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EFFECT OF AGE AND HOUSING SYSTEMS ON PLASMA AND EGG YOLK CHOLESTEROL

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SUMMARY

In this study the effect of age and housing systems on the levels of plasma and egg yolk cholesterol were investigated using commercial laying hens. A sharp increase of plasma cholesterol level was observed at week 27 of age followed by a sharp decline throughout weeks 32 and 37 of age reaching a plateau by week 42 of age. This pattern was interestingly observed in both housing systems (caged & floored). However, the sharp increase in the plasma cholesterol level at week 27 was 4-times higher ($P<0.01$) in the caged system; whereas at 37 weeks the decrease in the plasma cholesterol level was greater ($P<0.01$) and more prominent in the floored system (2-folds) than the corresponding decrease in the caged system. In a similar manner, the egg yolk cholesterol levels in both systems followed the same pattern from week 22 to 42 of age which corresponded with the increase and decrease of the plasma cholesterol levels as well as the rate of egg production. The significant ($P<0.01$) difference observed was the 2-fold increase of egg cholesterol at week 27 in the floored system in comparison with that of the caged system.

Keywords: Hens, housing system, egg, plasma, cholesterol

INTRODUCTION

The role of serum cholesterol in the development of atherosclerosis and factors affecting serum cholesterol levels in man and in experimental animals has been a subject of considerable interest and have received much attention throughout (Naber, 1976; Stadelman and Pratt, 1989). Cholesterol synthesis increases in hens as they mature, and this is thought to be due to an increase in demand for egg production CNaber, 1983).

The effect of age of hen upon egg yolk cholesterol may be expected because it affects the hen's serum cholesterol (Weiss *et al.*, 1967). However, Jones (1969), Turk and Barnett (1971), showed that the cholesterol concentration in the egg yolk does not change with the age of the hen. On the other hand, Spencer *et al.* (1978) found that cholesterol concentration in eggs increased as the age of hen increased. However, Bair and Marion (1977) reported that egg yolk cholesterol tended to decrease with advances in age. Weiss and Fisher (1957) found that the correlation

between the rate of egg production and serum cholesterol level was not significant; however, Leveille and Fisher (1958), Wilcox *et al.* (1963) and Weiss *et al.* (1967) reported a significant negative correlation between these two variables.

Since there is so much contradiction on the effect of age upon the plasma and egg yolk cholesterol, the aim of this study was to investigate further into the effects of age as well as the type of housing system on the plasma and egg yolk cholesterol levels.

MATERIALS AND METHODS

Number of 280 laying hens (Hy-Line) commercially obtained at the age of 16 weeks was divided into two equal groups, where one was raised in a windowed floor pens and the other groups raised in a windowed caged system. In the latter group each pair of hens were assigned to a single cage. All hens were provided with a 16 hour light/day and were offered feed and water *ad libitum* using the normal commercial laying ration (17% protein and 2800 Kcal/kg metabolizable energy).

Twenty blood samples were randomly obtained at five ages (22, 27, 32, 37, and 42 weeks) from both caged and floored hens. Blood samples (5 ml) were taken from the brachial wing veins into EDTA-treated syringes. Blood samples were immediately centrifuged for 5 min. at 2500 r.p.m. and the plasma were kept at -20° C for later analysis. Plasma cholesterol was determined by enzymatic kits (Quimica Clinica Aplicada kits; 43870 Amposta/Tarragona/Spain). Absorbance was measured in duplicate at 510 nm on a Spectrophotometer.

Twenty eggs, randomly chosen from eggs laid during each age (22, 27, 32, 37 and 42 week) from both systems (cage and floor) and were used in determining the egg weight and egg yolk cholesterol concentration (mg/g yolk) according to Zlatkis *et al.* (1953). All readings were recorded in duplicates.

The percentage of eggs produced weekly from each system (cage and floor) was calculated at all the ages. Results were statistically analyzed using a two-factor analysis of variance with system (floor/cage) and age as independent variables (Patersen, 1985). The significant differences among individual means were tested according to Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The results presented in this study highlights the differences in the levels of plasma and egg yolk cholesterol as affected by age and /or the housing systems. A sharp increase in plasma cholesterol concentration at 27 weeks of age occurred followed by a sharp decrease in 32 and 37 weeks of age in both systems (Table 1 and Fig. 1), this is in agreement with the results of Mady (1990) regarding the caged system. A significant difference ($P<0.01$) in plasma cholesterol level was observed in both systems (hens raised in the caged system had a higher plasma cholesterol level). The sharp increase in plasma cholesterol that was observed in the cage system between weeks 22 and 27 was in the order of 25% compared to an increase of 5% only in the floor system in the same period. Although the plasma cholesterol has been decreased at week 32, it was approximately 7% higher than that of the initial age at week 22. In contrast, the plasma cholesterol level in those raised in the floored system was 5% lower at week 32 compared to week 22. These differences between the cage and floor systems existed in spite of the similar decrease in the plasma

cholesterol levels between weeks 27 and 32. The overall decrease in the plasma cholesterol between weeks 22 and 37 was much higher in the floored system approximately 2-folds than that of the caged system. There was a decrease of 20% in the caged system compared to 26% decrease in the floor system between weeks 32 and 37.

Table 1. Effect of age and housing on the cholesterol level in plasma and egg yolk.

Age (wks)	Cholesterol level in			
	Plasma (mg/dl)		Egg (mg/yolk)	
	Cage	Floor	Cage	Floor
22	150 ± 7.6^{c}	158 ± 7.3^{bc}	249 ± 4.5^{c}	256 ± 4.4^{bc}
27	187 ± 7.3^{a}	166 ± 7.3^{b}	261 ± 5.9^{b}	283 ± 2.2^{a}
32	161 ± 6.9^{b}	149 ± 8.8^{c}	214 ± 3.3^{e}	222 ± 3.8^{e}
37	129 ± 10.6^{de}	111 ± 5.6^{f}	222 ± 3.2^{e}	233 ± 8.1^{d}
42	133 ± 4.4^{d}	123 ± 4.3^{e}	228 ± 2.1^{de}	241 ± 2.2^{cd}

a,b,c,d,e Means bearing different letter superscripts are significantly different ($P<0.01$)

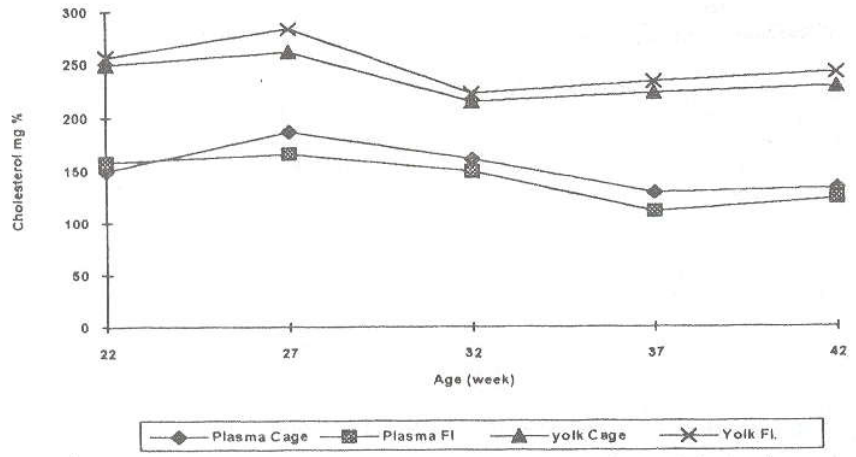

Figure 1. Effect of age and housing systems on plasma and egg cholesterol.

Similar significant differences ($P<0.01$) were found in the egg yolk cholesterol levels in both systems with the exception of the floor system having an overall higher levels (Table 1). As with the plasma, the egg yolk cholesterol was observed to follow a similar pattern in both systems (Fig 1). The egg yolk cholesterol level being highest at week 27 in both systems, followed by a decline of 18-22% at week 32 in both systems. Interestingly, the egg yolk cholesterol increased slightly but significantly

(P<0.01) at the next age of 37 weeks in the floored system with no significant change in the caged system.

The change in egg yolk cholesterol concentration (mg/g); yolk weight (g) and the percentage of egg production are shown in (Table 2). The overall results show significantly (P<0.01) higher levels of cholesterol in eggs laid by young hens similar to that obtained by Gissel *et al.* (1976). The results of the caged system suggest no significant change of egg yolk cholesterol (mg/yolk) or that of cholesterol concentration (mg/g yolk) with the increasing age of hen. These data are in agreement with that of Jones (1969) and Turk and Barnett (1971) and Spencer *et al.* (1978). This might be due to the increase in egg yolk weight with the advancing age of the hen.

Table 2. Mean of egg cholesterol (mg/g yolk), yolk weight (g) and percentage of egg production.

Age	Egg cholesterol (mg/g yolk)		yolk weight (g)		Egg production%	
(wks)	Cage	Floor	Cage	Floor	Cage	Floor
22	19.5 ± 0.2^{b}	20 ± 0.4^{b}	12.9 ± 0.2^{c}	12.8 ± 0.2^{c}	44	39
27	19.6 ± 0.3^{b}	21 ± 0.4^{a}	13.3 ± 0.3^{c}	13.5 ± 0.3^{c}	92	89
32	13.1 ± 0.3^{d}	13 ± 0.3^{d}	15.2 ± 0.2^{b}	16.2 ± 0.1^{ab}	77	83
37	13.0 ± 0.2^{d}	14 ± 0.3^{c}	16.5 ± 0.2^{a}	16.7 ± 0.1^{a}	74	74
42	14.0 ± 0.2^{c}	14 ± 0.3^{c}	16.6 ± 0.2^{a}	17.0 ± 0.3^{a}	72	72

^{a,b,c,d}Means bearing different letter superscripts are significantly different (P<0.01)

The rate of egg production was maximum at week 27 and decreased to reach a plateau at weeks 32 to 42; which corresponds to the leveling off the yolk weight in the same period. The data presented show a positive correlation between the rate of egg production with that of the plasma and egg yolk cholesterol.

In conclusion, cholesterol level in the plasma and egg yolk increase sharply as the rate of egg production increases and this might be associated with the need of hens to optimize the level of egg production. However, the decrease of cholesterol concentration (mg/g yolk) with the increasing age might be corresponded to the increase of yolk weight.

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REFERENCES

Bair, C. W. and W. W. Marion, 1977. Yolk cholesterol in eggs from various avian species. Poult. Sci. 57:1260-1265.

Duncan, D. B., 1955. Multiple range and multiple F tests. Biometrics 11: 1-42.

Jones, D., 1969. Variation in the cholesterol content of egg yolk. Nature 221:780

Gissel, C., A. Lindfeld and L.H. Ehnenbrink, 1976. Effects of breed, age and diet of hens on the cholesterol content of the egg yolk. Archiv Fur Geflugelkunde, 40:134-140.

Leveille, G. A. and H. Fisher, 1958. Observation on lipid utilization in hens fed vegtable and animal fat supplemented diets. Poult Sci. 37:658

Mady, M.E.I., 1990. Variability of serum thyroxin and cholesterol in serum and egg yolk with reproductive state. Egypt. J. Animal Prod. 27:99-106.

Naber, E.C., 1983. Nutrient and drug effect on cholesterol metabolism in the laying hens Federation Proceedings 42:2486-2495.

Naber, E.C., 1976. The cholesterol problem, the egg and lipid metabolism in the laying hen. Poult Sci. 55:14-30.

Petersen, R.G., 1985. Design and Analysis of Experiments. Marcel Dekker, INC. New York and Basel.

Spencer, J.V., W.A. Becker, L.W. Mirosh and J.A. Verstrate, 1978. Effect of fertilization and age of hen on the cholesterol content of chicken egg yolk. Poult. Sci. 57:261-264

Stadelman J.W. and D.E. Pratt, 1989. Factors influencing composition of the hens egg. World Poult. Sci. 45:247-266

Turk, D.E. and B.D. Barnett, 1971. Cholesterol content of market eggs. Poult Sci 50:1303-1306

Weiss, H.S. and H. Fisher, 1957. Plasma lipid and organ changes associated with the feeding of animal fat to laying chickens. J. Nutr. 61:267.

Weiss, J. F., R.M. Johnson and E.C. Naber, 1967. Effect of some dietary factors and drugs on cholesterol concentration in the egg and plasma of the hen. J Nutrition 91:119-128.

Wilcox, F.L., Jr. Charms, L.D. Vanvleck, W.R. Harvey and C. S. Shaffner, 1963. Estimates of genetic parameters of serum cholesterol level. Poult. Sci. 42:37.

Zlatkis, A., B. Zak and A.J. Boyle, 1953. A new method for the direct determination of serum cholesterol. J. Lab. Clin. Med. 41: 486-492.

تأثير العمر ونظام التربيه على كوليسترول البلازما وصفار البيض

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في هذه الدراسه تم بحث تأثير العمر ونظام التربيه على مستوىالكوليسترول في بلازما وصفار البيض للدجاج التجاري. الزيادة الحادة في مستوى كوليسترول البلازما لوحظت في الأسبوع ٢٧ من العمر متبوعه بنقص حاد خلال الاسبوع ٣٢،٣٧ من العمر واصلا لمستوي الثبوت في عمر ٤٢ اسبوع. هذه الظاهره شوهدت في كلا النظامين من بيوت التربيه (اقفاص وارضي). وقد كانت الزيادة الحادة في مستوى كوليسترول البلازما بعمر ٢٧ اسبوع لنظام التربيه بالاقفاص اربعة أضعاف ($P<0.01$) مما هو في النظام الأرضي. أما عند عمر ٣٧ اسبوع كان الإنخفاض في مستوى كوليسترول البلازما أعظم ($P<0.01$) بالنظام الأرضي موازيا لضعفين مما هو في نظام الأقفاص. أما بالنسبة لمستوى كوليسترول صفار البيض فقد لوحظت نفس التغيرات السابقة في كوليسترول البلازما وذلك عند المتابعه من عمر ٢٢ الى عمر ٤٢ أسبوع. والتى أرتبطت بالتغيرات في مستوى كوليسترول البلازما ومعدل انتاج البيض. ففي النظام التربية الأرضي وعند عمر ٢٧ اسبوع كانت الزياده معنويه ($P<0.01$) في مستوى كوليسترول صفار البيض وموازيه لضعفين مما هو في نظام التربية فى الاقفاص.