

Meat Science and Muscle Biology

M157 Molecular background of differential expression of *THRSP* in bovine longissimus muscle. Lisa Schering*, Elke Albrecht, Yinuo Liu, Christa Kühn, Klaus Wimmers, and Steffen Maak, *FBN Dummerstorf, Dummerstorf, Germany*.

Increased expression of thyroid hormone responsive protein (*THRSP*) has been related to higher intramuscular fat (IMF) content in previous studies in cattle. Higher expression of the *THRSP* gene (1.7-fold, $P < 0.05$) could be confirmed in M. longissimus of bulls of a Charolais × Holstein F₂-cross with high IMF ($6.8 \pm 2.4\%$, $n = 10$) compared with those with low IMF ($1.9 \pm 0.5\%$, $n = 10$). The presented study aimed at elucidation of the background of the observed expression differences. First, we screened the *THRSP* locus including 700 bp located 5' of the transcription start and 1,000 bp containing the 3'-untranslated region (UTR) for single nucleotide polymorphisms (SNPs) with potential effects on gene expression. Only 3 out of 23 previously annotated SNPs were polymorphic in our sample. One new SNP (c.*695T>C) was found in the 3'UTR. None of the SNPs was related to expression of *THRSP*. To account for the possibility that an elevated amount of *THRSP* mRNA is an effect of more adipocytes in muscle samples with high IMF, we analyzed adipocytes and myocytes separately. Cells of the respective types were isolated by laser capture microdissection from unstained sections of M. longissimus. Total RNA was extracted from both cell types and cDNA was reversely transcribed from mRNA. Besides *THRSP*, fatty acid binding proteins (FABP) 3 and 4 were determined as specific markers for muscle and fat cells, respectively. In 2 independent experiments, we found exclusive expression of FABP3 in myocytes and of FABP4 in adipocytes indicating purity of the cell type preparations. *THRSP* expression was observed in adipocytes but not in myocytes. Moreover, expression of *THRSP* was not different in subcutaneous fat between both groups of bulls (1.0-fold, $P = 0.93$) despite a high level of expression. Our results suggest that differences of *THRSP* mRNA abundance in muscle of cattle with differing IMF result from variable numbers of *THRSP*-expressing adipocytes in the samples rather than from different activity of the gene.

Key Words: cattle, *THRSP*, intramuscular fat

M158 Effects of feeding different sources of vegetable oils on meat quality traits of Nellore steers. Fabiane de Souza Costa*¹, Anderson Roberto Cabral¹, Marília Aparecida Izepe da Silva¹, Beatriz de Conti Fiorese¹, Danielle Leal Mataram¹, Saulo da Luz e Silva¹, and Angélica Simone Cravo Pereira², ¹University of Sao Paulo/Faculty of Animal Science and Food Engineering, Pirassununga, Sao Paulo, Brazil, ²University of Sao Paulo/School of Veterinary Medicine and Animal Science, Pirassununga, Sao Paulo, Brazil.

The objective of this study was to examine the effect of feeding soybean, sunflower or linseed oils on beef quality traits of feedlot finished Nellore steers. Ninety-six steers were individually fed one of the following diets: CON = a control diet with 79% of concentrate and 21% of corn silage, without oil; SOY = diet with soybean oil; SUN = diet with sunflower oil; LIN = diet with linseed oil. Different oil sources were included at 3.5% of DM in substitution of corn at the same percentage. After 84 d of feeding steers were harvested and after 48 h of chilling 2 samples of *Longissimus* muscle (2.5 cm thick) were collected between 12th and 13th ribs, vacuum packed and aged for 0 and 14 d. Samples were analyzed for pH, color (L*, a*, b*), cooking loss (CL) and Warner-Bratzler shear force (WBSF). Data were analyzed using the MIXED procedure of SAS

software as a randomized complete block (initial body weight) design, considering treatment, aging period, treatment × aging interaction as fixed effects, and block as a random effect. There was no treatment × aging period interaction for any trait. Treatments did not affect any trait evaluated in this study ($P > 0.05$). The average pH values (5.6 ± 0.02) were within the normal range for all treatments. The WBSF also did not differ among treatments but the average values (8.2 ± 0.46 kg) were considered very high, indicating a tough meat. The average cooking loss was $23.9 \pm 1.71\%$ and also is within the range normally reported in the literature for Nellore cattle. Color attributes averaged 32.7, 14.7 and 12.6 for L*, a* and b*, respectively. The pH showed a small increase with aging period, from 5.5 to 5.6 ($P < 0.001$) but was within the normal range. The WBSF and CL decreased with increase of aging period ($P < 0.001$) from 10.5 to 6.0 kg for WBSF and from 25.6 to 22.2% for CL for 0 and 14 d of aging, respectively. The L* values increased with aging period ($P < 0.001$) from 29.4 to 35.9, however the a* (14.6 ± 0.70) and b* (12.6 ± 1.80) values were not affected by aging. Inclusion of different oil sources does not affect meat tenderness and color attributes of feedlot finished Nellore steers.

Key Words: tenderness, feedlot, linseed oil

M159 Effects of beta agonist and immunocastration on fatty acid profile of cattle. Madeline Rezende Mazon*, Saulo da Luz Silva, Daniel Silva Antonelo, Keni Nubiato, Juan Fernando Morales Gomez, Roberta Ferreira Carvalho, and Paulo Roberto Leme, *University of São Paulo, Pirassununga, São Paulo, Brazil*.

Beta agonists (BAA) are known for decreasing lipogenic activity and increasing lipolysis on beef and immunocastration (IM) could be an alternative tool to improve fat deposition. Therefore, this work was developed to evaluate the effect of BAA and IM on meat quality traits of feedlot finished Nellore cattle. Ninety-six bulls (409 ± 50 kg LW; 20 mo old) were divided into 2 groups and half of the bulls remaining bulls and the other half receiving 2 doses of IM vaccine (Bopriva) over a 30 d period before arrival at the feedlot. Cattle were fed for a period of 70 d on common diet (76% concentrate and 24% roughage). Each of these groups were then split in 3 groups and fed during 30 d one of the following treatments: control diet without BAA (CON); CON diet plus 80 mg/day zilpaterol hydrochloride (Zilmax; ZIL); CON diet plus 300 mg/day of ractopamine hydrochloride (Optaflexx; RAC). The cattle fed ZIL were 2 d withdrawal period before harvested. After 100 d on feed, cattle were harvested and one samples of LM was collected between 12/13th ribs for fatty acid profile determinations. Data was analyzed by ANOVA as randomized complete block (initial LW) design in 2 × 3 factorial arrangement and means were compared by Student *t*-test. There was no significant interaction of gender condition and BAA for any traits evaluated. Immunocastrated cattle had a greater percentage of MUFA (45.9 vs. 43.0; $P = 0.002$), palmitoleic (3.0 vs. 2.6; $P = 0.002$), Oleic (36.1 vs. 33.3; $P = 0.002$) and total Lipids (3.2 vs. 2.3 g; $P = 0.002$) compared with non-castrated, respectively, whereas non-castrated had greater stearic concentration (13.8 vs. 12.6; $P = 0.006$). Treatments CON and RAC showed greater values than ZIL for myristic (2.5 and 2.4 vs. 2.1; $P = 0.017$) and palmitic (23.7 and 23.0 vs. 21.9; $P = 0.009$), whereas ZIL treatment had greater values than CON and RAC for linoleic (8.5 vs. 6.7 and 6.5; $P = 0.030$), arachidic (2.6 vs. 1.8 and 1.8; $P = 0.046$), Omega 6 (12.1 vs. 9.2 and 9.4; $P = 0.039$). Beef from cattle fed ZIL presented greater CLA and PUFA concentrations, thus having more healthy beef. Immunocastrated cattle have more fat (lipids), MUFA and

saturated fatty acids. Sex condition and BAA can be used to change the fatty acid profile of beef from Nellore cattle.

Key Words: zilpaterol, ractopamine

M160 Growth and serial real-time ultrasound measurements for backfat and loin muscle area in three breeds of swine. L. L. Lo* and C. C. Tsai, *Chinese Culture University, Taipei, Taiwan.*

A serial real-time ultrasonic measured of backfat and loin muscle area was recorded to examine the rate of change per unit of live weight during the finishing stage of production. Sixty-nine sets of 3 littermates (boar, gilt, and barrow one each) involving the 3 major breeds Duroc, Landrace, and Yorkshire in Taiwan were used in this study. Real-time ultrasonic measurements of backfat and loin muscle area were collected at average body weight (BW) of 57.2, 78.8, 94.2, 113.5, and 128.1 kg. Backfat was measured off the midline at the 3/4 point (TRBF) over the tenth rib. Loin muscle area (LMA) images were collected from the left side of each pig at the 10th rib. Deposition rates were calculated for the dependent ultrasound traits TRBF and LMA in models that included the independent variables BW and BW². Body weight was regressed on age and age² for growth rate (GR). The serial measurements data were analyzed using a mixed model (PROC MIXED, SAS) that included the fixed effects of test group, breed, sex, and random effect of animal. Significant breed effects were detected for deposition rate of TRBF ($P = 0.0405$), LMA ($P = 0.0210$), and GR ($P = 0.0082$). Backfat thickness was deposited at a mean of 0.109 mm/kg, whereas LMA was averaged 0.299 cm²/kg deposited across 3 breeds. Average GR across breeds was 677.3 g. Barrows deposited fat at a greater rate ($P = 0.0220$) and grew at a greater rate ($P = 0.0462$), when compared with gilts. However, barrows grew at a lesser rate ($P = 0.0380$) than boars. The results of this study indicated that effects of breed and sex play important roles for rates of backfat and loin muscle deposition and weight per day of age in swine, and therefore, breed- and sex-specific adjustment factor are required.

Key Words: backfat, loin muscle area, pig

M161 Effects of gender status on beef quality from crossbred Angus x Nellore cattle. Lenise F. Mueller*¹, Júlio C. C. Balieiro¹, Adrielle M. Ferrinho¹, Joyce J. M. Furlan¹, Laura R. R. Mantilla³, Fernando S. Baldi², and Angélica S. C. Pereira¹, ¹University of Sao Paulo, Pirassununga, Sao Paulo, Brazil, ²Sao Paulo State University, Jaboticabal, Sao Paulo, Brazil, ³University Cooperative of Colombia, Medellin, Colombia.

The goal of this study was to evaluate the influence of gender status on beef quality from feedlot crossbred Angus x Nellore cattle. Twenty months old cattle (n = 454) presenting initial mean weight of 265 kg ± 24.24 were grouped into lots, confined and assigned into the following treatments: bulls, steers, immunocastrated, and heifers. Cattle were fed ad libitum high-grain diet containing 80% concentrate. At the end of the experimental period (190 d), 40 cattle from each group were chosen based on body weight (bulls 555 kg ± 43.36, steers 478 kg ± 32.40, immunocastrated 509 kg ± 30.75, and heifers 468 kg ± 34.21) and harvested. Steaks (2.54 cm thick) were collected from the *Longissimus dorsi* and aged for 0, 7, and 14 d (d) at 2°C; after aging, all steaks were stored at -18°C until analyzed for tenderness and pH. Statistical analyzes were performed using the proc MIXED SAS program (version 9.2), including the fixed effect of gender status (bulls, steers, immunocastrated, and heifers), and the covariate d on feed, and the random effect of cattle within of gender groups. Significant effects for gender status were evaluated by *t*-test using PDIF option. On d 0, immunocastrated

cattle and steers beef presented decreased shear force values ($P > 0.05$), when compared with heifers and bulls; heifers presented decreased shear values when compared with bulls ($P < 0.05$). After 7 d of aging bulls presented increased shear values (4.74kg ± 0.20) when compared with the other treatments ($P < 0.01$). Also, no difference was detected between immunocastrated cattle (3.40kg ± 0.20), steers (3.32kg ± 0.20), and heifers (3.94kg ± 0.20), however heifers presented increased shear force values when compared with steers ($P < 0.05$). At 14 d of aging bulls presented increased shear values (3.84kg ± 0.15) when compared with the other groups ($P < 0.01$); there was no difference ($P < 0.05$) between the other categories. Gender status influenced pH values, bulls showed higher pH values when compared with the other groups ($P < 0.05$). Despite the effect of gender status on beef quality, it is important to highlight that the use of steers, immunocastrated cattle and heifers is necessary to attend demanding consumers seeking for tender beef.

Key Words: immunocastration, tenderness, beef

M162 Influence of aging on intramuscular color variations in beef semimembranosus. Mahesh Narayanan Nair*, Shuting Li, Ryan Chaplin, Gregg Rentfrow, and Surendranath P. Suman, *University of Kentucky, Lexington, KY.*

Previous research documented intramuscular variations in the color and color stability of beef semimembranosus, which can be separated into color-labile inside (ISM) and color-stable outside (OSM) regions. Post-mortem aging is employed to improve beef quality attributes such as tenderness and palatability. Aging can also influence fresh beef color, whereas its effect on intramuscular color variations in beef semimembranosus is yet to be examined. Therefore, the objective of the present study was to evaluate the influence of aging on color and color stability of ISM and OSM and to examine if aging can mitigate intramuscular color variations. Semimembranosus muscles from 8 (n = 8) beef carcasses (USDA Choice, 24 h post-mortem) were vacuum packaged and aged at 2°C for 7, 14, and 21 d. On each aging period, muscles were fabricated into ISM and OSM steaks. Aerobically packaged steaks were stored in the dark at 2°C for 6 d. On d 6 of storage, lightness (L^*), redness (a^*), yellowness (b^*), and color stability (ratio of reflectance at 630 nm and at 580 nm) were evaluated on the steak surfaces using a HunterLab LabScan XE colorimeter. The data were analyzed using PROC MIXED procedure in SAS. OSM exhibited greater ($P < 0.05$) surface redness (a^* value) than ISM after 7 and 14 d of aging. However, after 21 d of aging, ISM and OSM demonstrated similar a^* values ($P > 0.05$). While OSM was darker ($P < 0.05$; lower L^* value) than ISM at all aging periods, there was no difference ($P > 0.05$) in yellowness throughout the aging. Color stability was greater ($P < 0.05$) in OSM than in ISM on d 7 and 21 of aging, whereas ISM and OSM exhibited similar ($P > 0.05$) color stability on d 14. These results suggested that 21 d aging could be employed to potentially minimize the intramuscular variation in redness of beef semimembranosus.

Key Words: semimembranosus, beef color, aging

M163 Effect of oil source and storage time on burger sensorial traits from Nellore cattle. Anderson R. Cabral*¹, Fabiane de Souza Costa¹, Maria E. Groto¹, Saulo da Luz e Silva¹, and Angélica S. Cravo Pereira², ¹University of Sao Paulo/FZEA, Pirassununga, SP, Brazil, ²University of Sao Paulo/FMVZ, Sao Paulo, SP, Brazil.

The aim of this study was to evaluate the effect of fed plant based oil source over 2 different storage period in sensorial burger traits. Ninety-six Nellore steers were confined for 82 d. The experimental design used

was a split plot in a 4×2 factorial arrangement (3 oil sources plus control \times 2 storage time). The oils sources were sunflower oil (SU); linseed oil (LO) and soybean oil (SO). Plant oils were added to the feedlot diet at a rate of 3.5% of concentration in each diet (based upon DM). Utilizing the *Longissimus dorsi* and subcutaneous fat from the carcass. 40 (100g/patties) hamburger patties were prepared per treatment utilizing a commercial formulation (85.4% of meat, 12% of fat, 2% of salt, 0.3% of garlic and 0.3% of emulsifier) with a weight around 100g and packed in plastic bags permeable to oxygen and then immediately frozen at -18°C and stored for 2 time periods, 0 and 90 d. The burgers were grilled in 170°C for 4 min on each side (internal temperature 75°C). Each panel member received 4 pieces (one for each treatment) randomly. Sensory analysis was performed utilizing an acceptance test with 9 point hedonic scale (9 = like extremely, 1 = dislike extremely) by a consumer panel (n = 100). They evaluated aroma (A), texture (T), juiciness (J), flavor (F) and overall acceptability (OA). The data was analyzed using a mixed model (MIXED procedure of SAS), including the fixed effects of oil source, storage time, the interaction between storage time with oil source and the random animal effect. There was no interaction between storage times with oil source ($P = 0.56$ to A, $P = 0.51$ to T, $P = 0.85$ to J, $P = 0.41$ to F, $P = 0.89$ to OA) for any sensorial trait evaluated, neither the oil source for A ($P = 0.08$) and J ($P = 0.26$) nor storage time for A ($P = 0.36$) and J ($P = 0.07$). There was an effect ($P = 0.01$) of storage time for T (0d = 6.29; 90d = 5.90). There was a reduction OA ($P = 0.02$) at time zero (6.87) compared with the time 90d (6.58). The hamburgers patties from SO, SU and control were tastier than those fed LO (7.12, 7.10, 7.04 vs. 6.65) ($P = 0.001$). In conclusion, the storage time and oil source have an effect on the burger sensorial traits, and the use of linseed oil or the burger storage for a period of 90d would reduce the acceptance by the consumers.

Key Words: lipid, texture, flavor

M164 Association of SNPs in the *THRSP* gene with morphological and biochemical traits of longissimus muscle in F_2 offspring of a Charolais \times Holstein cross. Elke Albrecht*, Lisa Schering, Dirk Dannenberger, Gerd Nuernberg, Christa Kuehn, and Steffen Maak, *Leibniz Institute for Farm Animal Biology, Dummerstorf, Germany*.

Expression and genetic variants of the thyroid hormone responsive protein (*THRSP*) gene has been reported to be associated with marbling and fatty acid composition in cattle. The study was undertaken to investigate the effect of 2 single-nucleotide polymorphisms (SNP) in the *THRSP* gene, namely c.88 G>A and c.194 C>T, on morphological and biochemical traits of the longissimus muscle. Genotyping of 247 F_2 -generation bulls of a Charolais \times Holstein cross revealed that both SNPs were in complete linkage disequilibrium in our data set with 37 bulls of the GG/CC, 110 of the AG/CT, and 100 of the AA/TT diplotype. Muscle fiber composition, intramuscular fat cell and marbling traits were analyzed using image analysis. Fatty acid concentrations/proportions were determined with gas chromatography using internal standard procedure as fatty acid methyl esters. The F_2 design yielded substantially increased variation within the population compared with

both founder breeds regarding muscle structure, fat cell, and marbling data within F_2 bulls ranged from 4.5 standard deviations (cross sectional area of intermediate muscle fibers) to 7.4 standard deviations (area percentage of slow muscle fibers). Furthermore, absolute and relative fatty acid composition exceeded variation of muscle structural traits with differences between individuals up to 11.3 standard deviations (C21) indicating extreme divergence in fat deposition within the population. However, association analysis indicated no clear effect of *THRSP*-SNP diplotype on longissimus muscle structure and intramuscular fat deposition, but showed an indication on association of the *THRSP*-SNPs with muscle fatty acid composition ($P < 0.05$).

Key Words: cattle, fatty acid, muscle structure

M165 Meat quality of *M. Longissimus dorsi* of lambs fed with sunflower cake. Anny Graycy Vasconcelos de Oliveira Lima, Ronaldo Lopes de Oliveira*, Thadeu Mariniello Silva, Patrícia Gonçalves Cirqueira, and Marcondes Dias de Freitas Neto, *Federal University of Bahia, Salvador, Bahia, Brazil*.

This trial was conducted to determine the effect of sunflower cake on the physicochemical properties of meat lamb. Forty crossbreed Santa Ines rams were fed 50% hay (Tifton-85 chopped) to 50% concentrate (corn, soybean meal, urea, ammonium sulfate and inclusion of sunflower cake) on diet. The 4 treatment diets were 0, 10, 20, and 30% sunflower cake. To account for the increasing concentration of sunflower cake, corn and soybean meal were removed from the diet. The rams were fed the treatment diets twice daily for a period of 71 d in feedlot, and were slaughtered after that. After a period 24 h postmortem, the *Longissimus dorsi* muscle were removed of carcass, separated into proximal and distal portions. The muscles from the distal portion's left side were used to determine the pH and color measurements with Minolta colorimeter and pH probe. The muscles from proximal portion the right side were used to measure the cooking loss and Warner-Bratzler shear force analysis was conducted according to the guidelines of AMSA. The experiment followed a completely randomized design with 4 treatments and 10 replicates per treatment. The data were analyzed using PROC GLM procedure of SAS (SAS Institute, Cary NC) with the treatments as the fixed effect. Regardless of inclusion rate, sunflower cake did not have an effect on pH ($P = 0.15$), L^* ($P = 0.28$), cooking loss ($P = 0.23$), shear force ($P = 0.47$). There was an effect on color a^* ($P = 0.03$) and b^* ($P = 0.04$) with increasing concentration of sunflower cake, that characterizing bright cherry red color meats. Many factors (endogenous and exogenous) can contribute to meat color stability as pH, muscle source and mitochondrial activity, as well as live animal related factors, such as management, diet, and genetics. The competition between mitochondria and myoglobin (Mb) is a key component in the development of bright-red color. Probably occurred saturation Mb with oxygen forming oxymyoglobin or saturation Mb with carbon monoxide, forming carboxymyoglobin that offer bright cherry-red color meat. The sunflower cake inclusion has provided bright redder color meat without changing the cooking loss and tenderness of meat.

Key Words: color, cooking loss, tenderness