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SUPPLEMENTING PIG DIET WITH 0.2% SWEET CHESTNUT (*Castanea sativa* Mill.) WOOD EXTRACT HAD NO EFFECT ON GROWTH, CARCASS OR MEAT QUALITY

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ABSTRACT

The effect of tannin supplementation on growth performance, carcass and meat quality of pigs was studied. Natural extract of chestnut wood (Farmatan produced by Tanin Sevnica d.d., Sevnica, Slovenia) in the concentration of 2 g/kg of feeding mixture was added in the feed of experimental group of pigs (n = 15) from 30 kg to slaughter at app. 100 kg of live weight. During rearing growth performance *i.e.* daily gain in different periods was recorded. After the slaughter carcass traits such as carcass weight, muscle and fat thickness, carcass and ham leanness, muscle and fat area were recorded. Meat quality was assessed as colour (Minolta L*a*b*), pH value and water-holding capacity (tray drip loss). Based on spectral data the percentage of metmyoglobin and intramuscular fat content were also determined. The results showed no effect of adding tannins in pigs' diet on any of the studied characteristics. A given concentration of chestnut wood extract of tannins is probably too low to cause any impact on growth, carcass or meat quality. Furthermore, no detrimental effect was either observed. Based on the presented results we cannot exclude possible beneficial or detrimental consequences of higher tannin concentration on growth, carcass or meat quality.

Key words: pigs / animal nutrition / chestnut tannins / / carcass quality / meat quality / growth

1 INTRODUCTION

Tannins are a very complex and diverse natural polyphenolic compounds which could be found in many plant *species*. Tannins have traditionally been considered as anti-nutritional substances but it is now known that their beneficial or anti-nutritional properties depend upon their chemical structure, the amount ingested, animal species and some other factors. Tannins are most often divided into two groups (condensed and hydrolysable tannins) according to their chemical structure and function. However, the new technologies used to analyze molecular and chemical structures have shown that a division into condensed and hydrolysable tannins is far too simplistic (Muller-Harvey and McAllan, 1992). Variable chemical structure of tannins could also be responsible for the diversity of their effects which we found in the literature. Studies on the use of tannins in livestock production are quite numerous. Most often the effects of extracts of different tannin-rich plant species are tested from the nutritional/dietary (digestion, nitrogen balance) or health promoting point of view (antioxidant potential, preventing diarrhoea). The majority of literature data refers to ruminants (Vasta *et al.* 2008; Zimmer and Cordesse, 1996; Deaville *et al.*, 2010; Liu *et al.*, 2011b), rabbits (Gai *et al.*, 2009; Liu *et al.*, 2009, 2011a, 2012) and poultry (Schiavone *et al.*, 2008; Lau *et al.*, 2003). In terms of meat quality tannins were mainly associated with colour stability, antioxidative status and shelf life (Staerl *et al.*, 2011; Luciano *et al.*, 2009, 2011).

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In pigs, the effect of tannins on antioxidant potential, digestibility, enzyme activity and tannins as supporting treatment for diarrhoea were studied (Mariscal-Landín *et al.*, 2004; Štrukelj *et al.*, 2010; Frankič and Salobir, 2011). However, there is a lack of studies on carcass and meat quality of pigs supplemented with tannin extracts, apart from studies dealing with pigs pastured on tannin-reach feeds (acorns or chestnut) such as Spanish Iberian or Italian Cinta Senese pigs (Nieto *et al.*, 2002; García-Valverde *et al.*, 2007; Pugliese *et al.*, 2009; Tejerina *et al.*, 2011). Due to small number of papers and heterogeneity of their results the aim of present study was to test the effect of chestnut wood extract in concentration of 2 g/kg on growth rate, carcass and meat quality of fattening pigs.

2 MATERIAL AND MEAT QUALITY MEASUREMENTS

2.1 ANIMALS

The study was conducted at the Pig Research Centre of Faculty of Agriculture and Life Sciences (University of Maribor, Slovenia). The pigs (n = 30) were the progeny of Landrace × Large White dams and Landrace × Pietrain sires (free of the *RYR1* gene). The animals originated from several sequential litters born within one week. Surgical castration of the male pigs was performed at the age of three or four days. At the body weight of 30 kg, piglets were divided into control (n = 15, one pen) and experimental group (n = 15, one pen). Pigs of different sexes (castrates, gilts) were allotted within litter to the control group and group fed feed mixture supplemented with tannins. Pigs were fed *ad libitum*. Feed consumption and feed conversion ratio were measured per pen. In our trial, chestnut wood extract, a commercial preparation "Farmatan" (Tanin Sevnica d.d., Sevnica, Slovenia), was added in the concentration of 2 g/kg of feed mixture. To randomize slaughter day effect, pigs were slaughtered in two subsequent series at the age of 26 weeks in a commercial abattoir. Prior to slaughter, the animals were fasted for 12 hours. On the day of slaughter, pigs were loaded at 6 a.m., transported for 20 minutes to the local abattoir where they were slaughtered at about 8 a.m. During the transport and lairage there was no mixing of the pigs. The slaughter was performed according to the routine abattoir procedure (CO_2 stunning, vertical exsanguination, vapour scalding, dehairing, evisceration, veterinary inspection and SEUROP carcass classification).

2.2 GROWTH TRAITS

During the experiment the weighing of animals was carried out three times. Pigs were weighed at the beginning of the experiment (when experimental group started to receive tannin, *i.e.* at app. 30 kg of live weight), at app. 60 kg of live weight and at the end of the experiment (at app. 100 kg of live weight). Average daily gain was calculated for three periods: from 30 kg to 60 kg, from 60 kg to 100 kg and from 30 kg to 100 kg.

2.3 CARCASS QUALITY MEASUREMENTS

At the end of the slaughter line, the pigs were classified according to SEUROP by the approved classification body (Bureau Veritas), using a method that consists of taking two measurements at the carcass split line: DM fat (minimal fat thickness over the *m. gluteus medius*) and DM muscle/width (shortest distance between the cranial end of *m. gluteus medius* and dorsal edge of the vertebral canal). The carcass lean meat percentage was calculated according to the formula approved for Slovenia (Commission decision, 2008). One day after the slaughter, additional carcass traits were measured. The hind leg (without shank) was cut off the carcass between 6th and 7th *lumbar vertebra*. It was weighed prior to and after the removal of subcutaneous fat, and the ratio between the weights (ham meat %) was calculated. A digital image of the carcass cross section (last rib) was taken with a digital photo camera (Canon PowerShot G3, Canon Inc., Tokyo, Japan). The loin eye area (*longissimus dorsi* (LD) area) and corresponding fat area (fat over LD) were determined from the images with LUCIA.NET 1.16.5 software (Laboratory Imaging s.r.o, Prague, Czech Republic).

2.4 MEAT QUALITY MEASUREMENTS

Meat quality characteristics were measured on LD muscle samples at the location of last rib. The measurements of pH were performed in two replicates one hour (pH_1) and 24 hours *post mortem* (pH_U) in central area of LD muscle sample using a MP120 Mettler Toledo pH meter fitted with a combined glass electrode InLab427 (Mettler-Toledo, GmbH; 8603 Schwarzenbach, Switzerland). Measurements of colour (Minolta L*a*b*) were taken in triplicate on a freshly cut surface of LD (at the level of the last rib) using a Minolta Chroma Meter CR-300 (Minolta Co. Ltd, Osaka, Japan) with an 11 mm diameter aperture and D65 illuminant, calibrated against a white tile. To assess colour stability, measurements of colour were repeated 48, 72 hours and 7 days after slaughter

(storage at 4 °C in oxygen permeable polyethylene film). To assess water-holding capacity tray drip loss method (simulating retail displaying) was applied. Shortly, two 2.0 cm thick slices were weighted, placed in plastic trays, covered with a moisture permeable plastic overwrap and stored at 4 °C. Samples were reweighed after 24 hours and 6 days. Metmyoglobin percentage and intramuscular fat content was analysed from diffuse reflectance spectroscopy. Meat spectra were recorded on fresh meat one day after slaughter and after ageing of meat for six days at 4 °C protected with permeable plastic overwrap. Spectra were scanned on the wavelength range from 400 to 2500 nm using instrument NIR Systems model 6500 (Silver Springs, MD, USA). For the calculation of metmyoglobin Kubeka-Munk equation and the protocol described in Osawa (1995) was applied. Intramuscular fat content was determined using internal calibration models developed on NIR spectra.

2.5 STATISTICAL ANALYSIS

Analysis of variance (ANOVA) using GLM procedure of SAS 9.1 (SAS Inc., Carry, NC, USA) was performed in order to evaluate the effect of tannin supplementation on growth rate, carcass and meat quality traits. The model comprised fixed effects of treatment group (TG), sex, litter, interaction TG × sex and, as a covariate, weight at the beginning of the experiment for growth data and carcass weight for carcass traits. For meat quality traits slaughter batch was added to the model as a random effect. Least squares means (LS means) were compared using the PDIFF option in SAS.

3 RESULTS AND DISCUSSION

3.1 FATTENING PERFORMANCE

Feed consumption and conversion were measured for the whole pen therefore no statistical evaluation of differences could be made. Overall, pigs supplemented with tannins had 3% higher consumption and conversion ratio than the control (Table 1). However, it is worth noting that differences were more important in the first phase of fattening (8% and 13% for feed consumption and conversion, respectively). The effect of tannin supplementation in feeding mixture of pigs on their growth rate in the periods from 30 to 60 kg, 60 to 100 kg and 30 to 100 kg of live weight is presented in table 2. Tannin enriched feeding mixture caused ≈ 5% better growth rate, but the difference was not significant. In the literature we found no data on the effect of chestnut wood tannins on pig growth performance. Štukelj *et al.* (2010) studied supplementation with a combination of organic acids and tannins in the diet of weaned piglets, but they observed no effect on average daily gain. An effect of tannins on growth rate of pigs was not anticipated as tannins are often considered as anti-nutritive substances. The positive effect of tannins in low concentration on growth, however, could be due to the effect of tannins on gut health (Goel *et al.*, 2005). Several studies on the effect of tannins in chestnut wood extract on growth performance were carried out on rabbits. Their results showed either no effect (Liu *et al.*, 2009) or a positive one (Liu *et al.*, 2011a, 2012).

Table 1: *Feed consumption and feed conversion ratio*

	[1] Consumption (kg/day/animal)		[1] Feed conversion ratio	
Fattening phase	Control	Farmatan	Control	Farmatan
30–60 kg	1.91	2.06	2.44	2.76
60–100 kg	2.89	2.92	4.43	4.24
30–100 kg	2.28	2.34	3.48	3.57

[1] measured per pen therefore no statistical evaluation of the differences could be made

3.2 CARCASS QUALITY

Carcass quality traits were assessed at the end of slaughter line and one day after slaughter. No differences were observed in any of studied carcass quality characteristics (Table 2) which is in agreement with the absence of difference in growth performance. Similar results, *i.e.* no effect of tannin supplementation on carcass quality traits were obtained on rabbits (Liu *et al.*, 2009) and poultry (Schiavone *et al.*, 2008). However, Liu *et al.* (2011, 2012) demonstrated that tannin supplementation can improve growth performance.

3.3 MEAT QUALITY

In modern livestock production, animals are often exposed to oxidative stress which could cause the degradation of lipids and proteins and is among important factors that contribute to the deterioration of meat and meat products (flavour, colour, shelf life, nutritive value). For this reason adequate supplementation with antioxidants must be considered. As tannins have often been demonstrated to exert antioxidative potential, colour stability (oxidation) was evaluated in this study. No effect of tannin supplementation was found (Table 2) although

Table 2: *Analysis of variance*

N = 30	Mean ± SE		P					
	Control	Farmatan	TG	Sex	Litter	TG × Sex	Initial LW	RMSE
Growth rate								
ADG (30–60 kg), g/d	805 ± 27	809 ± 29	0.9104	0.6723	0.3974	0.4915	0.0028	98
ADG (60–100 kg), g/d	772 ± 38	810 ± 40	0.4396	0.0472	0.5389	0.8930	0.7734	118
ADG (30–100 kg), g/d	768 ± 26	799 ± 28	0.3738	0.0829	0.3215	0.9296	0.0640	83
	Mean ± SE		P					
	Control	Farmatan	TG	Sex	Litter	TG × Sex	Warm CW	RMSE
Carcass quality traits								
Carcass weight, kg	82.2 ± 2.7	82.5 ± 3.2	0.9455	0.2312	0.0860	0.6425	/	9.5
Muscle thickness, mm	70.3 ± 1.1	71.6 ± 1.3	0.4312	0.5465	0.2632	0.1547	0.0006	3.9
Fat thickness, mm	20.0 ± 1.5	19.7 ± 1.8	0.8762	0.8414	0.1998	0.6171	0.0353	5.4
Meat percentage, %	54.8 ± 1.2	55.2 ± 1.4	0.8158	0.8066	0.2041	0.5382	0.1176	4.3
LD muscle area, cm^2	45.5 ± 1.6	46.8 ± 2.0	0.5738	0.6473	0.0889	0.8718	0.0245	5.5
Fat over LD, cm^2	17.2 ± 0.9	16.6 ± 1.1	0.6427	0.4885	0.0379	0.2344	0.0214	3.0
Belly leanness (1–7)	4.0 ± 0.2	4.2 ± 0.3	0.6767	0.8373	0.0274	0.7867	0.0621	0.8
Ham, kg	10.4 ± 0.2	10.4 ± 0.3	0.9233	0.6175	0.2751	0.8653	0.0037	0.9
Ham (muscle+bone), kg	8.5 ± 0.3	8.6 ± 0.3	0.9214	0.9276	0.4147	0.7887	0.0139	0.9
Ham meat, %	82.1 ± 1.0	82.5 ± 1.2	0.7967	0.1757	0.0471	0.8356	0.8884	3.4
	Mean ± SE		P					
	Control	Farmatan	TG	Sex	Litter	TG × Sex	Slaughter batch	RMSE
Meat quality traits								
pH – 1 hour *pm*	6.26 ± 0.07	6.27 ± 0.09	0.9023	0.3797	0.3450	0.6937	0.9489	0.27
pH – 24 hours *pm*	5.46 ± 0.01	5.48 ± 0.02	0.4787	0.1660	0.0475	0.9688	0.0002	0.05
Intramuscular fat, %	2.9 ± 0.2	2.9 ± 0.3	0.8841	0.0532	0.9229	0.9406	0.8555	0.3
Minolta L* – 1 day *pm*	56.8 ± 0.8	56.3 ± 1.0	0.6662	0.0440	0.3967	0.9608	0.2775	2.9
Minolta L* – 7 day *pm*	59.7 ± 0.6	59.4 ± 0.8	0.8048	0.0492	0.2435	0.6075	0.3511	2.1
Minolta a* – 1 day *pm*	8.5 ± 0.3	7.8 ± 0.4	0.1014	0.1231	0.0819	0.1538	0.8787	1.0
Minolta a* – 7 day *pm*	7.9 ± 0.2	7.5 ± 0.2	0.1880	0.2563	0.0254	0.2765	0.3041	0.7
Minolta b* – 1 day *pm*	4.5 ± 0.3	3.8 ± 0.4	0.1763	0.0571	0.3751	0.2706	0.9830	1.1
Minolta b* – 7 day *pm*	7.9 ± 0.1	7.6 ± 0.2	0.1869	0.0628	0.0224	0.2566	0.9240	0.5
Drip loss – 1 day *pm*	4.8 ± 0.5	4.0 ± 0.6	0.3318	0.7932	0.3408	0.6309	0.5711	1.7
Drip loss – 7 day *pm*	8.9 ± 0.4	8.5 ± 0.6	0.6004	0.7628	0.2955	0.6686	0.9040	1.6
MetMb % – 1 day *pm*	6.2 ± 0.4	6.5 ± 0.6	0.6184	0.1577	0.0676	0.7196	0.6360	1.5
MetMb % – 7 day *pm*	28.3 ± 0.6	27.0 ± 0.8	0.1452	0.6424	0.0014	0.1953	0.1376	2.0

TG – treatment group (tannin supplementation), RMSE – root mean square error, LW – live weight, CW – carcass weight, ADG – average daily gain (g/day), MetMb % – metmyoglobin percentage; SE – standard error

somewhat lower values for drip loss and metmyoglobin formation were observed for tannin supplemented pigs. It is likely that supplementation with tannins was too low to have any detectable consequence for meat quality. Meat quality traits in association with tannin supplementation were examined in rabbit and lamb meat. In accordance with our result Liu *et al.* (2009) observed no particular benefit of tannins on rabbit meat. On the contrary, same authors (Liu *et al.*, 2012) demonstrated improved meat quality (lower cooking loss) of chestnut tannin supplemented pigs. In lamb, extended colour stability, higher muscle antioxidant capacity and reduced metmyoglobin

formation during storage period was recorded as a consequence of tannin-rich quebracho extract (Luciano *et al.*, 2009, 2011).

4 CONCLUSION

Supplementing pig diet with chestnut wood extract rich in tannins had no effect on growth rate, carcass traits or meat quality. No more did the inclusion of tannins in the feed demonstrate any detrimental effect in pig fatteners. We may speculate that tannin concentration 2 g/kg was too low to cause a detectable effect. It would be worthwhile testing other tannin preparations or higher concentrations since pigs are known to be able to consume larger quantities of tannins (e.g. acorn).

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