

# COMPOSITION OF BEEF FROM THE PORTUGUESE MARKET PLACE AND ITS RELATION WITH CONSUMER EXPECTATIONS

A.C.G.Monteiro<sup>1\*</sup>, R.J.B.Bessa<sup>2</sup> and J.P.C. Lemos<sup>2</sup>

<sup>1</sup> Departamento de Ciências e Engenharia de Biosistemas, Instituto Superior de Agronomia,  
Universidade de Lisboa, Lisboa, Portugal

<sup>2</sup> Departamento de Produção Animal e Segurança Alimentar, Faculdade de Medicina Veterinária,  
Universidade de Lisboa, Lisboa, Portugal

\*crismonteiro@isa.utl.pt

**Beef samples were collected in a hypermarket in order to study their composition and relationship with consumer expectations concerning beef. The physical, chemical and sensory characteristics of *longissimus lumborum* of Carnalentejana-PDO (protected denomination of origin), imported meat from Brazil and regular beef samples (Portuguese standard beef) were assessed and compared. Brazilian beef presented higher ageing period, Myofibrillar Fragmentation Index (not different from regular beef) and off-flavour score, as well as lower juiciness (not different from PDO beef) and overall acceptability score. The PDO beef presented lower pH than the other two beef types. All beef types presented Warner-Bratzler shear force (WBSF) mean values lower than 5.4 and mean sensory tenderness score of 5.5 which means that all beef types would be considered slightly to moderately tender.**

**Chemical and physical parameters were not well correlated with sensory attributes. Cooking losses correlated inversely with juiciness, and WBSF was moderately inversely correlated with tenderness. All sensory attributes were well correlated with overall acceptability. Tenderness and juiciness scores were highly positively correlated. Flavour score was also well correlated with off-flavours scores. Consumers expected PDO beef to have higher sensorial quality and to be healthier and safer, which was not confirmed by the physico-chemical analysis.**

**Key Words – beef quality, colour, tenderness, consumer preferences.**

## I. INTRODUCTION

The consumption of fresh beef has been negatively affected by several phenomena. At the level of the individual consumer, the increasing concerns for healthy and safe food, as well as environmental and ethical issues related with animal production are the main reasons for the decrease in beef consumption [1]. However, despite the health and safety concerns, sensory properties such as appearance, texture,

juiciness and flavour still remain the main purchasing and repeated purchasing criteria [2].

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 retaining the rural population.

Despite being a niche market, the consumption of Portuguese certified beef has increased due to public perception of its higher nutritional value and safety. From the Portuguese beef autochthonous products, Carnalentejana-PDO has the highest market share of this beef segment. However, commercial crossbred cattle produced under intensive systems provide the main supply of beef at competitive prices. Beef production in Portugal only supplies 50% of national beef consumption. The main markets of importation are Spain, France and Netherlands, which beef composition is similar to the Portuguese regular beef. The fourth importation origin is Brazil, where the beef industry is very strong with a high potential for exportation to several international markets. Brazilian beef production system is mainly based on grazing of local breeds crossbred with exotic breeds, with a finishing period. So, Brazilian beef composition is expected to be different. However, for consumer these differences are not very clear and expectations concerning certified beef are very high. The aim of this study was to compare beef quality from the three main market segments, certified beef, Portuguese regular beef and imported (Brazilian), and relate it with consumer expectations.

## II. MATERIALS AND METHODS

This study was performed on 46 retail beef samples which were collected during 5 month in a

supermarket chain in Lisbon, one sample per batch marketed in the supermarket during the trial period. Collection of samples was made in order to mitigate consumer purchase.

The Carnalentejana-PDO beef (PDO from now on; n=16) 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, mainly the breed, origin and production system.

The regular beef (n=15) is obtained from crossbred young bulls (crosses mainly with Charolais and Limousin sires), produced in Portugal, in a conventional intensive concentrate based system, being the most consumed beef type in Portugal, and sold without a specific brand.

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. Brazilian beef was the imported beef chosen because it is the one that can be differentiated from the Portuguese regular beef.

Samples of *longissimus lumborum* were collected (around 0.7–1.0 kg) from the strip loin, trimmed from their visible fat and connective tissue, and then minced, vacuum packaged and frozen at -18 °C until analyses were performed. Two steaks were left intact for Warner Bratzler Shear Force (WBSF) determination and sensory panel evaluation.

The ultimate pH ( $\text{pH}_u$ ) was measured with a HI99163 portable pH-meter. Meat colour measurements were carried out after 1 hour of blooming to allow oxygenation, with a Minolta CR 300 colorimeter with a C illuminant and a 2° standard observer in the CIELAB space.

The dry matter content was determined by microwaves (Smart System 5, CEM Microwaves Technology Ltd., Buckingham, UK), following the device specifications. Protein content was determined by the Kjeldahl method [3], after digestion with sulphuric acid, and intramuscular fat content according to the AOAC official method [4], and expressed as mg/g muscle.

The total pigment content, collagen concentration (% DM) and solubility (% total collagen), and

Myofibrillar Fragmentation Index (MFI) were determined as described by Monteiro et al [5].

Cooking losses were determined after steaks were weighted, grilled until it reached 70 °C of internal temperature, and weighted again. Sample preparation for WBSF evaluation (TA-tx2i, Stable Micro Systems) was made as described by Monteiro et al. [6]. Steaks for sensory analysis were thawed at 4 °C for 24 hours. Cooking procedures were similar to WBSF determination. Panellists assessed a profile composed by tenderness, juiciness, flavour and overall acceptability (OA).

Our team work also made questionnaires to consumers at the purchasing moment in the hypermarket, with the same three beef types. The questionnaires covered consumers' usage of quality cues and evaluation of beef quality in the real purchase environment.

Statistical analysis was carried out using the GLM procedure of SAS by analysis of variance and principal component analysis. The relationship between the variables was determined using the Pearson's correlation coefficients (SAS, 2004).

### III. RESULTS AND DISCUSSION

Brazilian beef had higher ageing period than the other two beef types (78 days vs. 12 and 13 in PDO and regular beef, respectively). PDO beef presented lower ultimate pH than the other two beef types, and lower MFI than Brazilian beef.

All beef types presented similar colour parameters values which were similar to those presented by Monteiro *et al.* [6] in Carnalentejana-PDO beef. The same authors presented similar collagen solubility and cooking losses, but higher total collagen content and lower intramuscular fat and pigment content as well as lower WBSF value than the values presented in this study. Serra *et al.* [7] in beef of a Spanish breed also observed similar  $L^*$ ,  $a^*$  and pigment content as well as a slightly lower cooking losses than the values presented in this study. The  $L^*$  value as well as the pigment content were also similar to the values presented by Monteiro et al. [5].

All beef types presented a mean WBSF value of 5.4. Beef sensory tenderness was scored with an average value of 5.45, *i.e.*, between slightly and moderately tender. Both results indicate that this beef types will be well accepted by the Portuguese consumer, as others authors realized that beef with WBSF lower than 5.5 is well accepted by the Portuguese consumer [5,8].

Table 1 – Physical and chemical characteristics of *Longissimus lumborum* muscle from Carnalentejana-PDO, Brazilian and regular beef

Variables	PDO		Brazilian		Regular		S
	Mean	Sem	Mean	Sem	Mean	Sem	
DM (%)	26.1	0.22	26.9	0.31	26.4	0.33	ns
pH	5.63 <sup>b</sup>	0.023	5.78 <sup>a</sup>	0.04	5.78 <sup>a</sup>	0.04	**
L*	33.69	0.62	33.5	0.71	33.3	0.86	ns
a*	21.01	0.36	20.8	0.37	19.90	0.64	ns
b*	3.83	0.39	4.44	0.28	3.39	0.58	ns
h*	9.86	1.08	12.3	0.85	9.01	1.54	ns
C*	21.41	0.39	21.3	0.37	20.7	0.48	ns
Pigment (% DM)	1.61	0.08	1.50	0.11	1.79	0.16	ns
IMF (% DM)	6.82	0.43	7.66	0.56	7.46	0.70	ns
Co (% DM)	2.38	0.09	2.34	0.10	2.45	0.12	ns
CS (%)	17.42	0.63	18.3	0.77	17.4	1.13	ns
MFI	51.56 <sup>b</sup>	6.50	76.8 <sup>a</sup>	6.71	57.5 <sup>ab</sup>	4.37	*
CL (%)	27.04	1.04	28.7	1.06	28.4	0.84	ns
WBSF (kg)	5.48	0.39	5.28	0.32	5.42	0.25	ns

DM=dry matter; IMF=intramuscular fat; Co= Total collagen; CS=collagen solubility; MFI=myofibrillar fragmentation index; CL=cooking losses

Several authors reported that ageing periods higher than 7 days improve beef tenderness, sensory and instrumentally measured [9]. However, the same authors referred that ageing periods longer than 11 days does not produce any additional improvement in tenderness [9]. All beef types had an ageing period long enough to allow the beneficial effect of the enzymatic activity of proteases on myofibrillar structure. Moreover, despite the much longer ageing period of Brazilian beef, it did not bring any additional tenderness improvement, but could have diminished the differences that may have existed due to the *Bos indicus* nature of Brazilian beef. In cattle, it is well known that *Bos indicus* breeds are rated less tender and juicy than *Bos taurus* breeds, which seems to be associated with differences in muscle protein turnover in the living cattle [10]. Accordingly, the higher MFI showed by Brazilian beef did not reflected lower WBSF value or higher tenderness score. This higher MFI probably resulted from the longer ageing period (78 days).

The lack of collagen effect has been shown by other authors who referred that muscles with low collagen content like *longissimus lumborum* might provide a

limited contribution to background toughness in comparison with myofibrillar toughness [11].

Differences obtained in juiciness value, could also result from the longer ageing period of Brazilian beef samples, as some authors referred that very long ageing periods cause an excessive myofibrillar fragmentation, and consequently a decreased water holding capacity and therefore juiciness [12]. Sensory perception of tenderness is multifaceted and is partly influenced by stimulation of the salivary glands as well as actual juiciness of beef *per se*. Although sensory tenderness and juiciness are treated as separated attributes of meat quality, they may have a degree of interdependence, because changes that occur in meat structure may affect both sensory attributes. It has also been suggested that there is a “halo effect” between tenderness and juiciness, whereby a beef sample judged to be very tender would often also be judged as very juicy [13]. This is probably due to the fact that as tender the beef is more easily juices are released from the spaces between the muscles fibres creating a sensation of a juicer meat. Factors that affect beef water holding capacity will also affect negatively cooking losses and juiciness. The rigor process could result in mobilization of water out of the myofibril and from the extra myofibril spaces, as the overall volume of the cell is constricted [12]. During cooking, water is loss probably due to the heat induced protein denaturation The greatest cooking losses will result in less juiciness which is in agreement with the negative correlation obtained between cooking losses and juiciness ( $r=-0.31$ ), but also with the trend for a higher cooking losses value presented by Brazilian beef, which presented the highest MFI and the lowest juiciness.

In general, chemical and physical parameters were not well correlated with sensory attributes, WBSF was well inversely correlated with tenderness ( $r=-0.50$ ), though. All sensory attributes were well correlated with overall acceptability. Tenderness and juiciness were positively correlated ( $r=0.49$ ). Flavour was also well correlated with off-flavours ( $r=0.44$ ). Off-flavour was highly correlated with overall acceptability ( $r=-0.66$ ), presenting Brazilian beef the highest and lowest values in these attributes, respectively. The high off-flavour value presented by Brazilian beef could be due to the highest ageing period, as it is well known that during ageing enzymatic reactions can produce volatile compounds, which alter the flavour of beef [14]. In addition, the

typical production system of Brazilian beef is based on grazing. Several researches have reported that beef from pasture fed animals have more off-flavours than meat from concentrate fed animals. Moreover, flavours and/or off-flavours present in beef depend on the pasture composition [14]. The lower acceptance of beef obtained from grass fed animals, as Brazilian beef, can be attributed to the increased intensity of negative attributes as barny, bitter, grassy and gamey.

From the aforementioned results we realised that consumers' expectations concerning beef quality did not match with the actual quality of the products, as consumers judged beef types differently according to credence attributes and visual appreciation. PDO, Brazilian and regular beef were perceived as having high, medium and low intramuscular fat content, respectively. Moreover, PDO beef was preferred over the other two beef types in terms of extrinsic cues (origin, brand and label information), and perceived as having higher expected quality than Brazilian and regular beef in all quality traits considered, *i.e.*, in taste, tenderness, juiciness, nutrition, healthiness and safety [15], which was not confirmed by the physic-chemical analysis, showing that consumer expectations were not fulfilled.

#### IV. CONCLUSION

Considering the physical and chemical characteristics measured muscle from the three beef types were similar. Nevertheless, Carnalentejana-PDO beef was less consistent in tenderness and national undifferentiated beef in colour characteristics. The greatest differences between the three beef types were in sensory attributes with Brazilian beef presenting the worse score in juiciness, off-flavours and overall acceptability. Off-flavour strongly influenced the overall acceptability. Consumer expectations concerning beef were not fulfilled.

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