COMPOSITION OF WEIGHT GAIN IN NELLORE STEERS AT DIFFERENT FEED INTAKE LEVELS[1]

G. Aferri[2*], R. R. P. S. Corte[3], A. S. C. Pereira[4], S. Luz e Silva[3], D. M. C. Pesce[3], G. F. Alleoni[5], P. R. Leme[3]

[1]Received: 27/03/2019. Accepted: 15/12/2019.
[2]Agronomic Institute of Campinas, Jaú, SP, Brazil.
[3]University of São Paulo, Faculty of Animal Science and Food Engineering, Pirassununga, SP, Brazil.
[4]University of São Paulo, Faculty of Veterinary Medicine and Animal Science, Pirassununga, SP, Brazil.
[5] *In memorian*
*Corresponding author: gabriela@iac.sp.gov.br

ABSTRACT: Thirty six Nellore steers, with an average initial age and weight of 20 months and 360 kg, were fed the same diet in three levels of dry matter intake: *ad libitum* or in two restriction levels 75g DM/kg BW$^{0.75}$ or 60g DM/kg BW$^{0.75}$ during 58 days (Phase 1) to evaluate the effects of feed restriction on weight gain, feed efficiency, diet digestibility, and composition of weight gain in restriction and re-alimentation phases. All steers were fed *ad libitum* for 78 days (Phase 2). Body composition was estimated with the marker deuterium oxide, which allowed repeated measurements of the same animal and studying its response to re-alimentation. Average daily gain in the restriction phase reflected different weight gain rates provided by feed levels of 0.288 kg, 0.656 kg, and 1.169 kg, respectively for 60g DM/ BW$^{0.75}$, 75g DM/ BW$^{0.75}$ and *ad libitum*. Feed efficiency increased according to feed intake level in Phase 1 and no differences between treatments were observed in Phase 2. Dry matter digestibility did not differ between treatments in both Phase 1 and Phase 2; however, it differed between phases for the same treatment with 78.8% in Phase 1, and with 68.7% in Phase 2 for the treatment with 60 g DM/BW$^{0.75}$, and 77.8% in Phase 1 and 71.3% in Phase 2 for the treatment with 75 g DM/BW$^{0.75}$. The deposition of empty weight gain, daily water deposition, ether extract, protein, ash, and energy increased with a higher feed intake level in Phase 1. In Phase 2, no difference occurred between the diet intake levels for empty weight gain, chemical components deposition, and retained energy in the gain. Diet digestibility decreased in Nellore steers fed *ad libitum* after the period of feed restriction, regardless of the previous restriction level to which the animals were submitted.

Key words: Beef cattle, *Bos taurus indicus,* digestibility, feedlot, feed efficiency

COMPOSIÇÃO DO GANHO DE PESO DE NOVILHOS NELORE EM DIFERENTES NÍVEIS DE INGESTÃO DE ALIMENTOS

RESUMO: Trinta e seis novilhos Nelore, com média de peso e idade inicial de 360 kg e 20 meses, foram alimentados com a mesma dieta em três níveis de ingestão de material seca: à vontade ou em dois níveis de restrição alimentar quantitativa 75g MS/kg PV^{0,75} ou 60g MS/kg PV^{0,75} durante 58 dias (Fase 1) para avaliar os efeitos da restrição alimentar no ganho de peso, eficiência alimentar, digestibilidade da dieta e na composição do ganho de peso. Todos os novilhos foram alimentados *ad libitum* por 78 dias (Fase 2). A composição corporal foi estimada com o marcador óxido de deutério, o qual permite repetir a avaliação no mesmo animal e estudar as respostas à realimentação. O ganho médio diário na fase de restrição alimentar refletiu as diferentes taxas de ganho de peso proporcionadas pelos níveis de alimentação, sendo 0,288 kg, 0,656 kg e 1.169 kg, respectivamente para 60g MS/PV^{0,75}, 75g MS/PV^{0,75} e *ad libitum*. A eficiência alimentar variou de acordo com o nível de ingestão de alimentos na Fase 1 e não foram observadas diferenças entre tratamentos na Fase 2. A digestibilidade da matéria seca não diferiu entre tratamentos tanto na Fase 1 como na Fase 2, mas foi diferente entre as Fases para o mesmo tratamento com 78,8% na Fase 1 e 68,7% na Fase 2 para o tratamento 60 g MS/PV^{0,75} e 77,8% na Fase 1 e 71,3% na Fase 2 para o tratamento 75 g MS/PV^{0,75}. A composição do ganho de peso vazio, a deposição diária de água, extrato etéreo, proteína, cinzas e energia aumentaram de acordo com o nível de ingestão de alimentos na Fase1. Na Fase 2, não houve diferença entre os níveis de ingestão da dieta para ganho de peso vazio, deposição dos componentes químicos e energia retida no ganho. Novilhos Nelore alimentados ad libitum após período de restrição alimentar tiveram a digestibilidade da dieta diminuída, independentemente do nível de restrição anterior a que os animais foram submetidos.

Palavras-chave: *Bos taurus indicus,* confinamento, digestibilidade, eficiência alimentar, gado de corte

INTRODUCTION

The biological responses of each animal to the restricted nutritional period vary according to the severity of feed restriction, feed quantity and quality after the restriction period, and the animal development stage (ELLENBERGER et al., 1989; WRIGHT and RUSSEL, 1991; HERSOM et al., 2003; KEOGH et al., 2016; ZHANG et al., 2018). When the animal undergoes a period of limited growth and afterward receives high quality diet *ad libitum*, it normally exhibits greater growth rate and feed efficiency than before a feed restriction (ALLEN, 1990).

To understand these variations in animal performance is of great importance because the high feed cost during feedlot finishing of beef cattle makes profitability dependent on an efficient and productive feed use for maintenance and growth, with low losses or excesses (NKRUMAH et al., 2006; GREENWOOD et al., 2017).

In general, in the Brazilian beef cattle production system, animals are kept in pastures during weaning and growing phases, exposed to quantitative and qualitative variations of pasture that may not attend nutritional requirements for animal growth (VAZ and RESTLE, 2003). When a slight or moderate nutritional deficiency occurs, the animal recovers weight loss; however, this may not happen if the nutritional deficiency is severe, preventing animals from expressing all their growth potential (LOPES et al., 2018).

Many studies have evaluated the effects of feed restriction for different periods, severity, nutrient type (e.g. protein, energy), animal category, and breeds and their effects on performance and carcass traits for days on feedlot (DURUNNA et al., 2011; KEOGH et al., 2016; O'SHEA et al., 2016; ZANTON et al., 2016; LOPES et al., 2018; ZHANG et al., 2018). However, little information is available on the effects of moderate restriction on performance and chemical composition of Zebu breeds (FREITAS et al., 2006) finished under feedlot for short periods (MILLEN et al., 2009), typical in Brazilian conditions.

Therefore, this work evaluated the effects of moderate quantitative feed restriction on weight gain, feed efficiency, diet digestibility, and gain composition in Nellore steers feedlot finished with high concentrate diet.

MATERIALS AND METHODS

The experiment was carried out at the Department of Animal Science of the Faculty of Animal Science and Food Engineering of University of São Paulo, Pirassununga, São Paulo. The Research Ethics Committee of the FZEA/USP, under N º 6706080515, approved the procedures.

Thirty-six Nellore steers (*Bos taurus indicus*) with 20 months of age and initial weight of 359±13 kg were used to evaluate the effect of three levels of dry matter intake (DMI) in a completely randomized design with three treatments and 12 replications. The animals were allocated to individual pens and submitted to 28 d of adaptation to the management and diet.

The feedlot had two distinct phases in sequence. In the first phase with 58 days, one group of animals was fed *ad libitum* representing the control treatment, another group were fed with 75 gr of DM for kg of metabolic body weight (treatment 75g DM/kg $BW^{0.75}$) and the other group was fed with 60g DM/kg $BW^{0.75}$ (treatment 60g DM/kg $BW^{0.75}$) (LEME, 1993). The two last treatments represented the treatments with feed intake restriction. In the second phase with 78 d, the animals submitted to feed restriction were fed *ad libitum.*

The diet of both phases was composed by 20% of sorghum silage and 80% of concentrate. The diet was formulated to have 13.62% of crude protein, 8.53% of rumen degradable protein, 76.43% of total digestible nutrient, 54.44% of neutral detergent fiber, and 2.74 Mcal of metabolizable energy per kg of DM.

The concentrate and forage were individually weighed, mixed, and offered daily in the morning. When the diet was offered *ad libitum*, intake was adjusted in relation to the leftovers. The intake adjustment in the restricted feeding phase was carried out at day 0 and 28, considering weighing the animals after 14 h of complete fasting. Feed efficiency was calculated as kg of DMI in the period by kg of weight gain in the period.

The diet apparent digestibility was estimated in the middle of the first and second phases of feedlot using six animals for each treatment. The samples of feed, leftovers, and feces were collected for three consecutive days, oven dried at 65°C for 72 h with forced air circulation and ground through a 2-mm mash Wiley mill. The feces samples were collected directly from the animal rectums.

The diet digestibility was estimated using the indigestible fiber in acid detergent as marker. The samples of feed, leftovers and feces were individually placed in nylon bags (10x17 cm and porosity of 53 µ - Ankon) and incubated simultaneously in the rumen of four Nellore steers with ruminal cannulas, for 168 h. Then, the bags were washed thoroughly in current water and dried in an oven with forced air circulation at 65°C for 72 h. Later, the acid detergent fiber (ADF) was determined according to AOAC (2000).

The body composition of animals was estimated three times in the trial: all animals at the beginning and finishing of Phase 1, and at the finishing of Phase 2 for animals that received restricted treatments in Phase 1. We determined the body composition by the indirect method of isotopic dilution with deuterium oxide.

The deuterium oxide (99.8% of purity, MW 20.03) was inserted into the right jugular vein through injection of 0.1 g/kg of body weight. The blood samples before and after deuterium oxide application were analyzed by mass spectrometry, where the water content was separated from blood by vacuum distillation, retained in trap at –196 °C and decomposed by metallic zinc reaction at 500°C under vacuum system (COLEMAN et al., 1982). The deuterium space (DS) was calculated as the ratio of quantity of D_2O injected (mg) and the difference between final and initial D_2O (mg/mL) concentration.

The chemical composition of empty body of Nellore steers from data of deuterium oxide dilution was estimated using the equations described by Leme et al. (1994):

Water (%) = 65.9654 + (0.0977*DS) – (0.0909*Shrunk Body Weight), (R^2 = 0.83).

Fat (%) = 93.92968 – 1.27598*Water (%), (R^2 = 0.97).

The protein and ash content in the empty body were estimated by the relationship of water with these two components. Relations specifically for Nellore steers were used: protein/water equals 0.3009 and ash/water equals 0.0747 (LEME et al., 1994).

The deposition rate of body constituents and weight gain composition in the two feeding phases were calculated from body composition data of water, ether extract (EE), protein, and ash of the same animal at the beginning, middle, and end of the feedlot period.

The animals were slaughtered after the feedlot period and the empty body weight (EBW) was obtained after emptying of intestinal tract. The relationship of EBW with shrunk body weight (SBW) generated the equation EBW (kg) = -15.74911 + 0.98517*SBW (kg), (R2 = 0.96 and Sy.x = 8.64) that was used to determine the EBW necessary to estimate *in vivo* chemical composition of animals.

The animals of the treatment fed *ad libitum* were slaughtered after 78 d of feeding, 20 d after the beginning of Phase 2. Therefore, all treatments were compared only until the end of Phase 1 and afterward, only treatments 60 g DM/$BW^{0.75}$ and 75 g DM/$BW^{0.75}$ were compared.

The effects of treatments were evaluated by the analysis of variance using the Mixed procedure of SAS (SAS Institute Inc., Cary, NC, USA), according to following model: $Y_{ij} = \mu + t_i + e_{ij}$, where: Y_{ij} = observation of the i^{th} animal on the j^{th} treatment, µ = mean, t_i = effect of the DMI level, e_{ij} = inherent error of each observation ~ NID (0, δ2e). When a significant effect of treatment was detected ($P<0.05$), means of treatments were compared by the Student's t-test.

RESULTS

The SBW was affected by feed intake level in Phase 1 (P=0.005) with 421.2 kg for animals fed *ad libitum* and greater than in animals fed 60 g DM/$BW^{0.75}$ (373.9 kg); however, it was not different with 400.0 kg in the group fed 75 g DM/$BW^{0.75}$.

The final SBW after 78 d of animals fed *ad libitum* in Phase 2 did not differ between animals fed 60 g DM/$BW^{0.75}$ (476.3 kg) and animals fed 75 g DM/$BW^{0.75}$ (489.2 kg). The SBW increased ($P<0.001$) from Phase 1 to Phase 2 in both treatments.

The shrunk weight daily gain in Phase 1 was 0.297 kg for animals fed 60 g DM/$BW^{0.75}$, 0.677 kg for animals fed 75 g DM/$BW^{0.75}$ and 1.207 kg for animals fed *ad libitum*. The ADG in Phase 2 was 1.336 kg/day and 1.175 kg/day, respectively, for animals fed 60 or 75 g DM/$BW^{0.75}$, after the feed restriction period. The ADG in initial 20 d of Phase 2 (from day 58 to

Table 1 –Dry matter digestibility and feed efficiency of Nellore steers during feed restricted (Phase 1) and feed *ad libitum* (Phase 2)

Characteristics	Treatment, g DM/kg $BW^{0.75}$			SE	P
	60	75	*Ad libitum*		
			Phase 1		
Dry matter intake, g/kg $^{BW0.}$75	52.0^{c}	67.0^{b}	98.7^{a}	2.6	<0.001
Feed efficiency, kg DMI/kg DWG	-3.0^{c}	20.0^{b}	92.0^{a}	3.0	0.029
Dry matter digestibility, %	78.8^{A}	77.8^{A}	73.9	1.8	0.177
			Phase 2		
Dry matter intake, g/kg $BW^{0.75}$	89.1	88.3	--	2.3	0.557
Feed efficiency, kg DMI/kg DWG	141.0	124.0	--	10.0	0.331
Dry matter digestibility, %	68.7^{B}	71.3^{B}	--	3.1	0.501

DMI: dry matter. $BW^{0.75}$: metabolic body weight. DWG: daily weight gain. SE: standard error.
$^{A, a}$: different letters, lower case in the row and upper case in the column, indicate a significant difference (P<0.05).

78 of the feedlot period) was 2.553 and 1.767 kg/day for animals fed 60 or 75 g DM/$BW^{0.75}$, respectively.

The DMD did not differ between treatments in Phase 1 and in Phase 2; however, it was higher (P=0.003) in Phase 1 than in Phase 2, with a decrease of 10.1 percentage points in the group fed 60 g DM/$BW^{0.75}$ and 6.5 percentage points for animals fed 75 g DM/$BW^{0.75}$.

The DMI (P<0.001) and feed efficiency (P=0.029) increased according to the feed intake level in Phase 1 and showed no differences between treatments in Phase 2 (Table 1).

The EWG, daily water deposition, EE, protein, ash, and energy showed increased (P<0.001) deposition according to the feed intake level elevation in animals in Phase 1 (Table 2). In Phase 2, there was no difference between the diet intake levels for weight gain, chemical components, and energy in EBW gain of Nellore steers (Table 2).

The EWG composition in animals fed 60 g DM/$BW^{0.75}$ was different between Phases 1 and 2 (P<0.001) for all components. The gain composition of animals fed 75 g DM/$BW^{0.75}$ was different (P<0.001) between the phases of lower value in Phase 1 and, consequently, the energy content in the gain was also higher in Phase 2 (P<0.001).

The deposition rate of chemical components, the retained energy as protein, and the energy in EBW gain were not different between feed intake levels, either in Phase 1 or in Phase 2 (Table 3).

The deposition rate of water, EE, protein, and ash was not different between Phases 1 and 2 for animals fed 60 g DM/$BW^{0.75}$. In animals fed 75 g DM/$BW^{0.75}$, the deposition rate of EE increased (P =0.004), while the other components decreased in Phase 2.

The energy retained as protein in the gain was higher in Phase 1 for the two animal groups. The energy deposited on EBW gain was higher in Phase 2 for animals fed 75 g DM/$BW^{0.75}$.

DISCUSSION

Reduction in feed consumption may decrease feed costs in beef cattle production systems (GREENWOOD et al., 2017) and, consequently, achieve different SBW, as observed at the end of Phase 1, which may be obtained by previously defined intake levels. The feed restriction allowed the necessary growth of animals during 58 d of the feedlot period (KEOGH et al., 2016) with the animals fed 60 g DM/$BW^{0.75}$ eating 47% less than animals fed *ad libitum* and obtained a final weight 11% lower. For the group fed 75 g DM/$BW^{0.75}$, the feed saving was 32% with 5% less weight gain.

The final SBW after 78 d of re-alimentation for animals fed 60 g DM/$BW^{0.75}$ or 75 g DM/$BW^{0.75}$ were not different, despite differences observed for WG in both Phase 1 and Phase 2, as expected (DURUNNA et al., 2011). Therefore, the higher WG rate in the second phase offset the lower gain in Phase 1, producing an-

Table 2 – Daily deposition of chemical components and energy in empty body weight gain of Nellore steers during feed restricted (Phase 1) and feed *ad libitum* period (Phase 2)

Characteristics	Treatment, g DM/ $BW^{0.75}$			SE	P
	60	75	*Ad libitum*		
		Phase 1			
Weight gain, kg	0.288^{cB}	0.656^{bB}	1.169^{a}	0.147	<0.001
Water, kg	0.133^{cB}	0.299^{bA}	0.503^{a}	0.041	<0.001
Ether extract, kg	0.105^{cB}	0.245^{bB}	0.475^{a}	0.031	<0.001
Protein, kg	0.040^{cB}	0.090^{bA}	0.151^{a}	0.012	<0.001
Ash, kg	0.010^{cB}	0.022^{bA}	0.038^{a}	0.003	<0.001
Energy (Mcal)	0.021^{cB}	0.048^{bB}	0.092^{a}	0.005	<0.001
		Phase 2			
Weight gain, kg	1.225^{A}	1.103^{A}	--	0.143	0.233
Water, kg	0.446^{A}	0.359^{A}	--	0.081	0.101
Ether extract, kg	0.612^{A}	0.609^{A}	--	0.052	0.947
Protein, kg	0.134^{A}	0.108^{A}	--	0.024	0.101
Ash, kg	0.033^{A}	0.027^{A}	--	0.006	0.101
Energy (Mcal)	0.084^{A}	0.082^{A}	--	0.009	0.731

DM: dry matter. $BW^{0.75}$: metabolic body weight. SE: standard error.
$^{A, a}$: different letters, lower case in the row and upper case in the column, indicate a significant difference (P<0.05).

Table 3 – Deposition rate of chemical components in empty body weight gain of Nellore steers during feed restricted (Phase 1) and feed *ad libitum* (Phase 2)

Characteristics	Treatment, g DM/ $BW^{0.75}$			SE	P
	60	75	*Ad libitum*		
		Phase 1			
Water, %	43.4^{A}	44.7^{A}	42.6	3.1	0.889
Ether extract, %	40.3^{A}	38.6^{B}	41.4	4.3	0.889
Protein, %	13.1^{A}	13.4^{A}	12.8	0.9	0.889
Ash, %	3.2^{A}	3.3^{A}	3.2	0.2	0.889
Retained energy as protein, %	19.0^{A}	19.7^{A}	16.4	2.5	0.621
Energy (Mcal/kg EBWG)	4.4^{A}	4.3^{B}	4.5	0.3	0.879
		Phase 2			
Water, %	35.9^{A}	32.7^{B}	--	2.1	0.576
Ether extract, %	50.6^{A}	55.1^{A}	--	2.9	0.576
Protein, %	10.8^{A}	9.8^{B}	--	0.6	0.576
Ash, %	2.7^{A}	2.4^{B}	--	0.2	0.576
Retained energy as protein, %	12.0^{B}	10.4^{B}	--	1.2	0.354
Energy (Mcal/kg EBWG)	5.2^{A}	5.4^{A}	--	0.2	0.592

DM: dry matter. $BW^{0.75}$: metabolic body weight. EBWG: empty body weight gain. SE: standard error.
$^{A, a}$: different letters, lower case in the row and upper case in the column, indicate a significant difference (P<0.05).

imals of adequate weight for slaughter (MANNI et al., 2017; GREENWOOD et al., 2017).

After 20 d in Phase 2, animals fed 60 g DM/BW$^{0.75}$ and 75 g DM/BW$^{0.75}$ had a BWG above expected, characteristic of compensatory weight gain (FONTES et al., 2007). This phenomenon is most evident up to 55 d after the re-feeding phase, when the liver completes its recovery (KEOGH et al., 2016), although total BW takes more time for recovery (KEOGH et al., 2015).

The DMD of diets was not different between treatments, both in Phase 1 and Phase 2. This is probably related to the use of the same diet in different quantities in Phase 1 (O'SHEA et al., 2016), because differences in diet digestibility were observed with an increase of concentrate rates in diets with similar metabolizable energy (ZANTON and HEINRICHS, 2016; ZHANG et al., 2018).

However, when comparing the same treatments between Phase 1 and Phase 2, digestibility decreased, possibly because of the feed intake increase in the re-alimentation phase (O'SHEA et al., 2016; KEOGH et al., 2017), due to the negative relationship between feed intake and digestive efficiency, influenced by the persistence of digesta in the gastrointestinal tract (CLAUSS and HUMMEL, 2017). Thus, the decrease extent in diet digestibility in compensatory gain seems to be related to the severity of feed restriction to animals (HAYDEN et al., 1993; HERSOM et al., 2003).

The higher DMI and feed efficiency in Phase 1 in animals fed *ad libitum* were attributed to the nutritional plan used (KEOGH et al., 2015). Response to deprivation is highly variable (NRC, 1996) and the regulation mode of its expression involve multiple physiological and biochemical processes, highly dependent on the management used (KENNY et al., 2018).

At the beginning of the re-alimentation phase, nutrient absorption increased (KEOGH et al., 2016) due to the development of ruminal papillae caused in the period of quantitative feed restriction (KEOGH et al., 2017; REIS et al., 2017) providing compensatory weight gain. However, DMI and feed efficiency were during all periods of Phase 2 did not alter because of the restriction level in Phase 1, as reported in the literature (TOLLA et al., 2003; FIEMS et al., 2015; MANNI et al., 2017).

Therefore, the intake of 60 g DM/kg BW$^{0.75}$ provided greater feed savings for similar weight gain, which can be used as a strategy to reduce feed costs in feedlot (LOPES et al., 2018) without hindering meat production (MANNI et al., 2017) or animal growth in feed system with high-concentrate diets (ZHANG et al., 2018).

The time required for the animal to adapt to higher DMI (HERSOM et al., 2003; TOLLA et al., 2003) varies according to restriction severity; however, its expression is more evident between 30 and 60 d and coincides with the period of greater weight gain and feed efficiency increase (ELLENBERGER et al., 1989; KEOGH et al., 2016; O'SHEA et al., 2016). This paradoxical aspect of lower consumption with greater weight gain is characteristic of the compensatory WG and for feedlot systems, it is the period of greater interest, due to reduction in feed costs (GREENWOOD et al., 2017; KEOGH et al., 2017).

The changes observed during compensatory gain can also be related to the type of feed restriction (FONTES et al., 2007). When it occurred in response to quantitative restriction of a high quality diet, the results can be different from those observed in the qualitative restriction (FIEMS et al., 2015), because quantitative restriction does not hinder production, a strategy of using feed successfully (GREENWOOD et al., 2017).

Even at low rates of gain and early stages of growth, some fat is deposited and both protein and fat are synthesized as rates of gain increases (NRC, 1996). The component of greater variation in the composition of WG is fat (WRIGHT and RUSSEL, 1991), because the use of energy intake in the diet is conditioned to the maintenance of basal metabolism, which may exceed 50% of energy requirement in adult cattle (KENNY et al., 2018).

The metabolic processes within the visceral organs has a high metabolic cost, mainly those associated to the functions of gastrointestinal tract and liver (KENNY et al., 2018), which therefore undergo down-regulation to adjust the activities of organs when animals are subjected to food restriction (KEOGH et al., 2016).

Another aspect that contributed to the efficient use of energy was the diet with high concentrate content, since it reduces energy expenditure with rumination and losses with caloric increase (ZHANG et al., 2018).

Therefore, animals had energy input to grow, even in the diet with 60 g DM/kg $BW^{0.75}$, nevertheless, it was observed (not measured) a reduction in paunch girth, similar to reports by Zhang et al. (2018), possibly indicating a greater effect of quantitative feed restriction on visceral organs.

Protein deposition is related to the efficiency of dietary N utilization, as reported in the literature (ZANTON and HEINRICHS, 2016), with an increase in this efficiency associated to feed restriction of high energy density diets. This may explain why protein deposition rates in Phase 1 showed no differences, despite the different amounts deposited related to the intake level.

The organism starts to reverse the path in the re-alimentation period, changing the regulation of cellular processes as well as metabolism of lipids and carbohydrates, suggesting an upregulation of these processes (KEOGH et al., 2016). At the beginning of the feedback period, a possible increase in the capacity of protein synthesis sustains the compensatory gain (KEOGH et al., 2016). According to Cunningham (2018), the critical pathways for readjustment to *ad libitum* include mitochondrial energy production pathways, fatty acid metabolism, and propanoate metabolic pathways.

The higher metabolic rate that occurs in the feedback (LOPES et al., 2018) provided the largest deposition of all gain components; however, with no differences between the two restriction levels. The decrease of approximately 30% in DMI in the treatment with 75 g DM/kg $BW^{0.75}$ was sufficient to trigger the genetic mechanisms of downregulation (KEOGH et al., 2016), acting especially in EE deposition, the only component altered from Phase 1 to Phase 2.

The higher EE deposition rate and lower rates of water, protein, and ash appear to reflect the full gain compensation at 78 d post re-alimentation for animals fed 75 g DM/kg $BW^{0.75}$. While for the group fed 60 g DM/kg $BW^{0.75}$, no differences in the rates of all components were observed. This fact may be related to the time required for the recovery of different tissues, since at 55 d, there was 100% recovery of the liver with only 48% recovery of BW (KEOGH et al., 2016).

Thus, to obtain the benefits of compensatory weight gain, the restriction severity must be considered (GREENWOOD et al., 2017; KENNY et al., 2018), as well as the type of diet (REIS et al., 2015; MANNI et al., 2017) and time in restriction and feedback (CUNNINGHAM et al., 2018; LOPES et al., 2018), as these are the principal variables for the differences in the results observed (ALVES, 2003).

The duration of reduced maintenance is subject to the extent and duration of restricted growth and to the nutritional regimen during the recovery period (NRC, 1996), which could alter the energy deposited in the gain. However, there was no difference in the energy deposited in the gain between the feeding phases. In the feedback phase, the energy retained as protein was lower and the fat tissue gain was higher, which has been used to produce carcasses with a higher or lower fat content to serve different markets (GREENWOOD et al., 2017).

CONCLUSIONS

The Nellore steers in the restrict phase had greater participation of protein in the energy deposited in the gain compared to the phase when animals were fed *ad libitum*; however, there was no change in the deposition rate of tissues between the feeding levels in Phase 1.

When the steers were fed *ad libitum* after the feed restriction period, diet digestibility decreased, regardless of the level of previous restriction to which the animals were submitted.

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