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EGG YOLK CHOLESTEROL LEVELS IN CHICKEN AND JAPANESE OUAIL

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Tavuk ve bıldırcında yumurta sarısı kolesterol düzeyleri.

Özet: *Bu çalışma yumurta sarısındaki kolesterol miktarını belirlemek ve farklı tavuk ve bıldırcın ırklarının yumurtalarını kolesterol miktarı yönünden karşılaştırmak amacıyla Japonya'da National Institute of Animal Industry'de yürütülmüştür.*

Çalışmada enstitünün araştırma çiftliğinde bulunan Normal White Leghorn (WLDW), Cüce White Leghorn (WLdw), Gut'lu Fayoumi (FG), Gut olmayan Fayoumi (FN), Babcock (B), Araucana (A) ırk tavuklar ve Renkli (CQ) ve Albino (AQ) bıldırcınlardan toplam 80 *yumurta kullanılmıştır.*

Değerler Wet Yolk Extraction metodu ve Gaz Kromatografi yoluyla elde edilmiş ve veriler standard istatistik tekniklerle analiz edilmiştir.

Ortalama kolesterol değerleri (mg) sırasıyla WLDW, WLdw, FG, FN, B, A, CQ ve AQ için 12.65, 11.40, 13.09, 12.09, 12.43, 13.26, 13.68 ve 12.61 *olarak bulunmuştur. Tavuklar arası* ($P<0.01$), *bıldırcınlar arası* ($P<0.05$), *tavuk ile bıldırcın arası* ($P<0.01$) *farklar istatistiksel olarak önemli çıkmıştır.*

En düşük kolesterol değerine sahip olan WLdw tavukların aynı zamanda en düşük yumurta ağırlığı ve en düşük yumurta sarısı ağırlığına da sahip olduğu gözlenmiştir.

Yumurta ağırlığı ile yumurta kolesterolü arasında 0.3–0.7 *arasında değişen fenotipik korrelasyonlar bulunmuştur.*

Tüm bulgular göstermektedir ki ,dikkatli bir seleksiyonla yumurtanın içerdiği kolesterol miktarını azaltmak mümkündür.

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Summary: *This work was carried out in National Institute of Animal Industry in Japan. The purpose of this study was to determine the cholesterol levels in egg yolks of different poultry species and quail strains and also to make comparisons among eggs of different poultry species for cholesterol contents.*

A total of 80 *eggs were used from chickens of White Leghorn Normal (WLDW), White Leghorn Dwarf (WLdw), Fayoumi Gout (FG), Fayoumi Nongout (FN), Babcock (B), Araucana (A) and from quails of Coloured (CQ) and Albino (AQ) strains.*

For the determination of cholesterol The Wet Yolk Extraction method and Gas Chromotography were used. The data were analysed using standard statistical techniques.

The mean values (mg) of yolk cholesterol were 12.65, 11.40, 13.09, 12.09, 12.43, 13.26, 13.68 *and* 12.61 *for WLDW, WLdw, FG, FN, B, A, CQ and AQ respectively. There were significant differences among chicken strains* ($P<0.01$), *among quails* ($P<0.05$) *and between chickens and quails* ($P<0.01$).

WLdw which had the lowest cholesterol value, had also the lowest egg weight and yolk weight.

The correlations between egg weight and total cholesterol were ranged from 0.3 to 0.7.

Depending on the results obtained it may be stated that the yolk cholesterol level in egg could be reduced by selection among the chickens and quails.

Introduction

Cholesterol has received a considerable attention recently, being one of the contributing factors in heart disturbances in humans. The rate of mortality due to heart diseases tends to be increasing.

Evidence is conflicting as to whether the nutritional qualities of egg as food for humans are outweighed by its cholesterol content. The tendency of people to lower the intake of dietary cholesterol, results to decrease their egg consumption.

The aims of this research work were to determine the nutritional value of eggs from different poultry species and birds.

Egg yolk cholesterol is affected by some environmental factors such as age, season (8, 16), and diet (6, 9, 11). Nix et al (10) indicated that molting may affect yolk cholesterol level.

Several reports indicated that genetics may also play a role in determining cholesterol levels in egg yolk (2, 5, 7, 13, 15, 16).

Edwards et al (5) found significant variation among chickens in the same breed and also among strains.

Cunningham et al (4) reported that the heritability values for yolk cholesterol ranged from 0.21 to 0.24.

Harris and Wilcox (7) have also concluded that egg yolk cholesterol was not highly heritable. Washburn and Nix (16) reported mean heritability estimates for yolk cholesterol in the Athens–Canadian randombred and Athens randombred populations of chickens to be 0.29 and 0.19 respectively.

On the other hand, reports have indicated that cholesterol concentration per gram of yolk was significantly higher in eggs laid by hens having a low rate of egg production (2). A low but significant negative correlations exists between yolk cholesterol and rate of egg production (2, 14, 15).

Ansah et al (2) and Washburn and Marks (17) have also found negative correlations between egg production and egg yolk cholesterol. The correlation coefficient of yolk cholesterol with egg weight were inconsistent, low and nonsignificant (2).

Simmons and Somes (13) while comparing Araucana and White Leghorns, they found that Araucana had higher concentrations of yolk cholesterol than White Leghorn eggs. In another study Somes et al (14) reported considerably lower egg production for Araucanas.

Ansah et al (2) produced eggs which contained significantly lower cholesterol by selection. Cunningham et al (4) also observed significant line differences after a single generation of bidirectional selection for yolk cholesterol in a closed Leghorn population.

Turk and Barnett (15) reported that turkey, duck and coturnix quail eggs contained greater cholesterol concentrations than chicken eggs. Ono and Inno (11) found that yolk cholesterol levels were 11.2 mg for White Leghorn an 13.8 mg for quails.

The purpose of this study was to determine the cholesterol levels in egg yolks of different poultry species and quail strains and also to make comparisons among eggs of different poultry species for cholesterol contents.

Materials and Methods

1– *Materials:* A total of 80 eggs were used from chickens of White Leghorn Normal (WLDW) (10), White Leghorn Dwarf (WLdw) (12), Fayoumi Gout (FG) (8), Fayoumi Nongout (FN) (11), Babcock (B) (16), Araucana (A) (4) and from quails of Coloured (CQ) (10) and Albino (AQ) (9) strains. The eggs were collected at Poultry Research Farm, National Institute of Animal Industry in Japan.

Hexane, 5 α Cholestane, 95 % Ethanol, 50 % KOH, Nitrogen gas and distillated water were used as chemical reagents. The equipment used were 0.1 gr and 0.1 mg balances, Taiyo Recipro Shaker, Taiyo dry Thermounit block heater, climper and Hewlett Packard 5830 A Gas Chromotograph.

2– *Methods:* For the determination of cholesterol the extraction of wet yolk was used. Method is as follow:

1. The eggs were weighed on a balance, broken, shells discarded, yolks were separated from white and weighed.

2. Vitellin membrans were removed and 0.4 ml of homogenized yolk was taken for each egg and weighed, than put into the sampling tube.

3. 260 ml of 95 % Ethanol and 40 ml of 50 % KOH were mixed and added 3 ml for each sample and capped the tubes. Heated until residues became white on a dry block heater at 80°C. That was saponification process.

4. Added 3 ml distillated water. After that, treated with hexane 5 times using shaker.

5. Per ml of Hexane mixed with 1.5 mg of 5 α Cholestane and added 1 ml of this mixture into the each tube and then evaporated on a dry block heater at 40°C by nitrogen gas.

6. At last added about 5 ml hexane, shaked by hand until became transparent. This is actually extraction process.

7. Samples were measured using Hewlett Packard 5830 A Gas Chromotograph (4 ft long, id 3 mm, od 6 mm, 3 % OV–17 Column Packing, on a support of chromosorb WAW–DMCS with a mesh size of 60–80, column temperature + 270°C, FID temperature + 300°C, injection temperature + 300°C, carrier gas N_2 with of low rate of 30 ml / min).

8. Yolk cholesterol was calculated by following formulas:

$$K = \frac{\text{Cholesterol weight (st)} / 5\alpha \text{ Cholestane Weight (st)}}{\text{Area Cholesterol (st)} / \text{Area } 5\ \alpha \text{ Cholestane (st)}}$$

$$\text{Yolk Chol} = \frac{\text{Chol.area (sam)} / 5\alpha\text{Chol.area (sam) X K X weight of } 5\alpha \text{ Chol (sam)}}{\text{Weight of sample (0.4 ml yolk)}}$$

$$\text{Total Chol} = \frac{\text{Cholesterol X Yolk weight}}{\text{Sample Weight}}$$

9. The data were analysed using standard statistical techniques. Specifically analysis of variance and LSD tests were applied and the determinations of correlation coefficients between some traits were carried out.

Results

The mean values of yolk cholesterol, yolk weight, egg weight and total cholesterol are presented in table 1. Analysis of data are given in tables 2 through 7. There were significant differences among the various chicken groups ($P<0.01$) for all characteristics measured. The lowest cholesterol value was 11.40 mg for the White Leghorn dwarf strain and the highest value of 13.27 mg was obtained for the Araucana strain. The LSD test revealed that there were significant differences between WLdw and all the others; A and FN, A and B (table 3).

For total cholesterol value, the WLdw group had the lowest value as 378.72 mg, it was also found that there were significant differences ($P<0.01$) between this strain and all the others (table 4).

The difference between the quail strains for yolk cholesterol (%) was also found to be significant (table 5).

Table 1 Summary of data

Measurement		Egg Weight	Yolk Weight		Yolk Cholesterol		Total Cholesterol	
		gr	gr	%	mg / gr	%	mg / gr	%
Breed	n	$\bar{X}$ $S_{\bar{x}}$	$\bar{X}$ $S_{\bar{x}}$	$\bar{X}$ $S_{\bar{x}}$	$\bar{X}$ $S_{\bar{x}}$	$\bar{X}$ $S_{\bar{x}}$	$\bar{X}$ $S_{\bar{x}}$	$\bar{X}$ $S_{\bar{x}}$
WLDW	10	57.66 ± 1.48	18.10 ± 0.53	31.38 ± 0.39	12.65 ± 0.21	2.31 ± 0.06	552.41 ± 18.68	41.43 ± 0.17
WLdw	12	45.63 ± 0.74	13.71 ± 0.33	30.02 ± 0.40	11.40 ± 0.26	3.03 ± 0.06	378.72 ± 11.19	41.16 ± 0.19
FN	11	52.14 ± 1.32	17.59 ± 0.27	33.89 ± 0.78	12.09 ± 0.49	2.39 ± 0.05	512.28 ± 31.39	41.93 ± 0.64
FG	8	57.42 ± 0.99	19.40 ± 0.89	33.79 ± 1.42	13.09 ± 0.49	2.16 ± 0.07	610.69 ± 24.94	41.35 ± 0.23
B	16	65.59 ± 1.03	19.37 ± 0.45	29.59 ± 0.68	12.43 ± 0.10	2.14 ± 0.05	584.15 ± 12.91	41.12 ± 0.16
A	4	55.56 ± 1.84	18.16 ± 0.64	32.76 ± 1.36	13.26 ± 0.27	2.32 ± 0.07	573.45 ± 29.48	42.06 ± 0.33
AQ	9	10.12 ± 0.09*	3.24 ± 0.08*	31.97 ± 0.61	12.61 ± 0.40	2.52 ± 0.04	100.34 ± 4.27*	8.14 ± 0.08*
CQ	10	11.06 ± 0.29*	3.60 ± 0.15*	32.52 ± 0.84	13.86 ± 0.73	2.26 ± 0.09	126.68 ± 11.31*	8.00 ± 0.12*

* Data were multiplied by 5 to compare with the others.

Table 2. Analysis of variances for chicken strains

Source of variation	df	MEAN SQUARES						
		Egg Wei. gr	Yolk gr	Weight %	Yolk mg / gr	Cholesterol %	Total mg / gr	Chol. %
Breeds	5	596.3**	52.32**	39.17**	4.06**	1.27**	77898.18**	1.35
Error	55	14.59	2.68	6.42	1.04	0.04	4393.95	1.17
Total	60							

** P < 0.01

Table 3. LSD test for yolk cholesterol among chickens

Genotype	A	FG	WLDW	B	FN	WLdw
$\bar{X}$	13.26	13.09	12.65	12.43	12.09	11.40
WLdw	1.86**	1.69**	1.25**	1.03*	0.69	—
FN	1.17**	1.00*	0.56	0.34	—	
B	0.83*	0.66	0.22	—		
WLDW	0.61	0.44	—			
FG	0.17	—				
A	—					

* P < 0.05
** P < 0.01

Table 4. LSD test for total cholesterol among chickens

Genotype	FG	B	A	WLDW	FN	WLdw
$\bar{X}$	610.69	584.15	573.45	552.41	512.28	378.72
WLdw	231.97**	205.43**	194.73**	173.69**	133.56**	—
FN	98.41**	71.87*	61.17*	40.13	—	
WLDW	58.28*	31.74	21.04	—		
A	37.24	10.70	—			
B	26.54	—				
FG	—					

* P < 0.05
** P < 0.01

Table 5. t test for quails

Traits		Albino $\bar{X}$ $S_{\bar{x}}$	Coloured $\bar{X}$ $S_{\bar{x}}$	t
Egg Weight (gr)		10.12 ± 0.09	11.06 ± 0.29	2.54*
Yolk	(gr)	3.24 ± 0.08	3.60 ± 0.15	2.17*
Weight	(%)	31.97 ± 0.61	32.52 ± 0.84	0.94
Yolk	(mg / gr)	12.61 ± 0.40	13.86 ± 0.73	1.46
Chol.	(%)	2.52 ± 0.04	2.26 ± 0.09	2.60*
Total	(mg / gr)	100.34 ± 4.27	126.68 ± 11.31	2.09
Chol.	(%)	8.14 ± 0.08	8.00 ± 0.12	1.00

* P < 0.05

The comparison between quails and chickens showed that there were significant differences between quails and WLdw (table 6, 7).

The mean values in Albino and Coloured quails were 12.61 and 13.86 mg while in chicken groups of WLDW, WLdw, FG, FN, B and A the cholesterol values were 12.65, 11.40, 13.09, 12.09, 12.43 and 13.26 respectively.

Table 6. t test for Albino quails and chicken breeds

Traits	Breeds	WLDW	WLdw	FN	FG	B	A
Egg Weight	(gr)	4.34**	5.28**	1.02	6.39**	10.65**	3.66**
Yolk	(gr)	2.82*	4.84**	3.00**	3.43**	1.15	2.71*
Weight	(%)	0.83	2.79*	1.86	1.21	3.26**	0.60
Yolk	(mg / gr)	0.09	2.63*	0.80	0.75	0.56	1.02
Chol.	(%)	2.10*	5.10**	1.30	3.60**	3.80**	2.00
Total	(mg / gr)	1.80	5.53**	0.27	3.31**	3.55**	1.91
Chol.	(%)	1.66	1.10	1.52	1.27	1.14	1.97

* $P < 0.05$
** $P < 0.01$

Table 7. t test for Coloured quails and chicken breeds.

Traits	Breeds	WLDW	WLdw	FN	FG	B	A
Egg Weight	(gr)	1.13	6.15**	1.59	1.11	5.93**	0.11
Yolk	(gr)	0.08	5.39**	0.53	1.15	0.06	0.10
Weight	(%)	1.22	3.07**	1.20	0.80	2.68*	0.16
Yolk	(mg / gr)	1.57	3.42**	2.03	0.81	2.47*	0.50
Chol.	(%)	0.50	7.70**	1.30	0.71	1.20	0.35
Total	(mg / gr)	1.36	4.86**	1.92	0.33	1.05	0.64
Chol.	(%)	2.31*	2.04	2.19*	1.86	2.24*	2.10

* $P < 0.05$
** $P < 0.01$

Rank order for this study is given in table 8. It shows that the strain with the lowest level of cholesterol also had the lowest egg weight and egg yolk weight.

Tablo 8. Rank order for some characteristics.

Egg Weight gr	Ylk Weight gr	Yolk Cholesterol mg / gr	Total Cholesterol mg / gr
Chickens			
B	FG	A	FG
WLDW	B	FG	B
FG	A	WLDW	A
A	WLDW	B	WLDW
FN	FN	FN	FN
WLdw	WLdw	WLdw	WLdw
Quails			
CQ	CQ	CQ	CQ
AQ	AQ	AQ	AQ

As it is given in table 9 the phenotypic correlation coefficients between egg weight and yolk weight were 0.6–0.8; egg weight and total cholesterol were 0.3 – 0.7; yolk weight and total cholesterol were 0.2 – 0.5.

Table 9. Phenotypic correlation Coefficients between some characteristics.

Characteristics		n	r
Egg Weight - Yolk Weight	(Chickens)	61	0.6258
" "	(Quails)	19	0.8496
Egg Weight - Total Cholesterol	(Chickens)	61	0.3290
" "	(Quails)	19	0.7475
Yolk Weight-Total Cholesterol	(Chickens)	61	0.2296
" "	(Quails)	19	0.5820

Discussion

These results were similar to some previous reports. Edwards et al (5), Turk and Barnett (15), Somes et al (14), Ono and Inno (11) have also reported that the differences among the chicken strains for yolk cholesterol were statistically significant.

As Somes et al (14)'s report it is probably the reason that Araucana had the highest yolk cholesterol might possibly be due to its lower egg production. It is also possible that layer strains have lower yolk cholesterol content because of the negative correlation between yolk cholesterol and egg production.

The differences between the quail strains for yolk cholesterol (%) was found to be significant. Similar results were reported by Anglin and Briles (1).

It was found in this study that yolk cholesterol level was significantly higher in quail egg than chicken egg. Similar results were reported by Ono and Inno (11) and Turk and Barnett (15).

The egg used in this study were collected under the same environmental conditions. Therefore all the differences among the groups might have been related to their genetic make up. Thus as it was suggested by Ansah et al (2) the genetic manuplation through selection, that is to change yolk cholesterol, should be possible.

The correlations between egg weight and total cholesterol (0.3–0.7) were considerably high. However these correlations were inconsistent. Smilar inconsistent correlations between egg weight and yolk cholesterol were obtained by Becker et al (3). These results indicated that egg weight did not contribute significantly to the lower yolk cholesterol levels. This positive correlations might be because of the negative correlations between egg production and egg weight.

In conclusion, the results obtained would indicate that part of the differences among breeds in yolk cholesterol level might have been due to genotypes of the breeds. This would also be interpreted that there might be feasibility of reducing yolk cholesterol by selection.

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