EFFECT OF INCLUSION OF ESSENTIAL OILS ON FATTY ACID COMPOSITION OF CROSSBRED YOUNG BULLS FINISHED IN A FEEDLOT

Dayane C. Rivaroli[1], Fernando Zawadzki[1], Jéssica Monteschio[1], Mariana G. Ornaghi[1], Carlos A. Fugita[1], Juliana A. Torrecilhas[1], André M. Jorge[2] and Ivanor N. do Prado[1]

[1] Department of Animal Science, Universidade Estadual de Maringá, 87020-900 Maringá, Paraná, Brazil.

[2] Department of Animal Production, Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista, 18618-000 Botucatu, São Paulo, Brazil.

Abstract – The objective of this study was to assess of the effects of the inclusion of essential oils (MixOil®) on fatty acid composition of meat of young bulls finished in feedlot. Twenty seven 12 month-old crossbred (Angus vs. Nellore), average weight of 243.2 ± 35.3 kg were randomly assigned to one of three finishing diets composed with MixOil®: without addition of blend (E0.0), with 3.5 g/animal/day (E3.5) and with 7 g/animal/day (E7.0) of blend. Component of blend consisted on seven plants extracts: oregano, garlic, lemon, rosemary, thyme, eucalyptus and sweet orange. Animals were slaughter with 440.3 ± 42.7 kg and carcasses were labeled and chilled for 24 h at 4oC. Longissimus muscle (LM) was used to determinate amount the fatty acids. The addition of essential oils in the diet not had a significant effect (P>0.05) composition of fatty acids.

Key Words – lipids, meat quality, natural additives.

I. INTRODUCTION

To increase productivity and thus meet the market demand, the use of strategies is needed, for example the use of intensive systems. For intensive finishing systems feeding diets with high percentage of grains is required [1].

High energy diets like the high grain can cause metabolic disorders, for that reason, the use of dietary antibiotics such systems it has been usual, since these may prevent diseases, metabolic disorders and improve feed efficiency [2].

However, since 2006 the European Union has been restricting the use of antibiotics due to the emergence of bacterial resistances and the possible risk for human health due to the presence of residues in final products [3].

Essential oils have been studied as a natural alternative to substitution of ionophores in intensive systems [4].

Several studies have reported varied activities of essential oils [5]. 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 [6].

Antimicrobial activity of essential oils can also influence the composition of fatty acids in meat, since it have an effect of modulation the ruminal fermentation may then decrease biohydrogenation ruminal and consequently increase the deposition of PUFA in meat [7, 8].

This study was conducted to investigate the effect of adding the blend of essential oils in the diet of young bulls finished on feedlot on the fatty acid composition of muscle.

II. MATERIALS AND METHODS

Twenty-seven 12 month-old crossbred (½ Angus vs. ½ Nellore) young bulls, average weight of 243.2 ± 11.7 kg, respectively, were randomly assigned to one of three finishing diets (n = nine for young bulls per treatment). The three experimental treatments were: (E0.0) diet without addition of the blend of Essential oils (EO), (E3.5) diet with 3.5 g/animal/day of the blend of EO, and (E7.0) diet with 7.0 g/animal/day of the blend of EO. The blend of EO used consisted of seven plants extracts: oregano (*Origanum vulgare*), garlic (*Allium sativum*), lemon (*Citrus limonium*), rosemary (*Rosmarinus officinalis*), thyme (*Thymus vulgaris*), eucalyptus (*Eucalyptus saligna*) and sweet orange (*Citrus aurantium*), registered as Mixoil® (Animal Wellness Products – Oakland – Nebraska – USA).

The blend of EO had powdery texture; and it was mixed directly to the concentrate each two weeks in a commercial mixer where diets were prepared during experimental period. The young bulls were finished with their respective diets under intensive conditions (90:10; concentrate : forage). The concentrate consisted of corn grain (819 g/kg of dry matter, DM), soybean meal (65 g/kg of DM), Limestone (4.6 g/kg of DM), yeast (0.5 g/kg of DM), mineral salt (4.1 g/kg of DM) and urea (6.2 g/kg of DM). Sugar-cane pellets were used as-forage. The basal diet was the same for all animals, formulated according to NRC [9] recommendations for a 1.5 kg/day average daily gain. All diets were isoenergetics and isonitrogenous. The diet consisted of 125 g/kg of DM of crude protein, 22 g/kg of DM of ether extract, 303 g/kg of DM of neutral detergent fiber, 14.8 g/kg of DM of acid detergent fiber and 708 g/kg of DM of nutrient digestible total. The mineral salts consisted of (g/kg of DM) 150 Ca, 88.0 P, 0.08 Co, 1.45 Cu, 10.0 S, 1.0 Fe, 0.88 F, 0.06 I, 10.0 Mg, 1.10 Mn, 0.02 Se, 120 Na and 3.40 Zn. The young bulls were finished for 4 months. The bulls were slaughtered with 440.3 ± 42.7 kg at a commercial slaughterhouse 20 km from Experimental Farm (Maringá, PR) according to Brazilian practices. After slaughter, the carcasses were labelled and chilled for 24 h at 4°C. After chilling, the carcasses were weighed and the right side of carcass was used to determine the quantitative and qualitative characteristics. The *Longissimus thoracis* (LM) was excised from the left side of the carcass between the 7^{th} and the 9^{th} ribs, sliced into steaks (2.5 cm thick) weighed, vacuum-packed, and aged for either 24 h and 7 or 14 days before being frozen and stored (-20ºC) for one month for subsequent analyses. Before the 6th rib was frozen, *Longissimus thoracis* (LT) of this rib was separated, weighed, and divided into two parts to determine the chemical composition and fatty acids.

Total lipids were extracted using a method with a chloroform/methanol mixture [10]. Fatty acid methyl esters (FAMEs) were prepared by triacyl glycerine methylation [11]. Fatty acid methyl esters (FAME) were analyzed in a gas chromatograph (Varian, USA), equipped with a flame ionization detector and a fused silica capillary column CP-7420 (100 m, 0.25 mm, and 0.39 μmo.d., Varian, USA) Select Fame. The column temperature was programmed at 165°C for 18 minutes, 180°C (30°C min^{-1}) for 22 minutes, and 240°C (15°C min^{-1}) for 30 minutes with 45-psi pressure. The injector and detector were kept at 220°C and 245°C, respectively. Gas flows (White Martins, São Paulo, Brazil) were 1.4 mL min^{-1} for carrier gas (H_2); 30 ml min^{-1} for make-up gas (N_2); and 30 mL min^{-1} and 300 mL min^{-1} for H_2 and synthetic flame gas, respectively. The sample was injected by using a split mode 1/80. Fatty acids (FA) were identified by comparing the relative retention time of FAME peaks of the samples with standard FAMEs 189-19 from the Sigma Company, St Louis, MO, USA by spiking samples with the standard. The peak areas were determined by using Star software (Varian, Walnut Creek, CA, USA).

The experimental design was completely randomized with three treatments and nine replications. The characteristics that were under study were tested for normality. Those that showed a normal distribution were analyzed through analysis of variance by using the procedure proc MIXED with SAS (2004)[12] statistical package (Statistical Analysis System, version 8.1). Differences between group means were assessed by using the Tukey Test (p<0.05).

III. RESULTS AND DISCUSSION

The percentages of saturated fatty acids (SFA), monounsaturated (MUFA), polyunsaturated (PUFA), *n*-3 fatty acids, fatty acids *n*-6, PUFA:SFA, and the *n*-6:*n*-3 ratio of the *LT* from crossbred feedlot cattle were not influenced (P>0.05) by the addition of essential oils in the feed (Table 1). Thus, SFA, MUFA, and PUFA fatty acid percentages vary minimally in function this diet [13].

The percentage of SFA MUFA, PUFA, n-3 fatty acids, and n-6 fatty acids was 47.15, 47.44, 5.8, 0.28, and 4.99%, respectively. The majority of the fatty acids observed on LM were MUFA (47.45%) followed by SFA (47.07%) and PUFA (5.76%).

The PUFA:SFA and *n-6:n-3* ratios observed in this study were 0.12 and 17.43 respectively.

In the rumen, the unsaturated fatty acids provided to diet, can be toxic to microbial population. So as defense mechanism, the bacteria make these fatty acids biohydrogenation forming saturated fatty acids [14]. Therefore, feeding essential oils could lower the biohydrogenation of fatty acids by reducing the number and activity of bacteria involved in the biohydrogenation of unsaturated fatty acids, can decrease the lipolysis and increase PUFA deposition in the *LT* [15]. In our study, the addition of essential oils did not increase (P>0.05) PUFA values. Similarly, other study Valero M. V [13] did not observe changes in total fatty acid for LM from crossbred bulls finished in a feedlot.

Table 1 Effect of essential oils inclusion on fatty acid composition in the *Longissimus thoracis* of crossbred young bull meat

Tbars	Essential oils			SEM[4]	*P*[5]
	E0.0[1]	E3.5[2]	E7.0[3]		
SFA[6]	47.86	47.46	46.13	1.02	0.47
UFA[7]	52.33	53.11	54.30	1.08	0.41
MUFA[8]	47.61	47.25	47.47	1.10	0.97
PUFA[9]	4.72	5.85	6.82	0.90	0.25
n-3	0.25	0.30	0.29	0.02	0.51
n-6	4.00	5.07	5.91	0.80	0.24
PUFA:SFA	0.10	0.12	0.15	0.02	0.18
n-6/*n*-3	15.70	16.90	19.70	2.18	0.41

[1]Without essential oils; [2]3.5 g essential oils/animal/day; [3]7.0 g essential oils/animal/day; [4]SEM: Standard error of mean. [5]Probability. n = nine bulls per treatment. [6]saturated fatty acids; [7]unsaturated fatty acid; [8]polyunsaturated fatty acids; [9]monounsaturated fatty acid.

The recommended ratio of PUFA:SFA is higher than 0.45 [16] and it has an important role in reducing cardiac risks [17]. However, the ratio that was found in the present study was 0.12. typical of intensive rearing conditions.

Western countries have a high dietary ratio of *n*-6/*n*-3 because of the high consumption of linoleic acid (LA, *n*-6) from the common use of vegetable oils containing LA (e.g. soybean oil and sunflower oil). The FAO/WHO recommends a diet with a 4:1 ratio of *n*-6/*n*-3.

The mean ratio of *n-6*/*n-3* that was observed was 17.5. The high ratio of *n-6*/*n-3* was due to the high consumption of LA (*n-6*) from the common use of cereals containing LA (eg maize. soybean). Enser, M. [18] observed that meat from pasture-fed animals have lower *n-6*/*n-3* ratios than those fed grain. because the temperate grasslands have higher levels of α-linolenic acid (*n-3*) and linoleic grains (*n-6*). The HMSO [16] recommends consumption of a 4:1 ratio of *n-6*/*n-3* or less. Omega 3 fatty acids and its derivate helps to avoid heart disease and cancer [19].

IV. CONCLUSION

The addition of essential oils did not modified the fatty acid composition of *Longissimus thoracis* muscle of young bulls finished on feedlot. Thus, these two additives that improve animal performance, feed efficiency and shelf life, as observed in other studies could be added in the diets for animal finished in feedlot system without to change meat quality.

ACKNOWLEDGEMENTS

The Foundation for Research Support of the State of São Paulo (process 2012/18873-8 research support and 2012/11918-6 master scholarship).

REFERENCES

1. Ito, R.H., T. Ducatti, J.M. Prado, I.M. Prado, P.P. Rotta, M.V. Valero, et al. 2010. Soybean oil and linseed grains on performance and carcass characteristics of crossbred bulls finished in feedlot. Semina: Ciencias Agrarias 31:259-268.
2. Goodrich, R. D., Garrett, J. E., Gast, D. R., Kirick, M. A., Larson, D. A., & Meiske, J. C. (1984). Influence of monensin on the performance of cattle. Journal of Animal Science, 58(6), 1484-1498.
3. Russell, J. B., & Houlihan, A. J. (2003). Ionophore resistance of ruminal bacteria and its potential impact on human health. FEMS Microbiology Reviews, 27(1), 65-74
4. Benchaar, C., Calsamiglia, S., Chaves, A. V., Fraser, G. R., Colombatto, D., McAllister, T. A., & Beauchemin, K. A. (2008). A review of plant-derived essential oils in ruminant nutrition and production. Animal Feed Science and Technology, 145(1-4), 209-228.
5. Jayasena. D. D. & Jo. C. (2013). Essential oils as potential antimicrobial agents in meat and meat products: A review. Trends in Food Science & Technology. 34(2). 96-108.
6. Bakkali. F.. Averbeck. S.. Averbeck. D. & Idaomar. M. (2008). Biological effects of essential oils–a review. Food and Chemical Toxicology. 46(2). 446-475.
7. Scollan ND, Dhanoa MS, Choi NJ, Maeng WJ, Enser M, Wood JD. Biohydrogenation and digestion of long chain fatty acids in steers fed on different sources of lipid. The Journal of Agricultural Science. 2001;136(03):345-55.

8. Martineau R, Petit HV, Benchaar C, Lapierre H, Ouellet DR, Pellerin D, et al. Effects of lasalocid or monensin on in situ biohydrogenation of flaxseed and sunflower seed unsaturated fatty acids. Can J Anim Sci. 2008;88(2):335-9.
9. NRC (2000). Nutrient Requirements of beef Cattle (7th rev. ed.). Washington. DC. USA : Natl. Acad. Press.
10. Bligh EG, Dyer WJ. A rapid method of total lipid extraction and purification. Can J Biochem Physiol. 1959;37(8):911-7.
11. ISO-R-5509. Animal and vegetable fats and oils – Preparation of methyl esters of fatty acids. Method ISO 5509. International Organization for Standardization, Geneva, Switzerland. 1978.
12. SAS. (2004). SAS/STAT User guide. Version 9.1.2. Cary. NC. USA: SAS Institute Inc.
13. Valero, MV, Torrecilhas, JA, Zawadzki, F, Bonfé, EG, Madrona, GS, Prado, RM, Passetti, RAC, Rivaroli, DC, Visentainer, J, Prado, IN (2014) Propolis or cashew and castor oils effects on composition of Longissimus muscle of crossbred bulls finished in feedlot. Chilean Journal of Agricultural Research 74, 445-451
14. Martineau R, Petit HV, Benchaar C, Lapierre H, Ouellet DR, Pellerin D, (2008). Effects of lasalocid or monensin on in situ biohydrogenation of flaxseed and sunflower seed unsaturated fatty acids. Can J Anim Sci. 88(2):335-9.
15. Wood JD, Enser M, Fisher AV, Nute GR, Sheard PR, Richardson RI, et al. Fat deposition, fatty acid composition and meat quality: A review. Meat Sci. 2008;78(4):343-58.
16. HMSO. (1994). England Department of Health Nutritional. Aspects of cardiovascular disease. Report on Health and Social Subjects, 46, 37-46.
17. Wood, J. D., Enser, M., Fisher, A. V., Nute, G. R., Whittington, F. M. & Richardson, R. I. (2003). Effects of diets on fatty acids and meat quality. Options Méditerranéennes, Series A, 67, 133-141.
18. Enser, M., Hallett, K. G., Hewett, B., Fursey, G. A. J., Wood, J. D. & Harrington, G. (1998). Fatty acid content and composition of UK beef and lamb muscle in relation to production system and implications for human nutrition. Meat Science, 49(3), 329-341.
19. Calder, P. C. (2004). n-3 Fatty acids and cardiovascular disease: evidence explained and mechanisms explored. Clinical Science, 107(1), 1-11.