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QUALITATIVE, CHEMICAL AND NUTRITIONAL TRAITS OF DRY-CURED HAM OF SARDA BREED PIGS: EFFECT OF REARING SYSTEM

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ABSTRACT

The aim of the study was to evaluate the effect of different rearing systems on some traits of Sarda breed pig ham. Twelve pigs were randomly assigned to the following three feeding systems: A, outdoor rearing system and fed *ad libitum* with a commercial concentrate; B, outdoor rearing and fed with ground barley (1.8 kg/head/day); C, fed at pasture in the woods and receiving 500 g/head/day of barley grain. After slaughter (22 months of age) the left thighs were processed for the production of the "pressuttu" (Sarda hams). After 14 months of ripening, ham weight loss was recorded and composition and chemical properties were determined in muscle and fat tissue. Rearing systems affected tissue and chemical composition of Sarda ham. Fresh ham weight and fat percentage were the highest in group A which showed the lowest value of seasoning weight loss (18.94 ± 1.51 vs. 28.44 ± 1.66 vs. 24.76 ± 1.32 for A, B and C group respectively). Dry-cured ham from pigs reared in outdoor system B showed higher content ($P < 0.001$) of total protein and soluble nitrogen (SN/TN) than those from the other groups. Hams from groups A and B were characterized by the highest content of the saturated fatty acids (SFA). Fatty acids profile of dry-cured ham from group C showed the highest value of oleic and linolenic acids, and consequently the highest monounsaturated (MUFA), polyunsaturated (PUFA) fatty acids content and more favorable values of PUFA/SFA and ω6/ω3 ratio. Pasture feeding is more suitable to obtain products with high nutritional properties.

Key words: Sarda breed pig / ham chemical compositions / feeding system / rearing system

1 INTRODUCTION

During the first half of the last century, production of the Mediterranean pig was very important considering both the farm and the general economy (Tirapicos Nunes, 2007). Biodiversity is an important component of the complex rural area. The responsibility of the man is to protect the balance between the different forms of life. "*This only is denied to God: the power to undo the past*" (Agathon, from Aristotle, Nicomachean Ethics, 448 BC-400 BC). The man, however, is doing everything to destroy it. The conservation of autochthonous pigs is very important to maintain genetic variation within-breeds and to obtain economic advantages through the obtainment of high quality products (Pugliese, 2012). Today the consumer is aware and sensitive, paying more attention to quality and typicality of the food and also inclined to rediscover and recover the ancient flavours and pleasant odours, linked to the tradition and their place of origin. In Sardinia, there are plenty of historic documents concerning an autochthonous swine breed (Porcu *et al.*, 2007a) officially recognized as Sarda breed pigs in 2006 (Porcu *et al.*, 2007b). Sarda breed pigs and/or its crossbreds are reared in various breeding system (Porcu *et al.*, 2007a) in wide wooded areas of Sardinia where the archaic traditions of breeding and production of salami, sausages and typical ham have been preserved. Sarda pig has lived for centuries completely free in the Sardinian mountains, showing a great ability to use poor food such as wild fruits of woods and only occasionally was supple-

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mented with flour or grains. In fact many rural families raised Su Mannale (the pig fattened for familiar provisions) that after finishing could reach a weight over 200 kg (Porcu *et al*., 2012a). Dry-cured meat products, locally very appreciated, are produced directly in the farms by different artisanal technologies. In a previous research (Porcu *et al*., 2007c) some chemical-physical characteristics of Sarda ham were studied, but no information is available about the effect of rearing system. The aim of this study was to evaluate the effect of different rearing systems on quality, chemical and nutritional traits of dry-cured ham from Sarda pigs.

2 MATERIALS AND METHODS

The research was carried out on twelve male pigs of "*Sarda*" breed assigned to three groups (A, B, C), each including four animals. Pigs were reared outdoors, group A had *ad libitum* access to commercial feed, group B received 1.8 kg/day of ground barley, group C was grazed on woody pasture and received a daily supplement of 500 g of barley-corn (Porcu *et al.*, 2012a). Animals were slaughtered at 22 months of age and live weight of 294 ± 29, 171 ± 7 and 202 ± 29 kg for groups A, B and C, respectively (Porcu *et al*., 2012b). The left thighs from each carcass were processed for the production of the "*pressuttu*" (Sarda hams) at the meat product pilot plant located in the Agency Agris, Bonassai (Olmedo-SS) as described in Table 1.

Table 1: *The dry-curing process of Presuttu (Sardinian ham)*

Stage	Description
Salting	Ham is completely covered with salt and placed in a salting room for 1 day/kg at 4 °C and 75–80% relative humidity.
Resting	Ham is first brushed and washed with vinegar to remove superficial salt, covered in pepper and then it is kept for 60 days in a chamber with a temperature 2–4 °C and 65–75% relative humidity.
Seasoning	Ham is kept in a cellar for a minimum of 270 days. The conditions in the cellar are: temperature between 14–15 °C, 70–80% relative humidity with three changes of air from the outside

After 14 months of seasoning the weight loss was recorded. A ham sample of about 4 cm was isolated and dissected into the major tissues: lean, fat, scraps and rind. On lean tissue chemical composition (AOAC, 1990) was determined. On subcutaneous fat total lipids were extracted according to modified Folch method (Christie, 1989). Lipids were subjected to acid transmethylation (Chin *et al*., 1992) and fatty acid methyl esters (FAMEs) were determined by gas chromatography. Data were processed by ANOVA procedure of StatGraphics centurion XV using "rearing system" as fixed effect. The multiple comparisons between means were performed using Tukey's HSD Test.

3 RESULTS AND DISCUSSION

Rearing systems affected properties of Sarda ham (Table 2). Group A had heavier fresh and consequently seasoned ham and sample cut weight than the other two groups, it also had higher fat content, which all can be related to higher slaughter weight.

The proximate composition, cholesterol and α-tocopherol concentrations, determined in dry-cured ham from Sarda pigs differently reared, are shown in Table 3. Dietary treatment had no significant effect ($P > 0.05$) on lean tissue dry matter, fat, α-tocopherol and cholesterol content. Dry-cured hams from pigs reared outdoors in the wood and fed with ground barley (B) showed a significantly ($P < 0.001$) higher content of protein and soluble nitrogen (SN/TN) compared to that of dry-cured hams from other groups (A, C). Ash content in dry-cured hams from pigs A, tended ($P = 0.057$) to be higher than in pigs B or C. NaCl content tended to be higher in A samples, which could be due to the ham's salting period that has been longer in A than the others according to their greater fresh weight (Table 2).

Rearing system significantly affected fatty acid composition of dry-cured hams fat (Table 4). Hams from pigs reared outdoors in wood and fed *ad libitum* with commercial concentrate (A) and ground barley (B), respectively, were characterised by the highest content of C14:0, C16:0, C18:0 and then by the highest saturated fatty acids content (SFA). The content of C14:0 and C16:0 acids and SFA should be controlled, in the diet, as these fatty acids are considered to be hyperlipidemic and thought to be responsible for increased plasma cholesterol content (Ulbricht and Southgate, 1991). Fatty acids profile of dry-cured hams from pigs on wood pasture (C) showed the highest value of oleic (C18:1 9c) and linolenic (C18:3 9c, 12c, 15c) acids and consequently the highest monounsaturated (MUFA) and polyunsaturated (PUFA) fatty ac-

Table 2: *Properties of hams from pigs of Sarda breed reared in different systems (mean ± sd)*

	Rearing system			
	A	B	C	P-value
Fresh ham (kg)	$26.33^{a} \pm 2.66$	$15.88^{b} \pm 0.74$	$18.03^{b} \pm 3.19$	*
Seasoned ham (kg)	$21.34^{a} \pm 2.39$	$11.37^{b} \pm 0.72$	$13.56^{b} \pm 2.54$	*
Weight loss (%)	$18.94^{c} \pm 1.51$	$28.44^{a} \pm 1.66$	$24.76^{b} \pm 1.32$	*
Sample weight (kg)	$0.\ 895^{a} \pm 126.61$	$0.541^{b} \pm 115.02$	$0.610^{b} \pm 67.43$	*
Fat (%)	$53.87^{a} \pm 89.45$	33.42 ± 54.44 b	$39.80^{b} \pm 19.66$	*
Lean (%)	27.38 ± 29.19	43.20 ± 35.51	34.85 ± 33.01	ns
Scraps (%)	13.17 ± 23.25	15.57 ± 11.23	19.00 ± 15.16	ns
Rind (%)	5.58 ± 16.91	7.81 ± 13.57	6.35 ± 18.96	ns

A – reared outdoor with ad libitum intake of commercial concentrate; B – reared outdoor and fed ground barley (1.8 kg/head/day); C – pastured in the woods and supplemented with barley grain (500 g/head/day)
Means with different letters within row are significantly different *P < 0.05; ns – non-significant.

ids content. Significant increase in MUFA and PUFA in hams from pigs raised extensively with free availability of acorn and pasture has been reported by Flores *et al.* (1988). PUFA are included in the calculation of PUFA/SFA and ω6/ω3 ratios used for nutritional assessment of food fat. Nutritionist recently focused on the type of PUFA and on their balance in the diet in particular between ω6 and ω3 PUFA. Nutritional recommendations suggest to increase the level of ω3 fatty acids in the diet, trying to focus on foods that have a lower value of this ratio (ω6/ω3), because it is a risk factor in cancers and coronary heart disease (Enser, 2001), especially if it exceeds 4 (British department of Health, 1994). Hams from pigs reared at pasture (C) showed more favorable values PUFA/SFA and a ω6/ω3 than hams obtained from pigs reared outdoors (A and B). Hams from pigs C were characterized also by significantly lower atherogenic (AI) and the thrombogenic (TI) indices thereby showing a higher nutritional quality of A and B products.

4 CONCLUSIONS

These preliminary results show that rearing system based on natural pasture feeding is more suitable to obtain products with high nutritional values compared to other outdoor rearing systems. Further and more extensive trials will be carried out aiming to improve the production performances of Sarda breed pigs reared in natural pasture, from which very high quality traditionally recognised meat products are obtained.

Table 3: *Effect of rearing system on chemical parameters (mean±sd) in dry-cured ham from Sarda pigs*

	Rearing system			
Chemical parameter	A	B	C	P-value
Dry matter (g/100g lean)	58.08 ± 1.86	57.82 ± 1.53	57.76 ± 2.10	ns
Fat (g/100g lean)	19.89 ± 2.04	17.79 ± 2.33	21.74 ± 3.24	ns
Proteins (g/100g lean)	$26.43^{b} \pm 0.67$	$30.80^{a} \pm 1.49$	$26.29^{b} \pm 1.14$	***
SN/TN (%)	$0.25^{c} \pm 0.02$	$0.36^{a} \pm 0.00$	$0.31^{b} \pm 0.03$	***
NaCl (g/100g lean)	7.80 ± 0.87	7.51 ± 0.93	6.97 ± 0.39	ns
Ash (g/100g lean)	$9.32^{a} \pm 0.32$	$8.75^{ab} \pm 0.79$	$8.22^{b} \pm 0.51$	†
α-tocopherol (μg/g)	1.95 ± 1.01	1.56 ± 0.50	1.91 ± 0.48	ns
Cholesterol (μg/g)	935.8 ± 46.3	939.8 ± 61.5	894.1 ± 38.8	ns

A – reared outdoor with ad libitum intake of commercial concentrate; B – reared outdoor and fed ground barley (1.8 kg/head/day); C – pastured in the woods and supplemented with barley grain (500 g/head/day)
SN/TN – Soluble nitrogen/Total nitrogen, †P < 0.10, *P < 0.05, ***P < 0.001, ns – non-significant,
Means with different letters within row are significantly different (P < 0.05).

Table 4: *Effect of rearing system on fatty acid profile (mean ± sd) in dry-cured ham fat from Sarda pigs*

	Rearing system			
Fatty acid (% of FAME)	A	B	C	P-value
C12:0	0.08 ± 0.01	0.08 ± 0.01	0.08 ± 0.00	ns
C14:0	1.50^{ab} ± 0.13	1.69^{a} ± 0.16	1.44^{b} ± 0.07	*
C16:0	24.56^{a} ± 0.81	25.27^{a} ± 0.73	22.24^{b} ± 0.64	**
C18:0	13.85^{a} ± 0.59	12.78^{a} ± 0.62	9.70^{b} ± 0.69	***
C18:1 9c	38.99^{b} ± 0.73	37.87^{b} ± 1.13	43.14^{a} ± 3.63	*
C18:2 9c,12c	8.48^{a} ± 0.67	6.70^{b} ± 0.61	8.21^{a} ± 0.56	*
C18:3 9c,12c,15c	0.51^{c} ± 0.10	0.88^{b} ± 0.19	1.43^{a} ± 0.08	***
SFA	40.91^{a} ± 1.48	40.86^{a} ± 1.43	34.56^{b} ± 1.20	***
MUFA	49.88^{b} ± 1.17	51.30^{b} ± 1.07	55.58^{a} ± 0.84	***
PUFA	9.21^{a} ± 0.78	7.84^{b} ± 0.80	9.86^{a} ± 0.53	*
UFA	59.09^{b} ± 1.48	59.14^{b} ± 1.43	65.44^{a} ± 1.20	***
PUFA/SFA	0.23^{b} ± 0.03	0.19^{b} ± 0.02	0.29^{a} ± 0.02	**
ω3	0.51^{c} ± 0.10	0.88^{b} ± 0.19	1.43^{a} ± 0.08	***
ω6	8.60^{a} ± 0.68	6.82^{b} ± 0.63	8.33^{a} ± 0.58	*
ω6/ω3	17.05^{a} ± 1.75	7.90^{b} ± 1.30	5.83^{b} ± 0.65	***
AI	0.52^{a} ± 0.03	0.54^{a} ± 0.04	0.43^{b} ± 0.02	**
TI	1.30^{a} ± 0.08	1.25^{a} ± 0.09	0.92^{b} ± 0.04	***

A – reared outdoor with ad libitum intake of commercial concentrate; B – reared outdoor and fed ground barley (1.8 kg/head/day); C – pastured in the woods and supplemented with barley grain (500 g/head/day)
FAME – fatty acid methy esters; SFA – Saturated fatty acids, MUFA – Monounsaturated Fatty Acids, PUFA – polyunsaturated Fatty Acids, UFA – Unsaturated Fatty Acids, ω3 – omega 3 fatty acids, ω6 – omega 6 fatty acids, AI = (C12:0 + (C14:0 × 4) + C16:0) / UFA; TI = (C14:0 + C16:0 + C18:0) / ((0.5 × ω6) + (0.5 × MUFA) + (3 × ω3) + (ω3 / ∑ω6).
Means with different letters within row are significantly different; *P < 0.05, **P < 0.01, ***P < 0.001, ns – non-significant

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