



Effects of Farm Formulated Hay Feeds on Growth Performance of Heifer Calves

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Abstract – Optimal nutrition during early life is critical for maximum growth and development of heifer calves. Farm-made hay feeds are widely used in small- to medium-scale farming due to their low cost and availability; however, their effects on calf growth performance are not well established. This study evaluated the impact of different hay types on growth performance in heifer calves. Twenty healthy 12-week-old heifer calves were randomly assigned to four groups (n = 5 per group). Groups A, B, and C were fed Kikuyu, *Paspalum*, and *Desmodium* hay, respectively, along with a commercial calf starter, while the control group received a commercial Total Mixed Ration (TMR). The trial lasted four weeks, with weekly body weight measurements. In week 2, weight gain was significantly higher in the TMR group than in the *Desmodium* hay group ($p < 0.05$). During weeks 3 and 4, the TMR group gained significantly more than all hay-fed groups. TMR-fed calves recorded the highest Average Daily Gain (ADG) with a consistent upward trend, whereas hay-fed calves showed a declining trend. Although TMR enhanced growth, body weights remained below optimal targets, indicating the need for improved diet formulations and optimized hay-to-starter ratios to achieve desired growth benchmarks in heifer calves.

Keywords- Body weight gain, Forage, TMR feeding, Weaned calves feeding,

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Introduction

The intensive system of cattle farming is practiced in up-country areas of Sri Lanka, where the government and private companies own large cattle stocks of European breeds, namely Ayrshire, Jersey, and Friesian. Feeding pattern and health of the calves become one of the main challenges in the up-country dairy farming system. Calves are the future of the dairy herds and used for herd replacements and males are future breeding bulls. The rumen development is an important requirement at this stage and largely dependent on the age of calves. A smooth transition from liquid feed (milk or milk replacer) to solid feed (grains or forage) is important in minimizing weight loss and distress at weaning (Weary et al., 2009). Consumption of solid feed is critical for the weaned calves in commercial farming operations. Underfeeding results in high mortality and increased age at puberty in heifer calves. High mortality rates in young calves and the disposal of bull calves result in a loss of quality germplasm. Unbalanced feeding and incidence of disease in heifer calves can reduce the age at first calving (Heinrichs & Kmicikewycz, 2016).

Research studies have indicated that forage feeding of calves are found with the potential to encourage early rumination, enhance rumen pH and rumen muscle strength, while also reducing cancerous proliferation and keratinization of rumen papilla (Tamate et al., 1962). However, large amounts of forage in the ration can reduce dry matter intake and average daily gain of calves (Hill et al., 2010). According to Karami et al. (2021), Holstein female calves should be fed forage at a restricted level after weaning to achieve optimal growth performance. They further stated that the increased average daily gain as a result of higher dry matter and energy intake is associated with consumption of lower forage ration. According to Zou et al. (2018), feeding alfalfa and oat hay mixed together with starter diet for postweaning dairy calves improved dietary nitrogen efficiency and growth performance. Though, the female calves are kept as the future dairy replacements (Ahmad et al., 2009), they are not fed as per requirement to reach early puberty impacting lifetime productivity.

Different feeding methods during postweaning period are available to minimize the feeding cost without negatively affecting growth rate and health. In the upcountry dairy farming conditions, calves are provided with hays in addition to calf starter after weaning during the first month period to mitigate calves' growth reduction and to reduce nutritional problems. This feeding period may lead to increased illnesses and weight loss due to poor nutrition. Therefore, postweaning management of female calves and maintaining targeted growth are serious concerns to farmers. How the present calf feeding system in postweaning period affects growth under local conditions are not documented.

The present study hypothesized that different type of hay feeding may affect the growth of heifer calves especially female in postweaning period. The present study aimed to obtain an understanding of weight gain in heifer calves associated with feeding methods practiced locally in postweaning period.

Materials and Methods

Site Selection

The experiment was conducted in the Dayagama farm belongs to National Livestock Development Board (NLDB) which is located in Dayagama, Sri Lanka. The elevation of the location is 1640 m from mean sea level. Annual rainfall is 2500-3000 mm and around 265 rainy days per year. The day and night time temperatures vary from 15-20°C and 7-10°C respectively. The land extent of farm is around 232 ha, and 63.5 ha is planted with Rye grasses, 73.4 ha with kikuyu, and 8 ha with clove. Dayagama NLDB farm has 245 milking cows, 300 heifers, 120 dry herd and 90 weaning heifers and 58 pre-weaning calves.

Selection of Experimental Animals

Twenty healthy, heifer calves at three months of age were selected and allocated randomly to four treatment groups (Group A, Group B, Group C, and Control group) with 5 heifer calves per group. All the experimental calves in each group were averagely weighed around 57 kg before the experiment. To avoid variations, the experimental animals were selected from the same breed, Jersey, reared under the same environmental conditions, same body condition, and with same healthy conditions. The four experimental groups were reared throughout the experimental period in clean, disinfected, and cemented flour cages with ad-libitum water supply.

Formulation of Experimental Feed, the Feeding Regimen, Data Collection and Data Analysis

For this investigation, a commercially available TMR was used as the control feed. The experimental feeds consisted of *Paspalum* hay, *Desmodium* hay, and Kikuyu hay, each provided together with a commercial calf starter (Table 1). The feeding trial lasted four weeks. Body weights of the calves were recorded once weekly throughout the trial using a digital livestock weighing scale. Weighing was carried out in the morning before feeding and watering to minimize variation due to gut fill. Data on weekly weight gain and ADG were compiled, and the results were subjected to statistical analysis to compare growth performance across dietary treatments.

The different hay types were produced at the farm itself to use in the experiment. The main objective of the study is to identify the most effective feed type from these feeding mixtures to feed during postweaning period in terms of weight gain. Ingredients of all three rations were manually mixed until a properly and evenly mixed feed mixture is obtained and this was done throughout the experimental period (Table 2).

Table 1
Experimental feed formulation

Experimental ration	Proportions (%)				
	Calf starter	Kikuyu hay	<i>Paspalum</i> hay	<i>Desmodium</i> hay	Total
A	25	75	0	0	100
B	25	0	75	0	100
C	25	0	0	75	100

Each animal was fed individually and separately with only the required feed in right amount based on the feeding regime (Table 2) to avoid dominations and competition within a group for the feed. Ad-libitum water was supplied to the calves. The feeding trial was performed for four weeks.

Table 2
Feeding regime of the study

Week	Amount of feed per animal per day (kg/day)
1	2
2	2.5
3	3
4	3.5

The statistical analysis was performed using SPSS software. Means and standard deviations were obtained using descriptive statistics. The different means were compared by one-way Analysis of Variance (ANOVA), and the Post Hoc Tukey test was applied to determine significant differences among the calculated means of the various treatments. Statistical significance was considered at the 5% probability level ($p < 0.05$).

Results

The comparisons of pre-experiment body weight of heifer calves (Table 3) indicated that there is no significant difference ($p > 0.05$) in mean observed weight between different treatments and the highest mean weight was found with control group and the lowest mean weight was found with group A, the mean value ranged between 57.6 kg to 56.9 kg. The comparisons of body weight gain in week 1 showed no significant difference ($p > 0.05$) between different treatment groups. The highest mean body weight gain of 59.9 kg was obtained by control group and the lowest body weight gain of 58.52 kg was obtained by treatment group C.

The comparisons of body weight gain of week 2 indicated a significant difference ($p < 0.05$) between different groups (Table 3). The highest mean body weight gain of 62.89 kg was obtained by control group. The lowest mean body weight gain of 59.40 kg was obtained by treatment group C. Likewise, body weight gain in week 3 showed a significant difference ($p < 0.05$) between different groups with the highest mean body weight of 66.67 kg for control group and the lowest mean body weight gain of 59.99 kg for treatment group C. The body weight gain in week 4 showed a significant difference ($p < 0.05$) between different treatment groups with the highest mean body weight of 71.34 kg for control group and the lowest mean body weight gain of 60.29 kg for calves in group C.

According to Figure 1, the highest Average daily weight gain of 0.49 kg was obtained for calves fed with commercial TMR. The lowest ADG of 0.11 kg was obtained for calves fed with Feed C.

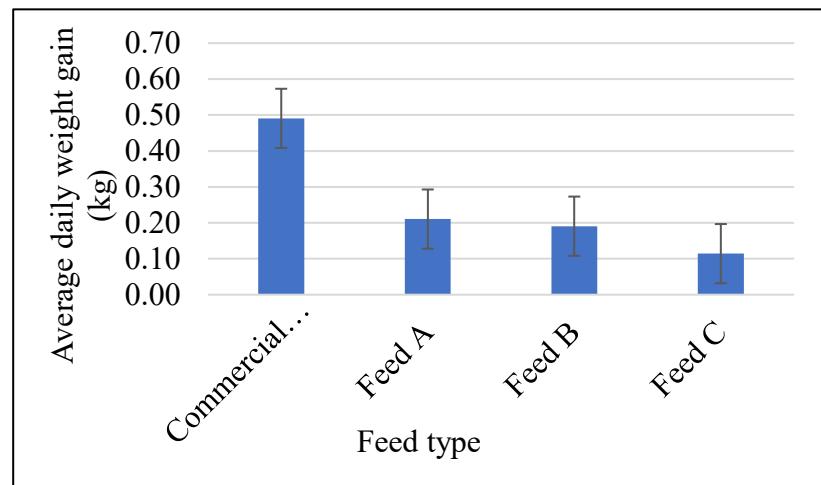
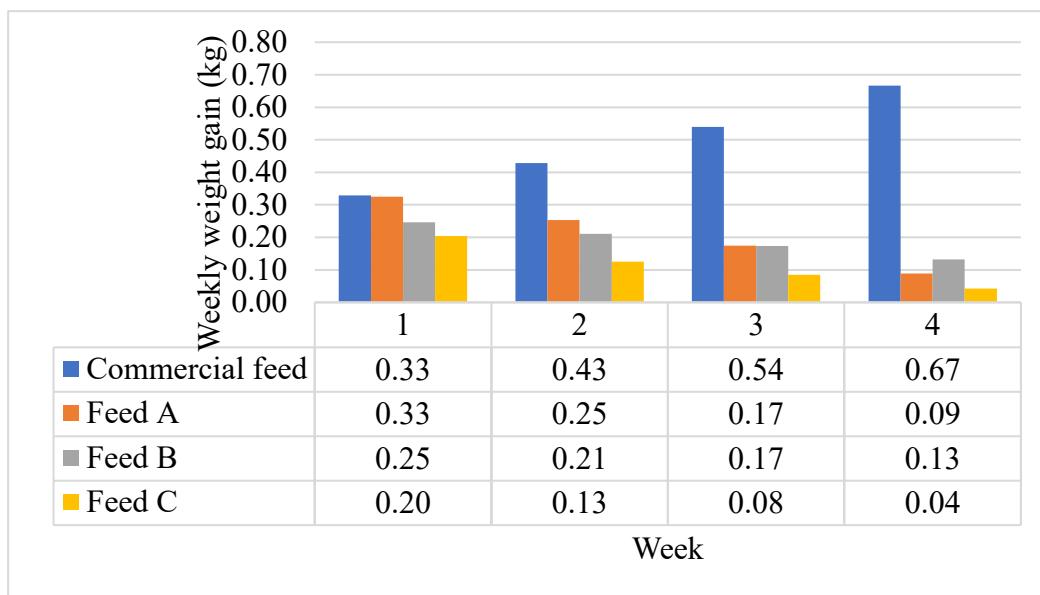


Figure 1. Average daily weight gain in heifer calves during the four weeks of experiment

Table 3*Comparisons of body weight of heifer calves between treatments during four weeks*

Treatment	Mean body weight gain (kg)				
	Pre-experiment	Week 1	Week 2	Week 3	Week 4
Commercial	57.60 ± 0.92 ^a	59.90 ± 0.96 ^a	62.89 ± 1.01 ^b	66.67 ± 1.07 ^b	71.34 ± 1.14 ^b
Feed					
Feed A	56.90 ± 0.50 ^a	59.17 ± 0.53 ^a	60.95 ± 0.54 ^{ab}	62.17 ± 0.55 ^a	62.79 ± 0.56 ^a
Feed B	57.40 ± 0.57 ^a	59.12 ± 0.59 ^a	60.60 ± 0.61 ^{ab}	61.81 ± 0.62 ^a	62.73 ± 0.63 ^a
Feed C	57.10 ± 0.74 ^a	58.52 ± 0.76 ^a	59.40 ± 0.77 ^a	59.99 ± 0.78 ^a	60.29 ± 0.79 ^a

According to Figure 2, weekly average body weight gain of heifer calves fed with commercial TMR increased continuously from 0.33 kg in week 1 to 0.67 kg in week 4. For the calves fed with Feed A, Feed B and Feed C, weekly average body weight gain decreased continuously from week 1 to week 4.

**Figure 2.** Weekly average body weight gains in heifer calves during four weeks of experiment

Discussion

Managing postweaned heifer calves has become a serious challenge to farmers since they face with poor growth, poor performance, problem in the supply chain of commercial TMR and the high cost of feeding with TMR under local conditions. Therefore, farmers are in search for a feeding method which is low cost and locally available without compromising health and growth performance of heifer calves which will become the future replacement stock. Previous studies indicated the importance of inclusion of hay in the diets of postweaned calves (Karami et al., 2021; Zou et al., 2018). Most importantly, addition of correct percentage of hay is a critical aspect with regard to weight gain of postweaned calves, because, overfeeding of forage causes for decreasing of weight gain (Hill et al., 2010).

Karami et al. (2021) found that forage to concentrate ratio of 20:80 enhanced the growth and physiological functions in postweaned Holstein dairy calves when compared to the forage

to concentrate ratio of 50:50 and 35:65. According to Zou et al. (2018), diet with 40% of forage which includes alfalfa hay alone or 26.7% of alfalfa hay and 13.3% of oat hay mixed together improved the daily weight gain greatly in weaned Holstein dairy calves. They further stated that the optimum average daily gain in weaned dairy calves needs to be maintained at 0.82 to 0.93 kg/day and which was achieved with 40% of forage in the diet. In the present study 75% of forage was included in the diet considering the local availability of forage species i.e., Kikuyu, *Paspalum* and *Desmodium* to produce hay.

According to Johnson et al. (2018), postweaning heifers up to 7.5 months of age achieved an ADG of 0.83 ± 0.16 kg/day. In the present study, the highest ADG of 0.49 kg/day for the heifer calves during the four-week experimental period (from 12 to 16 weeks of age) suggests that the commercial TMR supported better growth compared to Feed A, Feed B, and Feed C, which contained 75% forages. Karami et al. (2021) reported that greater ADG is generally achieved in weaned calves when fed diets with higher energy density, greater concentrate levels, and increased feed intake. However, the ADG of heifer calves fed the commercial TMR in this study was lower than the predicted ADG reported by Zou et al. (2018) and also below the values observed by Johnson et al. (2018). This discrepancy may indicate that the nutrient composition and energy density of the commercially available TMR used in this study were not optimally balanced for supporting the targeted growth rate of heifer calves.

Therefore, the TMR should be balanced according to the nutrient requirements of heifer calves since weaned calves need to be supplied with 18% Crud Protein (CP) (63 g CP/day) (Hill et al., 2008) considering that protein is an essential nutrient for the growth of young calves. The present study found that calves fed with commercial TMR continuously increased in ADG which agrees with Johnson et al. (2018) where they found that ADG increased in calves from week 1 to week 9 and again from 63 days to 229 days. The much lower ADG in the heifer calves fed with Kikuyu, *Paspalum* and *Desmodium* hay-type diets is due to the overfeeding of forage which led to the decrease of ADG (Hill et al., 2010). Further, ADG was found to be decreasing from week 1 to week 4 among the heifer calves fed with hay types in the present study and the decrease was significant compared to the heifer calves fed with commercial TMR. The reason could be lower level of CP in feeds that were fed to weaned calves reduced ADG (Hill et al., 2008), further, feeding grass hay reduced dry matter intake and metabolizable energy intake causing for decreased ADG (Mitchell and Heinrichs, 2020). The results may indicate that the decision to replace TMR with hay and calf starter combination needs to be taken without compromising growth performance of heifer calves for which percentage of hay to be included may be either 40% (Zou et al., 2018) or 20% (Karami et al., 2021) or 11.3% (Mitchell and Heinrichs, 2020).

In the present study, 75% of forage inclusion was much higher, further forages are less energy dense and less digestible compared with starter feeds in postweaned calves. Therefore, their consumption could, delay rumen epithelial development and decrease the growth of young heifer calves (Hill et al., 2008). The present study suggests that on farm experiment on feeding of postweaned heifer calves needs to be conducted with the inclusion of varying percentages of different hay types from 11% to 40% to determine the appropriate hay to calf starter ratio that will promote optimum heifer calves' growth.

Conclusion

The study found that heifer calves fed with commercial TMR gained highest body weight. However, the TMR used at present seems not an appropriate diet to feed foundation heifer calves since it does not support to achieve expected ADG. Hence, it is recommended that the commercial TMR used in the present study needs to be reformulated. The inclusion

75% of Kikuyu, *Paspalum* and *Desmodium* hay in the diets of heifer calves significantly reduced ADG, thus the appropriate ratio of hay to calf starter should be investigated.

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