NUTRITIONAL QUALITY OF CULL COWS WITH VERY EARLY WEANED CALVES IN ARGENTINA

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***Abstract*—The objective of this work was to evaluate the effect of very early weaning of calves in cull cows on nutritional quality of meat. Two treatments were assayed: cull cows with very early, thirty days, weaned calves (CVEW) and cull cows with traditionally, seven months, weaned calves (CTW). Cows with very early weaned calves were grazed on pasture, meanwhile cows with traditional weaning were grazed on pasture and finished in feedlot to obtain the same frame score and slaughter weight than CVEW. Fatty acid composition and amino acid composition were determined on *L. dorsi* muscle by gas-chromatography and cation-exchange chromatography, respectively. Meat from CVEW contained lower SFA ($P < 0.1$), MUFA ($P < 0.1$), *n*-6 PUFA ($P > 0.1$) and higher *n*-3 PUFA ($P < 0.1$) and *cis*-9, *trans*-11 CLA ($P < 0.05$) than meat from CTW. Amino acids did not present significant difference between the treatments assayed. However, a tendency of higher level of amino acids in meat from CYEW compared to meat from CTW was observed. The results indicate that the very early weaning would allow produce high nutritional quality cull cow meat.**

***Index Terms*—cows, meat nutritional quality, very early weaning.**

I. INTRODUCTION

Nutrition is coming to the fore as a major modifiable determinant of non-communicable chronic diseases, with scientific evidence increasingly supporting the view that alterations in diet have strong effects, both positive and negative, on health throughout life (WHO, 2003). Optimal nutrition is focused to optimize the quality of the diet in terms of nutrients and non-nutrients content, and as well as other food properties that favour health maintenance.

Meat is frequently associated with a negative health image due to its high fat content. However, meat from ruminants contains long-chain *n*-3 polyunsaturated fatty acids (PUFA) and conjugated linoleic acids (CLAs), which have potential human health benefits (Waters, Kelly, Boyle, Moloney, & Kenny, 2009). Meat is one of the main protein sources with high nutritional value, source of fat soluble vitamins E, A and D, being an excellent source of Complex B vitamins, and of minerals like iron and zinc (Biesalski, 2005).

The impact of early weaning (60 days) and very early weaning (30 days) of calves on the reproductive performance (Galli, Monje, Vittone, Sampedro & Busto, 2005; Galli et al., 2008; Geraci et al., 2009; Vittone et al., 2009) and organoleptic quality (Galli et al., 2008; Teira et al., 2009; Perlo et al., 2009) of cows meat has been demonstrated under research and commercial conditions in Argentina.

The objective of this work was to evaluate how the very early weaning of calves would affect nutritional profile (fatty acids and amino acids contents) of cull cow meat.

II. MATERIALS AND METHODS

II.1 *Animals and experimental design*

Thirty Hereford and Polled Hereford cows from the Concepción del Uruguay (INTA) Experimental Station herd (5.5 – 6.0 frame) were allotted to two weaning treatments. Treatments were as follow: cull cows with very early, one month, weaned calves (CVEW) and cull cows with traditionally, seven months, weaned calves (CTW). All

cows were grazed on native pasture, mostly C4 species, established in the Experimental Station (32°29'28" S; 58°20'49" W, 25 m above mean sea level) in the Province of Entre Ríos in Argentina. Cows from CTW were finished in feedlot to obtain the same body condition and slaughter weight of treatment CEVW.
After a one day finishing period on this pasture, as usual in commercial herds, animals were slaughtered in an officially authorized sanitary and handling controlled (SENASA, National Control Service for Animal Sanitary Status), commercial packing house. The packing house was located 120 km north of the Experimental Station where top value hind quarter cuts (removed at the 10th rib level) were weighed and samples were analyzed in the Instituto Tecnología de Alimentos, INTA (Buenos Aires) and, Facultad de Ciencias de la Alimentación y Facultad de Bromatología de la Universidad de Entre Ríos, Entre Ríos, Argentina.

II.2 *Analytical procedures*
Carcasses were refrigerated in commercial chambers with forced air circulation (0 ± 2 °C) during 24 h. Steaks of *Longissimus dorsi* muscle at 12th rib were taken from each treatment, carefully dissected and used for chemical analysis. All samples were stored at -20°C until analysis were performed.

II.2.1. *Fatty acid analysis*
Five gram samples were taken for fatty acid analysis. Lipids were extracted as described by Folch, Lees and Sloane-Stanley (1957) method. The fatty acid methylation procedure was a combination of alkaline and acidic catalysts. The lipids extracted were initially methylated with 2M KOH in methanol which was followed by a 2M solution of HCL in methanol to avoid possible isomerisation of conjugated dienes associated with the use of BF_3/CH_3OH (Park et al., 2001). Both methylation procedures were carried out at 50 °C for 20 min. Two ml of hexane was added to the tube containing the methyl ester of fatty acid (FAME) and the tubes were centrifuged (500 rpm) for 1 min. An aliquot of the supernatant (300 mL) containing FAME was transferred to 2-mL glass vials before injection. The FAME were separated by gas-chromatography using a Agilent Series 6890 equipped with a flame ionization detector and an Agilent Series 7683 automatic injection system using a CP7420 – Select CB for FAME capillary column (100 m x 0.25 mm i.d., 0.25 m film thickness). The FAME preparation was injected in the split mode with a split ratio of 1:65. Nitrogen was used as the carrier gas with a 1.4 mL/min flow rate. Both injector and detector were kept at constant temperatures of 250 °C. The column oven temperature was held at 70 °C for 2.5 min, increased at 10 °C/min to 165 °C and held for 22 min, increased to 240 °C at 3 °C/min and held for 10 min. Identification was achieved by comparing the retention time of unknown FAME with those of known FAME standard mix (37 FAME, Supelco Inc., Bellefonte, PA, United States). Quantitative analysis of FAME was based on undecanoic acid as internal standard.

II.2.2. *Amino acid analysis*
Sample amino acid content was determined by direct hydrolysis (in triplicate) in vacuum glass tubes with 6 N HCl at a ratio of 1 mL of acid by each 0.2 mg of nitrogen of the sample (determined by Kjedhal method). The hydrolysis was conducted at 110 °C for 24 h. The amino acids were separated by means of cation-exchange chromatography, using a Biochrom 30 automatic amino acid analyser (Biochrom Ltd Cambridge, Cambridgeshire, UK) with a high-resolution cation-exchange resin column Ultropac (9±0.5 mm particle size, Pharmacia Biotech) 200x4.6 mm. The amino acids were determined and measured using ninhydrin derivative reagent at 570 nm. Proline was measured at 440 nm. Quantitative analysis of amino acids was based on L-Norleucina as an internal standard.

III. RESULTS AND DISCUSSION

Beef lipids are not generally regarded as a healthy component of the human diet. There are concerns about its relatively high concentrations of hypercholesterolemic, saturated fatty acids (SFA) and low concentration of hypocholesterolemic polyunsaturated fatty acids (PUFA). The weaning system of cull cows affected the fatty acid composition of the meat. It was observed that the meat from CVEW contained lower SFA ($P = 0.09$), MUFA ($P = 0.06$) and *n*-6 PUFA ($P > 0.1$) than meat from CTW (**Table 1**). The last years, have seen a growing interest in *n*-3 PUFA prompted by increasing evidence that these PUFA elicit a wide range of nutritional benefits in the human body. The increasing awareness of the need for diets to contain higher levels of *n*-3 PUFA has focused on the importance of meat as a natural supplier of these to the diet. The ratio of *n*-6:*n*-3 PUFA is also a risk factor in cancers and coronary heart disease. The ratio of *n*-6:*n*-3 PUFA is particularly beneficial in ruminant meats, especially from animals with high grass intake containing high levels of linolenic acid. Ruminants also naturally produce conjugated linoleic acids (CLAs) which may have a range of nutritional benefits in the diet (Enser, 2001). The *cis*-9, *trans*-11 isomer of CLA is most prevalent, comprising 80 to 90% of total CLA in food products from ruminants (Waters et al., 2009). In the present work, the content of *n*-3 PUFA ($P = 0.09$) and cis-9, trans-11 CLA ($P = 0.04$), the most abundant of CLA, was higher in meat from CVEW compared to meat from CTW. Although, the ratio of *n*-6:*n*-3 was higher than the value of 4.0 recommended in human diets by the World Health Organization (WHO, 2003), CVEW evidenced a lower value than CTW ($P = 0.001$). Differences in the fatty acid composition of the muscle from treatments assayed were due to the diet.

In the case of very early weaning, the cows were grazed only on pasture, whereas cows from traditional weaning were finished in feedlot. These results agree with those published by García et al. (2008) who found that grass beef had lower content of SFA, MUFA and *n*-6 PUFA and higher content of *n*-3 PUFA and CLA.

Table 1. Fatty acid composition (mg/100 g of muscle) from meat of cull cows with very early weaning (CVEW) and cull cows with traditional weaning (CTW).

	CVEW[a]	CTW[b]	Significance level of ANOVA[c]
			Treatment
SFA[d]	789.73 ± 90.75	1048.34 ± 114.44	*
MUFA[e]	661.25 ± 91.76	944.28 ± 106.05	*
PUFA[f]	55.53 ± 5.75	54.74 ± 4.65	NS
n-6[g]	37.11 ± 3.66	43.62 ± 3.70	NS
n-3[h]	6.82 ± 0.71 A	5.14 ± 0.47 B	*
n-6:*n*-3	5.85 ± 0.46 B	8.75 ± 0.63 A	***
cis-9, *trans*-11 *CLA*	11.60 ± 1.77 A	5.97 ± 0.79B	**

[a,b]Mean ± Standard error of the mean

[c]NS: not significant; *$P < 0.1$, ** $P < 0.05$, *** $P < 0.001$; Different letters in the same row indicate significant differences $P < 0.05$.

[d]Sum of SFA = C12:0 + C14:0 + C15:0 + C16:0 + C17:0 + C18:0 + C20:0 + C22:0.

[e]Sum of MUFA = C14:1 + C15:1 + C16:1 + C18:1 + C20:1.

[f]Sum of PUFA = *n*-6 + *n*-3 + *cis*-9, *trans*-11 CLA.

[g]Sum of *n*-6 = C18:2 + C18:3 + C20:2 + C20:3 + C20:4 + C22:2.

[h]Sum of *n*-3 = C18:3 + C20:3 + C20:5 + C22:6.

As an essential part of a mixed diet, meat ensures adequate delivery of essential micronutrients and amino acids (Biesalski, 2005). The analysis of variance showed that amino acids composition of meat from cull cows was not affected by the weaning system. However, it was observed a tendency of the meat from CVEW to contain higher level of amino acids compared to meat from CTW (**Table 2**).

Table 2. Amino acid composition (g/100 g of muscle) from meat of cull cows with very early weaning (CVEW) and cull cows with traditional weaning (CTW).

	CVEW[a]	CTW[b]
Alanine	1.48 ± 0.05	1.38 ± 0.07
Arginine	1.56 ± 0.07	1.46 ± 0.08
Aspartic acid	2.42 ± 0.08	2.28 ± 0.12
Cystine	0.27 ± 0.02	0.24 ± 0.02
Glutamic acid	4.09 ± 0.20	3.79 ± 0.20
Glycine	1.06 ± 0.03	1.00 ± 0.05
Histidine	1.07 ± 0.03	1.10 ± 0.06
Isoleucine	0.99 ± 0.10	0.91 ± 0.08
Leucine	2.07 ± 0.09	1.93 ± 0.11
Lysine	2.20 ± 0.16	2.21 ± 0.13
Methionine	0.72 ± 0.03	0.67 ± 0.04
Phenylalanine	1.03 ± 0.04	0.95 ± 0.05
Proline	0.99 ± 0.03	0.92 ± 0.04
Serine	1.29 ± 0.04	1.21 ± 0.06
Threonine	1.19 ± 0.05	1.12 ± 0.06
Tyrosine	0.89 ± 0.04	0.82 ± 0.04
Valine	1.08 ± 0.09	1.01 ± 0.08

[a,b]Mean ± Standard error of the mean

IV. CONCLUSION

Results of the present work indicate that the meat from cull cows with very early weaning had higher level of components reported beneficial to human health. The diet program employed in the treatments determined the differences in the fatty acid composition of the meat. Cows with very early weaning raised exclusively on pasture have a positive impact on fatty acid tissue profile, mainly due to an increase in the proportion of *n*-3 fatty acids and CLA. Thus, the very early weaning system could be an important tool to produce high nutritional quality cull cow meat.

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