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Effect of Genotype on Fatty Acid and Cholesterol Contents of Hen's Egg

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This study was conducted to compare egg cholesterol and fatty acid contents in eggs from Denizli and Gerze which are local Turkish breeds (lay white shell colour egg) and two white and brown layer hybrids. Egg samples were obtained from 36 weeks of age hens and randomly selected for the cholesterol and fatty acid analyses. Twenty egg of each genotype were used to evaluate the effect of genotype on egg fatty acid and cholesterol contents. Turkish local breeds have low egg weight (53.94 and 54.30 g) and high egg yolk percentages (35.94 and 34.90 %) compared to the commercial hybrids (59.00 and 63.15 g; 32.67 and 32.65 %). There were differences among the genotype groups concerning egg cholesterol contents (14.63 and 15.20 mg/g yolk for pure breeds and 16.42 and 15.44 mg/g yolk for layer hybrids). Total saturated fatty acid (SFA) concentrations (32.39 and 33.11 % for pure breeds and 31.91% and 33.46% for layer hybrids); total unsaturated fatty acid (USFA) concentrations (67.61 and 66.89 % for pure breeds and 68.09 and 66.54 % for layer hybrids); USFA:SFA ratios (2.09 and 2.02 for pure breeds and 2.13 and 1.99 for layer hybrids) were found different significantly ($p < 0.05$). It may be considered as an advantage that the local breeds with higher egg yolk percentages were found similar or even lower than that of the layer hybrids.

Key Words: Yolk cholesterol, Fatty acid profiles, Turkey hen breeds.

INTRODUCTION

The possible relationship between dietary cholesterol and saturated fatty acids and coronary heart disease has had a negative impact on egg consumption. Substantial declines in egg consumption have been seen in developed and developing countries. The annual per capita consumption dropping from 280-300 eggs in 1980's to 180-200 eggs in 2000's in a many European countries and USA[1-3]. It is recommended that dietary cholesterol

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intake of human diet should be less than 300 mg/day[4] and one egg contains 195-210 mg cholesterol, although, in general, the cholesterol content of eggs has been overestimated[5,6].

There are efforts to reduce cholesterol and to raise unsaturated fatty acid contents of egg yolk by modified diets and genetic selection. Incorporation of omega-3 fatty acids in egg yolk by changing hen diets has been more successful[3,7-10]. Selection for decreasing yolk cholesterol was not effective[11]. Chung *et al.*[12] considered selection of eggs for lower cholesterol in content impractical under current commercial operating conditions. Therefore, it is desirable to find a genetic population of laying hens with low cholesterol and saturated fatty acid contents, because a low cholesterol egg could have significant commercial advantage[13].

Egg cholesterol and fatty acid concentrations may be affected by the housing systems[14], breed, age and yolk weight[2]. Campo[2] also reported significant differences among the four Spanish breeds of hens and F_2 cross population and a white leghorn population for the cholesterol levels (19.09, 16.30, 15.65, 14.56 and 14.54 mg/g yolk for the pure breeds and 13.14 mg/g yolk for the F_2 cross population). Eggs from breeders contained significantly more cholesterol than commercial layer strains[15-17]. Besides, eggs with the heaviest yolk and the largest yolk:albumen ratios might be expected to contain the highest amount of cholesterol. Differences for percentage yolk and percentage albumen have been described for commercial layer strains[18,19].

The objective of this study was to compare egg cholesterol and fatty acid contents in eggs from two Turkish breeds of hens and two brown and white layer hybrids. Some performance parameters and egg quality traits of these breeds were not found economical for the commercial farms. They have been produced extensively at family farms[20]. Yet egg yolk cholesterol content and egg fatty acid composition of these breeds have not been compared. Besides, some studies on these breeds indicate that they are rather valuable as genetic resources due to some characteristics. Especially, the studies on leg colour and feathering rate of the Denizli breed seem to be very promising[21].

EXPERIMENTAL

Egg samples were obtained from Denizli and Gerze which are local Turkish breeds (lay white shell colour egg) and white and brown layer hybrids maintained at the Experimental and Production Station of Sinop (in the coast of Black Sea) in a conservation program of genetic resources[20]. All genotypes were reared in separated pens exposed to the same experimental conditions concerning stocking densities, lighthing, vaccination and other rearing procedures. During the rearing and laying periods chicks were housed on floor pens with windows. They were fed with same standard

diets *ad libitum* (containing 16 % CP and 2700 Kcal ME/kg; 3.5 % Ca and 0.8 % P) during the laying period.

Egg samples were collected from 36 weeks age hens and randomly selected for the analyses of the cholesterol and fatty acid contents. Twenty eggs of each genotype were used to evaluate the effect of genotype on egg fatty acid and cholesterol contents. Eggs were weighed (0.1 g), broken and then the yolk separated from the albumen. 20 Samples for each treatment were freezer dried and stored at -20 ºC before the fatty acid and yolk cholesterol analyses were performed. The total fat of yolks was extracted according to Folch *et al.*[22] and methylated with 5 % boron trifluoride methanol complex in methanolic solution[23]. The lipid profile was determined at the Laboratory of the Marmara Research Center linked to the Scientific and Research Council of Turkey by using Perkin-Elmer autosystem XL gas chromatograpy[24]. The mass of cholesterol in each sample was converted into miligrams of cholesterol per gram of yolk for each egg. Fatty acid contents were presented as saturated and unsaturated fatty acid percentages. Analyses were performed at the Laboratory of the Marmara Research Center linked to the Scientific and Research Council of Turkey.

Statistical analysis carried out by using the Generalized Linear Model Procedure of SPSS (Version 11.0). The significant differences among the mean values of threatment determined by Duncan test[25].

RESULTS AND DISCUSSION

Mean values indicating the genotype effects on egg weight, egg yolk weight, yolk percentage and egg yolk cholesterol contents are presented in Table-1.

TABLE-1
EGG CHOLESTEROL CONTENTS OF PURE BREEDS AND LAYER HYBRIDS

	Genotype groups				SEM	p
	Denizli breed	Gerze breed	White layer hybrid	Brown layer hybrid		
Traits						
Egg weight (g)	53.94 [a]	54.30 [a]	59.00 [b]	63.15 [c]	0.473	**
Egg yolk weight (g)	19.38 [a]	18.94 [a]	19.28 [a]	20.62 [b]	0.174	**
Yolk percentage (%)	35.94 [a]	34.90 [b]	32.67 [c]	32.65 [c]	0.221	**
Cholesterol contents						
mg/100 g eggs	527.12 [a]	527.55 [a]	535.50 [a]	530.10 [a]	1.997	
mg/total egg yolk	283.39 [a]	286.53 [a]	315.98 [b]	319.76 [b]	4.564	**
mg/1 g egg yolk	14.63 [a]	15.20 [a,b]	16.42 [c]	15.44 [b]	0.125	**

[a-c]Means within the same row groups with no common superscript differ according to Duncan's multiple-range test ($p < 0.05$). **: $p < 0.01$.

Among the genotype groups, differences for yolk cholesterol concentrations (mg per yolk and mg/L g egg yolk) were significant ($p < 0.01$). Eggs from the Denizli and Gerze breeds had significant smaller amount of cholesterol than the white and brown layer hybrids. Lower cholesterol concentration (milligrams per gram of yolk) was found in Denizli breed than in the layer hybrids, whereas eggs from the Gerze breed showed lower cholesterol concentration than the white layer hybrid ($p < 0.01$). There was no significant difference between Denizli and Gerze breeds in cholesterol concentration.

Onbasilar *et al.*[26] reported that the significant differences between Denizli breed and Hyline brown hybrid in terms of egg weight (55.61 g and 66.28 g), yolk percentage (32.51 and 25.49 %) and total cholesterol content (238.87 mg/egg and 216.73 mg/egg) but no significant differences in yolk cholesterol (13.24 mg/g yolk and 12.85 mg/g yolk). USDA's current cholesterol values[27] are 247 mg/egg for 58 g egg and 276 mg/egg for 65 g egg which are less than the the values observed in the present study. The egg weights of the pure breeds in the present study were lower (54.30 g and 53.94 g for the Gerze and Denizli) and yolk percentage were higher than those of layer hybrids (Table-1). Yannakopoulos *et al.*[28] reported 25.23 % yolk ratios and 220 mg per egg population in which regular eggs were sampled. Smaller eggs tend to have a larger percentage of yolk and higher cholesterol contents as reported by some workers[2,28,29]. The Denizli and the Gerze breeds have lower egg weights and higher yolk ratio than the hybrid layers, while these breeds have lower or similar cholesterol levels compared to commercial hybrids.

TABLE-2
FATTY ACID PROFILE OF EGG YOLKS OF PURE BREEDS AND LAYER HYBRIDS

	Genotype groups				SEM	p
	Denizli breed	Gerze breed	White layer hybrid	Brown layer hybrid		
Saturated fatty acids (%)	32.388 [a]	33.114 [b]	31.911 [a]	33.456 [b]	0.286	**
Myristic acid (C14:0)	0.412	0.461	0.403	0.474	0.030	NS
Palmitic acid (C16:0)	24.307 [a]	25.251 [b]	24.100 [a]	25.218 [b]	0.154	**
Stearic acid (C18:0)	7.669	7.402	7.408	7.764	0.103	NS
Unsaturated fatty acids (%)	67.612 [a]	66.886 [b]	68.089 [c]	66.544 [b]	0.112	**
Palmitoleic acid (C16:1n7)	4.469	4.461	4.471	4.417	0.057	NS
Oleic acid (C18:1n9)	44.811	44.542	44.913	44.286	0.103	NS
Linoleic acid (C18:2n6)	17.572	17.072	17.919	17.085	0.105	NS
Linolenic acid (C18:3n3)	0.760	0.811	0.786	0.756	0.102	NS
Unsaturated:Saturated ratio	2.087 [a]	2.019 [a]	2.133 [b]	1.989 [c]	0.009	**

[a-c]Means within the same row groups with no common superscript differ according to Duncan's multiple-range test ($p < 0.05$). **$p < 0.01$; NS = non significant differences

Table-2 presents fatty acid compositions of the yolks from pure breeds and layer hybrids. Total saturated fatty acid concentrations, total unsaturated fatty acid concentrations; USFA:SFA ratios were found different significantly ($p < 0.05$). Milinsk *et al.*[9] reported unsaturated:saturated fatty acids ratios 1.59 for the Red Lohman and the White Lohman hens feeding with a soyabean-corn control diet. GROBAS *et al.*[8] found the differences for fatty acid concentrations of the eggs from white and brown commercial hybrids.

Conclusion

The cholesterol contents of eggs of these two pure Turkish breed were found slightly lower than the commercial layer hybrids. It can be suggested that the cholesterol levels can be reduced by increasing egg weights and egg production. The total unsaturated/saturated fatty acids ratios were similar to those found in various studies. It may be possible to reduce cholesterol levels of the eggs produced from these breeds preserved as gene resources and raised at extensive family farms and also to increase use of these breeds through the studies aimed at increasing the egg yields.

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REFERENCES

1. S. Yalcin, Ö. Altan and Ç. Koçak, First Animal Production Symposium of Trakya Region, pp. 177-186, Tekirdag, Turkey (1992) (in Turkish).
2. J.L. Campo, *Poultry Sci.*, **74**, 1061 (1995).
3. R. Ayerza and W. Coates, *Poultry Sci.*, **79**, 724 (2000).
4. W.V. Brown, *Ann. N.Y. Acad. Sci.*, **598**, 376 (1990).
5. M.E. Van Elswyk, L.S. Shake and P.S. Hargis, *Poultry Sci.*, **70**, 1258 (1991).
6. M. Sarica and C. Erensayin, in eds: M. Turkoglu and M. Sarica, Poultry Products, Section 4, p. 489, Ankara, Turkey (2004).
7. H.R. Kutlu, M. Görgülü and I. Unsal, *J. App. Anim. Res.*, **20**, 49 (2001).
8. S. Grobas, J. Mendez, R. Lazaro, C. Blas and G.G. Mateos, *Poultry Sci.*, **80**, 1171 (2001).
9. M.C. Milinsk, A.E. Murakami, S.T.M. Gomes, M. Matsushita and N.E. Souza, *Food Chem.*, **83**, 287 (2003).
10. A. Mirghelenj, S.H. Rahimi and M. Barzgar, World Poultry Congress, Full text in CD, June 8-13, 2004, Istanbul, Turkey (2004).
11. H.L. Marks and K.W. Washburn, *British Poultry Sci.*, **18**, 179 (1977).
12. S.L. Chung, L.K. Ferrier and E.J. Squires, *Can. J. Anim. Sci.*, **71**, 205 (1991).
13. P.B. Siegel, Proceedings of IX European Symposium on the Quality of Eggs and Egg Products, 9-12 September, Kusadasi, Turkey, p. 49 (2001).
14. C.J. Lopez-Bote, R.S. Arias, A.I. Rey, A. Castano and B. Isabel, *Anim. Feed Sci. Tech.*, **72**, 33 (1998).
15. R.W. Simmons and R.G. Somes, *Poultry Sci.*, **64**, 1264 (1985).
16. L.M. Hall and J.C. Mckay, *Br. Poultry Sci.*, **33**, 941 (1992).

17. M. Stepinska, J. Niemiec and K. Cywa-Benko, Proceedings of the 5th European Symposium on the Quality of Eggs and Egg Products, France, p. 459 (1993).
18. P.A. Curtis, F.A. Gardner and D.B. Mellor, *Poultry Sci.*, **65**, 501 (1986).
19. R.H. Harms and S.M. Hussein, *J. Appl. Poultry Res.*, **2**, 166 (1993).
20. A. Sekeroglu, Egg Production and Some Egg Quality Parameters of Gerze and Denizli Turkish Hen Breeds. Institute of Sci., M.Sc. Thesis, Samsun (1994).
21. M. Sarica, in eds.: M. Turkoglu and M. Sarica, Poultry Breeds and Hybrids, Section 2, 33-71, Poultry Science, ISBN:270-442-5, Bey-Ofset, Ankara, Turkey, p. 489 (in Turkish) (2004).
22. J. Folch, M. Lees and G.H. Sloane Stanley, *J. Biol. Chem.*, **226**, 497 (1957).
23. W.R. Morrison and M.L. Smith, *J. Lipid. Res.*, **5**, 600 (1964).
24. IUPAC, Standard Methods for the Analyses of Oils, Fats and Derivatives, Pergamon Press, Oxford, edn. 6, pp. 96-102 (1987).
25. Y. Bek and E. Efe, I. Çukurova University Agricultural Faculty, Lecture Notes No. 71 Adana, Turkey (1989).
26. E.E. Onbasilar, F. Atasoy and S.Yalcin, The Egg Cholesterol Levels of Denizli and Hyline Brown Chickens, Proceedings of IX European Symposium on the Quality of Eggs and Egg Products, 9-12 September, Kusadasi, Turkey, p. 85 (2001).
27. USDA, Nutrient Database for Standard Refernce Release 13, NBD No. 10199, United States Department of Agriculture, USA (2000).
28. A. Yannakopoulos, A. Tserveni-Gousi, N. Botsoglou and A.Valalis, World Poultry Congress, Full Text in CD, June 8-13, 2004, Istanbul, Turkey (2004).
29. S. Akkan, A. Alcicek and H. Basmacioglu, *Egean Univ. J. Agric.*, **37**, 1 (2000).

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