Comparative Aspects of Serum and Egg Cholesterol of Single Comb White Leghorn and Saudi Arabian Baladi Fowl

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ABSTRACT. Data on serum and yolk cholestrol were collected from Single Comb White Leghorn (SCWL) and Saudi Arabian Baladi (SAB) fowl that had been maintained as randombred closed flocks. Young pullets had significantly higher serum cholesterol levels than males of the same age in the two breeds. Serum cholesterol levels of SAB adult hens were higher ($P \le 0.01$) than those of SCWL hens.

The phenotypic correlation coefficients between cholestrol levels in peripheral serum of adult birds and egg constituents were inconsistent, low in magnitude and generally nonsignificant. There were positive correlations of cholesterol serum levels with yolk weight (+ .26; $P \le 0.05$) and body weight (+ .19; $P \le 0.05$) in SCWL which had heavier body weight ($P \le 0.01$) than SAB birds.

Phenotypic correlations between yolk cholesterol and the egg traits were small, inconsistent and generally nonsignificant; except for the correlation between yolk cholesterol and yolk weight (+.45; $P \le 0.01$), egg weight (+.64; $P \le 0.01$) and body weight (+.47; $P \le 0.01$) in SAB hens, which had smaller yolk weight ($P \le 0.05$) smaller egg weight and body weight ($P \le 0.01$) than SCWL hens. The results indicate that neither peripheral serum cholesterol nor yolk cholesterol have significant effects on egg constituents in SAB compared with SCWL fowl.

The relationship between serum and egg yolk cholesterol is subject to considerable debate. It has been suggested that the egg represents an excretory mechanism for excess blood levels of cholesterol so that the laying hen can prevent hyper-cholesterolemia by disposal of cholesterol in the yolk (Weiss *et al.* 1967, and Daghir and Porooshani 1969). Weiss and Scott (1979) have reported, however, that plasma cholesterol has no effect on egg cholesterol levels and that ovarian synthesis of cholesterol may be important in maintaining an essential level of

cholesterol. Recently, Hollands et al. (1980) indicated that the relationship between plasma and egg yolk cholesterol remains unclear.

Estimates of the average cholesterol levels in young pullets and adult Leghorn hens were 146 and 238 mg%, respectively (Wilcox et al. 1963). Sim et al. (1980) obtained an estimate of 83 to 102 mg% in 2yr old cockerels. The findings of Hollands et al. (1980) showed that the males of the Single Comb White Leghorn (SCWL) breed, 9 to 10 weeks of age, had a significant higher mean cholesterol level than the females. Most of the data on the cholesterol content of chicken eggs ranged from 12.0 to 18.0 mg/g yolk (Daghir et al. 1960, Miller and Denton 1962, Turt and Barnet 1971, Becker et al. 1977, Bitman and Wood 1980, and Ansah et al. 1985). However, much higher levels of 20.0 to 29.0 mg/g volk have been reported (Combs and Helbacka 1960, Harris and Wilcox 1963, Chand et al. 1972, and Chand and Spara 1973). A number of reports have investigated the relationship between serum cholesterol or/and yolk cholesterol levels and some of the production traits in hens. The phenotypic correlation between yolk cholesterol and egg production was reported to be (-.17; -.14 to .15; and -.27 to -.38) by Harris and Wilcox (1963), Washburn and Nix (1974) and Cunningham et al. (1974), respectively.

Early investigators found no significant correlation between egg production and adult blood cholesterol levels (Lorenz *et al.* 1938, Weiss and Fisher 1957, and Johnson *et al.* 1959). However, Hollands *et al.* (1980) indicated that the correlation between plasma cholesterol and egg production was negative.

Harris and Wilcox (1963) obtained negative phenotypic correlations (-.09 to -.17) between yolk cholesterol and yolk weight. Correlation coefficient of yolk cholesterol level with egg weight and yolk weight were low (Washburn *et al.* 1976). Hollands *et al.* (1980) indicated that the phenotypic correlation between yolk and plasma levels of cholesterol in three lines of SCW Leghorns was small, as were (-.03 and -.08) reported by Harris and Wilcox (1963) and those (.013 and .14) reported by Washburn and Nix (1974) for estimates from two strains.

This trial was undertaken to determine serum and yolk cholesterol levels in Single Comb White Leghorn (SCWL) and Saudi Arabian Baladi (SAB) fowl maintained as randombred closed flocks and the effect of breed and sex on these levels. In addition, it provides information on the relationship between these variables and some egg and body weight traits.

Experimenal

Birds used in this study were Single Comb White Leghorn (SCWL) and Saudi Arabian Baladi (SAB) chickens that had been maintained as randombred closed flocks in a controlled environment house with a lighting schedule of 14L:10D. House temperature ranged from 20.6 to 26.5°C. The number of birds used was 231 females, 148 males; 152 females and 29 males for SCWL and SAB, respectively. Both breeds of birds were fed the same commercial grower and layer diets (Table 1). Feed and water were provided ad libitum. Blood samples were drawn by heart puncture at 16 weeks of age for males and females. At 32 weeks of age, blood samples were taken from 97 and 87 SCWL and SAB hens, respectively. The sampling dates for these two respective ages were October and February 1985/1986. The samples were taken in the morning starting at 9 AM using the same procedure for handling birds and collecting blood samples for both breeds of birds. Body weight and serum cholesterol level of individual birds were determined.

	Diets	
	Grower (12-21 wks.)	Layer (22-72 wks.)
Crude protein %	13.65	17.00
Crude fat %	3.00	3.00
Crude fiber %	5.50	5.00
Calcium %	1.00	3.50
Phosphorous %	0.60	0.60
Salt	0.35	0.35
Met energy Kcal/kg	2692	2692

Table 1. Composition of the commercial grower and layer diets fed to SCWL and SAB chickens

Ingredients

1. Yellow corn, soybean meal, wheat mill run, alfalfa meal, salt, calcium carbonate, dicalcium phosphate, manganese, iron, copper, iodine, zinc, vitamin A, E, D3, K, thiamine, riboflavin, niacin, pantothenic acid, biotin, choline chloride, B12, ethoxyquin, fermentation products.

2. Yellow corn, soybean meal, wheat mill run, alfalfa meal, meat and bone meal, animal fat, salt, calcium carbonate, manganese, iron, copper, iodine, zinc, methionine, vitamin A, E, D3, K, thiamine, riboflovin, niacin, pantothenic acid, folic acid, biotin, choline chloride, B12, ethoxyquin, fermentation products. Manufactured by: Grains Silos Flour Mills Organization, Feed Mill, Riyadh, Saudi Arabian.

Single serum samples were analyzed for their cholesterol content by the method of Pearson *et al.* (1953). At 32 weeks of age, two consecutively laid eggs were collected from 74 SCWL and 54 SAB hens, randomly chosen, to determine cholesterol content of the yolk. Eggs were individually weighed and hard boiled for 10 min. The yolks were separated from the whites and their weights recorded. A sample of 2 g from each egg was kept in a screw-top vial and frozen until analyzed. Yolk cholesterol level was expressed in m/g yolk or per whole yolk according to the method of Bair and Marion (1978).

The mean egg production per hen housed during the first 90 days was 58.4 and 51.2 egg for SAB and SCWL, respectively. However, our study was based on the

first 60 days egg production. The data were subjected to statistical analyses at King Saud University Computer Center, according to the following linear models:

$$1 - Y_{iik} = U + B_i + S_i + (BS)_{ii} + e_{iik}$$

where Y_{ijk} is the serum cholesterol from the kth 16 week old chicken of the ith breed and the jth sex.

$$2 - Y_{ij} = u + B_i + e_{ij}$$

where Y_{ij} is the jth observation of any of the traits at 32 weeks of age, of the ith breed. The traits here are: serum cholesterol, yolk cholesterol, yolk weight, egg weight, age at sexual maturity, number of eggs laid during the first 60 days, and body weight at 32 weeks of age.

Pearson correlations among the traits were estimated. The statistical analyses were done according to Goodnight *et al.* (1982).

Results and Discussion

Data pertaining to serum cholesterol levels for SCWL and SAB chickens are presented in Table 2. Females at 16 weeks of age had a significantly higher mean cholesterol level than the males in the two breeds. These findings are in contrast with the report of Hollands *et al.* (1980) who showed that SCWL males, 9 to 10 weeks of age, had a significantly higher mean cholesterol level than females.

		Serum cholesterol mg%		
Sex		SAB		SCWL
	n	$x \pm S.E.$	n	$x \pm S.E.$
Males	29	82.1 ± 4.56^{a}	148	79.2 ± 2.01^{a}
Females	152	84.6 ± 1.99^{b}	231	85.7 ± 1.28^{b}
Combined	181	83.4 ± 2.49	379	82.4 ± 1.28

Table 2. Least squares means of 16 week-old chicken serum cholesterol level mg% of SCWL and SAB

Within the same column, any two means with different small case letters, are significantly different from each other at $P \leq 0.05$.

The combined cholesterol blood values, for males and females, at 16 weeks of age showed no significant difference between the two breeds; however, the SCWL

combined value (82.42 mg%) was somewhat lower than that of the SAB chickens (83.42 mg%).

It is worthy to note that serum cholesterol levels at 16 weeks of age, were extremely variable among individuals as the female values ranged from 37 to 190; and 27 to 178 while the male values ranged from 45 to 172 and from 38 to 122 mg% for the SAB and SCWL, respectively. These results may be interpreted to indicate that blood can be sampled at this age, *i.e.* before sexual maturity, and this may help in improving efficiency of selection if studies reveal correlation with some egg traits.

Although average serum cholesterol levels of young pullets (16 weeks) for the two breeds, remained similar, yet cholesterol increased ($P \le 0.05$) in SAB adult compared with SCWL adult hens (Table 3).

	Breed			
Traits		SAB		SCWL
	n	$x \pm S.E.$	n	$x \pm S.E.$
Serum cholesterol (mg%)	86	113.2 ± 3.90^{a}	97	102.6 ± 3.60^{b}
Yolk cholesterol (mg/g yolk)	55	16.5 ± 0.47	76	17.5 ± 0.23
Yolk cholesterol (mg/whole yolk)	55	215.7 ± 8.38^{a}	76	237.9 ± 7.00^{b}
Yolk weight (g)	54	12.9 ± 0.27^{a}	76	13.6 ± 0.23^{b}
Egg weight (g)	54	42.8 ± 0.75^{A}	76	49.6 ± 0.63^{B}
Body weight (g)	87	1204.0 ± 18.10^{A}	97	1342.0 ± 17.20^{B}
Age at sexual maturity (days)	33	178.7 ± 4.30	28	176.6 ± 4.60
Egg No. at first 60 days	33	42.2 ± 1.80^{a}	28	36.6 ± 1.99^{b}

Table 3. Least squares means and standard errors of some traits in adult hens of SCWL and and SAB

^{A,B} Means within the same raw with different capital letters differ significantly at $P \le 0.01$.

^{a,b} Means within the same raw with different small letters differ significantly at $P \le 0.05$.

The increases in serum cholesterol values between 16 and 32 weeks of age were 34 and 19.8% for the SAB and SCWL, respectively. This increase is expected since cholesterol synthesis increases in hens as they mature and this is believed to result from an increase in the demand for egg production.

The mean values for yolk cholesterol, yolk weight, egg weight, body weight, age at sexual maturity and egg production are shown in Table 3. No significant difference was evident in cholesterol/g yolk between the two breeds. On the other hand, estimates for mean cholesterol/whole yolk of SCWL were significantly greater than those of SAB. This may be due to the large size of eggs and the lower

Fouad M. Attia ct al.

rate of egg production of SCWL compared with the SAB layers. These result are similar to the findings of Bartov *et al.* (1971). The mean yolk cholesterol values, obtained in this study, are well within the range of most reported data (Daghir *et al.* 1960, Miller and Denton 1962, Turt and Barnett 1971, Becker *et al.* 1977, Bitman and Wood 1980, and Ansah *et al.* 1985). Yolk weight of the SCWL population was significantly greater than that of the SAB. Both egg and body weights of the SCWL hens showed highly significant estimates than those of the SAB.

Phenotypic correlations (Table 4), between adult serum cholesterol and the egg traits were inconsistent and low in magnitude and generally insignificant except for the positive correlation with yolk weight (+.25; $P \le 0.05$) and body weight (+.19; $P \le 0.05$) in SCWL. These results confirm the findings reported by several investigators (Harris and Wilcox 1963, Washburn and Nix 1974, Cunningham *et al.* 1974, and Hollands *et al.* 1980). These results may indicate a lack of consistent relationships between serum cholesterol of adult hen and the egg traits with the exception of egg and body weight.

Traits	SAB	SCWL
Mean yolk colesterol mg/g	$05(54)^{1}$	+.09 (76)
Mean yolk wt	06 (54)	+.26*(76)
Mean egg wt	+.59 (54)	+.08 (76)
Serum chlesterol at 16 weeks of age	+.14 (31)	
Age sex maturity	+.21 (31)	+.04 (29)
Body wt	+.16 (86)	+.19*(97)
Egg production during 60 days	+.01 (33)	+.06 (28)
2 2 2		

 Table 4. Phenotypic correlations of serum cholesterol of 32 weeks old hens with estimates of egg traits and body weight in SAB and SCWL

¹ Number of birds

* P ≤ 0.05

Phenotypic correlations (Table 5) between yolk cholesterol and the egg traits were small and nonsignificant except for the correlation between yolk cholesterol and yolk weight (+.45; $P \le 0.01$), egg weight (+.63; $P \le 0.01$) and body weight (+.47; $P \le 0.01$) in SAB chickens.

It is concluded that SCWL and SAB breeds of chickens differed markedly in phenotypic correlation between yolk cholesterol and egg traits, as well as traits related to body weight and egg production.

SAB	SCWL
20 (20) ¹	
05 (54)	+.09 (76)
+.46**(53)	12 (76)
+.64**(55)	+.02 (76)
+.47**(54)	+.07 (76)
+.07 (20)	+.12 (29)
24 (21)	04 (23)
	SAB $20 (20)^{1}$ 05 (54) $+.46^{**}(53)$ $+.64^{**}(55)$ $+.47^{**}(54)$ +.07 (20) 24 (21)

Table 5. Phenotypic correlation of mean yolk cholesterol level (mg/g) with serum cholesterol levels (mg%) and some egg traits and body weight

¹ Number of birds

 $** P \le 0.01$

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فؤاد محمد عطية و عبدالله العلي السبيل و محمد فؤاد شاور

قسم الانتاج الحيواني ـ كلية الزراعة ـ جامعة الملك سعود ـ ص . ب ٢٤٦٠ الرياض ١١٤٥١ المملكة العربية السعودية

جمعت البيانات عن كولسترول صفار البيض والسيرم من عشيرتين مغلقتين عشوائيتي التزاوج من اللجهورن الأبيض والبلدي العربي السعودي . لقد وجد ان مستوى كولسترول السيرم في دجاجات (١٦ أسبوع) أعلى معنوياً عنه في الذكور نفس العمر من كلا العشيرتين بالرغم من أن متوسط العشيرتين غير مختلف كذلك كان مستوى كولسترول السيرم في الدجاجات البالغة من البلدي السعودي أعلى معنوياً من مستواه في اللجهورن .

وكانت معاملات الإرتباط الظاهري بين مستوى كولسترول السيرم في الدجاجات البالغة مع الصفات الأخرى المدروسة، خاصة صفات البيض، متباينة ومنخفضة القيمة وغالباً غير معنوية ما عدا معامل الإرتباط مع وزن الصفار (+ ٢٥, • احتمال ٥٠,) في اللجه ورن وهذا ينطبق على معاملات الإرتباط الظاهري بين مستوى كولسترول الصفار والصفات المدروسة الأخرى ما عدا معاملات الإرتباط مع وزن الصفار (+ ٤٥, • احتمال ١٠,) ومع وزن البيض (+ ٣٣, • احتمال ١٠,) ومع وزن الجسم (+ ٤٧, • احتمال ١٠, •) في دجاجات البلدي العربي السعودية والتي تميزت بصغر وزن الصفار (احتمال ٥, •) وصغر وزن البيضة وصغر وزن الجسم (احتمال ١٠,) عن اللجهورن

وقـد اظهرت البيـانات عـدم تأثـير مستـوى كـولسـترول السـيرم ومستـوى كولسترول الصفار على صفات البيض المدروسة ما عدا ما ذكر آنفاً .