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LOWERING YOLK AND MEAT CHOLESTEROL IN MANDARAH AND SILVER MONTAZAH STRAINS

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ABSTRACT

Total of 120 pullets from each strain Mandarah and Silver Montazah were used to study the effect of copper sulphate and worm-wood on decrease yolk and meat cholesterol concentrationin laying hens. Birds were randomly assigned to 3 groups according to dietary additives: group (1) was supplemented with 250 mg copper as $CuSo_4.H_2O$/kg diet, group (2) was supplemented with 2% worm-wood and group (3) was fed basal diet as control. Water and feed were provided *ad libitum*. After 8 weeks of treatment (24-32) weeks of age, additives were removed and hens were switched to basal diet for 4 weeks (32-36) weeks of age.

Supplementing 250 mg copper to diet for 8 weeks, significantly decreased plasma cholesterol by 36.0% and 30.7% for Mandarah and Silver Montazah, respectively.while the depression was 42.4% and 28.3% in both strains, when fed 2% worm-wood, respectively. Reduction in yolk cholesterol was 19.2% and 25.3% in Mandarah and Silver Montazah at 32 weeks of age by adding dietary copper. But yolk cholesterol depression was 22.2 and 30.1% in both strains by using 2% worm-wood in diet, respectively. Copper addition resulted reduction of 77.0 and 80.3% in breast muscle cholesterol and 73.6 and 81.1% in thigh muscle cholesterol for Mandarah and Silver Montazah, respectively. The corresponding depressions by dietary worm-wood were 74.3, 79.0 and 77.9 and 81.0%, respectively.

Cholesterol concentration was much higher by about 22-24% in thigh than breast muscle Cholesterol level was more by about 4 fold in skin than muscles. Cholesterol depression by dietary additives was more by about 2 fold in muscle than breast in thigh.

INTRODUCTION

Fowl eggs had relatively high cholesterol content (200-300 mg). A reduction in the cholesterol content of market eggs would be of great interest to both egg producers and health of consumers Each 1% reduction in plasma cholesterol is associated with 2% decrease in the coronary heart disease (Lipid Research Clinics Program 1984 a , b).

Intensive search efforts have been directed to alter cholesterol deposition in egg yolk. Conventional nutrition manipulation, dietary fiber, certain drugs or genetic selection programs have resulted in only modest 5-7% reduction in egg cholesterol levels with an associated decrease in egg production. Nowadays, the natural biological feed additives, which not accompanied with adverse effects, were used instead of synthetic drugs.

Using black seed, garlic or fenugreek caused 11-20% reduction in yolk cholesterol (Hassan, 2000). The reduction in yolk cholesterol increased to 35% by using either 10% sorbitol, 250 mg copper/kg diet or replacing 12% beer-by-product from the basal diet (Safaa, 1999). Supplemented 1% black seed, 200 mg copper or 200 mg vitamin C in Lohmann diet depressed yolk cholesterol by 24.0, 22.4 or 24.9%, respectively (Safaa, 2003). (Emam, 2004) observed a yolk cholesterol depression of 46.4, 28.8 and 30.2% by addition

3% dietary garlic, fenugreek or worm-wood from 20-36 weeks of age, respectively.

The present study was undertaken in an attempt to decrease both yolk and meat cholesterol by using 250 mg copper or 3% worm-wood in both Mandarah and Silver Montazah local layers.

MATERIAL AND METHODS

A total of 120 pullets from each strain of Mandarah and Silver Montazah, were used to study the effect of copper sulfate and worm-wood supplementation decreasing yolk and meat cholesterol concentration. At 24 weeks of age, birds were divided randomly to 3 groups allotted to dietary additives: 1- supplemented with 250 mg copper as $CuSo_4.H_2O$/kg diet , 2- supplemented with 2% worm-wood and 3- fed basal diet as control.

Birds were housed individually in separate layer cages in open system house, and fed a commercial layer ration containing 17% crude protein and 2800 Kcal ME/kg diets. Birds exposed to 17 hours light/day. Water and feed were provided *ad libitum*. After 8 weeks of treatment (24-32 wk), additives were removed and hens were switched to basal diet for 4 weeks (32-36 wk).

To determine the cholesterol concentration in blood and yolk, 8 blood and yolk samples/group were collected every 2 weeks from the same hen. Blood samples were collected in heparinized tubes. Samples were centrifuged at 3000 r.p.m for 10 minutes to get plasma that kept at 20C until the cholesterol determination which carried out using commercial kit according to Allain *et al.* (1974) and egg yolk cholesterol according to the method of Folch *et al.* (1973).

To determine muscle and skin cholesterol concentration, 3 hens/group were slaughtered at 24, 32 and 36 weeks of age. Pieces from breast muscle, breast skin, thigh muscle and thigh skin were rapidly dissected out and homogenized with electric mincer. Thereafter one gram was taken from each sample in a sterile tube containing mixture of 15 ml chloroform and methanol (2:1), and shaken, then 5 ml distilled water. Tubes were centrifuged at 2500 r.p.m for 10 minutes. The aqueous layers was filtered, and received the lipid extraction in sterilized glass vial that was stoppered thightly and stored in a deep-freezer till chemical analysis. Cholesterol concentration in breast muscle, breast skin, and thigh muscle and thigh skin were determined by commercial kit according to Allain *et al.* (1974).

Plasma, yolk, liver, muscle and skin cholesterol were determined every 4 weeks from 24-36 weeks of age in both strains.

Statistical analysis:

Data were statistically analyzed by the one-way analysis of variance using the General Linear Method procedure (GLM) of SAS, (1985). When significant treatment effects were detected, means were separated by using Duncan's new multiple range test (Duncan, 1955).

RESULTS AND DISCUSSIONS

1. Plasma total cholesterol:

Results in Table (1) declared that plasma total cholesterol at 24 weeks of age (before treatment) was 119.3 and 123.6 mg/100 ml for Mandarah and Silver Montazah hens, respectively. The result of Silver Montazah was lower than that reported (190.4 mg/100 ml) for this strain by Kout El-kloub *et al.* (2004). Comparing with other strains, plasma cholesterol was 159.9 mg/100 ml for Dandarawi (Metwally, 2004), 122.3 mg/100 ml for Matrouh (Abaza *et al.*, 2004), 208.6 mg/100 ml in LSL (Attia, 2002) 219.0 mg/100 ml for Isa-Brown, 188.0 mg/100 ml in Fayoumi (Safaa, 1999) and 189.6 mg/100 ml for Leghorn (Al-Ankari *et al.* 1998).

Table (1): Plasma total cholesterol (mg/100 ml) of Mandarah and Silver Montazah hens ($\bar{X}$ ± S.E).

Age (wk)	Mandarah			Silver Montazah		
	Control	Copper	worm-wood	Control	Copper	worm-wood
24	119.3	119.0	118.3	123.6	115 6	129 2
(Zero time)	± 1.5	± 18.6	± 5.3	± 9.5	± 5.9	± 5 8
	(0.0)	(0.0)	(0.0)	(0 0)	(0.0)	(0.0)
28	120.6^{a}	77.3^{c}	69.5^{d}	119.0^{a}	81.2^{c}	93 9^{b}
	± 1.2	± 2.9	± 2.4	± 0.7	± 3.5	± 2.9
**Change (%)	(+1.0)	(-35.0)	(-41.3)	(-3.7)	(-29.8)	(-27.3)
32	122.2^{a}	76.2^{bc}	68.1^{c}	114.6^{a}	80.1^{bc}	92 7^{b}
	± 6.1	± 9.3	± 2.1	± 2.2	± 5 8	± 3 9
**Change (%)	(+2.4)	(-36 0)	(-42.4)	(-7.3)	(-30 7)	(-28 3)
After treat.						
34	112.6^{a}	67 3^{b}	65.6^{b}	117.1^{a}	68.4^{b}	72 4^{b}
	± 3.5	± 1.6	± 1.8	± 1.4	± 1.3	± 4 8
**Change (%)	(-5.6)	(-43.4)	(-44.5)	(-5.3)	(-40 8)	(-44.0)
36	114.7^{a}	72.8^{b}	67.7^{b}	120.9^{a}	80 6^{b}	85.9^{b}
	± 3 4	± 6.3	± 11.1	± 6.8	± 1.4	± 3.9
**Change (%)	(-3 9)	(-38 8)	(-42.8)	(-2.2)	(-30 3)	(-33.5)
Overall mean	117.2^{a}	83 8^{bc}	80.0^{c}	119.0^{a}	86.2^{bc}	95 0^{b}
	± 1.9	± 6.8	± 4.7	± 1.5	± 0.8	± 3 8

Means with different superscripts in the same row are significantly different P ≤ 0.05 .

** **change percentage in plasma total cholesterol in comparison to the values obtained at 24 weeks (zero time).**

After supplementation of 250 mg copper to the diet for 4 or 8 weeks, plasma cholesterol decreased significantly by 35.0 or 36.0% for Mandarah and by 29.8 or 30.7% in Silver Montazah hens, respectively. The reduction was more in Mandarah than Silver Montazah, hens.

When hens were switched to basal diet for 4 weeks, plasma cholesterol in both strains started to return back to normal level, but still insignificantly better in Mandarah than Silver Montazah hens.

In this study, the reduction of plasma cholesterol was higher than those reported by other workers. Al-Ankari *et al.* (1998) obtained 19.7 % reduction by adding 250 mg copper in Leghorn layer diet. Safaa (1999) noted a decrease of 34.2 and 27.7 % after 4 weeks in Isa Brown and Fayoumi hens when fed 250 mg copper/kg diet, respectively. Attla (2002) reported a significant decrease in serum cholesterol when LSL hens fed diet containing 250 mg copper / kg diet for 4 weeks. It is clear that strains were different in their response for dietary copper; some of them were more sensitive.

With regard to the hens treated by 2% worm-wood addition, it can be observed that significantly depressions of 41.3 and 42.4% in Mandarah and 27.3 and 28.3% in Silver Montazah after 4 and 8 weeks of treatment, respectively. When hens switched to basal diet for 4 weeks, the corresponding depression in the two strains was still high (42.8 and 33.5%). In this study, the reduction was higher than reported by Emam (2004) who obtained 21.2% reduction in plasma cholesterol when Bovens hens were fed 3% worm-wood from 20 to 36 weeks of age.

Comparing both additives, results declared that, in general, dietary worm-wood had insignificantly more effect to reduce plasma cholesterol than copper.

2. Yolk cholesterol (mg/g yolk):

Data in Table (2) showed that the overall mean for the control birds of yolk cholesterol was 16.9 and 17.9 mg/g yolk ml for Mandarah and Silver Montazah eggs, respectively and the differences between them was significant. Strain differences were reported by many workers where yolk cholesterol (mg/g yolk) was noted to be 9.75 in Leghorn eggs (Al-Ankari *et al.* 1998), 13.4 in LSL eggs (Attla 2002), 16.47 in Matrouh eggs (Abaza *et al.* 2004) and 17.2 in Lohmann eggs (Safaa 2003).

Adding 250 mg copper/kg diet decreased significantly yolk cholesterol for both strains. Reduction in yolk cholesterol was 16.8 and 19.2% in Mandarah and 23.3 and 25.4 % in Silver Montazah compared by the control group at 28 and 32 weeks of age, respectively. After switching hens to the basal diet with no copper addition, reduction stilled 22.7 and 8.4% in Mandarah and 28.8 and 9.8% in Silver Montazah at 34 and 36 weeks of age, respectively.

Safaa (1999) obtained a reduction of 32.7 and 15.6% in yolk cholesterol in Isa-Brown and Fayoumi hens by adding 250 mg copper for 4 weeks, respectively. After switching hens to basal diet,this reduction was stilled 19.8 and 10.7% in both strains, respectively. Also Safaa (2003) noted a reduction of 9.7 and 6.9% in yolk cholesterol of Lohmann hens at 33 and 35 weeks of age when fed 200 mg copper/kg layer diets. Al-Ankari *et al.*, (1998) found a reduction of 5.2, 9.4 and 14.2% in yolk cholesterol when Leghorn hens were fed 50, 150 or 250 ppm copper in diet, respectively.

Table (2):Yolk cholesterol (mg/g yolk) of Mandarah and Silver Montazah local hens ($\bar{X}$ ± S.E).

Age (wk)	Mandarah			Silver Montazah		
	Control	Copper	worm-wood	Control	Copper	worm-wood
24	16 9	16 7	16.8	17.5	18 1	18 1
(Zero time)	± 0.1	± 0.3	± 0.2	± 0.3	± 0.4	± 0.4
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
28	16.8^{b}	13.9^{c}	13.0^{d}	18.2^{a}	13.9^{c}	13 6^{cd}
	± 0.3	± 0.1	± 0.2	± 0 4	± 0 1	± 0 3
**Change (%)	(-0.59)	(-16.8)	(-22.6)	(+4.1)	(-23 3)	(-24 7)
32	16 7^{b}	13 5^{c}	13.0^{dc}	18 1^{a}	13.5^{c}	12.7^{d}
	± 0.2	± 0.2	± 0.2	± 0.1	± 0.2	± 0 3
**Change (%)	(-1.2)	(-19.2)	(-22.6)	(+3.4)	(-25.4)	(-29 8)
After treat.						
34	17.3^{b}	12.9^{c}	13.1^{c}	18.1^{a}	12.9^{c}	12.6^{c}
	± 0.3	± 0.2	± 0.2	± 0.1	± 0.1	± 0.2
**Change (%)	(+2.4)	(-22.7)	(-22.0)	(+3.4)	(-28.8)	(-30 4)
36	16.7^{b}	15.3^{b}	16.4^{b}	17.9^{a}	16.3^{b}	16.4^{b}
	± 0.3	± 0.5	± 0.3	± 0.1	± 0.6	± 0.5
**Change (%)	(-1.2)	(-8.4)	(-2.3)	(+2.3)	(-9.9)	(-9.4)
Overall mean	16.9^{b} ± 0.2	14.6^{d} ± 0 1	14.8^{cd} ± 0.1	17.9^{a} ± 0.2	15 2^{c} ± 0 3	14 9^{cd} ± 0 2

Means with different superscripts in the same row are significantly different p≤0.05.
** change percentage in yolk cholesterol in comparison to the values obtained at 24 weeks (zero time).

This decrease in both plasma and yolk cholesterol supported the hypothesis that higher copper level decreased the formation of hepatic glutathione and ultimately formation of cholesterol (Kim *et al.*, 1992). Glutathione acts in regulating cholesterol biosynthesis through the stimulation of the enzyme (3-hydroxy-3-methyl-gluteryl co-enzyme-A reductase) in rats (Valsala and Kurup 1987).

Using 2% worm-wood in the diet, decreased significantly yolk cholesterol by 22.6 or 22.6% in Mandarah and by 24.7 and 29.8% in Silver Montazah at 28 and 32 weeks of age than control, respectively.

After switching hens to basal diet, the depression in yolk cholesterol was 22.0 and 2.3% in Mandarah and 30.4 and 9.4% in Silver Montazah at 34 and 36 weeks of age than control, respectively. Emam (2004) obtained a decrease of 19.9, 30.2 and 4.5% in yolk cholesterol of White Bovans hens fed 3% worm-wood in diet from 16-20, 20-36, 36-56 weeks of age, respectively. The best yolk cholesterol depression obtained when dietary additive used from 20-36 weeks of age.

It can be concluded that yolk cholesterol decreased significantly by both dietary additives while worm-wood was insignificantly better than copper. Silver Montazah was insignificantly more stimulated to decrease yolk cholesterol by both dietary additives than Mandarah hens.

3. Liver cholesterol:

Results in Table (3) indicate that liver cholesterol was 154.4 and 154.0 mg/g liver at 24 weeks of age for Mandarah and Silver Montazah, respectively. Emam (2004) reported a higher value of liver cholesterol (260.8 mg/g) for White Bovans hens at 32 weeks of age.

Liver cholesterol level at 32 weeks of age decreased significantly by 6.1% in both strains by adding 250mg copper/kg diet. Safaa (1999) obtained also a decrease in liver cholesterol in Isa-Brown and Fayoumi when fed 250 mg copper/kg diet. Attia (2002) reported also significant reduction in liver cholesterol, when LSL hens were fed copper for 4 weeks.

Liver copper regulates cholesterol biosynthesis by reducing hepatic glutathione concentration, which play a major role in cholesterol homeostasis (Kim *et al.*, 1992).

Concerning worm-wood treatment, it can be observed a decrease of 5.0 and 5.9% in liver cholesterol in Mandarah and Silver Montazah at 32 weeks of age, respectively. After treatment, liver cholesterol returned back to normal level. This depression was lower than that reported by Emam (2004) who obtained 25.8% decrease in liver cholesterol of White Bovans hens fed 3% worm-wood in diet.

Table (3): Liver cholesterol (mg/g Liver) of Mandarah and Silver Montazah local hens ($\bar{X}$ ± S.E).

Age (wk)	Mandarah			Silver Montazah		
	Control	Copper	worm-wood	Control	Copper	worm-wood
24 (Zero time)	154.4 ± 0.1 (0.0)	154.5 ± 0.1 (0.0)	154.2 ± 0.4 (0.0)	154.0 ± 0.3 (0.0)	154.5 ± 0.2 (0.0)	154.1 ± 0.1 (0.0)
32	*155.5^{a} ± 0.2	145.1^{c} ± 0.4	146.6^{b} ± 0.3	155.0^{a} ± 0.1	145.1^{c} ± 0.1	145.0^{c} ± 0.1
**Change (%)	(+0.7)	(-6.1)	(-5.0)	(+0.6)	(-6.1)	(-5.9)
After treat. 36	156.1^{a} ± 0.1	154.1^{b} ± 0.1	154.4^{b} ± 0.2	156.0^{a} ± 0.1	156.0^{a} ± 0.1	156.2^{a} ± 0.3
**Change (%)	(+1.1)	(-0.3)	(+0.1)	(+1.3)	(+1.0)	(+1.4)
Overall mean	155.3^{a} ± 0.1	151.2^{c} ± 0.1	151.7^{b} ± 0.2	155.0^{a} ± 0.1	151.9^{b} ± 0.1	151.8^{a} ± 1.0

Means with different superscripts in the same row are significantly different ($p \leq 0.05$).

** change percentage in liver cholesterol in comparison to the values obtained at 24 weeks (zero time).

4. Breast and thigh muscle cholesterol:

It can be observed from Table (4) that breast muscle cholesterol at 24 weeks of age was 62.6 and 64.6 mg/100 g meat in Mandarah and Silver Montazah, respectively.

Table (4):Breast muscle and thigh muscle cholesterol (mg/100g meat) of Mandarah and Silver Montazah local hens ($\bar{X}$ ± S.E).

Age (wk)	Mandarah			Silver Montazah		
	Control	Copper	Worm-wood	Control	Copper	Worm-wood
			Breast muscle cholesterol			
24 (Zero time)	62.6 ± 2.4 (0.0)	63.4 ± 1.6 0	58.4 ± 1.5 0	64.6 ± 1.2 0	66.0 ± 1.7 0	64.7 ± 0.3 0
32	63.1^{b} ± 1.5	14.6^{c} ± 1.1	15.0^{c} ± 1.4	66.5^{a} ± 0.6	13.0^{c} ± 0.4	13.6^{c} ± 0.5
**change (%) After treat.	(+0.8)	(-77.0)	(-74.3)	(+2.9)	(-80.3)	(-79.0)
36	65.6^{a} ± 0.9	17.9^{b} ± 0.5	15.3^{c} ± 1.2	65.8^{a} ± 0.7	14.3^{c} ± 0.4	14.9^{c} ± 0.2
**change (%)	(+4.8)	(-71.8)	(-73.9)	(+1.7)	(-78.3)	(-77.0)
Overall mean	63.7^{a} ± 0.9	32.0^{b} ± 0.8	29.5^{c} ± 0.8	65.6^{a} ± 0.6	31.1^{bc} ± 0.7	31.1^{bc} ± 0.2
			Thigh muscle cholesterol			
24 (Zero time)	76.4 ± 0.5 (0.0)	75.2 ± 0.6 0	74.8 ± 1.0 0	80.2 ± 0.5 0	79.9 ± 0.3 0	79.7 ± 0.4 0
32	79.6^{a} ± 0.7	19.9^{b} ± 2.3	16.6^{bc} ± 0.9	80.5^{a} ± 0.3	15.1^{c} ± 0.9	15.1^{c} ± 1.0
**change (%) After treat.	(+4.2)	(-73.6)	(-77.9)	(+0.3)	(-81.1)	(-81.0)
36	79.3^{a} ± 0.5	19.5^{b} ± 1.5	17.2^{bc} ± 0.6	80.6^{a} ± 0.4	16.5^{c} ± 0.4	14.8^{c} ± 0.9
**change (%)	(+3.8)	(-74.1)	(-77.0)	(+0.4)	(-79.4)	(-81.5)
Overall mean	78.4^{b} ± 0.5	38.2^{c} ± 0.9	36.2^{d} ± 0.4	80.4^{a} ± 0.1	37.2^{cd} ± 0.4	36.5^{cd} ± 0.7

Means with different superscripts in the same row are significantly different p≤0.05.
**** change percentage in breast muscle and thigh muscle cholesterol in comparison to the values obtained at 24 weeks (zero time).**

Thigh muscle cholesterol was 76.4 and 80.2 mg/100 g meat in both Mandarah and Silver Montazah strains, respectively. It means that cholesterol concentration was much higher by about 22-24% in thigh than breast muscle. Similar results were reported by Konjufca *et al.*, (1997). They explained that cholesterol is usually associated with adipose tissue, which was more abundant in thigh than breast muscles. Also, thigh muscles have a much greater content of slow-twitch fibers than breast muscles. Slow-twitch

fibers have many more mitochondria, their mitachondria are bigger, and the metabolic rate are much faster in comparison to fast-twitch fibers. Slow-twitch sarcoplasmic reticulum was found to contain two to three times as much cholesterol as fast-twitch caudofemoralis sarcoplasmic reticulum in rabbits (Bloch 1991). The higher cholesterol concentration reduces membrane fluidity (Yeagle 1989), lowers Ca+ATP ase activity (Madden *et al.*, 1979) and contraction and relaxation rates.

Safaa (2003) reported that cholesterol concentration were of 78.2 and 89.0 mg/100 g meat for breast and thigh muscles in Arber acres broilers at 6 weeks of age, respectively. In this study, muscle cholesterol levels of layers were lower than those reported by Safaa (2003) in broilers. Komprada *et al.* (1991) found that the cholesterol content and fatty acid composition of chicken tissues were influenced by rate of growth. Cholesterol in breast and thigh muscles, however, tended to decrease with increasing growth rate Indications exist that increasing intestinal viscosity impairs digestion of lipids and decreased bile acid re-absorption in the ileum (Smits and Annison 1996). This can reduce the cholesterol concentration in plasma, as shown in an experiment with chitosan (Razdan *et al.*, 1997), and consequently also, reduce cholesterol deposition in tissues. Unfortunately, the digestibility of protein was also negatively affected (Smits and Annison 1996).

With regard to copper addition, the reduction in breast muscle cholesterol was 77.0 and 80.3% and in thigh muscle cholesterol it was 73.6 and 81.1% in both Mandarah and Silver Montazah, respectively. After treatment, cholesterol level was reduced significantly by 71.8 and 78.3% in breast and 74.1 and 79.4% in thigh muscles in Mandarah and Silver Montazah, respectively. Similar results were reported by Bakalli *et al.* (1995) and Pesti and Bakalli *et al.* (1998) who found that copper supplements in excess of nutritional requirements lowered both breast and thigh muscle cholesterol. Skrivan *et al.* (2000) observed significant reduction of 24.8% in *cholesterol content of meat when Ross broilers fed 0.79 mg CuSo4 /kg diet.* They concluded that copper supplementation was a good efficient method to reduce cholesterol than substitution of feeding with oil.

In the present study, the reduction of cholesterol in both breast and thigh muscles for Mandarah and Silver Montazah hens were higher than reported by Bakalli *et al.* (1995) (7.0 and 14.5%), by Konjufca *et al.* (1997) (27.3 and 20.8%) and by Safaa (2003) (63.4 and 72.5%) in broilers

Concerning worm-wood supplementation, the same trend was observed, where, the reduction in cholesterol content in breast muscle was 74.3 and 79.0% and in thigh was 77.9 and 81.0% in Mandarah and Silver Montazah layers, respectively. After treatment the corresponding values were 73.9 and 77.0% in breast and 77.0 and 81.5% in thigh, muscles, respectively.

5- Breast and thigh skin cholesterol:

Cholesterol concentration in both breast and thigh skin are presented in Table (5). Cholesterol concentration in skin was 290.4 and 285.0 for breast and 308.9 and 311.6 mg/100 g skin for thigh in Mandarah and Silver Montazah layers, respectively.

Comparing cholesterol levels in muscle and skin, it can be observed that cholesterol level was more by about 4 fold in skin than muscles. Similar result was obtained also by Safaa (2003) who noted that cholesterol levels were 374.3 and 371.7 mg/100 g skin compared by 78.2 and 89.0 mg/100 g muscle in breast and thigh of broilers at 6 weeks of age, respectively.

Table (5): Breast skin and thigh skin cholesterol (mg/100g skin) of Mandarah and Silver Montazah local hens ($\bar{X}$ ± S.E).

Age (wk)	Mandarah			Silver Montazah		
	Control	Copper	worm-wood	Control	Copper	worm-wood
			Breast skin cholesterol			
24 (Zero time)	290.4 ± 5.8 (0.0)	291.0 ± 1.3 0	290.2 ± 0.6 0	285.0 ± 3.6 0	283.8 ± 1.7 0	283 4 ± 1.5 0
32	292.3^{a} ± 4.7	178.3^{b} ± 0.6	173.0^{b} ± 5 3	287.5^{a} ± 2.7	167.1^{b} ± 2 6	167.6^{b} ± 2.8
**change (%)	(+0.6)	(-38.7)	(-40.4)	(+0.9)	(-41.1)	(-40 8)
After treat 36	239.1^{a} ± 4 0	179.6^{c} ± 0.7	177.2^{c} ± 2.0	282.6^{b} ± 2.9	155 3^{e} ± 2.3	163.0^{d} ± 1.3
**change (%)	(-17.7)	(-38.3)	(-39.0)	(-0.8)	(-45.3)	(-42 5)
Overall mean	292.0^{a} ± 4.1	216.3^{c} ± 0.5	213.5^{c} ± 2.2	285.1^{b} ± 1.9	202.0^{d} ± 1.6	204.7^{d} ± 0 4
			Thigh skin cholesterol			
24 (Zero time)	308.9 ± 0 7 (0.0)	305.3 ± 2.4 0	304.4 ± 0 4 0	311.6 ± 0 6 0	310.6 ± 0.6 0	309.4 ± 1 7 0
32	306.6^{a} ± 1.8	193.9^{b} ± 3.2	183.7^{bc} ± 7.7	310.3^{a} ± 0.6	192.5^{bc} ± 3.6	180 8^{c} ± 1 8
**change (%)	(-0.7)	(-36.5)	(-39.7)	(-0.4)	(-38.0)	(-41 6)
After treat 36	309 2^{a} ± 1 3	178.2^{b} ± 4.9	183.3^{b} ± 6 5	305 9^{a} ± 2 9	187.8^{b} ± 1.8	185 9^{b} ± 4 0
**change (%)	(+0.1)	(-41.6)	(-39 8)	(-1 8)	(-39 5)	(-39 9)
Overall mean	308.2^{a} ± 1.08	225.8^{b} ± 1.3	223.8^{b} ± 4.8	309.3^{a} ± 1.0	230.3^{b} ± 1.3	225.4^{b} ± 2.1

Means with different superscripts in the same row are significantly different p≤0.05.
**** change percentage in breast skin and thigh skin cholesterol in comparison to the values obtained at 24 weeks (zero time).**

With regard to copper addition, the significant reduction in skin cholesterol was 38.7 and 41.1% in breast and 36.5 and 38.0% in thigh for Mandarah and Silver Montazah layers, respectively. After treatment, the corresponding reduction was 38.3, 45.3% and 41.6 and 39.5%.

In the present study, the reduction of skin cholesterol was higher than those obtained by Safaa (2003) (17.3% in breast and 22.9% in thigh when Arber Acres broilers fed 200 mg copper/kg diet for 6 weeks.

Concerning worm-wood treatment, the same trend was observed, where the significant reduction in skin cholesterol content was 40.4 and 40.8% in breast and 39.7 and 41.6% in thigh for Mandarah and Silver Montazah, respectively. These reductions, after treatment, were 39.0, 42.5, 39.8 and 39.9%, respectively.

It can be concluded that both feed additives decreased muscle and skin cholesterol in both breast and thigh. Cholesterol depression was more (about 2 fold) in muscle than skin in both breast and thigh. In general, there were insignificant differences between both feed additives.

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تقليل مستوى الكوليستيرول في اللحم و صفار البيض في سلالتى المندرة و المنتزة الفضى

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تم اجراء التجربة على عدد ١٢٠ طائر من كل من السلالتين المندرة و المنتزة الفضى لتقليل مستوى الكوليستيرول فى كل من البيض و اللحم ، تم تقسيم الطيور عشوائيا الى ثلاثة مجموعات تبعا للأضافات الغذائية : ١- اضافة النحاس بمعدل ٢٥٠ ملجم /كجم علف ٢- اضافة ٢% من الشيح ٣- تغذية العليقة الاساسية بدون اضافات .

ترك الماء و العلف بطريقة حرة ، و استمرت الاضافات الغذائية لمدة ٨ اسابيع (٢٤-٣٢ اسبوع من العمر) بعدها تركت الطيور على العلف الاساسى لمدة ٤ أسابيع (٣٢-٣٦ اسبوع من العمر) .

مستوى الكوليستيرول فى البلازما انخفض معنويا بمعدل ٣٦,٠ و ٣٠,٧ % عند المعاملة بالنحاس و ٤٢,٤ و ٢٨,٣ % عند المعاملة بالشيح فى كل من سلالة المندرة و المنتزة الفضى على التوالى . لوحظ ايضا انخفاض معنوى فى مستوى كوليستيرول صفار البيض بمعدل ١٩,٢ و ٢٥,٣% عند المعاملة بالنحاس و ٢٢,٢ و ٣٠,١ % عند المعاملة بالشيح لكلا السلالتين على التوالى ، مستوى الكوليستيرول فى لحم الصدر انخفض معنويا بمعدل ٧٧,٠ و ٨٠,٣ % و فى لحم الفخذ بمعدل ٧٣,٦ و ٨١,١% فى كل من سلالة المندرة و المنتزة الفضى على التوالى عند المعاملة بالنحاس ، معدلات الانخفاض كانت ٧٤,٣ و ٧٩,٠ و ٧٧,٩ و ٨١,٠ % فى مستوى كوليستيرول لحم الصدر و الفخذ لكلا اسلالتين عند اضافة الشيح الى العلف على التوالى .

لوحظ ارتفاع تركيز الكوليستيرول بحوالى ٢٢-٢٤% فى لحم الفخذ عن لحم الصدر ، بينما يزداد تركيز الكوليستيرول حوالى ٤ أمثال فى الجلد عن اللحم ، على العكس انخفاض مستوى الكولبستيرول بالاضافات الغذائية اكثر مرتين فى اللحم عن الجلد لكلا من الصدر و الفخذ .