# Effect of different feeding strategies on animal welfare and meat quality in Uruguayan steers

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## Abstract

Eighty four steers were randomly assigned to T1: pasture (4% of animal live weight: LW), T2: pasture (3% LW) plus concentrate (0.6% LW), T3: pasture (3% LW) plus concentrate (1.2% LW), and to an *ad libitum* concentrate treatment, T4, to study the effects on animal welfare and meat quality. Differences in average daily gain (T4>T3>T2>T1) were due to the different energetic composition of the diets and were not attributable to animal welfare problems. Animals from T4 had the best performance but also showed the highest values of acute phase proteins (stress indicator). It seems that T1, T2 and T3 would not compromise animal welfare, but special considerations must be taken into account in a feedlot system, specially preventing diet diseases. No adverse effects on meat quality were detected in T1, and tenderness was enhanced. Calm animals showed lower shear force and final pH values. Independently on the feeding strategy, temperament appears to be an important factor considering its influence on meat quality.

## Introduction

Sensibility about animal welfare have increased in the past years being a strong issue in developed countries. Animal welfare is the combination of different aspects of the conditions of life for animals. Its status should include and integrate productive, physiological and behavioural indicators. Temperament is a very important trait in livestock farming, especially in beef cattle. Animals with a bad (wild) temperament make handling difficult and time consuming, can lead to injuries to man or beast and lead to damage to pens and fences. According to Fordyce *et al* (1988), temperament is also strongly related to productivity and meat quality. The acute phase proteins (APP) are a group of blood proteins that change in concentration in animals subjected to external or internal challenges, such as infection, inflammation, surgical trauma or stress. There is also evidence in cattle that physical stress can induce APP (Alsemgeest *et al*., 1995). APP analysis may be used to help monitor the health and welfare of production animals on the farm (Eckersall, 2000), or to identify the disease and health status of animals at slaughter. Uruguayan meat has been traditionally produced on pastures. However, in the past few years, intensive systems have been growing including a wide range between pasture and concentrate utilization, in order to attend different markets requirements. The objective of this experiment is to evaluate the effect of these emerging rearing systems on animal welfare, and its effects on meat quality.

## Materials and methods

Eighty Hereford steers backgrounded on pasture were finished on one of the following diets with increasing amounts of concentrate: A) pasture (alfalfa - *Medicago sativa*, white clover -*Trifolium repens* and fescue -*Festuca arundinacea*) 4 % of live weight (LW), B) pasture 3 % of LW and concentrate (corn 0.6% of LW), C), pasture 3 % of LW and concentrate (corn 1.2% of LW), and D) concentrate (corn, sunflower pellets and hay) *ad libitum*. The intensive feed treatment (T4) was located in 3 open-air plots on concrete flooring (8 square meters per animal). Animals from all treatments had *ad libitum* access to water and mineral salts. They were weighed early in the morning without previous fasting every 14 days. Every 28 days, fat thickness and ribeye area were registered by ultrasound techniques. *Tameness and temperament.* The *Flight zone* (meters) was registered twice for each treatment (the first day of the experiment and 2 days before slaughter). The test was performed by the same person, who slowly walked toward the group of animals and when half of them turned away, the distance was registered. *Hair whorl position* was recorded at the starting day and it was categorized as high: if the center of the hair whorl was above the top of the eyes; middle if the center was located at eyes level; low if the center was located below the bottom of the eyes. Temperament ratings were assessed once a month after weighting and ultrasound measuring, by different tests: a) *Crush score*

(CS): the behaviour of each animal was assessed when put into a crush using a 1 (calm) to 5 (combative) scale, b) *Flight-time* (FT): the amount of time it takes an animal to cover a fixed distance (5 meters) after they leave the chute - restraining devices, was recorded. Each animal was hold by the neck while in the squeeze chute, c) *Exit speed* (ES) from the squeeze chute was registered and it was ranked as 1 = walked, 2 = trotted, and 3 = ran out of the chute. All three are measures of the docility of an animal all are correlated with each other. *Phisiological measure.* Once a month and in the slaughter moment, *acute phase proteins* (APP-haptoglobin) were measured in serum with a plate reader, ELISA (EMS Reader MF V2.9-0. Methodology: Bovine Hapt. ELISA test Kit, Life Diagnostics). Diseases, lameness and pain indicators, were registered daily. *Slaughter and sampling procedures*. Good management practices were followed during loading and unloading for minimising stress. Animals were slaughtered by humanitarian procedures in a commercial abattoir when they reached an average of 500 kg of LW in each treatment and at least 6 mm of fat covering (determined by ultrasound technique). The rate of pH decline was measured at 1, 3 24 and 48 hs post mortem (p.m.) in the Longissimus thoracis (LT) muscle between 12-13th rib using a thermometer (Barnant 115) with type E thermocouple and pHmeter (Orion 210A) with gel device. After 48 hours, two steaks were fabricated and vacuum packaged individually, aged for 7 and 20 days at 2-4 $^{o}$C for tenderness determination (Warner Bratzler model D2000- WB). The LT steaks were placed inside polyethylene bags and cooked in a water bath until an internal temperature of 70 oC was achieved using Barnant 115 thermometer with type E thermocouple. About six 1.27-cm diameter cores were removed from each steak parallel to the muscle fiber orientation. A single peak shear force measurement was obtained for each core using the WB and an average value was calculated for each steak. *Statystical analysis.* APP and FT were transformed to follow a normal distribution, $APP_t = \frac{-1}{\sqrt{APP}}$ , where $APP_t$ is the variable on the transformed scale and APP is the original one and, $FT_t = \sqrt[3]{FT}$ , where $FT_t$ is the variable on the transformed scale and FT is the original one. Analyses of variance were carried out assuming a general linear model (Proc GLM, SAS, 2003), to study the effect of treatment and qualitative traits (CS, ES, HWP) on production variables and $APP_t$. Means were were compared by Lsmeans procedure (SAS, 2003). Several correlation analysis were performed between productive (ADG, $pH_{48h}$), phisiological ($APP_t$) and cuantitative temperament related data ($FT_t$).

## Results an discussion

*Productive variables* Remaining pasture after grazing (more than 1.100kg/DM) indicated that consumption was not restricted in any treatment (Hodgson, 1968). Differences in average daily gain (Table 1), were due to total dry matter or digestive dry matter consumption, associated to different concentrate/energy proportion of the diet (Vaz Martins *et al.*, 2007). Animal welfare was not compromised from this isolated perspectives (consumption and nutrition), considering that minor daily gains were registered for T1 with 0.516 kg/animal. Fat thickness and ribeye area were also higher as long as supplementation increased (Vaz Martins *et al*, 2007). However, productivity is not enough to ascertain an adequate animal welfare status.

**Table 1.** Mean Average daily gain per treatment

| | T1 | T 2 | T3 | T4 |
|---|---|---|---|---|
| Average daily gain (kg/an) | 0,516 d | 0,936 c | 1,115 b | 1,560 a |

[a,b,c,d] Means within the same line with different letter differ with P<0.05

ADG, ribeye area and fat thickness (productive variables) were not related to temperament (P>0.05). Temperament classification was done, but all animals were considered tame. According to Grandin (1995), cattle with a round hair whorl located above the eyes became significantly more agitated while they were restrained in a squeeze chute (crush) compared to cattle with a hair whorl located either between or below the eyes, and these last are even calmer. In this experiment, hair whorl position was related neither to temperament nor to productive variables.

*APP - bovine Haptoglobin.* Productive variables were not related to serum APP. No significant differences (P>0.05) were found between treatments, except for T3 (Table 2). Average APP values were below values considered “hazard” by the literature, from the health perspective. However, according to Chadwick (2006, Ch. Chadwick, Pers. Comm., Life Diagnostics, Inc.P.O. Box 5205. West Chester, PA 19380), considering differences in determination techniques, it is the relative changes that are most important within a particular study. From this perspective, T4 had the highest average values of APP during the experiment, especially during the first months, possibly due to feeding diseases registered in this treatment. Although the mechanism of APP induction in response to stress is yet to be elucidated, activation of the hypothalamic–

pituitary–adrenal (HPA) axis by stress signals may be a trigger of systemic or local (intra-pituitary) cytokine production, thereby augmenting hepatic APP synthesis and release into the bloodstream (Murata *et al*, 2004). Besides, although preventive measures had been applied and health monitoring was permanent, mortality rate was 9,5 % in T4 because of diet disorders, without any death in other treatments. From this perspective, animals in T4 were more stressed, health was compromised and mortality was relevant.

**Table 2.** Mean APP values by treatment

| | T1 | T 2 | T3 | T4 |
|---|---|---|---|---|
| $APP_t$ | -0,5629 | -0,5464 | -0,6677 | -0,5086 |
| APP (µg/ml) | 5,6 a | 6,1 a | 3,4 b | 7,6 a |

[a, b] Means within the same line with different letter differ P<0.05

However, APP did not compromise ADG in any treatment during the period pre or post its determination, and T4 had the highest ADG and final liveweights. This reinforces the theory that productive indicators are not enough to determine animal welfare status. T4 also had the highest APP values (P<0.05) at slaughter.

*Temperament.*In spite of temperament ratings, there were neither excitable nor aggressive animals in this experiment and differences in their temperament were not reflected in productive variables. According to Fordyce *et al* (1988), *Bos Taurus* show calm temperaments with minor differences and variability when compared to *Bos indicus* animals. In this experiment all animals were Hereford and is important to consider that a proper handling procedure was performed during the whole period. The Flight zone is the animal´s personal space. When a person enters it, the animals will move away but its size will slowly diminish when they receive frequent, gentle handling. Flight zone in both dates, showed lower values in T4 (Figure 4). Considering FZ values in the first and the last determination (Figure 1) is possible to assure that animals were tame and used to human proximity (higher final FZ was 2,5 meters in T3).

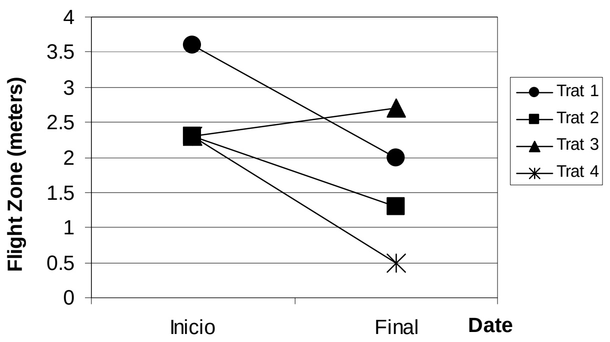


**Figure 1.** Initial and final Flight Zone values by treatment.

According to these results, animal temperament and management (human handling), are key factors for minimising stress. *Animal welfare and meat quality.* Temperament showed a significant correlation to meat quality traits. According to FT values, meat from calmer animals had lower shear force values with 20 aging days and calmer animals showed lower values of $pH_{48}$ (Table 3). These results suggest that temperament could be even more relevant when working with more excitable animals like *Bos indicus* and it crosses or/and when human handling is not proper. Animals with higher APP values also had higher pH48 values, indicating that this stress is playing an important role in the muscle to meat transformation process. However, all pH values were below 5.8.

**Table 3.** Correlation between APP and FT to meat quality traits

| Variables | $pH_{48}$ | $Tendernes_{20}$ | FT |
|---|---|---|---|
| APP | 0.34 ** | ns | ns |
| FT | -0.28 * | -0.30 ** | |
| $Tenderness_{20}$ | 0.39 ** | | |

* P < 0.05 ** P< 0.01

## Conclusions

From a productive perspective, animal welfare was not affected by the different feeding systems. But, animals in T4 were more stressed, health was compromised and an important mortality rate was registered. Regardless of the feeding strategy, and even considering that animals were calm, temperament appears to be an important factor considering its influence on meat quality. Next studies should evaluate pathological behaviours as indicators of discomfort, boredom or frustration as possible consequence of not performing non elastic demands behaviours.

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