

Effect of calf starter substitution in lactating dairy cow concentrate on feed efficiency and feed cost of weaned female Holstein Friesian calves

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ABSTRACT

Analyzing feed efficiency and feed cost of weaned female Holstein Friesian (HF) calves fed with lactation cow concentrates with different levels of calf starter substitution was the aim of this study. Four weaned female HF calves (aged 4-5 months, average weight of 101.38 ± 14.21 kg) were used for research material. Feeds were calf starter (CS), lactating dairy cow concentrate (LDCC) and elephant grass. The study used a Latin square design, 4 concentrate treatments, i.e. 75% CS + 25% LDCC (P1), 50% CS + 50% LDCC (P2), 25% CS + 75% LDCC (P3), 100% LDCC (P4); 4 replications in 4 periods (each period in 1 month). The concentrate (in dry matter) was given 1% BW; forage and drinking water were based on ad libitum basis. The research parameters were average daily gain (ADG), feed efficiency (FE) and feed cost per gain (FC/G). The data obtained were analyzed using ANOVA. The treatments had no effect on the parameters ($p > 0.05$). Feed efficiency at P2 = 19.77%; P3 = 17.86%; P1 = 16.71% and P4 = 15.92%. Feed cost per gain at P3 = IDR. 29,363/kg ADG; P2 = IDR 30,492/kg ADG; P4 = IDR 30,800/kg ADG and P1 IDR 33,927/kg ADG. The conclusion was that with sufficient quality forage feed, using 100% LDCC to weaned female HF calves could result in FE and FC/G that was similar with the substitution of CS (25-75%) in LDCC.

Introduction

A calf is a newborn cow up to eight months old that has just begun ruminating. Newborn calves require special care, accuracy, precision, and perseverance. The success of raising female Holstein Friesian (HF) calves greatly affects the future of the dairy farming business because female calves will be used as replacement stock. Raising calves from birth until weaning is an important part of dairy farming (Purwanto and Muslih, 2006). The method of weaning calves is by stopping the provision of milk or milk replacer (Anggraeni *et al.*, 2008). In addition to milk, feed for calves such as concentrates and forages must be given as early as possible or from the first week to stimulate the development of the rumen, and calves can be weaned at the age of 70–90 days (Permana *et al.*, 2023). However, in general, weaning is the period when calves start to switch from milk to forage and concentrates, which is done when the calves are 4–5 months old (Widiawati and Winugroho, 2014).

Good quality ration given to weaned calves should contain sufficient nutrients to meet their needs. Feed quality affects average daily weight gain (ADG), feed efficiency, and feed costs. Factors that influence feed efficiency include the quality of feed ingredients; the better the quality of the feed provided, the higher the feed efficiency value (Usman *et al.*, 2013). Feed efficiency also affects the feeding costs incurred during the rearing period. If an animal's feed efficiency is high, the amount of feed consumed is less, which can help reduce feed costs (Rahayu, 2013).

Feed given to weaned female HF calves consists of forage and concentrate, with the aim of stimulating rumen development and meeting nutritional requirements. At the beginning of weaning, the provided concentrates should preferably be calf starter, as it has a high protein and energy contents. Calf starter is made from feed ingredients that are sources of protein and carbohydrates, with a total digestible nutrients (TDN) content of 76% and a crude protein (CP) content of 19–21% (Mukodiningsih *et al.*, 2008; BSN, 2024). To achieve high nutritional content, high-quality feed ingredients are necessary, and the components used to make calf

starter are relatively expensive. As a result, feed costs are also relatively high, leading many farmers to prefer using lactating cow concentrate, as it is cheaper than calf starter. However, since nutrient content of lactating cow concentrate is lower than that of the calf starter, it is suspected that the use of lactating cow concentrate for weaned calves may affect their growth, and that substituting calf starter with lactating cow concentrate as a supplementary feed source for weaned female HF calves will have a positive effect on growth. However, the use of calf starter will increase feed costs. Therefore, it is necessary to determine the right combination of calf starter and lactating cow concentrate that can be applied with ideal or profitable feed cost efficiency for farmers.

This study aimed to determine and examine the effect of substituting calf starter into lactating dairy cow concentrate on feed efficiency and feed costs in weaned female HF calves. The benefit of this research was to provide information regarding the effect of providing calf starter on feed efficiency and feed costs in weaned female HF calves. The hypothesis of this study was that substituting calf starter into lactating dairy cow concentrate can improve feed efficiency with feed costs that are not different from those of dairy cow concentrate.

Materials and methods

Materials

Four post-weaning female Holstein Friesian (HF) calves (aged 4-5 months, average weight of 101.38 ± 14.21 kg) were used for the research materials. The metabolic cages were used to keep the calves for the duration of the study. Other materials included elephant grass forage, lactating dairy cow concentrate (LDCC) and calf starter (CS) (Table 1). The equipment used in this research included a mixer to homogenize the feed ingredients, a drum to store the concentrate, a digital scale to weigh the concentrate feed, a hanging scale to weigh the forage, and a livestock scale to weigh the body weight of the livestock.

Table 1. Nutrient content of feed (%).

Feed	Water	Ash	EE	CF	CP	NFE	TDN
Lactation Cow Concentrate (LCC)	9.42	9.9	6.42	26.87	16.4	40.41	64.91
Calf Starter (CS)	11.17	12.32	5.25	8.74	19.7	53.99	76.13
Elephant Grass	78.08	13.31	2.17	28.64	12.13	43.75	58.5
P1	10.73	11.71	5.54	13.27	18.87	50.61	73.32
P2	10.29	11.11	5.83	17.8	18.05	47.21	70.52
P3	9.86	10.5	6.13	22.33	17.25	43.79	67.71
P4	9.42	9.9	6.42	26.87	16.4	40.41	64.91

EE = ether extract, CF = crude fiber, CP = crude protein, NFE = nitrogen free extract, TDN = total digestible nutrients, DM = dry matter

Methods

Feed (forage and concentrate) treatments were adjusted to the dry matter (DM) needs of the female Holstein Friesian calves. Concentrate was given as much as 1% body weight (based on DM) in two doses, i.e. at 06:00 and 15:00. Forage and drinking water were based on ad libitum basis. The forage was given after one hour from giving the concentrate. The treatment concentrates were 75% CS + 25% LDCC (P1), 50% CS + 50% LDCC (P2), 25% CS + 75% LDCC (P3), and 100% LDCC (P4). Table 1 shows the nutritional content of the given feed.

The Latin Square Design (LSD, 4 treatments and 4 periods) was used in this research. A logbook on a regular basis was used for recording the feeding and residues of feed and drinking water. The study has 4 periods, observation in every period was carried out for 30 days, then break for 5 days. After that, continued to the next period. The parameters measured were average daily gain (ADG), feed cost per gain (FC/G) and feed efficiency (FE).

Statistical analyses

The analysis of variance (ANOVA) based on the Latin Square Design was used to analyze all data. If the treatment effect was significant, then continued to determine the differences between treatments with Duncan's test.

Results

The average feed efficiency (FE) can be seen in Table 2. Analysis of variance showed that the treatments did not affect feed efficiency ($P>0.05$). Feed efficiency for P1 was 16.71%, P2: 19.77%, P3: 17.86%, and P4: 15.92%. The average feed cost per gain (FC/G) can be seen in Table 3 and statistical analysis indicated that the given treatments did not result in a significant effect on feed cost per gain (FC/G) ($P>0.05$). Feed cost per gain at P3 = IDR. 29,363/kg ADG; P2 = IDR 30,492/kg ADG; P4 = IDR 30,800/kg ADG; and P1 = IDR 33,927/kg ADG.

Table 2. Average Feed Efficiency (%).

	P1	P2	P3	P4
Period 1	24.9	34.1	23.66	22.56
Period 2	17.17	20.96	18.45	16.33
Period 3	10.22	9.37	12.86	12.77
Period 4	14.56	14.65	16.48	12.05
Average	16.71±6.17	19.77±10.66	17.86±4.51	15.92±4.80

The treatment of feed efficiency showed results that were not significantly different ($P>0.05$)

Discussion

The use of various types of calf starter (CS) substitution treatments in the lactating dairy cow concentrate (LDCC) on weaned female Holstein Friesian calves did not have a significant effect on FE. This means that P1,

Table 3. Average feed cost (IDR) per gain (FC/G).

	P1	P2	P3	P4
Period 1	20,113	14,484	20,176	20,722
Period 2	27,884	23,079	31,591	24,406
Period 3	49,800	51,892	36,831	37,030
Period 4	37,912	32,512	28,853	41,042
Average	33,927±12,847.53	30,492±16,054.58	29,363±6,961.71	30,800±9,766.62

Treatment of feed cost per gain (FC/G) showed results that were not significantly different ($P>0.05$)

P2, P3, and P4 all had relatively similar feed efficiency outcomes. Feed efficiency is closely related to dry matter intake (DMI) and average daily gain (ADG). If the DMI and ADG are relatively similar, this will also result in relatively similar feed efficiency values. The results for ADG (0.55 kg/day (P1), 0.61 kg/day (P2), 0.62 kg/day (P3) and 0.53 kg/day (P4)) and DMI (3.43 kg/day (P1), 3.54 kg/day (P2), 3.58 kg/day (P3) and 3.34 kg/day (P4)) in this study also showed no significant differences, and it can be concluded that in all treatments, the animals consumed almost the same amount of dry matter and had nearly the same ADG. The body weight of livestock is directly proportional to the level of feed intake. This aligns with NRC (2001); Winarti *et al.* (2011) and Van Saun (2024), who stated that the higher the body weight, the greater the feed intake. Therefore, DMI affects ADG. Ransa *et al.* (2020) reported that factors affecting ADG are DMI and the nutrients content of feed.

The calculation of dry matter intake (DMI) shows relatively similar results between those substituted with CS (25-75%) and those given 100% LDCC, even though their nutrient content differs. This is because both calf starter and lactating cow concentrate are believed to have good palatability. As a result, providing feed at 1% of body weight (BW) can be well consumed, followed by sufficient forage intake. Dry matter intake has an effect on the weight gain of livestock. According to Purwadi (2017), in addition to indicating consumption level, DMI is also used as a parameter to evaluate feed palatability. Similar feed efficiency also shows that the nutrient content of 100% LDCC (P4) produces the same effect as the substitution of CS in LDCC (P1, P2, P3), which has better nutrient content. These results are influenced by the rumen function of weaned female Holstein Friesian calves, which are already capable of fermentative digestion, and the microbial protein formed can be utilized by calves' bodies for growth. Therefore, consuming lactating dairy cow concentrate (CP 16% and TDN 67%) gives the same feed efficiency as consuming concentrate substituted with calf starter (CP 19% and TDN 76%), provided it is accompanied by high-quality forage (elephant grass) given ad libitum. Research data shows that the average DMI was 2.57% BW, with forage intake at 1.69% BW and concentrate intake at 0.88% BW. This is in line with Drackley (2008), who stated that solid feed given to weaned calves can improve rumen function by increasing rumen microbes. Uhia *et al.* (2006) stated that calves receiving low-quality forage and qualitative supplementation had a protozoa count of 2.59×10^6 cells/ml of rumen fluid. According to Budiasa *et al.* (2018), calves given treatment in the form of 40% concentrate and 60% king grass showed a protozoa count of 3.69×10^6 cells/ml of rumen fluid. This information indicates that the number of microbes

(protozoa, bacteria, fungi) has already developed well in the rumens of post-weaning calves. Therefore, providing calf starter and high-quality forage in sufficient amounts can increase the microbial population in the rumen, enabling calves to optimally digest feed.

Table 2 shows the average FE ranked (from highest to lowest) as follows: (P2) 19.77%, (P3) 17.86%, (P1) 16.71%, and (P4) 15.92%. These study results are still below those reported by Rastgoo *et al.* (2020), who stated that the efficiency in weaned female calves ranges between 33.00% - 47.00%. The study by Gading *et al.* (2019) found that feed efficiency in weaned female calves ranges between 21–25%. This is influenced by several factors, namely feed quality, age, average daily gain (ADG), and digestibility. According to Tarmidi (2004), besides feed intake and body weight gain, both the quality and quantity of feed also have an effect on efficiency, due to the digestible nutrients contained in the feed.

Feed cost per gain (FC/G) is the amount of feed cost required for livestock to produce 1 kg of gain (Handayanta *et al.*, 2017). FC/G is calculated from the price of feed during the research, which is spent daily by the farmer, divided by the average weight gain achieved. The data on DMI and ADG in this study, which showed no significant difference, are suspected to be a factor in the insignificant feed cost results across all treatments ($P>0.05$). Therefore, feed cost is also directly related to FE. Feed cost per gain (FC/G) will be higher if feed efficiency is low. Handayanta *et al.* (2017) stated that the value of feed cost per gain is quite high due to low feed efficiency.

It shows that the use of various types of calf starter substitution treatments in lactating dairy cow concentrate on weaned female HF calves had no significant effect on feed cost per gain (Table 4). This result was due to the price of calf starter (IDR 4,831/kg) not being much higher than the price of lactating cow concentrate at the Teaching Farm (IDR 4,307/kg). This may also be influenced by the amount of forage feed consumed, which tended to increase as calf starter substitution decreased, resulting in relatively similar feed costs across all treatments. It is evident that forage feed consumption was P1 (1.62 %BW), P2 (1.65 %BW), P3 (1.78 %BW), and P4 (1.68 %BW). This is in line with the opinion of Gustiani and Rismiyanti (2015), who stated that the cost of feed depends on the price of the feed ingredients used, the level of consumption, and the level of feed efficiency. According to Handayanta *et al.* (2017), the relatively high value of FC/G is due to the relatively high price of feed ingredients and low feed efficiency, meaning that the feed costs incurred are not commensurate with the daily weight gain achieved.

Table 4 shows the average results for FC/G, ranked from highest to lowest as follows: (P1) IDR 33,927/kg ADG; (P4) IDR 30,800/kg ADG; (P2) IDR 30,492/kg ADG; and (P3) IDR 29,363/kg ADG. The study by Bjorklund *et al.* (2013) stated that the feed costs for weaned calves ranged from IDR 36,000 to IDR 50,000/ kg ADG. Research by Gading *et al.* (2019) reported that the feed costs for weaned calves ranged from IDR 17,000 to IDR 19,000/ kg ADG. High feed costs can affect the income of farmers. This is in line with the opinion of Artonang (1993), who stated that farmers' income would be profitable if their earnings are sufficient to cover all production facilities. The net income from cattle farming is obtained from the income minus the expenses incurred during the production/maintenance process.

In this research, the non-significant results in FE and FC/G indicate that the lactating dairy cow concentrate (Table 1: CP = 16.40%, TDN = 64.91%) can be used for growing weaned calves on smallholder farms, especially when accompanied by the ad libitum provision of quality grass. This occurs because the rumen of weaned calves is already ready to digest roughage, allowing nutrients from forages and concentrates to complement each other.

Conclusion

Administering 100% LDCC to weaned female HF calves could result in feed efficiency and feed cost per gain that not significant with the sub-

stitution of CS (25-75%) in LDCC.

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Conflict of interest

The authors have no conflict of interest to declare.

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