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Do all the consumers accept marbling in the same way? The relationship between eating and visual acceptability of pork with different intramuscular fat content

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ABSTRACT

Several reports show that intramuscular fat (IMF) and/or marbling affect the sensory acceptability of meat. The aim of the present work was to (1) investigate using Spanish consumers the eating and visual acceptability of pork with different levels of IMF, (2) understand more about this acceptability by studying segments of consumers and (3) determine which fresh pork characteristics are important at the point of purchase. Loin section (n = 40) were sorted into four IMF groups: 0.96 ± 0.30% (G1), 2.11 ± 0.07% (G2), 3.72 ± 0.26% (G3), and 5.78 ± 0.19% (G4). Consumers (n = 200) evaluated the acceptability, tenderness and juiciness of cooked loin chops from each IMF group and then ranked raw chops according to visual preference. Two groups of consumers — 'lean loin lovers' (55.5%) and 'marbled loin lovers' (44.5%) — were identified based on their visual preferences; however, according to their eating acceptability scores, all the consumers preferred loins with higher IMF levels. Accordingly, the minimum IMF content recommended to ensure a good taste is between 2.2% and 3.4%.

1. Introduction

An important factor that affects consumer acceptability of pork is the amount of intramuscular fat (IMF), which varies across breed, sex, diet and weight at slaughter (Cilla et al., 2006; D'Souza, Pethick, Dunshea, Pluske, & Mullan, 2003; Gou, Guerrero, & Arnau, 1995; Raj et al., 2002). The IMF is moderately related to the amount of marbling or visual fat (Brun, Gispert, Valero, & Font i Furnols, 2011; Faucitano, Rivest, Daigle, Lévesque, & Gariepy, 2004). Some reports show positive relationships between the acceptability or the tenderness of pork and the level of IMF content and/or marbling (Bejerholm & Barton-Gade, 1986; Berge, Culioli, & Ouali, 1993; Cannata et al., 2010; Fortin, Robertson, & Tong, 2005), due to the lubrication during chewing (Johnson, Drevjani, Allen, & Reasbeck, 1988), whereas others noted only minor contributions of IMF/marbling on pork acceptability (Channon, Kerr, & Walker, 2004; Moeller et al., 2010; O'Mahoney, Cowan, & Keane, 1991–1992; van Laack, Stevens, & Stalder, 2001) or even negative relationships (Andrighetto, Gottardo, Andreoli, & Cozzi, 1999). Some research has demonstrated that highly marbled loins were less accepted by consumers than low marbled ones (Brewer, Zhu, & McKeith, 2001; Fernandez, Monin, Talmont, Mourot, & Lebret, 1999; Moeller et al., 2010) while this effect is not clear in other studies (O'Mahoney et al., 1991–1992). Nevertheless, Ngapo, Martin and Dransfield (2007a) reported that acceptability of marbling depends on the country, *i.e.* consumers of some Asiatic countries (Japan, Taiwan, and Korea) preferred marbled meat. Furthermore, it has been demonstrated that acceptability of meat differs among consumers (Carbonell, Izquierdo, Carbonell, & Costell, 2008; Font i Furnols et al., 2009; Fortomaris et al., 2006; Ngapo et al., 2007a; Ngapo, Martin & Dransfield, 2007b; Verbeke, Pérez-Cueto, & Grunert, 2011), thus it is imperative to identify these segments of consumer, and develop marketing strategies for each of these segment (Næs, KubberØd, & Sivertsen, 2001).

The objectives of the present study were to: (1) investigate with Spanish consumers the eating and visual acceptability of pork differing in IMF content, regardless of other pork quality attributes, (2) understand more about this acceptability by studying segments of consumers; and (3) determine which fresh pork characteristics are important for consumers at the point of purchase.

2. Materials and methods

2.1. Sample selection and preparation

One hundred loin sections (*longissimus thoracis* between the 1st and the 3rd ribs from the last rib) with subcutaneous fat were obtained from 3 different slaughter plants on multiple days to have a representation of various producers and genetic types, and to ensure a variability of intramuscular fat (IMF) content. At 24 h *post mortem*, electrical conductivity (EC) was measured using a Pork Quality Meater (PQM-Kombi, Aichach, Germany) and ultimate pH

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Table 1
Intramuscular fat content (%) by group (n = 10/group).

Group	IMF content (%)				Marbling (NPPC)[a]
	Mean	StdDev.	Min.	Max.	
G1	0.96	0.30	0.53	1.36	1 (100%)
G2	2.11	0.07	2.01	2.19	1 (30%) and 2 (70%)
G3	3.72	0.26	3.41	4.12	3 (100%)
G4	5.78	0.19	5.50	5.98	3 (80%) and 4 (20%)

[a] National Pork Producers Council scale; % of samples of each value.

(pHu) was measured using a Crison Portable pH-Meter (Crison, Barcelona, Spain) equipped with a Xerolyt Electrode. All PSE (EC ≥ 6.0 mS) according to Barton-Gade, Warris, Brown, and Lambooij (1995), and DFD (pHu ≥ 6.0) according to Joo, Kauffman, Kim, and Kim (1995) loin sections were excluded from the study.

Marbling was determined by a trained technician according to National Pork Producers Council (NPPC, 1999) standards, ranging from 1 (devoid of marbling) to 10 (abundantly marbled), whereas IMF was measured by near infrared FoodScan equipment (Foss Analytical, Denmark) at wavelengths between 850 nm and 1050 nm. The IMF determined with this equipment correlates well ($IMF_{Soxtec} = -0.270 + 0.997 \cdot IMF_{FoodScan}$, $R^2 = 0.92$, RMSE = 0.17%) with the Soxtec reference method (Soxtec™ 2050, Foss Analytical, Denmark). Forty loins were selected to give four levels of IMF content (10 loin sections/IMF group) as defined in Table 1. At 1 day *post mortem* loins were placed in an aluminium bag and frozen at −20 °C.

For the eating evaluations, loin sections were thawed for 24 h at 4 °C. Then the central part of the section was cut into three 1.5 cm-thick slices and the subcutaneous fat was trimmed to a thickness of 3 mm. The slices were placed directly on the oven grill tray and cooked in a pre-heated oven (FAGOR Innovation Class A; Fagor Electrodomésticos, S. Coop., Mondragón, Spain) at 200 °C without turning. The internal temperature of the slices was measured by means of thermocouple K probes (Beamex Oy Ab, Pietarssari, Finland) and slices were cooked to an endpoint internal temperature of 76 °C, which is recommended to discriminate samples when considering various sensory properties (Bejerholm & Aalsyng, 2003). After reaching this temperature, the meat was removed from the oven. The edges of the slices were trimmed and each slice was divided into 1.5 cm-thick pieces (approximately four pieces/slice) perpendicular to the subcutaneous fat. The pieces were wrapped in aluminium foil, coded, and kept warm in a heater at 55 °C until serving (maximum 10 min later).

Raw loin slices 1.5 cm-thick were used for visual evaluation. Four slices, one from each IMF group, were placed on a white tray, coded and covered with transparent film. All the slices were trimmed of subcutaneous fat to a similar thickness and prepared to similar shape to avoid any consumer bias based on shape.

2.2. Experimental design and consumer evaluation

Consumers (n = 200) between the ages of 18 and 73 years, who lived or worked in Barcelona or its surroundings, were selected to be representative of the Spanish population (Table 2). An average of 10 consumers participated in each of the 20 evaluation sessions.

The sensory evaluation was twofold:

First, an eating analysis was performed. Consumers evaluated the overall acceptability, as well as the tenderness and juiciness, of four blind samples from each IMF group according to a nine-point scale (1 = I dislike very much/very hard/very dry to 9 = I like very much/very tender/very juicy). Samples were served monadically to the consumers following a predetermined order to avoid the first sample and carry over effect (MacFie, Bratchell, Greenhoff, & Vallis, 1989).

Secondly, a visual analysis was performed. A tray containing 4 fresh loins slices (one from each IMF fat group and from the same loin they had evaluated for cooked sensory attributes) was shown to the consumers, and they were instructed to rank the samples according to their purchasing preference. Furthermore, the consumers' explanation for their order of preference was recorded. The presentation of the loin slices on the tray was changed between sessions to avoid biases.

Consumers were also asked two additional questions: (1) Which is the main factor you consider when you buy pork loins? (price, colour, marbling and area size were suggested); and (2) Why do you

Table 2
Socio-demographic characteristics of consumers[a].

	Men	Women	Total	Cluster 1			Cluster 2		
				Men	Women	Total	Men	Women	Total
Total	96	104	200	41	48	89	55	56	111
Age									
18 to 25 years	16	14	30	4	2	6	12	12	24
26 to 40 years	32	30	62	11	11	22	21	19	40
41 to 60 years	33	41	74	18	21	39	15	20	35
60 to 73 years	15	19	34	8	14	22	7	5	12
Finished level of studies									
Primary school	11	17	28	5	13	18	6	3	9
Secondary school	53	58	111	24	23	47	29	35	64
University	31	29	60	12	12	24	19	17	36
Work situation									
Employed	53	53	106	20	20	40	33	33	66
Unemployed	41	50	91	20	28	48	21	22	43
Economical contribution at home									
100%	15	17	32	8	10	18	7	7	14
>50%	22	12	34	9	5	14	13	7	20
50%	31	21	52	16	9	25	15	12	27
<50%	8	24	32	2	11	13	6	13	19
0%	19	27	46	6	12	18	13	15	28
Pork consumption									
More than twice week	35	38	73	14	21	35	21	17	38
Once a week	46	59	105	20	25	45	26	34	60
Fortnightly	12	5	17	6	1	7	6	4	10
Once a month or less	1	0	1	0	0	0	1	0	1

[a] Number of consumers in each category.