PERFORMANCE AND BEHAVIOR OF DAIRY CALVES FED DIETS CONTAINING MILK AND CITRIC FLAVOR AGENTS

Desempenho e comportamento de bezerros leiteiros alimentados com dietas contendo agentes de flavor lácteo e cítrico

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ABSTRACT

While young ruminants prefer milk aroma and researches about this theme are being developed, the use of citric aroma, very appetized for older ruminants, are low utilized to young animals. This work aims to compare the influence of milk and citric flavor agents on the diets of nursing dairy calves. In this trial, 12 animals of Holstein breed were distributed in a randomized block design with four treatments (concentrate without flavor agent, concentrate with milk flavor or citrus flavor, and concentrate with milk plus citrus flavor agent) and three repetitions. The parameters evaluated were: concentrate dry matter intake (CDMI), hay dry matter (HDMI), milk dry matter intake (MDMI) and total dry matter intake (TDMI), average weight gain (ADWG), feed conversion (FC), initial (IBW) and final body weight (FBW), initial thoracic perimeter (ITP) and final thoracic perimeter (FTP), initial abdominal perimeter (IAP) and final abdominal perimeter (FAP), initial withers height (IWH) and final withers height (FWH) and animal behavior. The CDMI, HDMI and TDMI, as well as IBW, FBW, ITP, FTP, IAP, FAP, IWH and FWH did not show differences (P>0.05). The averages daily gain and feed conversion showed no differences, with means of 0.55 kg/animal and 2.09, respectively. The diets did not affect animal behavior parameters (P>0.05).

Index terms: Dry matter intake, palatability, performance, behavior, flavour.

RESUMO

Enquanto ruminantes jovens preferem aroma de leite e pesquisas sobre este tema são desenvolvidas, o uso de aroma cítrico, muito apreciado por ruminantes adultos, é pouco utilizado para animais jovens. Portanto, com este trabalho visou-se comparar a influência de aromas lácteo e cítrico nas dietas de bezerros na fase de aleitamento. Neste experimento foram utilizados 12 animais da raça Holandesa, distribuídos em um delineamento de blocos ao acaso, com quarto tratamentos (concentrado sem palatabilizante e concentrado com palatabilizante lácteo, cítrico e lácteo mais cítrico) e três repetições. Foram avaliados o consumo de matéria seca do concentrado (CMSC), do feno (CMSF), do leite (CMSL) e do total (CMST), ganho médio diário (GMD), conversão alimentar (CA), peso inicial (PI) e final (PF), perímetro torácico inicial (PTI) e final (PTF), perímetro abdominal inicial (PAI) e final (PAF), altura de cernelha inicial (ACI) e final (ACF) e o comportamento animal. O CMSC, CMSF e CMST não apresentaram diferenças da mesma forma que as mensurações de PI, PF, PTI, PTF, PAI, PAF, ACI e ACF. O ganho médio diário e a conversão alimentar não foram diferentes, obtendo-se médias de 0,55 kg/animal e 2,09, respectivamente. As dietas também não influenciaram os parâmetros de comportamento animal (P>0,05).

Termos para indexação: Consumo de matéria seca, palatabilidade, desempenho, comportamento, flavorizantes.

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INTRODUCTION

The main objectives of animal production are profit and high quality feedstuffs, causing a minimum negative impact on animal welfare and the environment (WEBER-NIELSEN & BERGFELD, 2003). In dairy farms, the objective is to obtain the maximum milk yield with a reduction in the nursing time of calves. More economic systems of calf breeding, with the adoption of improved feeding management practices, may make possible greater feed efficiency for replacement heifers as well as male calves destined for meat production.

Nevertheless, when calves are born, their digestive tract do not present morphological characteristics equal to that of an adult ruminant yet. The manipulation and knowledge about microbes, digestive juices and their functions in pre-ruminants calves is necessary to utililize the nutrients with greater efficiency (GUILLOTEAU et al.,

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1994). The intake of solid feedstuffs will accelerate the process of the development of reticulum-rumen system in calves (CHURCH, 1988).

The use of additives in animal production has as objective to improve animal performance, with better development in a shorter time. Flavor agents should contribute for a higher feed intake, since the cattle have sensibility to different taste and aromas, it might be reflected in better performance and body development (NOMBEKELA et al., 1994). The palatability is determined by foods characteristics, which cause a response in animal senses such as vision, smell, touch and taste, resulting in an appetite more or less developed for specific foods (CHURCH, 1988; MATTHEWS, 1983). Also Baumont (1996) observed that the feed palatability complex is part of physical (plant structure, defense mechanism) and chemical (taste, smell) characteristics, which determine the animal preference. Ruminants prefer feeds, which physical characteristics allow a faster/ greater ingestion, due to rumen digestion and rate of passage.

Some researches demonstrate different preferences of both young and older ruminants about some flavor agents. While young ruminants prefer milk taste and aroma, older ruminants, such as dairy cows prefer citric taste and aroma. This experiment aims to compare milk and citric flavor agent added to concentrate for nursing dairy calves.

MATERIALS AND METHODS

The experiment was conducted in the Dairy Sector of the Department of Animal Science, Universidade Federal de Santa Maria, Brazil, from April 11th to June 6th, 2003. Twelve male dairy calves, Holstein breed, put on trial after a post-colostral period (four days old) and weaned with fifty-six days old, were used.

The calves were fed with the concentrate containing different flavor agents, using the following treatments: T0 – control (standard concentrate) without addition of flavor agent; T1 – standard concentrate + milk flavor agent (300g MFA/ton. concentrate); T2 – standard concentrate + citrus flavor agent (300g CFA/ton. concentrate); T3 – standard concentrate + citrus flavor agent plus milk flavor agent (150g MFA + 150 CFA/ton. concentrate). The addition of flavor agent in the concentrate was made in a mechanical mixer, shaked for, approximately, 10 minutes to guarantee efficient mixture of the additive and concentrate. The standard concentrate composition was soybean meal, corn grain and wheat bran. The milk flavor agent attempted to reproduce cow's milk aroma and was composed of a white fine powder with an immediate aromatic perception of milk, while the citrus flavor agent produced an aroma and taste of orange, also supplied as a white fine powder. The vehicle utilized by the two flavor agents was silica oxide (SiO_2) and calcium carbonate ($CaCO_3$).

From birth up to the fourth day, the calves received 4L of colostrum, in two daily feedings. From the fifth day on, they received 4L of whole milk, divided in two feedings, at 7:30 a.m. and 5:30 p.m., during all experimental time. After first week old, calves received water and concentrate *ad libitum* up to wean time (56th days old). Alfalfa hay was introduced into the diet from the third week and were offered an amount of concentrate and hay up to a surplus of 10 to 15 % of offered feed consumed. The nutritional value of the diets is presented in Table 1.

Total feed intake was estimated by calculating the difference between the amount of concentrate and hay offered and the orts taken daily. The intake was evaluated using the following parameters: concentrate dry matter intake (CDMI), hay dry matter intake (HDMI), milk dry matter intake (MDMI) and total dry matter intake (TDMI). Feed conversion was calculed from TDMI and total weight gain during the experimental period (56 days). The body development was evaluated by measuring thoracic and abdominal perimeters with measuring tape; wither height were measured using an adapted ruler and live weight was obtained in a mechanical scale. Evaluations were conducted weekly during all experimental periods before feeding in the morning period. In the evaluation of animal behavior, the

TABLE 1 – Nutritional value of diet offered to dairy calves in the experimental period (dry matter basis).

Item	Dry matter (%)	Crude protein (%)	NDF[1] (%)	Fat (%)	Ash (%)	TDN[2] (%)
Whole milk	12.00	-----	-----	-----	-----	-----
Concentrate	86.65	19.18	41.60	9.96	6.41	78.41
Hay	86.62	20.18	18.09	6.46	7.97	62.10

[1] Neutral Detergent Fiber; [2]Total Digestible Nutrients, calculated.

animals were observed during a period of 12 hours (720 minutes), from 6 a.m. to 6 p.m., at each five minutes. During the experimental period, four evaluations (April 25th; May 9th; May 23rd and June 6th, 2003) were made. Time of ingestion of solid feeds (concentrate, hay) and liquid (milk, water), idleness (stood up and laid down), rumination (stood up and laid down) and playing activities were observed.

The experimental design was randomized blocks, in which the blocking factor was the calves birth order. The data were analysed by ANOVA and Tukey's Test at 5 % probability utilizing SAS statistical program (SAS INSTITUTE, 1997). The statistical model adopted was as follows: $Y_{ij} = \mu + \tau_i + \beta_j + \varepsilon_{ij}$, where i represent the repetitions index; j is the treatments index; Y_{ij} represents the dependent variables; μ is the general mean; τ_i effect of treatment; β_j is the effect of blocks and e_{ij} represents the residue.

RESULTS AND DISCUSSION

The means of concentrate, hay, milk and total dry matter intake and feed conversion, which was found during the experimental period, are shown in Table 2. No differences (P>0.05) among treatments were observed. These results agree with the conclusions of Chandler et al. (1968), Cheeke (1991), Miller et al. (1958) and Shuh & Wegner (1979). According to these authors, the use of flavor agents did not contribute to increased feed ingestion. The response obtained contest those of Albright (1993) who noted a tendency of increasing the intake with the use of flavor agents and with results observed by Lucci (1989), who observed an increased intake of diets with apple and milk flavor agents.

Chua et al. (2002) and Hafez & Dyer (1972) mentioned a probable influence of flavoring agents in increasing intake, when the animals are isolated in individual pens. Howeverer, this comportment did not was observed in this research.

The use of basic feeds of excellent quality, with 20 % crude protein (CP) and 80 % total digestible nutrients (TDN), and the use of alfalfa hay, might interfere in a possible effect of flavor agents on the solid feeds intake. A greater variation in the quality of feed ingredients might occur by using flavoring agents over a greater period of time, in terms of feed intake by calves. Atwood et al. (2001) mentioned the preference of beef calves for feeds with high content of protein or energy, and this could explain why there were no significant differences among diets. Cheeke (1991) noted a possibility of flavor agents affecting and increasing the intake of poor quality feeds. Notwithstanding, some authors (LUCCI, 1989; MORRILL & DAYTON, 1974; NOMBEKELA et al., 1994) reported that the use of flavor agents increased intake in good quality feeds, which was not confirmed in the present experiment.

There was a major variability in concentrate intake when compared with hay intake. This behavior has been observed previously by Severo (1995) and Vasconcelos (1996), who compared installations and liquid diets, observed coefficients of variation of 43.6 e 12.0 %, respectively, for concentrate and hay intake. There was a more uniform intake for hay as demonstrated by a lower coefficient of variation (Table 2). This condition was also observed by León (1994) in similar work, also using alfalfa hay, with a coefficient of variation (with intake) of 5.42%. Severo (1995) and Vasconcelos (1996) observed coefficients of variation of 20.5 e 45.1 % by using the same feed management of Bermudagrass and millet hay, respectively.

TABLE 2 – Concentrate dry matter intake (CDMI), milk dry matter intake (MDMI), hay dry matter intake (HDMI), total dry matter intake (TDMI) and feed conversion (FC) of calves, in kg, submitted to different diets.

Item	Treatment				Average± error standard	Value of P
	Control	Control +MFA	Control +CFA	Control + MFA + CFA		
CDMI	30.7	29.4	21.6	28.9	27.6±5.68	0.643
MDMI[1]	26.8	26.8	26.8	26.8	26.8	-
HDMI	8.29	8.70	8.43	10.6	9.02±1.32	0.687
TDMI	65.8	65.0	56.9	66.5	63.5±6.27	0.685
FC	2.03	2.01	2.05	2.28	2.09±0.23	0.172

(P<0.05); [1]Estimated dry matter = 120g/l; MFA = milk flavor agent; CFA = citrus flavor agent.

The average daily intake, through the experimental period, was 498g of concentrate/calf. This value was superior to the results obtained by Vasconcelos (1996) of 342g/calf/day, who compared different diets, installations and year with seasons. Susin et al. (1988) observed a concentrate dry matter intake of 532g/calf/day, in weaned calves at 45 days.

No significative effect (P>0.05) was observed among treatments for feed conversion. The general average observed (2.09) was higher than the values obtained by León (1994) and Severo (1995) with 1.79 and 1.76 respectively, but similar to values (2.11) observed by Vasconcelos (1996).

In Table 3, the means of live weight (kg), thoracic perimeter, abdominal perimeter and wither height (cm), at the start and the end of the experimental period, and the estimate changes in these parameters for all treatments are shown. It can be seen, there were no significant differences among the treatments.

It was observed that the mean of initial weight of animals, 42.4 kg, was higher in comparison with other works (LEÓN, 1994; SEVERO, 1995; VASCONCELOS, 1996), developed in the same region, with male calves of Holstein breed of individual initial weight varying from 36.3 to 37.3 kg. The data demonstrate a crescent linear effect ($Y = 34.8+4.47x$; $R^2 = 0.58$; $P< .0001$) for average weight gain. Similar data were obtained by Severo (1995), with $Y = 36.19+0.63x$; $R^2 = 0.85$.

The average daily gain (545 g/animal/day) was superior to that (452 g) observed by Liziere et al. (2002), who conducted work with similar periods of weaning and feed management. Schalch et al. (2001) observed values of average daily gain of 453g/animal/day and variation of the measurement of wither height and thoracic perimeter up to weaning time of 10.0 and 14.4 cm, respectively. In the present work, the variations of wither height and thoracic perimeter were 10.6 and 18.6 cm at weaning time, respectively.

In Table 4, it is showed results of time spent by calves in each activity in all treatments. The analyses demonstrate that no significant differences were found among treatments.

A probable effect of flavor agents, which might be observed by higher atractivity of calves for feedstuffs that contained these additives, as well as the frequency and amount consumed, was not observed. Although ruminants have a great sensibility to feel different smells and tastes, the research demonstrated that the use of flavor agent did not influence the feeding behavior of animals.

TABLE 3 – Initial (ILW) and final liveweight (FLW), variation of liveweight (VLW), average daily weight gain (ADWG), feed conversion (FC), in kg, initial (ITP) and final thoracic perimeter (FTP), variation of thoracic perimeter (VTP), initial (IAP) and final abdominal perimeter (FAP), variation of abdominal perimeter (VAP), Initial (IWH) and final wither height (FWH), variation of wither height (VWH), in cm, of Holstein calves submitted to different diets.

Item	Treatment				Average± error standard	Value of P
	Control	Control + MFA	Control + CFA	Control + MFA+CFA		
ILW	40.8	40.8	41.1	47.0	42.4±2.47	0.306
FLW	73.5	73.8	68.6	76.0	73.0±4.87	0.755
VLW	32.6	33.0	27.5	29.0	30.5±2.77	0.524
ADWG	0.58	0.58	0.49	0.51	0.54±0.04	0.526
ITP	82.0	82.0	83.6	86.3	83.5±1.88	0.393
FTP	104.0	101.8	99.3	103.3	102.1±3.18	0.742
VTP	22.0	19.8	15.6	17.0	18.6±3.24	0.344
IAP	79.0	82.0	80.0	85.3	81.5±1.77	0.157
FAP	104.0	105.3	98.6	107.6	103.9±3.46	0.382
VAP	25.0	23.3	18.6	22.3	22.3±3.48	0.572
IWH	77.0	78.3	78.5	78.0	77.9±1.29	0.845
FWH	89.0	89.1	86.6	89.5	88.5±1.66	0.636
VWH	12.0	10.8	8.16	11.5	10.6±1.01	0.827

(P<0.05); MFA = milk flavor agent; CFA = citrus flavor agent.

TABLE 4 – Time spent, in minutes, for solid intake (concentrate, hay), liquid intake (whole milk, water), rumination (Stood up, Laid down) and idleness (Stood up, Laid down) of dairy calves submitted to different diets.

Item	Treatment				Average± error standard	Value of P
	Control	Control + MFA	Control + CFA	Control +MFA+CFA		
Intake						
- Concentrate	46.7	45.0	44.0	51.1	46.7±0.47	0.287
- Hay	90.6	82.8	68.9	86.7	82.2±0.86	0.369
- Total	137.2	127.8	112.9	137.8	128.9±1.96	0.098
Intake						
- Whole milk	10.0	10.0	10.0	10.0	10.0	-
- Water	5.60	5.00	8.90	11.7	7.8±0.01	0.114
- Total	15.6	15.0	18.9	21.7	17.8±0.04	0.114
Rumination						
- Stood up	8.30	3.30	5.60	2.8	5.0±0.01	0.203
- Laid down	98.9	93.9	95.0	97.8	96.4±2.26	0.995
- Total	107.2	97.2	100.6	100.6	101.4±2.57	0.971
Idleness						
- Stood up	208.9	206.7	181.0	202.8	199.8±5.65	0.679
- Laid down	251.1	273.3	306.7	257.2	272.1±13.3	0.696
- Total	460.0	480.0	487.7	460.0	471.9±17.4	0.796

($P<0.05$); MFA = milk flavor agent; CFA = citrus flavor agent. Time of watch: 6 a.m. at 6 p.m. (720 minutes).

The results were similar to those observed by other researchers (CHANDLER et al., 1968; MILLER et al., 1958; MORRILL & DAYTON, 1974; SHUH & WEGNER, 1979). The animals of the Control + CFA treatment showed higher concentrate intake. However, comparing the intake based on the percentage of live weight, the values are more numerically similar.

It was observed that within the behaviour activities, a great part of time was spent in idleness (65.5 %). The results in the time of total idleness were similar as observed in other research with calves (VASCONCELOS, 1996). The time of total idleness, in calves, is higher than in adult animals, which is 42 % approximately (CAMARGO, 1988). The time spent in laid down idleness was higher than when the calves were stood up idleness (Table 4), the inverse was observed by authors above cited. This behavior could probably occur due to housing being over a slatted floor.

The results of time spent in intake of solid feeds were 126.9 minutes (17.6 % of time), with 46.7 and 82.2 minutes observed for the concentrate and hay, respectively. These values are similar to the values obtained by Weber (2002). Liquid intake occupied a minor part of evaluated activities, with a total of 17.8 minutes (2.47 % of time). The time spent in rumination observed in this work (14.0 %) was superior at that verified in others trials, probably due a larger intake of hay. The intake of 161 g/calf/day was superior at the values found by Severo (1995), with values of 84 g/calf/day.

During the experimental period, playing activity was not observed. Comparing different installations (individual x collective cages), Chua et al. (2002) found no differences between individual or paired-housed calves. The results confirmed the observations made by Keer & Wood-Gush (1987) that calves raised in conventional housing would affect the expression of behavior due to the limitation of movement.

CONCLUSIONS

There were no differences among animal performance and behavior parameters when milk and/ or citric flavor agents are included in the diets of nursing dairy calves.

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