Evaluation of meat quality traits from European pig production systems in relation to sustainability: An approach.

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Abstract— **A set of measurements defined within the Q-PORKCHAINS project was used to assess meat quality traits in 10 pig production systems from 4 European countries. The objective was to evaluate the suitability of meat according to the different market shares in each system in order to integrate meat quality within the global analysis of sustainability of each producing system. The meat quality variables included were meat colour, ultimate pH (pHu), drip losses (DRIP) and intramuscular fat content (IMF). Five meat quality dimensions linked to sustainability and the requirements for good meat quality products for each of the dimensions were defined. The dimensions and requirements were: fresh meat (MLOIN <20mm, pHu 5.5-6.0, colour 2.5-4.0, DRIP ≤5), cooked products (pHu 5.5-6.2, IMF <3%), cured products from high/best value meat cuts (pHu 5.5-6.2, IMF ≥3%), specialties (depending on the product) and other elaborated products (no specific requirements). Preliminary results from 3 production systems showed high levels of suitability in the alternative system A for dry products (77.3%), whereas in alternative system B the percentage of suitable carcasses for dry cured products was 62.3%. The next step is to evaluate the dimensions for all the studied systems and to match suitability with the market shares to obtain global sustainability scorings.**

Keywords— **sustainability, meat, quality.**

I. INTRODUCTION

Quality of pork and pork products has become a complex theme involving the total pork chain from fork-to-farm. Aspects related to economic and environmental sustainability of producing systems have been recently integrated to the demands by European citizens, producers and consumers. The meat quality concept is nowadays influenced by multiple interacting factors, including the conditions under which the meat is produced. Thus, quality aspects and sustainability in the production of pork and pork products are of high priority in the EU.

Since 2007, the European project Q-PORKCHAINS has been conducted with the overall objective expressed on its title: 'Improving the quality of pork and pork products for the consumer: Development of innovative, integrated, and sustainable food production chains of high quality pork products matching consumer demands'.

The present work comes from the studies carried out within the WP2.2, aiming to study of the diversity, flexibility and sustainability of pig production systems.

Sustainability of systems were evaluated in an integrated view according to animal health, animal welfare, economic sustainability, environmental impact, genetic resources, human working conditions, meat safety, societal conformity and meat quality, being the latter the object of the present study.

In terms of meat quality, a tool to evaluate the suitability of technological meat quality to elaborate the main pork products in each production system has been developed. The tool should value positively those systems which produce meat which matches as much as possible with the main pork products' market shares.

In a first approach to test the meat quality tool feasibility, three production systems have been assessed.

II. OBJECTIVES

The general objective was to develop a standardized and repeatable tool to evaluate meat quality in a sustainability context, in order to integrate the meat quality score within the global analysis of sustainability of each production system. The specific objective of the meat quality tool was to define a proper sustainability scoring system based on the suitability of meat for different pork products and the market shares of the different production systems for these products.

III. MATERIAL AND METHODS

Data collection

Carcass and meat quality data were obtained from three different pig production systems, including conventional and alternative types. The 'system A' was defined as an adapted indoor system from conventional practices, but using a traditional breed and focused in the production of high quality meat. 'System B' was characterized by its traditional livestock practices based on outdoor production and by the use of a native pig breed. The main goal of this production system is to obtain meat to elaborate pork specialties. The 'system C' was a conventional pig production system that rears conventional crossbreds to obtain carcasses for the bulk market.

Meat quality measurements

The acceptability of meat to elaborate different pork products by each production system was analyzed according to technological meat quality criteria. Acceptability benchmarks for meat quality variables were permitted to be different depending on each system's market orientation and needs.

The meat quality variables used in the suitability analysis were the following: the ultimate pH at *Longissimus lumborum* (LL) and *Semimembranosus* (SM) level measured at 24 hours *post-mortem*, the meat colour at LL level measured by the subjective Japanese Colour Scale (Nakai, 1975), the drip losses on a LL sample using the methodology described by Rasmussen, A. and Andersson, M. (1996), the minimum back fat depth at *Gluteus medius* level (MLOIN) at the left-side carcass, and intramuscular fat content (IMF) on a LL sample, determined by either Soxtech (AOAC, 1990) without acid hydrolysis, or Near Infrared Spectroscopy methodologies.

Considerations on data analysis

The main pork products were grouped in dimensions which represented the most usual products in the market. These dimensions were: fresh meat, considering both non-processed cuts and pork products consumed as fresh (e.g. minced meat, fresh meat sausages); cooked products, made by non-processed hams and shoulders; dry products, elaborated also from entire hams and shoulders; specialties, typical from each production system and with high added value; and other meat products with no specific technological meat quality requirements.

The market shares for each pork product type within each production system were obtained from the literature and personal communications from production system experts.

The meat quality parameters previously defined were measured in a minimum of 25 pigs per system. Each carcass was categorized as suitable or not for the different dimensions of meat products (fresh meat, cooked or dried products, specialties and other) according to literature and expertise criteria. Table 1 summarizes the suitability criteria applied for systems A to C.

Table 1. Market share for the different dimensions of pork meat products and suitability criteria according to technological meat quality for each production system.

		System A	System B	System C
Fresh	MS	5	8	45
	S	pHL 5.5-6.0; colour 2-4; MLOIN < 40; drip ≤ 5	pHL 5.5-6.0; colour 2-4; MLOIN < 40; drip ≤ 5	pHL 5.5-6.0; colour 2-4; MLOIN < 20; drip ≤ 5
Cooked	MS	2	0	16
	S	pHL 5.5-6.2; IMF < 3	pHL 5.5-6.2; IMF < 3	pHSM 5.5-6.2; IMF < 3
Dried	MS	73	3	15
	S	pHL 5.6-6.2; IMF ≥ 3	pHL 5.6-6.2; IMF ≥ 3	pHSM 5.6-6.2; IMF ≥ 3
Specialty	MS	0	54	0
	S	NR	IMF ≥ 3%; MLOIN > 20;	NR
Other	MS	20	35	24
	S	NR	NR	NR

MS: market share (%); S: suitability; NR: no requirements

IV. RESULTS AND DISCUSSION

The percentages of carcasses suitable for each pork product dimension according to the established meat quality criteria are shown in Table 2. When the market share for a pork product type was 0, indicating no interest in producing this type of pork product, the suitability score was considered as not applicable. In the case of the 'other products' dimension all observations were considered suitable due the lack of meat quality requirements. System A presented high matching values for dried products category (77.3 %) indicating that animals produced in this system would produce hams and shoulders suitable for elaborating dried products. Nevertheless, the values obtained for fresh meat were notably low (23.9 %) and none of the observations was suitable for producing cooked products, in accordance with the low market share for this type of product (2 %). Considering system B, the suitability values were favourable to produce the specialty products typical from this system (100%) and, to a lower extent, for dried hams and shoulders (62.3 %). Results showed that none of the observations matched with fresh meat criteria. System C did not present high suitability percentages for any of the dimensions, but it presented half of the carcasses suitable for producing fresh meat (51.4 %) or for cooked hams and shoulders dimension (51.7 %). None of the pig carcasses from this system were suitable to elaborate dried products.

Table 2. Percentage of carcasses matching suitability criteria by each pork product type.

Pork product dimension	System A (%)	System B (%)	System C (%)
Fresh	23.9	0	51.4
Cooked	0	N.A.	51.7
Dried	77.3	62.3	0
Specialty	N.A.	100	N.A.
Other	100	100	100

N.A.: not applicable.

After the suitability assessment, and according to technological meat quality traits, data were analyzed including the market share for each dimension. The objective was to obtain information on the degree of matching between the potential to produce different pork products and the real market demands of each production system. Thus, the results related to meat suitability according to each pork product category, measured as per one, were multiplied by the market share, also measured as per one, to correct the effect of market demands for each dimension. The values obtained of suitability for each dimension and total are expressed as per one in Table 3 for each production system.

System A obtained the maximum value for the dried products dimension (0.56) and the sum of all categories was 0.78. In the case of system B the maximum value was obtained for the specialities (0.54) and the total sum was 0.91. On the other hand, results obtained in system C

indicated that the fresh pork was the most valuable from all categories (0.23), presenting a total value of 0.55.

Table 3. Suitability by market share.

	System A	System B	System C
Fresh	0.01	0.00	0.23
Cooked	0.00	0.00	0.08
Dried	0.56	0.02	0.00
Specialty	0.00	0.54	0.00
Other	0.20	0.35	0.24
Sum	0.78	0.91	0.55

In order to obtain a final meat quality tool for sustainability assessment, repeatable enough to be used in further analysis, a scoring system was set up according to suitability by market shares results. From the results obtained, and taking into account the possible results using this methodology, four benchmarks were established in order to obtain a sustainability scoring system based on 4 levels. Table 4 shows such scores, which tend to reward production systems with high sustainability scores.

Table 4. Sustainability scores according to suitability by market share benchmarks.

Suitability by market share	Sustainability score
0 - 0.50	1
0.51 - 0.70	2
0.71 - 0.85	3
> 0.86	4

Using this methodology it is possible to obtain a final meat quality sustainability score for each system. The main results regarding the final scores are presented in Table 5. From these results, it may be suggested that system B obtained a very high sustainability score, because it is able to produce meat which suits the technological meat quality requirements for the different products and, at the same time, accomplishes with the market expectations. The high score obtained by system A may be explained by a good matching between suitability of meat to produce dried products and the notable market share for this type of product. Finally, system C presented a lower sustainability value, which could be explained by the combination of average meat suitability values and a low level of matching with the market shares.

Table 5. Meat quality sustainability scores in relation to suitability of meat by market shares.

	Market share · suitability	Score
System A	0.78	3
System B	0.91	4
System C	0.55	2

V. CONCLUSIONS

The methodology used in the present study allowed developing a scoring system to assess the meat quality sustainability of different pig producing systems. The development of a tool for meat quality sustainability assessment will contribute to set up a global integrated tool of pig producing systems sustainability.

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