PE8.14 Indoor and outdoor pigs: effects of packing and ageing on meat shelf life 81.00

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***Abstract*- There are few research works on the effects of outdoor systems on the quality of pork meat. The short shelf life of packed refrigerated meat is one of the main problems in its commercialisation. An approach to overcoming the problem is to use vacuum packing in order to preserve a fresh appearance and delay microbial growth and lipid and pigment oxidation. After slaughter, samples of *Longissimus* muscle (three last ribs) were obtained from 18 pigs breeded in outdoor (with o without pasture) or indoor conditions; chilled slices without bone (commercial refrigerator at 4°C ± 1), with or without vacuum packed (Multivax; Cryovac pouches of 100 microns) were analyzed at 3, 6 and 9 days of storage. For raw meat, the luminosity increased with the time of storage and was higher in vacuum packing. Parameter b* was less under vacuum packing and lipid oxidation was less on Outdoor+Pasture meat. Meat under vaccum presented more MUFA due to the higher presence of oleic fatty acid; the influence of the diet on linolenic content and n6/n3 rate was not clear due to the interaction between factors. Individual analysis of data showed meat more tender, oily and juicy for the vacuum packaging and stored for longer; the characteristic 'pig' odour and the persistency of the taste were high in vaccum conditions. In conclusion, reared system of pig influenced the lipid oxidation, less in outdoor pigs with high quality pasture, but didn´t influence the eating attributes of meat. Vacuum packaging ensure higher characteristic 'pig' flavour and better eating quality of pig meat up to 9 days of ageing to storage without vaccum.**

Key words: pork quality, indoor, outdoor, packing, ageing.

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I. INTRODUCTION

There exist alternatives to introduce factors of differentiation in meat production such as the production system and feeding. There are few research works on the effects of outdoor systems on the quality of pork, in some cases with contradictory results due to the fact that there exist a great number of factors that influence on them [1] [2]. Thus, the exercise that pigs do when pasturing has a direct and indirect effect on said quality, by the reduction of the growing speed, less consumption of supplementary food and the change in the proportions of the different types of muscular fibres [3]. On another hand, the quality of adipose tissue as regards its nutritional value, organoleptic and conserving properties, is related to the composition in fatty acids [4]. Furthermore, said composition is highly influenced by different factors, such as the genotype, sex, age, live weight, fattening grade of pigs and especially by nutrition [5] [6]. The current consumer interest shown by the quality and nutritional value of foods, result in an increasingly selective demand and a growing need for product´s differentiation [7]. Meat quality is defined as a combination of traits that provide an edible product that is attractive, appetizing, nutritious and palatability after cooking [8]. The freshness of meat is affected by lipid oxidation, which is considered as a major nonmicrobiological factor involved in quality

deterioration of meat. An approach to overcoming the problem of limited shelf life is to use vacuum packing, in order to preserve a fresh appearance and delay microbial growth and lipid and pigment oxidation in refrigerated slices of meat. Therefore the objective of this study was to assess the effects of packing and ageing on the eating quality of meat of pigs bred under indoor or outdoor production systems.

II. MATERIALS AND METHODS

A summer-autumn trial was conducted at Experimental Station INTA Marcos Juárez and the Meat Quality Laboratory of the Agronomy Faculty at the University of Buenos Aires. Both sex, fifty four pigs INTA-MGC (initial average weight of 26.4 ± 0.7 kg) were used, randomly distributed in 3 treatments: O+P: pigs in outdoor conditions on a 1.4 ha lot, in a pasture with alfalfa (*Medicago sativa*) and white clover (*Trifolium repens*); O: pigs in outdoor conditions on a 1.4 ha lot with no implanted pasture; I: pigs in indoor conditions located in stall with concrete floor. The pigs were fed *ad libitum* with standard feed from 25 to 60 kg of live weight and from 60 kg to slaughter (111.6 ± 7.09 kg) with finishing diet on a maize and soya basis. After slaughter, samples of *Longissimus* muscle (three last ribs) were obtained from 18 pigs; chilled slices without bone (commercial refrigerator at 4°C ± 1), with or without vacuum packed (Multivax; Cryovac pouches of 100 microns) were analyzed at 3, 6 and 9 days of store. Fatty acids were extracted according to the technique described [9] and analyzed as methyl esters by gas chromatography (Shimatzu 14-B capilary column Resteck 2560); trombogenic index was calculated as [10]. There were determined, the lipidic oxidation (TBAR's index; µg of malonaldehide/ g meat) [11], the colour (CIELAB System, L* (lightness), a* (redness), b* (yelowness) and C* as $\gamma(a^{*2} + b^{*2})$), using a Minolta Chroma Meter-CR300 and the pH (Testo 205). Tenderness was measured with an Instron 4442 Universal Testing Machine (Canton, MA, USA) with a Warner Bratzler shearing attachment on cooked samples (water bath heating at 70 ^{0}C for 50 minutes). Cooking losses were determined by weight difference. The slices were cooked in double contact grill to reach 71ºC ± 1ºC in the center of the sample (cold point), monitored by thermocouples. The samples were analyzed by an analytical panel of 8 trained assessors according to international standards and experience in sensory analysis of meat [12] [13] [14] [15]. Each assessor received samples (1x1x1m cubes) in containers coded with three digit random numbers. The following descriptors were assessed: the overall colour, brightness, odour, flavour, taste, tenderness, untuosity, juiciness and persistence, using an unstructured linear scale of 10 cm without anchorage. The ends of the scales corresponded to the intensity of the attribute: light pink, not bright, extremely soft, very tender, dry, not oily, low persistence (lower limit: 0) and red, shiny and extremely strong (intense), tough, juicy, persistent, very oily (upper limit: 10). Statistical analysis of data was performed using the Proc Mixed of SAS (2004) for repeated measurements. Differences between treatments were analyzed by Tukey test ($p < 0.05$).

III. RESULTS AND DISCUSSION

For raw meat, the luminosity increased with the time of storage and was higher in vacuum packing. Neither the reared system, nor the packaging or the cooling time showed a clear influence on colour parameters and lipid oxidation due to the interaction between the factors (Table 1) except for the less b* value under vacuum packing ($p<0.001$) and less lipidic oxidation owing to pasture presence in the diet (O+P meat; $p<0.05$). After cooking, the colour parameters presented interaction between all the factors. For fatty acids (Table 2), meat under vacuum conditions presented more MUFA due to the higher presence of oleic fatty acid; the influence of the diet on linolenic content and n6/n3 relation was not clear due to the interaction between factors. The sensory colour (Table 3) was influenced by all the factors; it was slightly less coloured on outdoor and vaccum meat but only O+P meat resulted brighter. The storage time influenced the fat/meat relation (increased from 3 to 9 days, $p<0.05$) and the 'oil' flavour, that decreased with the increases of storage time ($p<0.01$). Tenderness, untuosity and juiciness showed 'time x packaging' interaction ($p<0.05$). The individual analysis of the data showed meat more tender, oily and juicy for the vacuum packaging and stored for longer. Packaging influenced the 'pig' odour and the persistency; the characteristic 'pig' odour ($p<0.05$) and the persistence ($p<0.01$) were higher in vacuum conditions. Indoor or outdoor production system didn´t influence the eating attributes of meat.

IV. CONCLUSION

From these results, production system of pig influenced the lipid oxidation, less in outdoor pigs with high quality pasture, but didn´t influence the eating attributes of meat. Vacuum packaging ensure higher characteristic 'pig' flavour and better eating quality of pig meat up to 9 days of storage under refrigerated conditions respect the ageing without vacuum storage.

ACKNOWLEDGEMENT

The authors acknowledge the financial support of the Universidad de Buenos Aires within Proyect. GO37 Programación Científica 2008 – 2010 UBA Ciencia y Técnica.

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Table 1. Effect of packing and ageing on pH, colour, shear force, and TBAR's of 'outdoor' and 'indoor' pig meat

	Days (D)			Breed system (BS)			Packing (P)		Probability						
Traits	3	6	9	I	O	O+P	V	NoV	D	BS	P	DxBS	DxP	BSxP	DxBSxP
L *	52.7a	53.3ab	54.3b	56.4	52.8	54.1	54.9b	52.0a	0.027	ns	0.005	ns	ns	ns	ns
a *	9.22	9.28	9.12	9.51	8.73	9.38	9.67	8.74	ns	ns	Sig.	0.005	0.001	ns	ns
b *	5.47	6.00	5.65	5.65	5.93	5.54	4.32a	7.1b	ns	ns	<0.0001	0.105	ns	ns	ns
C *	10.9	11.2	11.0	11.3	10.6	11.3	10.7	11.4	ns	ns	ns	0.004	0.017	ns	ns
TBAR μg/g	0.23	0.27	0.29	0.30b	0.29ab	0.19a	0.18	0.34	ns	0.027	Sig.	ns	0.013	ns	ns
pH	5.71c	5.65ab	5.63a	5.66	5.69	5.64	5.61a	5.72b	0.0007	ns	0.0028	ns	ns	ns	ns
Shear force, N	30.0	29.2	31.6	30.8	31.1	30.4	Nd	Nd	ns	ns					
Cooked meat															
L *	71.1	71.1	71.3	70.5	72.0	71.0	71.3	71.0	ns	ns	ns	ns	ns	Sig.	<0.0001
a *	6.13	5.54	7.46	6.54	5.92	6.67	6.85	5.90	Sig.	Sig.	Sig.	Sig.	ns	ns	0.0001
b *	11.5	11.0	11.8	11.0	11.4	11.9	11.9	11.0	ns	ns	ns	ns	ns	Sig.	0.017
C *	13.2	12.4	14.0	13.0	129	13.7	13.8	12.6	Sig.	ns	Sig.	ns	ns	Sig.	0.002

Breed system: I: indoor, O: outdoor without pasture, O+P: outdoor with implanted pasture; Packing: V: vacuum, NoV: without vacuum

Shear force was measured on meat without vaccum packing. Nd: no determined

Table 2. Effect of packing and ageing on faty acid profile (%totFA) of 'outdoor' and 'indoor' pig meat

Traits	Days (D)			Breed system (BS)			Packing (P)		Probability							St.
	3	6	9	I	O	O+P	V	NoV	D	BS	P	DxBS	DxP	BSxP	DxBSxP	error
C16:0	23.2	22.6	22.8	23.34	22.7	22.59	22.8	22.9	ns	ns	ns	ns	ns	ns	ns	1.05
C18:0	11.8	11.2	12	12.17	11.6	11.28	11.7	11.6	ns	ns	ns	ns	ns	ns	ns	1.30
C18:1	43.6	43.7	43.7	42.35	44.3	44.42	44.6a	42.8b	ns	ns	0.031	ns	ns	ns	ns	2.95
C18:2	10.4	10.8	10.3	10.96	10.32	10.30	9.91	11.1	ns	ns	ns	ns	ns	ns	ns	2.33
C18:3	1.04	1.28	1.23	1.200	1.19	1.175	1.22	1.14	ns	ns	ns	ns	ns	ns	0.058	0.42
C20:4	2.24	2.81	2.54	2.646	2.39	2.564	2.32	2.74	ns	ns	ns	ns	ns	ns	ns	1.09
SAT[1]	37.1	35.7	37	37.51	36.3	36.06	36.6	36.6	ns	ns	ns	ns	ns	ns	ns	1.91
MUFA[2]	47.9	47.9	47.6	46.34	48.4	48.70	48.7a	46.9b	ns	ns	0.043	ns	ns	ns	ns	3.04
PUFA[3]	14.9	16.2	15.3	16.14	15.1	15.26	14.6	16.3	ns	ns	ns	ns	ns	ns	ns	3.78
n6/n3	13.8	11.6	10.5	12.86	11.54	11.60	10.5	13.4	ns	ns	Sig.	ns	Sig.	ns	0.023	4.41
Trombogenic Index[4]	0.76	0.74	0.79	0.790	0.76	0.749	0.78	0.74	ns	ns	ns	ns	ns	ns	ns	3.60

SAT[1] saturated fatty acids; MUFA[2] momounsaturated fatty acids; PUFA[3] polyunsaturated fatty acids.

4: (C14:0+C16:0+C18:0)/(0.5 x C18:1 + 0.5 x other PUFA+ 0.5 x n6+3 x n3+ n3/n6).

Breed system: I: indoor, O: outdoor without pasture, O+P: outdoor with implanted pasture; Packing: V: vacuum, NoV: without vacuum

Table 3. Effect of packing and ageing on sensory attributes of 'outdoor' and 'indoor' pig meat

	Days (D)			Breed system (BS)			Packing (P)		Probability						St. error
	3	6	9	I	O	O+P	V	NoV	D	BS	P	DxBS	DxP	BSxP	
Colour	5,76 a	4,08 b	5,04 a	5,31 b	4,32 a	4,52 a	4,60 b	4,81 a	<0,0001	0,0025	0,0052	ns	ns	ns	2,52
Brightness	1,51	1,34	1,75	1,46 b	1,36 b	1,98 a	1,38	1,76	ns	0,0065	ns	ns	0,0083	ns	1,53
Fat/meat relation	7,69 b	8,15 ab	8,65 ab	8,18	8,32	8,34	7,89	8,57	0,0261	ns	ns	ns	ns	ns	3,23
'Pig' Odour	5,51	5,48	4,91	5,32	5,24	5,28	5,54 b	5,08 a	ns	ns	0,0368	ns	ns	ns	2,08
'Pig' Flavor	4,87	5,35	4,95	5,17	5,14	5,13	4,94	5,30	ns	ns	ns	ns	ns	ns	1,81
Oil Flavor	1,59 a	1,19 ab	1,09 b	1,32	1,40	1,23	1,36	1,29	0,0091	ns	ns	ns	ns	ns	0,74
Sweet taste	1,31	1,33	1,53	1,22	1,43	1,47	1,29	1,44	ns	ns	ns	ns	ns	ns	0,66
Metalic taste	0,76	0,99	0,64	0,68	0,94	0,79	0,74	0,85	ns	ns	ns	ns	ns	ns	0,97
Tenderness	4,51	4,38	5,04	4,63	4,35	4,49	4,78	4,27	Sig.	ns	ns	ns	0,0115	ns	1,75
Untuosity	2,33	2,35	2,39	2,18	2,21	2,30	2,38	2,12	Sig.	ns	ns	ns	0,0368	ns	1,58
Juiciness	2,33	2,74	3,27	2,63	2,60	2,95	2,85	2,63	ns	ns	ns	ns	0,0246	ns	1,26
Persistency	4,54	4,89	4,99	4,63	4,72	5,02	5,10 b	4,56 a	ns	ns	0,0084	ns	ns	ns	1,88

Breed system: I: indoor, O: outdoor without pasture, O+P: outdoor with implanted pasture; Packing: V: vacuum, NoV: without vacuum

Probability DxBSxP: no significative ($p<0,05$)