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Effect of pasture on chestnut woods on meat quality and fatty acid composition of fat in Cinta Senese pigs

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SUMMARY – Seven Cinta Senese pigs were reared in a paddock and fed on barley; other 7 pigs were reared in the woods and fed on chestnuts. A sample cut was removed from the loin and dissected. The following analyses were carried out on *Longissimus lumborum* (LI): colour measurements, moisture, intramuscular fat, water-holding capacity and shear force. Colour measurements and total fatty acids were determined on subcutaneous fat. As sample cut composition is concerned, no differences were found for total lean, LI and *Psoas major* percentages but pig fattened with chestnut showed a higher percentage of subcutaneous fat (41.7 *vs* 37.6%) due to the more important development of the inner layer. The a*, b* and chroma values were lower in pigs fattened with chestnut (3.45 *vs* 4.83; 3.83 *vs* 5.19; 5.17 *vs* 7.11 respectively). The chestnut diet registered higher MUFA (48.9 *vs* 47.6%), C18:1 (46 *vs* 44.6%) and PUFA n-3 (1.46 *vs* 1.2%) contents and a lower thrombogenicity index (0.944 *vs* 0.999).

Keywords: Cinta Senese, pig, meat quality, fatty acid, chestnut.

RESUME – *"Effet du pâturage en châtaigneraie sur la qualité de la viande et la composition en acides gras de la graisse chez les porcs Cinta Senese". Sept porcs Cinta Senese ont été élevés en paddock et alimentés avec de l'orge et sept autres ont été élevés sous bois et alimentés avec des châtaignes. Une partie de la longe a été disséquée. Sur le* Longissimus lumborum *(LI) les analyses suivantes ont été conduites : couleur, humidité, pourcentage de la graisse intramusculaire, capacité de rétention hydrique et tendreté. Les mesures de la couleur et de la composition en acides gras de la graisse sous-cutanée ont été effectuées. Les porcs engraissés avec les châtaignes ont présenté le plus haut pourcentage de graisse sous-cutanée (41,7 contre 37,6%). Les valeurs des paramètres a*, b* et chroma ont été plus faibles dans les porcs engraissés avec les châtaignes (3,34 contre 4,83 ; 3,83 contre 5,19 ; 5,17 contre 7,11). L'alimentation aux châtaignes a déterminé une concentration plus élevée d'acides gras monoinsaturés (48,9 contre 47,6), C18 : 1 (46 contre 44,6%) et polyinsaturés n-3 (1,46 contre 1,2%) et un indice de thrombogénicité plus faible (0,944 contre 0,999).*

Mots-clés : *Cinta Senese, porc, qualité de la viande, acides gras, châtaignes.*

Introduction

The extensive rearing system of pigs in Tuscany relies on Cinta Senese, a local genotype, and on nutritional strategy based on the availability of natural resource. Cinta Senese, in comparison with improved breeds, is characterized by lower *in vita* performance (Acciaioli *et al*., 2002) and fatter carcass (Franci *et al.*, 2003). Therefore an opportunity for the survival of the breed is linked to the development of products with added values deriving from particular rearing system. The presence of different woodland systems in Tuscany (oak-grove, chestnut-grove) can be exploit to characterize products depending by alimentary source. The aim of this work was to assess the effect of pasture in chestnut wood on sample joint composition, physical traits of meat and on fatty acid composition of subcutaneous fat in Cinta Senese pig.

Materials and methods

Fourteen Cinta Senese pigs were submitted to the trial: 7 pigs were reared in paddock of 1 ha and fed barley (3 kg/pig/d) and 7 pigs were reared under traditional extensive system in wood and fed chestnuts. In Table 1 fatty acid composition of the two feeds is reported. The trial has been carried out from November to February corresponding to fattening period of pig; every 15 days, animals were weighed and thickness of subcutaneous fat was measured. Pigs were slaughtered on average at 145 kg of live weight. At 45 minutes and 24 h post-slaughter on *Longissimus lumborum* (LI) muscle, pH_1 and pH_u were measured. From loin a sample cut was removed (portion from 2° to 5° lumbar vertebra inclusive) and dissected. Muscular, adipose and bony tissues were separated.

Table 1. Fatty acid composition of the feeds (%)

	Chestnut	Barley
C 16:0	13.1	26.8
C 18:0	0.70	2.50
C 18:1	38.70	17.30
C 18:2	41.00	45.70
C 18:3	4.50	5.10
MUFA	39.60	18.10
PUFA n-3	4.50	5.10
PUFA n-6	41.50	45.80

On LI the following analyses were carried out: (i) colour measurements L*, a* and b* with a Minolta Chromameter CR-200 and the hue angle and chroma parameters also were calculated; (ii) moisture; (iii) intramuscular fat as ether extract; (iv) water-holding capacity determined by the following techniques: drip loss, cooking loss by water-bath and filter paper press method; (v) shear force measurements by Instron 1011 apparatus on raw and cooked meat; and (vi) total fatty acid profile of subcutaneous fat, separately for inner and outer layer.

Data were analyzed by GLM procedure (SAS, 1996) following these models: $Y_{ij} = \mu + D_i + b_i(X_{ij}) + e_{ij}$ for physical-chemical traits and $Y_{ijk} = \mu + D_i + L_j + E_{ijk}$ for fatty acid determination where D, X, and L were diet, weight of sample joint and layer of adipose tissue, respectively.

Results and discussion

In Table 2 sample joint composition and fat thickness are reported. At dissection the weight of sample joint was the same for the two diets and no differences were found for total lean and for *Longissimus lumborum* (LI) and *Psoas major* (Pm) percentages. Pig fattened with chestnuts showed higher percentage of subcutaneous fat due to higher incidence of inner layer. Despite of these results no differences were found for fat thickness, neither on outer nor inner layer.

Table 2. Sample joint composition and fat thickness

	Diet		RSD
	Chestnut	Barley	
Live weight at slaughter (kg)	146.1	144.5	14.7
Sample joint (g)	2198	2226	277.3
Total lean (%)	43.37	45.71	2.39
Psoas major (%)	9.40	9.93	1.77
Longissimus lumborum (%)	28.46	29.77	1.35
Other muscles (%)	5.51	6.01	1.05
Total fat (%)	46.75	43.66	3.57
Subcutaneous fat (%)	41.68[a]	37.58[b]	3.18
Outer layer (%)	17.67	17.16	2.52
Inner layer (%)	24.01[a]	20.40[b]	2.74
Intermuscular fat (%)	5.06	6.09	1.36
Bone (%)	9.87	10.64	1.99
Subcutaneous fat thickness (mm)	30.9	29.3	4.32
Outer layer thickness (mm)	14.9	13.8	2.87
Inner layer thickness (mm)	16.1	15.5	2.74

a, b means different ($P<0.05$).

The chemical composition of Ll and Pm (Table 3) was similar in the two diets. These results are in partial accord with Coutron-Gambotti *et al.* (1998) that on Corsican pigs fattened with chestnuts, in comparison with concentrated diet, found higher value of thickness on subcutaneous fat and the same percentage of intramuscular fat on *Biceps femoris.*

Table 3. Chemical traits of *Longissimus lumborum* and *Psoas major* muscles

Diet	*Longissimus lumborum*		*Psoas major*		RSD
	Chestnut	Barley	Chestnut	Barley	
Moisture (%)	72.69	72.52	71.47	70.73	0.92
Protein (%)	23.94	23.89	21.6	22.02	0.85
Ether extract (%)	3.32	3.10	6.22	7.00	0.99
Ash (%)	1.10	1.12	1.06	1.08	0.04

a, b means different (P<0.05).

The diet had a limited effect on physical characteristics (Table 4), the only notable difference involving colour parameters of subcutaneous fat. Thus a*, b* and chroma values were lower in pigs fattened with chestnut and so their fat was less coloured and, therefore, more appreciated by Italian industry. These results are consistent with other results recorded on Cinta Senese fattened with acorn (Pugliese *et al.*, 2005) and on Nero Siciliano reared on wood (Pugliese *et al.*, 2004).

Table 4. Physical traits of *Longissimus lumborum* and subcutaneous fat

	Diet		RSD
	Chestnut	Barley	
Water holding capacity			
drip loss (%)	1.71	1.19	1.01
cooking loss in water-bath (%)	19.46	17.85	4.66
filter paper press (cm^2)	8.44	7.71	1.53
Shear force			
WB on raw meat (kg)	9.33	10.26	2.37
WB on cooked meat in water-bath (kg)	10.59	12.03	2.23
Colour of Ll			
L*	47.24	46.66	3.56
a*	13.83	13.65	1.46
b*	4.35	4.09	1.48
Hue	0.29	0.29	0.07
Chroma	14.54	14.27	1.81
Colour of backfat			
L*	79.95	79.08	1.46
a*	3.45^a	4.83^b	1.21
b*	3.83^a	5.19^b	0.85
Hue	0.84	0.83	0.09
Chroma	5.17^a	7.11^b	1.37

a, b means different (P<0.05).

It is probable that these results are related to fatty acid composition of backfat (Table 5) because of its correlation with colour. Indeed pigs fattened with chestnut showed an higher percentage of oleic acid that seems to be associated at white colour of fat (Maw *et al.*, 2003). Overall fatty acid composition of total lipids in chestnuts diet was characterised by a higher proportion of monounsaturated. These results can be explained by a ready incorporation into pork fat of dietary fatty

acid (Fontanillas *et al.,* 1998) since chestnut, in comparison with barley, is characterized by an higher content of MUFA (Table 1). Also, chestnuts diet induced an higher level of n-3 fatty acids so, pig fattened with chestnuts showed lower thrombogen*icity* index and, consequently, the best dietetic property of fat.

Table 5. Fatty acid composition of subcutaneous fat

Diet	Diet		Layer		RSD
	Chestnut	Barley	Outer	Inner	
Total lipids (%)	78.57	78.94	78.74	78.77	3.16
C 12:0 (%)	0.057	0.057	0.05[b]	0.06[a]	0.006
C 14:0 (%)	1.22	1.24	1.21	1.24	0.08
C 16:0 (%)	21.88	22.02	21.34[b]	22.57[a]	0.74
C 16:1 (%)	1.84	1.96	1.98[b]	1.82[a]	0.19
C 17:0 (%)	0.42	0.43	0.43	0.41	0.08
C 16:3 (%)	0.36	0.39	0.41[b]	0.35[a]	0.08
C 18:0 (%)	10.97	11.49	10.45[b]	12.01[a]	0.72
C 18:1 (%)	46.00[a]	44.60[b]	45.94[b]	44.67[a]	1.22
C 18:2 (%)	13.73	14.60	14.62	13.71	1.18
C 18:3 (%)	1.18[a]	1.00[b]	1.17[a]	1.01[b]	0.11
C 20:0 (%)	0.14[a]	0.16[b]	0.14[b]	0.16[a]	0.017
C 20:1 (%)	1.12[a]	1.04[b]	1.10	1.06	0.089
C 20:2 (%)	0.75	0.76	0.81[b]	0.70[a]	0.083
C 20:4 (%)	0.05	0.05	0.05	0.04	0.028
C 20:3 (%)	0.27[a]	0.20[b]	0.29[b]	0.19[a]	0.049
MUFA (%)	48.97[a]	47.59[b]	49.02[b]	47.54[a]	1.31
PUFA n-3 (%)	1.46[a]	1.20[b]	1.46[b]	1.20[a]	0.15
PUFA n-6 (%)	14.53	15.40	15.48[b]	14.45[a]	1.26
Atherogenicity[†] index	0.413	0.422	0.437[a]	0.398[b]	0.022
Thrombogenicity[††] index	0.944[a]	0.999[b]	1.03[a]	0.90[b]	0.05

a, b within criterion means different (P<0.05).

[†] Atherogenicity index =[C12:0+(4*C14:0)+C16:0]/[(n-3+n-6)+MUFA.

[††] Thrombogenicity index =(C14:0+C16:0+C18:0)/[(0.5*MUFA)+(0.5*n-6)+(3*n-3)+(n-3/n-6)].

As regard differences between layers, outer layer showed higher *percentage* of MUFA and of all types of polyunsaturated fatty acid. This confirms other results (Geri *et al.*,1988) that indicate*d* an higher level of insaturation in outer than in inner layer of subcutaneous fat.

Conclusion

Our results show that it is possible to fatten Cinta Senese pigs in chestnut-wood with valuable advantages. The main effects of chestnuts diet occurred on adipose traits that resulted more unsaturated, with an appreciable increment of oleic acid. Moreover the highest content in polyunsaturated n-3 fatty acid induced in fat of pig fattened with chestnuts the best dietetic property even if it could worse the technological traits. Indeed the total polyunsaturated percentage has been found higher than value of 15% above which fat consistency and oxidative stability can be negatively affected (Warmants *et al.*, 1996). But it is probably that the pasture in wood provides a source of grass and, consequently, of vitamine E that has been reported to limit oxidation in meat products (López-Bote, 2000).

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