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# THE EFFECT OF ZINC ENRICHED RATION ON LIPID AND LIPOPROTEIN PATTERNS IN CHICKENS

BY

*KH. KHILO and ** A. A. MANDOUR

* Department of Biochemistry, Fac. Vet. Med. Kafr El-Sheikh, Tanta Univ.
**Department of Biochemistry, Fac. Vet. Med. Alex. Univ.

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## SUMMARY

This study was conducted to determine the effect of high dietary zinc (1000 ppm/kg ration) on serum total lipids, triacylglycerols, total cholesterol, phospholipids, high density lipoprotein cholesterol (HDLC), low density lipoprotein cholesterol (LDLC) and very low density lipoprotein cholesterol (VLDLC) of Hubberd broiler chickens for two and four weeks. The obtained data revealed that the high dietary zinc singificantly (P≤ 0.01) decreased both triacylglycerol and VLDLC throughout the experimental period. On the other hand, the total serum cholesterol and phospholipids were significantly decreased (P< -0.05) at 2nd week and highly significantly decreased (P. 0.01) at 4 week. Moreover, the HDLC was significantly (p ≤0.01) increased in treated group at 2nd and 4th week . While the LDLC was significantly (p≤0.01) decreased at 4th week. Serum total lipids showed no significant changes within the experimental period.

## INTRODUCTION

The nutritional significance of the essential mineral, zinc residue in the fact that it is needed for physiological processes ie over 200 metal coenzymes (Prasad, 1984) through these enzymes, zinc is required for bone formation, cell mediated immunity, sex maturity, protein metabolism (Hoekstra et al., 1971). Therefore, the zinc deficiency is accompanied by many biochemical defects include abnormal nucleic acid and protein synthesis as well as lipid and lipoprotein metabolism (Kaneko,1989). Moreover, Sung et al., (1986) reported that zinc deficiency leads to defect in chylomicrons synthesis which consequently resulted in impairment of the intestinal absorption and metabolism of lipids. William et al., (1989) observed that the laying hens lost much of the adipose tissue around the liver, intestine and gizzard during the period of high zinc feeding. Hoekstra et al., (1974) reported that there was a direct increase in serum cholesterol level in rats kept on diet deficient in copper and rich in zinc. On the other hand. Bedi et al., (1981) mentioned that the supplementation of zinc increase HDL levels in cholesterol fed rabbits, while Agag (1983) that there is no significant variations in serum total lipids between zinc-deficient and zinc treated ewes. In poultry, the use of high dietary zinc to increase the body weight, food conversion also as a method of inducing a forced rest in laying hens was advised by many authors. So, this study was planned to emphasize the relationship between the high dietary zinc and the lipid and lipoprotein pattern in broiler chickens.

## MATERIAL AND METHODS

This investigation was carried out on forty 12 weeks old Hubbard broiler chickens. The birds were obtained from El-Nobareya company.

They were fed a ration purchased from pyramids company (Table 1) for two weeks before the experiment, the system of light, temperature and humidity were adjusted as recommended for broiler production (King, 1977). The birds were divided into two equal groups (20 each) as follows: Group 1 : Kept on basal diet and considered as control group
Group II: Kept on basal diet plus zinc sulphate

(1000 ppm/kg ration) and considered as treated group.

The blood samples were collected from the wing vein after two and four weeks from the beginning of the experiment. The clear sera were separated and used for determination of total lipids (Frings et al., 1972); triacyglycerol, (Sidny and Bernard, 1973); total cholesterol (Zak et al., 1954); phospholipids (Connerty et al., 1961); HDL cholesterol (Morin and prox, 1973) while the LDL cholesterol and VLDL cholesterol were calculated according to the following relationships described by Bauer (1982).

$$VLDLC = \frac{\text{plasma triacylglycerol}}{5}$$

$$VDLC = \text{Total cholesterol} - HDLC - \frac{\text{triacylglycerol}}{5}$$

The concentrations are expressed in mg/dk.
The obtained data were statistically analyzed according to the method of Snedecor and Cochran (1971).

## RESULTS AND DISCUSSION

From the present investigation it is evident (table, 21 that high dietary zinc markedly increased ($p <= 0.01$) the levels of triacylglycerol and VLDLC at 2nd and 4th weeks, as well as LDLC at 4th week post-experiment , however,it significantly decreased the concentration of total serum cholesterol, phospholipids and HDLC throughout the experimental period. Total serum lipids showed a non significant increase in treated group when compared with those in control group (table 2).

The non significant increase in total serum lipids with significant elevation of triacylglycerol and decreased cholesterol adn phospholipids indicates a possible alterationin lipid pattern. The mobilization of such lipids form adipose tissue surrounding liver, gizzard and intestine may be the cause of these alterations as proved by William, et al., (1989). The non significant change in serum total lipids noticed during zinc supplementation is compatible with those reported by Agag (1983).

On the other hand, it could be observed that there is a definite relationship between the observed changes in lipid pattern and the adverse effect of high dietary zinc on B-cells of islets of Langerhans and this relation was previously reported by Brever et al., (1979) who mentioned the high zinc level may inhibit the insulin release

**Table (1): Composition of the basal diet**

| Ingredients | % |
|---|---|
| Yellow corn | 56.00 |
| Cotton seed meal | 9.00 |
| Bean meal | 11.60 |
| Fish meal | 10.00 |
| Bone meal | 2.00 |
| Lime stone | 5.60 |
| Salt | 0.10 |
| Vitamin and mineral premix | 0.20 |
| Sand | 2.20 |
| Total | 100.00 |
| Calculated analysis | |
| ME (Kcal/Kg) | 2700.00 |
| Protein % | 17.00 |
| Calorie: Protein (C/P) | 158.80 |

Table (2): Mean Values of total serum lipids, triacylglycerol, total cholesterol, phospholipids, HDLs, LDLs, and VLDLs in chickens fed high zinc level (mg/dl).

| Time | Two weeks | | Four weeks | |
|---|---|---|---|---|
| Group Mean +S. E | Control | Treated | Control | Treated |
| F. lipids | 573.10+7.89 | 578.34+8.24 | 550.21+6.78 | 558.71+9.46 |
| Triacyiglycerol | 188.00+5.45 | 212.92+6.43** | 191.24+627 | 221.37+4.06** |
| T. cholesterol | 196.82+7.60 | 181.04+5.50* | 183.97+4.16 | 160.82+5.34** |
| Phospholipids | 169.28+2.75 | 160.34+3.48* | 164.95+3.18 | 150.18+4.80* |
| HDLC | 80.73+5.17 | 50.64+4.92* | 88.02+3.99 | 44.50+2.13** |
| LDLC | 78.89+79 | 87.82+3.26* | 61.18+4.11 | 84.50+3.08** |
| VLDLC | 37.60+1.09 | 42.58+1.15** | 38.36+0.51 | 44.27+1.01** |

* = Significant at P< 0.05 **= Significant at P< 0.01

via interferring with intracellular function of calcium in beta cells, as confirmed by Abd El-Maged (1983) who found an increase in serum triacylglycerol in diabetic.

It is well known that many classes of lipids are transported in blood as components of lipoprotein and therefore, changes in plasma lipids should be reflected in the amounts and distribution of lipoprotein. In normal cock plasma, almost more than 50% of the lipoprotein is HDL followed by LDL and VLDL respectivley (Yu et al., 1976). Although triacylglycerol constitute a much greater percentage of VLDL than HDL., HDL is the major carrier of plasma triacylglycerol in poultry (Gould and Siegel, 1985). HDL concentration is inversely related to the incidence of coronary atherosclerosis because they reflect the efficiency of cholesterol-scavenging from the tissues. The HDL in plasma vary reciprocally with the chylomicrons and VLDL and directly with activity of lipoprotein lipase (Martin et al., 1983). VLDL is of hepatic origin being the vehicle of transport of triacylglycerol from the liver to the extrahepatic tissues. The elevation of VLDLs and LDLs in zinc treated birds could be attributed to the increase in triacylglycerol concentration from one side and to the diabetogenic effect of high zinc diets from other side. Bennion and Grandy (1977) reported an increase in triacylglycerol; VLDL and LDL fractions in diabetic patients.

It may be worthy that the finding of Mc-Cormik and Cunningham (1989) who found 10,4 and 27 fold increase in hepatic, renal and pancreatic zinc respectively in hens fed high dietary zinc. It is clear from the previous obtained data that the pancreas accumulates a greater concentration of zinc which may results in some type of sequestering function of pancreas when extremely high levels of zinc fed (William et al., 1989).

Our results confirm previous reports on the effect of high dietary zinc. Furthermore, these obtained results show that the hgh levels of zinc alterate lipids and lipoprtein pattern in chickens which in turn may affect the effectiveness of zinc as forced resting agent and consequently the egg production.

## REFERENCES

Abd El-Maged, S. S. (1983):" Biochemical effects of oral antibiotic drups in serum constituents in pory; M. V. Sc. Thesis, Fac. Vet. Med. Zag. Univ.

Agag, B. I. (1983): Some causes of unthriftiness in Egyptian lambs and their combact. ph. D. Thesis, Fac. Vet. Med. Zag. Univ.

Bauer, J. D. (1982): Clinical laboratlory methods. 9th ed. The C. V. Company 11 1830 Westline Industrial Missouri 63116. Chapter 33, page 555.

Bedi, H. K. et al., (1981): J. Assoc. Physicians India 29, 813. Cited after Kaneko, J. J. (!981): edditor of Clinial Biochemistry of Domestic Animals 1th ed. Academic Biochemistry of Domestic Animals. 1th Academic Press. INC.

Bennion, L. J. and Grandy, S. M. (1977): Effects of diabetes melitis on cholesterol metabolism in man. News Engl. J. Med. 296: 71.

Brewer, G. J.; J. C. Aster; C. A. Knutsen and W. C. Krucheberq (1979): Zinc inhibiton of calmodulin, A proposed molecular mechanism of zinc action on cellular function. Amer. J. Hematol. 7: 53-60.

Connerty, H. V.; Briggs, A. R. and Eaten, E. H. J. (1961): Clin. Chem. 7: (37): 580. Cited in h. Varely. A. H. Gewenlok and M. Bell (1980): ed. of practical clincial biochemistry 5th. ed 669. William Hedical Books LTD. London.

Fringss, C. S.; Fendley, T. W.; Dunn, R. T. and Queen, C. A. (1972): Improved determination of totla serum lipids by the sulpho-phosphovanillin raction. Clin. Chem. 18 (7) 673-674.

Gould, N. R. and Siegel, H. S. (1985): Serum lipoprotein in chickens after adminstration of adrenocorticotrophin or exposure to high temperature. Poult. Sci. 61-571.

Hoekstra, W. G.; Suttie, J. W. Centher, H. B. and Mertz, W. (1974): Trace element metabolism in animals. 2nd ed. University, Park Pres Baltimore,

Kaneko, J. J. (1989): Clincial biochemistry of domestic animals. 4th ed. Academic Press. INC.

King, J. O. L. (1977): An introduction to animal husbandry, Blackwell scientific Publications Oxford.

Martin, D. W.; Mayes, P. A. and Rodweel, V. W. (1983): Harpers Review of Biochemistry. Middle East eddition. Lange Medical Publication.Loss Altos. California.

Mc-Cormick, C. C. and Cunningham, D. L. (1984): Forced resting by ligh dietary zinc. Tissue zinc acumulation and reproductive organ weight changes. Poult. Sci. 63: 1207-1212.

Morin, L. G. and Prox, J. (1973): J. Clin. Chem. 19 776. Cited after Bauer, J. (1982) edditor of clinical laboratory methods. 9th ed. page. 551-555. C. V. Mosby Company 11830 West, Line. Industrial Missouri 63116 U. S. A.

Prasad, A. S. (1984): Discovery and importance of zinc in human nutrition. Fe. Proc. 13: 2825-2831

Sidney, P. C. and Bernard, R. (1973): Improved manual spectrophotometric procedure for determination of serum triglycerides. Clin. Chem. 19 (9): 1077-1078.

Snedecor, C. H. and Chochran, W. G. (1971): Statistical methods. 6th ed. Iwoa state Unviersity Press. Ames. lowa.

Sung, 1.; Johan, E. and Jasmine Chow (1986): Effect of marginal zinc deficiency on the lymphatic absorption of (C11) cholesterol. J. Nut. 116: 2363-2371.

William, G. N.; R. D. Miles; M. D. Quart and D. R. Campbell (1989): Short term high level zinc feeding and tissue zinc concentration in mature laying hens. Poult. Sci, 68: 539-515.

Yu, J. Y.; Campbell, L. D. and Marquardt, R. R. (1976): Immunological and compositional patterns of lipoprteins in chickens (Gallus domesticus) plasma. Poult. Sci. 55: 1626-1631.

Zak, B.; Dichenman, R.; Whitsee, E.; Burnet, H. and Cherney, P. (1954): Rapid estimation of free and total cholesterol. Amer. J. path. 24-130.