BULL PRODUCTION FACTORS AFFECTING PROXIMATE AND MINERAL COMPOSITION OF COOKED *LONGISSIMUS* STEAKS

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Background

Beef is one of the most preferred foods by Venezuelans. Its chemical composition has been well characterized in foreign countries where research (Byers *et al*., 1988) has indicated that intrinsic (gender, species, etc.) and extrinsic factors (plane of nutrition, growth regulation, castration, etc.) are largely responsible for the variation found in beef nutrient composition. Nevertheless, information regarding the proximate and mineral composition of beef produced under tropical conditions is scarce. It is well known that recommended dietary allowances (RDA) are referred to nutrients supplied by the food once it has been processed or cooked. According to Ramos Galvan (1995) this aspect has not been taken into account when designing food composition tables, which express the content of a specific nutrient per 100 g of net weight without indicating the edible portion and/or the refuse of the food. In order to diminish the risk of transmissible diseases by consumption of contaminated meats, thoroughly cooking has been recommended. Over-cooking might produce protein losses, especially from those zones more exposed to heat (Maynard *et al*. 1981). On the other hand, significant losses on mineral content might occur due to leaking or dilution, depending on cooking procedures (Ramos Galván, 1985). Beef cattle producers of Venezuela are constantly searching for new management alternatives to increase cattle productivity and to avoid the traditional need for beef imports (Morón *et al.*, 1999). Bull production offers the advantages of a faster and more efficient growth with a higher yield of lean beef as compared to steers (Huerta and Ríos, 1993). Strategic supplementation has been recommended to complement nutritional deficits of grasses, and to reach elevated production indices and yield from grazing herds (Rowe, 1999). Likewise, the use of anabolic implants allows for accelerating growth rate and improving the production efficiency of grass fed beef (Araujo *et al.* 1991). Efforts to improve beef cattle productivity through better genetics, nutrition and growth regulation must now take into consideration marketplace trends for leaner and more nutritious foods.

Objectives

The purpose of this study was to evaluate the effects of anabolic implant regimes and a supplementation strategy of grass-fed bulls on proximate and mineral composition of cooked beef *longissimus* steaks

Materials and methods

Animals

Seventy-seven bulls representing seven breed-types (Brahman, Angus, Romo Sinuano, Senepol, Simmental, commercial Zebu crossbred and ¾ Bos taurus) were raised in a ranch (Hato Santa Luisa) located at the Western Llanos of Venezuela, under the same pre- and post-weaning conditions including a common antiparasitic treatment at 90 days of age, vaccination program and supplementation with a mineral mixture. The fattening trial was conducted when the dry season started. The zone corresponds to a tropical dry forest with an annual temperature that varies from 22 to 29°C. This savannah area presents a hydric deficit during the rainy season (May-October). The precipitation averages 1,400 mm/year, and most (60%) of it occurs during June to August.

Implant regimes and strategic supplementation

Implant regimes were as follows: 1 = Ralgro™ (72 mg) administered to bulls at 0 d on fattening with reimplantation at d 90 (**RAL-RAL**); 2 = Combined strategy, consisting of Revalor™ administered to animals at 0 d on fattening followed by reimplantation with 72 mg of Ralgro™ on d 90 (**RAL-REV**). Bullocks were

randomly allotted to one of the two following treatments: a) Mineral supplementation *ad libitum* that served as a control diet; and b) Strategic supplementation *ad libitum*, consisting of an adjustment ration of 10% of feather flour, 77.9% of rice flour, 5% of molasses, 7% of minerals and 0.1% de ionophore (Salocin™), during 58 d; followed by a second ration of 49.9% of cotton seed, 28.0% of rice flour, 7.0% of minerals, 10% of feather flour, 5.0% molasses, and 0.1% ionosphere (Salocin™), which was offered during the following 114 d.

Sample collection

Animals were slaughtered ca. 500 kg liveweight. At 48 h *post-mortem* carcasses were reduced to wholesale cuts. One 2.5 cm thick steak (*longissimus dorsii*) was excised from each carcass and individually vacuum-packaged in multi-laminar plastic bags (Cryo-vac™) using a Koch-Ultravac™ packaging machine. Each sample was identified by animal number and kept frozen at -22ºC. To be prepared for chemical analyses, steaks were cooked on an electric broiler (Oster™) to reach an internal endpoint temperature of 70ºC, and trimmed to zero fat cover and other surrounding muscles. Cooked lean samples were ground for homogenization with a Black & Decker food manual processor and packaged by duplicates in hermetically sealed plastic (Zip-lock) bags and immediately stored at -20ºC until chemical analyses.

Chemical analyses

Except for total lipids (by the Folch *et al.* 1957 method), proximate analysis was performed according to the A.O.A.C. (1990). Except for phosphorus (by the A.O.A.C., 1990 method), mineral analyses were conducted by atomic absorption and/or atomic emission with ashing procedure (A.O.A.C, 1990), following the analytical methods described by Perkin-Elmer (1994).

Statistical Analyses

A completely randomized design with an unbalanced number of animals was used. Proximate and mineral composition data were subjected to an analysis of variance (ANOVA) by using the procedure PROC GLM of the Statistical Analysis System (SAS, 1996) to test differences due to supplementation and implant regime. The least squares means (LSMEANS) were separated by Tukey-Kramer´s test (SAS, 1996).

Results and discussion

Effect of implant regime and strategic supplementation on the proximate and mineral content:

ANOVA revealed a significant effect ($P<0.01$) of implant regime on the total intramuscular lipid content (Table 1). Beef derived from animals implanted with RAL-REV showed 0.4g more total lipids than those implanted with RAL-RAL. Lee *et al*. (1990), found that trembolone acetate plus 17β estradiol implanted in the stocking phase did not cause any decrease in the content of muscle lipids. Table 2 shows the effect of RAL-RAL on the content of Cu. The *longissimus* muscle of bulls implanted with RAL-RAL presented 0.01 mg less Cu than that of bulls implanted with the RAL-REV implant combination. Sodium was the only mineral affected by supplementation ($P<0.05$) (Table 3). Cooked samples from the strategic supplemented group had 2.1 mg of sodium than those samples obtained from the control group-

Effects of supplementation x implant regime on proximate and mineral composition

ANOVA revealed that beef derived from supplemented animals which had been implanted with RAL-REV had a higher protein content than those subjected to the other treatments. However, samples from animals fed with the control diet and implanted with RAL-REV showed lesser protein content than counterparts implanted with RAL-RAL. This would explain the synergistic effect of the strategic protein mineral ionophore supplementation and androgenic implant on the activation of protein anabolism and documents that the effectiveness of growth regulation regimes is regulated by the nutrition program provided.

Conclusions

The enhancement of protein accretion depends not only of the use of anabolic growth regulators, but also, it depends of nutrition of the animal, indicating the importance of an integrated nutrition-growth regulation plan in beef production.

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Table 1
Least Square means ± standard error for the nutrient content of 100g of cooked longissimus sample, according to implant regime

Component [a]	Implant regime		P value
	RAL-RAL (n = 43)	RAL-REV (n = 33)	
Protein	35.52 ± 0.16	35.88 ± 0.20	NS
Moisture	59.92 ± 0.52	59.37 ± 0.64	NS
Dry matter	40.06 ± 0.52	40.63 ± 0.63	NS
Ash	1.36 ± 0.02	1.36 ± 0.02	NS
Total lipids	3.63 ± 0.07	4.03 ± 0.07	0.0003

[a:] g/100g cooked muscle
NS: Non significant (P> 0.05)

Table 2
Least Square means ± standard error for mineral content of cooked *longissimus* sample, according to implant regime

Component[a]	Implant regime		P value
	RAL-RAL (n = 43)	RAL-REV (n = 33)	
Ca	10.29 ± 0.26	10.27 ± 0.31	NS
Mg	29.61 ± 0.30	29.76 ± 0.37	NS
Na	70.48 ± 0.57	70.11 ± 0.70	NS
K	413.45 ± 2.58	406.97 ± 3.13	NS
P	230.98 ± 1.82	233.03 ± 2.20	NS
Fe	3.05 ± 0.09	3.01 ± 0.11	NS
Cu	0.07 ± 0.003	0.08 ± 0.003	0.0003
Zn	5.80 ± 0.10	5.86 ± 0.13	NS
Mn	0.01 ± 0.0008	0.01 ± 0.001	NS

[a]mg/100g cooked muscle
NS: Non significant (P> 0.05)

Table 3
Least Square means ± standard error for the mineral content of cooked *longissimus* sample, according to supplementation

Component [a]	Treatment		P value
	Strategic Supplement (n = 27)	Control (n = 49)	
Ca	10.02 ± 0.32	10.54 ± 0.24	NS
Mg	29.85 ± 0.89	29.52 ± 0.28	NS
Na	71.34 ± 0,5	69.24 ± 07	0.02
K	409.20 ± 3.30	411.26 ± 2.37	NS
P	230.00 ± 2.32	234.08 ± 1.67	NS
Fe	3.15 ± 0.12	2.91 ± 0.08	NS
Cu	0.08 ± 0.004	0.07 ± 0.003	NS
Zn	5.92 ± 0.13	5.73 ± 0.10	NS
Mn	0.01 ± 0.001	0.01 ± 0.0008	NS

[a]mg/100g cooked muscle
NS: Non significant (P> 0.05)

Table 4
Least Square means ± standard error for the nutrient content of 100g of cooked *longissimus* sample, according to supplementation x implant regime

Component	Treatment				P Value
	Strategic Supplementation		Control		
	RAL-RAL (n = 17)	RAL-REV (n = 10)	RAL-RAL (n = 26)	RAL-REV (n = 23)	
Protein, g	35.36 ± 0.25[a/c]	36.21 ± 0.33[b/c]	35.67 ± 0.20[b/c]	35.53 ± 0.21[b/d]	0.05
Moisture, g	59.89 ± 0.81	58.64 ± 0.81	60.00 ± 0.66	60.10 ± 0.70	NS
Dry matter, g	40.12 ± 0.81	41.37 ± 1.1	40.03 ± 0.66	39.90 ± 0.70	NS
Ash, g	1.37 ± 0.02	1.37 ± 0.03	1.35 ± 0.02	1.34 ± 0.02	NS
Total lipids, g	3.61 ± 0.10	3.99 ± 0.13	3.66 ± 0.08	4.07 ± 0.09	NS

[a,b/c,d:] different letters in the same row (within the same treatment) indicate significant differences (P<0.05).
NS: Non significant (P> 0.05)