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RESEARCH ARTICLE

Bottle-Feeding on Some Performance Criteria of Holstein Calves during the Sucking Period

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Abstract

The present study investigates the effects of consuming starter feed from a bucket or bottle on dry matter intake, live weight gain, daily live weight gain, and feed conversion ratio during the weaning period in Holstein calves. Sixteen Holstein calves were used. The calves were randomly divided into two groups: the bucket group (n=8) was fed starter feed from a bucket, while the bottle group (n=8) was fed starter feed from a bottle in addition to the bucket, starting from the 4th day, along with milk until weaning. All calves were weaned at the 60th day of age. The average weaning weight was recorded as 82.30 kg (±2.73 kg) in the bottle group and 79.15 kg (±3.33 kg) in the bucket group. A non-significant difference was observed in the daily live weight gain between the two groups (p>0.05), with an average of 0.69 kg (±0.03 kg) in the bottle group and 0.66 kg (±0.04 kg) in the bucket group. In conclusion, the method of administering starter feed to suckling calves did not affect parameters such as feed consumption, live weight gain, daily live weight gain, or feed conversion ratio.

Introduction

The digestive system of newborn ruminants is markedly distinct from that of adults. It is clear that in newborn ruminants, the rumen is not yet fully developed or functional. Instead, the abomasum is larger and more active during this period (Davis and Drackley, 1998). The rumen develops muscularly, microbially, papillary, and volumetrically over time, becoming more active. It is essential to understand that feeding strategies for calves play a crucial role in rumen development and can influence their lifetime productivity during the early stages of life (Diao *et al.* 2019).

The basis of rumen development lies in the formation of rumen microbiota and the development of papillae. The main indicators of rumen development are the length, width, and density of the rumen papillae, as well as the thickness of the rumen wall (Vi *et al.* 2004). Volatile fatty acids, particularly butyric and propionic acids, play a crucial role in rumen development. Butyric acid promotes thickening of the rumen wall, stimulates capillary development, and fosters the growth of rumen papillae (Weigand *et al* 1975; Mentschel *et al.* 2001). Volatile fatty acids are fermentation products formed during the digestion of carbohydrates in the rumen. When calves are fed carbohydrate-rich diets that are easily fermented, the production of volatile fatty acids is increased, which has a positive effect on rumen development (Heinrichs and Lesmeister, 2005).

Calf rumen development is significantly influenced by forage and concentrates (Suárez *et al.* 2007; Öztop and Özkaya, 2024). Concentrated feeds are rich in protein and energy and lower in neutral detergent fiber (NDF) compared to forage, making them highly digestible. These feeds are especially abundant in easily fermentable carbohydrates, which quickly convert into volatile fatty acids in the rumen, accelerating the development of rumen microbiota and papillae (Suárez *et al.* 2007). A low proportion of forage helps to prevent rumen acidosis and hyperkeratosis, also promotes rumen muscular development (Resources, N. 2021).

When no forage is given, deaths due to these nutritional diseases can occur (Önal and Macit, 2024).

High live weight gain during the weaning period in calves increases milk yield in the first lactation. Soberon *et al.* (2012) reported that female calves with 1 kg more live weight at weaning produce 235 kg more milk in their first lactation. The effect of live weight gain on milk yield can be linked to mammary gland development. The first three months after birth are classified as the isometric phase for mammary gland development (Moallem *et al*. 2010). And there is a positive correlation between body weight gain and mammary gland development during this phase (Sejrsen *et al.* 1982). Increased dry matter intake in calves accelerates rumen development and live weight gain (RG, 1965), while also reducing weaning stress (Khan *et al*. 2011). Therefore, newborn calves should be encouraged to consume starter feed as early as possible, as this intake will stimulate rumen development through the production of volatile fatty acids. There are many methods and studies focused on increasing starter feed consumption in calves (McGahee *et al*. 1992; Hopkins, 1997; Suárez *et al.* 2007; Nedelkov *et al*. 2019). One of the methods that is the use of a feeding bottle. The feeding bottle is designed to mimic the mother's nipple, containing starter feed with a larger nipple than a typical bottle (Figure 1). The purpose of this bottle is to attract calves by imitating the mother's nipple, encouraging them to consume more starter feed earlier than they would normally. However, research on the use of feeding bottles is limited and largely outdated (McGahee *et al.* 1992; Quigley *et al*. 1992; Quigley *et al*. 1994; Hopkins, 1997).

Studies on the feeding bottle have yielded varying results. McGahee *et al.* (1992) investigated the effects of offering calf starter feed in either a bottle or a bucket on feed consumption and live weight gain in 20 calves. According to the study, using a feed bottle did not affect live weight gain but led to greater feed consumption during the first week. A similar study was conducted by Quigley *et al*. (1992) on 45 calves. This study found that presenting the starter feed in either a bottle or a bucket had no effect on overall feed consumption. Quigley *et al.* (1994) further examined the effects of offering starter feed in a bottle or a bucket on dry matter intake, live weight gain, and blood parameters in 40 calves. According to their results, there was no significant effect on feed consumption, live weight gain, blood glucose, beta-hydroxybutyric acid, or urea levels. However, the study suggested that feed bottles could be used as an alternative to buckets due to their ability to reduce feed wetting and insect contamination. Hopkins *et al*. (1997) explored the effect of using feed bottles on live weight gain in 56 calves during the weaning period.

Figure 1. The use of the feed bottle in calf box.

They concluded that serving starter feed in either a feed bottle or a bucket had no impact on feed consumption or live weight gain.

The hypothesis of the study was that calves would start consuming starter feed earlier when they were introduced to it through a feed bottle. As a result, dry matter intake was expected to increase, and live weight gain would be faster. The study aimed to investigate the effect of the feed bottle on feed consumption and weaning live weight in Holstein calves.

Materials and Methods

The animal material of the study consisted of 16 newborn Holstein calves at the Bilim Farm in the Konya Ereğli region. After birth, the calves were housed in individual 1x1 square meter cages in the delivery room for 3 days, after which they were moved to individual cages on the fourth day. The calves were randomly divided into two groups. Calves in the bucket group (n=8) were fed 2 liters of milk three times a day for 20 days, then 2.5 liters three times a day until the last 10 days of weaning, followed by 2 liters twice a day for the final 10 days. All calves are weaned at the 60th age old. In addition to milk, they consumed starter feed ad libitum from a bucket. Calves in the bottle group (n=8) consumed starter feed ad libitum from both a bucket and a bottle, alongside the same daily amount of milk. All calves were feed alfalfa hay equivalent to 10% of the starter feed starting from 10 days of age. During the study period, all animals had access to fresh and clean water. The starter feed and alfalfa hay were commercial products supplied by the farm, with their nutrient contents provided in Table 1.

While the DM, CP, Ash analyses were performed according to AOAC (1990), and NDF and ADF analyses were performed according to Van Soest (1976) in the starter feed used in the study.

The birth weights, as well as the live weights at the first and second months, were recorded within 24 hours after birth using an electronic scale. The starter feed placed in both the bucket and the bottle was weighed daily, and the consumption amount was calculated. The feed conversion ratio was determined based on feed intake, milk consumption, and live weight data.

For this purpose:

$$\text{Feed conversion ratio} = \frac{\text{Daily dry matter consumption}}{\text{Daily live weight gain}}$$

The data were subjected to statistical analysis in the Minitab (16) software package program. Intergroup variance analysis was performed with the Anova model. In case of difference between groups, Tukey test was applied. The statistical significance level was accepted as 0.05.

Results

Birth weights, 1st month and weaned live weights of calves are given in Table 2.

The first month and average daily live weight gains of calves are given in Table 3.

Daily and total starter consumption and feed conversion ratios of calves are given in Table 4.

Discussion

There was no significant difference between the groups in terms of first month and weaning live weights (p>0.05). The method of feeding starter feed—whether from a bucket or a bottle—did not affect the weaning weight. Quigley *et al.* (1992) reported that the weaning weights of Holstein calves were 66.9 kg in the bottle group and 68.8 kg in the bucket group, with no significant difference between

Table 1. The nutrient content of feeds %.

Item	DM	CP	C	Ash	EE
Starter	90.5	17.89	8.24	7.95	2.99
Alfalfa hay	89.2	16.79	25.15	8.12	2.05

DM: dry matter; CP: crude protein; C: Cellulose; EE: ether extract

Table 2.The birth, first and second month live weights of calves (kg).

Group	n	BLW	LW30d	LW60d	TLWG
Bottle+Bucket	8	40.88±1.62	61.19±1.61	82.30±2.73	41.42±1,74
Bucket	8	39.75±1.59	64.93±1.79	79.15±3.33	39.40±2,15
P		0.63	0.14	0.48	0.78

BLW: Birth Live weight, LW30 and LW60d: live weight 30 and 60 days, TLWG: Total live weight gain

Table 3. The first, second month and average Daily live weight gains of calves (kg).

Group	n	DLWG (30d)	ADLWG
Bottle+Bucket	8	0.68±0.04[b]	0.69±0.03
Bucket	8	0.84±0.03[a]	0.66±0.04
p		0.01	0.48

LWG30d, 60d: Daily live weight gain 30 and 60 days

Table 4: Daily and total starter consumption and FCR of calves.

Group	n	Daily starter intake (kg)	Total starter intake (kg)	Total Alfalfa Intake (kg)	Total Milk Intake (L)	FCR*
Bottle+Bucket	8	0.64±0.02	38.48±1.00	3.85±0.1	385	2.11±0.08
Bucket	8	0.67±0.03	40.27±1.50	4.03±0.2	385	2.27±0.09
p		0.33	0.33	0.33	-	0.18

*FCR: Consumed milk and dry matter of alfalfa hay were added to the feed conversion

weight gains, reporting 597 g for bottle-fed calves and 700 g for bucket-fed calves. Additionally, Quigley *et al.* (1992) observed no difference in weight gain between calves fed starter feed from a bucket, a bottle, or without supplementary feed before weaning. The results of the current study align with these previous findings. Although the factors influencing daily live weight gain in calves before weaning are not fully understood, several elements such as colostrum consumption, milk feeding protocols, total dry matter intake from feed and milk, management practices, and environmental temperature have been identified as important contributors (Hyde *et al.* 2021). In this context, the primary influential factor related to feed is the dry matter content and intake, while the feeding method (bucket or bottle) does not appear to have a significant impact. In studies on Holstein calves, daily live weight gains have been reported as 525 g by Yaylak *et al.* (2015) and 580 g by Rosenberger *et al.* (2017). The calves in the current study exhibited higher daily weight gains compared to these reports, likely due to differences in daily milk consumption and dry matter intake.

There was no significant difference between the daily starter feed and alfalfa hay consumption of the groups ($p>0.05$). Whether calves consumed feed from a bottle, or a bucket did not affect their daily feed intake. McGahee *et al.* (1992) similarly reported that the method of feeding, whether from a bottle or bucket, did not influence weekly feed consumption. Likewise, Hopkins *et al.* (1997) found no significant difference in weekly starter feed consumption between calves consuming feed from a bottle or an open bucket. Quigley *et al.* (1992) reported that calves fed from a bottle consumed 564 g of starter feed in the first week, compared to 563 g for calves fed from a bucket. By the sixth week (weaning), this increased to 1,672 g and 1,648 g, respectively, with no significant difference between the groups. Similarly, Quigley *et al*. the two. In a similar study, Quigley *et al.* (1994) found weaning weights of 65.8 kg for calves fed from a bottle and 68.7 kg for those fed from a bucket, again showing no significant difference. Likewise, Hopkins *et al*. (1997) found no difference in weaning weights between calves fed starter feed from a bottle or a bucket. The findings of the current study align with previous research, showing no effect of feeding method on weaning weight. While studies specifically on the use of feed bottles are limited, other weaning weight studies on Holstein calves have reported varying results. Koçak and Güneş (2005) reported a weaning weight of 77.8 kg at 70 days, Nejad *et al.* (2013) reported 67.9 kg at 56 days, and Yaylak *et al.* (2015) found a weaning weight of 79.7 kg at 77 days. The results from Koçak and Güneş (2005) and Yaylak *et al.* (2015) were similar to those of the current study, while Nejad *et al.* (2013) reported lower weaning weights, likely due to the earlier weaning age in that study.

In this study, daily live weight gain of calves varied across periods. During the first month, calves in the bucket group gained significantly more weight than those in the bottle group ($p<0.05$). However, in the second month, the trend reversed, with the bottle group gained more daily weight gain compared to the bucket group. Across the entire period from birth to weaning, there was no significant difference in daily live weight gain between the groups ($p>0.05$). This indicates that the use of a feed bottle had no overall effect on daily live weight gain.

McGahee *et al.* (1992) reported similar findings, where calves fed with a feed bottle gained more weight in the first four weeks, but after the fifth week, calves fed from a bucket gained more. However, the total weight gains were similar by the end of the study. In contrast, the current study showed the opposite pattern in the second month. Similarly, Quigley *et al.* (1994) found no significant difference in daily live

(1994) reported daily feed consumption of 784 g in the bottle group and 774 g in the bucket group, which was higher than the values observed in the current study. In a more recent study, Rosenberger *et al.* (2017) reported daily feed consumption for calves fed 6, 8, 10, and 12 liters of milk per day as 0.3, 0.1, 0.1, and 0 kg, respectively, during the 7–41-day period. During the weaning period (42-54 days), these values increased to 1.2, 1.0, 0.7, and 0.5 kg, respectively. Daily feed consumption during the weaning phase for Holstein calves was reported as 465 g by Aragona *et al*. (2020), 759 g by Laarman and Oba (2011), and 195 g between days 14-41, increasing to 1,155 g between days 42-55, by Engelking *et al.* (2020). These studies highlighted that feed consumption during the weaning period was influenced by factors such as the starch content of the feed, the consumption and amount of forage, and the volume of milk intake. The variation in daily feed intake observed in the current study is likely related to differences in feed composition and the amount of milk consumed.

The feed conversion ratios (FCR) of calves fed from either a bottle or a bucket were similar ($p>0.05$). These ratios were calculated based on the total intake of milk, starter feed, and alfalfa. Since milk intake was consistent across groups, the amount of feed consumed played a key role in determining the feed conversion rates. Quigley *et al.* (1992) reported the pre-weaning daily live weight gain (DLWG) to feed consumption (FC) ratio as 0.305 for calves fed from a bottle and 0.309 for those fed from a bucket. During the weaning period, these values were 0.472 and 0.455, respectively. The pre-weaning ratios from their study were lower than those observed in the current study, while the weaning period values were similar. The higher FCR observed in the current study is likely due to increased feed intake. Aragona *et al.* (2020) reported a DLWG/FC ratio of 0.37, while Rosenberger *et al*. (2017) found a much higher value of 0.73. The feed conversion rate observed in the present study was lower than that reported by Aragona *et al.* (2020) but higher than the value reported by Rosenberger *et al*. (2017). This difference in FCR may be attributed to variations in feed composition and the amount of dry matter consumed.

Conclusion

The study determined that providing supplemental starter feed to suckling calves from either a bucket or a bottle had no significant effect on live weight, daily live weight gain, dry matter consumption, or feed utilization rate. However, the protective design of the bottle offers advantages in preventing exposure to external factors. It helps reduce pest contamination during summer and protects feed from moisture in rainy weather. Thus, while the feed bottle does not influence growth performance, its use may be beneficial in maintaining feed quality under certain environmental conditions

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Conflict of Interest

In the study, dry matter intake and live weight were monitored. The EU ethics committee decision is not required.

Author Contribution

The design, planning was done by RA and HHŞ, execution, data collection, analysis and writing of the article were done by HHŞ, RA and AEG. Authors approval the final version of manuscript.

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