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Behavioural Responses of Dairy Calves to Cafeteria Feeding vs. Single Feeding

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Abstract: This study was carried out to investigate whether cafeteria feeding affects behaviour of newborn milk fed dairy calves. Twenty Holstein Friesian calves were divided into two treatment groups single (TMR) and cafeteria feeding. Each calf was observed once a week for a period of 1 h at 5 min intervals at different times of a day after the initiation of daily feeding to monitor eating, ruminating, drinking, licking objects, playing, resting, body care and idle standing activities. The proportional count of eating, ruminating, drinking, licking objects, playing, resting, body care and idle standing were determined as 5.33, 6.52; 5.56, 8.89; 1.36, 1.09; 5.61, 5.14; 2.19, 1.60; 64.00, 62.58; 2.89, 3.59, 12.82 and 10.14%, respective to feeding systems TMR and cafeteria. There were not any statistically significant difference between cafeteria and TMR calves with respect to growth performance and blood parameters, except urea concentration, which was higher in cafeteria calves. In conclusion, cafeteria feeding increased welfare status of calf by decreasing idle standing behaviour and increasing body care without affecting growth performance significantly. Also, pre-ruminant calves in cafeteria feeding are able to make their own diet, more nitrogenous and less fibrous, as more appropriate to their digestive physiology.

Key words: Pre-ruminant, behaviour, body care, idle standing, welfare, dairy calves

INTRODUCTION

Adult ruminants can make a diet from offered ingredients (Forbes, 1995; Forbes and Provenza, 2000; Yurtseven and Gorgulu, 2004, 2007; Gorgulu *et al*., 2003, 2008). Pre-ruminants lambs and goat kids are usually kept with their mothers and consequently, have more chance to learn the organoleptic and metabolic properties of feedstuffs under supervision of their elder partners in a flock compared to those kept individually. However, pre-ruminant dairy calves kept in individual pens have been forced to consume a starter diet and to drink milk. Also, it has been not certain that one type of food is good or sufficient for calf's welfare during consuming food. Because of undeveloped rumen of calves, their diets should be nutritive and also be appropriate for rumen development. Choice feeding or cafeteria feeding would give a chance to calves in order to make their own diet so that their rumen could develop and they could feel themselves more comfortable. Weaned lambs (Gorgulu *et al*., 1996; Sahin *et al*., 2003; Keskin *et al*., 2004) and goat kids (Bateman *et al*., 2004) are successful to make their own diet from offered feed ingredients to match their nutritional requirements, above all, more than nutritional requirements. However, there has been a lack of study on cafeteria feeding in calves during preweaning and after weaning. Above all, there is a need to understand calves in order to feed them correctly without affecting their welfare, behaviour and health status. Also, behavioural consequences of cafeteria feeding on calves will be a cue for determining their welfare status.

New born calves make behavioural decisions where is safe or comfortable for them to result their maximal fitness with a successful dietary self selection to maintain their physiological and nutritional needs (Rose and Kyriazakis, 1991; Forbes, 1995; Nicol, 1997). In dairy farming, when calves kept in shelter, they are allowed to drink a certain amount of milk and concentrate feed with or without available hay in different qualities depending on facilities and supplies. In calf feeding, calf starter with good quality hay generally offered to calves beside a definite milk allowance depending upon the determined birth weight without considering their welfare or nutritional preferences. It would be relevant to investigate whether cafeteria feeding affect the calves behaviour so that an efficient nutritional management can be developed for optimum production by giving them more liberty. Liberty in food choices may increase welfare activities in animals such as body care, eating, ruminating and playing. Evidently, Keskin *et al*. (2004) saw this in cafeteria fed lambs partially.

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Therefore, the present study was conducted to answer the questions, how calves change their daily activities in response to cafeteria feeding compared to single feeding? and are pre-ruminant and inexperienced calves (in dietary choice) able to make their own diet from offered choices?

MATERIALS AND METHODS

This study was conducted at Research and Training Farm of Cukurova University in Adana Province of Turkey. Adana is located between 36°N latitude and 36°E longitude in the Eastern Mediterranean region. Twenty Holstein Friesian male calves were kept with their mothers during 7 days colostrum and transition milk feeding. In practice (in dairy farms), 3 or 4 days colostrum feeding are sufficient for calves to be with their mothers. We allowed calves drink transition milk as well. Then, these calves were separated from their mothers and allocated into 2 experimental groups cafeteria (n = 10) and Total Mixed Ration (TMR, n = 10) to be kept in individual pens sized 2.25 m^2 located in a semi-open barn. These pens were made from metal materials. When allocating calves into experimental groups, initial body weights were equally distributed into experimental groups to eliminate the effects of initial body weights on determined parameters. The experiment lasted 56 days after 7 days colostrum and transition milk feeding. Natural day light, 24-31°C ambient temperature and humidity (27.11-28.92%) were available during the experimental procedure. Ambient temperature and humidity were monitored inside barn kept 1.75 m high from the floor by using a data logger (Hobo 8 Family, Onset Computer Corporation's Boxcar, USA). All experimental pens were cleaned with water and furnished with new bedding material daily to serve calves hygienic housing conditions during experimental period. Conventionally, each experimental calf was offered daily whole milk with a plastic bucket 2 L in the mornings and 2 L in the evenings during the experimental period. The main chemical contents of milk offered to calves were fat 3.71%, total protein 3.58%, casein 2.72% and lactose 4.19%.

Control or single fed calves was offered TMR including 20% alfalfa hay having 1.5-2 cm size while, cafeteria calves were, simultaneously, offered barley, corn, corn gluten meal, soybean meal, wheat bran, all of them, except alfalfa hay, included the representative mineral and vitamin supplementation as TMR had. The feed ingredients of TMR were corn, barley, wheat bran, soybean meal, corn gluten meal and alfalfa hay. They included, respectively, 88.5, 98.7, 149.2, 379.2, 549.2 and 116 g crude protein per kg. These ingredients were offered cafeteria calves to allow them make their own diets. The nutrient content of TMR is given in Table 1.

Table 1: Comparison of feed ingredients and nutrient contents in single and cafeteria feeding

Feed ingredients	Single diet (TMR)	Calf-made diet	p-values ¥
Corn	12.00	8.50±1.56	0.05
Barley	42.56	9.97±2.68	0.00
Wheat bran	6.96	8.91±2.52	0.46
Soybean meal	5.92	69.28±5.45	0.00
Corn gluten meal	9.60	1.79±0.37	0.00
Alfalfa hay	20.00	1.55±0.36	0.00
Premix	2.96*	**	
Nutrient contents			
ME, Mcal kg^{-1}	2.61	2.76±0.02	0.00
CP (%)	17.25	30.50±1.50	0.00
RUDP (CP (%))	36.98	24.72±0.35	0.00
ADF (%)	14.19	10.33±0.23	0.00
NDF (%)	25.49	24.09±0.57	0.04
Crude ash (%)	8.18	6.51±0.14	0.00
Crude oil (%)	0.74	1.29±0.05	0.00

¥ diets selected by calves were compared with one sample t-test; *This amount of premix included 1.9 kg limestone, 1.0 kg dicalcium phosphate, 0.5 kg salt and 0.1 kg vitamin and mineral mixture; Each kg vitamin and mineral mixture provided 8.000.000 IU vitamin A, 1.000.000 IU vitamin D_3, 30 g vitamin E, 50 g Mn, 50 g Zn, 50 g Fe, 10 g Cu, 150 mg Co, 800 mg I and 150 mg Se, **: Barley, corn, corn gluten meal, soybean meal, wheat bran were suplemented with mineral and vitamin mixture (2.96%) in cafeteria feeding

Table 2: The description of behaviour elements observed during experimental period

Behaviours	Description of behaviour
Eating	Eating TMR or feed ingredients in cafeteria feeding
Ruminating	Ruminating behaviour either in standing or in lying The primarily activity was ruminating. Either standing or lying behaviour was not considered
Drinking	Drinking from water buckets
Idle standing	Standing without any movement or behaviour, only standing
Playing	Different body movements, sounding, jumping and buck kicking
Licking objects	Touching equipments and floor
Body care	Self grooming
Resting	Act of lying without ruminating activity
Others	Act of defecation and urination, etc.

Feed intakes and body gain were recorded to calculate feed conversion ratio. Fresh water (26.02-28.24°C) was available freely during the day. Drinking water temperature was measured by using infrared thermometer.

Our experimental procedures did not compromise calf welfare or any other ethical concerns.

Experimental calves were observed for determining the effect of feeding system on daily activities. Behavioural observations were recorded three times in a day and these observations were made once a week for a period of 1 h starting at 0800, 1300 and 1600 h in 5 min intervals. Each calf was monitored to determine and record behavioural activity. The recorded activities were eating, ruminating, drinking, resting, idle standing, playing, body care, licking objects and others. The descriptions of behavioural elements are given in Table 2. The method of behavioural observation was based on the methods of time sampling and point sampling

Table 3: The behaviour responses of dairy calves to cafeteria feeding and single feeding

Treatment groups/behaviours	Eating	Ruminating	Drinking	Licking objects	Playing	Resting	Body care	Idle standing	Others
Cafeteria feeding	6.520	8.890	1.090	5.140	1.600	62.580	3.590	10.140	0.370
Single feeding (TMR)	5.330	5.560	1.360	5.610	2.190	64.000	2.890	12.820	0.230
Chi-square (χ^2)	2.524	23.007	1.779	2.163	4.959	7.765	1.600	18.677	1.087
Asymp. sig	0.112	0.000	0.182	0.141	0.026	0.005	0.206	0.000	0.297

Table 4: Behavioural activities of dairy calves in day times

Treatment /behaviours	Time	Eating	Ruminating	Drinking	Licking objects	Playing	Resting	Body care	Idle standing	Others
Cafeteria feeding	08:00-09:00	7.020	9.260	0.300	6.200	1.490	61.910	3.960	9.330	0.520
	13:00-14:00	5.160	6.670	2.140	5.380	1.450	63.760	2.480	12.480	0.340
	16:00-17:00	7.290	10.580	0.960	3.770	1.840	62.180	4.250	8.810	0.240
	Chi-square (χ^2)	4.821	4.299	3.444	0.652	4.207	2.216	0.539	13.694	2.000
	Asymp.sig	0.090	0.117	0.179	0.722	0.122	0.330	0.764	0.001	0.368
Single feeding (TMR)	08:00-09:00	4.100	5.270	0.950	5.640	1.460	64.540	2.710	15.240	0.070
	13:00-14:00	6.230	4.770	1.850	6.000	2.540	63.080	2.770	12.310	0.310
	16:00-17:00	5.710	6.630	1.290	5.180	2.590	64.360	3.200	10.810	0.300
	Chi-square (χ^2)	8.122	15.257	16.439	10.114	0.900	4.508	8.533	5.150	1.857
	Asymp. sig	0.017	0.000	0.000	0.006	0.638	0.105	0.014	0.076	0.395

Table 5: Eating incidence of offered feedstuffs in cafeteria calves

Time/ feedstuffs	Barley	Wheat bran	Corn	Soybean meal	Corn gluten meal	Alfalfa hay	Total eating incidences
08:00-09:00	9	4	1	36	0	5	55
13:00-14:00	7	5	4	50	2	11	79
16:00-17:00	8	7	5	50	4	0	74
Chi-square (χ^2)	0.286	0.875	2.600	2.882	0.667	2.250	-
Asymp. sig.	0.867	0.646	0.273	0.237	0.414	0.134	-

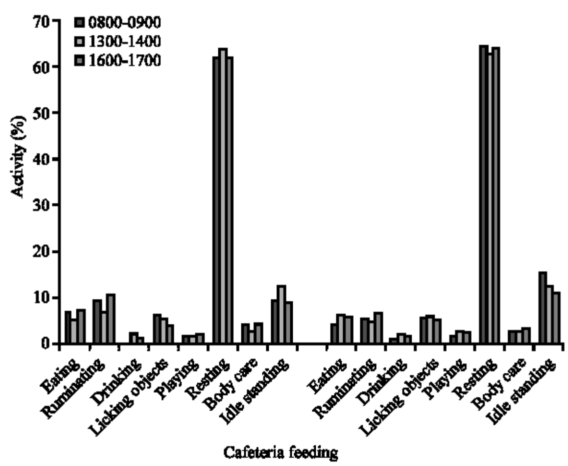

Fig. 1: Some behavioural activities of dairy calves in day times

(Fraser and Broom, 1990) with some modifications. Point was a calf in individual pen while scan was the first seen activity by observer. When the observer scanned the individual calf, the first seen activity was marked on the data collection form for specific time intervals.

Dry matter, crude protein, ash and ether extract of foods were analysed. ADF and NDF analysis were based on the method of Van Soest *et al.* (1991). Blood parameters were determined by using KEYLAB (Discrete Random Access Analyser) auto analyser. Blood samples were taken from calves once at the end of experiment by a veterinarian working at Research and Training Farm of Cukurova University.

The effect of feeding methods (TMR, cafeteria) was compared in this experiment. The data concerning growth performance were analysed using one way ANOVA. Difference between the diets selected by calves and TMR was separated by one sample t-test (Windows version of SPSS, release 10.01). In the same software, behavioural data were analysed by Chi-square (χ^2) based on frequency for 13 observation times (1st, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55 and 60th min) for 1 h observation. The proportional counts of behaviours were presented in Table 3-5 and Fig. 1.

RESULTS AND DISCUSSION

Table 1 shows that the comparison of feedstuffs and nutrient contents in man-made diet, which was single diet or TMR and calf-made diet, which was a result of diet selection by calves in cafeteria feeding. Cafeteria calves made a diet more nitrogenous but less fibrous than single fed calves (30.5 vs. 17.3% crude protein) by selecting the higher amount of soybean meal but the lower amounts of barley and alfalfa.

Table 3-7 show the experimental results regarding growth performance, behaviour and blood parameters. Also, Fig. 1 shows the time dependent behavioural

Table 6: Growth performance of calves in single and cafeteria feeding system during the period of 7-63 days

Feeding system /parameters	Single feeding (TMR)	Cafeteria feeding	SED	p-values
Live weight at 7 days	41.30	41.00	0.73	0.805
Live weight at 63 days	66.90	68.70	1.65	0.614
Total feed intake (kg calf^{-1})	32.00	40.80	2.56	0.087
Total body gain (kg calf^{-1})	25.60	27.70	1.29	0.430
Feed conversion ratio (kg feed: kg gain)	1.30	1.48	0.09	0.336

Table 7: Some blood parameters of calves in single and cafeteria feeding system (mg dL^{-1})

Treatment/ blood parameters	Urea (BUN)	Glucose	Cholesterol	Triglyceride
Single feeding (TMR)	33.1± 8.22	74.1± 3.63	70.3±10.39	29.2±6.37
Cafeteria feeding	73.3±7.31	66.1±3.14	58.0±9.00	27.2±5.21
p-values	0.01	0.15	0.41	0.75

responses of calves to feeding systems. According to Table 6, calves were not affected by feeding system with respect to growth performance (total body gain and feed conversion ratio) even though there was a tendency to increase feed intake in cafeteria fed calves.

Cafeteria calves tended to show more eating behaviour and less idle standing, licking objects and drinking behaviour. Cafeteria calves reduced significantly playing and resting behaviour ($p<0.01$, Table 4). Cafeteria calves tended to show more eating behaviour and this increased ruminating behaviour. Also, cafeteria calves tended to increase self grooming (body care) and decreased idle standing behaviour in comparison to TMR calves (Table 3).

According to Table 4, single fed calves showed a higher activity of eating and drinking at noon ($p<0.05$), ruminating and body care at afternoon ($p<0.01$) while cafeteria fed calves showed a higher activity of eating and ruminating at afternoon, drinking at noon and body care at afternoon without any statistical significance. Idle standing behaviour of calves was affected by day times. At noon time, cafeteria calves showed more idle standing behaviour than mornings and afternoons ($p<0.01$).

According to eating incidence of offered feedstuffs in cafeteria calves, the preference for soybean meal was predominant between the other feedstuffs (Table 5). Cafeteria calves preferred soybean meal against corn gluten meal and barley against corn irrespective to times in a day. No calf ate corn gluten meal in the mornings and alfalfa hay in the afternoons.

Blood analysis showed that blood urea concentration of cafeteria fed calves was higher than single fed calves (Table 7).

Feeding system did not affect growth performance even though cafeteria feeding tended to increase feed intake. This reflected to poorer feed efficiency in cafeteria fed calves but this was not statistically significant. This might be attributed to a 13% more locomotor activity in cafeteria calves than TMR ones. The higher concentration of blood urea might be attributed to the higher amount of soybean meal intake. Also, this protein source might have been used, partially, for compensating energy requirements, firstly because of lower intake rate of barley and secondly, lower intake rate of fibrous feedstuff, alfalfa hay and barley. Cafeteria calves had been still pre-ruminant and perhaps, did not need volatile fatty acids as much as what they are going to require when becoming fully ruminant animal. Higher blood urea concentration would be evidence for this assumption. However, cafeteria calves did not increase drinking behaviour. If there had been metabolic disconfort due to high nitrogen diet, cafeteria calves would have shown more drinking behaviour than TMR animals for metabolic clearance of urea (Cooper *et al*., 1991). Lastly, heat production by metabolism of higher dietary protein ingestion may result poorer feed efficiency in cafeteria calves.

Cafeteria calves tended to show more eating behaviour and less idle standing, licking objects and drinking behaviours. Cafeteria calves reduced significantly playing and resting behaviour. This was absolutely different than what observed in cafeteria lambs by Keskin *et al*. (2004). This might be a result of species difference and space allowance per calf in the current study.

On dry matter basis, milk offered to calves included about 25.2% crude protein. Similarly, cafeteria calves made a diet (30.5% crude protein), which was closer to dry milk protein content rather than that (17.2% crude protein) of single diet. This shows that inexperienced pre-ruminant calves were able to make their own diet by selecting predominantly soybean meal which has been known a rapid digestible protein source for protein requirement of pre-ruminant calves. Pre-ruminant animals might have possessed a sufficient dietary experience passing from their mother. Simitzis *et al*. (2008) proved this in their study that prenatal exposure to oregano essential oil via maternal ingestion drastically influenced lamb feeding preferences till adulthood. Furthermore, the present finding regarding the ability of protein selection closer to milk protein content may encourage us to investigate the optimal protein content of calf starter for different calf management systems.

Cafeteria calves tended to show more eating behaviour and this increased ruminating behaviour, more likely, because of total 8 kg higher feed intake in these calves compared to single fed calves. In addition to this, cafeteria calves tended to increase self grooming (body care). This was also expected that present cafeteria calves under *ad libitum* feeding condition felt themselves more comfortable and spent their spare time for body care apart from eating and ruminating. The decrease in idle standing behaviour in comparison to TMR calves may be explained the enhanced welfare status of cafeteria calves by offering more food choices.

Single fed calves showed a higher activity of eating and drinking at noon, ruminating and body care at afternoon while cafeteria fed calves showed a higher activity of eating and ruminating at afternoon without any statistical significance. In summer season, higher activity of drinking can be explained at noon. Also, eating activity was required to drink water since water intake depends on mainly dry matter intake.

The preference for soybean meal by cafeteria calves was predominant among feedstuffs. Higher Blood Urea Nitrogen (BUN) concentration in cafeteria calves may be explained by this preference. Lynch and Bond (1983) found blood urea nitrogen about 33-74 mg dL^{-1} in calves. The determined BUN values (33-74 mg dL^{-1}) in the present study were not higher than normal ranges. For this reason, it may be invalid to mention the metabolic clearance for blood urea, supported with insignificant drinking behaviour between treatment groups. Also, the tendency of lower blood glucose and cholesterol in cafeteria calves may be attributed to the higher locomotor activity (20.3 vs. 17.6%) in these calves compared to TMR calves.

The concept and content of the five freedoms have been guided by FAWC's (Farm Animal Welfare Council, London) philosophy of approach in farm animal studies. They provide widely accepted guidelines to all concerned with the keeping of livestock as to how they might fulfil their obligation to the animals they use at every stage of production. Because of the opportunities of voluntarily food intake and diet choice from offered feed ingredients by the present calves, cafeteria feeding will help the one of the 5 pillars of animal welfare, i.e., freedom from hunger and thirst by ready access to fresh water and a diet to maintain full health and vigour. At the same time, freedom of pain will be sustained by selecting feed ingredients from offered choice in order to balance pre-ruminal condition of calves. Also, their dietary choice will help ruminal development by producing different ratios of volatile fatty acids from selected feed ingredients during growth. The observed lower rate of idle standing and higher rate of body care in cafeteria calves compared to TMR calves might be a sign of the help of cafeteria feeding on animal welfare.

CONCLUSION

The present results showed that cafeteria feeding increased welfare status of calf without affecting growth performance significantly.

Also, pre-ruminant calves in cafeteria feeding are able to make their own diet, more nitrogenous and less fibrous, as more appropriate to their digestive physiology.

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