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Moisture and fat content, marbling level and color of boneless rib cut from Nellore steers varying in maturity and fatness

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ABSTRACT

This study analyzed rib steaks (M. *longissimus thoracis*) of Nellore steers (n = 60) for intramuscular moisture and fat content, marbling level, and visual and instrumental color. Carcass sides were classified on the kill floor according to teeth maturity (2, 4 and 6 permanent incisors), and fatness (2 — slight and 3 — average). The cranial end of the boneless cut was aged for 14 days, and frozen. Steaks of 2.5 cm thick were cut and thawed for analysis. Moisture and fat content were determined in minced lean. CIE color was measured with a MiniScan XE™, and visually evaluated by an eight-member panel, which also assessed marbling. In this type of cattle and ranges of maturity and fatness considered, increasing either maturity or fatness causes a slight reduction in moisture and an increment in lipid content. But neither maturity nor fatness seems to affect the visual perception of meat color on display.

1. Introduction

The most important aspect of meat quality in beef is the sensory, or eating quality, defined as tenderness, juiciness and flavor, usually assessed by a trained taste panel (Dikeman et al., 2005). But color is the most important deciding factor for consumers at the moment of purchase, and often is their basis to select or reject the product, if meat odor is not detected first (Renerre, 1982).

Consumers have consistently rated leanness as an important selection criterion when evaluating retail steaks, and marbling contributes to the visual appraisal of fat content; therefore, consumer perception of marbling could be negative as it increases overall fat in the product, which is not as "trimmable" as subcutaneous and seam fat (Killinger, Calkins, Umberger, Feuz, & Eskridge, 2004).

Visual appraisals of color are closely related to consumer evaluations and set the benchmark for instrumental measurement comparison, but results are influenced by personal preference, lighting, and appearance factors other than color. The color of uncooked meat is usually described as pink or red, but colors range from nearly white to dark red (AMSA, 1991).

Several studies have been carried out on the effects of the degree of carcass fatness on beef quality as measured on its thickness over the loins, visually evaluated as fat thickness (FT) and marbling level, or in terms of chemical fat. Some studies also considered animal age or physiological maturity (Fiems, De Campeneere, Van Caelenbergh, De Boever, & Vanacker, 2003; Harper, 1999; Lawrence, Whatley, Montgomery, Perino, & Dikeman, 2001; May, Dolezal, Gill, Ray, & Buchanan, 1992; Moon, Yang, Park, & Joo, 2006; Wulf & Wise, 1999), but they were generally conducted in North America or in Europe with *Bos taurus* cattle finished on feed-lots.

Brazilian beef production is the second largest in the world. It produced 9.7 million t carcass weight equivalent (CWE) and slaughtered 40.5 million heads in 2008. The regular production system in the country is to do the entire cycle under pasture condition, and 80% of the national herd has influence of zebu cattle (*Bos indicus*) (Ferraz & Felício, 2010); the Nellore being by far the most prevalent breed of this group. However, there are only a few studies about lean composition and color traits available.

The purpose of this study was to investigate the effects of three teeth maturity groups (2, 4 and 6 permanent incisor teeth) and two classes of carcass fatness (2 — slight and 3 — medium) on muscle fat and moisture percentage, marbling level, and visual and instrumental color of the boneless rib cut (M. *longissimus thoracis* — LT) of Nellore steers raised in tropical grasslands and harvested at industrial conditions during an annual carcass contest organized by the Brazilian Nellore Breeders Association.

2. Material and methods

2.1. Carcass and samples collection

Details on the selection of animals, type of cattle and slaughter procedures are given by Pflanzer and Felício (2009).

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Carcasses were selected during a contest of Nellore breed carcasses at a slaughterhouse in the state of Mato Grosso do Sul, in the Center-Western region. From a daily total of 822 steers slaughtered, left sides of carcasses were classified, according to maturity and fat cover, and then 10 sides of each group were randomly selected.

Left sides of carcasses (n = 60) were classified into six categories. The classification was done by combining teeth maturity of 2, 4, or 6 permanent incisors (a pair was counted when a permanent incisor had erupted) in animals from 20 to 24 months, 30 to 36 months and 42 to 48 months old (Corrêa, 1996), with visual fatness, 2 = slight, and 3 = medium, on a scale of 1–5, where 1 = absent, 4 = high and 5 = very high (MLC, 1975; OJEU, 2007). After chilling the carcass, approximately 1 kg of the cranial end of the boneless ribeye (6th through 9th ribs) was removed, labeled, and aged for 14 days postmortem at 2 ± 1 °C. Then, it was frozen at −18 °C, and transported to the laboratory for analysis. In the lab, steaks of approximately 2.5 cm thick were cut with a bandsaw from the frozen meat and thawed to 4 °C for analysis.

2.2. Chemical analysis

Steaks were trimmed of fat and connective tissue, ground and oven dried to a constant weight (12 h). Moisture content was determined by weight difference (AOAC, 1980). The extraction of intramuscular lipids was performed using the Bligh and Dyer (1959) method, which is a recommended method for determining total lipid in biological tissues (Iverson, Lang, & Cooper, 2001).

2.3. Meat color and marbling level

2.3.1. Instrumental color

Color readings were taken in the L*, a* and b* color space (also referred to as the CIELAB color space) in three locations of each steak (*M. longissimus thoracis*) sample after a 30 min bloom time at 4 °C using a HunterLab Chromameter CM 508-d (MiniScan™ XE) with illuminant D-65, 10 °C standard observers angle and an aperture size of 3.5 cm. The unit was calibrated using a black and a white standard plate, as specified by CIE, 1986. Color saturation (Chroma), which is a measure of the intensity of the red color, was calculated from the formula $[(a^*)^2 + (b^*)^2]0.5$ and hue, a measure of overall color, was calculated from arctan b*/a*.

2.3.2. Visual appraisal

After the physical measurement of color, visual evaluation of the steaks was conducted in a display (4 °C ± 2 °C) equipped with fluorescent tube lighting (PHILIPS, model TLD 32 W), placed 15 cm from the sample and easily accessible for the evaluators. Eight students were instructed on how to evaluate the color and marbling level based on pictorial standards adapted from Meat Evaluation Handbook (AMSA, 2001). The color standard consisted of 7 categories of color, ranging from A20 (beef light) to E100 (darker meat), and the judges could score samples with intermediate values. For marbling level, the standard consisted of 8 categories, from Select (−) to Prime (−).

2.4. Statistical analyses

The experimental design was a 3 × 2 factorial with 3 levels of teeth maturity and 2 levels of fat class, and the data were analyzed using the GLM procedure and Tukey test of the Statistica 7.0 software (Statsoft, 2005).

3. Results and discussion

3.1. Chemical analysis

There were no differences (P > 0.05) for pH values (24 h) among the three teeth maturity groups or between the two fat classes. The average pH was 5.7–5.8, which is within the acceptable range. In experiments of this kind, the pH is important because samples with high pH (>6.0), defined as DFD, may undergo physical changes, especially in color, which changed from light red to a dark color and progressively decrease the L*, a* and b* values as described by Purchas, Yan, and Hertley (1999).

There was a significant effect (P < 0.05) of maturity on the lipid and moisture contents (Fig. 1). Samples from maturity 6 carcasses were lower in moisture (71.0%), and higher in lipid (5.7%) than those from maturity 2, which had levels of 72.3% and 4.2%, respectively, however, neither one differed (P > 0.05) from maturity 4 samples. Mojto, Zaujec, and Gondeková (2009) found less total water and more intramuscular fat (73.8% and 4.5%, respectively) in *M. longissimus dorsi* (LD) samples from cows over 4 years than in samples from cows under 4 years of age (75.2% and 3.3%, respectively).

Different results were found by Reagan, Carpenter, and Smith (1976) in a study of 3 age categories (9–34, 44–96 and 119–323 months). The authors did not find variation for the lipid content among maturity classes, and only the moisture content differed between the groups (75.3% and 76.7%). Galli et al. (2008) divided the studied set of Hereford cows into 4 age groups: 3, 4–5, 6–8 and 12 years. Content of total water varied from 73.4% to 75.2% and the 12 year old cows (the oldest) had the least amount of intramuscular fat (1.97%).

French et al. (2001) and Enser et al. (1998) reported 4.4% and 2.8% fat content in LD from castrated *Bos taurus* animals finished on

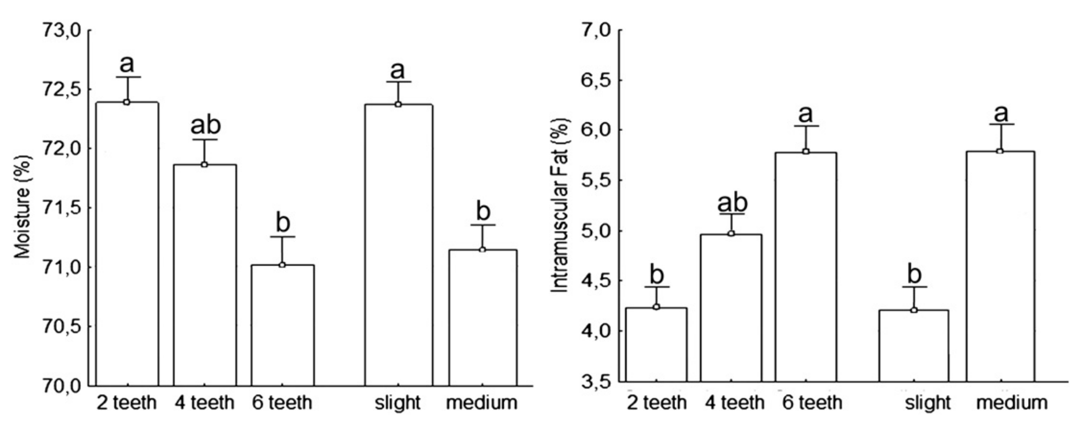

Fig. 1. Means with standard error of moisture and intramuscular fat by maturity group and fat class. a, b) Within a factor, bars without a common superscript letter differ (P < 0.05). Interactions between teeth maturity and fat class were not significant (P > 0.05). Maturity — permanent incisors (2 pi = 20–24; 4 pi = 30–36; and 6 pi = 42–48 months of age). Fat classes (2 — slight 1–3 mm; 3 — average 4–6 mm of fat over the striploin).