

Meat Science and Muscle Biology I

M142 Effect of power ultrasound on the physicochemical properties of beef longissimus dorsi muscle. C. Valenzuela-Gonzalez^{*1}, A. D. Alarcon-Rojo¹, E. Santellano¹, and A. Quintero-Ramos², ¹Universidad Autonoma de Chihuahua, Facultad de Zootecnia y Ecologia, Chihuahua, Mexico, ²Universidad Autonoma de Chihuahua, Facultad de Ciencias Quimicas, Chihuahua, Mexico.

High-intensity ultrasound has been used to modify the physical or chemical properties of food. Several areas have investigated the potential future development of this technique in the food industry. To determine the effect of power ultrasound on the physicochemical characteristics of beef, we excised the m. longissimus dorsi muscle from 4 Holstein cows at 48 h postmortem. Any visible fat was trimmed away and the meat was cut into 5 cm slices, before chopping into 4-cm³ cubes. Half of the cubes from the same slice remained untreated (control samples), whereas the other half were irradiated with power ultrasound for 4 or 8 min. Ultrasound waves were applied at a frequency of 40 kHz using water as the transmission medium. We then evaluated the meat pH, color (L*, a*, and b*), water-holding capacity (WHC), drip loss (DL), and shear force (SF). The adjusted model for statistical analyses included the effects of treatment, sonication time, and the interaction of treatment x sonication time. Data were analyzed using the mixed procedure method in SAS. If the main effects or their interaction were significant ($P \leq 0.05$), the means for a given characteristic were compared among time and treatment groups using the least significant difference method. There was an effect ($P \leq 0.05$) of ultrasound on the a*, b*, pH, WHC, and DL of the meat samples. The ultrasound-treated meat had a lower redness (a*) and yellowness (b*) compared with the control samples for both ultrasound application periods. Ultrasonication of meat for 8 min produced the highest pH value and the lowest DL ($P \leq 0.05$). There was no effect ($P \geq 0.05$) of ultrasound on the L* and SF of meat. It has been reported that ultrasound alone did not change the peak force of pork, and it was only effective when combined with marination. However, the use of power ultrasound may be an alternative method for improving the physicochemical properties of beef.

Table 1. Least squares means \pm standard error for physicochemical properties of beef L. dorsi muscle treated with power ultrasound

Sonication time, min	Treatment ¹	Luminosity, L*	Redness, a*	Yellowness, b*	pH	Drip loss, %	Shear force, kg/cm ²
4	C	24 \pm 1a	14 \pm 1a	12 \pm 1a	5.3 \pm 0.1a	9.2 \pm 0.4a	1.8 \pm 0.3a
4	HPU	24 \pm 1a	11 \pm 1b	11 \pm 1a	5.4 \pm 0.1a	8.3 \pm 0.4a	2.0 \pm 0.3a
8	C	23 \pm 1a	14 \pm 1a	12 \pm 1a	5.3 \pm 0.1a	9.2 \pm 0.4a	2.3 \pm 0.3a
8	HPU	22 \pm 1a	11 \pm 1b	8 \pm 1b	5.5 \pm 0.1b	7.1 \pm 0.4b	2.4 \pm 0.3a

a,bMeans in columns without common letters differ significantly ($p \leq 0.05$).

¹C = control, HPU = high power ultrasound.

Key Words: power ultrasound, beef, quality characteristics

M143 Diffusion of sodium chloride in bovine meat treated with power ultrasound in continuous and pulse modes. E. B. Ordaz-Portillo, A. D. Alarcon-Rojo, and C. Valenzuela-Gonzalez,^{*} Universidad Autonoma de Chihuahua, Chihuahua, Mexico.

To evaluate the effect of power ultrasound on the diffusion of sodium chloride in beef muscles, an experiment with 6 replicates was carried

out using the Semitendinosus muscle of adult Holstein cows. Semitendinosus muscle was cut transversally into one -inch -thick slices and placed in an ultrasonic bath containing a salt solution that just covered the slice. The ultrasound was applied in both, pulsed and continuous modes for 6 treatment times (10, 20, 30, 40, 50 and 60 min) and in 2 salt solutions (5% and 10% sodium chloride). To assess the diffusion of salt into meat the concentration of sodium chloride was measured with a digital refractometer in 3 regions of the meat slice (external, middle and inner). The data were analyzed using PROC GLM of SAS and included the ultrasound mode, salt solution concentration, ultrasound application time, slice (external, middle and central) region and their possible interactions as fixed factors. The results showed significant differences ($P \leq 0.05$) in the diffusion of salt which depended on the salt solution concentration. There was also a significant interaction between ultrasound mode and slice region. The highest salt diffusion was observed in the 60 min continuous mode with 10% sodium chloride solution. The application of ultrasound in continuous mode resulted in the highest salt diffusion in all meat slice regions, with the external region having the highest salt concentration. The increase in salt concentration was proportional to the sonication time. It is concluded that power ultrasound may be a potential method for improving sodium chloride transfer during meat processing.

Key Words: salt diffusion, power ultrasound, beef

M144 Meat traits of steers fed with whole cottonseed. D. P. Borges da Costa^{*1}, R. de Oliveira Roça², Q. P. Borges da Costa³, L. da Silva Cabral⁴, D. P. D. Lanna⁵, E. da Silva Lima³, D. G. Fagundes¹, and N. L. Filho¹, ¹Instituto Federal de Mato Grosso, Campo Novo do Parecis, Brazil, ²Faculty of Agricultural Sciences, Universidade Estadual Paulista, Botucatu, Brazil, ³Faculty of Veterinary Medicine, Universidade Estadual Paulista, Botucatu, Brazil, ⁴Universidade Federal de Mato Grosso, Cuiabá, Brazil, ⁵Escola Superior de Agricultura "Luiz de Queiroz," Universidade de São Paulo, Piracicaba, Brazil.

The objective of this study was to determine the effect of inclusion whole cottonseed in the diet on the meat characteristics of Nelore steers. Thirty-six steers (average initial body weight of 333.50 kg and aged 20 mo) were housed during 94 d in pens with 3 animals each. The animals were distributed, equally, among 4 treatments, and these corresponded to diets containing increasing amounts of whole cottonseed: without whole cottonseed, 14.35% of whole cottonseed, 27.51% of whole cottonseed and 34.09% of whole cottonseed in relation to the dry matter of the diet. The animals' final live weight average was 446.64 kg \pm 27.96 kg. These animals were slaughtered and was collected from the left half carcass of each animal, it was taken off part of the sirloin steak, in the 12th thoracic vertebra - 3rd lumbar vertebra, individually wrapped in plastic bags, identified and frozen at -18oC and were sent for analysis. A completely randomized design with 4 treatments and 9 replications was used. Treatments' effects if significant ($P < 0.05$) were estimated by regression analysis. MIXED from SAS (2001) for statistical analysis. The protein values, shear force; lipid oxidation, meat and fat color were similar among the treatments. However, the addition of the whole cottonseed levels linearly reduced the intramuscular fat percentage and increased moisture content of meat. Whole cottonseed feeding reduced the fatty acids concentration of C14:1 cis 9, C16:1 cis 9, C17:0, C17:1 and C18:1 cis 9 in the meat. The fatty acids C13:0 ISO,

C13:0 ANTEISO, C14:0 ISO, C15:0 ISO, C15:0 ANTEISO, C17:0 ISO, C18:0 and C18:1 trans 10 - trans 11 content in the meat have increased by the whole cottonseed addition in the diet. Inclusion of 27.51 and 34.09% of whole cottonseed in the diet altered negatively the meat aroma and flavor, respectively. The whole cottonseed diet did not change the concentration of conjugated linoleic acid, saturated fatty acids and the total unsaturated in the meat.

Key Words: flavor, CLA, stearic acid

M145 Lipid peroxidation and color of meat from young bulls fed different levels of crude glycerin. M. M. Ladeira,* J. R. R. Carvalho, M. L. Chizzotti, E. M. Ramos, P. D. Teixeira, M. C. L. Alves, P. E. P. Barros, and O. R. Machado Neto, *Federal University of Lavras, Lavras, MG, Brazil.*

The use of crude glycerin in ruminant diets has the objective of decrease the operational cost. However, its effects on the meat characteristics should be better studied. The objective was to evaluate lipid peroxidation, using thiobarbituric acid reactive substances (TBARS), and color of meat from young bulls fed different levels of crude glycerin in the diet. Forty-four Red Norte animals were slaughtered at average live weight of 519 ± 15 kg, and the levels of crude glycerin (83% glycerol) were: 0, 6, 12 and 18% DM. The experiment was conducted in a completely randomized design, with 4 treatments and 11 repetitions. The basal diet was consisted of 30% corn silage, 12% soybean meal, 56% of corn grain and 2% mineral mixture. Corn was partially replaced by glycerin, and to achieve an isonitrogenous diet, corn gluten meal (21% CP) was used. After slaughter, samples were taken from the Longissimus dorsi muscle. Then, they were vacuum packed and maintained refrigerating at 4°C for 0, 7, 14 and 21 d post mortem. The color reading was conducted on the surface, using the CIE L*a*b* system. When significant effects ($P < 0.05$), regressions analysis using PROC REG of SAS 9.1.3 were done. There was no effect of storage time on color and lipid peroxidation ($P > 0.05$). The indices of lightness (L*), red (a*), yellow (b*), saturation index (C*) and the index of hue angle (h) showed a quadratic effect ($P < 0.01$) with the inclusion of crude glycerin (Table 1). Therefore, the meat changed from a red-purple color when the animals received 6% of glycerin, for the cherry-red when 18% was used. It was observed a tendency ($P = 0.07$) of increase on TBARS in the muscle of animals fed crude glycerin. As a conclusion, the use of a crude glycerin provided meat with better color and better appearance to the consumer. Funded by Fapemig, CNPq, Capes and INCT-CA

Table 1. Lipid peroxidation and color characteristics of meat of young bulls fed different levels of crude glycerin

Item	Crude glycerin, % DM basis				SEM	P-value
	0	6	12	18		
TBARS, mg of malonaldehyde /kg of meat	0.25	0.22	0.27	0.27	0.04	0.07
L*	32.8	30.4	33.1	35.6	0.55	<0.01 ¹
a*	18.0	16.1	17.4	18.1	0.31	<0.01 ¹
b*	2.54	0.53	2.26	3.28	0.30	<0.01 ¹
C*	18.3	16.1	17.7	18.5	0.35	<0.01 ¹
h*	6.94	1.75	6.57	9.67	0.91	<0.01 ¹

¹Quadratic effect.

Key Words: beef, glycerol, TBARS

M146 The use of visible and near infrared spectroscopy for quality control of organic and conventional beef stored under protective atmospheres. M. Ólivan¹, V. Sierra¹, G. Fiorentini^{2,4}, N. Prado³, P. González³, B. Álvarez³, J. Díaz³, and K. Osoro¹, ¹*Servicio Regional de Investigación y Desarrollo Agroalimentario (SERIDA), Apdo. 13, 33300 Villaviciosa, Asturias, Spain,* ²*Universidade Estadual Paulista (UNESP), Jaboticabal, SP, Brazil,* ³*Asociación de Investigación de Industrias Cárnicas del Principado de Asturias (ASINCAR), Polígono de la Barreda, Noreña, Spain,* ⁴*Bolsista Processo n°2469-11-1 - CAPES, Setor Bancário Norte, Brasília, Brazil.*

The objective of this work was to evaluate the potential of Visible (VIS) and Near Infrared Spectroscopy (NIRS) for on-site control of beef shelf life on meat trays stored at display counters. Beef samples (steaks) were obtained from the Longissimus dorsi muscle of 12 young bulls managed under organic (pasture or maize silage plus organic concentrate) or conventional (finished at feedlot with concentrate meal and barley straw ad libitum) feeding. These beef samples were packed under 2 different protective atmospheres (vacuum and 80%O₂-20%CO₂) and analyzed after 1, 3, 5, 8, 12 and 15 d of storage, so the global study included a total of 144 samples (12 animals x 2 protective atmospheres x 6 storage time). Meat quality analysis included color (L*, a*, b*), microbiology (mesophilic, anaerobic, enterobacteriaceae), texture (Warner-Bratzler shear force “WBSF”) and oxidative status (TBARS index). VIS/NIRS spectra were obtained by using a portable LabSpec 5000 fitted with a fiber optic probe (ASD Inc., USA) in reflectance mode (350–2500nm). Representative spectra of each beef steak were calculated as the average of 5 scans obtained on the steak surface, with or without film interaction, that is, before and after tray wrap opening. VIS/NIRS calibrations were calculated using the software Unscrambler 9.7. The results of the calibration statistics showed good prediction for beef color (L*, a*, b*) when measured on intact (R² of 0.84, 0.88 and 0.73, respectively) or opened (R² of 0.90, 0.88 and 0.74, respectively) meat trays. However, poorer predictions were obtained for other shelf life parameters showing high stability along the storage period, like microbial spoilage (R² between 0.40 and 0.55), TBARS (R² < 0.40) and texture (R² < 0.37). Furthermore, VIS/NIRS spectra showed some potential for classification of beef samples into shelf-life quality grades.

Key Words: beef, NIRS, shelf life

M147 Fatty acid composition of cattle fattened with tropical forage at rainy and drought season. M. E. E. Rodríguez*¹, G. Corral-Flores¹, B. S. Solorio², A. D. R. Alarcón¹, J. A. Grado-Ahuir¹, C. Rodríguez-Muela¹, L. P. Cortés¹, and V. E. B. Segovia¹, ¹*Facultad de Zootecnia y Ecología. UACH, Chihuahua, México,* ²*Fundación Produce Michoacán A. C., Morelia, México.*

The objective of this study was to quantify intramuscular fat and fatty acid composition of meat from cattle fattened on tropical forages (*L. leucocephala*, *P. maximum* and *C. plectostachyus*) under the intensive Silvopastoral System (SSPi) at 2 seasons (rainy n = 12 and drought n = 10). Intramuscular fat of *L. dorsi* (Ld) and *Semimembranosus* (Sm) muscles was extracted and fatty acids (myristic, mirystoleic, palmitic, palmitoleic, stearic, oleic, linoleic, eicosanoic, arachidonic acid (ARA) and docosahexaenoic (DHA) acids) were quantified. The effect of season was analyzed with a linear model. The intramuscular fat was higher ($P \leq 0.05$) in rainy ($3.530 \pm 0.22\%$) vs. drought ($2.47 \pm 0.21\%$) season and myristic, mirystoleic, palmitic, palmitoleic and stearic acid were not different ($P \geq 0.05$) between seasons. Oleic acid had higher concentration ($P \leq 0.05$) in the rainy ($40.69 \pm 3.15\%$) vs. drought (27.52

± 3.46%), while linoleic, linolenic and eicosanoic acid concentration were lower ($P \leq 0.05$) in rainy season. For the essential fatty acids, ARA concentration was lower ($P \leq 0.05$) in rainy ($0.08 \pm 0.10\%$) vs. drought ($0.48 \pm 0.11\%$) season and DHA had similar concentration ($P \geq 0.05$) along year seasons. It is concluded that beef fattened with tropical forages yield leaner meat in both seasons and its fatty acid compositions is maintained during the year. The SSPi is another alternative toward more sustainable meat production and promising source of dietary fat for human nutrition.

Table 1. Least squares means \pm SE of intramuscular fat composition (% of fatty acids) of cattle fattened with tropical forages at two season

Variable	Rainy	Drought
Total fat	3.53 \pm 0.22 ^a	2.47 \pm 0.21 ^b
Oleic	40.69 \pm 3.15 ^a	27.52 \pm 3.46 ^b
Linoleic	0.11 \pm 0.88 ^b	3.11 \pm 0.97 ^a
Linolenic	1.67 \pm 0.51 ^b	6.10 \pm 0.56 ^a
Eicosanoic	0.11 \pm 0.18 ^b	0.93 \pm 0.20 ^a
Arachidonic acid (ARA)	0.08 \pm 0.10 ^b	0.49 \pm 0.11 ^a

^a^bSuperscripts different between columns denote significant difference between season ($P \leq 0.05$).

Key Words: Silvopastoral System, meat, fatty acids

M148 Genetic parameters for fat thickness measured in different anatomical points of Longissimus muscle in Nellore cattle. M. N. Bonin^{*1}, F. J. Novais¹, S. L. Silva¹, R. C. Gomes², A. S. Figueiredo¹, P. F. Torralvo¹, L. G. Figueiredo¹, P. A. B. McLean¹, V. N. Barbosa¹, J. H. A. Campo¹, T. V. Solpelsa¹, M. H. A. Santana¹, F. M. Rezende¹, and J. B. S. Ferraz¹, ¹College of Animal Science and Food Engineering, University of Sao Paulo, Pirassumunga, Brazil, ²State University of Londrina, Londrina, Brazil.

Carcass backfat thickness (FT) is usually measured between the 12th and 13th ribs, however, in Brazil, the forequarter is not separated from the hindquarter at this section to preserve the loin integrity. Therefore, investigating alternative anatomical points to measure carcass traits in the Brazilian industry is needed. The purpose of this work was to evaluate the genetic correlation between fat thickness measured in different anatomical points of the *Longissimus* muscle (LM). Nellore bulls with 30 mo of age were evaluated for fat thickness between the 12th and 13th ribs by ultrasound (FTU, $n = 2,028$) using an equipment Aloka SSD500 micrus and a linear 17.2 cm probe and directly in the carcass, at the same site, after slaughter (FTC, $n = 610$). The other anatomical point was the section between the last lumbar and first sacral vertebra, that is the site where the loin is separated from the carcass hindquarter in Brazilian industries (FTLS, $n = 1,072$). For the estimation of genetic parameters a pedigree matrix with 14,722 animals was used and multi-traits analyses were carried out including the fixed effects of age at ultrasound evaluations and at slaughter, using the software VCE 6.0 (Groeneveld et al., 2008). The range for FT was 0.00 to 9.00 mm for FTU, 0.5 to 13.00 mm for FTC and 0.5 to 6.00 mm to FTLS. The FTU presented high genetic correlation with FTC (0.90 ± 0.05) and FTLS (0.80 ± 0.14). These correlations suggest that ultrasound is a good predictor of FT in the carcass and is highly correlated with the fat deposition in the loin since that the measures were collected in different anatomic points of the LM. FTC presented a moderate genetic correlation with FTLS (0.52 ± 0.14). The traits heritability values were moderate to low, but similar among each other, with values of 0.14 (0.04), 0.17 (0.07) and 0.13 (0.04) for FTU, FTC and FTLS, respectively. These results suggest that there is a genetic control of the FT deposition in the loin of Nellore bulls and

that the FTLS may be a useful tool for genetic evaluation programs for carcass traits in Brazilian industries.

Key Words: *Bos indicus*, Brazilian cuts, ultrasound

M149 Comparative effects of two beta adrenergic agonists on Warner-Bratzler and slice shear force of USDA Choice strip steaks from calf-fed Holsteins. A. J. Garmyn^{*1}, J. N. Martin¹, J. C. Brooks¹, R. J. Rathmann¹, J. M. Hodgen², K. D. Pfeiffer², C. L. Armstrong², D. A. Yates², J. P. Hutcheson², and M. F. Miller¹, ¹Texas Tech University, Lubbock, ²Merck Animal Health, DeSoto, KS.

Our objectives were to determine the effects of zilpaterol hydrochloride (ZH), ractopamine hydrochloride (RH), or no β -adrenergic agonist (β -AA) on Warner-Bratzler shear force (WBSF) and slice shear force (SSF) of USDA Choice strip steaks in response to 2 postmortem aging periods (14 or 21 d). Calf-fed Holstein steers ($n = 565$) were assigned to one of 3 treatments: ZH (8.3 mg/kg of DM for 20 d; Merck Animal Health, DeSoto, KS), RH (300 mg/kg/d for 28 d; Elanco Animal Health, Greenfield, IN), or no β -AA (CON). Strip loins ($n = 315$) were obtained and portioned into 2.5-cm steaks using a Marel Portioning Machine (IPM-3, Marel Townsend, Des Moines, IA). Interactions between treatment and aging were not detected ($P > 0.10$) for any response variables. Supplementation with β -AA resulted in greater WBSF and SSF ($P < 0.01$). Control steaks (3.25 kg) had a lower average WBSF value than steaks from steers fed ZH (3.68 kg) and RH (3.67 kg), which did not differ. Similarly, CON steaks (14.13 kg) had a lower average SSF value than steaks from steers fed ZH (16.11 kg) and RH (16.00 kg). Aging for 21 d resulted in lower ($P < 0.01$) WBSF (3.43 vs. 3.64 kg) and SSF (16.36 vs. 14.46 kg) values compared with steaks aged 14 d. The percentage of steaks with WBSF values < 4.4 kg were affected ($P < 0.01$) by treatment, but postmortem aging had no effect ($P = 0.13$). Ninety percent of CON steaks would be considered tender (4.4 kg) based on ASTM guidelines, but β -AA supplementation resulted in a lower percentage of tender steaks for ZH (79.2%) and RH (77.3%). Feeding β -AA ($P < 0.01$) and postmortem aging period ($P = 0.02$) affected the percentage of steaks measuring < 3.9 kg of shear force. The percentage of very tender steaks was 84.0, 66.5, and 66.8% for CON, ZH, and RH, respectively. In conclusion, feeding β -AA to calf-fed Holsteins increased shear force values of USDA Choice strip steaks, regardless of postmortem aging period. Although, feeding β -AA reduced the percentage of tender steaks, no differences in shear force were observed between ZH and RH at these inclusion levels.

Key Words: beta agonist, dairy beef, shear force

M150 Carcass characteristics of Nellore steers receiving protected linseed oil during different periods of feedlot. T. M. Pivaro^{*1}, W. Henrique², A. A. M. Sampaio¹, J. L. V. Coutinho Filho², E. A. Oliveira¹, B. L. Rosa¹, and V. G. Carvalho¹, ¹FCAV/Unesp, Jaboticabal, SP, Brazil, ²APTA, São José do Rio Preto, SP, Brazil.

The objective was to assess the supply of linseed oil or linseed oil protected from ruminal degradation during different periods of feedlot feeding on carcass characteristics of 35 Nellore steers. The animals were housed in individual pens for 105 d at Sao Paulo Agency for Agribusiness Technology, in Sao Jose do Rio Preto, Brazil, and received one of the following diets: control (without oil), with linseed oil during all the confinement (LO), or protected linseed oil during all the feedlot (OLiP 3), in the last 70 d (OLiP 2) or the last 35 d (OLiP 1). The corn silage was used as the exclusive roughage in the proportion of 40% in DM of diet. All diets were isonitrogenous and those with addition of oil were

isoenergetic. The experimental design was a randomized block, balanced by animal weight, and the means were compared by Student's *t*-test at 5% probability. After slaughter, weight (HCW), dressing percentage (HCY), length (LC) and depth (DC) of hot carcass were determined. The longissimus muscle area (LMA) and the backfat thickness (BFT) between the 12th and 13th ribs were measured 24h after cooling, and the longissimus muscle area per 100 kg of carcass (LMAC) calculated. There were no differences among the variables assessed in this study (Table 1). Therefore, there was no benefit related to the addition of linseed oil, protected or not, to the diet or to the proposed durations for the supply of protected linseed oil during feedlot feeding over the carcass characteristics of Nelore cattle.

Table 1. Carcass characteristics of Nelore steers, finished in feedlot

Treatment	HCW (kg)	HCY (%)	LC (cm)	DC (cm)	LMA (cm ²)	LMAC (cm ² /100 kg)	BFT (mm)
Control	289.14	55.84	129.85	67.64	75.57	26.11	6.88
OLiP 1	287.78	55.45	129.07	67.21	74.14	25.83	7.56
OLiP 2	293.71	56.76	129.57	67.50	74.57	25.45	5.96
OLiP 3	298.92	56.35	128.28	65.50	80.14	26.85	6.66
LO	295.14	55.77	128.57	65.42	77.28	26.25	7.44
P ¹	0.4983	0.4527	0.8436	0.2754	0.3684	0.8443	0.7726
CV (%) ²	4.40	2.51	2.29	3.73	10.64	8.96	36.88

¹P = probability.

²CV = coefficient of variation.

Key Words: backfat thickness, longissimus muscle area, weight

M151 Meat fatty acids profile of Nelore steers receiving protected linseed oil during different periods of feedlot. T. M. Pivaro^{*1}, W. Henrique², E. A. Oliveira¹, A. A. M. Sampaio¹, B. L. Rosa¹, J. L. V. Coutinho Filho², and V. G. Carvalho¹, ¹FCAV/Unesp, Jaboticabal, SP, Brazil, ²APTA, São José do Rio Preto, SP, Brazil.

The objective was to assess the fatty acid profiles in the meat of 35 Nelore steers fed linseed oil or linseed oil protected from ruminal degradation (OLiP) during different periods of feedlot. The animals were housed in individual pens for 105 d at Sao Paulo Agency for Agribusiness Technology, in Sao Jose do Rio Preto, Brazil. The treatments were: control diet (CD), linseed oil during all the confinement (LO), or OLiP fed during the last 35 d (OLiP 1), last 70 d (OLiP 2) or all the confinement (OLiP 3). Corn silage was the exclusive roughage at the rate of 40% in DM of diet. The experimental design was a randomized block, balanced by animal weight, and means were compared by Student's *t*-test at 5% probability. The animals were slaughtered at an average weight of 522.71 ± 27.99 kg and samples were taken from the Longissimus between the 12th and 13th ribs and lyophilized after 24 h of carcass cooling. The fatty acids were quantified by gas chromatography. The ratio unsaturated:saturated was different among CD, OLiP 2 and OLiP 3 treatments (1.37, 1.16 and 1.16, respectively) while OLiP 1 (1.29) and LO (1.30) did not differ from any of the treatments. A similar result was observed for monounsaturated:saturated. However, OLiP 1 and LO differed in n-3 fatty acids (0.47 and 0.72%, respectively), and both did not differ from the other treatments (0.50% for CD, and 0.64% for OLiP 2 and OLiP 3). No difference was detected in the ratio of n-6:n-3 between treatments OLiP 2 and OLiP 3 (7.32 and 6.52, respectively), but both differed from OLiP 1 (9.12), DC (10.91) and LO (4.77), which differed from each other. Increasing the supply of protected linseed oil provides improvement in the amount of n-3 and, the ratio n-6:n-3 became closer to the ideal for a more balanced diet.

Key Words: Longissimus, meat quality, unsaturated

M152 Meat quality of crossbred cattle finished at feedlot and fed increasing levels of linseed oil. E. A. Oliveira^{*1,3}, B. L. Rosa¹, T. M. Pivaro¹, M. B. P. Costa¹, V. G. Carvalho¹, A. T. Andrade¹, W. Henrique², and A. A. M. Sampaio¹, ¹FCAV/Unesp, Jaboticabal, SP, Brazil, ²APTA, São José do Rio Preto, SP, Brazil, ³FAPESP Post-doctorate fellowship, São Paulo, SP, Brazil.

The aim was to assess the effects of increasing linseed oil supplementations (1, 3.8 and 5.2% in diet DM) and sex on meat quality of crossbred cattle Nelore × Canchim. Fifteen steers (427.80 ± 42.01 kg and 24 ± 2 mo old) and 14 heifers (400.57 ± 33.79 kg and 24 ± 2 mo old) were housed in individual pens and fed diets with 80% concentrate in DM and sugarcane IAC 86–2480 as the exclusive roughage source at Sao Paulo State University in Jaboticabal, Brazil. The experiment was a randomized block design, arranged in a 3 × 2 factorial scheme (oil ratios × sex) and means were compared by Student's *t*-test at 5% probability. After fattening period, the animals were slaughtered by blocks. After 24 h of cooling carcasses, samples of *Longissimus* muscle between the 12th and 13th ribs were taken and analyses were conducted (meat and fat color characteristics (L*, a*, b*), water holding capacity (WHC), cook loss (CL), shear force (SF) and pH)). Oil levels, sex, and the interaction between these factors did not show differences for meat and fat color characteristics L*, a*, b* (38.63, 7.65 and 18.75; 72.90, 7.65 and 18.75, respectively), WHC (66.93%), SF (5.04 kgF) and pH (5.71). The interaction was significant for the CL variable, and heifers fed 1% oil showed the highest value (37.44%) compared with those fed 3.8 and 5.2% of oil (32.34 and 29.41%, respectively). Thus, higher levels of linseed oil supplementation for heifers decreased CL, which can improve beef organoleptic aspects such as juiciness. Steers showed no difference among oil levels, with an average of 36.14%. Analyzing each linseed oil level, only 5.2% on diet showed higher values for steers compared with heifers (36.26 and 29.41%, respectively). The use of increasing levels of linseed oil in cattle diet, from 1 to 5.2% in DM, did not improve qualitative aspects of the meat, such as tenderness and color (characteristics related to the presentation to the customer). Steers and heifers fed increasing linseed oil supplementations produce meat with similar qualitative characteristics except for CL.

Key Words: cook loss, meat color, shear force

M153 A study of the variance in tenderness and carcass traits of pasture and feedlot finished beef cattle. L. A. Goonewardene^{*1,2}, J. A. Basarab¹, Z. Wang², R. W. Seneviratne², W. N. P. Yalingasinghe², P. S. Mir³, J. L. Aalhus⁴, and E. K. Okine², ¹Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada, ²University of Alberta, Edmonton, Alberta, Canada, ³Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada, ⁴Agriculture and Agri-Food Canada, Lacombe, Alberta, Canada.

Tenderness is an important beef quality trait and consumers judge the overall acceptability based primarily on tenderness, flavor, color and texture. The objectives of this study were to compare the variance (based on a variance ratio) in Warner-Bratzler (WB) tenderness and selected carcass traits in pasture (P, n = 47) and feedlot (F, n = 48) finished steers. The 7 dietary treatments making up P and F were: 1) steers on pasture only throughout (n = 12), 2) steers on pasture supplemented with cracked barley grain throughout (n = 12), 3) steers on pasture supplemented with whole sunflower seed (WSS) throughout (n = 23), 4) steers with no supplement on pasture and feedlot (n = 12), 5) steers supplemented with WSS on pasture and no supplement in the feedlot (n = 12), 6) steers with no supplement on pasture but supplemented with WSS in the feedlot (n = 12) and 7) steers supplemented with WSS on pasture and the feedlot (n = 12). Steers in treatments 1–3 were harvested directly off pasture

and steers in treatments 4–7 were finished in the feedlot. The variation in WB tenderness in steaks taken from the M. longissimus thoracis from P steers (3.92 kg) was higher ($P < 0.01$) than in F steers (1.89 kg). The highest variance was in P finished steers fed cracked barley supplement (6.33 kg) and this was higher ($P < 0.01$) than steers given no supplement on pasture but supplemented with WSS in the feedlot (1.19 kg) and steers supplemented with WSS on pasture and in the feedlot (1.82 kg). Steaks from pasture finished steers are expected to be more variable in tenderness, less tender and have consistently less trimmable subcutaneous fat compared with steaks from feedlot finished steers.

Key Words: toughness, pasture, Warner-Bratzler

M154 Partitioning of Energy into Muscle and Fat in Relation to Beef Composite Type and Age at Harvest. N. P. Y. Welegedara*¹, E. K. Okine¹, J. A. Basarab², Z. Wang¹, C. Li³, H. Bruce¹, S. Markus², J. Stewart-Smith⁴, and L. A. Goonewardene^{1,2}, ¹University of Alberta, Edmonton, Alberta, Canada, ²Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada, ³Agriculture and Agri-Food Canada, Lacombe Research Centre, Lacombe, Alberta, Canada, ⁴BeefBooster Inc., Calgary, Alberta, Canada.

Beef composite types (CT) have combined favorable traits of pure breeds. The objective was to compare energy required to grow muscle (M) and fat (F) in the carcass tissues of 5 BeefBooster composites (M1,

M2, M3, M4 and TX) serially slaughtered at 6 harvest ages (HA) from 274 to 456 d in 2 years. The foundation breed for the M1 was Angus, M2 was Hereford, M3 was various small breeds, M4 was Gelbvieh or Limousin and TX was Charolais. The energy requirement for M (EM) and F (EF) deposition, the ratio of EF:EM and the proportion (%) of energy required to produce M and F without accounting for turnover, were analyzed by GLM of SAS with CT, HA, interaction of CT and HA and year as main effects. EM, EF, EF: EM ratio and proportions of energy required to produce M and F were different ($P < 0.01$) for CT and HA. EF was dependent on both CT and HA due to interaction ($P = 0.03$). EF was 1158.7, 1121.6, 1013.3, 1012.3, 1052.5 Mcal, EP was 384.6, 412.7, 330.3, 410.9, 428.9 Mcal and EF: EM was 2.95, 2.61, 2.97, 2.38 and 2.40 for M1, M2, M3, M4 and TX respectively. EF was 423.7, 831.3, 1058.8, 1213.1, 1394.3 and 1508.8 Mcal, EP was 275.1, 362.3, 412.8, 416.4, 441.6 and 453.0 Mcal and EF: EM was 1.54, 2.33, 2.60, 2.95, 3.19 and 3.38 for harvest ages at 274, 347, 372, 399, 427 and 456 d respectively. The proportion of energy required to produce F increased from 60.2% at 274 d to 76.8% at 456 d ($P < 0.01$) and the proportion of energy required to produce M decreased from 39.8% at 274 d to 23.2% at 456 d ($P < 0.01$). Based on energy partitioning and energetic efficiency of producing M and F, M1 and M3 can be harvested before 456 d and TX harvested after 456 d to avoid the production of excessively fat carcasses.

Key Words: energy partitioning, fat, muscle