Variability of beef quality from the Portuguese market place

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Beef samples were collected in a hypermarket in order to study their composition and variability. The physical, chemical and sensory characteristics of *longissimus lumborum* of Carnalentejana-PDO (protected denomination of origin), regular and imported from Brazil beef samples were assessed and compared. Regular beef presented higher variability in the colour traits, a*, b* and pigment content, whilst PDO beef presented higher variability in MFI and WBSF. The PDO beef presented greater percentage of beef samples with extreme values in WBSF, *i.e.*, values lower than 4.5 kg and higher than 7.0 kg, than the other beef types. All beef types presented WBSF mean value lower than 5.4 and mean sensory tenderness score of 5.5 which means meaning that all beef types would be considered slightly to moderately tender and well accepted by the Portuguese consumer. Tenderness variability of PDO beef and colour variability of regular beef are detrimental for these beef types in the purchasing moment, as consumer expect these beef types to have the same eating quality previously experienced.
Key Words – beef quality, colour, tenderness, beef variability, consumer preferences.

I.   INTRODUCTION

Health and safety concerns as well as ethical issues related to animal production have decreased beef consumption. Despite such concerns, sensory properties such as colour, texture, juiciness and flavour still remain the main purchasing and repeat purchasing criteria [1].

However, one of the main problems of the beef industry concerns consistency of the quality, mainly tenderness, which affects all the intervenient of the market. Moreover, consumers have difficulty in selecting beef because they are unsure of its quality. They expect the same eating quality when repeating the purchasing. Thus, especial attention must be paid to the variability of eating quality of beef.

In Portugal there are several beef products with Protected Denomination of Origin label, originated from autochthonous beef breeds raised in traditional production systems. The promotion of certified products is of considerable benefit to the rural economy, by improving the incomes of farmers and by retaining the rural population. Despite being a niche market, the consumption of Portuguese certified beef has being increasing due to public perception of its higher nutritional value and safety. From the Portuguese beef autochthonous products, Carnalentejana-PDO is commercially the most important, having the highest market share of certified beef. However, commercial crossbred cattle produced under intensive regimens provide the main supply of beef at competitive prices. Presently, Portuguese beef production only comprises about 50% of national beef consumption. The main imported markets are Spain, France and Netherlands, being the fourth importation origin Brazil. Brazilian beef industry is very strong with a high export potential to several international markets. Brazilian beef production system is mainly based on grazing with crossbreds of domestic breeds with exotic breeds, with a finishing period. Therefore, Brazilian beef quality is expected to be different from the European regular beef production. However, for consumer these differences are not very clear and expectations concerning certified beef are very high. Moreover, beef variability can be a huge market problem, as consumer expects when repeating the purchase to have the same experienced beef quality.

The aim of this study was to compare beef quality and variability from the three main market segments, certified beef, regular beef and imported (Brazilian).

II. MATERIALS AND METHODS

This study was performed on 46 retail beef samples (*Longissimus lomborum*) which were collected during 6 month in a supermarket chain from Lisbon. The samples were representative of all batches (1 sample per batch) marketed in the supermarket during the trial period. Samples of *longissimus lomborum* muscle were chosen in a hypermarket in order to reproduce consumer's purchase.

The Carnalentejana-PDO (PDO now on; n=16) beef is obtained from Alentejana purebred young bulls produced in a traditional semi-extensive production system according to the product specifications. Protected Designation of Origin (PDO) beef is branded beef certified by the European legislation following strict rules detailed in the specification book for each product. The regular beef (n=15) is obtained from animals produced in a conventional intensive concentrate based system, being the most consumed beef type in Portugal, and sold without a specific brand. This group consists of beef from young bulls from different crossbred animals, mainly with Charolais and Limousin sires, produced in Portugal.

Brazilian beef (n=15) is obtained from crosses of local breeds, like Nelore (*Bos indicus*), with more exotic breeds (*Bos taurus*), and is produced in a traditional semi-extensive production system based on pastures followed by a finishing period with concentrates.

Samples were trimmed from their visible fat and connective tissue, and then minced, vacuum packaged and frozen at -18 ºC until analyses were performed.

The ultimate pH (pHu) was measured with a HI 99163 portable pH-meter (Hanna Instruments Inc., Rhode Island, USA), and colour with a Minolta CR 300 colorimeter (Konica Minolta Holdings Inc., Tokio, Japan) with a C iluminant and a 2º standard observer in the CIELAB space, after 1 hour of blooming to allow oxygenation.

The intramuscular fat content was measured according to the AOAC official method [2], and expressed as mg/g muscle.

The total pigment content was determined through the quantification of the cyanometmyoglobin and cyanomethemoglobin [3].

Collagen concentration (%DM) and solubility (% total collagen) and myofibrillar fragmentation index (MFI) were determined as described by Silva et al. [4].

Steaks for cooking losses were weighted, grilled until it reached 70 ºC of internal temperature, and weighted again. The same steaks were used for Warner Bratzler Shear Force (WBSF) evaluation after being chilled at room temperature. A minimum of eight cores were removed parallel to the muscle fiber orientation and sheared with a texturometer (TA-tx2i, Stable Micro Systems). Steaks for sensory analysis were thawed at 4 ºC for 24 hours. Cooking procedures were similar to WBSF determination. Panellists assessed a profile composed by tenderness, juiciness, flavour and overall acceptability (OA).

Statistical analysis was carried out using the GLM procedure of SAS by analysis of variance. Data was checked for normality and homocedasticity (SAS, 2004). For some variables significant differences of variance between groups were found and then were analysed by PROC MIXED model allowing for variance heterogeneity. The coefficients of variation were also determined.

III. RESULTS AND DISCUSSION

The regular beef presented higher variability in the generality of the colour parameters and in pigment content, as shown by the higher CV in a*, b* and h* colour parameters, pigment and total collagen content, and also higher a*, b* (not different from PDO beef), and higher pigment variance (no t different from Brazilian beef). The higher variability in a* parameter of colour presented by regular beef could be due to the higher variability presented by this beef type in total pigment content, as a* parameters reflects the pigment content of beef.

Appearance, colour and fat content, has been point out as the first criteria consumers use to judge meat. Moreover, consumers have colour preferences well defined. The greater variability presented by regular beef in colour can be detrimental in the purchasing moment. The higher variability in regular beef samples could result from the greater heterogeneity of this beef type, as it is constituted by samples from animals with different backgrounds (animals from different crosses). Despite the highest variability presented by regular beef in a* parameter, the value obtained was similar to the value obtained by Maher *at al.* [5] for all the ageing periods studied by those authors. However, the b* parameter CV

obtained by the quoted authors were much lower than the presented here.

Beef tenderness has been considered for decades the most important palatability attribute. However, the lack of tenderness consistency in beef has been a major concern to the beef industry, mainly because it is the main reason for consumers to repeat or not repeat the purchase. All beef types presented a WBSF value lower than 5.4 which makes these beef types slightly tender. Other author presented similar WBSF values [6], and considered beef as slightly tender. Also beef sensory tenderness was scored with an average value of 5.45, *i.e.*, between slightly and moderatadly tender. The PDO beef presented higher CV in MFI and WBSF values. Accordingly, PDO beef also presented higher data dispersion in WBSF. The WBSF CV presented by the beef types were similar to the value presented by George and coworkers [7] in top sirloin, but a bit lower (excepting the value presented by PDO beef) than the value presented in strip loin samples. Maher *et al.* [5] presented higher WBSF variability value in *longissimus dorsi* muscle. The higher variability in WBSF values could be due to differences in the weakening of the myofibrilar matrix by enzymatic activity of proteases, as indicated by the higher variability in the MFI. Moreover, a lower MFI could result from a higher glycolytic rate. This could not be measured as beef was bought in the supermarket. PDO beef had lower final pH which could result from a higher glycolytic rate that would have a detrimental effect in proteolytic activity decreasing fragmentation of the myofibrillar structure [8]. The ageing period of PDO beef ranged between 3 and 23 days long. Several authors reported that ageing periods higher than 7 days improve beef tenderness, sensory and instrumentally measured [8]. All beef types had an ageing period long enough to allow the beneficial effect of the enzymatic activity of proteases on myofibrillar structure. Despite the lack of mean differences the distribution of the beef samples was different.

About 37.5% of PDO beef samples presented shear force value lower than 4.5, whilst only 20% and 13% of Brazilian and regular beef, respectively, presented value lower than 4.5 (Figure 1).

Figure 1 – Relative frequency distribution of Warner-Bratzler shear force values for Carnalentejana-PDO, Brazilian and regular beef.
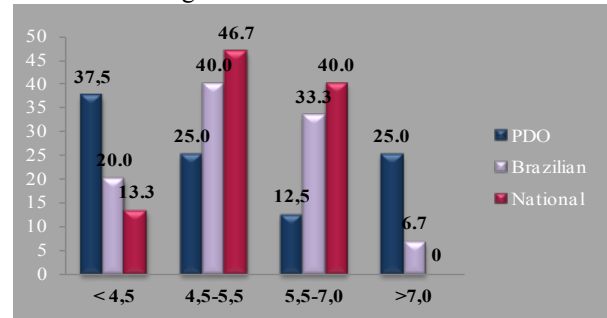

Nevertheless, all three beef types presented around 60% of the samples with WBSF values lower than 5.5. These results indicate that PDO beef presented the highest percentage (62.5%) of samples with a tenderness value ($\leq$ 5.5) that makes it highly acceptable by the Portuguese consumers [9]. PDO beef was also the beef type with highest percentage of samples (25%) with WBSF higher than 7. All Regular beef samples presented WBSF $\leq$7.

Intrinsic meat quality attributes such as texture and flavour are important factors that consumers consider when deciding to repurchase beef. This is particularly important for products like branded quality beef as PDO beef that in the consumer perspective have higher organoleptic quality, having also a higher market price. The great variability in tenderness presented by PDO beef represents a commercial problem.

The CV values observed in the sensory attributes studied were similar for all beef types, excepting the off-flavour attribute. The PDO and regular beef had higher off-flavour CV due to the low number of samples where off-flavours were detected, being thus score with the minimum value (1 in a 1 to 8 scale). The CV values obtained in this study for the sensory attributes were similar to other studies [5,7].

The relative frequency distribution of panel tenderness ratings is shown in Figure 2. The panel scores for tenderness ranged from 1 (extremely tough) to 8 (extremely tender). All three beef types were scored similarly, averaging 5.45 (between slightly tender and moderately tender). Aproximately, 87% of the regular beef samples were scored by the panel between 5 and 7. Only Brazilian beef presented samples scored extremely tender ($\geq$ 7).

Figure 11 – Relative frequency distribution for sensory panel tenderness ratings of PDO, regular and Brazilian.
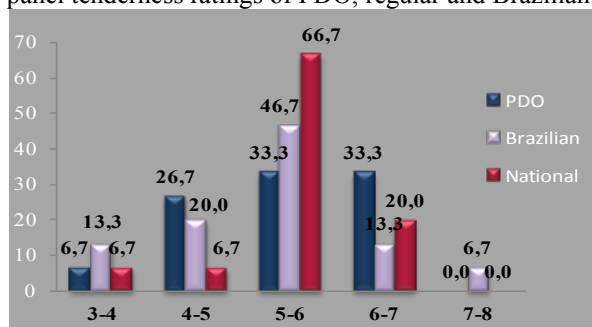
PDO beef presented samples with scores almost equally distributed (Figure 2) between the intermediate tenderness classes. Brazilian beef presented the highest percentage of samples scored below 5 (33.3%), i.e., rated less tender.

Variability differences between techniques to measure tenderness (instrumental and sensory) have been explained with differences in the muscle fibre orientation of samples. It is also important to note that the instrumental measurement of texture is made by a single compression (shear) step, while the sensory method of evaluation includes several steps outside and inside the mouth, from the first bite through mastication and swallowing [10], and maximum intensity perception seems to occur anywhere between the first and the fourth bite [11].

IV. CONCLUSION

In the physical and chemical characteristics measured the three beef types were considered similar. Nevertheless, PDO beef was less consistent in tenderness and regular beef in colour characteristics. PDO beef presented the highest percentage of samples with low (62.5%) and high (25%) WBSF, however the sensorial panel rated beef samples tenderness equally distributed between the tenderness classes.

The great variability observed in Portuguese beef types is not desirable and represents a problem to the consumer in the purchasing moment.

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