**Revista Brasileira de Zootecnia**
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ISSN 1806-9290
www.sbz.org.br

R. Bras. Zootec., 43(10):551-555, 2014

## Short Communication

# Live weight and metabolic hormone profile in steers moved in drives

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**ABSTRACT** - The objective was to determine the effects of driving on the growth of steers during 55 days of moving by drive and 84 days after the arrival. Twenty-five steers were randomly chosen from a herd of 1,000 Nellore cattle, which were evaluated in two periods: the driving period, in which animals were moved a distance of 700 km on foot for 55 d; and the post-driving period, which lasted 84 d. Serum samples were obtained for hormone dosing ($T_3$, $T_4$, cortisol, and IGF-I) by radioimmunoassay using commercial kits. The data was collected at different time points during the experiment. No changes in live weight were observed between days 0 and 55. During the post-driving period, on the 28th, 56th, and 84th d, the average weights were 226.10 kg, 224.28 kg, and 242.6 kg, respectively; differences in weight were observed on the 84th d when compared with the 56th d. There were no changes in insulin and $T_3$ levels in either periods; the lowest $T_4$ concentration was observed during the driving period. The serum $T_4$ concentration increased after 56 d of post-driving, and it was greater than the concentrations detected on the other days. The highest levels of cortisol were identified after 28 d of post-driving. An increase in IGF-I concentration was observed after 56 and 84 d of post-driving. Moving cattle by driving does not alter the weight of the animals and weight gain occurs during the post-driving period due to an increase in the $T_4$ and IGF-I levels.

Key Words: compensatory gain, metabolism, post-driving, transportation

## Introduction

The Central West and Northern regions of Brazil, which together hold approximately 111.10 million cattle (IBGE, 2010), commonly display the traditional figure of cattle drives in long trips on country roads. The difficulties imposed by the environment combined with the lack of government investment on road infrastructure make this means of transportation still widely used.

In the case of Mato Grosso do Sul State - Brazil, with a flock of 22.3 million cattle (IBGE, 2010), the State Agency for Animal and Plant Health Protection estimates that driving represented about 20% of the means of transportation for livestock in 2009, 2010 and 2011, accounting for 2.7, 2.6 and 2.6 million cattle, respectively. Such transport type is still the most efficient in the Pantanal region due to the situation of roads, which in certain times of the year are inaccessible to motor vehicles, making the transport of such animals difficult. Depending on the destination and animal category, these cattle entourages travel for more than 60 days to fattening farms; these journeys sometimes exceed 700 km, distances which could be completed in about 10 to 15 h on reasonably conserved roads using trucks.

Basal metabolism is reduced in animals if there is food restriction during long walks, mainly because of decreased volume and activity of the viscera, but also due to hormonal changes (Yambayamba et al., 1996a; Yambayamba et al., 1996b). A decrease in the plasma levels of insulin, triiodothyronine ($T_3$), thyroxine ($T_4$), and insulin-like growth factor 1 (IGF-I) occurs during periods of food restriction, whereas the levels of cortisol and growth hormone (GH) increase (Yambayamba et al., 1996b; Blum et al., 1985; Hornick et al., 2000). Therefore, physical stress combined with food restriction during long walks can lead to weight loss, with serious consequences on the animal growth, changes in body composition and endocrine, metabolic, and compensation mechanisms. In this context, the questions are: what is the relationship between walking and weight loss? Which endocrine changes are observed along the walk? How do these animals recover after their arrival at the destination farm?

Received May 16, 2013 and accepted July 1, 2014.
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http://dx.doi.org/10.1590/S1516-35982014001000007

To answer those questions we conducted an exploratory study whose objective was to describe the effects of transport on foot on the growth of steers during 55 days of driving and 84 days after arrival at the destination farm.

## Material and Methods

The study was conducted in accordance with ethical standards and approved by the Ethics Committee and Biosafety of Universidade Federal de Mato Grosso do Sul, under protocol no. 158/2007.

Twenty-five steers with an average weight of 217.7±18.0 kg were randomly chosen from a group of 1,000 Nellore cattle to participate in the study. The animals were between 12 and 15 months old and moved in drives over 700 km, from the municipality of Porto Murtinho to the municipality of Iguatemi, both located in the State of Mato Grosso do Sul - Brazil. During the experimental period the temperature ranges varied from a minimum of 2.5 °C to 15.8 °C to a maximum of 23.3 °C to 37 °C and precipitation varied from 0 mm to 40.1 mm.

The drive was conducted by a team of seven people with more than 30 years of experience in transporting cattle by drive. The study was conducted in two stages. The first phase, lasting 55 days, began on February 18, 2009, and consisted of the driving period. The second phase, which lasted 84 days, began on May 9, 2009, and represented the recovery phase after the animals arrived at the farm for fattening and entered the post-driving period.

During the driving period, the animals walked on average 12 km per day, in approximately eight hours, but those values varied depending of the grass and water availability on the side road. When the animals had grass and water available on the road they walked less than 10 km/day or even stopped for one day or two, but when they did not have the water and grass available they walked more than 12 hours/day.

Measurements of live weight and collection of blood samples were performed during the experiment at the beginning (day 0), in the middle (day 20), and at the end of the trip (day 55) on the Oriente (located at 22º02.451'S and 57º37.631'W), Água Amarela (21°47.822'S and 56°08.349'W), and Mato Alto (23°50.000'S and 54°50.000'W) farms, respectively. The animals were regrouped on 580 ha of Mombaça grass (*Panicum maximum* Jacq), which was fenced for 60 days and evaluated upon arrival and during the post-driving period on days 28, 56, and 84; live body weight was measured and blood samples were collected always at 07.00 h after a 16-hour period of solid and liquid deprivation.

A collective scale used especially for cattle and with the maximum load of 5,000 kg and accuracy of 500 g was used; however, the animals were weighed individually.

Forage samples were collected, during the post-driving period, to evaluate the forage mass. The collections for evaluation of forage were performed every 28 days at the time of weight measurements. Eight samples were collected in a metal square of 0.5 m$^2$ (1 × 0.5 m) by cutting at 5 cm above the soil. The material was weighed fresh in the field, homogenized, and two sub-samples were taken from it; one was conditioned in paper bags to determine dry matter (DM) and estimated forage biomass. The samples were dried in a forced-ventilation oven at 65 °C for 72 hours, and the leaves were expressed as percentages of the total weight.

Blood samples were collected by jugular venipuncture from each animal to determine hormonal parameters, and stored in tubes without anticoagulant at room temperature for two hours. These samples were subsequently centrifuged at 2,400 rpm for 10 min; the serum was transferred to Eppendorf tubes and stored at −20 ºC for later analysis.

The following parameters were analyzed in the serum samples: insulin, $T_3$, $T_4$, cortisol, and IGF-I by radioimmunoassay (RIA) using the Coat-A-Count® commercial kit for insulin, $T_3$, $T_4$, and cortisol (Siemens Medical Solutions Diagnostics, Los Angeles, CA, USA), and IGF-1-RIA-CT (DIAsource ImmunoAssays S.A., Belgium) for IGF-I.

The sampling design used was the simple random sampling, and the animals were drawn from a large group of the same gender, age, and similar weight.

The data underwent normality, homogeneity of variances, and presence of disparate values (outliers) tests before the inferential tests. The hormonal variables were transformed [log (x + 1)] to homogenize variances because they failed to meet the basic assumptions of the parametric analysis; however, the estimates presented in the results were obtained from the inverse transformation of the values obtained in the analysis. Therefore, the results were presented in the same unit as the original values.

The PROC MIXED procedure of SAS software (Statistical Analysis System, version 9.0) was used for the analysis of replicate measurements over time; the matrix structure of the Toeplitz covariances (TOEP) was chosen for weights, and the Composed Harmonic Symmetric (CSH) covariance matrix was chosen for the hormones insulin, $T_3$, $T_4$, cortisol, and IGF-I. Adjusted Tukey's test was used for the comparison of means at the 5% level of significance.

## Results

An effect of the period (driving or post-driving) was observed on the live weight of the animals (Table 1); the lowest weight was observed on the 20th day during driving and the highest on the 84th day during post-driving.

The serum concentrations of insulin, $T_3$, $T_4$, cortisol, and IGF-I changed between both periods (driving and post driving). The lowest serum concentrations of $T_4$ were observed during driving (on days 0, 20, and 55). The highest serum concentration of cortisol and the lowest concentration of IGF-I were observed on the 28th day of post-driving. The highest serum concentrations of IGF-I and the lowest of cortisol levels were observed on the 56th and 84th days during post-driving.

## Discussion

An average weight loss of 4.9 kg was observed when considering the difference between the initial weight and the 20th day of driving. However, an average weight gain of 9.78 kg between 20th and 55th days was observed during driving (arrival at the fattening farm). This weight loss observed between days 0 and 20 could be associated with grass and water availability during the first period of driving; moreover, there might have been a small increase in requirements for maintenance due to the process of walking (Di Marco and Aello, 1998). These authors identified that bovine animals subjected to walking at a constant speed require approximately 9 and 16 kcal.100 kg $LW^{-1}$ to walk 1 km on flat and sloped terrains, respectively.

Weight gain in the final stages of driving could be explained by either a metabolic adaptation, or the fact that the animals passed through an area which provided enough foraging for feeding beyond their maintenance requirements during this phase.

There was no significant difference in the live weight between days 0 and 55 during driving (Table 1). This demonstrates the possibility that there was no severe food restriction, which by definition leads to weight loss and is characterized by changes in the synthesis:degradation ratio and consequent mobilization of tissues (Hornick et al., 2000).

No significant difference in the weights of the animals was observed between the arrival at the farm (55 days) and on days 28 and 56 during the post-driving period. This probably occurred because the walking led to physical stress with a consequence on the later weight gain; after the arrival, the animals grazed on Mombaça grass (*Panicum maximum* Jacq) with a forage mass of 6,729 kg of dry matter per hectare (kg DM/ha) and 9% of leaf.

The greatest weight gains were observed on day 84, possibly because the necessary time for the physical recovery of the animal had passed, combined with a better quality of forage mass (4,349 kg DM/ha), especially leaf (21%). The animals presented a weight gain of 18.32 kg as compared with the weights on day 56, added to the gains of 16.50 and 20 kg on days 28 and 55, respectively. The weight gain during this period could be the result of the various processes described by Murphy et al. (1994) and Yambayamba et al. (1996a). These processes consist of reduction of the size of metabolically active organs (viscera, spleen, and liver) leading to a decrease in the requirements for maintenance, reduction of physical activity, and increase in the digestibility of diet.

The small change in the serum concentration of insulin observed in this study diverged from the results reported by Blum et al. (1985) and Yambayamba et al. (1996b). These authors observed a reduction in plasma concentration of insulin in animals that were at maintenance-level food restriction reflecting the lower supply of protein and energy as compared with those fed *ad libitum*; normal levels were reached within a few days of refeeding. It is therefore

Table 1 - Least squares means of live weight and serum hormone concentrations[1] in steers (N = 25) subjected to driving for 60 d and in the post-driving period of 84 d

| | Periods (days)[2] | | | | | | P-value[3] |
|---|---|---|---|---|---|---|---|
| | Driving | | | Post-driving | | | |
| Days | 0 | 20 | 55 | 28 | 56 | 84 | |
| Live weight (kg) | 217.72±3.39c | 212.82±3.39d | 222.60±3.39bc | 226.10±3.39b | 224.28±3.39bc | 242.60±3.39a | <0.0001 |
| Insulin (μ IU/mL)[1] | 1.09±0.05ab | 1.34±0.07a | 0.96±0.04ab | 1.03±0.05ab | 1.27±0.08ab | 0.84±0.04b | 0.0064 |
| Total T3 (ng/dL)[1] | 113.24±0.10ab | 99.78±0.12ab | 138.53±0.13ab | 101.77±0.08b | 141.59±0.05a | 100.79±0.11ab | 0.0010 |
| Total T4 (ng/dL)[1] | 3.33±0.06d | 3.83±0.04bcd | 3.51±0.06cd | 4.55±0.03b | 7.19±0.05a | 4.42±0.04bc | <0.0001 |
| Cortisol (μg/dL)[1] | 1.09±0.04c | 1.02±0.04c | 2.35±0.11b | 4.52±0.08a | 0.99±0.03c | 0.92±0.04c | <0.0001 |
| IGF-I (ng/mL)[1] | 206.88±0.18b | 198.18±0.20b | 69.81±0.19c | 68.64±0.28c | 485.43±0.12a | 522.01±0.15a | <0.0001 |

Distinct letters in the same row indicate significantly different values by the Tukey's test adjusted to 5% significance.
[1] Transformation [log (x + 1)] to homogenize the variances; however, the estimates were obtained by inverse transformation of the values obtained in the analysis.
[2] Driving: walking period until the arrival at the farm for fattening; Post-driving: period after the arrival of animals at the farm.
[3] Comparison between the evaluation days.

assumed, in this study, that the animals did not suffer severe food restriction during driving because no severe weight loss or decreased insulin levels were observed during the restricted-feeding period (Table 1).

The lowest serum concentrations of $T_4$ (Table 1) were observed during the driving period (days 0, 20, and 55), whereas the same was not observed for $T_3$. The low concentrations of $T_3$ and $T_4$ allow the body to decrease energy costs through a reduction in basal metabolism. According to Squires (2003), the thyroid hormones increase the production of heat and usage of oxygen by the heart, liver, kidneys, and pancreas.

An experiment with calves fed diets with food restriction for 95 days determined that during the first 20 days of restriction neither $T_3$ nor $T_4$ showed a significant reduction; however, on day 48, a reduction of 19% and 26% in the levels of $T_3$ and $T_4$, respectively, was observed as compared with the controls animals (Yambayamba et al., 1996b). In endurance horses, no change or only a transient decrease in plasma free $T_4$, free $T_3$, $T_3$ and $T_4$ were observed after rides between 40 and 56 km, wherein a more marked decrease was reported with longer rides (160 km; Graves et al., 2006). This demonstrates that the thyroid hormones are associated with the basal metabolic rate. The reduction in the levels of $T_4$ in the serum observed in the present study could be primarily responsible for the reduction of the maintenance requirements.

Ruminants have the ability to adapt to medium-to-long-term periods of malnutrition because they reduce the needs of weight gain by reducing the metabolic rate. This effect is mediated by decreased concentrations of thyroid hormones causing the reduction of oxidation in the tissues and basal metabolism with lower rates of protein and fat turnover, thereby saving energy and limiting the rate of body fat and protein mobilization (Chilliard et al., 1998).

The highest cortisol serum concentrations were obtained upon arrival at the farm (day 55) and after 28 days of post-driving, at the values of 2.35±0.11 and 4.52±0.08 μg/dL, respectively (Table 1). In none of the sampling days were the observed cortisol values above the basal levels, according to Grandin (1997).

It is known that IGF-I is one of the most important anabolic hormones involved in the process of growth with predominant production in the liver. Through interaction with GH receptors, IGF-I is also produced in a paracrine or autocrine pathway by several cells such as those of the musculoskeletal system including myoblasts, satellite cells, myofibers, and fibroblasts (Hornick et al., 2000; Hossner, 2005). Consequently, the serum concentrations of IGF-I decline sharply during food restriction due to the low availability of GH receptors or reduced activity of these receptors (Davis, 1988). Food restriction is also associated with reduced IGF mRNA in hepatic and extra-hepatic tissues (Emler and Schalch, 1987). In this context, the lowest concentrations of IGF-I (Table 1) observed at the end of driving and beginning of the post-driving period (69.81±0.19 and 68.64±0.28 ng/mL, respectively) might have been caused by the effects of slight food restriction on the GH receptors and IGF-mRNA.

The highest serum concentrations of IGF-I were observed at 56 and 84 d during post-driving (485.43±0.12 and 522.01±0.15 ng/mL, respectively). These results corroborate those obtained by Ellenherger et al. (1989), Hays et al. (1995), Henricks et al. (1994) and Renaville et al. (2000), who observed that the levels of IGF-I increased gradually to values similar to those of animals in non-restricted diets during refeeding; these peak levels of IGF-I correlated with the highest growth rates in ruminants at two to four weeks of refeeding.

## Conclusions

Cattle weight is not affected during driving. Levels of $T_4$, cortisol, and IGF-I are altered during driving; however, no alteration is observed in the levels of insulin and $T_3$. The increase in levels of $T_4$ and IGF-I during the post-driving period could be the responsible element for the anabolic processes in weight gaining during post-driving.

## Acknowledgments

The authors are grateful to the funding from Fundação de Apoio ao Desenvolvimento da Ciência e Tecnologia do Estado de Mato Grosso do Sul (FUNDECT); the daily and annual reports of the transportation by droving in the state from Agência Estadual de Defesa Sanitária Animal e Vegetal - MS (IAGRO - MS); Maurílio Meireles and his team for droving the animals; and Agricultural NPP Ltda. for the animals and infrastructure necessary for the development of this project. We also thank PhD. Eunice Oba for allowing the use of the Laboratory of Endocrinology of the Department of Animal Reproduction and Veterinary Radiology at the Veterinary and Animal Science College of UNESP, campus Botucatu.

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