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Effect of essential oils on meat and fat qualities of crossbred young bulls finished in feedlots

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ABSTRACT

Twenty-seven animals (½ Angus - ½ Nellore) were fed for four months with one of the following diets: without addition of essential oils (E0.0), with 3.5 (E3.5) or 7 (E7.0) g/animal/day of an essential oil blend (oregano, garlic, lemon, rosemary, thyme, eucalyptus and sweet orange). Chemical composition, fatty acid profile and meat color were evaluated in *Longissimus* muscle. In addition, the effects of aging (one, seven and 14 days) on the meat water holding capacity, texture and lipid oxidation were evaluated. Essential oils had no effect on chemical and fatty acid composition, meat color, water holding capacity or texture, but an inclusion of 3.5 g/day decreased lipid oxidation. The addition of 7.0 g/animal/day had a pro-oxidant effect on meat during aging and resulted in higher values for lipid oxidation at 14 days of aging. Aging significantly affected thawing losses and texture. A dose of 3.5 g/animal/day could be recommended in feedlot animals, but greater doses could have a pro-oxidant effect.

1. Introduction

In Brazil, traditional cattle production systems are extensive and pasture-based (Ferraz & Felício, 2010) and Zebu breeds (*Bos indicus*) such as Nellore and European crossbreds (*Bos taurus* × *Bos indicus*) are frequently used (Rotta et al., 2009). In recent years, due to the increased domestic and export beef demand linked to large annual growth in the meat market, the use of more intensive production systems has also increased and performance and meat quality have also improved through this intensification (Prado et al., 2008). Thus, production systems are changing in Brazil and feeds with more energy including a high percentage of concentrate are being utilized, contributing to a shift towards feedlot production systems (Miguel et al., 2014; Rotta et al., 2009).

Over the last decade, the addition of antibiotics in livestock production systems has been common, especially when animals are reared intensively, in order to prevent diseases, metabolic disorders, and to improve feed efficiency (Benchaar, Duynisveld, & Charmley, 2006; Goodrich et al., 1984). However, due to the emergence of antibiotic resistance and possible risks to human health due to residues in the final products (Russell & Houlihan, 2003), their use has been forbidden in some regions such as the EU, where research has begun to focus on investigating natural alternatives, which are well accepted by consumers (Verbeke et al., 2010). In this sense, plant extracts have an interesting role as a safe food additive (Benchaar et al., 2008; Valero et al., 2014a).

There are several activities of essential oils (Jayasena & Jo, 2013) as feed additives for livestock because they improve feed efficiency and animal productivity due to their antimicrobial, anti-inflammatory, antioxidant, and digestive modulatory effects on ruminal metabolism (Bakkali, Averbeck, Averbeck, & Idaomar, 2008; Benchaar et al., 2008). Their antimicrobial activity can decrease ruminal biohydrogenation and consequently increase the deposition of PUFA in meat (Martineau et al., 2008; Scollan et al., 2001).

However, studies on the effects of essential oils on meat quality are still scarce. It has been demonstrated that this effect exists using the essential oils of diverse plants. Oregano and thyme are two species that elevate antioxidant potential due to the presence of phenolic terpenes such as thymol and carvacrol (Bakkali et al., 2008). Each plant has specific active components that dictate the characteristics of its extract. When using a blend, essential oils could have a synergistic effect, influencing their mode of action in animal metabolism and affecting beef quality.

The aim of this study was investigate the effect of different doses of an essential oil blend on meat quality: chemical composition, color, water holding capacity, texture, lipid oxidation and fatty acid

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composition of the *Longissimus thoracis* muscle of intensively reared young bulls throughout aging (1, 7 and 14 days).

2. Materials and methods

2.1. Locality, animals and diets

This experiment was approved (no. 185/2012-CEUA) by the ethical committee of São Paulo State University "Julio de Mesquita Filho" (UNESP). The study was conducted at the Rosa & Pedro Sector of the Experimental Station at Iguatemi Farm, Maringá city, Paraná, Brazil.

Twenty-seven 12 month-old half-brother crossbred young bulls (F1 – ½ Angus - ½ Nellore) with an average weight of 243.2 ± 35.3 kg, were randomly assigned to one of three finishing diets ($n = 9$ per treatment). The bulls were allocated in individual pens.

The basal diet was the same for all animals (Table 1), and was formulated according to the NRC (2000) recommendations for a 1.50 kg average daily gain. The three experimental diets were as follows: E0.0 diet without the addition of the essential oil blend or control diet; E3.5 diet with 3.5 g/animal/day of the essential oil blend; and E7.0 diet with 7 g/animal/day of the essential oil blend. The oil blend (MixOil®) was produced by Animal Wellness Products (A.W.P.™), Oakland, Nebraska, USA, and was added directly into the concentrate. Components of the blend consisted of seven plant extracts: oregano (*Origanum vulgare*), garlic (*Allium sativum*), lemon (*Citrus limonium*), rosemary (*Rosmarinus officinalis*), thyme (*Thymus vulgaris*), eucalyptus (*Eucalyptus saligna*), and sweet orange (*Citrus aurantium*).

Young bulls were finished on their respective intensive diets (90:10 concentrate:sugarcane bagasse pelletized) for four months until they reached commercial weights (440.3 ± 42.7 kg), with 1.64 ± 0.04 kg of average daily gain. Afterwards, they were slaughtered at a commercial abattoir situated 20 km from the feedlot, after a solid fasting period of 12 h according to the standard cattle finishing routine in Brazil. After slaughter, carcasses were divided medially through the sternum and vertebral column, identified, and chilled at a temperature below 4 °C for 24 h. After 24 h, *Longissimus thoracis* (LT) was excised from the left side of the carcass between the sixth and the ninth ribs for subsequent analyses.

2.2. Nutrient and diet analyses

The dry matter (DM) content of the ingredients (sugarcane bagasse pellets and concentrate mix) were determined by oven drying at 65 °C for 72 h (Table 1). The analytical DM content was determined by drying at 135 °C for 3 h using method 930.15. The organic matter content was calculated as the difference between the DM and ash contents, with ash determined through combustion at 550 °C for 5 h using method 936 (AOAC, 2005). The neutral detergent fiber and acid detergent fiber contents were determined using methods described by Mertens (2002). Nitrogen content in the samples was determined using method 976.05 (AOAC, 2005). The total digestible nutrient content was obtained using the methodology described by Kearl (1982). Samples were analyzed at the Laboratory of Feed Analyses and Animal Nutrition, at the State University of Maringá.

2.3. Sampling and meat quality

Longissimus thoracis (LT) from sixth rib having been previously separated, was weighed and divided into two parts to determine its chemical and fatty acid composition. The rest of the LT was excised from the left side of the carcass between the seventh and the ninth ribs, sliced into steaks (2.5 cm thick), weighed, vacuum-packed (99% vacuum, with a Sulpack SVC 620 machine, in Polyamide/Polyethylene pouches of 120 μm and 1 cm^3/m^2/24 h 0_2 permeability, 3 cm^3/m^2/24 h $C0_2$ 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), and aged for either 24 h, 7 or 14 days before being frozen and stored (−20 °C) for one month for subsequent analyses.

2.4. pH measurements

At 24 h post-mortem, the LT pH was measured using a Meter Text Model (Tradelab, Contagem MG Brazil) pH-meter and a penetration electrode at the point of the 3rd lumbar vertebra (Young, West, Hart, & Van Otterdijk, 2004).

2.5. Chemical composition

The chemical composition (percentage of water, ash, crude protein, total lipids, and total collagen) was determined by the principle of near infrared transmittance using a Food Scan Lab TM (Foss NIR Systems, Inc., USA) instrument, which operates in transmittance mode from 850 to 1050 nm at 2 nm intervals. Samples (60 g) of minced meat were placed into a glass cup (90 × 90 × 15 mm) and scanned in duplicate. The spectrum of each sample was the average of five scan locations and was recorded as log $1/T$ (T = transmittance). The duplicate scans of each sample were examined for consistency and then averaged. Total lipids were extracted using the Bligh and Dyer (1959) method with a chloroform/methanol mixture.

2.6. Meat color

Meat color was assessed in fresh meat before the steaks were frozen using a Minolta CR-400 spectrophotometer with a 10° view angle and a D65 illuminant at 24 h, and 7 and 14 days of aging under vacuum package conditions, after blooming for 30 min. Five measurements were taken per sample.

Table 1
Composition (g/kg DM) of the diets fed to crossbred young bulls from 243.2 to 440.3 kg of body weight.

Parameters	Ingredients, g/kg on DM							Diets, g/kg on DM
	SCBP[a]	Corn grains	Soybean meal	Limestone, 36%	Yeast	Mineral salt	Urea	
Dry matter	947.0	889.3	886.0	993.0	980.0	993.0	980.0	881.3
Organic matter	980.0	991.0	937.0	107.1	–	107.0	5.6	973.4
Ash	19.7	9.50	62.5	832.9	–	893.0	994.4	26.60
Crude protein	18.3	89.9	490.0	–	300.0	–	2600	125,0
Ether extract	36.0	35.0	13.0	–	–	–	–	22.0
Neutral detergent fiber	787.4	177.0	137.0	–	–	–	–	303.0
Acid detergent fiber	492.0	44.0	59.7	–	–	–	–	148.0
Total digestible nutrients	430.0	900.0	840.0	–	–	–	–	703.0
Diets	100	819.5	65.1	4.60	0.50	4.10	6.20	

[a] Sugarcane bagasse pellet.