Contrasting appraisals of quality and value of beef carcasses in Spain and the United States

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SUMMARY

The objective of the current paper was to compare those parameters used in the European Union and United States beef grading system, in typical carcasses of each market (Spain in the case of Europe), and their influence in the economic value of beef. To achieve these objectives, twenty Spanish intact bulls of the Pirenaica breed (Southern Europe) were slaughtered at 351 days of age and 330 kg of carcass weight on average. These carcasses could be considered the typical Spanish yearling bull. Twenty US beef steers carcasses were randomly selected at Tyson Fresh Meats, Joslin (Illinois) which have been designated as "Angus influenced". Spaniard bulls produced carcasses with superior conformation scores, higher carcass yield, and greater longissimus dorsi area; the US carcasses, were heavier because they were significantly older than the Pirenaica bulls carcasses, (18 vs 12 months), although both type of carcasses had the same maturity grade (A). Beside, US carcasses were fatter because they showed higher marbling grades, thinker dorsal fat and a higher proportion of pelvic, kidney and hearth fat. The Spaniard beef had a higher economic value than the US beef with regard to pricing based on the European beef carcass grading system (21% higher per kilogram basis and 11% higher per carcass basis). However, the Spaniard beef had a lower value than the US beef when using the USDA beef grading system (27% higher per kilogram basis and 35% higher per carcass basis). These results show that each beef market values different characteristics when pricing beef and a highly valued product in a market not necessary have to be highly evaluated in other market.

Keywords: beef, carcass, grading systems

Introduction

Beef carcass grading systems predict the economic value of a beef carcass through differences observed in carcass traits that influence retail yield and palatability. Most beef grading systems used today evaluate carcasses or primal cuts using the visual evaluation of parameters easily measured on a moving slaughtering chain. Beef quality grading systems, such as the United States Department of Agriculture [12] take into account factors both related to beef quality palatability, such as the degree of marbling, skeletal maturity, and lean color, and carcass yield, such as dorsal fat thickness, amount of pelvic, kidney and hearth fat, longissimus dorsi area, and carcass weight. The European Beef Carcass Grading system takes into account carcass conformation and fatness [6, 7], although these factors are probably more related to carcass cutability than palatability.

In the European grading system, Conformation has six grades which form the word SEUROP; S being those carcasses with "superior" conformation to P = "poor". Degree of Fatness is related to the amount of subcutaneous and thoracic fat being 1 = "low" to 5 = "very high". The United States Department of Agriculture beef grading system consists of two major factors: degree of marbling and degree of maturity. Marbling is evaluated on the lean cut surface of the longissimus muscle at the 12th rib surface and is placed in one of ten different degrees; from practically devoid to abundant. Maturity refers to the physiological age of the animals. Both

Resumé

L’objet de ce travail a été comparer les paramètres utilisés dans l’Union Européenne (EU) et dans les États-Unis (EE.UU) pour la classification des carcasses de chaque marché (Espagne dans le cas de l’Europe, Illinois dans le cas américain) et leur influence sur la valeur économique de la viande bovine. 20 carcasses de mâles entiers de race Pirenaica (Espagne) ont été abattus à 351 jours d’âge et 330 kg de poids de carcasse. 20 carcasses avec du sang Angus (plus de 50%) ont été sélectionnées par Tyson Fresh Meats, Joslin (Illinois, EE.UU.). Les carcasses espagnoles ont montré une plus grande conformation, plus rendement à l’abattage et une plus grande area du muscle longissimus dorsi que les carcasses américaines. Par contre, ces dernières ont été plus lourdes parce que elles étaient plus âgées (18 vs 12 mois) que les carcasses européennes, mais les deux types de carcasses ont eu le même degré de maturité (A). En plus, les carcasses EE.UU. étaient plus engraisées parce qu’ont eu plus de graisse intramusculaire, plus de graisse dorsal et une plus élevée proportion de gras pelvique-renal et cardiaque. Les carcasses européennes ont eu une valeur économique plus élevée que les américaines quand les animaux ont été classifiés selon le système UE (21% plus élevée sur la base d’un kilogramme et 11% plus élevée sur la base de la carcasse). Cependant, les carcasses américaines ont eu une valeur économique plus élevée que les européennes en utilisant le système USDA (27 et 35%, respectivement). Ces résultats montrent que chaque marché de la viande bovine à différents caractéristiques et que le prix dans un marché peut être différent que dans un autre pour une même viande.

Mots clés: bovines, carcasses, systèmes de classification.
Marbling and maturity are combined to determine a final Quality grade from 1 to 5. Carcass retail yield is obtained from the combination of adjusted fat thickness measured at the 12th rib, rib eye area at the 12th rib, hot carcass weight, and percentage of kidney, heart and pelvic fat.

Different segments of the meat industry chain have different points of view when defining the term "beef quality" and give economic value to different factors. In this sense, carcass or meat traits that could be associated with palatability (tenderness, juiciness, aroma, and flavour) are not considered by the European beef carcass grading system.

Visual appraisal by trained evaluators is a method commonly used in beef grading systems. Photographical standards are used but the fast rate of grading in commercial packaging plants cause inaccuracies in the application of grades by online graders when compared to expert graders working without a time constraint [3]. These inaccuracies, due to subjectivity and low repeatability, could cause loss of confidence in the current grading systems.

The objective of this study was to compare those parameters used in the European Union and in the United States for beef carcass grading, in the characteristic beef carcass produced both in Spain (Southern Europe) and the United States, and their influence in the economic value both the carcass and the kilogram of beef.

Material and methods

**PRE-HARVEST, HANDLING AND HARVESTING**

Two different groups of animals were raised in two different areas, Spain (Southern Europe) and the United States (Mid-West region). Both groups of animals were raised and slaughtered following the established standards for humane care and use of animals. Twenty intact bulls of *Pirenaica* breed were born on private farms located in the region of Navarra (Northern Spain). After weaning at approximately six months of age, the calves were fed commercial concentrate and barley straw, both *ad libitum*, and were harvested and dressed in an officially approved slaughterhouse: animals were transported approximately 20 km and harvested upon arrival using standard methods of stunning and dressing at La Protectora SA slaughterhouse (Pamplona, Spain). Animals were slaughtered at an average carcass weight of 330 kg and average days at 351. After chilling for 24h at 3°C, carcasses characteristics were recorded by a trained staff from the Department of Animal Production and Meat Quality of the Universidad Pública de Navarra.

Twenty US steer carcasses were randomly selected from carcasses that had met live Certified Angus Beef specifications at Tyson Fresh meats (Joslin, IL, US). Carcasses weighted 371 kg on average. Even though specific animal genetics, chronological age and feeding regime were unknown for the twenty steer carcasses, they have been designated as "Angus influenced" since their hair coat was at least 51 percent black. In addition, all twenty were qualified as "A" maturity carcasses and were considered high quality beef as 19 out of 20 had United States Department of Agriculture Quality grades of average Choice or higher. After chilling for 24h at 3°C, carcass characteristics were recorded by meat scientist from the Department at Animal Sciences of the University of Illinois.

Both researchers’ teams were trained for using both classification systems in the evaluation of American (USA) and European (Spain) beef carcasses.

**ANIMAL SLAUGHTERING AND CARCASS EVALUATION**

After chilling, both US and Spaniard carcasses were evaluated and graded for Conformation and Fatness according to the official European standards [6, 7]. Carcass measurements associated with yield grades and beef quality grades according to the standards of the American Meat Association [2] were collected.

In the European grading system, Conformation has six grades which form the word SEUROP; S being those carcasses with "superior" conformation; E = "excellent"; U = "very good"; R = "good"; O = "fair"; P = "poor". Degree of Fatness is related to the amount of subcutaneous and thoracic fat and is the following: 1 = "low"; 2 = "slight"; 3 = "average"; 4 = "high"; 5 = "very high". Conformation and fatness categories were subdivided into three subcategories (+, 0, -) to improve accuracy of classification. For conformation, carcasses were scored from 18 for S+ to 1 for P-, while degree of fatness was scored from 15 for 5+ to 1 for 1-.

The United States Department of Agriculture beef grading system consists of two parts: Quality grade and Yield grade [13]. The beef carcass quality grade is based on two major factors: degree of marbling and degree of maturity. In addition to these factors, colour, texture and firmness of lean in the *longissimus* muscle cut surface could be considered in determining the final quality grade. Marbling is evaluated on the lean cut surface of the *longissimus* muscle at the 12th rib surface and is placed in one of ten different degrees; practically devoid, traces, slight, small, modest, moderate, slightly abundant, moderately abundant, and abundant. Each grade is subdivided into percentage increments of 10%, from 0% to 100%, and the percentages are written as superscripts. Maturity is the second factor used in determining quality grade, and it refers to the physiological age of the animals or beef skeletal maturity. Indications of physiological maturity in the skeleton are noted and the color and texture of lean are evaluated in the muscle. These observations are then combined into an overall physiological maturity evaluation. Maturity categories A and B are from young carcasses, while carcasses from mature cattle are designated as C, D and E. In actual practice, graders divide the maturity groups into percentages in increments of 10%, from 0 to 100%, and the percentages are written as superscripts following the maturity
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designation. After the degrees of marbling and maturity have been estimated, these two factors are combined to determine a final Quality grade.

Yield Grading is a numerical value from 1 to 5 obtained from the combination of the following factors: adjusted fat thickness measured at the 12th rib, rib eye area at the 12th rib, hot carcass weight, and percentage of kidney, heart and pelvic fat. The United States Department of Agriculture yield grade regression equation used to calculate the Yield grade was the following: yield grade: 2.5 + (2.5* adjusted fat thickness (inch)) + (0.2*percentage of kidney, pelvic and heart fat) + (0.0038* hot carcass weight (pounds)) - (0.32* area of ribeye (inch²)). This is routine official method for classifying beef carcasses in USA.

For more precise carcass grading, photographic standards developed for both the European and US grading systems were used. In addition, a grid and calipers (probe) were used to measure longissimus dorsi area and dorsal fat thickness. The estimated percentage of kidney, heart and pelvic fat was estimated visually.

Price for kg of US and Spaniard beef carcasses for the Spanish beef market (Tables 1 and 5) was calculated following the prices recorded by the European Commission [8]. To calculate carcass value and price of kg of beef, the local currency was used in each market and grading/classification system (euro or dollar). To get the economic value in the other currency, it must be considered that the relationship euro-dollar at the time of the study was 1 euro = 1.54 dollar.

Price for kg of beef for the US beef market (Tables 2 and 5) was calculated taking as suggested price that reported for beef with Quality grade of Choice (143.48$/100lbs) [14].

At this reference price, in the Spanish yearling bulls, discounts must be applied due to the fact that they had a low Quality grade (Standard; -14.67$/100lbs) and because their age and sex, they would be considered bullocks (-26.43$/100lbs). However, a premium due to their high carcass yield (yield grade 0.6; +2.75$/100lbs) must be applied too. In the US steers, only a premium due to their medium-high carcass yield (yield grade 2.6; +0.96$/100lbs) must be applied to the reference price [15].

STATISTICAL ANALYSIS

One fixed effect was considered (product origin) and an analysis of variance was performed using the following model: \[ Y = \mu + C_i + \varepsilon. \]
Where:
\[ Y \] = the study variable.
\[ \mu \] = the Least Squares Mean.
\[ C_i \] = the type of meat (i = 1: Spanish beef, i = 2: US beef).
\[ \varepsilon \] = random element.

Data were analysed using SPSS for one way ANOVA (2006).

Results and discussion

Table 3 presents the average Conformation and Fatness scores for both types of carcasses (Spaniard bulls and US steers) taking into account the factors used in the European beef grading system. Table 4 shows the average values of factors used in the United States Department of Agriculture beef grading system.

The major differences between both types of carcasses were related to fatness. The Spaniard carcasses had a significantly lower fatness scores according to the European beef carcass grading system, a lower degree of marbling according to the US standards (Traces vs Modest) and a thinner layer of subcutaneous fat (p ≤ 0.001). Although both types of carcasses had the same grade of maturity (A), US steers were graded as more mature (p ≤ 0.01). Because the higher degree of marbling, the US beef had a higher Quality grade (Choice vs Standard, p ≤ 0.001), which would suggest superior palatability. Quality grade is a key factor in determining the economic value of a beef carcass in the US [14, 15], with the higher the US Quality grade, the higher the economic value of beef. The increase in intramuscular content may be linked to an increase in other fat depots such as subcutaneous fat or inner fatty depots [10]. In the Spanish market, excess fatness is economically penalized, although almost a Fatness score of 2 is required to prevent weight loss during cold storage, while maintaining sensory quality [1, 8].

Spaniard bulls produced carcasses with superior Conformation scores (Table 3), lower Yield grade, and greater longissimus dorsi area (p ≤ 0.001) (Table 4), the Angus carcasses were heavier (p ≤ 0.001). The higher maturity grade and the heavier carcass weight of US steers may be related to their older age at slaughter.

The Spanish beef market demands young bullock cattle with superior muscling that will yield a higher percentage of
<table>
<thead>
<tr>
<th>Yearling cattle</th>
<th>Carcass grade</th>
<th>Price €/100kg</th>
<th>Heifer*</th>
<th>Carcass grade</th>
<th>Price €/100kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>U2</td>
<td>327.6</td>
<td>U2</td>
<td>338.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U3</td>
<td>320.9</td>
<td>U3</td>
<td>351.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>359.7</td>
<td>R2</td>
<td>285.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>303.2</td>
<td>R3</td>
<td>327.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O2</td>
<td>247.8</td>
<td>O2</td>
<td>283.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O3</td>
<td>291.7</td>
<td>O3</td>
<td>287.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O4</td>
<td></td>
<td>O4</td>
<td>274.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1: For calculating price of steers beef, data of heifer beef has been taken into account due to steer is not produced in Spain and there are not references of market price. Heifer has been chosen because could be considered the type more similar to steer

Table I: Market prices of beef carcasses of yearling bulls and heifer in the Spanish market. Prices for the week of 12th may 2008 (European Commission, [8])

Suggested price: 143.48 $/100lbs:
Quality grade of Choice
Carcass weight between 600-900 pounds

Premium applicable to the studied carcasses:
- Yield grade between 1.0 - 2.0
  +2.75 $/100lbs
- Yield grade between 2.5 – 3.0
  +0.96 $/100lbs

Discounts applicable to the studied carcasses:
- Bullock/Stag
  -26.43$/100lbs
- Quality grade of Standard
  -14.67$/100lbs

Table II: Market prices, premiums and discounts of beef United States market for the week of 12th may 2008 (United States Department of Agriculture – American Meat Association, [14, 15])

<table>
<thead>
<tr>
<th>Spain</th>
<th>United States</th>
<th>(St. Error)</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conformation score(1-18)¹</td>
<td>9.65 (U-)</td>
<td>7.25 (R)</td>
<td>(0.23)</td>
</tr>
<tr>
<td>Fatness score(1-15)²</td>
<td>4.45 (2-)</td>
<td>11.70 (4)</td>
<td>(0.28)</td>
</tr>
</tbody>
</table>

1: Conformation score: Carcass conformation score by comparison with the official standards of the European beef carcass grading system. Numerical transformation of the official classes where 1 = P- and 18 = S+; 2: Fatness score: Carcass fatness score by comparison with the official standards of the European beef carcass grading system. Numerical transformation of the official classes where 1 = 1- and 15 = 5+. Difference ***: p ≤ 0.001.

Table III: Carcass characteristics associated with the European beef grading system for the two types of carcasses: Spaniard yearling bulls and US steers

<table>
<thead>
<tr>
<th>Spain</th>
<th>United States</th>
<th>(St. Error)</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass weight (kg)</td>
<td>329.96</td>
<td>371.61</td>
<td>(6.60)</td>
</tr>
<tr>
<td>Marbling¹</td>
<td>102.50 (Trace)</td>
<td>486.50 (Modest)</td>
<td>(12.85)</td>
</tr>
<tr>
<td>Maturity²</td>
<td>37.50 (A)</td>
<td>55.00 (A)</td>
<td>(3.30) (A)</td>
</tr>
<tr>
<td>PHK Fat³ (%)</td>
<td>1.40</td>
<td>2.15</td>
<td>(0.13)</td>
</tr>
<tr>
<td>LDA⁴ (cm²)</td>
<td>104.47</td>
<td>90.23</td>
<td>(2.48)</td>
</tr>
<tr>
<td>Fat thickness⁵ (cm)</td>
<td>0.23</td>
<td>1.13</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Yield grade⁶</td>
<td>0.59</td>
<td>2.68</td>
<td>(0.16)</td>
</tr>
<tr>
<td>Quality grade⁷</td>
<td>151.50 (Standard)</td>
<td>361.95 (Choice)</td>
<td>(5.10)</td>
</tr>
</tbody>
</table>

1: Marbling: degree of marbling of the longissimus muscle at the 12th rib by comparison with the official standards of the United States Department of Agriculture beef grading system. Numerical transformation of the official grades where 10 = Practically devoid10 and 890 = Abundant90; 2: Maturity: degree of physiological maturity by comparison with the official standards of the United States Department of Agriculture beef grading system. Numerical transformation of the official grades where 10 = A10 and 590 = D90; 3: PHK: percentage of kidney, heart and pelvic fat with regard to carcass weight; 4: LDA: longissimus muscle area at the 12th rib measured with a grab; 5: Fat thickness: dorsal fat thickness measured at the 12th rib measured with a calibre; 6: yield grade: 2.5 + (2.5*fat thickness (inch)) + 0.0038* carcass weight (pounds)) + (0.2*percentage of PHK fat) - (0.32*longissimus muscle area (inch2)); 7: Quality grade: degree of quality by comparison with the official standards of the United States Department of Agriculture beef grading system. 100 =Standard00; 490 = Prime 90. Difference: **: p < 0.01; ***: p < 0.001

Table IV: Carcass characteristics associated with the United States Department of Agriculture beef grading system for the two types of carcasses: Spaniard yearling bulls and US steers

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lean, and therefore, carcass conformation is the key factor for carcass economic value [8]. The Pirenaica breed produces later maturing animals with low fatness and superior conformation [1]. In the US beef market Yield grade may have less influence on the price of beef than the Quality grade, because different authors have shown that beef marbling has been related to beef tenderness [2, 16, 4], aroma, and flavour [5, 11].

The market prices of beef carcasses of yearling bulls and heifers in the Spanish market and the market prices, premiums and discounts of US beef markets were considered, using as a reference the prices reported by the European Commission [8] and United States Department of Agriculture – American Meat Association [14, 15] respectively, on the week of May 12th 2008 (Tables 1 and 2). Table 5 shows beef prices considering per kilogram basis and per carcass basis, according the European Union and the United States Department of Agriculture beef grading systems.

In addition to the disparity in currency value (exchange rate Euro/US dollar) the vis-à-vis comparison of the most or least valuable beef in Spain was more expensive than their counterparts in the US. The Spaniard beef had a higher economic value than the US beef when the pricing was based on the European beef carcass grading system (Table 5). This is due to the fact that carcasses of Pirenaica yearling bulls had higher conformation and lower fatness scores. In Spain, kilogram of beef from Pirenaica cattle would have an economic value around 21% higher than the Angus beef. The whole Spaniard carcasses would have a higher value too although the difference would be around 11%, due to the fact that the US carcasses were heavier. The kilogram of Spanish beef had a lower value than the US beef when using the United State Department of Agriculture beef grading system (Table 5). Although the Spaniard carcasses had superior Yield grade (p ≤ 0.001), they had considerably lower Quality grades (p ≤ 0.001). Beside, beef from non-castrated males (classified as Bullocks) and beef with lower quality grade than Choice is subjected to price discounts in the US; consequently, a kilogram of US beef was more valuable (27% higher) than the Spaniard beef. The difference in carcass value appraised by the two grading systems was greater in the US grading system. Because the US carcasses were heavier (p ≤ 0.001), their total carcass value was 35% higher that the Spaniard carcasses in the US grading system.

The differences presented in Table 5 illustrate that the US carcasses were more valuable according to the United States Department of Agriculture beef grading system, while the Spaniard carcasses were of greater value under the European grading system. These results clearly demonstrate the different objectives of the two markets. The US market emphasizes meat quality (palatability), whereas the Spanish market focuses on lean and meat production. To increase beef consumption in Spain, more emphasis on palatability to improve and satisfy consumer expectations may be required; consequently such carcass characteristics as high marbling should be incorporated into the Spanish beef grading system. Although in Spain there are beef breeds with excellent carcass characteristics, it would be desirable to have some breeds that also possess more marbling.

In conclusion, the found results show the evidence that in a global world beef grading systems are adapted to local characteristics of breeding systems, industry demons and consumers’ preferences. For these, different beef grading systems give economic value to different beef carcass parameters.

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