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ANIMAL PRODUCTION

Residual feed intake of Nellore calves is not repeatable across pre and post weaning periods

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ABSTRACT: *This study measured milk and solid feed intake in pre- weaning period and feed intake in postweaning period of Nellore calves, and to correlated them with performance traits and ingestive behavior of animals classified as most and least efficient. During pre weaning phase, feed efficiency was evaluated in 51 cow-calf pairs from 21±5 days after calving until weaning. During post-weaning phase, only male calves (n=23) were evaluated. Pre-weaning milk intake of calves was estimated based on cow's milk production. Pre-weaning daily metabolizable energy intake (MEI) of calves was estimated as the sum of MEI from milk and solid diet. There was no difference in ADG between calves with negative and positive pre RFI, with a consequent better feed conversion to more efficient calves. The most efficient calves spent less time at the feed bunk, with a shorter feeding duration and higher rate of intake, compared to the least efficient animals. Correlations between feed intake and metabolic body weight of the animals during pre- and postweaning phases were positive, of medium to high magnitude, and significant, while correlation between ADG values was close to zero. Results suggested that part of the animals ranked based on pre weaning feed intake won't maintain their rank during postweaning phase. In conclusion, calves classified as most efficient during pre-weaning phase have similar weight gain but lower milk intake and MEI than least efficient animals. The estimated pre RFI is weakly correlated with post RFI, showing that RFI is not consistent or repeatable across two periods.*
Key words: *beef cattle, dry matter intake, metabolizable energy intake, residual feed intake.*

Consumo alimentar residual de bezerros Nelore na pré e pós-desmama tem baixa repetibilidade

RESUMO: *Este estudo teve como objetivo mensurar o consumo de leite e sólidos no período pré-desmama e o consumo alimentar no período pós-desmama, e relacioná-los com características de desempenho e comportamento ingestivo de animais classificados como mais eficientes e menos eficientes. Na fase pré-desmama foram avaliados 51 pares vaca-bezerro da raça Nelore quanto à eficiência alimentar dos 21±5 dias após o parto até a desmama. Na fase pós-desmama, apenas os bezerros machos (n=23) foram avaliados. O consumo de leite dos bezerros na pré-desmama foi estimado pela produção de leite das vacas. O consumo diário de energia metabolizável do bezerro na pré-desmama (CEM), foi estimado pela soma do consumo de energia metabolizável do leite e do consumo diário de energia metabolizável da dieta. Bezerros CARpre negativo não diferiram dos bezerros CARpre positivo quanto ao GMD, resultando em melhor CA dos bezerros mais eficientes. Bezerros mais eficientes ficaram menos tempo no cocho, com menor duração da refeição e com maior taxa de alimentação comparativamente aos animais menos eficientes. As correlações entre o consumo alimentar e peso corporal metabólico dos animais na pré e pós-desmama foram positivas, de média a alta magnitudes e significativas, enquanto que a correlação entre ganho médio diário foi próxima de zero. Os resultados sugerem que parte dos animais classificados pelo consumo alimentar na pré-desmama manterão a classificação na pós-desmama. Na fase pré-desmama bezerros classificados como mais eficientes tem ganho de peso similar, porém com menor consumo de leite e consumo de energia metabolizável do que bezerros menos eficientes. A estimativa do consumo alimentar residual na fase pré-desmama é fracamente relacionada à estimativa do consumo alimentar residual na fase pós-desmama, mostrando que o consumo alimentar residual não é consistente e repetível nos dois períodos.*
Palavras-chave: *bovinos de corte, consumo alimentar residual, consumo de energia metabolizável, consumo de matéria seca.*

INTRODUCTION

The advances achieved in livestock farming are notorious and are responsible for the productivity growth of the sector. Research is performed during different stages of the animal's life to identify the best technology, management and strategy to be employed in a specific phase in order to reduce the slaughter age and production cycle. There are few studies on feed efficiency involving cows and calves because of the

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difficulty in measuring traits related to milk and solid feed intake during this phase (WALKER et al., 2015; SOUZA et al., 2019).

Knowledge of the outcome of selecting cattle for feed efficiency, both on growing animals and on the performance of these animals when adults, is fundamental to fully understand the impact of feed efficiency on the productivity of the herd (BLACK et al., 2013). HERD et al. (2004) reported the existence of at least five main factors that cause variation in the feed efficiency of growing animals, which are associated with feed intake, digestion, metabolism, activity, and thermoregulation. The feed efficiency measures most used in cattle are residual feed intake, residual weight gain, and residual intake and gain, which considered adjustments of feed intake and average daily gain for live weight and weight gain (SANTANA et al., 2014). However, few studies have so far evaluated the feed efficiency of calves during the pre- and postweaning phases.

This study measured milk and solid feed intake in preweaning period and feed intake in postweaning period of Nellore calves, and correlated them with performance traits and ingestive behavior of animals classified as most and least efficient.

MATERIALS AND METHODS

The experiment was conducted at Beef Cattle Research Center, an agency of the Institute of Animal Science of the State of São Paulo, located in Sertãozinho, northern region of the state of São Paulo (21º10' S latitude and 48º5' W longitude). The region has a humid tropical climate with an average annual temperature of 24 ºC and average annual rainfall of 1,312 mm.

During the preweaning test, 51 Nellore cow-calf pairs divided into two groups were evaluated: the first group consisted of 27 cow-calf pairs, with the calves born in 2016, and the second of 24 cow-calf pairs, with the calves born in 2017. For concentration of the births, all cows were submitted to a fixed-time artificial insemination protocol using semen from the same Nellore bull. The cows calved at 36.8±1.2 months of age. The cows and calves were identified with electronic radio frequency identification (RFID) ear tags and had *ad libitum* access to diet, water and mineral salt free-choice. Feed efficiency of the animals was evaluated from 21±5 days after calving until weaning, after 13 days of adaptation to the facilities.

In the first group, the pre-weaning performance test of cows and calves started in December 2016 and ended in May 2017. In the second group, the test started in October 2017 and ended in May 2018. Both tests had a mean duration of 152 days for the recording of dry matter intake (DMI) and data collection. During this phase, the diet (Table 1) was formulated to meet the requirements of primiparous females for growth, lactation and pregnancy (NRC, 2001).

During the postweaning phase, only male calves (n=23, including 15 of the first group and 8 of the second group) were submitted to feed efficiency testing (28 days of adaptation and 60 days of the test), together with the other contemporaneous animals of the herd. The diet of this phase (Table 1) was formulated to meet the requirements of young growing animals for an average daily gain of 1.0 kg day^{-1} (NRC, 2001).

In both feed efficiency tests (pre- and postweaning), the animals remained in a collective pen equipped with 10 feed troughs of the automated GrowSafe® feeding system (GrowSafe Systems Ltd.,

Table 1 - Ingredients of the pre- and post-weaning diets.

Item	--------------------Dietary proportion (% dry matter basis)--------------------	
	Preweaning	Postweaning
Corn silage	90.3	54.0
Ground corn	-	21.9
Soybean meal	8.51	11.7
Brachiaria ssp. hay	-	10.2
Mineral salt[a]	0.83	0.40
Urea[b]	0.32	-

[a]Composition per kilogram: 170 g calcium, 80 g phosphorus, 65 g sodium, 22 g sulfur, 8 g magnesium, 3600 mg zinc, 1000 mg copper, 700 mg manganese, 80 mg cobalto, 80 mg iodine, 4.5 mg selenium.
[b]Reforce N (Petrobras): 450 gkg^{-1} of N.

Airdrie, Alberta, Canada) and were weighed every 21 days without previous fasting. The diet (Table 1) was offered twice a day (8 am and 4 pm) and the amount of feed supplied was adjusted daily to maintain about 5% of leftovers. Diet samples were collected weekly for analysis and natural matter intake of each animal was recorded daily by the GrowSafe® system. The daily natural matter intake was multiplied by dry matter content of the diet to obtain the daily DMI.

The pre-weaning milk intake of calves (MI) was estimated from the milk yield of cows (MY) obtained by mechanical milking at 63±5, 84±5 and 150±5 days post-calving, according to the method proposed and adapted by Walker et al. (2015). The calves were removed from the cow at 8 am and each cow was milked mechanically after 10 minutes of intravenous administration of 2 mL oxytocin to stimulate milk secretion. Cows remained separated for 6-h and were subsequently milked to obtain the 6-h MY. This yield was multiplied by 4 to obtain the 24-h MY. Milk samples of each cow were collected from the milk meter of the machine after milking and homogenization for the determination of milk composition (protein, lactose, total solids, and fat). The MI was equal to MY as shown in table 2.

The energy value of milk expressed as gross energy (GEM) was estimated using the following equation (NRC, 2001): GEM = 0.057 protein % + 0.092 fat % + 0.0395 lactose %. This value was subsequently transformed into metabolizable energy (ME) of milk to obtain MI in Mcal. The energy value of the diet was predicted using the equation described by DETMANN et al. (2010): TDN = tdCP + tdNFC + dNDF + 2.25 x tdEE – FM_{TDN}, where TDN = dietary content of total digestible nutrients (% DM); tdCP, tdNFC and tdEE = truly digestible fractions of crude protein (CP), non-fibrous carbohydrates (NFC) and ether extract, respectively (% DM); dNDF = digestible fraction of neutral detergent fiber (% DM); FM_{TDN} = total fecal metabolic fraction (CP and NFC) to compute TDN (% DM), with 4.71 (maintenance) and 7.16 (production); 2.25 = atwater factor for equalizing lipids and carbohydrates. The TDN content of the diet was converted to ME and digestible energy (DE) using the equations suggested by NRC (2001): ME (Mcal kg^{-1}) = 1.01 x DE (Mcal kg^{-1}) – 0.45; DE (Mcal kg^{-1}) = 0.04409 x TDN (%).

The preweaning DMI of the calf, expressed as Mcal, was obtained by multiplying DMI by ME of the diet (4.22 Mcal kg^{-1} DM). The preweaning daily metabolizable energy intake (MEI) of the calf, expressed as Mcal, was estimated as the sum of metabolizable energy intake from milk (MI, Mcal day^{-1}) and from the diet (DMI, Mcal day^{-1}). The pre-weaning MEI of the calf was calculated after 35 days of age because of the low intake of solids on previous days.

During the pre- and postweaning phases, the average daily gain (ADG) of each animal (cow and calf) was estimated by the linear regression coefficient of weights as a function of days on test (DOT): $yi = \alpha + \beta^{*}DOTi + \varepsilon i$, where *yi* = animal weight in the i^{th} observation; α = intercept of the regression equation corresponding to the initial weight; β = linear regression coefficient corresponding to ADG; *DOTi* = days on test in the i^{th} observation, and εi = random error associated with each observation. The mean mid-test metabolic weight ($BW^{0.75}$) in the test was calculated as: $BW^{0.75} = [\alpha + \beta^{*}(\text{test duration})/2]^{0.75}$, where α and β are described above.

The RFI of cows was estimated as the residual from the regression of mean DMI on ADG, $BW^{0.75}$, MY and subcutaneous fat thickness as described by SOUZA et al. (2019). The pre-weaning RFI (preRFI) was estimated for each calf as the residual from the regression of mean MEI (MI+DMI) on ADG and $BW^{0.75}$ obtained during the preweaning phase. The post-weaning RFI (postRFI) of each calf was estimated as the residual from the regression of mean DMI on ADG and $BW^{0.75}$ obtained during the postweaning phase. Preweaning feed conversion (FC) was calculating as the ratio of MEI/ADG and postweaning FC was calculated as the ratio of DMI/ADG.

The daily means of the frequency of feed bunk visits, duration of bunk visit and feeding duration

Table 2 - Periods of milk intake by milk yield.

Milk intake (days of age)	Milk yield (days of lactation)	Milk yield (kg day^{-1})
35 to 63	63±5	11.6±4.2
64 to 84	84±5	10.1±1.6
from 85 days to weaning (on average at 190±13)	150±5	9.8±3.8

per animal were obtained using the PROC SUMMARY procedures (SAS Institute, Inc., Cary, NC, USA). The rate of intake was calculated as the ratio of daily DMI and bunk visit duration, expressed in kg/min. The DMI per visit was calculated as the ratio between daily DMI and daily frequency of bunk visits.

Analysis of variance was conducted using SAS's PROC GLM procedure to evaluate the effect of the preweaning RFI class (preRFI < 0 = negative RFI class; preRFI > 0 = positive RFI class) on the following preweaning traits of calves: MEI, DMI, MI, ADG, mean weight, $BW^{0.75}$, FC, frequency of feed bunk visits, bunk visit duration, feeding duration, feeding rate, and DMI per visit. Spearman's correlations between the variables obtained during the pre- and postweaning phases were estimated using SAS's PROC CORR procedures. Statistical significance was set at $p<0.05$.

RESULTS

The mean preweaning DMI of calves was 1.49±0.4 kg day^{-1}. The DMI increased during the post-weaning period to 7.64±0.8 kg day^{-1}, i.e., pre-weaning DMI accounted for 17% of the total amount ingested. Calves consumed on average 7.30±1.5 kg day^{-1} of milk and 9.57±1.9 Mcal day^{-1} of ME during the preweaning phase. The DMI from the diet corresponded on average to 41% of the MEI during this phase.

The multiple regression model for the calculation of pre RFI captured only 15% of the variation in the MEI of calves during the preweaning period, with 10% being explained by ADG, 3% by $BW^{0.75}$, 2% by calf sex, and 1% by RFI of cows.

There was a significant difference in MEI and MI between pre RFI classes (Table 3), with the most efficient calves having lower milk and total intake (DMI + MI) than least efficient calves during the preweaning phase. Despite these differences in intake, negative pre RFI calves did not differ from positive pre RFI calves in terms of ADG, resulting in better FC of more efficient calves (Table 3).

Other traits observed in the most efficient calves were a shorter bunk visit duration (P=0.0369), a shorter feeding duration (P=0.0025) and a higher rate of intake (P=0.0047) compared to the least efficient animals (Table 4).

Spearman's correlations were also estimated between the performance (Table 5) and ingestive behavior (Table 6) traits of calves obtained during the pre- and postweaning phases. The correlations of DMI and $BW^{0.75}$ between the pre- and postweaning phases were positive, of medium to high magnitude and significant, while the correlation between pre- and postweaning rate of intake was also significant but negative and of medium magnitude.

DISCUSSION

Maternal milk is the primary food of calves during the preweaning phase. However, at this stage there is also the beginning of solids intake, with

Table 3 - Least square means of preweaning performance traits of the calf and cow according to calf preRFI class.

Trait[1]	-------------------------------preRFI class----------------------------		SEM[2]	P
	Negative (n=24)	Positive (n=27)		
MEI (Mcalday^{-1})	7.65	11.2	0.27	<0.0001
DMI (kg day^{-1})	1.46	1.52	0.08	0.6117
DMI (Mcalday^{-1})	3.51	4.18	0.22	0.0387
MI (kg day^{-1})	6.51	8.00	0.25	0.0001
MI (Mcalday^{-1})	4.89	7.26	0.19	<0.0001
ADG (kg day^{-1})	0.977	1.010	0.03	0.4335
Mean weight (kg)	127	132	3.86	0.3822
$BW^{0.75}$ (kg)	38	39	0.87	0.3712
FC (McalADG^{-1})	8.26	11.1	0.35	<0.0001
RFI (Mcalday^{-1})	-1.52	1.35	0.18	<0.0001
RFI_{cow} (kg day^{-1})	-0.100	0.089	0.20	0.5058

[1]DMI: mean dry matter intake, MI: milk intake, MEI: daily metabolizable energy intake, ADG: average daily weight gain, $BW^{0.75}$: mid-test metabolic body weight, FC: feed conversion,RFI: residual feed intake. [2]SEM: standard error of the mean.

Table 4 - Least square means of pre-weaning ingestive behavior traits of calves according to pre RFI class.

	----------------------preRFI class----------------------			
Trait[1]	Negative (n=24)	Positive (n=27)	SEM[2]	P
Frequency of bunk feed visits	15	14	0.57	0.6084
Bunk visit duration (min day^{-1})	62	72	3.28	0.0369
Feeding duration (min$visit^{-1}$)	4.00	4.87	0.19	0.0025
Rate of intake (kg min^{-1})	0.034	0.027	0.002	0.0047
DMI per visit (kg $visit^{-1}$)	0.10	0.11	0.004	0.1764

[1]DMI: mean dry matter intake. [2]SEM: standard error of the mean.

a daily increase of solids intake (from 35 to 190 days of age) of 0.022±0.003 kg DMI day^{-1} by the calves (BROLEZE et al., 2020). The intake of solid foods is low during this period (1.49±0.43 kg DM day^{-1}) but increases during the postweaning phase (7.64±0.82 kg DM day^{-1}) in order to satisfy maintenance energy requirements. This ingestive behavior was observed in the present study and was also reported in the literature (BOGGS et al., 1980; NKRUMAH et al., 2006). Studying weight gain from birth to weaning in Nellore calves, ALENCAR (1989) observed that 5.4 kg of milk were needed to produce 1.0 kg of weight gain. In the present study, 7.3 kg of milk were needed to produce 1.0 kg of weight gain, without accounting for the solid diet. Milk production is an important factor to be considered since it influences calf performance and body weight at weaning (VALADARES FILHO et al., 2016), ensuring a younger animal with ideal weight and finishing for slaughter.

Milk intake decreased until approximately 75 days of lactation and remained constant thereafter. In contrast, VARGAS JUNIOR et al. (2011), who measured milk intake (kg) as a function of calf age (days), observed a decline throughout the preweaning period. In the present study, the milk production of cows was measured only three times during lactation and the MI of calves was based on this production, a fact that might explain the difference to the results reported by VARGAS JUNIOR et al. (2011). The methodology used to measure the milk production of cows (WALKER et al., 2015); although, very laborious, can still be criticized. ALBERTINI et al. (2012) estimated the repeatability at the 24-h interval milk yield and determined the optimal number of milk measurements of about 6 times during lactation to detect phenotypic differences among cows. Moreover, the method used in the present study to estimate the milk yield of cows considers linear production over 24 h by estimating milk production at 6 h and multiplying it by four, which may overestimate the milk yield of cows. ALMEIDA et

Table 5 - Spearman correlation coefficients between performance and feed efficiency traits of calves obtained during the pre- and postweaning phases.

		--------------------------------------Postweaning-----------------------------------				
	Trait[1]	DMI	ADG	$BW^{0.75}$	FC	RFI
Preweaning	DMI	0.48*	0.19	0.37	0.18	0.35
	MI	0.68*	0.40	-0.42*	-0.02	0.33
	MEI	0.23	0.27	-0.42	-0.17	0.03
	ADG	-0.09	-0.10	0.09	0.001	-0.009
	$BW^{0.75}$	0.20	-0.10	0.68*	0.18	-0.15
	FC	0.19	0.24	-0.32	-0.006	-0.14
	RFI	0.21	0.27	-0.50	0.06	-0.18

[1]DMI: dry matter intake, MI: milk intake, MEI: metabolizable energy intake, ADG: average daily weight gain, $BW^{0.75}$: mid-test metabolic body weight, FC: feed conversion,RFI: residual feed intake. *$p<0.05$.

Table 6 - Spearman correlation coefficients between ingestive behavior traits of calves obtained during the pre- and postweaning phases.

		---Postweaning---				
	Trait[1]	FV	DV	FD	FR	DMI/visit
Preweaning	FV	0.36	0.33	-0.06	-0.16	-0.21
	VD	0.18	0.11	0.10	0.18	0.26
	FD	0.08	0.11	0.10	0.18	0.26
	FR	0.07	0.39	0.16	-0.50*	-0.28
	DMI/visit	-0.29	0.07	0.30	0.14	0.49

[1]FV: frequency of feed bunk visits, DV: bunk visit duration, FD: feeding duration, FR: feeding rate, DMI: dry matter intake. *$p<0.05$.

al. (2018), in grazing Nellore cows, determined that the proportion of total daily production represented by the ratio of afternoon/morning milking was 0.45 in early lactation (first third) and 0.41 in mid- and late lactation, and concluded that it is not accurate to multiply a once daily milking amount in order to calculate daily milk production. Despite the limitation of the methodology, it is also known that the maximum production of a beef cow can also be determined by the calf's ability to extract the milk produced and not only by cow's physiological ability to produce milk (VARGAS JUNIOR et al., 2011).

The MEI from the diet increased with increasing age of the calf, demonstrating that the calf's dependence on maternal milk decreases with increasing capacity of forage consumption and increasing energy requirements for maintenance. The mean pre-weaning MEI of 9.57±1.9 Mcal day^{-1} is similar to the estimated total requirements (maintenance + weight gain) of Nellore calves with a mean weight of 150 kg and ADG of 1.0 kg day^{-1} reported by VALADARES FILHO et al. (2016), which was 10.8 Mcal day^{-1}.

The inaccuracy in the assessment of preweaning intake of milk and solid feed by calves is an obstacle to the evaluation of feed efficiency. The pre RFI exhibited greater variation than the post RFI, a finding that might explain the low R^2 (0.15) of the regression of MEI on ADG, $BW^{0.75}$, calf sex and RFI of cows for the calculation of the calf's pre RFI. According to ALBERTINI (2006), to estimate milk production and composition, samples are collected at a given time and the results are extrapolated to 24 h; however, this method may introduce bias if the production and composition of milk vary throughout the day. ALBERTINI (2006), studying calves during the preweaning period, reported that the regression of MEI on weight gain, fat thickness and degree of marbling of the calf explained 60% of the variation in MEI. However, in contrast to the present study, the author measured the cow's milk production 7 times during lactation, in addition to fat variables of the calf at weaning, and thus obtained a more accurate model for MEI.

DURUNNA et al. (2011) suggested the evaluation of feed efficiency during the post-weaning period to be more accurate than pre-weaning assessment because of the difficulty in estimating daily milk intake during the preweaning period. Nevertheless, the authors highlighted the importance of understanding the association of RFI analyzed during two periods of the productive life of young animals since it assists in the identification and selection of animals that maintain their feed efficiency rank throughout life.

The most efficient animals spend less time at the feed bunk, with a consequently faster feeding duration; however, these animals had a higher rate of intake (kg min^{-1}), i.e., they consumed more feed within a shorter period of time than the least efficient animals (Table 4). NKRUMAH et al. (2006), studying Angus x Charolais crossbred steers, also observed that the most efficient animals spent less time for feeding than the least efficient animals. In another study, NKRUMAH et al. (2007) evaluated the RFI of Angus and Charolais steers and reported that the most efficient animals spent less time feeding and visited the feed bunk less often than the least efficient animals. ALDRIGHI et al. (2019) reported significant differences during the postweaning period between Nellore animals classified as low, medium and high RFI, with the most efficient animals consuming less feed and exhibiting better rumination efficiency (g DM h^{-1}) than the least efficient animals.

Rumination efficiency and/or rumination time (RT) could help to explain the rate of intake, but rumination was not measured in the present study. A significant simple correlation of 0.21 ($p<0.05$) between RFI and RT was reported by ALDRIGHI et al. (2019) when the animals were fed diet containing forage-to-concentrate ratio of 45:55. Conversely, BYSKOV et al. (2017), in which some cows were fed with a total mixed ration plus a fixed amount of concentrate, and some cows were fed with forage and concentrate separately, reported negative correlations of -0.34 to -0.03 between RT and RFI and concluded that the former is a weak indicator of feed efficiency. GREGORINI et al. (2015), which fed the cows with different levels of fresh cut herbage with two different dietary particle size distributions (coarse and fine), reported a longer RT in cows selected for negative RFI. A longer RT ensures full mastication of food particles, which can improve nutrient utilization by the animal (BYSKOV et al., 2017).

The Spearman correlation between DMI and MI obtained during the pre- and postweaning phases was positive and of medium magnitude, showing that the feed intake of calves is somewhat consistent up to one year of age, i.e., part of the animals ranked based on pre-weaning feed intake will maintain the rank during the postweaning period. The same was observed for pre- and postweaning $BW^{0.75}$, which showed a high positive correlation (0.68). However, in contrast to feed intake and $BW^{0.75}$, the correlation between pre- and postweaning ADG was close to zero. The same was reported for the other traits evaluated whose correlations between the pre- and postweaning phases were not significant, except for the rate of intake (pre- and postweaning correlation of -0.50). Evaluating four traits used in feed efficiency tests (ADG, DMI, feed conversion ratio, and RFI), ARCHER et al. (2000) and WANG et al. (2006) showed that ADG is the most variable trait, a fact that may explain the low correlation estimated in the present study between ADG in the two consecutive phases. GUIMARÃES et al. (2017), evaluating Senepol cattle in two consecutive feed efficiency tests at yearling, also reported a correlation close to zero between ADG values and a high correlation between DMI and $BW^{0.75}$. However, in contrast to the present study, the authors observed high correlations between the other feed efficiency traits (except for FC) and ingestive behavior obtained in the two phases (yearling and long yearling). Based on the difference in feeding and phase of the growth curve, the pre- and postweaning ADG of cattle may have a low correlation. Using a considerable database of Nellore cattle, ARAÚJO NETO et al. (2011) estimated a genetic and environmental correlation between ADG from 120 to 210 days (preweaning) and from 210 to 365 days (postweaning) of 0.36 and -0.15, respectively, which results in a low phenotypic correlation between pre- and postweaning ADG (0.21), supporting the findings of the present study. Another hypothesis for the close to zero correlation between pre- and postweaning ADG could be compensatory gain for calves after weaning; however, this phenomenon seems unlikely since all animals had access to the *ad libitum* diet throughout the pre and post weaning period.

In conclusion, calves classified as most efficient have a similar weight gain during the preweaning phase but lower MI and MEI than least efficient calves. The estimated pre RFI (in Mcal day^{-1}) is weakly correlated with post RFI (in kg DM day^{-1}), showing that RFI is not consistent or repeatable across the two periods.

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DECLARATION OF CONFLICTS OF INTERESTS

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

All authors contributed equally for the conception and writing of the manuscript. All authors critically revised the manuscript and approved the final version.

BIOETHICS AND BIOSSECURITY COMMITTEE APPROVAL

All animal procedures were approved by the Ethics Committee on Animal Use of Instituto de Zootecnia (Protocol 243-17), Nova Odessa, São Paulo, Brazil.

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