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EFFECT OF CONEFLOWER, THYME AND SAGE EXTRACTS IN THE DIET ON CHANGES IN CHICKEN WHITE MEAT QUALITY DURING STORAGE

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Key words: chick, breast meat, storage, plant extracts, fatty acids, TBA-RS

One hundred and sixty sexed Cobb chickens from 22 to 42 days of age were allocated to 4 groups and fed diets not supplemented with vitamin E and contained 4% rapeseed oil and 1% of stabilized fish fat. Experimental groups were supplemented with coneflower, thyme and sage dry extracts added in the amount of 560 mg/kg. At 42 day 32 chickens were killed, breast muscles were excised and frozen. Part of meat was analysed for fatty acids composition of lipid fraction, TBA-RS and vitamin E content and evaluated for sensory properties. Part was kept frozen (-20°C) for 6 month and then analysed in the same manner.

During frozen storage the percent of palmitic acid and linolic acid decreased but those of stearic acid, arachidonic acid, eicosapentaenoic acid (EPA) and docosahexsaenoic acid (DHA) increased in meat lipids of every groups. An increase of oleic acid was found only in control chickens and a decrease of linolenic acid on control and coneflower groups. The percent of saturated fatty acids (SFA) was observed to decrease, whereas that of polyunsaturated fatty acids (PUFA) n-3 and ratio of PUFA:SFA to increase in control chickens and in groups fed thyme and sage. In all groups improvement of PUFA n-6:n-3 ratio was found. Vitamin E content in meat of chickens from control and sage group decreased but TBA-RS content was not changed in any group. Sensory properties of boiled meat at the beginningt and the end of frozen storage period were changed for flavour in control, thyme and sage group.

INTRODUCTION

Plants contain a numerous natural antioxidants, which may acts against free radicals formed in the reduction of oxygen during lipid metabolism [Halvorsen *et al.,* 2002]. An extensive group of natural antioxidant sources makes culinary herbs and spices such as: marjoram and caraway [Abd El-Alim *et al.,* 1999], ginger [Fuhrman *et al*., 2000], oregano [Vichi *et al*., 2001], sage, savory and borage [Vichi *et al*., 2001; Bandonien *et al*., 2002], catnip, lavender, thyme, hyssop, anise hyssop [Dapkevicius *et al*., 1998], and rosemary [Galobart *et al*., 2001]. It seems not unlikely that antioxidative properties of flavonoids, carotenoids, essential oils and other plant substances fed to chickens may also affect the composition of fatty acids in tissue lipids and oxidative stability of meat [Koreleski & Świątkiewicz, 2006] – and reduce the changes in meat quality during frozen storage.

The present study was designed to evaluate the effects of dietary salvia (*Salvia officinalis*), thyme (*Thymus vulgaris*) and echinacea – purple coneflower (*Echinacea purpurea*) dry extracts added to diet on changes in fatty acid composition, TBA-RS and vitamin E content and sensory properties of boiled chicken breast meat during frozen storage.

MATERIAL AND METHODS

Experiment was conducted with 160 sexed Cobb chickens from 22 to 42 days of age. During earlier period (1-21 days) the birds were fed a standard diet. Chickens were allocated to 4 groups and fed diets not supplemented with vitamin E and containing 4% of rapeseed oil and 1% of stabilized fish fat (ethoxyquin, 250 mg/kg). Experimental groups was supplemented with coneflower, thyme or sage dry extracts added in the amount 560 mg/kg. At the end of experiment 32 representative chickens were chosen (4 males and 4 females from each group) and killed. Breast muscles (left and right) were excised and frozen. The left part of meat was analysed for fatty acids composition of lipid fraction, TBA-RS and vitamin E content and evaluated in a sensory test. The right part was kept frozen (-20°C) for 6 month and then analysed in the same manner.

The fatty acids (FA) composition of breast meat lipids was determined with a GC Varian 3400 gas chromatograph equipped with a CP-Wax 58, 25 m x 0.53 mm, 1.0 μm column and expressed as% of total FA. Samples were extracted as described by Folch *et al.* [1957] and evaporated under nitrogen, saponified with NaOH, converted to methyl esters [Morrison & Smith 1964], extracted with hexane and separated. Peak areas were measured with Star Chromatography Workstation software (Varian Star 4.5). As a measure of oxidative stability in meat thiobarbituric acid reactive substances (TBA-RS) were determined according to Salih *et al.* [1987] with modifications of Pikul *et al.* [1989]. Values were expressed as mg malondialdehyde/kg. The content of α-tocopherol was determined with HPLC Merck-Hitachi equipped with LiChr°CART 250-4

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Superspher 100 RP-18, 4 μm column and FL, Ex. 295 nm, Em. 350 nm detector – according to Manz & Philipp [1981]. Sensory analysis of meat was made before and after freeze storage by a panel of six persons. Panelists tested boiled meat and ranked flavour, taste, juiciness and tenderness in a 4-point scale (from 2- not accepted; to 5 – very good).

Data were subjected to one-way factorial analysis of variance (Statistica ver. 5.0 PL) and differences were examined with Duncan's multiple range test.

RESULTS AND DISCUSSION

In each group the percent level of palmitic acid ($C_{16:0}$) and linolic acid ($C_{18:2}$) in breast meat lipids decreased but levels of stearic acid ($C_{18:0}$), arachidonic acid ($C_{20:4}$), eicosapentaenoic acid ($C_{20:5, n-3}$, EPA) and docosahexaenoic acid ($C_{22:6, n-3}$, DHA) increased during storage (Table 1). An increase of oleic acid ($C_{18:1}$) was found only in control chickens and a decrease of linolenic acid ($C_{18:3, n-3}$) on control and coneflower diets.

As a result of those changes a decrease of saturated fatty acids (SFA) content and an increase of polyunsaturated fatty acids (PUFA) n-3 content were noted (Table 2). The ratio of PUFA:SFA increased in meat lipids of control chickens and in groups fed thyme and sage. In all cases the improvement of PUFA n-6:n-3 ratio was found. Observed differences in fatty acid profiles of breast lipids in the initial month and after 6 months of cold storage are not simple to elucidate. It is likely being a result of changes in meat fat content, direction of oxidation and degree of fatty acid saturation or desaturation perhaps when meat was stored, unfrozen and prepared for analyses. Reduction of linolenic and linolic acids in chicken meat and partly palmitic acid as an effect of frozen storage was observed [Miteva & Bakalivanova, 2006], however Coetzee & Hoffman [2001] did not find any changes of fatty acids proportions over storage time of meat from chickens fed diets with 120-200 mg vitamin E. In frozen pig ham stearic acid level was higher and that of palmitic acid lower after 30 days [Kingsley *et al*., 1978]. In frozen stored fish meat or squid meat a significant increase of long chain PUFA and a decrease of saturated fatty acids content in phospholipid and free fatty acid meat lipid fractions were noted [Fernandez--Reiriz *et al*., 1995; Paredi *et al*., 2006]. Admittedly De Pedro e*t al*. [2000] attributed differences in initial and frozen stored subcutaneous pig fat fatty acid content to a change in analysis in long assay period. In our earlier experiment [Koreleski & Świątkiewicz, 2006], the contribution of palmitic acid was however decreased whereas PUFA n-3 elevated in fat of frozen stored breast meat from chickens fed a diet greased with rapeseed oil.

In long stored breast meat vitamin E content decreased in control and sage group (Table 3). In meat from chicken fed coneflower and thyme extracts α-tocopherol level did not change significantly during storage. TBA-RS content in meat was not changed in any group. In the study of Lopez-Bote *et al*. [1998] sage extract decreased TBA-RS content in stored broiler meat but to a smaller extent than the added vitamin E. The superior oxidative stability of stored breast meat was confirmed in the case of oregano or especially oregano and vitamin E combination [Florou-Paneri *et al*., 2006]. Herbal supplementation of the chicken diet with echinacea herb, raw garlic and ginger did not influence dry matter, crude protein nor fat content in breast muscle [Gardzielewska *et al*., 2003].

There were no changes in sensoric properties of boiled meat during frozen storage, except deteriorated flavour in control, thyme and sage groups (Table 3). In coneflower group the negative effect of storage on flavour of boiled meat was reduced.

TABLE 1. Effect of storage on the content of selected fatty acids in lipid fraction of breast meat (% of total fatty acids).

Meat	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$ (LA)	$C_{18:3}$ (ALA)	$C_{20:4}$	$C_{20:5}$ (EPA)	$C_{22:6}$ (DHA)
I, Control:								
Fresh	17.1^b	6.02^a	27.6^a	35.8^b	2.52^b	3.78^a	0.501^a	2.35^a
Stored	11.8^a	7.86^b	29.8^b	31.9^a	2.26^a	7.76^b	0.723^b	4.28^b
SEM	0.97	0.32	0.51	0.75	0.06	0.70	0.043	0.45
II, Coneflower:								
Fresh	17.9^b	6.46^a	27.1	34.2^b	2.25^b	3.91^a	0.626^a	2.98^a
Stored	13.2^a	8.46^b	28.5	29.5^a	1.88^a	8.12^b	0.882^b	5.69^b
SEM	0.97	0.38	0.60	0.95	0.08	0.81	0.065	0.53
III, Thyme:								
Fresh	16.9^b	6.37^a	27.1	35.8^b	2.47	3.62^a	0.528^a	2.66^a
Stored	12.1^a	7.96^b	28.6	31.9^a	2.25	7.45^b	0.721^b	5.33^b
SEM	0.96	0.37	0.71	0.99	0.12	0.77	0.066	0.62
IV, Sage:								
Fresh	17.1^b	7.79^a	25.4	34.3^b	1.90	5.59^a	0.514^a	3.70^a
Stored	11.3^a	9.44^b	26.0	30.1^a	1.69	11.32^b	0.628^b	6.83^b
SEM	1.05	0.39	0.36	0.80	0.06	0.99	0.031	0.57

a, b – $p<0.05$

TABLE 2. Effect of storage on content of selected fatty acids in lipid fraction of breast meat (% of total fatty acids).

Meat	SFA	UFA	PUFA	PUFA n-6	PUFA n-3	UFA/SFA ratio	PUFA/SFA ratio	n-6/n-3 ratio
I, Control:								
Fresh	24.4[b]	75.6[a]	46.1	39.7	5.37[a]	3.10[a]	1.89[a]	7.42[b]
Stored	20.1[a]	79.9[b]	48.8	39.7	7.26[b]	4.00[b]	2.45[b]	5.59[a]
SEM	0.83	1.09	0.75	0.44	0.43	0.18	0.12	0.37
II, Cone-flower:								
Fresh	25.7[b]	74.2[a]	45.1	38.2	5.85[a]	2.89[a]	1.76	6.53[b]
Stored	22.1[a]	77.9[b]	47.9	37.7	8.46[b]	3.56[b]	2.20	4.49[a]
SEM	0.81	1.18	1.16	0.79	0.51	0.15	0.12	0.35
III, Thyme:								
Fresh	24.7[b]	75.3[a]	46.3	39.6	5.66[a]	3.06[a]	1.88[a]	7.03[b]
Stored	20.5[a]	79.5[b]	49.6	39.4	8.31[b]	3.92[b]	2.44[b]	4.96[a]
SEM	0.92	0.99	0.93	0.77	0.58	0.19	0.13	0.47
IV, Sage:								
Fresh	26.4[b]	73.6[a]	46.9[a]	40.0	6.12[a]	2.79[a]	1.78[a]	6.59[b]
Stored	21.0[a]	79.0[b]	52.0[b]	41.4	9.15[b]	3.78[b]	2.49[b]	4.54[a]
SEM	1.00	1.32	1.05	0.58	0.55	0.18	0.14	0.38

a, b – $p<0.05$

TABLE 3. Effect of storage on vitamin E and TBA-RS content and sensory properties of fresh and boiled breast meat.

Meat	Vitamin E (μg/g)	TBA-RS (mg of malondialdehyde/g)	Sensory properties (points)			
			flavour	taste	tenderness	juiciness
I, Control:						
Fresh	2.11[b]	0.373	4.65[b]	4.57	4.65	4.55
Stored	1.72[a]	0.381	4.37[a]	4.42	4.47	4.42
SEM	0.13	0.017	0.052	0.052	0.078	0.069
II, Coneflower						
Fresh	1.78	0.391	4.60	4.57	4.72	4.62
Stored	1.80	0.404	4.48	4.38	4.65	4.57
SEM	0.09	0.027	0.045	0.059	0.055	0.062
III, Thyme						
Fresh	1.80	0.372	4.67[b]	4.72	4.72	4.72
Stored	1.89	0.392	4.45[a]	4.52	4.56	4.62
SEM	0.20	0.011	0.051	0.052	0.065	0.058
IV, Sage						
Fresh	2.23[b]	0.367	4.77[b]	4.75	4.62	4.65
Stored	1.87[a]	0.455	4.37[a]	4.47	4.47	4.43
SEM	0.10	0.024	0.058	0.077	0.062	0.064

a, b – $p<0.05$

CONCLUSIONS

In the reported experiment plant extracts added to chicken diet containing stabilized fish fat did not affect the changes in fatty acid composition of breast meat fat nor TBA-RS content during frozen storage. Sensory properties were changed for flavour in control, thyme and sage groups.

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WPŁYW DODATKU EKSTRAKTU Z JEŻÓWKI, TYMIANKU I SZAŁWI DO PASZY NA ZMIANY ZACHODZĄCE W BIAŁYM MIĘSIE KURCZĄT PODCZAS PRZECHOWYWANIA

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Doświadczenie przeprowadzono na 160 kurczętach Cobb w wieku od 22 do 42 dnia życia, przydzielonych do 4 grup. Podstawowa mieszanka paszowa zawierała 4% oleju rzepakowego i 1% tłuszczu rybnego stabilizowanego etoksychinoliną (250 mg/kg) i nie zawierała dodatku witaminy E (grupa kontrolna). Kurczętom z grup doświadczalnych dodawano do paszy suche ekstrakty z jeżówki, tymianku lub szałwi w ilości 560 mg/kg. Po zakończeniu doświadczenia z każdej grupy wybrano 4 reprezentatywne kogutki oraz 4 kurki i dekapitowano. Z tuszek wyodrębniono mięśnie piersiowe, które podzielono wzdłuż osi ciała na dwie partie (lewą i prawą), szczelnie zawinięto w torebki foliowe i zamrożono. W lewej partii analizowano skład kwasów tłuszczowych w lipidach mięsa oraz oznaczono zawartość substancji reagujących z kwasem tiobarbiturowym (TBA-RS) oraz vitaminy E. Mięso ugotowano i poddano analizie sensorycznej. Prawą partię mięsa trzymano w zamrożeniu (-20°C) przez 6 miesięcy a następnie poddano analizie chemicznej i sensorycznej wykonanej w ten sam sposób. Skład kwasów tłuszczowych analizowano chromatograficznie w lipidach ekstrahowanych z mięsa, po ich zmydleniu i przeprowadzeniu w estry metylowe, stosując ekstrakcję heksanem.

α-Tokoferol oznaczano przy użyciu HPLC. Zawartość TBA-RS w mięsie przyjęto jako wskaźnik zmian oksydacyjnych i oznaczano kolorymetrycznie – wyrażając w mg aldehydu malonowego w 1 kg.

Podczas przechowywania zmienił się procentowy udział kwasów tłuszczowych w lipidach mięsa kurcząt ze wszystkich grup. Udział kwasu palmitynowego ($C_{16:0}$) i linolowego ($C_{18:2}$) uległ zmniejszeniu, natomiast kwasów stearynowego ($C_{18:0}$), arachidonowego ($C_{20:4}$), eicosapentaenowego ($C_{20:5,\ n-3}$, EPA) i docosaheksaenowego ($C_{22:6,n-3}$, DHA) zwiększył się. Wzrost udziału kwasu oleinowego ($C_{18:1}$) notowano tylko u kurcząt kontrolnych a kwasu linolenowego ($C_{18:3,n-3}$) u kontrolnych i otrzymujących ekstrakt z jeżówki. W wyniku tych zmian udział nasyconych kwasów tłuszczowych (SFA) malał, wzrastał natomiast wielonienasyconych kwasów tłuszczowych (PUFA) szeregu n-3 ł. Stosunek PUFA:SFA wzrastał w lipidach mięsa kurcząt kontrolnych oraz otrzymujących ekstrakt tymianku i szałwi. W mięsie kurcząt z wszystkich grup notowano polepszenie stosunku PUFA n-6:n-3.

Zawartość witaminy E w mięsie zmniejszyła się istotnie tylko w grupie kontrolnej i z ekstraktem z szałwi natomiast w przypadku zawartości TBA-RS nie stwierdzono różnic potwierdzonych statystycznie. W przypadku kurcząt kontrolnych i otrzymujących ekstrakt z szałwi i tymianku zapach gotowanego mięsa uległ zmianie podczas przechowywania.