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Validation of photographs usage to evaluate meat visual acceptability of young bulls finished in feedlot fed with or without essential oils

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ABSTRACT

Forty ½ Brown Swiss × ½ Nellore crossbred bulls were distributed into three experimental groups: CON – diet without addition of essential oils; CLO – diet with average 5,000 mg/animal/day of clove essential oils and CIN – diet with average 5,000 mg/animal/day of cinnamon essential oils to evaluate three methodologies of visual acceptability: with steaks directly in Trays and Sequential and Random photos. Seventeen consumers evaluated visual appearance of meat using a 9-point structured hedonic scale. CON group presented higher shelf-life than essential oils groups. Trays and Sequential scores were similar in the majority of days; thus digital images could be used to evaluate colour evolution. However, Random photos resulted in lower scores and slower acceptability decrease than Trays and Sequential photos ($p < 0.05$) among the second and fifth day of display. Random photos presented a lower and more constant standard deviation than Trays and Sequential photos ($p < 0.01$) indicating that this methodology promoted a higher standard situation for meat colour evaluation.

1. Introduction

Appearance determines how consumers perceive meat quality and influences purchasing decisions (Faustman & Cassens, 1990). In the case of beef, purchasing decisions are influenced by colour more than by any other quality factor, because consumers relate the bright cherry red colour to freshness and wholesomeness, while the brown colour is considered undesirable (Mancini & Hunt, 2005). In fact, the visible colour on meat surface continuously changes during display and storage, influencing consumer acceptance of beef (Prado et al., 2015). The use of antioxidants in animal nutrition are an alternative to improve colour stability because feed is an effective route of inhibition of animal lipid oxidation (Wulf et al., 1995). Essential oils are natural additives extracted from plants which have antioxidant powers. These additives have phenolic compounds which are able to neutralize the free radicals which are responsible for oxidative processes (Hui, 1996).

Visual assessments are a gold standard for estimating consumer perception (Mancini & Hunt, 2005) but are complex, expensive and time-consuming. O'Sullivan et al. (2003) showed that the sensory visual assessment of meat products can be undertaken effectively without training when the product, or rather the colour of that product, is familiar to the assessors. Difficulties of using meat in consumer surveys could be overcame through the use of photographs for the colour evaluation (Brugiapaglia & Destefanis, 2009).

Digital camera images have been used on instrumental assessing of meat colour (O'Sullivan et al., 2003). According to theses authors the images reduced the number of representative samples to explain the variations of meat colour surface. Lu, Tan, Shatadal, and Gerrard (2000) used digital images and trained panellists to predict pork loin visual colour. When digital images were assessed by consumers, they were able to distinguish before and after blooming (Brugiapaglia & Destefanis, 2009). Another advantage of digital images is their repeatability (Ngapo, Martin, & Dransfield, 2004, 2007). It is anticipated that computer vision inspection of food products will be consistent, efficient and cost effective (Lu et al., 2000).

However, in visual analyses consumers have daily contact with the meat, because they must score samples through the display period. This additional information of freshness provided by time (days of display), which in a real situation consumers do not possess, might influence consumers' perception and discolouration of meat can be overestimated. For that reason, validation of photographs is an important first step to confirm their usefulness in eliminating between-consumer differences in meat perception.

Therefore, the aim of this study was to compare perception of beef colour between viewing meat and their corresponding photographs

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with days in sequential or random order, taken under controlled and standardized conditions to assess the reliability and accuracy of using meat photographs as an assessment tool.

2. Material and methods

2.1. Ethic committee and local

This experiment was approved by Department of Animal Production and Research Ethic Committee at the State University of Maringá and followed the guiding principles of biomedical research with animals (CIOMS/OMS, 1985), and was conducted at the Rosa & Pedro Sector, State University of Maringá, Farm Experimental Station at Iguatemi city, Paraná, and Brazil South.

2.2. Animals and housing

A total of 40 (½ Brown Swiss × ½ Nellore) crossbred young bulls (half-brothers) 12 months old and live weight (LW) of 219 ± 11.7 kg were used in a complete Randomized design. At the beginning of the experiment, animals were adapted for two weeks in individual pens (10 m^2, partially covered, with concrete floors and automatic waterers) and the concentrate was supplied gradually. Animals were weighed at the beginning of experiment and every 28 days in the scale (Beckehauser Cia Paranavaí city, Paraná, Brazil South).

2.3. Diets

The basal diet was the same for all animals, formulated to be isonitrogenous and isoenergetic according to NRC (2000) recommendations for a 1.4 kg/day average daily gain, which consisted 90% of concentrate and 10% of pellets cane sugar (Table 1). The diet was offered *ad libitum* and the feed intake was recorded daily. Bulls were randomly assigned to one of three finishing diets according to the LW: CON ($n = 8$) – diet without addition of essential oils; CLO ($n = 16$) – diet with average 5000 mg/animal/day of clove essential oil and CIN ($n = 16$) – diet with average 5000 mg/animal/day of cinnamon essential oil. The clove essential oil contained 84.5%, 13.3 and 1.3% of eugenol, carophylenne and eugenyl acetate, respectively, and cinnamon essential oil contained 78.8%, 4.7% and 3.2% of cinnamaldehyde, carophylenne and alpha-pinene, respectively, as determined by Biondo et al. (2016). The essential oils were purchased from FERQUIMA® (Vargem Grande Paulista, São Paulo, Brazil) and stored at +4 °C in refrigerator until the beginning of the experiment. Essential oils antioxidant power were analysed by the ORAC method (Oxygen Radical Absorbance Capacity) as reported by Zulueta, Esteve, and Frígola (2009) which remained constant in the diet for up to 30 days of exposure. Essential oils had a liquid texture and were mixed with the feed from concentrate in a commercial mixer every two weeks, where diets were prepared and adjusted according to the intake of dry matter, in order to keep constant the dosage for animal/day.

Table 1
Chemical composition of diets fed to young bulls with or without essential oils (% DM).

Ingredient	DM[1]	CP[2]	OM[3]	Ash[4]	EE[5]	NDF[6]	ADF[7]	TDN
Pellet sugar cane[a]	94.7	1.8	98.0	2.0	0.5	78.7	49.2	45.0
Cracked corn[b]	88.9	10.0	99.1	0.9	3.5	17.7	4.4	90.0
Soybean meal[c]	88.6	49.7	93.7	6.2	1.3	13.7	5.9	72.0
Econbeef[d,*]	88.0	56.0	94.7	4.3	17.0	12.0	6.0	90.0
Limestone[e]	98.0			98.0				
Salt[f]	98.0			98.0				
Yeast[g]	98.0	30.0	98.0	2.0				
Diet								
CON[I]	89.9	13.3	97.5	2.49	3.99	29.3	12.5	82.5
CLO[II]	89.7	13.3	97.6	2.53	3.98	29.4	12.4	82.5
CIN[III]	89.3	13.3	97.7	2.55	3.96	29.4	12.4	82.4

[1]Dry matter, [2]Crude protein, [3]Organic matter, [4]Ashes, [5]Ether Extract, [6]Neutraldetergent fiber, [7]Acid detergent fiber, [8]Total digestible nutrients.
[a]Pellet sugar cane = 10.31%DM, [b]Cracked corn = 79.31%DM, [c]Soybean meal = 5.28%DM, [d]Econbeef = 4.22%DM [e]Limestone, [f]Salt 0.42%DM, [g]Yeast = 0.04%DM.
[I]CON = control (without essential oil); [II]CLO = diet with average 5000 mg/d of clove essential oil; [III]CIN = average 5000 mg/d of cinnamon essential oil;
[*]Econbeef = Calcium (50 g/kg), magnesium (57 g/kg), sodium (81 g/kg), sulfur (3.75 g/kg), cobalt (20 mg/kg), copper (500 mg/kg), iodine (25 mg/kg), manganese (1.500 mg/kg), selenium (10 mg/kg), zinc (2.000 mg/kg), vitamin A (400.000 UI/kg), vitamin D3(50.000 UI/kg), vitamin E (750 UI/kg), ether extract (168 g/kg) and urea (200 g/kg).

2.4. Slaughter and meat sampling

At day 187 (443.5 ± 26.2 kg), bulls were transported to a commercial slaughterhouse (Arapongas city, Paraná, south Brazil). Truck stocking density was 0.8 ± 0.2 bulls/m^2, and transport distance was <60 km. Animals were slaughtered, following the usual practices of the Brazilian beef industry, and they were stunned using a captive-bolt pistol. Carcasses were not subjected to electrical stimulation.

Twenty-four hours later, after chilling at 4 °C, *Longissimus dorsi* samples (6th to 13th rib) were identified and stored in vacuum bags (Polyamide/Polyethylene pouches of 120 μm and 1 cm3/m^2/24 h 02 permeability, 3 cm3/m^2/24 h CO_2 permeability measured at 5° and 75% relative humidity; water vapor transmission rate (WVTR) was 3 g/m^2/24 h at 38 °C and 100% RH; the vicat softening point of sealing was reached at 97 °C and it had a dart drop strength of 1300 g), then immediately transported to the Laboratory of Technology and Production of Animal Origin of the Animal Science Department at the State University of Maringá. Two-cm thick steaks were cut, vacuum-packaged (99% vacuum, with a Sulpack SVC 620 machine), aged for one day, before being frozen and stored at −18 °C for further analysis.

2.5. Evaluators

Consumer-based sensory panels were conducted with semi-trained evaluators ($n = 17$) who consumed beef on a regular basis (at least twice a week) were recruited from the Animal Science Department of the State University of Maringá (Table 2). Each evaluator attended two evaluation sessions separated by a two-week interval. In the first session, evaluators evaluated samples directly in a commercial expositor (Trays) and in the second session evaluators evaluated correspondent photos of samples in Sequential (Sequential) and Randomized (Random) orders.

2.6. Session 1 (trays)

Samples were thawed for 24 h at 4 °C. They were packaged individually in polystyrene trays (Darnel Embalagens LTDA, Curitiba, Paraná,

Table 2
Profile of semi-trained evaluators from the Animal Science Department of State University of Maringá.

Evaluator	Age	Gender	Position
1	40	Male	Professor
2	23	Female	Graduate student
3	22	Female	Graduate student
4	33	Female	Researcher
5	24	Female	Master student
6	26	Male	PhD student
7	27	Male	Master student
8	25	Male	PhD student
9	60	Male	Professor
10	23	Male	Graduate student
11	35	Female	Researcher
12	26	Female	PhD student
13	25	Female	Graduate student
14	26	Female	PhD student
15	26	Male	Master student
16	23	Female	Graduate student
17	25	Male	Graduate student