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MEAT QUALITY CHARACTERISTICS IN ARGENTINEAN AND ITALIAN BEEF FOR SALE AT THE ITALIAN SUPERMARKET

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Abstract – To understand how the transport, the long ageing and the processing can affect the Argentinean imported meat quality, beef samples of *longissimus thoracis* were purchased in a large retailer in Turin (Italy) and compared with beef of similar price of Italian origin obtained from Piedmontese race bred and produced in Piedmont (Italy). Samples were characterized for quality parameters (tenderness, pH, color, raw and cooked water holding capacity). Argentinean beef was qualitatively different and not uniform especially with reference to appearance of meat, which was more marbled and darker, but equally tender as Italian beef that was leaner and clearer.

Key Words – beef, meat quality, Argentina, Italia

I. INTRODUCTION

The production and marketing of Argentinean beef is today still troubled because of socio-economic and climate issues. In 50 years until 2015, the Argentinean consumption of beef has decreased from 90 to 59.7 kg/*capita*/year with a migration of consumers to pork and poultry, and in 2011 the consumption of beef was 56.6 kg *per capita*. Today domestic consumption absorbs more than 90% of national production, due to the decrease in production. So total exports were also affected from 596 Mg in 2005 to 242 Mg in 2015 with a minimum of 217 Mg in 2012 [1].

In Italy, the Argentinean beef is renowned for the high quality, the health and the production methods, attentive to animal welfare, although the sale price is quite expensive. Two quotes of beef are exported to Italy and Europe from Argentina. One is a tariff quota for fresh and frozen beef named "Hilton Quota," regulated by the Commission Regulation (EC) n° 810/2008 and defined as "Selected beef cuts obtained from steers, young steers or heifers having been exclusively fed through pasture grazing since their weaning..." [2]. The other quota is beef to excess the Hilton Quota or with different quality characteristics (feedlot system *e.g.*).

Italian consumers can not distinguish the two quotes because they are both marketed as Argentina's beef, even though the meat comes from steers of different breeds and is produced in different ways. Fattening generally occurs only through pasture or grazing plus integration with grains or intensive feedlot; moreover they can also be combined with each other at different levels. The breeds are generally British races, Zebu and their crosses. Feedlots are spreading, as feeding is more controlled and constant, growth is faster, the use of space is optimized, and younger and heavier steers are produced with more tender, clearer and leaner meat, although this is not so well confirmed. In general, Argentinean beef is characterized by qualitative variability caused by diet, breed, age and weight of animals [3].

Italian beef is produced in a way similar to intensive feedlot obtained by bulls, or more rarely steers, slaughtered at 16-20 months old.

In two previous researches, some quality parameters related to Italian and Argentinean beef coming from different feeding systems were compared. The Argentinean beef samples were taken in Argentina directly to the slaughterhouse and there analysed. The Argentinean beef resulted to be darker, more marbled and tender than Italian beef that was leaner and clearer [4].

To understand how the transport, the long ageing and the processing can affect the Argentinean imported meat quality, beef samples of *longissimus thoracis* were purchased in a large retailer in Turin (Italy) and compared with beef of similar price of Italian origin obtained from Piedmontese race bred and produced in Piedmont (Italy).

II. MATERIALS AND METHODS

The Italian beef was obtained from 33 Piedmontese cattle that received a standard diet

based on corn: 23 steers (It_S) were slaughtered at 511±40.0d and 10 bulls (It_B) at 558±16.5d. After two days from slaughtering, a 3cm thick sample of *longissimus thoracis* collected from the left side of each carcass between the 9th and 11th rib, was vacuum-packed, kept for a total of 7d at 2-4°C, and then frozen.

Ten Argentinean steaks of *longissimus thoracis* were bought in different moments in a great supermarket, manufactured by the same importer and immediately frozen. No other information was declared, except that meat was striploin coming from Argentine. It has been supposed that beef was obtained from steers as typical Argentinean production (Ar_S).

Rheological and physical measured traits of meat were: pH, thawing loss, WHC_{trend} and its parameters, total water loss, drip loss, total cooking loss, cooking loss, cooling loss, residual water, Meat Cooking Shrinkage (MCS), fat score, tenderness and colour [5, 6, 7, 8].

When the samples were used for the meat analysis, they were thawed for 48h at 2-4°C and the thawing loss was measured as the percentage of liquid lost during thawing. The meat pH was measured in the laboratory using a Crison pH25+ (Crison Instruments, S.A., Alella, Spain), equipped with an electrode and an automatic temperature compensator. The drip loss was expressed as the weight lost from the muscle sample (40x40x10 mm), which was kept at 4°C for 48h in a double bottom plastic container.

The WHC_{trend} was determined under a compression of 500N, and measured every 15s by means of 41 visual imaged areas, during a period of 600s. Three parameters were obtained from the following equation:

$$[area=k_0 + k_1*time + k_2*Ln(time)],$$

which describes the time-dependent water release in time, where "k_0" or the intercept is the meat area observed immediately after a compression of 250 mg started at time=0s; "k_1" is the linear coefficient that shows the slope; "k_2" is the coefficient to indicate the convexity of the curve till the maximum height [5]. A fourth parameter was the total area at the end of the compression (WHC_{trend} - ta).

The warming losses were then measured, first considering the fluid lost during 10min of cooking, until a pre-fixed internal temperature of 70°C was reached (cooking loss), and then cooling the samples at room temperature for 20min (cooling loss). The total cooking loss was calculated as the sum of the two components [8]. The residual available chewing water in the cooked meat (residual water) was obtained from three small cylinders (Ø 10mm), extracted from the sample used for the MCS. These cylinders were compressed to measure tenderness according to the SRR method: the difference in weight before and after compression indicated the water still available to the consumer for chewing the cooked meat [6].

MCS was measured using a Video Image Analyser:

$$MCS = \frac{(\text{raw area - cooked area})*100}{\text{raw meat area}}$$

by assessing the shrinkage in the meat sample area caused by cooking and cooling [7].

The intramuscular fat marbling content was assigned visually, and a score of 1 was assigned to meat without marbling fat and 5 to meat with abundant marbling fat.

Meat colour was evaluated by a Spectrophotometer CM-600d (Minolta Camera Co., Tokio, Japan), using a standard white tile (Illuminant D65, 10° Observer) in the CIELAB system (L^*, lightness; a^*, redness; b^*, yellowness; chroma and hue), by taking three readings for each sample, which consisted of a 1 cm thick slice of meat, after 60min of exposure to the environmental temperature.

Statistical analysis compared the three levels (AR_S, It_S, It_B) by GLM and Canonical Discriminant Analysis (STEPDISC and CANDISC) with the software SAS/STAT SAS 9.4 [9]. The results are expressed as the estimated means (LSMean and MSE) and then compared with the Tukey-Kramer Test adjusted for multiple comparisons.

III. RESULTS AND DISCUSSION

A first major problem of Argentinean and Italian beef is that there is not readily available information in the supermarket about the background of the product, except for the origin. No information about nutrition, sustainability, authenticity and ethics. It is not given to known when it was slaughtered and how many days was aged, nothing is known about the breed, feeding and rearing methods. Some Italian beef producers voluntarily provide information about the breed

and date of slaughter. Furthermore Argentinean beef is very expensive (38.41€/kg), 202% more than Italian beef (18.98€/kg), and with a great variability in the appearance, especially in marbling.
The results of the qualitative analysis on beef samples are reported in Table 1.

Table 1. Comparison of some quality parameters (LSMeans, DFE=40)

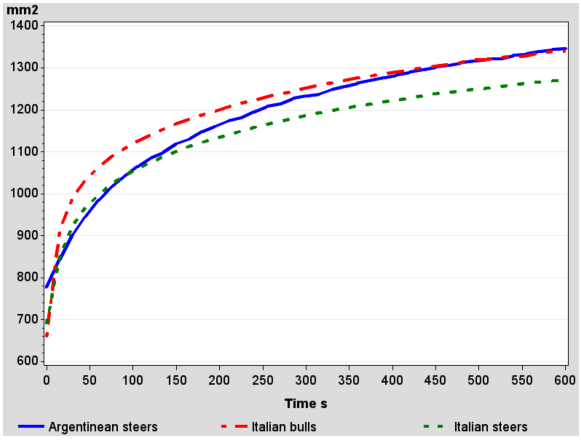
Parameters	Ar_S	It_S	It_B	RMSE
pH	5.5	5.6	5.6	0.121
Thawing loss	4.8	5.8	7.9	2.939
WHC_{trend} - k_0	714^{A}	660^{B}	650^{B}	39.05
WHC_{trend} - k_1	0.375^{A}	0.157^{B}	0.089^{B}	0.102
WHC_{trend} - k_2	67.98^{C}	82.68^{B}	100.38^{A}	11.88
WHC_{trend} - ta	1347^{A}	1271^{B}	1340^{A}	36.21
Total water loss	47.0^{A}	40.8^{B}	43.2^{A}	4.426
Drip loss	3.9	6.0	5.8	2.448
Total cooking loss	28.2^{A}	23.5^{B}	28.1^{A}	3.687
Cooking loss	23.4^{A}	17.4^{B}	23.3^{A}	4.325
Cooling loss	4.8	6.1	4.8	1.657
Residual water	18.8^{a}	17.3^{ab}	15.1^{b}	3.262
MCS	18.8	16.0	15.9	3.898
Fat score[#]	3.5^{A}	1.3^{B}	1.1^{B}	0.770
Tenderness	18.4	18.7	20.2	4.875
L^*	41.2^{B}	39.3^{B}	46.1^{A}	3.235
a^*	17.4	16.4	16.2	1.686
b^*	15.0^{b}	14.4^{bB}	17.4^{aA}	1.769
Chroma	23.0^{ab}	21.9^{b}	23.8^{a}	1.906
Hue	40.6^{B}	41.2^{B}	47.2^{A}	3.999

LSMeans by parameter in the same row with different letters are significantly different (a, b, c: P<=.05; A, B, C: P<=.01)
[#] Fat score range: 1 absent - 5 abundant fat.

Argentinean beef (Ar_S) is significantly different from IT_B and IT_S for a higher fat score. Visible fat is not appreciated by the Italian consumer, acting negatively on the willingness to buy the raw meet. On the contrary, when beef is eaten and the fat is not visible, Argentinean beef is appreciated for its taste.
One consequence of the abundance of visible fat in Argentinean meat is an inaccurate measurement with the colorimeter. Beef is less dark because it is impossible not to include fat in the measured area. In fact the color shows a difference between It_B *vs* IT_S and Ar_S. The L^*, b^* and Hue are significantly lower compared to It_B indicating a less bright and saturated colour with a duller overall appearance for Ar_S and IT_S. But visually Argentinean meat is darker than It_S.
Fluid losses on raw and cooked Argentinean meat show a behavior more similar to the Italian bulls (It_B) than the Italian steers (It_S).

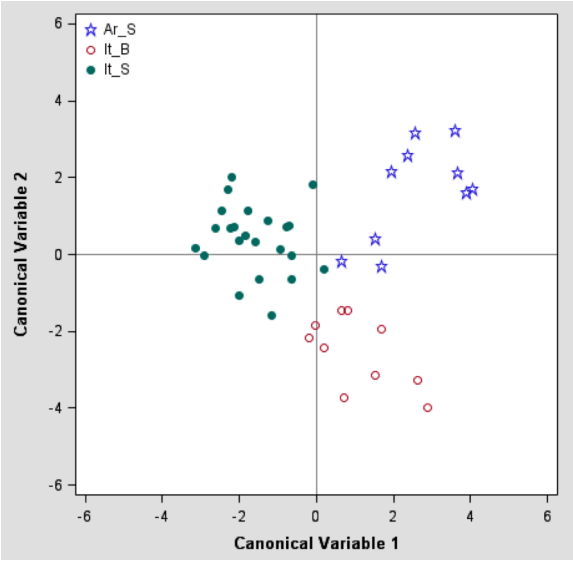
The Ar_S's WHC_{trend} has a behavior that swings between the two Italian beefs (Figure 1).

Figure 1. WHC_{trend} of Ar_S was significantly different with an intermediate behaviour



The Ar_S beef has a significant higher total water loss, total cooking loss, and cooling loss compared to the Italian steers. No differences for meat cooking shrinkage and tenderness.
Multivariate analysis was performed to synthesize the effect of origin and sex.
After a selection among the 20 measured parameters with the procedure STEPDISC, six parameters were retained: fat score, L^*, hue and a^*, WHC_{trend} - ta and k_1. The results of the analysis are in Figure 2 and show a clear separation due to fluid losses on the first axis and colour on the second axis.
The R^2 between the first canonical variable (Can1) and the classificatory variable is equal to 0.775 and 0.704 with Can2. This indicates a very strong contribution on the two axes of the selected parameters. The Can1 separates the It_S beef from the Ar_S and It_B beef and the largest contribution is due to the k_1 raw coefficient (6.3029). The Can2 separates the Ar_S from the It_B thanks to fat score and lightness.
These results confirm the differences obtained in our previous researches, except for tenderness. The Argentinean beef resulted to be more marbled and darker, but equally tender as Italian beef that was leaner and clearer. In previous researches the Italian beef was less tender, but it was obtained from literature analysis related to different breeds.
In this paper, the comparison was made with one of the best Italian beef breeds.

Figure 2. Canonical Discriminant Analysis applied to origin and sex



IV. CONCLUSION

The Argentinean beef production is facing a period of great change for both the technical and the socio-cultural aspect. In the Italian vision, Argentinean beef is linked to the pampas and a free breeding, in which animals live according to their needs. This vision is not transmitted through the packaging and supermarkets. Moreover, Argentinean beef is very expensive, 202% more than the Italian Piedmontese beef, and with a great variability in the appearance and in particular in marbling. Therefore, it would be more effective for the Italian market a more uniform looking in order to improve the beef aspect with regard to the expectations of Italian consumers (clearer and lean beef).

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