Original Paper

The effect of dietary *Rhus coriaria* L. supplementation on fatty acids composition in the table eggs

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The aim of the study was to analyse the effect of *Rhus coriaria* L. on fatty acids composition in the table eggs. In the experiment, laying hens Hy-Line Brown at the age of 20 weeks were used. The experiment lasted 21 weeks. Two diets for two hens' groups (10 pcs per group) were used in the trial. In the control group, hens were fed by commercial total feed mixture, while in the experimental group, the feed mixture was supplemented by *Rhus coriaria* L. seeds (1 % in feed mixture). During the last week of the experiment, the eggs of both groups were collected. After adjustment, they were analysed for fatty acids. The analysis of fatty acids esters (FAMEs) was performed. For the characterization of the lipid fraction, the triglycerides were hydrolyzed into glycerol and free fatty acids. In the experimental group of hens, significantly (P <0.05) higher percentage of myristic, myristoleic and palmitic acid was found in egg's yolk. The same effect of *Rhus coriaria* L. was found in palmitoleic acid (P <0.05). In the majority of fatty acid in yolk, a positive effect of the oleic acid was found (P <0.05), as well as lower percentage in yolk fat in experimental laying hens group with supplemented feed mixture. In the eggs from the experimental group a tendency (P >0.05) of a higher linoleic acid percentage was found. The same tendency (P >0.05) was found in γ-linoleic acid. In egg's yolk from control group of hens higher percentage of α-linoleic acid (P <0.05) was found. In arachidic and arachidonic acid, an effect of *Rhus coriaria* L. seeds supplementation in total feed mixture hens' diet was not found. The positive effect of the additive was found in essential polyunsaturated linoleic acid (P <0.05), as well as a tendency of higher level of γ-linoleic acid (P >0.05). The results showed that *Rhus coriaria* L. can be use in hens' nutrition as a phytogenic additive.

Keywords: nutrition, phytogenic feed additives, *Rhus coriaria* L., poultry, eggs, fatty acids

1. Introduction

Eggs contain many valuable nutrients, such as amino acids, lipids, vitamins and minerals (Kovacs-Nolan et al., 2005). From the nutritional point of view, one of the most important components of yolk lipids is their fatty acid profile (Gladkowski et al., 2011). Feed additives are used in poultry nutrition for performance improving. In the world, there is a new group of feed additives, phytogenics (Gálik, 2012). In recent years, many papers on the effect of different plant additives on poultry products quality have been published. Phytogenics can be beneficial in animal production mainly for the stimulation of the digestive enzymes production, such as lipase and amylase, thus having a beneficial effect on nutrient utilization (Williams and Losa, 2001; Ramakrishna et al., 2003; Bolukbasi et al., 2010). Much attention in recent years has been focused on herbs and spices extract (Gulmez et al., 2006). One of the interesting phytogenic additives in poultry nutrition is *Rhus coriaria* L. (Gálik, 2012), commonly known as sumac. The main compounds in *Rhus coriaria* L. are tannins and substantial amounts of flavonoids (Zalacain et al., 2003). However, sumac is rich in B vitamins and also gallic acid (El Sissi et al., 1972; Abas, 2009; Gálik, 2012). Abas (2009) reported that from nutritional view, *Rhus coriaria* L. seeds are rich in gallic acid, benzoic acid and L-ascorbic acid. The seeds of *Rhus coriaria* L. are a very good source of gallotannis, volatile oil, anthocyanin (Güvenec and Koyuncu, 1994), flavones, such as myricetin, quercetin and kaempferol (Mehrdad et al., 2009), nitrite and nitrate contents (Özcan and Akbulut, 2007).

The aim of the experiment was to study the effect of *Rhus coriaria* L. seeds on fatty acids composition in the table eggs.

2. Material and methods

2.1 Animals and diets

At 20 weeks of age, 20 (10 per group) Hy-Line Brown hens were housed in three-floor cages (943.2 cm^2 per hen), divided into two diets. Each diet contained 39.2 % of wheat meal, 23 % of maize, 19.2 % of soybean, 3.5 % of pea, 3 % of rape seed cake, 7 % of soya oil, 7.4 % of calcite and 4 % of mineral premix. The metabolic energy of the feed mixture was 11.34 MJ kg^{-1} and the mixture contained 15.92 % of crude protein, 4.53 % of total fat, and 45.62 % of starch. The calcium content was 4.22 % and phosphorus was 6.1 %.

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The experimental diet was supplemented with *Rhus coriaria* L. seeds (1 % in total feed mixture). During the experiment, the light regime was 16 hours. The experiment lasted 21 weeks and during the last week, the eggs were collected for analysis. Five eggs from each dietary treatment were randomly selected and analyzed. Nutrient composition of the diets was analyzed by standard laboratory methods (AOAC, 2000).

2.2 Analysis

The analysis of fatty acid methyl esters (FAMEs) was performed. For the characterization of the lipid fraction, the triglycerides were hydrolyzed (saponified) into glycerol and free fatty acids. Fatty acids were derivatized to the methylesters (FAMEs). After the FAMEs preparation, they were separated according to the carbon number (number of carbon atoms in the fatty acid chain, excluding the methyl ester carbon) and the degree of unsaturation by gas chromatography (GC) with flame ionisation detector (FID). For column check-out, a 37-component mixture (Supelco 47885-U) was used. The standard was diluted with 10 ml hexane (final concentration was 0.2–0.4 mg ml^{-1} per FAME) before the use. The total of 200 mg of sample in a 20 ml test tube was used. Dissolution of the sample in 5 ml hexane and addition of 1 ml 2 N potassium hydroxide in methanol was used. The tube was closed and shaken for 30 sec. The tube was heated for 30 sec at 60 °C in a water bath. After 1 minute, 2 ml of 1 N HCl was added and the tube was shaken. The upper (organic) layer was transferred into a 2 ml autosampler vial after passing it through a bed of anhydrous Na_2SO_4. The analyses were performed on an Agilent 6890A GC (Agilent technologies, U.S.A.) analyzer with a flame ionization detector (FID). Automated split injection was performed using an Agilent autosampler (Agilent technologies, U.S.A.). FAMEs were separated on DB-23 analytical column and identified by FID.

2.3 Statistical analysis

To calculate the basic statistic characteristics, to determine significance of differences and to compare results of the analysis of variance, one-way ANOVA and *t*-test were performed at $P<0.05$. The SAS statistical software was used (SAS Inc., New York City, U.S.A.).

3. Results and discussion

Phytogenic feed additives are used in animal nutrition and feeding for their potential beneficial effects, such as higher performance, reproduction and health status (Capcarová and Kolesárová, 2010). After 21 weeks of feeding trial, we found an insignificant effect ($P>0.05$) of *Rhus coriaria* L. on final body weight of hens. In the experimental group of hens we found a tendency of higher average final body weight in comparison to the control group (Figure 1). Abas (2009) reported that phytogenic feed additives use in poultry nutrition can negatively affect the performance for the content of some tannins and phenols. Weis et al. (2010) published that feed additives, mainly probiotics, can improve the body weight after intake.

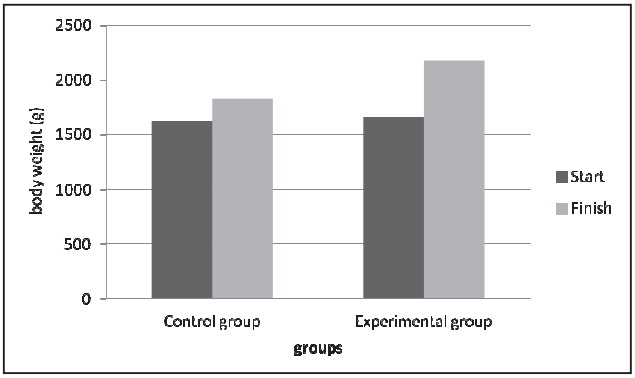

Figure 1 Body weight of hens during the experiment (10 pcs per group)

Dietary triglycerides may differ from each other in many aspects: the chain lengths of their constituent fatty acids, the number and position of double bonds, the geometry (cis or trans) of theses double bonds and the distribution of fatty acids over the three possible attachment sites on the glycerol molecule (Lewis et al., 1981; Mensink and Katan, 1992). Phytogenic feed additives can improve the animal products quality for the stimulation of digestive enzymes and in this way, the nutrients utilization can be much better (Williams and Losa, 2001; Ramakrishna et al., 2003). In our experiment, we found significantly ($P<0.05$) higher contents of myristic and myristoleic acids in fat of experimental yolk eggs (Table 1). Hens in the experimental group were fed with feed mixture supplemented by *Rhus coriaria* L. seeds. We found a similar effect of *Rhus coriaria* L. in palmitic and palmitoleic adic content, too ($P<0.05$). However, Bolukbasi et al. (2010) reported a lower tendency ($P>0.05$) in palmitic and palmitoleic fatty acids in table eggs after bergamot oil supplementation in the diet. A tendency of higher percentage of saturated fatty acids in egg's yolk was found by Vitana et al. (2012), who analysed the effect of extractive substances from spruce needle biomass on egg production and quality. In stearic acid, we detected values from 7.44 (control group) and 7.69 % (experimental group) of crude fat respectively (Table 1). Higher percentage of stearic acid in yolk's crude fat was found by Bolukbasi et al. (2010), with a tendency ($P<0.05$) of higher content after dietary bergamot oil consumption. We found lower percentage of stearic acid in both groups than Cherian et al. (2002) in the study with the effect of different diet in Lohman hens' nutrition on fatty acids composition in egg's yolk. Oleic acid is the major fatty acid of chicken eggs (Cherian et al., 2002). In egg's yolks produced from experimental laying hens, we found significantly lower ($P<0.05$) percentage of oleic acid in fat. However, *Rhus coriaria* L. seeds are rich in oleic acid (also in palmitic and linoleic acids) and others polyunsaturated fatty

Table 1 Effect of ***Rhus coriaria*** L. on the fatty acids composition in eggs

Fatty acid	Control group (10 pcs of hens)	Experimental group (10 pcs of hens)
	% of fat ±S.D.	
Myristic	0.40a ±0.009	0.41b ±0.009
Myristoleic	0.08a ±0.005	0.10b ±0.005
Palmitic	23.90a ±0.137	25.96b ±0.108
Palmitoleic	3.62a ±0.157	4.06b ±0.089
Stearic	7.44a ±0.353	7.69a ±0.090
Oleic	49.65a ±0.146	47.27b ±0.410
Linoleic	7.69a ±0.828	7.90a ±0.149
γ-linoleic	0.05a ±0.001	0.1a ±0.152
α-linoleic	0.30a ±0.065	0.17b ±0.005
Arachidic	0.03 ±0.030	n.d.
Arachidonic	1.19a ±0.099	1.19a ±0.038

S.D. – standard deviation, n.d. – not detected. The values followed by different superscript letters in the same line are significantly different (P <0.05)

acids (Dogan and Akgul, 2005). Higher level in diet and lower level in yolk's fat can indicate more dependence on body lipid stores for egg yolk fatty acid deposition and better nutrient utilization (Scheideler and Jaroni, 1998). In linoleic acid percentage in yolk fat we analysed insignificantly (P >0.05) higher value in egg's yolk produced from the experimental group of hens in comparison to the control group (7.90 vs. 7.69 %). *Rhus coriaria* L. is a very good source of linoleic acid, seeds can contain linoleic acid in ration to 27.4 % (Kizil and Turk, 2010). Eggs from the experimental hens' group were richer in γ-linoleic acid (P >0.05) percentage. However, we found a lower content of α-linoleic acid (P <0.05) in these eggs. In arachidic and arachidonic acids in yolk fat, we did not find significant differences between treatment group (P >0.05). The same effect of different phytogenic additives on arachidic and arachidonic acids in the table eggs was found by Bolukbasi et al. (2010).

4. Conclusions

After *Rhus coriaria* L. supplementation in the diet we found a positive effect on yolk fat composition. We found higher level of essential polyunsaturated fatty acids, such as linoleic acid (P <0.05), and a tendency of higher level of γ-linoleic acid (P >0.05), but lower level of α-linoleic acid (P <0.05). Our results showed that *Rhus coriaria* L. can be a possible feed additive in hens' nutrition.

5. Acknowledgements

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