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EFFECT OF FEED SUPPLEMENTATION WITH THE PURPLE CONEFLOWER (*ECHINACEA PURPUREA*) EXTRACT ON FATTY ACID PROFILE AND QUALITY OF PIG MEAT

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Key words: herb extracts, coneflower, pig feeding, meat quality

The effect of purple coneflower supplement to pigs feed was estimated on 96 fatteners originated from PL x PLW sows mated with a Duroc x Pietrain boar, of both sexes from 60 to 112 kg of body weight. All animals were fed barley, wheat, soybean basal mixture. Negative control group (I) received feed with no supplement. Group II (positive control) received the same mixture supplemented with antioxidant BHT. Experimental groups III and IV received a mixture supplemented with 500 or 1000 mg of coneflower water extract per 1 kg of feed, respectively. Fatteners receiving 500 mg of extract had the higher body weight gains and feed conversion but higher dose of the extract lowered these indices. The higher dose of extract improved water holding capacity of meat and raised its pH at 45 min after slaughter. Antioxidative effect of coneflower extract was found after 6 months of storage. The lower dose of extract decreased cholesterol content of meat and improved its lightness. The extract slightly raised PUFA content of meat fat and improved the PUFA n6/n3 ratio. Both doses of extract and BHT lowered the sensory assessment of boiled meat.

INTRODUCTION

Herbs and their extracts have been used in human and veterinary medicine for a long time [Viegi *et al*., 2003]. In recent years such preparations are proposed to replace the chemical medicines, mainly antibiotics, in animal feeding.

Purple coneflower used previously mainly in folk medicine now is the subject of research and its immunologic activity is well known [Goel *et al*., 2005]. Purple coneflower contains many substances of high biological activity, such as essential oils, polysaccharides, organic acids and polyphenols, especially flavonoids. Due to these active compounds this plant and its extracts have antibacterial, antivirus and anti-inflammatory effect. It also curbs oxidation of LDL cholesterol [Dalby-Brown *et al.,* 2005].

The main phenolic acid present in coneflower is cichoric acid, a derivative of caffeic acid, which has antioxidant activity [Gawlik-Dziki, 2004]. It is susceptible to enzymatic degradation during the preparation of coneflower products but it can be prevented by addition of ethanol and ascorbic acid [Nusslein *et al*., 2000]. Its content in preparations depends also on drying method [Stuart *et al.,* 2003].

Plant extracts, besides their antioxidative activity, can improve feed tastiness and have beneficial effect on intestinal microflora [Manzanilla *et al*., 2004]. Maass *et al.* [2005] found that supplement of *Echinacea* extract to piglet feed did not increased their body weight gains but improved feed utilization. Krusiński [2004] found that 2.5% supplement of coneflower seeds to fatteners feed improved body weight gains, especially in the second period of the experiment, increased feed utilization and improved carcass meatiness. On the other hand, according to Holden [2001], supplement of coneflower resulted in drip loss of juice from boiled meat and lowered its sensory evaluation. Thus the coneflower supplement to fatteners feed can affect meat quality.

The aim of this experiment was to estimate the effect of a dietary extract from purple coneflower on quality of pig meat.

MATERIAL AND METHODS

The experiment was carried out on 96 fatteners of both sexes (12 female and 12 castrated male pigs) originated from PL x PLW sows mated with Duroc x Pietrain boar from 60 to 112 kg of body weight. Animals were kept individually and had free access to water. They were allocated to 4 groups fed the same barley, wheat, soybean mixture containing rape seed oil and in 1 kg: 150 g of crude protein, 13.2 MJ of ME and 8 g of lysine. The control group (I) received feed with no supplement. Group II received the synthetic antioxidant BHT (150 mg per kg) and group III and IV 500 or 1000 mg per kg of feed of purple coneflower (*Echinacea purpurea)* water extracts, respectively. Samples of *longissimus* muscle were taken near the last thoracic and first lumbar vertebrae and analysed after slaughter. Meat acidity was measured with a pH-meter equipped with a Metron OSH 12-00 electrode 45 min and 24 h after slaughter. Meat colour was measured with a Minolta colorimeter. Water holding capacity (WHC) was estimated according to Grau & Ham method [1953]. Cholesterol content was analysed according to Rhee *et al.* [1982] and the

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fatty acid profile using a Varian 3400 gas chromatograph. Oxidation (TBA-RS) was analysed after 6 months of storage at –20°C with a modified method of Salih [Pikul *et al*..1989]. The sensory evaluation of meat after cooking was made on a 5-point scale using the method of Baryłko-Pikielna [1975]. Data obtained were analysed using STATISTICA 5.1 software package.

RESULTS

The fatteners receiving 500 mg of coneflower extract had higher body weight gains but higher dose of this extract resulted in lower weight gains and worse feed conversion (Table 1). The higher supplement of the coneflower extract significantly ($p<0.05$) improved water holding capacity of meat and raised its pH at 45 min after slaughter. Lower TBARS content of meat from animals receiving the coneflower extract suggests its antioxidative activity but it was significant after 6 months only. The same result was found in the case of BHT supplement. Both doses of the coneflower extract reduced cholesterol content of meat when compared to the control group. Only small improvement of water holding capacity and lowering of cholesterol content in meat with simultaneous oxidation processes were found in the study.

Meat of animals receiving 500 mg of extract had the highest lightness (Table 2) and lowest redness ($p<0.05$). After 6 months of storage meat became darker and its yellowness increased but its lightness was still highest in the group fed with lower coneflower supplement. Both extract supplements diminished results of the sensory assessment of boiled meat and differences of taste, crispiness and juiciness were significant. Sex had no significant effect on meat colour nor its sen-

TABLE 1. Meat and fat quality (*M. longissimus*).

Specification	Supplement				Sex		SEM
	without supplement	BHT	coneflower extract 500 mg/kg	coneflower extract 1000 mg/kg	gilts	barrows	
Average BWG (g)	859^{b}	840^{ab}	864^{b}	817^{a}	836	854	6.887
Average feed conversion per 1 kg BWG (kg)	3.59	3.67	3.54	3.72	3.69	3.57	0.034
pH 45 min after slaughter	6.20^{Aa}	6.27^{Aab}	6.25^{Aa}	6.39^{Bb}	6.32^{b}	6.23^{a}	0.023
pH after 24 h cooling	5.52	5.62	5.57	5.54	5.56	5.54	0.018
Water holding capacity (%)	22.42^{b}	21.26^{ab}	21.19^{ab}	20.21^{a}	20.66	21.45	0.326
TBARS after 2 weeks (mg/kg)	0.451	0.469	0.403	0.438	0.435	0.438	0.011
TBARS after 6 months (mg/kg)	0.743^{B}	0.560^{A}	0.558^{A}	0.571^{A}	0.588	0.570	0.020
Cholesterol (mg/100 g)	58.00^{b}	53.40^{ab}	53.00^{a}	53.80^{ab}	53.10	54.80	1.021

a,b – values in the same rows with different letters differ significantly ($p\leq0.05$); A, B – values in the same rows with different letters differ significantly ($p\leq0.01$).

TABLE 2. Meat colour L*a*b* and sensory evaluation of meat after cooking.

Specification	Supplement				Sex		SEM
	without supplement	BHT	coneflower extract 500 mg/kg	coneflower extract 1000 mg/kg	gilts	barrows	
After 24 h cooling							
Lightness	51.47^{ab}	51.54^{ab}	52.69^{b}	50.44^{a}	50.90	51.59	0.385
Redness	15.42^{ABb}	15.30^{ABb}	14.75^{Aa}	15.50^{ABb}	15.50	15.32	0.099
Yellowness	3.34	3.56	3.72	3.41	3.56	3.45	0.104
After 6 months							
Lightness	49.67^{ab}	49.43^{ab}	51.08^{b}	48.76^{a}	49.20	49.66	0.419
Redness	14.73	15.67	14.53	14.68	14.91	14.61	0.115
Yellowness	6.47	5.94	6.33	6.10	6.33	6.09	0.126
Sensory evaluation							
Odour	4.65	4.62	4.51	4.47	4.60	4.53	0.313
Taste	4.77^{b}	4.68^{ab}	4.58^{a}	4.56^{a}	4.67	4.62	0.288
Tenderness	4.65^{Bb}	4.42^{ABa}	4.56^{ABa}	4.34^{Aa}	4.49	4.45	0.035
Juiciness	4.72^{B}	4.40^{A}	4.45^{A}	4.38^{A}	4.48	4.50	0.036

a,b – values in the same rows with different letters differ significantly ($p\leq0.05$); A, B – values in the same rows with different letters differ significantly ($p\leq0.01$).

TABLE 3. Composition of fatty acids in meat (g/100 g of all estimated acids).

Acid	Supplement				Sex		SEM
	without supplement	BHT	coneflower extract 500 mg/kg	coneflower extract 1000 mg/kg	gilts	barrows	
C 10	0.06	0.07	0.08	0.10	0.06	0.09	0.016
C 12	0.05	0.06	0.06	0.05	0.05	0.06	0.005
C14	0.92	1.04	1.08	0.86	0.92	1.02	0.061
C16	20.77	22.25	20.03	20.38	20.21	21.51	0.514
C16:1	2.04	2.13	1.94	1.95	1.87 ^{a}	2.17 ^{b}	0.73
C18	11.43	1.77	11.61	11.25	11.19	11.35	0.139
C18:1	40.14	39.30	39.34	39.37	39.20	39.87	0.392
C18:2	18.86	19.28	20.37	20.20	20.65	18.70	0.509
C 18:3	1.53	1.14	1.26	1.14	1.18	1.17	0.021
C gama 18:3	0.13	0.11	0.13	0.13	0.13	0.12	0.005
C20	0.12^{b}	0.07^{a}	0.10^{ab}	0.11^{ab}	0.11	0.09	0.007
CLA	1.26	1.11	1.11	1.20	0.17	1.17	0.025
C20:4	2.55	2.22	2.82	2.71	2.81	2.34	0.125
C 22:1	0.02^{AB}	0.01^{A}	0. 03^{B}	0.02^{AB}	0.02	0.02	0.002
EPA	0.35	0.31	0.39	0.38	0.38	0.34	0.017
DHA	0.14	0.12	0.15	0.14	0.16b	0.11a	0.012
MUFA	42.20	41.44	41.31	41.34	41.09	42.06	0.402
PUFA	24.44	24.29	25.24	25.91	26.25	23.69	0.666
PUFA n 6	21.54	21.61	23.33	23.04	23.60^{b}	21.16^{a}	0.626
PUFA n 3	1.64^{ab}	1.57^{a}	1.85^{b}	1.67^{ab}	1.73	1.64	0.043
PUFA n6/n3	13.18^{ab}	13.73^{b}	12.63^{a}	13.74^{b}	13.67	12.97	0.161
UFA	66.64	65.73	67.04	67.25	67.46	65.87	0.498
SFA	33.36	34.27	32.96	32.75	32.54	34.13	0.498

a,b – values in the same rows with different letters differ significantly ($p \leq 0.05$); A, B – values in the same rows with different letters differ significantly ($p \leq 0.01$).

sory assessment but there was a tendency for improvement of points classification of gilts meat.

The coneflower supplements slightly raised the content of polyunsaturated fatty acids (PUFA) in meat fat (Table 3). Meat of gilts contained more of these fatty acids but differences were significant in the cases of PUFA n 6 and DHA, only.

DISCUSSION

Animals receiving lower supplement of coneflower extract had better body weight gains and feed utilization than the control ones and these receiving the synthetic antioxidant BHT. Maass *et al*. [2005] supplemented fatteners feed with 0 or 1.5% of dried aerial parts of coneflower or 4-6 mL of juice pressed from coneflower leaves. They found no difference in body weight gains of animals but feed utilization was significantly ($p<0.03$) better in the experimental groups.

Lower body weight gains of fatteners receiving the higher supplement of coneflower could be due to reduced protein digestibility and availability which resulted from forming protein x phenolics complexes [Carbonaro *et al.*,1996]. Plant phenols can also reduce activity of digestive enzymes [Rohn *et al.,* 2002]. In spite of lower body weight gains quality of meat from these animals was better. pH of meat after slaughter was higher, which was connected with higher water binding capacity. Such an interrelationship was found also by Toldra [2003].

Coneflower extract as well as BHT had antioxidant activity especially after 6 months of storage. This activity of coneflower is due to phenolic compounds present in its aerial parts and roots [Pellati *et al.,* 2004]. The lowest content of malonic aldehyde was found in meat of fatteners receiving 500 mg of extract. Its higher level yielded higher content of aldehyde. It is in accordance with the results of Payne *et al.* [2001] who found that plant active substances had beneficial effect when fed within dietary concentrations found in natural plant material but not when fed at higher concentration. Similar improvement of oxidative stability of pork was found in the other experiments using the extract from sage [Hanczakowska *et al.,* 2003] or extract from nettle [Hanczakowska *et al.,* 2007].

A protective effect of coneflower extract, especially its lower dose, was found also in the case of fatty acid profile of meat fat. It contained more polyunsaturated fatty acids (PUFA). According to Sloley *et al.* [2001], extracts from roots and aerial parts of coneflower also protected fat against oxidation.

The higher lightness of meat when lower level of extract was used suggests that it also rotected meat myoglobin.

Both extracts and BHT diminished results of the sensory assessment of meat. Holden *et al.* [2001] also found that a high level of coneflower extract resulted in unpleasant odour of boiled meat and raised drip loss of meat juice during boiling. It was likely to be the reason of low juiciness of meat found in this experiment.

CONCLUSIONS

Effectiveness of coneflower extracts depends on its content in the feed mixture. Its supplement in moderate amount (500 mg per kg of feed) improves body weight gains, feed utilization and oxidative stability of meat fat. Higher amount of this extract in feed can result in decreasing fatteners body weight gains and lowers sensory assessment of meat.

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WPŁYW DODATKU DO PASZY EKSTRAKTU Z JEŻÓWKI (*ECHINACEA PURPUREA*) NA PROFIL KWASÓW TŁUSZCZOWYCH I JAKOŚĆ MIĘSA TUCZNIKÓW

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Wpływ dodatku ekstraktu z jeżówki badano na 96 tucznikach mieszańcach, obu płci, pochodzacych od loch pbz x wbp pokrytych knurem Duroc x Pietrain o masie ciała 60-112 kg. Wszystkie tuczniki otrzymywały standardową mieszankę zawierającą jęczmień, pszenicę i poestrakcyjną śrutę sojową oraz olej rzepakowy. Grupa I – kontrolna żywiona była mieszanką bez dodatków (kontrola negatywna). Grupa II otrzymywała w mieszance dodatek syntetycznego przeciwutleniacza BHT (kontrola pozytywna). Grupy doświadczalne III i IV otrzymywały w mieszance dodatek ekstraktu z jeżówki purpurowej w ilości odpowiednio 500 lub 1000 m/kg paszy. Tuczniki otrzymujące w paszy 500 mg ekstraktu z jeżówki uzyskały wyższe średnie przyrosty dzienne i lepiej wykorzystywały paszę natomiast wyższa dawka jeżówki pogorszyła te wyniki. Mięso tuczników otrzymujących wyższy poziom dodatku jeżówki wpłynął na poprawę wskaźniki wodochłonności co związane było z wyższym pH 45 min po uboju ($p<0,05$). Przeciwutleniający efekt działania jeżówki został potwierdzony po 6 miesięcznym okresie mrożenia mięsa ($p<0,01$). Mięso tuczników otrzymujących mniejszą ilość ekstraktu z jeżówki było jaśniejsze, a pozom cholesterolu był niższy. U tych zwierząt tłuszcz mięsa zawierał więcej kwasów PUFA, a stosunek PUFA n6/n3 był niższy. Zastosowane dodatki zarówno jeżówki jak i BHT wpłynęły na pogorszenie oceny sensorycznej.