BENEFICIAL EFFECT OF DIETARY COPPER SULPHATE SUPPLEMENTATION ON JAPANESE QUAIL PERFORMANCE AND FATTY ACID PROFILE.

M.M. Wakwak

Biological Applications Department, Radioisotope Applications Division, Nuclear Research Center, Atomic Energy authority, Abou-Zaable, Cairo, Egypt

(Received 7/11/2005, accepted 28/12/2005)

SUMMARY

A total number of 240 unsexed 21-day old Japanese quail birds (113-116 gm) were divided equally into four groups (60 birds in each). First group received basal diet+ 4% used restaurant oil (basal oxidized oil, B-OxO), second group received basal diet+ 4% non oxidized oil (control, B-NOxO). The third and fourth groups received 200 mg CuSo4/kg plus B-OxO or B-NOxO, respectively. Feeding B-OxO (1[st] group) reduced body weight, egg production, egg weight, fertility and hatchability percent and increased mortality percent, cholesterol and triglycerides of blood, eggs and breast meat of the birds. Copper sulphate supplementation reduced the bad effect of oxidized oil on these parameters especially fatty acid profile and cholesterol content of blood, eggs and breast meat of the birds. Copper sulphate supplementation has a positive effect also when added to non-oxidized oil on body weight, egg production and cholesterol level.

***Key wards:** copper sulphate supplementation, cholesterol, fatty acids, oxidized oil, egg production, quails.*

INTRODUCTION

Because of the possible relationship between dietary cholesterol and human health problems, heart disease has had a negative impact on egg consumption (Metwally *2002).* It is recommended that the dietary cholesterol intake per day must be less than 300 mg (Brown 1990). An egg contains about 250 mg cholesterol, although, in general, cholesterol content of eggs has been overestimated (Van Elswyk *et al 1991).* Efforts were performed to reduce cholesterol content of poultry meat and egg yolk. Plasma cholesterol increased when dietary copper was depleted from the diet (Kelvay *et al., 1984).* Although, the mode of action of copper is not clear, pharmacological levels of dietary copper clearly affect both lipid metabolism and growth of poultry (Pesti and Bakalli, *1996).* They established also that including copper at a rate of 250 mg in excess of the basal level (10mg/kg diet) led to maximal improvement of growth rate. The use of supplementary copper to provide 150 mg/kg in poultry diets was concluded to decrease yolk cholesterol concentration without any effect on production performance (Balev and Coskun *2004).* They concluded that the inclusion of 250 ppm of copper in the broiler feed was acceptable for reducing the cholesterol in the meat (Premkumar *et al., 2002).* Total lipid and cholesterol levels in breast muscle were suppressed by copper supplementation significantly to 30%. These results showed that dietary copper supplementation alters lipid metabolism and changes the fatty acid composition of depot lipids of swine (Lauridsen *et al., 1999).* Feeding chickens supra normal levels of copper resulted in decrease of plasma, breast muscle cholesterol and plasma triglycerides (Pesti *et al., 1994).* Evidence indicates that liver copper regulates cholesterol biosynthesis by reducing glutathione concentrations (Kim *et al., 1992).*The range of concentration over which copper can influence or regulate cholesterol biosynthesis is not known. A series of experiments were conducted to test the hypothesis that the cholesterol content of chicken plasma and meat could be reduced by feeding copper in excess of the amount needed to maximize growth (Bakalli *et al., 1995).*

There has been growing interest over recent years in the modulation of the fatty acid composition and cholesterol content of poultry products (Skrivan *et al., 2000).* The susceptibility of meat lipids to oxidation depends on the presence of copper in the meat. Copper promotes oxidation of low-density lipoprotein in vitro (Strain, *1994)* and an essential component of superoxide dismutase, an enzyme defending living organisms against reactive oxygen species (Barman, *1974).* Copper sulphate supplementation reduced the saturated fatty acids proportion in abdominal fat of broiler (Skrivan *et al., 2000).*

Poultry producers and poultry researchers cooperate together to reduce the production costs through inclusion of cheap feed resources in the diets such as used restaurant oil (URO). It is a cheap fat source but characterized by changes in chemical and physical properties due to heating which may affect negatively their nutritive value (El-Faramawy and Fahmy *2005).* The study was designed to evaluate the fatty acid composition of URO and to investigate its improvement through using CuSo4.

The objective of the present study was to determine the effect of copper sulphate supplementation on the productive and reproductive performance and composition of fatty acids profile of eggs and meat of quails fed on oxidized and non-oxidized oils. Another object of this study was to further study the cholesterol- lowering effects of dietary copper in plasma, egg yolk and in breast muscle of these Japanese quail birds.

MATERIALS AND METHODS

A total number of 240 Japanese quail birds (113-116 gm) were reared at the animal house, Biological Application Department, Egyptian Atomic Energy Authority at Inshas. Water and feed were provided ad libitum and the quails were kept under the same condition of temperature and light regimen according to the quail strain catalog during the experimental period. The diet was based on corn and soybean meal, containing or exceeding the NRC (National Research Council, *1994).* The quails were divided into four groups of 60 birds / each. Quails were fed the experimental diets where the first group (G1) received basal diet+ 4% oxidized oil (used restaurant oil), second group (G2) received basal diet+ 4% non oxidized oil (control), third group (G3) received 200 mg CuSo4/kg + diet of the first group and finally the fourth group (G4) received 200 mg CuSo4/kg + diet of the second group. Growth data and mortality were recorded weekly by weighing the birds individually. Before maturation (laying eggs), 20 females and 10 males were transferred to laying battery and fed laying diets. Egg production was recorded daily and its parameters were recorded weekly till the end of the 10^{th} week of egg production. The parameters of egg production calculated as:

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

Contents	**Control**
Ground yellow corn	54.30
Soybean meal (44%)	34.80
Calcium carbonate	5.60
Dicalsium phosphate	1.70
Common salts	0.03
Fat	3.30
Lysine	0.10
Methionine	0.11
Choline chloride	0.025
Mineral premix[2]	0.025
Vitamins premix[3]	0.01
Calculated analysis:	
Crude protein	20.20
Kcal ME/kg	2895
Calcium %	2.62
Av. Phosphorus	0.41
Methionine + cyst%.	0.74
Lysine%	1.07

1- Oils were supplemented to it by 4% according to experimental design.

2- Each kilogram of diet contains Copper, 10mg; Iodine, 1mg; Iron, 30mg; Manganese, 55mg; Zing, 55mg and Selenium, 1mg

3- Each kilogram of diet contains, A, 12000 I.U; D3, 2000 I.U; E, 10mg; K, 2mg; B1,1mg; B6, 1.5mg; B12, 10ug; B2, 4mg; Pantothenic acid, 10mg; Niacin, 20mg; Folic acid, 1000ug; Biotin, 50ug; and Choline chloride, 500ug.

Table (2): Effect of CuSo4 supplementation on body weight changes (gm) of Japanese quail birds from fourth to seventh week of age.

Weeks	G1	G2	G3	G4
4^{th} week	$129.75^{b} \pm 3.62$	$131.33^{ab} \pm 3.68$	$135.08^{ab} \pm 3.63$	$141.0^{a} \pm 2.95$
5^{th} week	$172.26^{b} \pm 3.06$	$182.53^{a} \pm 2.36$	$183.96^{a} \pm 2.26$	$182.13^{a} \pm 2.75$
6^{th} week	$192.25^{b} \pm 3.19$	$198.81^{ab} \pm 2.22$	$201.89^{a} \pm 2.16$	$202.27^{a} \pm 3.18$
7^{th} week	$211.99^{c} \pm 3.19$	$228.0^{b} \pm 3.71$	$229.18^{a} \pm 2.82$	$237.38^{a} \pm 3.75$

a,b,c..... Means with different superscripts within rows differ at $P < 0.05$.

Table (3): Effect of CuSo4 supplementation on mortality Percent of Japanese quail birds.

Weeks	G1	G2	G3	G4
4^{th} week	12.7	3.2	2.1	2.3
5^{th} week	5.2	3.8	1.2	0.0
6^{th} week	6.2	1.9	2.1	1.2
7^{th} week	4.7	2.2	2.2	0.0
Total mean	$7.2^{a} \pm 1.8$	$4.4^{b} \pm 1.90$	$1.9^{c} \pm 0.23$	$0.9^{d} \pm 0.55$

a,b,c Means with different superscripts within rows differ at $P < 0.05$.

Hen day egg production % = number of eggs/ number of females/number of days x 100

Average egg weight = Total egg weight / total egg numbers.

Fertility and hatchability percent of fertile eggs were calculated weekly beginning of the 1st day of egg production till the end of the 6th week. Five birds of each group were randomly selected and starved over night, then sacrificed. The chosen birds were slaughtered by cutting the gullet and adjoining vessels between the 1st and 2nd cervical vertebra without separating the head from the body. The viscera and other inedible parts were removed. The remaining carcass was weighed to ascertain the carcass weight and frozen until breast meat analysis. Blood samples were collected at slaughtering time to determine cholesterol and Triglycerides concentrations using the method of Trinder *(1969)*. Low-density lipoprotein *(LDL)*, high density lipoprotein *(HDL)* concentration according to the method of Grove *(1979)* and thyroxin (*T4*) concentration determined by radioimmunoassay *(RIA)* techniques based on the methods described by Chopra *(1972)* and Larsen *(1972)*. Fatty acids profile of eggs and meat of all experimental traits performed by extracting the fat in chloroform and methanol (Bligh and Dyer, *1959)*. Fatty acids were converted into methyl esters and separated by using hp 6890 Gas Liquid Chromatography equipped with innowax-crosslinked polyethylene glycol column 30 m; *i.d.* 0.32 ml meter; 0.5 um film thickness.

Statistically analysis:-

Data were statistically analyzed using the general linear models procedure of the Costat program (1986). Analysis of variance was performed according to Sendecor and Cochran (1982). Differences between means were determined using the Duncan Multiple Range Tests for all variables (Duncan 1955).

RESULTS

Body weight and mortality:

The effect of dietary copper sulphate supplementation on the body weight and mortality of the Japanese quails are presented in Tables (2 and 3). The 1st Table shows that the group of quails that was fed URO (G1) has given the least results at 5,7 weeks of age while their body weight was comparable to those of G2 and G3 at 4th week and to the control (G2) at the 6th week of age. Group 3 which was fed on URO + cupper sulphate has given a total body weight higher than the control group at the 7th week of age that means cupper sulphate added to the diet increased the body weight. Table (3) shows that the (G1) received URO had the highest mortality rate percent compared to the other groups

Hen day egg production (%) and average egg weights:

Effect of supplementation dietary cupper sulphate on the hen day egg production and average egg weight of the Japanese quails are presented in Tables (4 and 5). The data showed that the G1 which was fed with URO only had the lowest egg production and egg weight. Improvement occurred when birds of this group were supplemented with copper sulphate. The best results obtained when the birds fed on normal oil with copper sulphate.

Female reproductive organs:

The effect of CuSo4 supplementation on female organs of Japanese quail birds is represented in Table (6). It is clear that the ovary weight at the end of the experiment decreased in the group 1 that was fed on URO than the control group. Group 4 fed on no

Table (4): Effects of CuSo4 supplementation on hen day egg production% of Japanese quail birds

Weeks	G1	G2	G3	G4
1st week	--------	------	04.3	04.5
2nd week	---------	6.8	11.3	12.5
3rd week	11.4	38.2	51.4	55.6
4th week	33.5	55.4	72.5	77.2
5th week	45.2	76.2	77.9	81.2
6th week	55.3	81.2	77.8	83.4
7th week	64.2	83.2	89.2	83.2
8th week	59.2	74.5	82.5	79.2
9th week	62.3	69.5	72.5	78.6
10th week	61.2	71.2	79.2	84.5
Total	$39.23^{b}\pm8.3$	$55.62^{a}\pm9.7$	$61.86^{a}\pm9.5$	$63.99^{a}\pm9.6$

a,b,c Means with different superscripts within rows differ at $P < 0.05$.

Table (5): Effects of CuSo4 supplementation on average egg weight (gm) of Japanese quail birds

Weeks	G1	G2	G3	G4
1st week	--------	------	6.3	7.5
2nd week	---------	$6.4^{b}\pm0.6$	$9.3^{a}\pm0.5$	$9.2^{a}\pm0.9$
3rd week	$6.1^{c}\pm0.3$	$9.2^{b}\pm0.5$	$10.4^{a}\pm0.4$	$10.6^{a}\pm0.7$
4th week	$8.5^{c}\pm0.6$	$10.4^{b}\pm0.7$	$11.5^{a}\pm0.9$	$11.2^{a}\pm0.5$
5th week	$9.2^{b}\pm0.6$	$11.2^{a}\pm0.8$	$11.9^{a}\pm0.8$	$11.2^{a}\pm0.7$
6th week	$9.3^{b}\pm0.5$	$12.2^{a}\pm0.3$	$12.8^{a}\pm0.7$	$12.4^{a}\pm0.8$
7th week	$9.2^{b}\pm0.4$	$12.2^{a}\pm0.9$	$12.2^{a}\pm0.5$	$12.2^{a}\pm0.5$
8th week	$9.7^{b}\pm0.9$	$12.5^{a}\pm0.6$	$12.7^{a}\pm0.5$	$12.9^{a}\pm0.6$
9th week	$10.1^{ab}\pm1.0$	$11.5^{a}\pm1.2$	$12.2^{a}\pm1.1$	$12.5^{a}\pm0.7$
10th week	$9.6^{b}\pm1.1$	$11.7^{a}\pm0.8$	$12.2^{a}\pm0.8$	$12.5^{a}\pm0.6$

a,b,c Means with different superscripts within rows differ at $P<0.05$.

Table (6): Effect of copper sulphate supplementation on reproductive organs of female Japanese quail birds

Organ weight	G1	G2	G3	G4
Ovary weight (gm)	$4.2^{b}\pm 0.55$	$7.33^{a}\pm 0.43$	$7.16^{a}\pm 0.48$	$8.13^{a}\pm 0.94$
Oviduct weight (gm)	$5.07^{c}\pm0.2$	$7.30^{bc}\pm 0.17$	$6.73^{bc}\pm 0.84$	$8.6^{a}\pm 0.55$
Oviduct length (cm)	$22.83^{b}\pm 1.02$	$32.43^{a}\pm 2.32$	$33.13^{a}\pm 1.27$	$33.66^{a}\pm 0.88$

a,b,c ..... Means with different superscripts within rows differ at $P < 0.05$

oxidized oil + CuSo4 gave the best highest weight. There was no significant difference between group2 and group 3 fed on URL+CuSo4. With respect to the oviduct weight G4 and G1 showed highly significant increase and significant decrease respectively than the other groups. The oviduct length in the first group was shorter than the other groups. There were slight differences between group 3 and group 4 that can be omitted.

Fertility and Hatchability:

The effect of CuSo4 supplementation on fertility and hatchability of Japanese quails birds is represented in table (7). The data of this table showed that the group fed with URO only had the lowest fertility and hatchability. Improvement occurred when birds of this group supplemented with copper sulphate. The best fertility and hatchability results showed when birds fed on normal oil with copper sulphate.

Cholesterol:

The effect of cupper sulphate supplementation on serum, egg and meat cholesterol of Japanese quail birds were shown in Table (8). The serum cholesterol concentration, egg cholesterol and meat cholesterol was significantly higher in group1 than the other groups. Group 4 has the best results, it has the lowest cholesterol concentrations.

Triglycerides:

The effect of cupper sulphate supplementation on serum, egg and meat triglycerides of Japanese quail birds is shown in Table (9). The serum triglycerides concentration was higher in group 1 than the control group but it was lower in the group 3 than the control group. The group 4 was the best group, with the least concentration recorded. It was noticed that there were no significant difference between group 3 and group 4 in egg and meat triglycerides.

T4, LDL and HDL:

The effect of cupper sulphate supplementation on serum T4, LDL and HDL of Japanese quail birds was represented in Table (10). The T4 concentration was in their lowest concentrations in group1 compared to all the other groups, which showed no significant differences between them. LDL was in their higher concentrations in group1 compared to control group (group 2). Group 4 has the lowest levels during the whole experimental periods. The HDL level was significantly lower in group 1 compared to the control group. The group 3 was the highest in HDL concentration; it was higher than the control and all the other groups.

Fatty acid profiles:

The effect of dietary CuSo4 supplementation on fatty acid profile of eggs is presented in Table (11). The data in this table showed that the group supplemented with used restaurant oil had an increase in palmitic acid (C16:0) and total SFA and decrease in linoleic (C18:2) and total USFA and U/ S ratio. In the contrary group received 200 mg/ kg CuSO4 and URO showed an increase in total USFA and U/S ratio and decrease in total SFA.

Data of Table (12) showed that URO had increased palmitic acid (C16:0) and total saturated fatty acid than that of the other groups while the groups supplemented with CuSo4 showed an increase in total USFA and U/S.

DISCUSSION

Productive parameters such as body weight and mortality percent were improved by adding copper sulphate to the diet of Japanese quail birds. The results of the present study are in

Table (7): Effect of CuSo4 supplementation on hatchability and fertility percent of Japanese quail birds

Weeks	G1	G2	G3	G4
		Fertility %		
1st week	34.20	72.07	76.72	86.70
2nd week	43.05	79.61	78.28	90.91
3rd week	60.91	85.00	86.02	88.89
4th week	68.72	81.84	82.54	89.66
5th week	57.30	79.90	82.90	90.20
6th week	59.40	84.60	86.70	89.50
Total mean	$53.85^{c}\pm5.2$	$69.69^{b}\pm1.9$	$71.50^{b}\pm1.6$	$77.46^{a}\pm0.6$
		Hatchability %		
1st week	53.95	60.95	63.57	66.18
2nd week	55.93	54.35	61.38	80.30
3rd week	59.54	71.67	67.74	81.11
4th week	51.06	75.51	77.14	76.89
5th week	50.20	77.80	79.80	80.40
6th week	53.4	77.60	79.40	79.90
Total mean	$53.95^{c}\pm1.4$	$80.50^{b}\pm3.9$	$82.19^{b}\pm3.4$	$89.31^{a}\pm2.3$

a,b,c Means with different superscripts within rows differ at $P < 0.05$

Table (8): Effect of CuSo4 supplementation on serum cholesterol (mg/dL), egg and meat cholesterol (mg/100g) of Japanese quail birds.

Items	G1	G2	G3	G4
Serum cholesterol	$293.28^{a}\pm 7.4$	$107.55^{b}\pm 8.9$	$98.57^{b}\pm 5.86$	$64.1^{c}\pm 10.3$
Egg cholesterol	$247.42^{a}\pm11.8$	$105.27^{b}\pm18.2$	$98.85^{c}\pm 4.2$	$83.75^{c}\pm 25.9$
Meat cholesterol	$278.7^{a}\pm25.3$	$131.8^{b}\pm 13.15$	$73.67^{c}\pm 17.8$	$66.1^{c}\pm 12.95$

a,b,c….. Means with different superscripts within rows differ at ($P < 0.05$)

Table (9): Effect of CuSo4 supplementation on serum, egg and meat triglyceride (mg /dl) of Japanese quail birds

	G1	G 2	G3	G4
Serum triglycerides	$459.2^{a}\pm 93.9$	$239.4^{b}\pm 53.3$	$202.5^{d}\pm 78.8$	$230.3^{c}\pm 46.2$
Egg triglycerides	$310.1^{a}\pm 21.8$	$203.3^{b}\pm 7.6$	$160.6^{c}\pm 1.04$	$130.3^{c}\pm 20.9$
Meat triglycerides	$214.1^{a}\pm 35.9$	$112.1^{b}\pm 40.3$	$91.2^{c}\pm 30.4$	$90.9^{c}\pm 10.7$

a,b,c… Means with different superscripts within rows differ at ($P < 0.05$)

Table (10): Effect of CuSo4 supplementation on serum thyroxin (T4) low density lipoprotein (LDL) and high density lipoprotein (HDL) of Japanese quail birds.

	G1	G2	G3	G4
T4 (nmol /dl)	$0.92^{b}\pm 0.037$	$1.1^{a}\pm 0.058$	$0.97^{a}\pm0.015$	$0.98^{a}\pm 0.015$
LDL (mg / dl)	$13.3^{a}\pm 1.21$	$9.4^{b}\pm 3.79$	$8.6^{b}\pm 4.17$	$5.8^{c}\pm 1.14$
HDL (mg / dl)	$22.4^{d}\pm 0.0$	$35.2^{b}\pm0.15$	$43.2^{a}\pm 1.73$	$25.6^{c}\pm 4.17$

a,b,c….. Means with different superscripts within rows differ at $P < 0.05$

Table (11): Effect of copper sulphate supplementation on fatty acid profile of Japanese quail eggs

Fatty acids	G1	G2	G3	G4
C14:0	0.57	0.63	0.51	0.55
C16:0	36.07	5.04	4.76	4.18
C17:0	0.33	0.22	0.24	0.3
C18:0	0.33	0.22	0.06	1.81
C19:0	0.12	0.22	0.13	-
C20:0	0.12	0.22	-	-
C16:1	0.08	5.58	5.84	23.11
C18:1	47.05	63.66	70.64	44.37
C20:1	0.18	0.12	0.13	0.41
C18:2	9.65	15.88	13.67	20.61
Others	5.95	8.87	4.02	4.66
SFA	37.09	6.11	5.7	6.84
USFA	56.96	85.24	90.28	88.5
U/ S	1.54	13.95	15.84	12.94

Table (12): Effect of copper sulphate supplementation on fatty acid profile of Japanese quail meat

Fatty acids	G1	G2	G3	G4
C14:0	0.75	-	0.84	0.63
C16:0	34.76	28.09	26.14	18.84
C17:0	0.14	-	0.14	0.11
C18:0	-	3.29	-	-
C19:0	0.87	-	-	-
C20:0	0.11	-	-	-
C22:0	-	-	-	0.08
C16:1	8.17	3.55	8.79	5.2
C18:1	23.62	43.41	41.58	42.54
C20:1	0.26	-	0.17	0.15
C18:2	27.23	16.3	18.45	28.17
Others	4.09	5.36	3.89	4.28
SFA	36.63	31.37	27.12	19.66
USFA	59.28	63.26	68.99	76.06
U/ S	1.61	2.02	2.54	3.87

agreement with those obtained by Pesti and Bakalli (1998). Also Skrivan *et al* (2000) reported that copper sulphate supplementation increased final body weight of chickens by 4.3%. Several possibilities exist for decreasing the cholesterol content in edible parts of chickens by nutrition. Komprda *et al.* (1999) 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 increase growth rate. Indications exist that increased intestinal viscosity impairs digestion of lipids and decrease bile acid 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 in this way (Smits and Annison, 1996). As it is known cholesterol is absent in vegetable oils. Furthermore, these oils contain phytosterols, which are able to block re-absorption of bile acids and cholesterol in the ileum (Sklan *et al.*, 1974)

Reproductive parameters such as egg production, egg weights, fertility, hatchability percents and sex organs weight were improved also by the dietary copper sulphate supplementation. The results of the present study are in agreement with those obtained by Metwally (2002) and Pesti and Bakalli (1998).

The data of the present study suggest the biggest reductions in egg yolk cholesterol and triglycerides will come from feeding 200 mg Cu/kg with the control or URO diets. This observed decrease is consistent with plasma and meat cholesterol reductions in the experiments with meat-type chickens (Bakalli *et al.* 1995; Pesti and Bakalli, 1996). Changes in the enzymes responsible for regulating cholesterol synthesis, oxidation, or elimination may be responsible for lowering cholesterol synthesis in mature as well as immature birds (Konjufca *et al.*, 1997). Reduced synthesis apparently results in less cholesterol being present in plasma and deposited in eggs.

Since the fatty acid composition of chicken carcass and egg can be influenced considerably by the contents of the diet, it is expected that diets containing high percent of SFA and/or USFA will influence carcass and egg fatty acid composition. Dietary saturated fatty acids are implicated as a risk factor for atherosclerosis. Changes in the profile of fatty acids of lipids of edible animal tissues have consequences for human health. It is important to know how to change the composition of fatty acids in poultry lipids in a desirable way. The results of this study are coincides with that of Skrivan *et al.*, (2000) and Sevcikova., *et al* (2003) who observed that copper sulphate supplementation reduced the saturated fatty acids proportion in abdominal fat of broilers.

REFERENCES

Bakalli, R.I., G.M. Pesti, W. I. Regnald, and V. Konjufca (1995). Dietary copper in excess of nutritional requirement reduces plasma and breast muscle cholesterol of chickens. Poult. Sci. 74:360-365.

Balev, T and B. Coskun (2004): Effects of dietary copper on production and egg cholesterol content in laying hens. Brit. Poult. Sci. 45(4):530-534.

Barman T. E. (1974): enzyme handbook. Suppl. L. Springer Verlag, Berlin.

Bligh, E. G. and W.J. Dyer (1964) A rapid method of total lipid extraction and purification. Can. J. Biochem.

Physiol., 37, 911.

Brown, W.V. (1990) Dietary recommendations to prevent coronary heart disease. Ann .N.Y , Acad. Sci. 598:376-388.

Chopra, J.A (1972). Radioimmunoassay for measurements of thyroxin in unextracted sera. J. Clin. Endoc. 34:938-947.

CoStat (1986). CoStat3.03., Co Hort Software. P.O.Box 1149, Berkeley, CA 94701.

Duncan, D. B. (1955). Multiple range and multiple F-test. Biometrics. 11: 1-12.

El-Faramawey A.A. and M.O. Fahmy (2005) Performance and fatty acid profile of Japanese quails fed on diets supplemented with used restaurant oil.Egypt.J.Rad.Sci.,Applic.Vol.18,no.2,pp497-508.

Folch, I, M. Lees, and G. H. Sloane-Stanley (1957). A simple method for the determination of total lipids from animal tissues. J Biol. Chem. 226:497-509.

Grove, T. H. (1979). Effect of reagent pH on determination of HDL cholesterol by precipitation with sodium phosphotungstate-magnesium. Clin Chem 25:560.

Kelvay, I.M.; I. Inman.; I.K. Johnson.; M. Lawler.; J.R Mahalko.; D.B. Miline.; H.C. Lukaski.; M. Bolonchuk.; and H.H. Sandstead (1984) Increased cholesterol in plasma in a young man during experimental copper depletion. Metabolism, 33:1112-1118.

Kim, S, P. Y. Chao and G.D.A. Allen (1992). Inhibition of elevated hepatic glutathione abolishes copper deficiency cholestrolemia. Faseb. J. 6:2467-2471.

Komprda, T., J. Zelenka, , P. Tieffova, M. Stohanddlova and J. Foltyn (1999). Effect of the growth intensity on cholesterol and fatty acids content in broiler chicken tissues. Archiv fur Geflugelkunde, 63: 36-43

Konjufca, V.H., G.M. Pesti and R.I. Bakalli (1997). Modulation of cholesterol levels in broiler meat by dietary garlic and copper Poult. Sci. 76:1264-1274.

Larsen, P. R. J. (1972). Clin. In Vest. 51: 1939-1949.

Lauridsen G, S. Hojsgaarg, M.T. Sorensen (1999): Influence of dietary rapeseed oil, vitamin E and copper on the performance and the antioxidative and oxidative status of pigs. J. Anim. Sci., 77,906-916.

Metwally M.A (2002) The effect of dietary copper sulphate on yolk and plasma cholesterol and production traits of dandrawi hens. Egypt. Poult. Sci 22:1083-1095.

NRC, National Research Council (1994). Nutritional Requirement of Poultry. 9^{th} rev. ed. National Academy Press, Washington, DC .

Pesti, G. M., and R. I. Bakalli (1996). Studies on the feeding of the cupric sulphate pentahydrate and cupric citrate to broiler chickens. Poult. Sci. 75:1086-1091.

Pesti. G. M., R. I. Bakalli and W. L. Regnald (1994). Reduction of turkey plasma cholesterol by dietary copper supplementation. Reprod. Nutr. Devel. 34:624-625.

Premkumar, K; R. Amutha; P. Saminathan and K. Viswanathan (2002). Effect of supplementation of copper and garlic on blood and meat cholesterol in broilers. Indian. J. Poult. Sci. 37:252-257.

Razdan, A., D. Pettersson and J. Pettersson (1997). Broiler chicken body weights, fed intakes, plasma lipid and small- intestinal bile acid concentrations in response to feeding of chitosan and pectin. British journal of nutrition, 78: 283-291.

Snedcor, G. W and W. G. Cochran (1982). Statistical Methods. 7th Ed. The Iowa State University Press. Ames.Iowa. USA.

Sevcikova, S; M. Skrivan.; V. Tumova. and M. Koucky (2003). Effect of supplementation of copper in copper sulphate and copper-glycine on fatty acid profile in meat of broiler chickens, cholesterol content and oxidation stability of fat. Czech-journal of Animal Science 48:10 , 432-440.

Sklan, D.; P. Budowski, annd S. S. Hurwitz (1974). Effect of soy sterols on intestinal absorption and secretion of cholesterol and bile acids in the chick Journal of Nutrition, 104: 1086-1090.

Skrivan, M; V. Skrivanova; M. Marounek; E. Tumova. and J. Wolf. (2000). Influence of dietary fat source and copper supplementation on broiler performance, fatty acid profile of meat and depot fat , and on cholesterol content in meat. Brit. Poult. Sci 41:608-614.

Smits, C.H.M. and G. Annison (1996). Non starch plant polysaccharides in broiler nutrition- towards a physiologically valid approach to their determination Worlds poultry science journal, 52: 203-221.

Strain J. J. (1994) Newer aspects of micronutrients in chronic disease : copper. Proc. Nutr. Soc. 53. 583-598.

Trinder, P. (1969). Clin. Biochem. 6:24.

Van Elswyk, M. E; L.S. Schak. and P.S. Hargis (1991): Evaluation of two extraction methods for determination of egg yolk cholesterol. Poult. Sci 70:1258-1260

التأثيرات النافعة لإضافة كبريتات النحاس لعلائق السمان اليابانى على الأداء الانتاجى وصورة الأحماض الدهنية

ماجدة محمد مصطفى وكوك

قسم التطبيقات البيولوجية- شعبة تطبيقات النظائر المشعة- مركز البحوث النووية- أبو زعبل- مصر

أجريت هذة التجربة لدراسة تأثير استخدام كبريتات النحاس في العليقة على الأداء الانتاجي وتغيير تركيب الأحماض الدهنية في السمان المغذى على الزيت المؤكسد (بعد استعمالة في عمليات القلي) والغير مؤكسد. وقد استخدم في هذه الدراسة 240طائر سمان يابانى عمر 3 أسابيع وكان متوسط وزن الطائر من 113-116 جرام. وقد قسمت الطيور إلى 4 مجموعات متساوية (60 طائر للمجموعة) وغذيت طيور المجموعات على العلائق آلاتية:

المجموعة الأولى:- غذيت على العليقة الأساسية + 4% زيت مؤكسد

المجموعة الثانية:- غذيت على العليقة الأساسية + 4% زيت غير مؤكسد

المجموعة الثالثة:- عليقة المجموعة الأولى + 200 ملجم / كجم نحاس من مركب كبريتات النحاس

المجموعة الرابعة:- عليقة المجموعة الثانية + 200 ملجم / كجم نحاس من مركب كبريتات النحاس

وقد أوضحت النتائج تحسن في كلا من وزن جسم الطيور وانتاج البيض ووزن البيض ونسبة الفقس ونسبة الإخصاب وانخفاض في مستوى الكولسترول والجلسريدات الثلاثية والليبوبروتينات المنخفضة الكثافة في الدم والبيض ولحم الصدر في المجموعات المضاف إليها كبريتات النحاس. وكانت أكثر المجاميع تحسنا المغذاة على الزيت المؤكسد + كبريتات النحاس

وتوصى الدراسة بإضافة كبريتات النحاس لعلائق طيور السمان اليابانى في فترتي التسمين والبياض بمقدار 200 ملجم نحاس لكل كجم عليقة وذلك لما لها من تأثير ايجابي واضح على المقاييس المذكورة، كما توصى الدراسة على استخدام الزيت المستخدم في القلي سابقا (المؤكسد) علي أن يضاف إليه كبريتات النحاس بنفس التركيز.