunflower oil supplementation increased the egg weight of pullets fed the control diet. The reduction in egg weight may be caused by the inhibitory effect of retinol on the synthesis of arachidonic acid from linoleic acid in the liver of laying hen.

Running Title: Lipoproteins, lipids and vitamins in plasma and eggs.

It was concluded that hens fed a diet supplemented with retinol produced eggs with a high concentration of retinol and cholesterol and that hens fed on a diet supplemented with sunflower oil produced eggs with a high concentration of stearic, linoleic and arachidonic acids, but none of the dietary supplements affected the composition of the plasma lipoproteins.

Lipids are synthesized in the liver of a laying hen and transported to the ovary by lipoproteins. Plasma very low-density lipoproteins (VLDL) are the major components of egg yolk (Yu *et al.* 1976, Chapman 1980). Several reviews have emphasized the role of dietary factors in modifying egg yolk lipid (Stadelman and Pratt 1989, McDonald and Shafey 1989, Shafey and Dingle 1992). The fat-soluble vitamins, like cholesterol, are transported by lipoproteins in the blood plasma and deposited in the egg yolks. The addition of vitamin A to the diet of laying hens did not affect plasma or yolk cholesterol concentrations (Dua *et al.* 1967, Weiss *et al.* 1967), whilst sunflower oil supplementation affected the fatty acid composition of egg yolk (Sim *et al.* 1973) and decreased the cholesterol concentration of blood but not of the egg yolk (Fisher and Leveille 1957). Information relating to the comparative influences of dietary components on lipid transport is scarce.

Reducing cholesterol and increasing the unsaturated to saturated fatty acid ratio of eggs would improve their perceived health status for human nutrition. This study was designed to investigate the effects of dietary concentrations of a form of vitamin A, (retinol), and sunflower oil on yolk concentrations of fatty acids, cholesterol and retinol and on plasma concentrations of lipids, lipoproteins and retinol and on the performance of layers.

Materials and Methods

A total of 48, Tegal strain birds (White Leghorn x New Hampshire) were randomly selected, then weighed and individually caged with a separate feed trough. Each bird was assigned to one of the experimental diets and treated as a replicate. Birds were housed in a two-tier cage system. Feed and water were available *ad libitum.* Diets were supplied as mash. A photoperiod of 14 h commenced when the birds were caged at 22 weeks of age and continued throughout the trial. Birds were fed on a wheat-based diet (mash, 17.5% protein, 11.7 MJ calculated metabolizable energy/kg) until 41 weeks of age at the commencement of the experiment. The experiment was a 2 x 2 factorial, the variables being vitamin A (0, 6 mg retinol/kg) and sunflower oil (0, 20 g/kg) levels. Each experimental diet was fed to 12 replicates.

Table 1. The composition of the basal diets (g/kg).

Ingredient	Basal diets	
	1	2
Maize	480.00	475.00
Sorghum	216.00	201.00
Meatmeal (52% protein)	90.00	90.00
Cottonseed	50.00	50.00
Soybean	85.00	90.00
Sunflower oil	–	20.00
Limestone	70.00	70.00
Salt	2.00	2.00
Lysine	2.00	2.00
Methionine	3.00	3.00
*Vitamin/mineral premix	2.00	2.00
Analysis		
Crude protein (N% x 6.25)	16.3	16.5
Linoleic acid (g/kg)	1.07	1.93
Calculated metabolizable energy (MJ/kg)	11.6	12.1
Retinol (mg)	2.1	1.9

* The composition of vitamins and minerals in the premix per kg diet were: retinol, 2.4 mg; cholecalciferol, 75 μg; DL-α-tocopheryl acetate, 5 mg; riboflavin, 3 mg; menadione sodium bisulphite, 300 μg; niacin, 15 mg; cyanocobalamin, 10 μg; biotin, 5 μg; choline, 100 mg; ethoxyquin, 20 mg; Co, 200 μg; I, 500 μg; Cu, 5 mg; Fe, 20 mg; Mn, 80 mg; Zn, 50 mg; Se, 100 μg; Mo, 200 μg; apocarotenoic ester, 150 mg; canthaxanthin, 50 mg.

The composition of the basal diets is shown in Table 1. Total feed consumption was measured over the 13-week experimental period. The birds were re-weighed when the experiment was concluded. Egg weight was based on a complete collection of eggs for three days, each week starting 2 weeks from the beginning of the experiment. Calculations of egg weight were based on 4-week periods. Two eggs were randomly sampled from each bird, then weighed and their yolks separated and weighed. Yolks from each three birds fed the same experimental diet were treated as a replicate, pooled together, homogenized, and a sample placed in an air tight container prior to analysis. Egg cholesterol and fatty acids were determined for the 4 replicates per diet every 2 weeks starting 3 weeks from the beginning of the experiment. Egg retinol was determined in the last three batches of sampled yolks.

At the completion of the experimental period, 7-ml of blood were withdrawn from the wing-vein of each bird. Blood was collected into glass tubes with a blood collecting cocktail (Edelstein and Scanu 1986), centrifuged at 2300 x g for 20 minutes at 4 °C and plasma was collected for analysis. Plasma samples from each two birds fed the same experimental diet were pooled into one sample prior to analysis. A total of 6 plasma samples per diet were available for analysis. Very low-density lipoproteins (VLDL) were separated at density 1.006 by ultracentrifugation using a Beckman (Beckman Inc., Palo Alto, CA) TL 100 centrifuge with a TL 41.2 rotor at 75,000 rpm for 3 hours. The substrate contained low-density and high-density lipoproteins. The concentrations of lipid and cholesterol in the total plasma and lipoprotein fractions were determined by kits provided by Boehringer Mannheim (Hoffman- La Roche, Zurich, cat. no. 124303 and 123087, respectively); triglycerides by a kit from Sigma (St. Louis, Missouri, USA, cat. no. 405-b); protein was determined by a kit provided by Pierce (Fairfield, Connecticut, USA, BCA, cat. no. 23225) and phospholipids by using the method of Zilversmit and Davis (1950) after extraction of lipids according to Folch *et al.* (1957). Fatty acid and cholesterol concentrations in the yolk lipid were determined by gas-liquid chromatography (Nugara and Edwards 1970 and Ishikawa *et al.* 1974), respectively. The concentration of retinol in the diet and yolk were determined according to the methods of Manz and Philip (1988), and in the plasma according to the method of Vuilleumier *et al.* (1983). Data collected were subjected to analysis of variance (Steel and Torrie 1980). Data relative to body weight gain, feed consumption, rate of lay, egg mass and plasma composition were statistically analyzed as a 2 x 2 factorial design. Parameters were using the following model: $Y_{ijl} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \varepsilon_{ijl}$ where μ = overall mean, α_i = fixed effect of vitamin A, β_j = fixed effect of sunflower oil, $\alpha\beta_{ij}$ = the interaction between vitamin A and sunflwoer oil, ε_{ijl} = the residual term associated with n observations (~ N [0, σ]). The remaining data were analyzed with a time as a repeat measure. Parameters were using the following model:

$Y_{ijkl} = \mu + \alpha_i + \beta_j + d_{ijk} + \rho_l + \alpha\beta_{ij} + \alpha\rho_{il} + \beta\rho_{jl} + \varepsilon_{ijkl}$ where μ = overall mean, α_i = fixed effect of vitamin A, β_j = fixed effect of sunflower oil, d_{ijk} = random effect of bird, ρ_l = fixed effect of period, $\alpha\beta_{ij}$, α, ρ_{il} and $\beta\rho_{jl}$ are corresponding interactions effects and ε_{ijkl} = the residual term. When significant variance ratios were detected, differences between treatment means were tested using the least significant difference procedure.

Results and Discussion

The effects of dietary retinol and sunflower oil on the performance of laying hens and on their yolk cholesterol, fatty acids and retinol contents are summarized in Tables 2 and 3, respectively. Birds given retinol supplements had a significantly ($p < 0.05$) higher egg production, egg mass, yolk cholesterol and retinol contents and daily egg cholesterol output and lower yolk arachidonic acid content than those fed on the control diet. Supplementation of vitamin A to approximately seven times (8.4 mg retinol/kg) the requirement for laying hens as recommended by NAS-NRC (1994) increased egg production and egg mass of laying hens. It appears that the level of retinol in the premix of the control diet (2.4 mg retinol/kg, twice the recommended level, NAS-NRC 1994) was not sufficient to support optimum performance of laying hens. This was not in agreement with Hill *et al.* (1961) and Mehner *et al.* (1965) who found no effect on egg production when 6 and 19.2 mg respectively, retinol equivalent/kg diet were fed to laying hens. However, March and Biely (1964) found that a moderately excessive level of retinol (6.6 mg/kg diet) caused a decline in egg production. This may be due to many factors including differences in strain and age of birds and/or experimental conditions. The addition of retinol to the diet reduced the arachidonic acid concentration of egg yolk, possibly due to the inhibitory effect of retinol on the synthesis of arachidonic acid in the liver of laying hen. This suggestion is supported by Burnhard *et al.* (1963) who found that the addition of fat-soluble vitamin such as vitamin E to rats' diets inhibited the synthesis of arachidonic acid from linoleic acid in the liver. The finding that retinol did not affect plasma cholesterol but increased yolk cholesterol concentration did not agree with Dua *et al.* (1967) and Weiss *et al.* (1967) who found that supplementation of retinol to laying hen diets did not significantly affect the concentration of cholesterol in either plasma or egg yolk.

Sunflower oil supplementation significantly ($p < 0.05$) increased stearic, arachidonic and ($p < 0.01$) linoleic acid and reduced oleic and ($p < 0.05$) palmitic acid concentrations in egg yolk lipid. The reduction in egg yolk palmitic and oleic acids was compensated for by the increase in stearic, linoleic and arachidonic acids. This finding may suggest that increasing dietary linoleic acid arachidonic acids content from feeding sunflower oil as well as other vegetable oils to layers may enhance the synthesis of linolenic and arachidonic acids in the liver and subsequently increase the deposition of these fatty acids in the yolk (Fisher and Leveille 1957, Sim *et al.* 1973, Shafey *et al.* 1992). It should be noted that while sunflower oil increased the concentration of yolk linoleic acid, it reduced monounsaturated (oleic) to polyunsaturated (linoleic) fatty acid ratio (5.08 vs. 3.53, $p < 0.01$). The substitution of oleic for linoleic in egg yolk has been reported by

Table 2. Performance of laying hens fed different levels of retinol and sunflower oil[1].

Treatment	Weight gain (g)	Feed consumption (g)	Rate of lay (egg/hen/day)	Egg weight (g)	Yolk weight (g)	Egg mass (g)
Sunflower oil (Oil)						
Control	87.4 ± 12.9 (24)	114.4 ± 9.3 (24)	0.85 ± 0.01 (72)	60.8 ± 0.5 (90)	18.5 ± 0.2 (72)	52.4 ± 0.9 (72)
With oil	102.1 ± 19.4 (24)	108.5 ± 3.9 (24)	0.84 ± 0.01 (72)	61.6 ± 0.5 (90)	18.6 ± 0.1 (72)	51.7 ± 0.9 (72)
Vitamin						
Control	93.2 ± 14.8 (24)	105.1 ± 3.6 (24)	0.83 ± 0.01 (72)	60.7 ± 0.5 (90)	18.4 ± 0.2 (72)	50.4 ± 0.9 (72)
With retinol	96.3 ± 18.6 (24)	117.0 ± 8.9 (24)	0.86* ± 0.02 (72)	61.8 ± 0.6 (90)	18.7 ± 0.1 (72)	53.1* ± 1.0 (72)
Interaction						
Oil x Vitamin	NS	NS	**	**	NS	NS

[1] Values are means ± standard error for number of samples given in parenthesis.
* Significantly different ($p < 0.05$).
** Significantly different ($p < 0.01$).
NS Not significantly different.

Table 3. Cholesterol, fatty acid and retinol concentrations of egg yolks from hens fed different levels of retinol and sunflower oil[1].

Treatment	Cholesterol			Fatty acids[2] (% Fatty acid methyl esters of yolk fat)						Retinol (mg/g yolk)
	Concent-ration (mg/g yolk)	Content (mg / yolk)	Daily output (mg/day)	16:0	18:0	18:1	18:2	18:3	20:4	
Sunflower oil (Oil)										
Control (24)	10.8 ± 0.3	191.2 ± 5.6	163.7 ± 5.7	26.8 ± 0.3	9.8 ± 0.1	46.2 ± 0.1	9.1 ± 0.3	0.3 ± 0.01	1.00 ± 0.3	3.93 ± 0.16
With oil (24)	10.9 ± 0.2	204.2 ± 4.8	178.1 ± 6.1	27.0** ± 0.3	10.2** ± 0.1	43.4** ± 0.3	12.3** ± 0.3	0.3 ± 0.01	1.73** ± 0.3	4.17 ± 0.15
Vitamin										
Control (24)	10.6 ± 0.3	191.8 ± 5.6	163.7 ± 5.7	26.4 ± 0.3	10.0 ± 0.1	44.2 ± 0.4	10.8 ± 0.6	0.4 ± 0.06	1.62 ± 0.02	3.95 ± 0.18
With retinol (24)	11.1* ± 0.3	204.2* ± 5.4	178.1* ± 6.1	27.6 ± 0.4	10.1 ± 0.1	45.3 ± 0.5	11.0 ± 0.5	0.3 ± 0.01	1.16* ± 0.02	4.37* ± 0.11
Interaction										
Oil x Vitamin	NS	NS	NS	NS	*	NS	NS	NS	NS	NS

[1] Values are means ± standard for number of samples given in parenthesis.

[2] 16:0 = palmitic acid; 18:0 = stearic acid; 18:1 = oleic acid; 18:2 = linoleic acid; 18:3 = linolenic acid; 20:4 = arachidonic acid.

* Significantly different ($p < 0.05$).

** Significantly different ($p < 0.01$).

NS Not significantly different.

Shafey *et al.* (1992). The importance of polyunsaturated fatty acids in human nutrition has been emphasized. Dietary polyunsaturated fatty acids are very effective in lowering blood cholesterol concentration and may be important in reducing the risk of coronary heart disease (Walsh 1975). However, the ratio of yolk unsaturated (oleic, linoleic, linolenic and arachidonic) to saturated (palmitic and stearic) fatty acids was not affected by dietary sunflower supplementation (1.55 vs. 1.56). The nonsignificant effect of sunflower oil supplementation on yolk cholesterol concentration was in agreement with McDonald and Shafey (1989). However, sunflower oil supplementation did not significantly affect egg production, yolk weight, egg mass, yolk retinol concentration nor daily egg cholesterol. There were no significant differences in weight gain, feed consumption and yolk weight nor of yolk linolenic acid, cholesterol concentration of birds fed the different diets. There was a significant interaction between dietary sunflower oil and retinol supplements on egg weight. Sunflower oil supplementation significantly ($p < 0.01$) reduced egg weight of pullets fed the retinol diet, whilst sunflwoer oil supplementation increased ($p < 0.01$) the egg weight of pullets fed the control diet. Egg weight is positively related to dietary linoleic acid content (Scott *et al.* 1982). Whilst, the reduction in egg weight may be caused by the inhibitory effect of retinol on the synthesis of arachidonic acid from linoleic acid in the liver of laying hens. Excess dietary retinol reduced arachidonic acid concentration in egg yolk (Table 3). It seems that the amount of arachidonic acid available for deposition in egg yolks is a limiting factor for egg weight. Linoleic and arachidonic acids are essential fatty acids for birds (Scott *et al.* 1982).

Results of plasma lipid, retinol and lipoprotein analyses are shown in Tables 4 and 5, respectively. There were no significant differences between the concentrations of plasma total lipid, triglycerides, cholesterol and phospholipids nor the composition of lipoprotein fractions from feeding the sunflower oil or vitamin supplements. The concentration of retinol was significantly ($p < 0.05$) higher in plasma from birds given the retinol diet than from those given the control diet. However the percentage of total plasma retinol found in VLDL was not significantly affected by dietary retinol content. Sunflower oil did not significantly affect the concentration of retinol in plasma nor the percentage of total plasma retinol found in VLDL. Results from lipoprotein analysis indicate that dietary sunflower oil and retinol contents did not affect the composition of plasma lipoproteins of laying hens. The high proportion of plasma total retinol found in VLDL indicated that most of the plasma retinol is transported in the VLDL fraction of the blood of laying hens. Dietary supplementation with retinol apparently increased the amount of retinol absorbed from the alimentary tract, transported in the blood and deposited in the egg yolk.

Table 4. Plasma triglyceride, cholesterol, phospholipid and retinol concentrations of laying hens fed different levels of retinol and sunflower oil[1].

Treatment	Total lipid (mg/ml)	TG[2]	C[2]	PL[2]	Retinol	
		(mg / ml)			(µg / ml)	(%in VLDL[3])
Sunflower oil (Oil)						
Control (12)	22.1 ± 2.0	12.6 ± 1.5	1.8 ± 0.2	6.9 ± 0.5	0.10 ± 0.02	85.8 ± 5.7
With oil (12)	17.4 ± 0.8	10.0 ± 0.6	1.4 ± 0.1	5.9 ± 0.4	0.14 ± 0.02	54.5 ± 8.9
Vitamin						
Control (12)	19.4 ± 2.6	10.4 ± 1.5	1.6 ± 0.1	6.5 ± 0.7	0.10 ± 0.01	60.7 ± 9.9
With Retinol (12)	18.6 ± 1.2	10.4 ± 0.7	1.4 ± 0.2	6.2 ± 0.3	0.16 * ± 0.02	71.6 ± 23.9
Interaction						
Oil x Vitamin	NS	NS	NS	NS	NS	NS

[1] Values are means ± standard for number of samples given in parenthesis.
[2] TG, triglycerides; C, total cholesterol; PL, phospholipids.
[3] The proportion of total plasma concentration found in VLDL.
* Significantly different ($p < 0.05$).
** Significantly different ($p < 0.01$).
NS Not significantly different.

Table 5. Triglyceride, cholesterol, and phospholipid content of very low density lipoproteins (VLDL) and low and high density lipoproteins (LDL + HDL) in the plasma of laying hens fed different levels of retinol and sunflower oil[1].

Treatment	VLDL[3]					LDL + HDL[4]				Recovery rate[7]
	Lipid mg/ml	Lipid composition %[5]			Recovery rate[7]	Lipid mg/ml	Lipid composition %[6]			
		TG[2]	C[2]	PL[2]			TG[2]	C[2]	PL[2]	
Sunflower oil (Oil)										
Control (12)	19.7 ± 1.7	57.0 ± 1.8	6.3 ± 0.6	31.4 ± 1.6	94.7 ± 0.7	2.2 ± 0.5	35.7 ± 2.9	11.0 ± 1.2	46.0 ± 3.5	92.7 ± 0.7
With oil (12)	15.2 ± 0.7	56.9 ± 1.6	5.7 ± 0.7	31.6 ± 1.7	94.1 ± 0.3	1.9 ± 0.2	40.0 ± 1.3	11.1 ± 1.1	41.6 ± 2.0	92.7 ± 0.5
Vitamin										
Control (8)	17.1 ± 2.0	54.0 ± 2.9	6.6 ± 0.9	33.7 ± 2.1	93.8 ± 1.1	2.0 ± 0.2	39.2 ± 1.9	10.3 ± 1.4	43.9 ± 2.5	93.3 ± 0.5
With retinol (8)	16.5 ± 1.2	56.6 ± 0.8	5.2 ± 0.6	32.7 ± 1.2	94.5 ± 0.4	2.3 ± 0.8	35.3 ± 4.4	11.6 ± 1.8	45.1 ± 6.0	92.0 ± 1.0
Interaction										
Oil x Vitamin	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1] Values are means ± standard for number of samples given in parenthesis.
[2] TG, triglycerides; C, total cholesterol; PL, phospholipids.
[3] Very low density lipoprotein fraction. [4] Low plus high density lipoprotein fraction.
[5] Relative lipid composition in VLDL lipid fraction. [6] Relative lipid composition in LDL + HDL lipid fraction.
[7] Relative lipid measured in lipoprotein fraction [TG + C + PL)/total lipid in lipoprotein fraction] * 100
* Significantly different ($p < 0.05$). ** Significantly different ($p < 0.01$). NS Not significantly different.

It was concluded that hens fed a diet supplemented with retinol produced eggs with a high concentration of retinol and cholesterol and that hens fed a diet supplemented with sunflower oil produced eggs with a high concentration of stearic, linoleic and arachidonic acids, but none of the dietary supplements affected the composition of the plasma lipoproteins.

References

Burnhard, K., Lindlar, F., Schwed, P., Vuilleumier, J.P. and **Wagner, H.** (1963) Fatty acid metabolism in vitamin E deficiency. *Zeit. fur Ernah.* **4:** 42-49.

Chapman, M.J. (1980) Animal lipoproteins: chemistry, structure, and comparative aspects. *J. Lip. Res.* **21:** 789-853.

Dua, P.N., Dilworth, B.C., Day, E.J. and **Hill, J.E.** (1967) Effect of dietary retinol and cholesterol on cholesterol and carotenoid content of plasma and egg yolk. *Poul. Sci.* **46:** 531-539.

Edelstein, C. and **Scanu, A.M.** (1986) Precautionary measures for collecting blood destined for lipoprotein isolation. *Meth. Enzy.* **28:** 151-155.

Fisher, H. and **Leveille, G.A.** (1957) Fatty acid composition of eggs as influenced by dietary fats. *Poul. Sci.* **30:** 1116. (Abstract)

Folch, J., Lees, M. and **Sloan-Stanely, G.H.** (1957) A simple method for isolation and purification of total lipids from animal tissues. *J. Biol. Chem.* **226:** 2497-2509.

Hill, F.W., Scott, M.L., Norris, L.C. and **Heuser, G.F.** (1961) Reinvestigation of the retinol requirements of laying hens and their progeny. *Poul. Sci.* **40:** 1245-1254.

Ishikawa, T.T., MacGee, J., Morrison, J.A. and **Glueck, C.J.** (1974) Quantitative analysis of cholesterol in 5 to 20 ul of plasma. *J. Lip. Res.* **15:** 286-291.

McDonald, M.W. and **Shafey, T.M.** (1989) Nutrition of the hen and egg cholesterol. *In:* Egg Industries Research Council **(Ed.),** Cholesterol in Eggs Seminar, (Sydney, Australia, Egg Industries Research Council), 33-39 pp.

Manz, U. and **Philip, K.** (1988) Determination of retinol in complete feeds, premixes and vitamin concentrates with HPLC, *In:* **Keller, H.E. (Ed.),** Analytical Methods for Vitamins and Carotenoids in Feed, (Basle, Switzerland, Hoffmann- La Roche), 5-7 pp.

March, B.E. and **Biely, J.** (1964) The effect of a moderate excess of dietary retinol on egg production. *Poul. Sci.* **43:** 393-396.

Mehner, A., Torges, H.G. and **Vogt, H.** (1965) Effect of increased amounts of vitamin A on egg quality. *Nutr. Abs. and Rev.* **36:** 604.

NAS-NRC, National Academy of Science- National Research Council (1994) Nutrient requirements of domestic animals. No. 1, Nutrient Requirements of Poultry. 7th **Ed.,** NAS-NRC (Ed.) (Washington, DC, NAS-NRC).

Nugara, D. and **Edwards, H.M.** (1970) Changes in Fatty acid composition of cockerel testes due to age and fat deficiency. *J. Nutr.* **100:** 156-160.

Scott, M.L., Nesheim, M.C. and **Young, R.J.** (1982) Nutrition of Chicken (Itheca, NY, M.L. Scott and Associates).

Shafey, T.M. and **Dingle, J.G.** (1992) Factors affecting egg fatty acid and cholesterol content, *In:* Australian Poultry Science Symposium, Poultry Research Foundation **(Ed.),** (NSW, Australia, University of Sydney and World's Poultry Science Association), 79-83 pp.

Shafey, T.M., Dingle, J.G. and **McDonald, M.W.** (1992) Comparison between wheat, triticale, rye, soyabean oil and strain of laying bird on the production, and cholesterol and fatty acid contents of eggs. *Brit. Poul Sci.* **33:** 339-346.

Sim, J.S., Bragg, D.B. and **Hodgson, G.C.** (1973) Effect of dietary animal tallow and vegetable sunflower oil on fatty acid composition of egg yolk, adipose tissue and liver of laying hens. *Poul. Sci.* **52:** 51-57.

Stadelman, W.J. and **Pratt, D.E.** (1989) Factors influencing composition of the hen's egg. *World's Poul. Sci. J.* **45:** 247-266.

Steel, R.G.D. and **Torrie, J.H.** (1980) Principles and Procedures of Statistics. (New York, McGraw-Hill Book Company Inc.)

Vuilleumier, J.P., Keller, H.E., Gysel, D. and **Hunziker, F.** (1983) Clinical chemical methods for the routine assessment of vitamins status in human populations. *Int. J. Vit. Nutr. Res.* **53:** 265-272.

Walsh, R.J., Day, M.F., Fenner, F.J., McCall, M., Saint, E.G., Scott, T.W., Tracey, M.W. and **Underwood, E.J.** (1975) Diet and Coronary Heart Disease, Report Number 18 (Canberra, Australian Academy of Science).

Weiss, J.F., Johnson, R.M. and **Naber, E.C.** (1967) Effect of some dietary factors and drugs on cholesterol concentrations in the eggs and plasma of the hen. *J. Nutr.* **91:** 119-128.

Yu, J.Y., Campbell, L.D. and **Marquardt, R.R.** (1976) Immunological and compositional patterns of lipoproteins in chicken plasma. *Poul. Sci.* **55:** 1626-1631.

Zilversmit, D.B. and **Davis, A.K.** (1950) Microdetermination of plasma phospholipids by trichloroacetic acid precipitation. *J. Lab. Clin. Med.* **35:** 155-160.

(Received 18/01/1997;
in revised form 02/05/1998)

تأثير إضافة فيتامين أ (الرتينول) وزيت دوار الشمس في علائق دجاج البيض على الصفات الإنتاجية وتركيز الليبوبروتينات والدهون والكليسترول والرتينول في البلازما والبيض

طارق محمد شافعي

قسم الإنتاج الحيواني - كلية الزراعة - جامعة الملك سعود
ص .ب (٢٤٦٠) - الرياض ١١٤٥١ - المملكة العربية السعودية

أجريت تجربة لدراسة تأثير إضافة فيتامين أ بمستويات (صفر ، ٦ ملجم رتينول / كجم) وزيت دوار الشمس (صفر ، ٢٠ جم / كجم) في عليقة دجاج البيض على الصفات الإنتاجية وتركيز الكليسترول والأحماض الدهنية والرتينول في صفار البيض ، وكذلك الدهون والليبوبروتينات والرتينول في بلازما دجاج البيض لمدة ١٣ أسبوعاً . وقد أظهرت النتائج أن إضافة الرتينول أدى إلى زيادة إنتاج البيض وكتلة البيض المنتجة وتركيز الرتينول في البلازما وتركيز الكليسترول والرتينول في الصفار والكليسترول المخزن يومياً في البيض ، وإلى تقليل تركيز حامض الأراشيدونيك في الصفار ، وذلك عند مقارنته بالعليقة القياسية .بينما لم يكن هناك أي تأثير معنوي على وزن الجسم وإستهلاك العلف ووزن الصفار ومعظم الأحماض الدهنية في صفار البيض وتركيز الليبوبروتينات والدهون في البلازما .

وأدت إضافة زيت دوار الشمس إلى زيادة معنوية في تركيز كلٍ من حامض ستيريك ولينوليك وأراشيدونك ، بينما قللت تركيز كلٍ من حامض البالميتيك والاوليك في صفار البيض ، بينما لم تتأثر كلٍ من الصفات الإنتاجية وتركيز الكليسترول وحامض اللينوليك والرتينول في صفار البيض ، وتركيز

الرتينول والدهون والليبوبروتينات في البلازما بإضافة زيت دوار الشمس إلى العليقة . وتأثر وزن البيضة بالتفاعل بين زيت دوار الشمس والرتينول في العليقة ، حيث أدى إضافة زيت دوار الشمس إلى العليقة المضاف إليها الرتينول إلى إنخفاض وزن البيضة ، بينما أدى إضافة زيت دوار الشمس إلى العليقة القياسية إلى زيادة وزن البيضة ، وربما يرجع الإنخفاض في وزن البيضة إلى التأثير المثبط للرتينول على تخليق حامض الأرشيدونيك من حامض اللينوليك في كبد دجاج البيض .

ونستخلص من هذه النتائج أن إضافة الرتينول إلى عليقة دجاج البيض أدى إلى إنتاج بيض ذي تركيز مرتفع من الرتينول والكليسترول ، بينما إضافة زيت دوار الشمس إلى العليقة أدى إلى إنتاج بيض ذي تركيز مرتفع من حامض الستيريك واللينوليك والأراشيدونيك ، ولم تؤثر إضافة إي من الرتينول أو زيت دوار الشمس إلى العليقة على الليبوبروتينات في بلازما دجاج البيض .