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THE EFFECT OF DIETARY SORBITOL ON EGG YOLK CHOLESTEROL CONTENT AND LIPID METABOLISM IN THE LAYING HENS

By

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Abstract: *Ninety laying hens of Gimmizah local strain at 32 weeks of age were used to study the effect of sorbitol on egg yolk cholesterol content and lipid metabolism. All hens were divided randomly into three equal groups (30 hens / group), the first group served as control and fed the commercial layer diet only, while the second and third groups were fed the commercial layer diet supplemented with 50 and 100 mg sorbitol / Kg of diet respectively.*

The results indicated that the addition of sorbitol to the Gimmizah laying hen diets decreased ($P \leq 0.01$) egg yolk and liver cholesterol (CH) and total lipid (TL) concentrations and serum triglyceride (TG), cholesterol (CH) and low density lipoprotein (LDL). Moreover, addition high level of sorbitol was increased ($P \leq 0.01$) serum high density lipoprotein (HDL) concentration,whereas serum glucose (GLC), glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) levels remained unchanged by the dietary sorbitol compared with the control group. Abdominal fat percentage was decreased ($P \leq 0.01$) when hens fed diet supplemented with sorbitol. While, no significant differences in excretion of bile volume of gall bladder and relative weights of liver, ovary and oviduct and oviduct length were observed among groups during the experimental period. Body weight, feed intake, egg weight and egg production percentage were decreased ($P \leq 0.01$) especially with high level of sorbitol compared with the control group. No significant differences were detected in relative weights of yolk and albumin, egg shape index , yolk index and Haugh unit score , except shell weight and shell thickness which were decreased ($P \leq 0.01$) when hens fed diet supplemented with high level of sorbitol compared with the control group during the later weeks of production (38,42 and 46 weeks).

INTRODUCTION

Egg yolk is one of the most concentrated sources of cholesterol in human's diet. Patients with atherosclerosis and coronary heart diseases are frequently avoided from consuming diets containing high cholesterol level (Friedman, 1968). The cholesterol in yolk (> 90%) is present as free (non esterified) cholesterol, this is synthesized in the liver of laying hens in response to estrogen stimulation and transported via blood to ovary, the lipoprotein (along with other yolk precursors) pass out of capillaries of the developing follicles, then taken up into the oocyte by receptor-mediated endocytosis (Griffin, 1990). The liver of laying hens exhibits greater lipid synthesis because it synthesizes triglyceride and secretes very low density lipoprotein (VLDL) in an amount sufficient to meet a high egg production rate (Nimpf and Schneider, 1991). Thus many intensive efforts were made to reduce the cholesterol content of the egg.

Sorbitol (also known as glucitol) is a very common sugar alcohol. It is made naturally by the body and occurs in some fruits, like prunes. It can also be chemically produced from glucose. It is used as a sugar substitute in diet and diabetic food products. Moreover, it is also used in many manufacturing processes, as a pharmaceutical aid, and in several research applications (Merriam- Webester, 2007). Sorbose can be produced from sorbitol by fermentation with Acetobacter suboxydans and by nonenzymatic condensation of glyceraldehyde and dihydroxy acetone (Furuse *et al*., 1990).

Dietary sorbitol or sorbose can be regulated lipid metabolism in laying hens (Atlla, 2002; Furuse *et al*., 1990). Plasma VLDL from the sorbose- treated hens was characterized by having less cholesterol and triglyceride per unit of protein, which indicates that sorbose may inhibit hepatic synthesis of cholesterol or triglyceride, or both (Beyer and Jensen, 1993). Previous investigations have shown that sorbose reduced feed consumption, body fat, serum triglyceride, cholesterol, LDL,VLDL and chylomicron levels, furthermore, sorbose supplementation of the laying hens diets decreased accumulation of liver fat, thus liver color improved (Furuse *et al*., 1990). While Atlla (2002) indicated that sorbitol supplementation to LSL laying hens in drinking water reduced cholesterol content in serum, egg yolk and liver, also decreased serum LDL and triglyceride, while no effect of sorbitol on serum HDL and glucose levels. Therefore, the present work was conducted to study the effect of dietary sorbitol on egg yolk cholesterol content and lipid metabolism in a local strain of laying hens.

MATERIALS AND METHODS

The present study was carried out at the El-Sabahia Poultry Research Station (Alexandria), Animal production Research Institute, Agricultural Research Center, Ministry of Agriculture. Ninety laying hens of Gimmizah local strain were used at 32 weeks of age. The birds were weighed and housed individually in layer cages in an open system house. The feed was ad- libitum on layer diet containing 16% crude protein and 2900 Kcal.ME/Kg of diet, water was also provided all time and the birds were exposed to 14 hours light daily throughout the experimental period. All hens were divided randomly into three equal groups (30 hens / group), the first group served as a control and fed the commercial layer diet without any additives, while the second and third groups were fed the commercial layer diet supplemented with 50 and 100 mg sorbitol / Kg of diet respectively. The experimental period were continued for 14 weeks from 32 to 46 weeks of age. All hens were individually weighed and the diet in each group was weighed to calculate the hen feed consumption while egg weight was recorded and egg production percentage was calculated. At 34, 38, 42 and 46 weeks of age, blood samples were withdrawn from randomly five birds in each group through the wing vein in tubes and kept at room temperature for one hour to clot, then the tubes were centrifuged at 3000 rpm for 15 minutes to separate clear serum which was stored at – 20 °C for determination of the triglyceride (TG), cholesterol (CH), high density lipoprotein (HDL), low density lipoprotein (LDL), glucose (GLC), glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) concentarations by spectrophotometer using available commercial Kits according to Soloni (1971); Richmond (1973); Warnick *et al.*, (1983); Assmann *c.*,(1984); Keilin and Hartree (1948) and Reitman and Frankel (1957), respectively. Also five eggs were randomly taken from each group at the time of blood sampling for egg quality measurements and determination of total lipids and cholesterol in yolk extracts .Lipids were extracted from yolk and liver samples by chloroform: methanol (2:1) according to Washburn and Nix (1974). Total lipids in yolk and liver extracts were determined according to Frings *et al.*, (1972). At the end of the experimental period (46 weeks of age), three random hens from each group were sacrificed to calculate relative weight of abdominal fat*, liver, ovary and oviduct. Oviduct length (cm), as well as bile volume of gall bladder (ml) was measured and liver samples were taken and stored at – 20 °C for determination of total lipids and total cholesterol in liver extracts.

*Abdominal fat including abdominal fat and fat surrounding the gizzard and proventiculus

Statistical Analysis:

Data were subjected to the ANOVA using SAS software (SAS, 1990). When significant differences were found, means were compared using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

A- Physiological Traits:

1- Egg Yolk Lipids:

Egg yolk total lipids (TL) and cholesterol (CH) decreased ($P \leq 0.01$) in response to addition of the sorbitol to the diet of laying hen except egg yolk TL with 50 mg sorbitol after 2 weeks of treatments compared with the control group (Table 1). After 14 weeks of treatments, it could be noticed that, egg yolk TL and CH were diminished ($P \leq 0.01$) by 14.7% and 17.6% (in egg yolk TL) and 34.4% and 44.5% (in egg yolk CH) when hens fed diet with 50 mg and 100 mg sorbitol, respectively compared with the control group. The reduction in CH level was more pronounced than TL (Table 1). These results are in agreement with those obtained by Atlla (2002) who found that 10% sorbitol addition in drinking water of LSL laying hens were significantly reduced egg yolk cholesterol by 20.2% and 30.4% after 2 and 4 weeks of treatment respectively compared with the control group, moreover, the birds in both treatments continued to produce eggs with significantly lower yolk cholesterol level after being switched to the control diet.

2- Blood Constituents:

Serum levels of triglyceride (TG), cholesterol (CH), high density lipoprotein (HDL), low density lipoprotein (LDL), glucose (GLC), glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) are presented in Tables (2) and (3). Results indicated that addition of the sorbitol to the control diet decreased ($P \leq 0.01$) serum TG, CH and LDL compared with the control group. After 14 weeks of treatment (at 46 weeks of age) , it can be noticed that the addition of 50 and 100 mg sorbitol to the control diet caused a significant decrease by 22.4% and 41.7% in TG; 36.6% and 46.2% in CH and 37.1% and 47.3% in LDL as a percentage of the control value (Tables 2). Moreover, it can be observed that serum TG, CH and LDL were decreased ($P \leq 0.01$) after 2 weeks of treatment. The reduction in serum TG, CH and LDL in the present study is consistent with the previous research, Atlla (2002) indicated that supplementation sorbitol at 10 % in drinking water of LSL hens were significantly reduced serum TG, CH and LDL by 37.5%, 35.9% and 29.7%, respectively compared with the control group. Beyer and Jensen (1993) observed that the laying hens

(Hy- line) fed dietary 10 or 20 % sorbose exhibited plasma cholesterol concentration approximately 50 % less than that of the control hens when determined after 2 and 4 weeks of treatment. They found that sorbose not only reduced plasma VLDL but also altered its composition, plasma VLDL from the sorbose treated hens was characterized by having less cholesterol and triglyceride per unit of protein. This indicated that sorbose may inhibit hepatic synthesis of cholesterol or triglyceride or both. Also, Furuse *et al.*, (1990) showed that the laying hens (White Leghorn) fed 100 and 200 mg sorbose per Kg of diet greatly reduced serum cholesterol, LDL, triglyceride and chylomicron concentrations. Moreover, the laying hens fed diets containing 100 and 200 mg sorbose per Kg of diet reduced serum VLDL by 38% and 84% respectively, compared with the control group. In addition, Goodridge (1987) indicated that sorbose may influence lipid metabolism in laying hens by a specific mechanism, such as the observation that certain dietary nutrients influence lipogenic enzyme gene expression.

In the present study, the opposite trend was obtained in HDL (Table 2). During the experimental period, it can be observed that serum HDL were increased ($P \leq 0.01$) by 8.2% as a percentage of the control group when addition high level of sorbitol (100 mg) to the laying hens diet. HDL is high density lipoprotein which plays a crucial role in reducing the risk of atherosclerotic cardiovascular diseases. Thus, HDL particles called good cholesterol (Belitz and Grosch 1992). On the other hand, Atlla (2002) observed that addition of 10 % sorbitol in drinking water for LSL laying hens had no significant effect on plasma HDL compared with the control group.

Results from Table (3) indicated that no significant differences were found in serum glucose, GOT and GPT concentrations when hens fed diet containing 50 and 100 mg sorbitol compared with the control group. Sorbose has been reported as an inactive transported sugar (Iiundian *y.*, 1979). Thus similar results for glucose obtained by Atlla (2002) who observed that sorbitol supplementation to the laying hens drinking water had no effect on blood glucose compared with the control group. Moreover, Furuse *et al.*, (1990) indicated that serum glucose concentration was not altered by dietary sorbose.

3- Liver Lipids and Bile Volume of Gall Bladder:

Liver total lipids (TL) and cholesterol (CH) concentrations and bile volume of gall bladder are presented in Table (4). The results indicated that there was a decrease ($P \leq 0.01$) in liver total lipids by about 12.63% and 20.89% and in liver cholesterol by about 39.72 % and 64.45% as the laying hens fed 50 and 100 mg sorbitol /Kg of diet compared with the control group, respectively. The reduction in liver CH level was more pronounced than liver TL. On the other hand, sorbitol had no effect on bile volume of gall bladder. These results are in agreement with the observation of Furuse *et al.*, (1990) indicated that dietary sorbose can be used as a potential regulatory of lipid metabolism in the laying hens since a decrease in liver fat accumulation could be expected. While, Atlla (2002) found that 10 % sorbitol supplementation in drinking water of LSL laying hens had no significant effect on liver cholesterol.

4- Internal Organs:

Results presented in Table (5) indicated that there were insignificant differences in relative weights of liver, ovary and oviduct and oviduct length when laying hens fed diet with 50 and 100 mg sorbitol compared with the control group. While addition of sorbitol at 50 and 100 mg to laying hen diets caused a significant ($P \leq 0.05$) decrease in abdominal fat percentage compared with the control group by 28.83% and 63.06% respectively. These results are in agreement with Furuse *et al.*, (1990) who observed that the synthesis of lipid and its transport into abdominal fats were decreased with dietary sorbose, consequently both absolute and relative weights of abdominal fat were reduced when laying hens fed dietary sorbose. Moreover, Furuse *et al.*, (1991b) indicated that the absolute and relative abdominal fat weights and fat content in the pectoral muscle were reduced when broiler chickens fed dietary sorbose.

On the other hand, Cahaner et *al.*, (1986) reported that an increase in abdominal fat in broiler lines was generally accociated with an increase in yolk fat concentration.

B- Productive Traits:

1- Body Weight and Feed Intake:

Body weight and feed intake were significantly ($P \leq 0.01$) influnced by addition of 50 or 100 mg sorbitol in laying hens diet. Results presented in Table (6) showed that body weight and feed intake were decreased ($P \leq 0.01$) as compared with the control group. These results are in agreement with Beyer and Jensen (1993) who indicated that the body weight and feed

intake were significantly reduced when laying hens (Hy- line) fed dietary sorbose for 4 weeks. Also Furuse *et al*., (1990 and 1991a) reported that body weight gain and feed intake of laying hen's fed diets containing 10 or 20 % sorbose were decreased in addition to reduction of energy metabolism .Moreover, in the present study no mortality was observed in the three groups during all the experimental period.

2- Egg Production Traits:

Results presented in Table (6) indicated that addition of sorbitol to the laying hens diet decreased ($P \leq 0.01$) by 4.9 (g) and 4.64 %, respectively egg weight and egg production percentage especially with high level of sorbitol (100 mg) except egg production percentage after 2 weeks of treatment compared with the control group. These results are in agreement with Atlla (2002) who showed that addition of 10% sorbitol in drinking water of laying hens was decreased egg production rate about 8 % after 4 weeks of treatment. Also Beyer and Jensén (1993) indicated that egg weight and egg production percentage were significantly reduced by 3.4 (g) and 18.9 %, respectively when the laying hens were fed 10 % sorbose for 4 weeks compared with the control group. While Furuse *et al*., (1990) observed that the egg production rate was not affected with 10 or 20 % dietary sorbose.

3- Egg Quality:

Results in Table (7) and (8) indicated that no significant ($P \leq 0.01$) differences in relative weight of yolk and albumen, egg shape index, yolk index and Haugh unit scores between groups of laying hens fed diet with 50 or 100 mg sorbitol compared with the control group during the experimental period. However, relative weight of egg shell and egg shell thickness were significantly decreased only with 100 mg sorbitol / Kg diet after 6 weeks of treatment (at 38 weeks of age) and thereafter as compared with the control group. These results are partly agree with Beyer and Jensen (1993) who indicated that relative yolk weight was significantly decreased, while albumen and shell relative weights were not affected by dietary sorbose.

It may be concluded from the present results that adding sorbitol by levels of 50 or 100 mg / Kg diet reduced cholesterol content in laying hen eggs, liver and blood as well as triglyceride and LDL levels in blood. Therefore, a reduction of the cholesterol content of market eggs would be of interest to both egg producers and patients with atherosclerosis and coronary heart diseases .Also dietary sorbitol can be used as a potential regulator of lipid metabolism by inhibit hepatic synthesis of cholesterol or triglyceride or both and lipoprotein in the laying hen.

Table (1): Effect of dietary sorbitol on egg yolk total lipids (TL) and cholesterol (CH) of Gimmizah laying hens.(Means ± SE)

Age (weeks)	Sorbitol (mg/Kg of diet)	TL (mg/g)	CH (mg/g)
34	0	250.10±1.75^{a}	13.80±0.63^{a}
	50	246.45±3.85^{ab}	10.85±0.58^{b}
	100	239.55±4.44^{b}	9.50±0.49^{c}
38	0	251.60±0.88^{a}	13.68±0.83^{a}
	50	231.40±3.36^{b}	10.45±0.90^{b}
	100	212.25±2.91^{c}	9.25±0.51^{c}
42	0	253.65±1.56^{a}	13.75±0.37^{a}
	50	224.15±3.76^{b}	9.58±0.26^{b}
	100	209.48±1.75^{c}	8.43±0.36^{c}
46	0	252.75±1.09^{a}	13.65±0.43^{a}
	50	215.60±2.57^{b}	8.95±0.41^{b}
	100	208.20±1.34^{c}	7.58±0.47^{c}

a,b,c = Means having different letters within each column are significantly different (P≤ 0.05)

Table (2): Effect of dietary sorbitol on serum triglycerides (TG), cholesterol (CH), high density lipoprotein (HDL) and low density lipoprotein (LDL) of Gimmizah laying hens. (Means ± SE)

Age (weeks)	Sorbitol (mg/Kg of diet)	TG (mg/100 ml)	CH (mg/100ml)	HDL (mg/100ml)	LDL (m1g/00ml)
34	0	136.85±3.20a	211.10±4.61a	23.25±1.34b	168.68±3.90^{a}
	50	125.58±1.79b	182.15±6.49b	23.93±0.77ab	145.75±5.06^{b}
	100	113.23±1.31c	146.88±6.60c	24.53±0.68a	126.53±2.24^{c}
38	0	137.00±2.46a	208.10±6.03a	23.95±0.62b	169.03±3.23^{a}
	50	121.50±1.43b	165.65±2.37b	25.15±0.67ab	132.60±2.61^{b}
	100	110.15±1.70c	134.60±2.94c	25.70±0.84a	115.30±2.11^{c}
42	0	137.50±2.59a	208.95±5.53a	22.83±1.18b	169.10±2.45a
	50	115.90±2.29b	142.15±3.76b	23.63±1.27ab	117.53±0.90b
	100	106.10±1.85c	121.70±1.34c	24.28±1.13a	100.45±0.94c
46	0	138.55±1.84a	215.18±3.83a	22.85±0.71b	170.98±3.03a
	50	107.45±1.62b	136.50±1.02b	23.75±0.84ab	107.55±2.09b
	100	80.78±4.28c	115.85±1.87c	24.73±0.80a	90.13±5.22c

a,b,c = Means having different letters within each column are significantly different (P≤ 0.05)

Table (3): Effect of dietary sorbitol on serum glucose (GLC) , glutamic oxaloacetic transaminase (GOT) and gulotamic pyruvic transaminase (GPT) of Gimmizah laying hens. (Means ± SE)

Age (weeks)	Sorbitol (mg/Kg of diet)	GLC (mg/100ml)	GOT (U/L)	GPT (U/L)
34	0	217.68±1.70	74.15±0.63	4.25±0.27
	50	216.63±2.32	74.50±0.44	4.53±0.21
	100	215.70±3.03	74.30±0.38	4.45±0.37
38	0	203.15±2.78	74.15±0.86	4.45±0.19
	50	202.05±2.26	75.00±0.46	4.78±0.45
	100	201.65±2.73	74.83±0.52	4.65±0.31
42	0	202.08±2.98	73.83±0.58	4.60±0.35
	50	199.20±1.55	74.53±0.20	5.00±0.20
	100	198.20±1.06	74.73±0.74	5.23±0.28
46	0	199.38±1.80	74.23±0.39	4.28±0.18
	50	196.15±0.98	74.93±0.52	5.03±0.42
	100	194.70±1.89	75.10±0.49	5.08±0.19

a,b,c = Means having different letters within each column are significantly different (P≤ 0.05)

Table (4): Effect of dietary sorbitol on liver total lipids (TL), cholesterol (CH) and bile volume of gall bladder (ml) of Gimmizah laying hens at 46 weeks of age. (Means ± SE)

Sorbitol (mg/Kg of diet)	TL (mg/g)	CH (mg/g)	Bile volume of gall bladder (ml)
0	254.20 ±2.00^a	6.47±0.34^a	0.603±0.012
50	222.10 ±1.29^b	3.90±0.36^b	0.607±0.018
100	201.10±0.81^c	2.30±0.25^c	0.613±0.014

a,b,c = Means having different letters within each column are significantly different (P≤ 0.05)

Table (5): Effect of dietary sorbitol on some internal organs measurements of Gimmizah laying hens at 46 weeks of age. (Means ± SE)

Sorbitol (mg/Kg of diet)	Liver (%)	Ovary (%)	Oviduct (%)	Abdominal fat (%)	Oviduct length (cm)
0	2.73±0.23	0.42±0.03	2.50±0.06	3.33±0.06a	54.67±1.25
50	2.50±0.16	0.44±0.02	2.47±0.03	2.37±0.09b	54.97±0.62
100	2.10±0.16	0.43±0.01	2.43±0.03	1.23±1.10^c	55.40±1.10

a,b,c = Means having different letters within each column are significantly different (P≤.05)

Table (6): Effect of dietary sorbitol on body weight, feed intake, egg weight and egg production percentage of Gimmizah laying hens. (Means ± SE)

Traits	Age (weeks)	Sorbitol (mg / Kg of diet)		
		0	50	100
Body weight (g)	34	1750±0.03^a	1680±0.05^b	1690±0.02^b
	38	1780±0.03^a	1660±0.03^b	1650±0.02^b
	42	1800±0.03^a	1620±0.03^b	1580±0.02^b
	46	1810±0.03^a	1590±0.03^b	1590±0.01^b
Feed intake (g/hen/day)	32 - 34	120.08±0.70^a	109.35±1.50^b	98.64±1.81^c
	34 – 38	121.59±0.49^a	102.86±1.25^b	95.10±1.35^c
	38 – 42	124.18±0.55^a	100.60±1.18^b	93.81±1.24^c
	42 – 46	122.84±0.89^a	101.89±0.80^b	92.13±1.10^c
Egg weight (g)	32 – 34	53.80±0.19^a	52.26±0.18^b	52.05±0.20^b
	34 – 38	53.71±0.14^a	53.34±0.30^a	51.32±0.18^b
	38 - 42	54.91±0.14^a	53.12±0.10^b	52.98±0.06^b
	42 - 46	55.90±0.11^a	54.38±0.09^b	53.12±0.08^b
Egg production (%)	32 - 34	60.00±0.69	60.24±0.54	59.60±0.59
	34 - 38	65.60±0.46^a	65.36±0.47^a	63.76±0.50^b
	38 - 42	70.59±0.38^a	69.84±0.44^a	68.28±0.40^b
	42 - 46	74.76±0.37^a	73.80±0.39^a	71.29±0.45^b

a,b,c = Means having different letters within each row are significantly different (P≤ 0.05)

Table (7): Effect of dietary sorbitol on relative weight of yolk, albumin, shell and shell thickness (mm) of Gimmizah laying hens. (Means ± SE)

Age (weeks)	Sorbitol (mg/Kg of diet)	Yolk (%)	Albumin (%)	Shell (%)	Shell thickness (mm)
34	0	26.50±0.35	61.21±0.18	12.29±0.27	0.427±0.004
	50	26.65±0.65	61.53±0.65	11.92±0.25	0.428±0.003
	100	26.86±0.28	61.25±0.27	11.89±0.17	0.401±0.003
38	0	26.13±0.42	60.72±0.38	13.15±0.16a	0.433±0.005a
	50	26.26±0.49	61.14±0.52	12.60±0.23a	0.427±0.002a
	100	26.68±0.32	61.57±0.48	11.75±0.19b	0.312±0.002b
42	0	26.41±0.12	60.48±0.18	13.11±0.23a	0.439±0.004a
	50	26.39±0.32	60.15±0.45	13.46±0.17a	0.427±0.003a
	100	26.98±0.26	60.99±0.25	12.03±0.17b	0.311±0.001b
46	0	26.52±0.30	59.99±0.42	13.49±0.22a	0.427±0.003a
	50	26.13±0.26	60.62±0.31	13.25±0.19a	0.429±0.002a
	100	26.92±0.30	60.90±0.35	12.18±0.16b	0.227±0.004b

a,b = Means having different letters within each column are significantly different (P≤ 0.05)

Table (8): Effect of dietary sorbitol on percentage of egg shape, yolk index and Haugh unit scores of Gimmizah laying hens. (Means ± SE)

Age (weeks)	Sorbitol (mg/Kg of diet)	Egg shape Index (%)	Yolk index (%)	Haugh unit (%)
34	0	75.53±0.45	45.85±0.14	89.63±0.45
	50	74.98±0.43	45.43±0.08	90.58±0.05
	100	75.68±0.13	44.60±0.11	89.80±0.07
38	0	75.43±0.57	45.58±0.10	89.50±0.11
	50	74.90±0.11	45.38±0.11	89.55±0.13
	100	75.43±0.09	45.58±0.11	89.48±0.15
42	0	75.40±0.09	45.48±0.14	89.51±0.35
	50	75.48±0.09	45.55±0.10	90.10±0.06
	100	75.68±0.30	45.58±0.11	89.88±0.05
46	0	75.58±1.10	45.63±0.15	89.68±0.09
	50	75.53±0.06	45.60±0.07	89.65±0.06
	100	75.70±0.32	45.65±0.06	89.68±0.09

REFERANCES

Assmann, G.; Jabs, H.U.; Kohnert, U.; Nolte, W.; and Schriewer, H. (1984). *LDLcholesterol determination in blood serum following precipitation of LDL with polyvinylsulfate. Clin Chim Acta.140:77-83.*

Atlla, A.A. (2002). *Influence of copper sulfate and sorbitol on lipids and cholesterol biosynthesis in laying hens. Egypt. Poult. Sci., vol. 22: 1063-1081.*

Belitz, H.D.; and Grosch,W. (1992). *Lehrbuch der lebensmittelchemine. Springer-verlae.Berlin, 966 p.*

Beyer, R.S.; and Jensen, L.S. (1993). *Reduced plasma cholesterol and lipoprotein in laying hens without concomitant reduction of egg cholesterol in response to dietary sorbose. Poult. Sci., 72: 88-97.*

Cahaner, A.; Nitsan, Z.; and Nir, I.(1986). *Reproductive performance of broiler lines divergently selected on abdominal fat.Poult.Sci., 65: 1236-1243.*

Duncan, D.B. (1955). *Multiple range and multiple F- test, Biometrics 11:1-42.*

Friedman, G.J. (1968). *Nutrition in relation to atherasclerosis.Pg.877-931 in M.G. Wohl and R.S. Goodhart (ed.) Modern Nutrition in Health and Disease. Lea and febiger, Philadelphia.*

Frings, C.S.; T.W., Fendly; R.T., Dunn; and C.A., Queen. (1972). *Improved determination of total serum lipids by the sulfo-phospho-vanillin reaction. Clinical Chemistry 18:673-674.*

Furuse, M.; Ishii, T.; Miyagawa, S.; Nakagawa, J.; Shimizu, T.; Watanabe, T.; and Okumura, J. (1991 b). *Effect of dietary sorbose on lipid metabolism in male and female broilers. Poult. Sci. 70: 95-102.*

Furuse, M.; Nakajima, S.; Nakagawa, J.; Shimizu, T.; and Okumura, f. (1990). *Regulation of lipid metabolism by dietary sorbose in laying hens. Poult. Sci. 69: 1508-1512.*

Furuse, M.; Yang, S. I.; Niwa, N.; Choi, Y. H.; and Okumura, J. (1991a). *Energy utilization in germ-free and conventional chicks fed diets containing sorbose. Br. Poult. Sci. 32: 383-390.*

Goodridge, A.G. (1987). *Dietary regulation of gene expression, enzymes involved in carbohydrate and lipid metabolism. Annu. Rev. Nutr.7: 157-185.*

Griffin, H.D. (1990). *Institute for Grassland and Animal Production, Rosin, Scotland. Poultry International- August.*

Iiundian, A.; Lich, M.; and Ponz, P. (1979). *Kinetics of intestinal sugar transport, in vivo. Rev.Esp.Fisiol. 35: 359-366.*

Keilin, D.; and Hartree, E.F. (1948). *The use of glucose oxidase (notatin) for the determination of glucose in biological material and for the study of glucose-producing systems by manometric methods. Biochem. J. 42, 230-238*

Merriam- Webester (2007). *Merriam-Webester's Medical Dictionary http://www.m-w.com/.*

Nimpf, J.; and Schneider, W.J. (1991). *Recepto-mrdiated lipoprotein transport in laying hens. J. Nutr. 121: 1471-1474.*

Reitman, S.; and Frankel, S. (1957). *A colorimeteric method for determination of serum glutamic oxalacetic and glutamic piruvic transaminases. Am J Clin Pathol 28: 56-63.*

Richmond, W. (1973). *Preparation and properties of a cholesterol oxidase from Nocardia sp and its application to the enzymatic assay of total cholesterol in serum.Clin.Chem.19:1350-1356.*

SAS Institute, Inc. c (1990). *SAS User's Guide: Statistics, Version 6. SAS Institute, Inc., Cary, NC.*

Soloni, F.G. (1971). *Simplified manual micromethod for determination of serum triglyceride. Clin.Chem.17:529-534.*

Warnick, G.R.; Benderson, J.; Albers, J.J. (1983). *Dextran sulfate-Mg2+ Precipitation Procedure for Quantitation of High Density Lipoprotein Cholesterol. In: Cooper G.R., ed. Selected Methods of Clinical Chemistry, Vol. 10:91-99. Washington, DC: American Association of Clinical Chemistry.*

Washburn, K.W.; and Nix, D.F. (1974). *A rapid technique for extraction of yolk cholesterol. Poult. Sci., 53: 1118-1122.*

الملخص العربى

تأثير سوربيتول الغذاء على محتوى صفار البيض من الكوليستيرول وتمثيل الدهون فى الدجاج البياض

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أجريت هذه الدراسة فى محطة بحوث الدواجن بالصبحية – الإسكندرية – معهد بحوث الإنتاج الحيوانى – مركز البحوث الزراعية – وزارة الزراعة و ذلك بهدف دراسة تأثير سوربيتول الغذاء على محتوى صفار البيض من الكوليستيرول و تمثيل الدهون فى الدجاج البياض. حيث أستخدم ٩٠ دجاجة من سلالة الجميزة المحلى عمر ٣٢ أسبوع قسمت عشوائيا إلى ثلاثة مجموعات متساوية (كل مجموعة ٣٠ دجاجة) أستخدمت المجموعة الأولى كنترول حيث غذيت على عليقة عادية دون أضافات بينما أضيف إلى المجموعة الثانية و الثالثة ٥٠ ملجم و ١٠٠ ملجم سوربيتول / كجم علف على الترتيب و أستمرت أضافة السوربيتول لمدة ١٤ أسبوع متتالية و أدى أستخدام السوربيتول فى علائق الدجاج البياض الحصول على النتائج الآتية:

- أنخفاض معنوى لمستوى الكوليستيرول و الدهون الكلية فى صفار البيض و الكبد و كذلك أنخفاض معنوى للجلسريدات الثلاثية و الكوليستيرول و الليبوبروتينات المنخفضة الكثافة فى السيرم .
- أرتفاع معنوى لليبوبروتينات العالية الكثافة فى السيرم خاصة مع المستوى العالى من السوربيتول بينما ظل مستوى الجلوكوز و الـ GOT وGPT دون تغيير باضافة السوربيتول للغذاء مقارنة بمجموعة الكنترول.
- أنخفاض معنوى للنسبة المئوية لدهن البطن للإناث التى غذيت على عليقة بها السوربيتول بينما لا توجد أختلافات معنوية أمكن ملاحظتها فى أفراز محتوى الصفراء للحوصلة المرارية و الوزن النسبى للكبد و المبيض و قناة المبيض و طول قناة المبيض بين المجموعات الثلاثة خلال الفترة التجريبية.
- أنخفاض معنوى لوزن الجسم والغذاء المستهلك ووزن البيضة و النسبة المئوية لانتاج البيض خاصة مع المستوى العالى من السوربيتول مقارنة بمجموعة الكنترول.
- أنخفاض معنوى للوزن النسبى للقشرة وسمك القشرة بأضافة السوربيتول لعلائق الدجاج خاصة المستوى العالى منه مقارنة بمجموعة الكنترول بينما لا توجد أختلافات معنوية فى الوزن النسبى للصفار و البياض ومعامل شكل البيضة و معامل الصفار ووحدات هيو بين المجموعات المغذاة على السوربيتول و مجموعة الكنترول.