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The effect of slaughter age on chemical and physical characteristics of dry cured ham of Alentejano pig fattened on acorns

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SUMMARY - Two groups of four hams, eighteen months seasoned, coming from pigs aged 12 or 15 months at slaughter and 130 kg LW (liveweight) were studied. Samples from the outer subcutaneous fat and from the muscle *semimembranosus* (SM) and *biceps femoris* (BF) were analysed. The outer subcutaneous fat of older pigs registered a higher amount of C18:1 (57.06 *vs* 55.34; P 0.05) and the colour revealed a higher saturation value (0.11 *vs* 0.09; *P* 0.05). Significant differences were not observed for gross chemical composition, fatty acid composition of neutral lipids, neither for pH, aW, NaCl, BVN e NPN values, in both muscles. Though and colour revealed similar values, in both muscles, except for b* and hue that were lower in BF of the older pigs. The aromatic profile did not show significant differences, but a trend for the hams of the younger pigs to present a higher level of linear and branched aldehydes in both muscles was observed. The same situation was observed for ketones, but only in SM.

Key words: Ham, age, pig, corn.

RESUME - *"Effet de l'âge d'abattage sur les caractéristiques physico-chimiques du jambon du porc Alentejano fini en "Montanheira". On étudié deux lots de quatre jambons, dix-huit mois de maturation, provenant de porcs de 12 ou 15 mois d'âge et abattus à 130 kg PV (poids vif). Nous avons analysé des échantillons de la couche externe du gras sous-cutané et des muscles* semimembranosus *(SM) et* biceps femoris *(BF). La couche externe du gras sous-cutané dans les jambons des porcs plus âgés a présenté une teneur plus élevée de C18:1 (57,06* vs *55,34 ;* P *0,05) et une couleur plus saturée (0,11* vs *0,09 ;* P *0,05). On n'a pas observé de différences significatives pour la composition chimique, la composition en acides gras des lipides neutres, ni pour le pH, aW, NaCl, NVT et NNP, dans les deux muscles. La dureté et la couleur ont révélé des valeurs proches, dans les deux muscles, excepté pour b* et le ton qui ont été plus élevés dans le BF des porcs plus âgés. Les composés volatils ne présentent pas de différences significatives, mais il y a une tendance pour les jambons des porcs moins âgés á présenter la plus grande concentration en aldéhydes ramifiés et non ramifiés dans les deux muscles. La même situation a été observée pour les cétones, mais seulement dans le SM.*

Mots-clés : *Jambon, âge, porc, acorn.*

Introduction

In the traditional exploitation system, where the pigs were fattened on acorns "montanheira", the season of birth of Alentejano pig, determine the age (and the weight) at the beginning of the fattening period (between October and February) and consequently, the duration of production cycle of raw matter for elaboration of Barrancos dry cured ham. The processing time is itself too extensive with repercussions in the income of this product and prolonging the cycle of raw matter production could to aggravate this problem. There are several works referring the influence of age on fat distribution (De Pedro, 1987; Almeida *et al*., 1993) and overall on its fatty acid composition (Enser, 1984; Geri, 1988) and on muscular tissue, especially, in pigments amount (Monin, 1989). Those factors have a great importance of technological point of view. Thereby, we analysed hams from Alentejano pigs born in two different seasons: in January and in October and fattened at the same "montanheira", in order to find if there are differences in product quality that justify the use of older animals and a longer production cycle.

Materials and methods

Animals: Eight pigs, four born in October and four born in January were used. All the pigs were fed restricted in the growing phase, between 40 kg LW and 75 kg weight at the beginning of "montanheira" and slaughtered after fattening with 130 kg LW.

Samples: The hams were processing by a local manufacturer in the village of Barrancos. The seasoned time was eighteen months. Were analysed samples from the outer layer of the subcutaneous fat and from the muscles *biceps femoris* (BF) and *semimembranosus* (SM).

Analytical proceedings: Water (Portuguese Norm PN-1614), Protein (PN-1612), Lipids of the subcutaneous fat (1- (water + protein), Neutral and Polar lipids (Marmer and Maxwell, 1981), ash (PN-1615); Fatty acid composition (metilation by the proceeding of Bannon *et al*., 1985 and GC/FID); pH; a_w; (at 25C∞); No protein nitrogen (NPN) (PN-3442); basic volatile nitrogen (BVN) (PN-1987), NaCl (PN-1845); Though in kg/cm^2 (Warner-Blatzer); Colour CIE L*A*B*, hue (∞) (arctg b*/a*), croma (÷a*^{2}+b*^{2}) and saturation (÷a*^{2}+b*^{2}/L*) (Colorimeter Minolta Cr-200). Volatile compounds (extraction by dynamic headspace, separation by GC, identification by electronic ionization in a mass spectrometer).

Results and discussion

The gross chemical composition (Table 1) was similar In the two groups of hams, whatever the muscle studied and the same situation was observed for the fatty acid composition of intramuscular neutral lipids (Table 2).

Table 1. Gross chemical composition of muscles *biceps femoris* and *semimembranosus* (Average ± standard error)

Slaughter age	Biceps femoris			Semimembranosus		
	12 months	15 months	Sig.	12 months	15 months	Sig.
Water (%)	50.65 ± 0.63	50.93 ± 1.24	NS	39.50 ± 0.50	38.14 ± 1.38	NS
Neutral lipids (%)	7.17 ± 0.76	6.36 ± 0.89	NS	5.13 ± 0.38	5.55 ± 0.62	NS
Polar lipids (%)	1.55 ± 0.05	1.38 ± 0.13	NS	1.35 ± 0.06	1.44 ± 0.08	NS
Protein (%)	28.02 ± 0.64	28.28 ± 0.24	NS	41.49 ± 0.29	44.31 ± 1.06	NS
Ash (%)	10.30 ± 0.56	10.82 ± 0.71	NS	8.77 ± 0.62	8.46 ± 0.64	NS

NS: Not significant

In respect to physical-chemical parameters the hams of older pigs registered a lower value of b* and hue. Such, can't be explain by the available results. On the other hand a great proteolytic activity at these hams is suggested by the higher values of VBN, although not significant. A further studies are necessary to confirm this observation (Table 3).

The outer layer of subcutaneous fat presented a greater amount of C18:1 and mono-unsaturated in hams from the older pigs, the more evident difference (Table 4). The larger amount of C18:1 observed in hams from older pigs already had been observed at raw matter (Neves, data not publish) and could be explain by the slightly higher deposition of fat registered in this pigs during the fattening period (Freitas, personal communication) feeding acorns rich in C18:1. The colour revealed some differences between average values, been significant only for saturation. This difference can't be explain by the gross chemical composition neither by the fatty acid composition, but maybe the chemical and structural deterioration due to the exposition of outer layer had induced this difference.

Table 2. Fatty acid composition of muscles *biceps femoris* and *semimembranosus* (Average ± standard error)

Slaughter age	Biceps femoris			Semimembranosus		
	12 months	15 months	Sig.	12 months	15 months	Sig.
C14:0	1.29 ± 0.06	1.39 ± 0.04	NS	1.28 ± 0.03	1.39 ± 0.07	NS
C16:0	25.48 ± 0.61	25.87 ± 0.50	NS	24.28 ± 0.37	25.14 ± 0.38	NS
C16:1	3.48 ± 0.16	3.70 ± 0.14	NS	3.66 ± 0.19	3.73 ± 0.19	NS
C18:0	10.22 ± 0.37	9.95 ± 0.57	NS	9.18 ± 0.22	9.32 ± 0.52	NS
C18:1	52.25 ± 0.36	51.07 ± 0.64	NS	52.12 ± 0.28	50.71 ± 0.70	NS
C18:2	5.06 ± 0.49	5.60 ± 0.38	NS	6.98 ± 0.31	7.02 ± 0.38	NS
C18:3	0.54 ± 0.05	0.60 ± 0.06	NS	0.63 ± 0.03	0.69 ± 0.05	NS
Saturated	37.27 ± 0.92	37.51 ± 1.07	NS	35.09 ± 0.55	36.22 ± 0.91	NS
Mono-unsaturated	56.64 ± 0.39	55.75 ± 0.65	NS	56.63 ± 0.36	55.40 ± 0.65	NS
Polly-unsaturated	6.11 ± 0.63	6.74 ± 0.47	NS	8.26 ± 0.68	8.39 ± 0.84	NS

NS: Not significant

Table 3. Physical-chemical parameters of muscles *biceps femoris* and *semimembranosus* (Average ± standard error)

Slaughter age	Biceps femoris			Semimembranosus		
	12 months	15 months	Sig.	12 months	15 months	Sig.
CIE L*	38.53 ± 0.60	36.93 ± 0.38	NS	29.83 ± 0.87	28.53 ± 0.46	NS
CIE a*	0.26 ± 0.15	0.91 ± 0.16	NS	8.98 ± 0.43	8.98 ± 0.80	NS
CIE b*	7.05 ± 0.39	5.23 ± 0.19	**	4.30 ± 0.48	3.45 ± 0.35	NS
Hue	26.21 ± 0.54	19.91 ± 1.56	**	25.36 ± 1.35	21.19 ± 2.28	NS
Croma	15.97 ± 0.85	15.52 ± 0.77	NS	9.96 ± 0.60	9.64 ± 0.78	NS
Saturation	0.41 ± 0.02	0.42 ± 0.02	NS	0.33 ± 0.01	0.34 ± 0.02	NS
Though	14.53 ± 1.30	14.32 ± 0.64	NS	10.23 ± 1.56	10.53 ± 0.33	NS
PH	5.57 ± 0.02	5.64 ± 0.04	NS	5.54 ± 0.03	5.69 ± 0.08	NS
A_w	81.18 ± 1.22	85.15 ± 1.27	NS	80.00 ± 1.67	81.50 ± 1.44	NS
NaCl	8.40 ± 0.81	7.79 ± 0.88	NS	6.88 ± 0.86	6.69 ± 0.86	NS
NPN	1.54 ± 0.05	1.49 ± 0.07	NS	1.79 ± 0.09	1.62 ± 0.08	NS
BVN	129.35 ± 15.18	144.80 ± 11.87	NS	90.38 ± 1.65	120.30 ± 14.76	NS

**(*P* 0.01); NS: Not significant

The aromatic profile of muscles BF and SM shown not significant differences (Table 5). However, a trend was observed for the hams from pigs aged 12 months to present a higher amount of linear and branched aldehyds in both muscles which can't be related with the higher values of VTN. The same trend was observed for ketones but only in SM. These differences could be related to the great

variability of volatiles in Barrancos ham expressed by the great standard error values and associated to a process without a close moniterization control, as the traditional process. Differences in aromatic profile were reported by the influence of feeding regime (López *et al.*, 1992).

Table 4. Gross chemical composition, fatty acid composition and colour values of outer layer of subcutaneous fat (Average ± standard error)

Slaughter age	12 months	15 months	Sig.
Gross chemical Composition			
Water (%)	1.52 ± 0.27	1.64 ± 0.03	NS
Protein (%)	1.60 ± 0.22	2.50 ± 0.44	NS
Lipids (%)	96.88 ± 0.45	95.77 ± 0.45	NS
Fatty acid composition			
C14:0	1.43 ± 0.05	1.32 ± 0.05	NS
C16:0	20.79 ± 0.16	20.29 ± 0.34	NS
C16:1	1.76 ± 0.10	1.78 ± 0.17	NS
C18:0	8.08 ± 0.30	7.48 ± 0.63	NS
C18:1	55.34 ± 0.40	57.06 ± 0.36	*
C18:2	8.92 ± 0.51	8.36 ± 0.32	NS
C18:3	0.81 ± 0.04	0.81 ± 0.05	NS
Saturated	30.79 ± 0.43	29.50 ± 0.85	NS
Mono-unsaturated	58.57 ± 0.43	60.53 ± 0.46	*
Polly-unsaturated	10.68 ± 0.58	10.03 ± 0.40	NS
Colour cielab			
CIE L*	61.48 ± 0.57	57.60 ± 3.48	NS
CIE a*	0.15 ± 0.56	1.35 ± 0.42	NS
CIE b*	5.42 ± 0.47	6.52 ± 0.51	NS
Hue	89.58 ± 4.93	78.18 ± 3.64	NS
Croma	5.50 ± 0.52	6.70 ± 0.51	NS
Saturation	0.09 ± 0.008	0.11 ± 0.005	*

*(P 0.05); NS: Not significant

Conclusion

This results didn't revealed important differences between hams from pigs aged 12 or 15 months, which could be explain by the fact that all pigs had been slaughtered at the same weight. The whole results suggests that:

(i) Pigs born in January could be fattened in "montanheira" in the end of the year and used in production of Barrancos ham without loss of quality.

(ii) The slaughter weight could be more important than age for the definition of Barrancos ham characteristics.

Table 5. Main volatiles compounds of Barrancos dry cured ham (Average ± standard error) (Area units/10^6)

Muscle	*Biceps femoris*			*Semimembranosus*		
Slaughter age	12 months	15 months	Sig.	12 months	15 months	Sig.
Aldehydes						
2-Methyl propanal	318.1 ± 40.0	260.6 ± 26.4	NS	450.3 ± 85.4	294.6 ± 49.6	NS
Butanal	52.43 ± 12.71	39.29 ± 7.75	NS	318.79 ± 185.48	339.51 ± 102.56	NS
3-Methyl butanal	5756.55 ± 904.58	3094.11 ± 296.40	NS	6434.4 ± 1881.5	5937.4 ± 1954.9	NS
2-Methyl butanal	1486.38 ± 226.16	1201.68 ± 177.05	NS	2938.06 ± 755.29	1749.78 ± 240.42	*
Pentanal	577.90 ± 103.28	563.35 ± 96.46	NS	479.64 ± 134.81	267.19 ± 35.75	NS
Hexanal	2675.07 ± 430.40	2452.60 ± 394.80	*	4706.7 ± 1352.0	3535.9 ± 1088.9	NS
Heptanal	261.25 ± 54.08	211.27 ± 30.89	NS	331.34 ± 66.09	256.38 ± 46.46	NS
Benzaldehyde	117.11 ± 11.11	111.87 ± 22.47	NS	325.81 ± 112.62	145.96 ± 25.63	NS
Nonanal	255.27 ± 41.24	273.74 ± 53.77	NS	515.05 ± 120.83	481.62 ± 193.12	NS
Alcoóis						
Ethanol	2773.65 ± 624.91	627.27 ± 241.35	*	1616.95 ± 286.14	1091.41 ± 182.53	NS
2-Methyl butenol	193.69 ± 65.98	206.21 ± 85.15	NS	97.26 ± 12.16	125.18 ± 26.92	NS
2-Methyl propanol	214.20 ± 127.23	109.30 ± 29.40	NS	472.42 ± 198.85	330.82 ± 75.95	NS
1-penten-3-ol	161.11 ± 24.16	189.73 ± 21.16	NS	171.26 ± 33.23	155.35 ± 32.17	NS
3-Methyl butanol	5055.8 ± 4694.8	347.00 ± 96.23	NS	1835.2 ± 900.84	1829.3 ± 1012.6	NS
2-Methyl butanol	335.09 ± 261.34	91.40 ± 25.37	NS	297.26 ± 22.65	296.76 ± 39.81	NS
Pentanol	352.32 ± 42.43	446.73 ± 102.87	NS	617.82 ± 213.86	404.70 ± 83.58	NS
Hexanol	219.00 ± 24.55	264.94 ± 62.09	NS	854.78 ± 298.51	400.76 ± 89.52	NS
1-octen-3-ol	93.74 ± 14.86*	122.19 ± 20.46	NS	302.65 ± 92.65	211.60 ± 42.11	NS
Ketones						
2-propanone	160.03 ± 16.90	177.87 ± 17.32	NS	165.45 ± 16.86	141.12 ± 14.84	NS
2-butanone	331.86 ± 50.38	378.73 ± 36.35	NS	594.38 ± 127.43	433.27 ± 67.14	NS
2,3-butanodione	117.48 ± 28.25	94.16 ± 13.20	NS	139.96 ± 26.99	84.48 ± 13.23	NS
2-pentanone	420.58 ± 89.07	791.85 ± 190.94	NS	367.42 ± 95.1	468.43 ± 198.71	NS
2-octanone	22.28 ± 3.84	17.87 ± 3.15	NS	38.02 ± 3.73	51.71 ± 5.51	*
n-alcanos						
Hexane	114.00 ± 27.48	65.29 ± 16.90	NS	594.38 ± 127.43	433.27 ± 67.14	NS
Heptane	331.95 ± 83.78	337.37 ± 72.58	NS	1111.5 ± 478.9	1454.3 ± 805.9	NS
Esters						
Ethyl acetate	208.09 ± 54.19	102.83 ± 57.24	NS	216.00 ± 64.76	88.44 ± 27.47	NS
Éthers						
Unknown ether A	3544.4 ± 1037.4	2864.6 ± 1254.4	NS	-	-	
Unknown ether B	1011.97 ± 156.69	988.4 ± 105.7	NS	1724.4 ± 203.8	1228.7 ± 168.3	NS

*(P 0,05); NS: Not significant

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