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FECAL INDICATORS OF NELLORE BOVINES FED HIGH CONCENTRATE DIETS

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ABSTRACT

The present work had as objective to evaluate the effects of high grain diets on fecal parameters in 20 Nellore bovines at 28 months of age. The experimental design was completely randomized. Treatments were constituted of the following diets: total mixed ration + sugar cane bagasse DT + BIN (10% *in natura* sugarcane bagasse, 54.52% ground sorghum, 10.94% cottonseed, 18% soybean hull, 2.54% soybean meal, and 4% premix); whole corn grain MGI (75% whole corn grain, 10% soybean hull, and 15% premix) and total mixed ration DT (44.41% ground sorghum, 16.7% cottonseed, 28.89% soybean meal, and 10% premix). For the assessment of fecal pH and fecal starch, samples of feces were taken from the rectum of each animal on the 54th, 55th, 56th and 57th days of the experiment in the morning. Fecal pH was determined after the addition of 100 mL of distilled water in 15 g of fresh feces by the introduction of the tip of the electrode of a microprocessed pH meter. The remaining sample was stored in ice for later freezing. Fresh feces of the animals were evaluated daily during the whole experimental length in three periods aiming at evaluating occurrences of gut disturbances. Percentage means of fecal starch, fecal dry matter, pH in the site of starch fermentation and starch intake were not influenced by treatments (P>0.05). NDF of feces and the score of fecal consistency were influenced by treatments (P<0.05). The MGI diet (with the lowest content of peNDF) presented the lowest score of feces and percentage of fecal NDF. However, the percentage of starch and fecal pH, fecal dry matter and starch intake were not affected by peNDF contents in the diets. Animals fed MGI had lower fecal NDF. The concentration of fecal NDF was similar for the treatments DT + BIN and DT. The lower content of fecal NDF in the treatment MGI is due to lower intake of NDF and possibly because of better digestibility of this diet. Animals in MGI treatment presented feces with softer consistence (score 2.92). Feces of the animals in DT + BIN treatment were more consistent (score 3.12), and the ones from the animals DT + BIN treatment DT were even harder (score 3.2). There was positive correlation between fecal starch and intake efficiency and a tendency of positive correlation between fecal starch and GMD. Diets with high concentrate proportion with the addition of 10% BIN in dry matter produces a higher frequency of consistent feces.

KEYWORDS: diet; feces; feedlot; starch

INDICADORES FECAIS DE BOVINOS NELORE ALIMENTADOS COM DIETAS DE ALTA PROPORÇÃO DE CONCENTRADO

RESUMO

O presente trabalho teve como objetivo avaliar os efeitos de dietas de alta proporção de concentrado sobre características fecais em 20 bovinos Nelore machos com idade de 28 meses, em delineamento inteiramente casualizado. Os tratamentos foram constituídos de dieta total mais bagaço *in natura* - DT+BIN (54,52% de sorgo moído, 10,94% de caroço de algodão, 18% de casca de soja, 2,54% de farelo de soja, 10% bagaço de cana *in* *natura* e 4% de núcleo farelado), milho grão inteiro - MGI (75% de milho grão inteiro, 10% de casca de soja e 15% de núcleo peletizado) e dieta total - DT (44,44% de sorgo moído, 16,70% de caroço de algodão, 28,86% de casca de soja e 10% de núcleo farelado). Para determinação do pH das fezes e do amido fecal, amostras de fezes foram coletadas do reto de cada bovino nos dias 54, 55, 56 e 57 de experimento no período da manhã. O pH fecal foi determinado após adição de 100 mL de água destilada deionizada em 15 g de fezes frescas úmidas com a introdução da ponta do eletrodo de um peagâmetro microprocessado. O restante da amostra foi colocado em gelo, para depois ser congelado. Com o intuito de avaliar ocorrências de distúrbios gastrintestinais, as fezes frescas dos animais nas baias experimentais individuais foram avaliadas diariamente durante todo o experimento em três períodos. Os valores médios em percentagem do amido fecal, matéria seca fecal, medida de pH para o local de fermentação do amido e consumo de amido/kg não foram influenciados (P>0,05) pelos tratamentos. A FDN das fezes e o escore de consistência fecal foram influenciados pelos tratamentos (P<0,05). A dieta MGI com menor teor de FDNfe apresentou menor escore de fezes e menor percentagem de FDN fecal. Porém, a percentagem de amido e pH fecal, MS fecal e o consumo do amido não foram afetados pelo teor de FDNfe nas rações. A concentração de FDN fecal foi igual para os tratamentos DT+BIN e DT. O menor teor de FDN fecal no tratamento MGI é função do menor consumo de FDN pelos animais e, possivelmente, da maior digestibilidade dessa dieta. Os animais do tratamento MGI apresentaram fezes com consistência mais mole, com o valor de escore de 2,92. As fezes dos bovinos do tratamento DT+BIN foram de consistência mais firme com valor de escore de 3,12, considerada normal, e a dos animais do tratamento DT foram de consistência mais dura com valor de escore de 3,20. Houve uma relação consistente positiva entre amido fecal e eficiência alimentar e uma tendência de relação positiva entre amido fecal e GMD. Dieta de alta proporção de concentrado com adição de 10% de BIN na matéria seca proporciona maior freqüência de fezes com escore de consistência firme.

PALAVRAS-CHAVE: amido; confinamento; fezes; ração..

INTRODUCTION

Starch is the major component of diets for bovine intensively fed, and it provides the greatest amount of digestible energy consumed by the animal. Therefore, the assessment of starch loss due to management and digestibility problems, caused by different ways of processing the grain, would improve bovine performance.

Processing methods for reducing the particle size or changing the protein matrix that cements starch granules would increase the extent of digestion in the rumen and small intestine. Performance data of bovine in the growing phase fed corn and processed sorghum indicated that the starch used was 42% more efficient, if digested preferably in the small intestine and not in the rumen (OWENS et al., 1986).

It is therefore necessary to predict the flow and the disappearance of the starch in the small intestine at the moment of formulating the diet. Based on current methods, adequate and reliable assessments of digestion in the small intestine are not available. Without the ability to precisely describe and predict the starch digestion in the small intestine it is not possible to optimize the efficiency of the digestive starch. Results can only be expected if starch fecal excretion is avoided by the grain processing and dietary management (HUNTINGTON et al., 2006).

LEDOUX et al. (1985) showed that fecal and ruminal pH were not influenced by hay levels. Instead, the animal performance and fecal pH did not increase as the hay level increased from 4 to 24% in the diet. Since consumption remained constant at 1.7% of body weight in the metabolism trial, this data suggests that consumption of corn starch was not high enough to decrease fecal pH. Moreover, RUSSELL et al. (1981) reported a high correlation between the consumption of fecal pH and starch in steers fed high concentrate diets.

TURGEON et al. (1983) found that the percentage of fecal starch and fecal pH were not influenced by particle size. Fecal starch decreased linearly as the level of forage in the diet increased. A negative relationship between fecal starch and fecal pH (r = -0.42) was observed. However, neither fecal starch nor fecal pH was highly correlated with animal performance.

LEE et al. (1982) observed that the correlation between pH and fecal starch was -0.86, -0.34, -0.31 and -0.54 for 56, 84, 112 and 140 days of the feeding period, respectively, occurring significant correlation only at 56 days. Fecal starch tended to be greater as the proportion of MGI was increased in the diet. In general, there was a trend to associate higher fecal pH with low fecal starch content. Therefore, fecal pH may be a useful indicator for assessing the overall starch in ruminants fed high concentrate diets, but not in all cases.

The aim of this study was to evaluate the effects of high concentrate diets on fecal indicators of male Nellore bovine in feedlot.

MATERIAL AND METHODS

The experiment was conducted at the Livestock Sector of Barreiro Farm, located in the city of Silvânia – Goiás State, at 16º29'50.05" latitude, 48º47'31.44" longitude and 1000 m altitude. The climate in the city is tropical with seasonal rainfall well distributed from October to March. The study was carried out from December 9th, 2007 to March 27th, 2008. The monthly average temperature over the experimental period was 24.23ºC, with average monthly rainfall of 279.08 mm and average air relative humidity of 74.25%. The laboratory evaluations were performed in the Laboratory of Food Analysis, School of Veterinary and Animal Science, UFG.

We used 20 Nellore bulls aged 28 months and with an average weight of 336.61 kg at the beginning of the experimental period. The animals were randomly selected and adapted to the treatment facility, the management and the diets for 21 days. The adaptation of animals to the experimental diets, total mix ration (TMR), was carried out by means of supplying feed restricted to 1.3% of body weight in natural matter, on the first day, and afterwards up to 10% increase in the diet every day until the end of the adaptation. The total duration of the experiment was 105 days in confinement, with weighings after fasting period, in intervals of 21 days.

A completely randomized was used with three treatments: total diet + *in natura* sugar cane bagasse (DT+BIN, n=7); whole corn grain (MGI, n = 6) and total diet (DT, n = 7). The animals were randomly assigned to individual pens (12 m²), which were cemented (7 m²), partially covered (7 m²) and provided with concrete feeders and drinkers (tap with a buoy). Before the beginning of the experiment, animals were identified with numbered earrings, weighed, vaccinated and submitted to ecto- and endoparasites control.

TABLE 1 – Warranty levels list and chemical composition of the cores included in the experimental diets

Warranty levels	Mash core	Pelleted core	Mash core
	DT + BIN	MGI	DT
		Values	
DM	90.0	90.0	90.0
TDN (%)	25.0	64.4	64.0
PB (%)	78.0	44.5	27.7
NNP Eq Prot (%)	62.50	9.40	2.30
Crude fiber (%)	2.0	7.50	13.0
Calcium (g / kg)	110	29.35	44.0
Phosphorus (g / kg)	22.0	5.87	8.8
Sulphur (g / kg)	9.0	2.40	3.60
Magnesium (g / kg)	2.50	0.67	1.0
Potassium (g / kg)	28.0	3.0	3.0
Sodium (g / kg)	34.75	12.01	12.0
Cobalt (mg / kg)	15.0	4.0	6.0
Copper (mg / kg)	500	133.4	200
Chromium (mg / kg)	3.5	0.93	1.40
Iodine (mg / kg)	12.50	3.34	5.0
Manganese (mg / kg)	500	133.40	200
Molybdenum (mg / kg)	1.0	0.27	0.40
Nickel (mg / kg)	1.0	0.27	0.40
Selenium (mg / kg)	5.0	1.32	2.0
Zinc (mg / kg)	750	200.10	300
Monensin (mg / kg)	750	200.10	300
Yeast (g / kg)	12.50	3.34	5.0
Vitamin A (IU / kg)	55,000	14,674	22,000
Vitamin D (IU / kg)	8,500	2,267	3,400
Vitamin E (UI/kg)	400	106.72	160

Diets were composed of whole corn grain (MGI), sorghum (SM), cottonseed (CA), soybean meal (SBM), soybean hulls (SH), *in natura* sugarcane *bagasse* (BIN) and nuclei-specific for each diet in order to meet mineral and protein demands of the animals (Tables 1 and 2).

TABLE 2 - Chemical composition of the ingredients used in the experimental diets supplied to the animals on dry matter basis (% DM)

Feedstuff	DM	CP	ADF	NDF	MM	EE
Corn	88.64	7.86	4.31	7.30	1.86	3.09
Sorghum	89.34	7.21	4.03	8.41	1.34	1.54
Cotton seed	89.55	23.10	28.34	41.38	6.20	16.13
Soybean meal	87.76	46.60	10.42	21.30	6.55	2.34
Soybean hull	92.35	10.91	40.52	64.34	3.38	0.92
In natura sugar cane bagasse	74.8	1.71	56.1	74.53	1.25	-

Source: values analyzed LANA / DPA / EV / UFG. DM: dry matter; CP: crude protein; ADF: acid detergent fiber; NDF: neutral detergent fiber; MM: mineral matter; EE: ether extract.

The treatments consisted of complete and isoproteic rations, formulated to meet the requirements of beef cattle for an average gain of 1.40 kg / day, according to NRC (1996), and were calculated by the CNCPS system (CORNELL, 2002) (Table 3).

TABLE 3 - Centesimal composition of experimental diets, total diet and *in natura* sugarcane *bagasse* (DT + BIN), whole corn grain (MGI) and total diet (DT) in dry matter (% DM)

Feedstuff	Treatments		
	DT+BIN	MGI	DT
Cotton seed	10.94		16.70
Soybean hull	18.00	10.00	28.86
Ground sorghum	54.52		44.44
Mash core	4.0		10.00
Whole corn grain		75.00	
Pellet core		15.00	
In natura sugar cane bagasse	10.00		
Soybean meal	2.54		

Chemical composition of the experimental diets is shown in Table 4. The virginiamycin (10% of Phibro Animal Health ®) was mixed in the diet afterwards, at a dose of 150 mg / head / day.

TABLE 4 - Chemical composition of the experimental diets: total diet and *in natura* sugarcane *bagasse* (DT + BIN), whole corn grain (MGI) and total diet (DT) in dry matter (% DM)

NUTRIENTS	Treatments		
	DT+BIN	MGI	DT
Dry matter[1]	88.00	88.00	88.00
Crude protein[1]	12.03	12.30	12.33
Total digestible nutrients [2]	74.68	81.21	80.41
Neutral detergent fiber [1]	42.10	32.95	39.04
Acid detergent fiber [1]	25.15	16.03	21.81
Physically effective neutral detergent fiber [3]	33.5	8.17	28.77
Ether extract[1]	3.34	2.88	4.81
Non-fibrous carbohydrate [4]	38.56	48.48	37.98
Starch[1]	39.78	54.62	48.70
Minerals[1]	4,57	3,39	5,28

[1] Analyzed values LANA / DPA / EVZ / UFG; [2]Table values: [3]MERTENS (1997): [4]SNIFFEN et al.1992).

The voluntary intake of diets and nutrients was determined by the difference between the offer and the leftovers. Diets were weighed and distributed in the form of total mixed diet in two daily meals at 8a.m. and 5p.m., allowing leftovers of approximately 5% of what was offered. Samples of diets offered and leftovers were weighed for daily control and collected twice a week, for laboratory analysis. The DM content of the diets was analyzed weekly and the experimental diets adjusted depending on the results. The weights of the animals were performed at the beginning of the adaptation period, at the beginning of the experiment and every 21 days, always after a 14-hour period of food and water fast.

Evaluation of particle size was performed using the particle separator of Pennsylvania State (PSPs). We used a set of three sieves with holes of 19 mm, 8 mm and 1.18 mm and a closed bottom box to determine the average particle size of samples of the offered diets and leftovers collected once in each experimental period. The box with the sample was stirred at 1.1 Hz (1.1 cycle per second) for a total of 66 cycles per minute at a distance of 17 cm. The sample was segregated into four strata of different sizes: above 19 mm, between 19 and 8 mm, between 8 and 1.18 mm and less than 1.18 mm, procedure systematically performed by the same operator. The calculation of the percentage of particles retained on each sieve was performed directly, considering the sum of the weights of the fraction retained on each sieve, subtracting the weight of the sieve. The weight calculation of mean particle size was given by the mean size of particles retained on each sieve and the retention percentage over the total weight of the stratified sample according to KONONOFF (2003). The calculations of peFDN were obtained according to MERTENS (1997).

To determine fecal pH and fecal starch pH, fecal samples were collected from the rectum of each animal in the morning, between 9:30 a.m. and 12:00 p.m. on days 54, 55, 56 and 57 of the experimental period. Fecal pH was determined after adding 100 mL of distilled deionized water to 15 g of fresh wet feces wetted with the introduction of the electrode tip of a pH meter microprocessor. The remaining sample was placed on ice, to be frozen afterwards (TURGEON, 1983).

Before analysis, fecal samples were thawed and composite samples from the four collection days were made for each animal, then they were dried in a forced air circulation oven at 65 °C (DM) and milled in a 1 mm Willey-type sieve.

In order to evaluate the occurrences of gastrointestinal disorders, the fresh feces of animals in experimental stalls were subjectively evaluated daily throughout the experiment in three consecutive periods (January, February and March) by a trained person considering four visual scores. The measure of fecal consistency was determined by visual score, as follows: 1 = liquid – liquid consistency with sound splash in contact with water and spreading easily on impact on the ground; 2 = soft: loose stools – spills moderately and diffusely on impact with the ground making the sound of an object splash into contact with water; 3 = firm – but not hard, forming a mass, but doughy and slightly dispersed and settled on impact with the ground; 4 = hard – hard appearance, original and unaltered form, settled on impact with the ground (IRELANPPERRY & STALLINGS 1993).

Chemical-bromatological evaluation of dry matter (DM), organic matter (OM), crude protein (CP), starch, ether extract (EE) and minerals of the diets, leftovers and feces was performed in the laboratory of chemical analyzes of the Animal Production Department of the School of Veterinary and Animal Science, UFG. Samples were pre-dried in a forced ventilation oven at 65 °C and DM determined at 105 °C. Measurements of CP (Kjeldahl method), EE and minerals of the rations (offer and leftovers) and feces were conducted in accordance with AOAC (1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were calculated by the sequential method of ROBERTSON & VAN SOEST (1981).

Starch determination in the diets (offered and leftovers) and feces was performed by enzymatic method according to the methodology described by CAMPOS et al. (2004).

The following statistical model was used: $Y_{ijk} = m + T_i + E_{ijk}$, where: Y_{ijk} = observed value for the analyzed characteristic; m = general average; T_i = effect of complete diet with high proportion of concentrate I; and E_{ijk} = random error common to all observations.

The results were analyzed by means of the procedures PROC GLM of SAS (2000), applying the Tukey test at 5% probability, for averages comparison. The square root was used to stabilize the variance data to stool consistency parameters – hard, firm, soft and liquid. For the analysis of stool score, Kruskal-Wallis was used. The results were analyzed by *Pearson's* correlation by means of CORR procedure.

RESULTS AND DISCUSSION

The average percentage of feces starch, fecal dry matter, pH measurement to the site of starch fermentation, starch intake/kg, average daily gain and feed efficiency were not affected (P> 0.05) by treatment (Table 5). The score of fecal consistency of stools and NDF were affected (P <0.05) by treatments.

TABLE 5 - Effect of high concentrate diet on fecal DM content, starch intake, fecal starch (% DM), fecal NDF (% DM), fecal pH, fecal consistency score, average daily gain (kg / day) and feed efficiency (kg/kg)

Variables / Items	Treatments			VC (%)
	DT + BIN [1]	MGI [2]	Date of	
Fecal dry matter (%)	24.79 a	24.81 a	20.81 a	36.74
Starch intake (kg)	3.15 a	3.32 a	2.73 a	27.45
Fecal starch (%)	24.00 a	28.46 a	22.69 a	22.32
Fecal NDF (%)	46.29 a	35.65 b	48.97 a	12.69
Fecal pH	6.96 a	7.15 a	6.74 a	3.54
Fecal consistency score	3.12 b	2.92 c	3.20 a	16.07
Average daily gain, kg / day	1.79 a	1.82 a	1.47 a	18.82
Feed efficiency, kg / kg	0.197 a	0.246 a	0.219 a	15.65

Means followed by different letters in the same line differ (P <0.05) by Tukey test. [1]Total diet plus *in natura* sugarcane bagasse; [2]whole grain corn; [3]total diet.

According to TURGEON et al. (1983), fecal starch decreased linearly as the forage level was increased in the diet. According to these authors, the reduction of intake observed with the increase of forage level explains, to some extent, the decrease of fecal starch. In the current study, fecal starch decreased as the forage level was increased in the diet. The authors´ explanation for the fecal starch decrease due to the diminished consumption of DM in the diet does not confirm the findings of this study, where there was an increase with the addition of forage to the diet and there was no difference of fecal starch levels among treatments.

LEE et al. (1982) observed, in Hereford steers confined for 112 days, that the percentage of fecal starch increased as MGI proportion also increased in the diet compared with steam-flaked corn. In general, there was a tendency of associating the highest fecal pH with low contents of fecal starch. Therefore, fecal pH may be a useful indicator for assessing the overall starch in ruminants fed with high concentrate proportion, but not in all situations, since GALYEAN et al. (1979) observed, in diets with different particle sizes of corn, that fecal pH was not related to fecal starch content. RUSSEL et al. (1980) reported a low correlation (r = -0.35) between fecal pH and the concentration of fecal starch in diets with high MGI addition (88.5%), when 0.9% sodium bicarbonate solution, 1.8% limestone and a combination of the two were included.

WHEELER & NOLLER (1977) found that pH measurements on stool samples are an excellent indicator of pH in the small intestine. Low fecal pH is associated with large amounts of starch in the feces of bovines fed a high concentrate diet. Similarly, DEGREGÓRIO et al. (1982) reported that pH is the simplest indicator of the fermented starch amount in the large intestine because it reflects the degree of acidity resulting from the fermentation.

Starch levels in the diet reflect the pattern of food intake and the form of grain processing. CAETANO (2008) reported levels of 8.6% fecal starch, 19.5% fecal DM and fecal pH of 6.56 for corn, and 13.2% fecal starch, 22.7% fecal DM and fecal pH of 6.07 for sorghum. In this study, fecal starch results (% DM) were higher by 81.82% for sorghum, 230.93% for corn and 71.89% for sorghum, for treatments DT + BIN, MGI and DT. The author observed 22.7% for the fecal DM of sorghum, which is similar to the value obtained in this work for the treatments DT and DT + BIN; however, the value of fecal DM of corn is 27.23% lower when compared to MGI treatment (Table 5).

The fecal pH values verified in this study for DT + BIN, DT and MGI treatments were, respectively, 14.66%, 11.04% and 8.99% higher than the values found by CAETANO (2008). Probably, the higher pH measures occurred due to a lower DM intake in the treatments. This fact agrees with the findings reported by LEDOUX et al. (1985) that, in DM intake of 1.7% of body weight, starch ingestion is not high enough to decrease fecal pH.

It is likely that higher levels of fecal starch obtained in the treatments used in this study, compared to CAETANO´s (2008) work, are related to increased starch ingestion. DEGREGÓRIO et al. (1982) reported that unprocessed corn and lower utilization of starch in the gastrointestinal tract leads to higher starch content in the feces. Furthermore, it may be due to the time of feces collection (in the mornings). CAETANO (2008) verified a significant relationship between fecal starch content and the time after the management of the animals. The variation of the starch as a function of time can be explained based on feeding behavior of animals and feedlot management, because the author showed that fecal starch behaved, in time, in a polynomial curve. This curve shows higher starch content in the feces during the first hours after feeding. As time passed, there is a decrease in starch content, which lasts 10 to 12 hours.

CAETANO (2008) also observed that the fecal starch value was 7.5% and 3.5% of DM in the morning and in the afternoon, respectively. Therefore, the difference of 100% between the levels in the morning and in the afternoon should be considered as a limiting factor for the use of this indicator without collection standardization.

Thus, time of collection and a larger amount of grain, besides, in the case of MGI treatment, the unprocessed corn (Table 3) in the diet may provide high starch content in the feces. It is important to emphasize that CAETANO (2008) worked with lower levels of starch, consisting of 26.54% of corn grain in diets with 81% concentrate.

NUNES (2008) observed starch consumption of 2.44 kg/day for diets with 73% concentrate (52% dry corn grain and 31.57% starch) and of 4.32 kg /day for diets with and 91% concentrate (70.25% dry corn grain and 48.40% starch). For fecal starch, the authors found contents of 13.9% and 19.27%, and for fecal pH, 6.02 and 5.97, respectively. Regarding starch consumption (SC), the fecal starch content (FSC) and fecal pH (FpH) of the feed with 91% concentrate was 30.12% higher for SC, 47.69% lower for FSC and 19.77% lower for FpH when compared with MGI ration with 75% whole grain corn and 54.62% starch. Thus, this author found that the animals of the treatment with 91% concentrate presented more starch in feces, due to lower utilization of digestible energy compared with treatment with 73% concentrate, because of the use of Nellore bovines in the experiment. In this study, some animals of MGI treatment (Figure 1) showed liquid feces, indicating fermentation problems, with symptoms of acidosis.

In this context, NUNES (2008) observed a difference in starch content in the feces of animals of different genotypes, indicating that Nellore bovines lose 28% more starch in the feces than crossbred animal, due to the characteristic of animals.

PUTRINO et al. (2006) verified higher DM intake by Nellore and Brangus cattle fed diets with 64.10% and 67.05% TDN, respectively. Therefore, CAETANO´s (2008) argument that Nellore cattle uses poorly the digestible energy may justify the present study, because diets of DT+BIN, MG and DT treatments presented TDN levels, respectively, 74.68%, 81.21% and 80.21% higher than the values observed by PUTRINO et al. (2006).

DEPENBUSCH et al. (2008) found, in fecal samples of 251 steers supplemented with diets (81% dry-rolled corn), mean values of fecal starch of 23%, with a minimum variation of 1.2% up to 59.6%, with a standard deviation of more than 11%. ZINN et al. (2007) compiled data of 32 metabolism studies on starch concentration and found out mean values of fecal starch of 5.9% with a wide range from zero to 44%. Therefore, the average content of fecal starch observed in this study are consistent because these authors have also worked with diets containing 90% concentratedand the values found here are close to the ones by these authors.

GOROCICA-BUENFIL & LOERCH (2005) emphasized a 45% increase in the concentration of fecal starch in cattle fed whole corn compared to ground corn grain, which was not observed in this study, although starch in the diets of treatments came from different grain sources (Table 3) and different processing forms. IRELANPPERRY & STALLINGS (1993) found that dairy cows fed diets with low forage content have lower fecal pH, higher fecal starch and lower score of stool consistency. Thus, cows consuming diets with low proportion of forage consume greater amount of matter, which could result in a faster passage rate, increasing the loss of starch through the rumen. However, the starch that is neither digested in the small intestine nor fermented in the large intestine passes to the feces. On the other hand, cows that ingest diets with high forage percentage show low starch intake and slower passage rate, leading to higher dietary digestibility and reduced starch loss in the lower gastrointestinal tract and feces. As a result, fermentation in the lower tract may be reduced, increasing fecal pH. Thus, of the variables mentioned earlier, the lower stool consistency score in MGI treatment is in accordance with the author.

The assessment of bovine feces can provide valuable information regarding the location and extent of digestion and fermentation of the feed consumed. Usually, most of the food ingested by bovines is degraded by the rumen and most of the nutrients are absorbed into the rumen or small intestine. When food is not properly fermented in the rumen, some non-degraded nutrients can reach the small intestine and be absorbed, but if the amount is too excessive, the passage rate is fast and the nutrients may escape digestion and absorption in the small intestine. When the diet lacks fiber or has high nonstructural carbohydrate (NSC) content, fermentation can occur in the large intestine, affecting negatively the health and production of bovine (KONONOFF et al., 2002).

Stool consistency in bovine depends largely on the water content and is a function of moisture content and the amount of time food stays in the digestive tract of the animal. The normal fecal material has a mush consistency and forms a round stacked dome with 25.4 to 50.8 mm high (KONONOFF et al. 2002).

The lower content of fecal dry matter in MGI treatment in this study compared to the content observed by CAETANO (2008), demonstrated by the stool consistency score (Table 5), is presumably caused by low peNDF (Table 4) in MGI diet, lower consumption of peFDN and NDF (IRELANPPERRY & STALLINGS, 1993).

MGI diet, with lower content of peFDN, showed lower score of stool consistency and lower percentage of fecal NDF. However, the percentage of starch and fecal pH, fecal DM and starch intake were not affected by peFDN content in the feed. The present data (Table 5) partly corroborate the findings by IRELANPPERRY & STALLINGS (1993), who found lower fecal NDF and higher fecal score in cows fed diets with low proportion of forage. On the other hand, unlike the results found by these authors, diets with total concentrate and with low proportion of forage did not influence the percentage of fecal starch, fecal DM, fecal pH and starch intake.

The concentration of fecal NDF was similar for DT+BIN and DT treatments. The lowest levels of fecal NDF in MGI treatment is provided by lower NDF intake by the animals and possibly by the higher digestibility of this diet.

The animals of MGI treatment showed softer stool, with the score value of 2.92 (Table 5). The feces of bovines of DT + BIN treatment were firmer with a score value of 3.12, which is considered normal, and animals of DT treatment presented harder feces, with a score value of 3.20.

IRELANPPERRY & STALLINGS (1993) pointed out that cows consuming diets with low proportion of forage have stools that visually appear to be more liquid. Thus, according to this author, cows that eat high forage diet, but eat more fiber and less DM, excrete feces receiving score of higher consistency (hard).

The soft consistency of feces in MGI treatment (Figure 1) possibly happened due to the lower fiber content and the higher concentration of starch in the diet (Table 4).

Although DT+BIN and DT treatments presented similar peFDN levels, they revealed different feces consistency.

Probably, harder stool consistency in DT treatment occurred because of distribution and difference in particle size, as reported by HEINRICHS & KONONOFF (2002), and in the fiber source, which provide a greater selection of food by the animals. Moreover, this treatment contains byproducts of non-forage fiber sources (NFFS) with smaller particle sizes, which reduce ruminal motility, as reported by FURLAN et al. (2006), and operate with less effectiveness than the forage (ARMENTANO & PEREIRA, 1999), which, coupled with the lowest dietary intake by these animals, reflect in the formation of harder stool due to a lower passage rate.

The firm consistency of stools for DT + BIN treatment may have occurred due to the higher fiber content in relation to MGI treatment and the use of a forage source that promotes better fiber efficiency, producing a slower passage rate.

Correlations of starch levels in the feces with fecal pH, average daily weight gain and feed efficiency are shown in Table 6. .

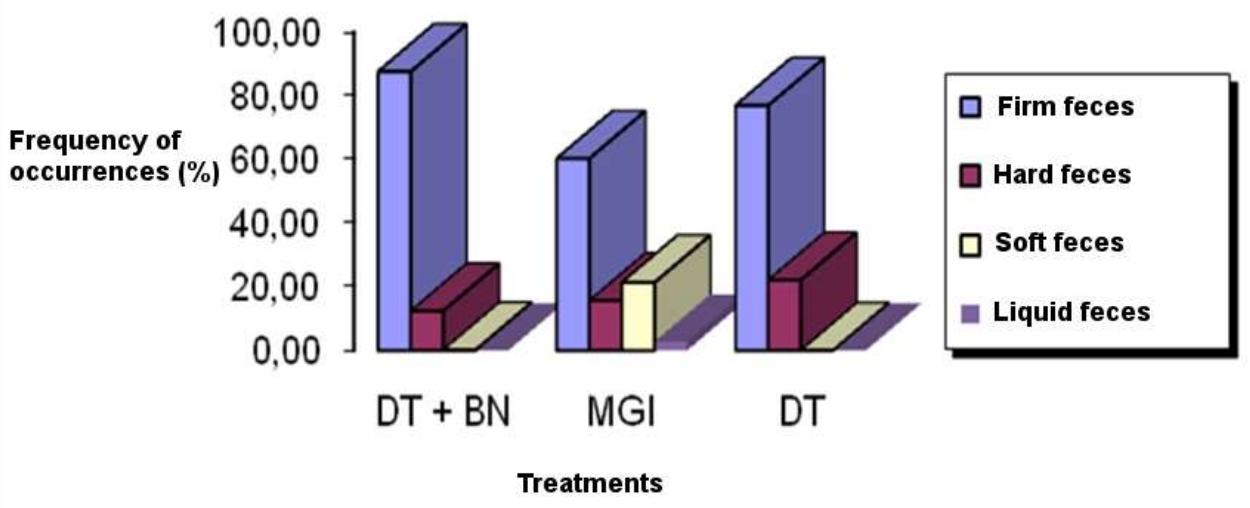

FIGURE 1. Feces characteristics of Nellore bovines in feedlot, fed high concentrate diet.

TABLE 6 - Correlations between fecal starch content and fecal pH, average daily weight gain, feed efficiency with their respective coefficients of correlation and probability levels

Correlation	Coefficients of correlation	P
Fecal starch x fecal pH	0.10	0.4
Fecal starch x daily weight gain	0.36	0.1
Fecal starch x feed efficiency	0.48	<0.03

There was no correlation between fecal pH (P> 0.01) and fecal starch. Therefore, this result disagrees with the ones found by WHEELER & NOLLER (1977), TURGEON et al. (1983) LEDOUX et al. (1985), IRELANPPERRY & STALLINGS (1993), MARUTA & ORTOLANY, (2002), CHANNON et al. (2004), CAETANO (2008), NUNES (2008) and DEPENBUSCH et al. (2008), because these authors observed a negative relationship between fecal pH and the starch in bovine feces.

CHANNON et al. (2004) demonstrated correlations between fecal starch and average daily weight gain. Previously, LEDOUX et al. (1985) obtained low positive correlation between the percentage of starch in the feces and the average daily weight gain. TURGEON et al. (1983), CAETANO (2008) and NUNES (2008) found no correlation between fecal starch and weight gain. In the present study we found no correlation between the fecal starch and average daily weight gain (P = 0.10). However we verified the existence of a correlation between fecal starch and feed efficiency (P <0.03) (Table 6), suggesting that starch intake may be related to animal performance. STELLA (2010) found no correlation between fecal starch and feed efficiency. The author concluded that in a diet with relatively low starch content, the fecal parameters were not indicative of feed efficiency.

Estimates of correlation between the characteristics of average daily weight gain (ADG), dry matter intake (DMI), starch intake (SI), neutral detergent fiber intake (NDFI), acid detergent fiber intake (ADFI), percentage of fecal neutral detergent fiber (fNDF) with stool consistency (hard, firm, soft and liquid) are shown in Table 7.

TABLE 7 – Simple correlation values of average daily weight gain (ADG), dry matter intake (DMI), starch intake (SI), neutral detergent fiber intake (NDFI), acid detergent fiber intake (ADFI), percentage of fecal neutral detergent fiber (fNDF) with indicators of fecal consistency: firm (FF), hard (HF), soft (SF) and liquid (LF)

Correlation	Coefficients of correlation	P
ADG x HF	-0.53	0.03
DMI x FF	0.68	0.0009
DMI x HF	-0.68	0.0036
SI x FF	0.54	0.013
SI x HF	-0.81	0.0001
NDFI x FF	0.69	0.0007
NDFI x HF	-0.58	0.019
ADFI x FF	0.71	0.0004
ADFI x HF	-0.52	0.036
NDFf x SF	-0.61	0.06
NDFF x LF	-0.55	0.012

Of the studied characteristics, only the percentage of fecal NDF with soft feces did not reach statistical significance. Dry matter intake (DMI), SI, INDF and ADFI presented positive estimate correlation with firm feces consistency. The GMD, DMI, SI, NDFI and ADFI presented a negative estimate of correlation with hard feces consistency. The fecal NDF obtained negative estimate of correlation with liquid feces consistency.

The dry matter intake was positively correlated (r = 0.68) with the consistency of FF and negatively (r = -0.68) with the HF, indicating that byproducts of non-forage fiber sources (NFFS), with smaller particle sizes, reduce rumen motility (FURLAN et al., 2006) and operate with less effectiveness than forage, providing less food intake and reflecting in the formation of harder feces due to lower passage rate (ARMENTANO & PEREIRA, 1999).

Starch intake was positively correlated with the consistency of FF (r = 0.54) and negatively (r = -0.81) with HF, showing that higher starch intake favors a faster passage rate, promoting a lower score of feces consistency. Intakes of NDF (r = 0.69) and ADF (r = 0.71) correlated positively with the consistency of FF. Intakes of NDF (r = -0.58) and ADF (r = -0.52) correlated negatively with the consistency of HF. Such occurrences demonstrated that low fiber intake can result in a lower score of feces consistency. The fecal NDF (NDFf) was negatively correlated (r = -55) with the consistency of LF, and the visual observation of the loss of fecal consistency may be due to the occurrence of more starch and less fiber in feces.

CONCLUSIONS

Diet with high concentrate content with the addition of 10% *in natura* sugarcane *bagasse* in the dry matter produces stools with scores of firm consistency.

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