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The effect of supplementing vitamin C and sodium to diets on the fatty acid profile of goose egg yolk lipids

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ABSTRACT

The study was conducted on 21 one-year-old Zatorska geese (3 groups of 7 birds each) during the laying period. The geese were fed unsupplemented diet or diet supplemented with 200 mg vitamin C/kg or vitamin C and sodium. Forty-five eggs were evaluated. Feeding geese with vitamin C-supplemented feeds increased the linoleic and docosahexaenoic acid contents and reduced the n-6/n-3 PUFA ratio, whereas the addition of sodium had only a slight influence on the fatty acid profile of egg yolk lipids.

KEY WORDS: geese, vitamin C, sodium salts, eggs yolk, fatty acids

INTRODUCTION

Assessment of the biological value of goose hatching eggs is important because they achieve relatively low fertilization and hatching indexes (Mazanowski and Kiełczewski, 2001). The genetic potential of the birds and their nutrition influence the biological value of eggs (Stadelman and Pratt, 1989; Jamroz, 1992), while hatching indexes and gosling growth depend on the chemical composition of eggs, in particular, on the egg yolk fatty-acid profile (Peach and Thomas, 1986; Badzinski et al., 2002). The studies of Acker and Ternes (1994) point to the protective role of fats, particularly unsaturated fats, in relation to the proteins forming complexes with them. Their positive influence on the thermal stability of lipoproteins is particularly important because hatching eggs become less sensitive

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to overheating. Moreover, complexes of lipids with proteins are believed to have a stabilizing effect on enzymes oxidizing unsaturated fatty acids. When there is a deficit of vitamin C and sodium, protein and energy utilization of feeds declines (Chatterjee et al., 1975). A change in the egg yolk fatty-acid profile may improve the reproductive indices of Zatorska geese.

The objective of this study was to assess the effects of supplementing vitamin C and sodium to diets on the fatty-acid profile in the yolks of hatching eggs of the Zatorska goose.

MATERIAL AND METHODS

The study was conducted on 21 one-year-old Zatorska geese maintained in separate cages in one room, in flocks made up of six geese and one gander. Three diets were prepared containing (in g/kg): wheat 500, oats 120, maize 100, wheat bran 50, soyabean meal 100, fish meal 50, grass meal 20, NaCl 2, mineral-vitamin premix 10, limestone 38, dicalcium phosphate 20, and crude protein 165 g/kg, and 2640 ME kcal/kg. The control diet (S) was unsupplemented, diet SC was supplemented with 200 mg/kg vitamin C, diet SCN with vitamin C (200 mg/kg) and Na (5 g Na_2SO_4 and 2 g $NaHCO_3$/kg). The birds were fed these diets for three months. In the last two weeks of the study, from a pool of individually collected eggs, 45 were randomly selected (15 from each group). The eggs were weighed, broken, the yolk separated and the dry matter and fat contents in it were determined by standard methods. The fatty acid profile of the egg yolks was determined using a Varian 3400 CX gas chromatograph equipped with a FID (the carrier gas was argon on a DB-23 column). The results were subjected to statistical analysis by single-factor analysis of variance and Duncan's multiple range test using SAS software (1996).

RESULTS AND DISCUSSION

Stadelman and Pratt (1989) found that an adequate supply of linoleic acid and vitamin C was essential to achieve maximal egg weight. In the present experiment, the eggs from geese fed the diet supplemented with vitamin C were somewhat heavier than those in the control group (Table 1). Lipids made up about 34.5% of the yolk. The share of saturated fatty acids was relatively low (37-40%), that of monounsaturated fatty acids was high (about 51%). The predominant saturated acids were palmitic and stearic acids (Table 1). The high share of monounsaturated fatty acids in the egg yolks results from the predominance of oleic acid, and of the polyunsaturated acids, from the high linoleic acid content. In comparison with chicken yolk lipids, those of goose egg yolk are characterized by a lower content of linoleic acid and a higher share of palmitic and oleic acids (Jaworski and Budsławski, 1973).

Table 1. Goose egg and egg yolk weight and fatty acid (FA) contents in yolk lipids, % total FA

Item	Dietary treatment		
	S	SC	SCN
Egg weight, g	145.3	149.9	149.9
Yolk weight, g	52.0	52.8	52.9
In egg yolk content, %			
dry matter	54.3	56.3	56.3
crude fat	34.4	34.7	34.7
Saturated (SFA)			
C14:0	0.57	0.54	0.51
C16:0	30.84^{a}	28.49^{b}	28.32^{b}
C18:0	8.49	8.12	7.96
Monounsaturated (MUFA)			
C16:1 n-9	5.37^{a}	4.39^{b}	4.48^{b}
C18:1 n-9	44.00^{a}	45.71^{ab}	46.55^{b}
C20:1 n-9	0.72^{a}	0.61^{ab}	0.56^{b}
Polyunsaturated (PUFA)			
C18:2 n-6 (LA)	7.16^{a}	8.73^{b}	8.12^{b}
C18:3 n-3 (LNA)	0.65^{a}	0.79^{b}	0.64^{a}
C20:4 n-6 (AA)	0.95	0.98	1.12
C22:5 n-6	0.12	0.13	0.16
C22:6 n-3 (DHA)	0.31^{A}	0.66^{B}	0.89^{C}
Other	0.82	0.85	0.69
total SFA	39.90^{a}	37.15^{b}	36.79^{b}
total MUFA	50.09	50.71	51.59
total PUFA	9.19^{A}	11.29^{B}	10.93^{B}
n-6/ n-3 PUFA	8.62^{A}	6.84^{B}	6.18^{B}
MUFA+PUFA/ SFA	1.48^{a}	1.67^{b}	1.70^{b}

^{a,b} means in rows with different letters differ significantly at $P< 0.05$; or ^{A,B} at $P< 0.01$

The share of linoleic acid ($P<0.05$) and docosahexaenoic acid (DHA) in the lipids of eggs from geese fed the vitamin C-supplemented diet was higher and the n-6/n-3 PUFA ratio, lower than in controls ($P<0.05$). Given the favourable influence of an increased egg yolk polyunsaturated fatty acid content on hatchability and development of goslings, supplementation of diets for laying geese with vitamin C should be recommended. Nonetheless, in our earlier studies (Barteczko et al., 2004) we demonstrated a decreased level of total cholesterol in the egg yolks of geese fed vitamin C- and sodium-supplemented diets. It seems justified, then, to carry out a detailed study on the hatching, mortality and development of goslings from geese fed vitamin C-supplemented diets. After adding sodium to vitamin C-supplemented diets the share of linolenic acid was found to have decreased ($P<0.05$) and that of docosahexaenoic to have increased ($P<0.01$) in egg yolk lipids. This did not, however, affect the n-6/n-3 PUFA ratio.

CONCLUSIONS

Supplementing diets for breeding geese with vitamin C changes the fatty acid profile of their egg yolks, which may have a favourable effect on their hatchability.

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STRESZCZENIE

Profil kwasów tłuszczowych lipidów żółtek jaj gęsi żywionych dietą z dodatkiem witaminy C i soli sodowych

Badania przeprowadzono na 21 jednorocznych gęsiach rasy zatorskiej podzielonych na 3 stadka po 6 samic i 1 samcu, w ciągu trzech miesięcy nieśności. Gęsi żywiono paszą bez dodatków, lub z dodatkiem 200 mg witaminy C/kg, lub z dodatkiem witaminy C i sodu. Ocenie poddano 45 jaj. Żywienie gęsi paszami z dodatkiem witaminy C spowodowało zwiększenie zawartości kwasów linolowego i dokozoheksaenowego oraz obniżenie proporcji n-6/n-3 PUFA w lipidach żółtek jaj; dodatek sodu miał niewielki wpływ na profil kwasów tłuszczowych.