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THE EFFECT OF FEEDING REGIME WITHOUT ROUGHAGE DURING THE PRE-WEANING PERIOD ON PRE- AND POSTWEANING PERFORMANCE OF DAIRY CALVES

A. E. KELES[1], M. GORGULU[2] and S. GONCU[2#]
[1] *Ministry of Agriculture, Cukurova State Farm, 01921 Adana, Turkey*
[2] *Cukurova University, Agriculture Faculty, Animal Science Department, Adana, Turkey*

Abstract

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A total of 44 Holstein calves (3 days old and average body weight 30 kg; 22 male and 22 female) were used to investigate the effect of method of feeding of roughage during pre-weaning on performance of Holstein calves during the pre- and postweaning period. Calves within each gender were assigned to two treatment groups. The first group was fed calf starter and ground alfalfa hay (1–2 cm lengths) and the second treatment group was fed calf starter only during pre-weaning period. Calves were weaned after 8 week then all calves were fed a total mixed diet containing 60% alfalfa hay and 40% calf grower for another 8 weeks. Gender had significant effects on all parameters except pre-weaning and overall daily gain. Daily gains for both genders receiving calf starter only were not different after weaning, but the male calves had higher daily gain than the female calves when calf starter and alfalfa hay were offered. There were no gender differences in feed to gain ratios when alfalfa hay and calf starter, but male calves consumed more feed per kg gain during postweaning when calf starter was supplied only during preweaning period. The results indicated that the calves receiving calf starter only during pre-weaning period consumed more feed and gained more live weight after weaning and the overall study. Calves may be raised without roughage in pre-weaning period but it could be deteriorate feed efficiency and feed cost per unit of gain due to increase in feed intake.

Key words: postweaning growth, no roughage, rumen development, feed intake, calves

Introduction

The successful rearing of calves is often dependent on optimum rumen development which is affected by calf feeding systems (Greenwood et al., 1997; Beharka et al., 1998; Coverdale et al., 2004). A smooth transition from a monogastric to a ruminant animal, with minimal loss in growth, requires adequate size and development of the reticulo-rumen for efficient utilization of solid feeds (e.g., concentrate and roughage). Encouraging calves to eat enough solid feeds can have a positive effect on initiating rumen development (Jones and Heinrichs, 2007). Many studies (Greenwood et al., 1997; Beharka et al., 1998; Coverdale et al., 2004) showed that roughage is essential for normal rumen development. Roughage consumption supports development of the rumen epithelium and papillae, as well as rumen motility (Bull, 1965), increased rumen size and muscular development (Tamate et al., 1962), and promotes rumination (Haskins et al. 1969; Hodgson, 1971, Lyford and Huber, 1988). However, high roughage based diets may not provide enough volatile fatty acids and energy for normal development of rumen papillae and calf growth (Nocek and Kesler, 1980). Feeding concentrate mixtures may increase feed intake and volatile fatty acid production compared to roughage based diets. Volatile fatty acids are required for rapid development of rumen papillae (Stobo et al., 1966). However, high-concentrate diets may cause a rapid accumulation of short chain fatty acids (SCFA) and lactic acid, accompanied by a decrease in rumen pH (Beharka et al., 1998), rumen motility (Owens et al., 1998), and keratinisation of the rumen papillae (Bull et al., 1965), resulting in decreased SCFA absorption. High concentrate consumption during the preweaning period may cause poorly shaped papillae depending

Corresponding author: sgoncu@cu.edu.tr

on concentrate composition resulting from reduced pH and keratinisation problem (Bull et al., 1965; Beharka et al., 1998) as well. Extension specialists do not recommend roughage for calves until weaning if enough concentrate is supplied (Nocek and Kesler, 1980; Lizieire et al., 2002; Jones and Heinrichs, 2007). In the recent studies, Porter et al. (2007) and Goncu et al. (2010) did not find any differences in daily gain, feed intake and feed to gain ratio during the pre-weaning period between the calves fed only calf starter and hay along with calf starter and/or the calf starter mixed with 10% alfalfa hay. Previous studies have shown the benefit of including ground hay with calf starter formulations to promote rumen development and performance (Greenwood et al. 1997; Beharka et al., 1998; Coverdale et al., 2004), but other research (Harris and Sheare, 2003; Jones and Heinrichs, 2007) did not recommend to include hay during pre-weaning period. Inconsistent results and suggestions for roughage feeding to pre-ruminant calves may arise from the length of weaning period. Rearing calves without roughage may be generally advised in early weaning systems such as 4-5 weeks as shown by Leibholz (1975) , Porter et al. (2007) and Goncu et al. (2010) as roughage intake is limited (10-90 gd^{-1}, Goncu et al., 2010; Gorgulu et al., 2010) for the first 3-4 weeks during calf rearing. No roughage usage during pre-weaning is practiced some countries. The USDA (2007) survey showed that hay was typically offered during the first in 25 days on smaller operations but often not until 40 days age in larger operations in the USA. However, rearing calves without roughage needs to be approved under longer weaning practice than 30-35 days. This study was carried out to determine the effects of different feeding regimes during pre-weaning period, such as feeding only concentrate or concentrate with hay, on pre-weaning or post-weaning performances of calves weaned at 8 weeks

Materials and Methods

A total of 44 Holstein calves (3 days old and average body weight 30 ± 0.27 kg; 22 male and 22 female) were used and assigned to two treatment groups within gender. The first group received calf starter and chopped alfalfa hay *ad libitum* (1-2 cm); the second group received calf starter only *ad libitum* during the pre-weaning period. After weaning at 8 weeks, the calves were kept in the calf hutches for a further 8 weeks for the second stage of the experiment. During the post-weaning period (8-16 weeks), calves were fed a total mixed ration *ad libitum* containing 40% of calf grower and 60% of alfalfa hay grounded to 1–2 cm lengths (Table 1).

All calves were kept with their dams for the first 3 days after calving, followed by housing in calf hutches (106 cm wide x 118 cm long x 140 cm deep) each with an individual paddock (136 cm wide x 120 cm long x 90 cm deep). All hutches had soil floors which were straw-bedded. Calves were fed colostrums as soon as possible after birth during the 3-day period. During the next 53 days, all calves received 212 L whole milk, 2 L at 7:00 am and 2 L at 16:00 pm from a bucket. All equipment was rinsed and cleaned thoroughly after every feeding. After cleaning, water was provided in the same buckets that were used for milk feeding. Calves were weaned abruptly at the end of 8 weeks. All calves were weighed initially and biweekly with an electronic scale with a 500 kg ±0.001kg capacity, and feed consumption determined daily. The chemical composition of the calf starter, grower, and alfalfa hay are given in Table 1. The dry matter, crude protein, ash and ether-extract contents of the feeds were determined according to the standard AOAC procedures (1998).

Table 1
Ingredient and chemical composition of starter, grower and alfalfa hay

Ingredients	Calf starter, g/kg	Calf grower, g/kg	
Corn	202	100	
Wheat	190	165	
Wheat middlings	160	200	
DDGS	100	100	
Barley	100	100	
Soybean meal	85	--	
Fulfat soybean	70	--	
Canola meal	27	--	
Sunflower meal	20	146	
Wheat bran	--	141	
Beet Molases	20	20	
Limestone	19	19	
Salt	5	8	
Vit.-Min. Premix*	1	1	
Toxin binding	1	--	
Chemical composition, g/kg			Alfalfa hay
DM	918.6	923.3	911.2
CP	185.6	168.5	140.2
ADF	119	102.5	388
NDF	253.1	239.4	489
Crude ash	78.4	73.8	39.7

*Vit-Min premix per kg contained 15000000 IU Vitamin A., 3000000 IU Vitamin D3, 30000 mg Vitamin. E, 125000 mg niacin, 50000 mg Mn, 50000 mg Fe, 50000 mg Zn, 10000 mg Cu, 800 mg I, 150 mg Co, 150 mg Se, 180.000 mg P, and 50000 mg antioxidant.

The NDF and ADF were analyzed using the methods of Van-Soest et al. (1991) with an ANKOM fiber analyzer. Statistical analysis of data was according to 2 (feeding) x 2 (gender) factorial arrangements in a completely randomized design (SPSS, 1999). Means were separated with the aid of a Duncan Multiple Range Test (Bek and Efe, 1995).

Results and Discussion

The feeding regime did not affect ($P > 0.05$) feed intake, daily gain and feed-to-gain ratio during the pre-weaning period. Gender had significant effects on birth weight, weaning weight, feed intake and feed to gain ($P < 0.01$), but daily gain was not affected ($P > 0.05$) by gender during pre-weaning and overall period (Table 2). Similarly Guler et al. (2006) were not determined any differences between female and male calves in respect to body weight and weight gain at 4 and 6 months olds in the study used acidified milk replacer.

In the current study, male calves had higher birth weight, feed intake and feed to gain ratio than female calves in both periods. The feeding regime and gender interaction affected feed intake ($P < 0.01$) and feed-to-gain ratio ($P < 0.05$) in the pre-weaning period. Female calves did not change their feed intake according to feeding regime during preweaning period, but the male calves receiving calf starter only consumed less feed than those receiving calf starter and alfalfa hay. It appeared that the inclusion of hay in the starter diet stimulated intake in male calves. Similar changes were observed for feed to gain as well. The findings related to gender on birth weight are supported by previous research (Kocak et al., 2007; Bilgic and Alic, 2004; Sahani et al., 1998).

The feeding regime x gender interaction for feed intake and feed-to-gain ratio during the pre-weaning period may be related to the amount of milk and the diet selected by male calve fed hay along with starter. Similar daily gains in both genders during pre-weaning period resulted from proportionally higher amount of milk consumption by female calves. All calves received 4 L milk/day during the pre-weaning period and females consumed relatively high amounts of milk for a constant body weight as they had lower birth weight. Furthermore, high feed intake by male calves fed starter along with hay were seen to compensate for a decrease in energy content of their diet due to high preference to hay. Higher feed intake increased their feed to gain ratio. Lower feed intake and a proportionally higher amount of milk may improve the feed conversion efficiency (Loerch, 1990) as the female calve in the present study.

In the post-weaning and entire experimental periods, feed intake, daily gain, and the feed-to-gain ratio were affected by feeding regimes ($P < 0.01$). Feeding calves without roughage increased feed intake and the feed-to-gain ratio during these

Table 2
The growth performances of the groups at pre and postweaning period

Feeding regimes (FR)	Alfalfa hay +Calf starter		Calf starter			P<		
Gender (G)	Female	Male	Female	Male	SEM	FR	Gx	FRxG
Pre-weaning Period (0-8 weeks)								
Birth weight, kg	29.63^{b}	31.00^{a}	29.45^{b}	31.36^{a}	0.27	0.74	0	0.33
Daily gain, g d^{-1}	605.35	606.33	622.07	633.44	17.66	0.22	0.72	0.77
Feed intake, g d^{-1}	768.40^{c}	972.68^{a}	804.09^{c}	915.43^{b}	13.16	0.41	0	0
Feed to gain*	1.27^{c}	1.61^{a}	1.30^{c}	1.46^{b}	0.04	0.22	0	0.05
Alfalfa ratio, g/kg	218.3	229.2	-	-	-	-	-	-
Weaning weight, kg	63.53^{b}	64.95^{ab}	64.29^{b}	66.83^{a}	0.83	0.12	0.02	0.5
Post-weaning (9-16 weeks)								
Daily gain, g d^{-1}	897.40^{b}	937.82^{a}	940.42^{a}	937.50^{a}	3.68	0	0	0
Feed intake, g d^{-1}	2369.97^{d}	2540.00^{c}	2908.50^{b}	3085.47^{a}	38.61	0	0	0.88
Feed to gain*	2.64^{c}	2.71^{c}	3.09^{b}	3.29^{a}	0.05	0	0	0.05
Overall (0-16 weeks)								
Daily gain, g d^{-1}	751.38^{b}	772.07^{ab}	781.25^{a}	785.47^{a}	7.94	0.01	0.12	0.3
Feed intake, g d^{-1}	1569.19^{d}	1756.34^{c}	1856.29^{b}	2000.45^{a}	14.03	0	0	0.13
Feed to gain*	2.09^{d}	2.27^{c}	2.37^{b}	2.54^{a}	0.01	0	0	0.62
Final weight, kg	113.79^{c}	117.47^{ab}	116.95^{b}	119.33^{a}	0.74	0	0	0.38

^{abcd} means in the same row with different superscripts differ (P < 0.05).
* solids from milk is not included feed to gain.

periods. Daily gain in the post-weaning period and the entire experimental period were increased by feeding starter only ($P < 0.01$). Similarly, all parameters except overall daily gain were affected by gender. Post weaning daily gain was similar for both genders. However some researchers reported no differences between genders after weaning (Guler et al., 2006; Sahani et al., 1998). Others reported higher daily gain for male compared to female calves (Coulibaly and Nialibouly, 1998).

There was no growth slump after weaning that affected postweaning performance of calves in the present study due to abrupt weaning. Severe growth slump after weaning is the case especially with high milk allowance (6-12 L d^{-1}: Huuskonen and Khalili, 2008) and weaning at 35-42 days (Khan et al., 2008; DePasille et al, 2011). In the present study calves were fed 4 L milk d^{-1} until 8 week. This amount of milk especially latter phase of milk feeding is not met calf requirement and may encourage calf to consume dry feed and those calves may not suffer marked growth slump when they weaned. High feed intake of calves at weaning week (1685 g/d^{-1}, not presented in the study) may be accepted as indicator of highly adapted calves to present feeding practice. Furthermore calf has ability to adapt rapidly to severe changes in its diets (Stobo et al., 1966; Boga et al., 2009).

After weaning and overall higher feed intake of the calves fed starter only compared to the calves fed starter along with hay could be attributed to better ruminal growth. The calves fed starter only consumed about 22% and 16% more feed during the post-weaning period and the entire experimental period, respectively. High concentrate intake may promote the growth of rumen tissues (Stobo et al., 1966) by increasing the number and size of ruminal papillae, the absorption of SCFA from the rumen and plasma Insulin-like growth factor-1(IGF-1) level (Shen et al., 2004; Zitnan et al., 2005). IGF-1 is a growth promoter in many cell types (Shen et al., 2004) including rumen epithelial cell (Zitnan et al., 2005). The calves fed starter only, therefore, gained better live weight after weaning and overall experimental period as a reflection of their high feed intake due to better ruminal growth. Roth et al. (2008) reported that concentrate-intake-dependent weaning (decreased milk allowance after the calves consumed 700 gd^{-1} and stopped 2000 gd^{-1} concentrate) improved daily gain and calves' welfare compared conventional system.

When postweaning daily gain and feed to gain were evaluated, female calves responded better to the no roughage diet. They consumed more feed and gained more live weight than female calves fed hay along with starter. However, male calves did not gain live weight concomitant with their feed intake when they were fed with starter only. The female calves receiving alfalfa hay along with starter could not consume enough feed after weaning. This could be related to their light body weight and the lowest feed intake both pre-weaning and postweaning period as discussed previously. The results may reveal that roughage may cause reduction in ruminal growth of female calves having lighter body weight than males when roughage was fed with starter during pre-weaning period. The feeding regime x gender interaction for daily gain and feed to gain ratio disappeared by the end of the study.

This study revealed that calves fed with starter only during preweaning had higher feed intake, daily gain and feed to gain ratio during postweaning and overall experimental periods. The high feed intake of those calve is probably related to better growth of their rumen tissues (Smith et al, 2002) as discussed before. It is obvious that high feed intake may result in high daily gain due to high nutrient intake (Stobo et al., 1966).

Conclusions

The basic sign of rumen development is sufficient solid feed intake of young animals during the pre and postweaning periods. The higher feed intakes and daily gain in postweaning and entire experimental period were observed when the calves fed concentrate only during the preweaning period.

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