performance and carcass traits, and has no impact on daily average and maximum core body temperature of finishing beef steers.

Key Words: Beta agonist, bovine, body temperature

T307 The effect of substituting fish oil in cow diets with DHA-micro algae on milk composition and fatty acids profile. R. B. Potu*[1], A. A. AbuGhazaleh[1], and S. Ibrahim[2], [1]*Southern Illinois University, Carbondale*, [2]*North Carolina A&T University, Greensboro*.

Fish oil (FO) in the cow diet has been shown to function as a modifier for ruminal biohydrogenation to maximize the production of vaccenic acid (VA; trans-11 C18:1), the precursor of conjugated linoleic acid (cis-9, trans-11 CLA). It also has been shown that the FO stimulatory effect on VA production is attributed to docosahexaenoic acid (DHA)'s ability to inhibit the reduction of VA to C18:0 in the rumen. In this experiment, the effect of substituting FO with DHA-micro algae on milk fatty acid composition was examined. Twenty-four Holstein cows in mid lactation (165 ± 22 DIM) allowed to graze on an alfalfa-based pasture were divided into four treatment groups (6 cows/treatment) and supplemented with 7 kg/d grain mix supplements containing 350 g soybean oil and either 150 g FO (FO), 100 g FO plus 50 g algae (2/3FO), 50 g FO plus 100 g algae (1/3FO), or 150 g algae (ALG). Cows were fed treatment diets for 3 wks and milk samples were collected from each cow during the last 3 days of the study. Grain supplement intake, milk production (17.96, 17.56, 17.55, and 19.26 kg/d for treatments 1 to 4, respectively), milk fat percentages (3.17, 3.49, 3.74, 3.43 for treatments 1 to 4, respectively) and yield, and milk protein percentages (3.35, 3.50, 3.71, and 3.42 for treatments 1 to 4, respectively) and yields were not affected ($P > 0.05$) by the treatment diets. Concentrations (g/100g fatty acids) of milk cis-9, trans-11 CLA (3.51, 3.69, 4.47, and 4.21 for treatments 1 to 4, respectively) and VA (11.80, 12.83, 13.87, and 13.53) were not affected ($P > 0.05$) by treatment diets. The results suggest that DHA-micro algae can substitute for FO in a cow's diet without any adverse effects on milk production, milk composition or milk cis-9, trans-11 CLA content.

Key Words: fish oil, algae, CLA

Ruminant Nutrition: Efficiency

T308 Residual feed intake and feeding behavior of Nellore bulls selected for post-weaning weight. T. L. S. Corvino*[1], R. H. Branco[2], A. Polizel Neto[1], S. F. M. Bonilha[2], L. A. Figueiredo[2], and A. G. Razook[2], [1]*Programa de Pós-gradução emZootecnia - UNESP, Botucatu, São Paulo, Brazil*, [2]*CAPTA Pecuária de Corte - Instituto de Zootecnia, Sertãozinho, São Paulo, Brazil*.

Residual feed intake (RFI) is the difference between DMI observed and predicted based on metabolic BW and ADG. Feeding behavior influences RFI, however the relationships between these traits are not well known. The objective of this research was to evaluate the differences in feeding behavior of low and high RFI Nellore bulls selected for post-weaning weight. The experiment was conducted at CAPTA Pecuária de Corte - Instituto de Zootecnia, Sertãozinho - São Paulo/Brazil. Sixty one Nellore bulls had RFI evaluated (112 d in individual pens) and were classified in: low RFI (<0.5 SD; more efficient; n=21), medium RFI (<0.5SD<; n=22), and high RFI (>0.5 SD; less efficient; n=18). Feeding behavior was evaluated at 10 min intervals, during 24 h, in two random d, to determine feeding and chewing categories. Measured traits were feeding duration (FD), chewing time (CT) and bunk attendance (BA). FD/DMI had significant difference for RFI levels, being more efficient bulls (low RFI) those with lesser intake and greater time spent on feeding than less efficient ones (high RFI). Low RFI bulls used food with higher efficiency, eating slowly and retaining more nutrients than high RFI bulls.

Table1. Feeding behavior of low and high RFI Nellore bulls

	RFI			
	Low	Medium	High	P
n	21	22	18	
RFI	-0.346[c]	-0.009[b]	0.415[a]	<0.001
DMI, kg/d	5.72[b]	5.94[b]	6.63[a]	0.007
FD, min/d	217[a]	225[a]	214[a]	0.609
FD/DMI, min/kg DM	39.1[a]	38.7[a]	32.6[b]	0.009
BA, event/d	9.3[a]	9.9[a]	9.8[a]	0.155
DMI/event, kg DM/event	0.62[a]	0.62[a]	0.68[a]	0.266
FD/event, min/event	23.5[a]	23.2[a]	22.4[a]	0.174
CT, min/d	477[a]	477[a]	504[a]	0.080
CT/DMI, min/kg DM	86[a]	82[a]	77[a]	0.150

Within a row, means without a common superscript letter differ ($P < 0.05$) by Student Newman-Keuls test.

Key Words: efficiency, nutrition, selection

T309 Effects of residual feed intake on carcass characteristics of Nellore bulls. S. F. M. Bonilha*[1], R. H. Branco[1], G. F. Alleoni[2], A. M. Castilhos[3], L. A. Figueirdo[1], and A. G. Razook[1], [1]*Instituto de Zootecnia, Agência Paulista de Tecnologia dos Agronegócios, Sertãozinho, SP, Brazil*, [2]*Instituto de Zootecnia, Agência Paulista de Tecnologia dos Agronegócios, Nova Odessa, SP, Brazil*, [3]*Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista, Botucatu, SP, Brazil*.

Residual feed intake (RFI) is an efficiency measurement calculated as the difference between actual feed intake and predicted DMI based on metabolic BW and ADG. Some studies, using *Bos taurus* breeds, have found differences on carcass characteristics, mainly those related to fat content, on animals selected for low RFI, but there is no information about relationships between RFI and carcass traits on Nellore breed. Therefore, the objective of this work was to evaluate carcass characteristics of Nellore bulls classified in low and high RFI levels. Thirty three young Nellore bulls, with minimum RFI -0.640 and maximum RFI

0.690, were slaughtered and had their carcasses evaluated. Table bellow shows the least-square means of DMI; ADG; empty BW (EBW); HCW; dressing percentage (DP); hindquarter percentage (HQP); edible fraction percentage (EFP); rib-eye area (REA); and fat thickness (FT). Low RFI bulls had lesser DMI than high RFI bulls. No differences were detected for ADG, EBW, and HCW indicating that low and high RFI bulls had the same body size. For yield measurements (DP; HQP; and EFP) no differences were detected, but there is a tendency of low RFI (more efficient) bulls to have greater HQP than high RFI (less efficient) ones. No differences were found for REA and FT. Low RFI bulls ate less than high RFI bulls and had carcasses of the same size and fat content.

Table 1. Carcass characteristics of low and high RFI bulls

	LOW RFI	HIGH RFI	P
	(n=18)	(n=15)	
DMI, kg	6.55[a]	7.51[b]	0.0485
DMI, %BW	1.76[a]	2.05[b]	0.0079
ADG, g	721[a]	756[a]	0.6954
EBW, kg	368[a]	362[a]	0.7210
HCW, kg	245[a]	242[a]	0.7938
DP, %	62.3[a]	62.3[a]	0.9689
HQP, %	46.5[a]	45.1[a]	0.0611
EFP, %	80.1[a]	80.3[a]	0.5715
REA, cm^2	74.8[a]	75.6[a]	0.8467
FT, mm	3.56[a]	3.22[a]	0.3658

Within a row, means with a common superscript letter do not differ ($P < 0.05$) by least-square means adjusted for Pdiff.

Key Words: development, efficiency, selection

T310 Relationships between residual feed intake and internal organs of Nellore bulls. S. F. M. Bonilha*[1], R. H. Branco[1], T. L. S. Corvino[2], G. F. Alleoni[3], L. A. Figueiredo[1], and A. G. Razook[1], [1]*Instituto de Zootecnia, Agência Paulista de Tecnologia dos Agronegócios, Sertãozinho, SP, Brazil*, [2]*Faculdade de Medicina Veterinária e Zootecnia, Universidade Estadual Paulista, Botucatu, SP, Brazil*, [3]*Instituto de Zootecnia, Agência Paulista de Tecnologia dos Agronegócios, Nova Odessa, SP, Brazil*.

Residual feed intake (RFI) is an alternative measurement of feed efficiency, which is theoretically independent of production level and body size, calculated as the difference between actual feed intake and predicted DMI based on metabolic BW and ADG. The objective of this work was to identify the relationships between RFI and size of important internal organs in Nellore bulls classified in low and high RFI levels. Thirty three young Nellore bulls, with minimum RFI -0.640 and maximum RFI 0.690, were slaughtered and had their internal organs weighted. Table bellow shows the least-square means of final BW (FBW); empty BW (EBW); liver (LIV); kidney (KID); gastrointestinal tract (GIT); KPH; and other internal organs (IOR). No differences were detected in body size between low and high RFI bulls. Low RFI bulls had smaller important internal organs (LIV, KID, and GIT) than high RFI bulls. For KPH, no differences were detected. Low RFI bulls ate less than high RFI bulls, had smaller internal organs and the same fat content.

Table 1.

	LOW RFI	HIGH RFI	P
n	18	15	---
FBW, kg	374[a]	391[a]	0.1148
EBW, kg	343[a]	357[a]	0.1797
LIV, kg	4.16[b]	4.63[a]	0.0043
KID, g	673[b]	786[a]	0.0389
GIT, kg	21.8[b]	24.3[a]	0.0411
KPH, kg	5.25[a]	5.38[a]	0.8018
IOR, kg	10.4[a]	11.1[a]	0.0711

Within a row, means with a common superscript letter do not differ ($P < 0.05$) by least-square means adjusted for Pdiff.

Key Words: development, efficiency, selection

T311 Genetics of feed conversion efficiency: Using a dynamic metabolic model to investigate the patterns of nutrient flux in the most efficient dairy animals. C. Shachtschneider, J. L. Vierck, and J. P. McNamara*, *Washington State University, Pullman*.

In dairy cattle, measures of efficiency take into account not only feed intake and milk production, but also metabolic flux in body tissues, primarily in visceral, muscle, and adipose tissues. Metabolic processes are affected by genotype, phenotype, and intake, processes that are usually under control of hormonal and neural systems. In continued work with the objective of identifying the patterns of metabolic flux in the most efficient dairy cattle, an existing mechanistic metabolic model (Molly, UC Davis) was used. Data were collected from 2nd to 4th parity cows over several experiments (approximately 150 animals) that measured nutrient intake, milk component output, changes in adipose tissue lipid and visceral and body protein and lipid, and metabolism rates and gene expression in adipose tissue. Explicit inputs into the model included nutrient intake, initial body fat and protein, milk production, fat and protein output. Each cow was simulated separately. Body fat, body protein and visceral protein all varied ($P< 0.05$) in daily flux and overall change in direct relation to their milk productive efficiency. Intake energy ranged from 89 to 139 Mcal/d; from 19.9 to 41.9 for maintenance; from -1.74, to -0.015) for change in body energy (to 120 DIM); and from 0.826 to 0.862 for (milk energy/(energy absorbed - maintenance E)). Nitrogen intake varied from 0.52 to 0.81 kg/d; milk N from 0.16 to 0.27), change in body N from -0.06 to -0.004): urea N from 0.26 to 0.37); and N balance from -0.032 to -0.008 kg/d. The model identified ($P <0.05$) differences in use of energy and nitrogen in body tissues of the most efficient versus less efficient dairy cattle, the rates of adipose tissue metabolism were directly related to overall efficiency. Feed intake was a major component of overall feed efficiency ($P < 0.01$), while the ability of body tissue to support milk production and recover after peak production was another major contributor ($p < 0.01$). Integrating all the biological process in the dairy animal will help us speed improvement of overall efficiency.

Key Words: effiiciency, integrative biology, metabolic models

T312 Associations between feed efficiency and gut microbial ecology and fermentation parameters in feedlot cattle. W. K. Krueger[1,2], G. E. Carstens[1,2], Z. D. Paddock[1,2], T. R. Calloway[3], R. C. Anderson[3], N. A. Krueger[3], V. Gontcharova[4], S. E. Dowd[4], R. R. Gomez*[2], and W. E. Pinchak[5], [1]*Intercollegiate Faculty of Nutrition, Texas A&M University*,

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The objective of this study was to examine the relationships between feed efficiency (residual feed intake; RFI) and gut microbial ecology and rumen and fecal fermentation parameters in feedlot cattle. Crossbred steers (N = 170; initial BW = 378 ± 30kg) were fed a high-corn finishing ration (ME = 3.0 Mcal/kg DM), and individual feed intake recorded for 70 d using GrowSafe feeding system. RFI was calculated as the difference between actual and expected DMI from linear regression of DMI on mid-test $BW^{0.75}$ and ADG. Rumen fluid and fecal samples were collected from the 6 most (low RFI) and 6 least efficient (high RFI) steers and assayed for VFA and pH, and in vitro procedures used to determine 24-h methane producing activity (MPA) and ammonia producing activity (APA). Initial BW (381 ± 27 kg) and ADG (1.5 ± 0.5 kg) were similar for steers with low and high RFI; low RFI steers consumed 24% less DMI (9.1 vs. 11.9 ± 0.3 kg) and had 26% lower feed:gain ratios than high RFI steers. No differences were observed between phenotype groups for ruminal 24-h MPA; however, steers with low RFI had higher (P = 0.02) fecal MPA (10.4 vs. 3.8 ± 1.7 µmol CH4/ml) than steers with high RFI. Ruminal and fecal APA, VFA, and pH were similar for sampled steers. Intestinal microbial ecology was examined using bacterial tag-encoded FLX 16s rDNA amplicon pyrosequencing methodology. There were no differences detected in the rumen or fecal Firmicute:Bacteriodetes ratio between steers with divergent RFI. Low RFI steers tended to have higher (P = 0.09) percentage of fecal Prevotella spp. and had lower (P < 0.05) fecal Spirochaetes and ruminal Cyanobacteria. These results indicate that there are no inherent differences in ruminal MPA, APA, VFA, and pH or gross microbial ecology between steers with divergent RFI. Subtle microbial shifts in fecal Prevotella, Spirochaetes, and ruminal Cyanobacteria, and fecal MPA due to divergent RFI may be evident. Further research into the potential associations between gut microbiota and inter-animal variation in RFI of beef cattle is warranted.

Key Words: feed efficiency, microbial ecology, residual feed intake

T313 Proteomic analyses in beef cows with low and high maintenance energy requirements. M. J. Prado-Cooper*[1,2], R. D. Madden[1], J. W. Dillwith[1], C. L. Bailey[1], E. C. Wright[1], C. R. Krehbiel[1], D. L. Step[1], and R. P. Wettemann[1], [1]*Oklahoma Agricultural Experiment Station, Stillwater*, [2]*Universidad Centroccidental, Barquisimeto, Lara, Venezuela*.

Spring-calving Angus x Hereford cows were used in two replications (rep 1, n = 32; rep 2, n = 37) to describe muscle proteome and evaluate protein abundance in beef cows with different maintenance energy requirements (MR). Gestating cows (4 to 7 yr of age) in the second to third trimester of gestation with a BCS of 5.0 ± 0.3 and BW of 576 ± 41 kg, were individually fed a complete diet to determine their MR based on achievement of constant BW. Cows were classified as having low (> 0.5 SD less than mean, LMR) or high (> 0.5 SD more than mean, HMR) MR. Greatest differences in MR for all cows were 24% and 25% in rep 1 and 2, respectively. Muscle biopsies from LM of LMR (n = 12) and HMR (n = 12) cows were taken after cows were on actual maintenance diets for 28 d, immediately frozen in liquid nitrogen, and stored at -80°C for proteomic analyses. Proteins were separated by two-dimensional gel electrophoresis and identified using mass spectrometry (MALDI-TOF and orbitrap). Protein abundance was quantified by two-dimensional, fluorescent, difference gel electrophoresis (2-D DIGE) to separate proteins, and DeCyderTM software (version 5.0, GE Healthcare Bio Sciences) for image analysis. From a total of 103 dissected spots, 78 proteins corresponding to 52 gene products were identified; the proteins were related to metabolism (33%), contractile apparatus (19%), cell structure (10%), cell defense (13%), and other processes (25%). Protein abundance tended to be greater in HMR cows for cofilin-2 (P = 0.11), and glyceraldehyde-3-phosphate dehydrogenase (P = 0.16). Identification of biomarkers for maintenance energy requirements will allow selection of cows that require less energy to maintain BW and may increase efficiency of beef production.

Key Words: beef cattle, maintenance energy requirements, proteomics

T314 Forage intake, rumen and blood variables, ultrasound and body measurements and behaviour in pregnant beef heifers differing in phenotypic residual feed intake. P. Lawrence*[1,2], M. McGee[1], D. Kenny[2], D. H. Crews, Jr.[3], and B. Earley[4], [1]*Teagasc, Grange Beef Research Centre, Dunsany, Co. Meath, Ireland*, [2]*UCD School of Agriculture, Food Science and Veterinary Medicine, Belfield, Dublin, Ireland*, [3]*Department of Animal Sciences, Colorado State University, Fort Collins*, [4]*Teagasc, Animal Bioscience Centre, Dunsany, Co. Meath, Ireland*.

The objective of this study was to characterise productivity-related variables in pregnant beef heifers differing in phenotypic residual feed intake (RFI), an alternative measure of feed efficiency. Seventy-three, pregnant (mean (SD) gestation day 169 (28 d)) Simmental and Simmental × Friesian-Holstein heifers (mean (SD) initial body weight (BW) 548 (47.1 kg)) were offered grass silage *ad libitum*. Dry matter intake (DMI), BW, body condition score (BCS) and measurements (withers height, chest depth, back length, pelvis width and girth), ultrasound fat (13^{th} rib), and fat and muscle (3^{rd} lumbar) depth, visual muscularity score, rumen fluid pH, blood variables (albumin, creatinine, beta-hydroxy butyrate, globulin, glucose, non-esterified fatty acids, total protein, triglycerides, urea, aspartateaminotransferase, alkaline phosphate, creatine kinase, fibrinogen, haptoglobin, anti-oxidant status and total bilirubin), feeding and activity behaviour, calf birth weight and calving difficulty were measured. Expected DMI was calculated by regressing average daily DMI on average daily BW gain (ADG), mean $BW^{0.75}$ and calving day over an 84-d period, for each breed separately. Within breed, heifers were ranked by RFI into low (efficient), medium and high (inefficient) groups. Overall mean (SD), ADG (kg/d), DMI (kg/d), and RFI (kg DMI/d) were 0.46 (0.17), 7.93 (0.88), 0.07 (0.70), respectively. Heifers with high RFI had 0.14 and 0.21 higher (P<0.001) DMI than medium and low RFI groups, respectively. The RFI groups did not differ in the variables measured, with the exception that bilirubin concentration (P<0.01) and muscularity score (P<0.05) were higher in low RFI, and rumen pH was higher (P<0.05) in high RFI, than the other two RFI groups. In conclusion, differences in phenotypic RFI in pregnant beef heifers were not noticeably associated with appreciable differences in the other traits measured.

Key Words: pregnant beef heifers, residual feed intake, grass silage