Pakistan J. Zool., vol. 49(4), pp 1429-1435, 2017. **DOI**: http://dx.doi.org/10.17582/journal.pjz/2017.49.4.1429.1435

Effects of Different Ration Forms on Growth Performance and some Behavioral Traits of Brown Swiss Calves

Mehmet Avci[1], Recep Aydin[1,*] and Jale Metin Kiyici[2]

[1]*Department of Zootechnics, Faculty of Agriculture, Ataturk University, Erzurum, Turkey*

[2]*Department of Zootechnics, Faculty of Agriculture, Erciyes University, Kayseri, Turkey*

ABSTRACT

The present study was conducted to investigate the effects of different ration forms on growth, feed conversion and behavioral characteristics of Brown Swiss calves. The calves in treatment group were supplied with mixed ration of chopped roughage (5-7 cm) and concentrate calf starter feed and the calves in control group were supplied with natural roughage and concentrate feed separately. The calves were supplied with milk at about 8% of their birth weights and weaned at 49th day. Mixed chopped and separate natural supply of roughage and concentrate feed did not created any significant differences in live weights, daily weight gains, feed conversion ratios and behavioral characteristics of the calves.

Article Information
Received 11 October 2016
Revised 26 Janary 2017
Accepted 24 March 2017
Available online 24 July 2017

Authors' Contribution
MA executed the experimental work and collected the data. RA and JMK designed research, analyzed the data and wrote the article.

Key words
Brown Swiss, Form of roughage, Live weight, Feed efficiency ratio, Behaviors of calves.

INTRODUCTION

Providing calves with sufficient milk not only provides high growth rates but also retards the development of rumen activities. There is a positive correlation between solid (concentrate or roughage) feed consumption and reticulorumen development. Therefore, parallel to growth rates, a feeding program including roughage and concentrate feed should also be applied to calves beside milk supply to provide early rumen development (Cozzi *et al*., 2002).

When the concentrate feed and roughage are supplied separately, animals will prefer and thus consume more concentrate feed because of the taste. Such a case will result in higher weight gains. On the other hand, reduced roughage consumption will result in fat accumulation in animal body and will reduce feed conversion ratios (Basaran and Gurbuz, 2000).

Since roughage and concentrate feeds are not able to be ground or chopped together and supplied as a single feed because of small size and insufficient capital sources of the facilities, there are quite high feed losses through feed selection and spread (Ozen *et al*., 2005).

The roughage pieces should be 5-7 cm long, thus considering the required piece sizes of roughage; regular thresher hay should not be preferred. If this is not possible, at least 5% of dry matter of total mixed ration should be composed of roughage chopped in 5 cm pieces. Instead of fine chopped hay, the straws chopped at certain sizes should be preferred for better rumination (Guven, 2007).

Previous researchers investigated the effects of roughage forms and concentrate feed supply on growth performance of calves. In those studies, roughages were chopped at various sizes (Turgut *et al*., 1997; Plaza *et al*., 2011; Keles *et al*., 2011) and supplied separately or together with pelletized or natural concentrate feeds (Stobo *et al*., 1985) and researchers investigated the effects on pre and post-weaning growth and feed conversion ratios (Greenwood *et al*., 1997; Coverdale *et al*., 2004; Kocak and Gunes, 2005) and behavioral characteristics (Tripon *et al*., 2008; Miller-Cushon and Devries, 2011; Castells *et al*., 2012).

The present study was conducted to investigate the effects of separate and mixed supply of chopped roughage and concentrate feed on growth, development, feed conversion and behavioral characteristics of the calves.

MATERIALS AND METHODS

This study was carried out in the Research Farm of the Agricultural College at Ataturk University, Erzurum in 2014. A total of 33 Brown Swiss calves were included in the research. Of these calves, 17 (10 male and 7 female) were placed in treatment group (concentrate feed + chopped roughage) and 16 (9 male and 7 female) were placed in control group.

* Corresponding author: raydin@atauni.edu.tr
0030-9923/2017/0004-1429 $ 9.00/0

The roughage provided to calves in treatment group was chopped in 5-7 cm pieces with hay chopper. The ration for treatment group was prepared as 20% chopped dry meadow grass + 80% concentrate calf starter feed I between the birth and 3-months of age; 30% chopped dry meadow grass + 70% concentrate calf starter feed II between 3 -6 months of age. Natural dry meadow grass and concentrate feed were provided separately to the calves in control group. Concentrate calf starter feed II was limited with 3 kg in both groups. Both concentrate feed and roughage were supplied in a weighted fashion and remaining feeds were also weighted and recorded in next day. Since concentrate feed and roughage consumptions were not able to be calculated separately in treatment group with mixed supply of roughage and concentrate feed, roughage + concentrate feed total consumptions were used in both groups for comparisons.

Nutritional composition of milk, roughage and concentrate feeds used in this study are provided in Table I.

Table I.- Nutritional composition of the feeds used in this study.

Nutrients	Milk	Calf starter feed I	Calf starter feed II	Dry meadow grass
Dry matter (%)	12.00	88.00	88.00	88.00
Crude protein (%)	3.80	18.00	17.00	7.10
Crude oil (%)	4.10	4.80	4.50	3.80
Crude ash (%)	0.70	8.00	10.00	8.40
Crude cellulose (%)	-	12.00	12.00	28.40

Calves were supplied with milk at about 8% of their birth weights and weaned at 49th day. Birth and weaning weights and the weights at 3 and 6-months of age were determined through weighing the calves with an animal scale. The behavioral parameters were specified as: 1, Lying (calf body is in contact with the environment or bedding); 2, Standing (standing up in a passive position); 3, Feeding (calf head is in feed bucket); 4, Drinking (calf head is in water bucket). Behavioral parameters were recorded once in a week between the hours 09:00-12:00 during the initial 15 min of each hour through walking along the barns and staying at least 2.1 m away from the partitions (Hunter and Houpt, 1989; Chua *et al*., 2002). Instantaneous sampling method was used to determine behavioral parameters and the codes assigned to each behavior were counted and calculated proportionally (Martin and Bateson, 1993).

Experimental data was subjected to statistical analyses by using univariate of general linear model (GLM) procedure in SPSS statistical software SPSS (2004).

The mathematical model used in analyses was as follows:

$$Y_{ijk} = \mu + a_i + b_j + (ab)_{ij} + e_{ijk}$$

Where, Y_{ijk} is observation value, μ is population average, a_i is effect of treatment group (control, treatment), b_j is effect of gender (female, male), $(ab)_{ij}$ is treatment group X gender interaction and e_{ijk} is random error with a mean of "0" and variance of $\sigma^2 e$.

RESULTS

Live weights and daily weight gains

Live weights and daily weight gains are provided in Tables II and III. Combined supply of chopped roughage and concentrate feed (treatment group) and separate natural supply (control group) did not have significant effects on live weights at weaning, 3 and 6-months of age and daily weight gains between birth - weaning, between weaning - 3 months of age, between 3 - 6 months of age and between birth - 6 months of age Live weights and daily weight gains in control group were not significantly higher than the treatment group (Tables II, III).

Gender significantly affected daily weight gains between birth - 6 months of age and group x gender interaction significantly affected both live weights at 6 months of age and daily weight gains between birth – 6 months of age ($P<0.05$) (Table III). With regard to group x gender interaction, while the male and female calves in treatment group had similar weights at 6 months of age, the male calves gained 18.73 kg more weights than the female calves in control group The male calves of control group had also 14.00 kg more weights than the male calves of treatment group ($P<0.05$) (Table II).

Feed consumptions

The amount of feed consumed for 1 kg weight gain was provided in Table IV. Calves in treatment and control groups consumed 139.14±4.29 kg milk per calf until weaning.

The differences in feed consumptions of the groups for 1 kg weight gain in periods between birth – weaning, between 3-6 months of age and between birth – 6 months of age were not found to be significant (Table IV). However in weaning – 3 months of age period, treatment group had 26.7% less feed conversion rate than the control group and the difference was found to be significant ($P<0.05$). Treatments did not have significant effects on feed conversion ratio of genders in all periods (Table IV).

Table II.- Live weights of calves.

	n	Live weights (kg)			
		Birth Weight	**Weaning Weight**	**Weight at 3- months of age**	**Weight at 6-months of age**
		$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$
General mean	33	37.71±1.18	51.65±1.33	72.98±1.82	144.86±2.25
Group		ns	ns	ns	ns
Treatment	17	37.88±1.68 ns	50.64±1.89 ns	72.85±2.58 ns	142.64±3.20 ns
Control	16	37.55±1.66	52.66±1.88	73.11±2.56	147.08±3.18
Gender		ns	**ns**	**ns**	
Female	14	36.55±1.84 ns	49.71±2.07 ns	70.17±2.83 ns	140.27±3.51 ns
Male	19	38.88±1.48	53.58±1.67	75.79±2.29	149.45±2.83
Group x gender interaction		ns	ns	ns	*
Treatment x female	7	37.67±2.70	50.00±3.04	73.33±4.15	142.83±5.15
Control x female	7	35.43±2.50	49.43±2.81	67.00±3.84	137.71±4.76
Treatment x male	10	38.09±1.99	51.27±2.24	72.36±3.07	142.45±3.8
Control x male	9	39.67±2.20	55.89±2.48	79.22±3.39	156.44±4.2

*, P<0.05 (significant); ns, not significant (P>0.05); $\bar{X} \pm S\bar{x}$, least squares mean ± standard error.

Table III.- Daily weight gains of calves.

	n	Daily weight gains (kg)			
		Birth – Weaning	**Weaning – 3 months of age**	**3-6 months of age**	**Birth – 6 Months of age**
		$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$
General mean	33	0.28±0.02	0.52±0.03	0.80±0.01	0.60±0.01
Group		ns	ns	ns	ns
Treatment	17	0.26±0.02	0.54±0.04	0.78±0.02	0.59±0.01
Control	16	0.31±0.02	0.50±0.04	0.82±0.02	0.60±0.01
Gender		ns	ns	ns	*
Female	14	0.27±0.02	0.50±0.04	0.78±0.02	0.58±0.01
Male	19	0.30±0.02	0.54±0.04	0.82±0.02	0.61±0.01
Group x gender interaction		ns	ns	ns	*
Treatment x female	7	0.25±0.03	0.57±0.06	0.77±0.03	0.59±0.02
Control x female	7	0.29±0.03	0.42±0.06	0.79±0.03	0.57±0.02
Treatment x male	10	0.27±0.03	0.51±0.05	0.78±0.02	0.58±0.02
Control x male	9	0.33±0.03	0.57±0.05	0.86±0.02	0.65±0.02

*P<0.05; ns, not significant (P>0.05); $\bar{X} \pm S\bar{x}$, least squares mean ± standard error.

Table IV.- Amount of feed consumed by calves for 1 kg weight gain (kg).

	n	**Pre weaning**	**Weaning – 3 months of age**	**3–6 months of age**	**Birth – 6 months of age**
		$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$
General mean	33	2.46±0.21	3.53±0.20	4.08±0.10	3.62±0.08
Group		ns	*	ns	ns
Treatment	17	2.71±0.29	3.11±0.28	4.24±0.14	3.55±0.11
Control	16	2.21±0.29	3.94±0.28	3.91±0.14	3.69±0.11
Gender		ns	ns	ns	ns
Female	14	2.62±0.32	3.80±0.30	3.96±0.15	3.62±0.12
Male	19	2.30±0.26	3.25±0.25	4.19±0.12	3.62±0.10
Group x gender interaction		ns	ns	ns	ns
Treatment x female	7	2.97±0.47	3.05±0.45	4.25±0.23	3.53±0.18
Control x female	7	2.26±0.44	4.56±0.41	3.66±0.21	3.71±0.16
Treatment x male	10	2.44±0.35	3.17±0.33	4.23±0.17	3.56±0.13
Control x male	9	2.16±0.39	3.32±0.36	4.15±0.18	3.67±0.14

*P<0.05; ns, not significant (P>0.05); $\bar{X} \pm S\bar{x}$, least squares mean ± standard error.

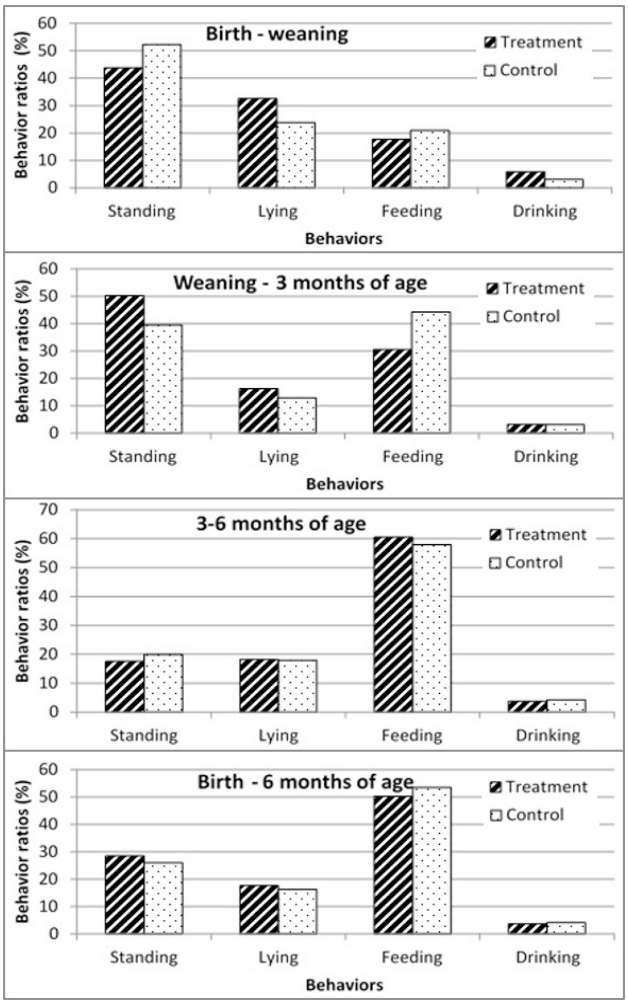

Fig. 1. Variations in behavioral characteristics of the calves

Behavioral characteristics

The behavioral characteristics (%) for the periods between birth – weaning and between weaning – 3 months of age are provided in Tables V and VI and the behavioral characteristics for the period between 3-6 months of age and between birth – 6 months of age are provided in Tables VII and VIII. The variations in behavioral characteristics of genders are presented in Fig. 1.

Lying and drinking behaviors were significantly effected in treatment and control groups between birth – weaning (P<0.05). The calves in treatment group exhibited 8.8% more frequent lying and 2.8% more drinking behavior than the calves in control group (Table V).

Between weaning and 3-months of age, the calves in treatment group presented 10.7% more standing behavior than the calves in control group and the calves in control group exhibited 13.8% more feeding behavior than the calves in treatment group. Treatments had significant effects only on feeding behavior of this period (P<0.05) (Table VI).

Table V.- Behavioral characteristics of calves between birth-weaning.

	n	Between birth – weaning (%)			
		Standing	Lying	Feeding	Drinking
		$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$
General mean	33	48.1±2.2	28.2±1.9	19.3±2.2	4.4±0.5
Group		ns	*	ns	*
Treatment	17	43.8±3.2	32.6±2.6	17.7±3.1	5.8±0.7
Control	16	52.3±3.2	23.8±2.6	20.9±3.0	3.0±0.7
Gender		ns	ns	ns	ns
Female	14	50.7±3.5	29.8±2.9	15.0±3.4	4.5±0.7
Male	19	45.4±2.8	26.6±2.3	23.6±2.7	4.3±0.6
Group x gender interaction		ns	ns	ns	ns
Treatment x female	7	45.8±5.1	32.2±4.2	15.6±4.9	6.4±1.1
Control x female	7	55.6±4.7	27.3±3.9	14.4±4.6	2.6±1.0
Treatment x male	10	41.8±3.8	33.1±3.1	19.8±3.6	5.2±0.8
Control x male	9	49.0±4.2	20.2±3.5	27.4±4.0	3.4±0.9

*P<0.05; ns, not significant (P>0.05); $\bar{X} \pm S\bar{x}$, least squares mean ± standard error.

Table VI.- Behavioral characteristics of calves between weaning-3 months of age.

	n	Between weaning – 3 months of age (%)			
		Standing	Lying	Feeding	Drinking
		$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$
General mean	33	44.9±2.8	14.6±1.1	37.4±2.5	3.2±0.3
Group		ns	ns	*	ns
Treatment	17	50.2±3.9	16.2±1.6	30.5±3.5	3.1±0.5
Control	16	39.5±3.9	12.9±1.6	44.3±3.5	3.2±0.5
Gender		ns	ns	ns	ns
Female	14	42.5±4.3	14.1±1.7	40.5±3.9	2.9±0.5
Male	19	47.3±3.5	15.0±1.4	34.3±3.1	3.5±0.4
Group x gender interaction		ns	ns	ns	ns
Treatment x female	7	50.1±6.4	13.6±2.5	33.1±5.7	3.2±0.7
Control x female	7	34.8±5.9	14.6±2.3	48.0±5.3	2.6±0.7
Treatment x male	10	50.3±4.7	18.8±1.9	27.8±4.2	3.1±0.5
Control x male	9	44.2±5.2	11.1±2.1	40.7±4.7	3.9±0.6

*P<0.05; ns, not significant (P>0.05); $\bar{X} \pm S\bar{x}$, least squares mean ± standard error.

Table VII.- Behavioral characteristics of calves between 3-6 months of age (%).

	n	Between 3-6 months of age			
		Standing	Lying	Feeding	Drinking
		$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$
General Mean	33	18.7±1.3	18.1±1.0	59.2±1.5	4.0±0.3
Group		ns	ns	ns	ns
Treatment	17	17.5±1.9	18.2±1.5	60.5±2.2	3.8±0.4
Control	16	19.9±1.8	17.9±1.5	57.9±2.2	4.2±0.4
Gender		ns	ns	ns	ns
Female	14	18.5±2.0	17.2±1.6	60.0±2.4	4.4±0.4
Male	19	18.8±1.6	19.0±1.3	58.5±1.9	3.7±0.4
Group x Gender Interaction		ns	ns	ns	ns
Treatment x Female	7	16.3±3.0	18.2±2.4	60.9±3.5	4.6±0.7
Control x Female	7	20.7±2.8	16.1±2.2	59.0±3.2	4.2±0.6
Treatment x Male	10	18.6±2.2	18.2±1.7	60.1±2.6	3.1±0.5
Control x Male	9	19.1±2.4	19.7±1.9	56.8±2.8	4.3±0.5

*P<0.05; ns, not significant (P>0.05); $\bar{X} \pm S\bar{x}$, least squares mean ± standard error.

Table VIII.- Behavioral characteristics of calves between birth-6 months of age (%).

	n	Between birth – 6 months of age			
		Standing	Lying	Feeding	Drinking
		$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$	$\bar{X} \pm S\bar{x}$
General Mean	33	27.3±1.4	16.9±0.7	51.9±1.6	3.9±0.2
Group		ns	ns	ns	ns
Treatment	17	28.5±2.0	17.6±1.0	50.3±2.3	3.7±0.3
Control	16	26.1±2.0	16.3±1.0	53.5±2.2	4.1±0.3
Gender		ns	ns	ns	ns
Female	14	26.5±2.2	16.1±1.1	53.4±2.5	4.1±0.4
Male	19	28.1±1.8	17.8±0.9	50.4±2.0	3.7±0.3
Group x Gender Interaction		ns	ns	ns	ns
Treatment x Female	7	27.7±3.2	16.7±1.7	51.4±3.6	4.3±0.5
Treatment x Male	10	29.3±2.4	18.5±1.2	49.2±2.7	3.1±0.4
Control x Female	7	25.3±3.0	15.5±1.6	55.3±3.4	3.9±0.5
Control x Male	9	26.8±2.6	17.1±1.4	51.7±3.0	4.4±0.4

*P<0.05; ns, not significant (P>0.05); $\bar{X} \pm S\bar{x}$, least squares mean ± standard error.

Treatments did not have any significant effects on calf behaviors between 3-6 months of age and similar behaviors were observed in both groups (Table VII). As compared to pre-weaning period, calves spent more time for feeding with the progress of growth period between 3 – 6 months of age (Fig. 1). Such a case may explain the reason for higher weight gains between 3-6 months of age with increased roughage and concentrate feed supply.

In both groups, between birth and 6 months of age, calves frequently spent their times (more than half of their times) with feeding, then standing and lying and the least with drinking (Fig. 1). The treatments, gender and group x gender interaction did not have significant effects on behavioral characteristics of both treatment and control groups in this period (Table VIII).

In treatment and control groups, calves mostly exhibited standing and lying behavior between birth and weaning, standing and feeding between weaning and 3 months of age, feeding and lying between 3 and 6 months of age, feeding and standing between birth and 6 months of age (Fig. 1).

DISCUSSION

Live weights and daily weight gains

Although previous researches mostly reported different results for roughage and concentrate feed supplies, almost all indicated that feed supply methods did not have significant effects on live weights and daily weight gains (Turgut *et al*., 1997; Keles *et al*., 2011; Miller-Cushon *et al*., 2013).

While live weights and daily weight gains of the calves in treatment and control groups increased normally between weaning and 3-months of age, the greatest daily weight gain was observed between 3-6 months of age (Table II). Such a case may be related to increased feed consumption and better feed conversion ratios of the calves because of developed rumens.

Turgut *et al*. (1997) and Miller-Cushon *et al*. (2013) indicated that concentrate feed + chopped roughage forms provided at different growth periods did not have significant effects on live weights and weight gains of young dairy calves. Present findings comply with those earlier findings.

The weaning weights in treatment and control groups (Table II) were different from the findings of some researchers (Turgut *et al*., 1997; Miller-Cushon *et al*., 2013) because of differences in weaning age (5 and 8 weeks) and treatments. Present findings comply with the results of Plaza *et al*. (2011) for Holstein calves, but pre-weaning weight gains were lower in present study. The weights at 3-months of age and daily weight gains

between weaning and 3-months of age were also lower than those previous findings. Present findings on daily weight gains between weaning and 3 months of age were relatively lower than the values reported by Keles *et al.* (2011) for Holstein calves supplied with concentrate feed (60%) + roughage (40%) between 8-16 weeks of age.

Present daily weight gains between 3-6 months of age in treatment and control groups (Table III) were similar with the findings reported by Plaza *et al.* (2009) for the group supplied with mixed ration of concentrate feed and roughage, but higher than the group supplied with separate feeds.

Current weights at 6 months of age and daily weight gains in treatment and control groups (Table III) comply with the values reported by Diler and Aydin (2009). However, current findings were quite different from the results of some other researchers (Turgut *et al*., 1997; Guler, 2000; Kartal and Yanar, 2011).

Feed consumption

Feed consumptions in treatment and control groups for 1 kg live weight gain during pre-weaning period were respectively calculated as 2.71±0.29 kg and 2.21±0.29 kg and present findings were different from the findings of some previous researchers (Turgut *et al*., 1997; Keles *et al*., 2011; Castells *et al*., 2012). The amount of feed consumed for 1 kg weight gain between weaning and 3 months of age comply with the values reported by Kincaid (1980), but different from the ones reported by Turgut *et al*. (1997) and Keles *et al*. (2011). The feed conversion ratios between birth and 6 months of age in treatment and control groups were different from the findings of some earlier researchers (Diler and Aydin, 2009; Guler, 2000; Kartal and Yanar, 2011; Yanar *et al*., 1999, 2002; Ugur *et al*., 2004; Coverdale *et al*., 2004) indicated that the groups supplied with calf starter feed and roughage had higher starter feed consumption and live weights at the end of experiments and related these better outcomes with higher feed conversion ratios and improved rumen systems.

As it was in present study, insignificant effects of mixed and separate supply of concentrate feed and roughage on live weights, daily weight gains, feed consumptions and feed conversion ratios of calves were also reported by previous researchers (Turgut *et al*., 1997; Keles *et al*., 2011; Kocak and Gunes, 2005; Goncu *et al*., 2010).

Behavioral characteristics

As it was seen from Tables V, VI, VII, VIII and Figure 1, the calves in treatment and control groups generally exhibited similar behaviors. More frequent standing behavior between birth and weaning may be related to mobility of the calves and relatively higher rates of lying behaviors may be related to resting desires of the calves after milk feeding (Table V). The behavioral characteristics of treatment and control groups were similar to findings of Kartal and Yanar (2011). Standing and drinking behaviors between birth and weaning were similar and lying and feeding behaviors were different from earlier researches.

Higher rates of standing and feeding behaviors in treatment and control groups after weaning may be related to increased concentrate feed and roughage supply to calves and thus more frequent consumption of these feeds. While present findings were similar with the feeding behaviors of Romanian 3-months of age Holstein calves as reported by Tripon *et al*. (2008), lying behaviors were quite lower than those calves. Standing and lying behaviors between birth and 6 months of age were different from the values reported by Kartal and Yanar (2011).

CONCLUSIONS

As to conclude, it was observed in this study that mixed and separate supply of concentrate feed and chopped roughage did not have significant effects on live weights, daily and total weight gains, feed conversion ratios and behavioral characteristics of brown Swiss calves. Mixed or separate supply of concentrate feed and roughage also did not have any negative effects on calves.

Statement of conflict of interest

We have declared no conflict of interest.

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