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Increase in Body Dimensions of Post-Weaning Female Holstein Friesian Calves Due to the Use of Lactation Cow Concentrate by Calf Starter Substitution

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ABSTRACT

The aim of the study was to analyze the increase in body dimensions of post-weaning female Holstein Friesian (HF) calves fed with lactation cow concentrate with different levels of calf starter substitution. The material was 4 post-weaning female HF calves aged 4-5 months, with an average weight of 101.38 ± 14.21 kg. The feed consisted of elephant grass, calf starter (CS), and lactation cow concentrate (LCC). The study used a Latin square design, with 4 concentrate treatments, i.e. P1 (75% CS and 25% LCC), P2 (50% CS and 50% LCC), P3 (25% CS and 75% LCC), P4 (100% LCC); and 4 replications in 4 periods (each period in 1 month). The concentrate was given 1% BW in the dry matter; elephant grass and drinking water were provided in a measurable ad libitum. The research parameters were the increase in body dimensions (heart girth (HG), body length (BL), and withers height (WH)). The treatments had no significant effect ($p>0.05$) on the increase in body dimensions, were P1 (HG = 2.31 cm/month, BL = 4.75 cm/month, WH = 1.95 cm/month), P2 (HG = 4.23 cm/month, BL = 4.38 cm/month, WH = 2.23 cm/month), P3 (HG = 4.60 cm/month, BL = 4.38 cm/month, WH = 2.35 cm/month), P4 (HG = 4,10 cm/month, BL = 3.48 cm/month, WH = 2.18 cm/month). It was concluded that with sufficient quality forage feed, giving 100% LCC to post-weaning female HF calves could result in an increase in body dimensions that was relatively the same as the substitution of CS (25-75%) in LCC as concentrate feed.

Keywords: post-weaning female HF calves, body dimensions, calf starter, lactation cow concentrate

INTRODUCTION

Feeding and drinking as well as calf health are important factors that need to be considered in order to get good calf growth, both pre-weaning and after-weaning. Calves that have been weaned do not get milk and fulfill their nutritional needs in full from forages and concentrates (Kusumawati et al., 2018; Atabany et al., 2020). Calves can be weaned when they are 8 weeks old, i.e. after they are able to consume calf starter 0.5-0.68 kg/day, but at this age weaning has a high risk of calf death so that calves are generally weaned at 3 months of age (NRC, 2001; Prihantoro et al., 2012). When weaning, the calf enters the initial phase of growth, so most of the nutrients consumed will be used for growth such as enlargement of the body skeleton (Imran et al., 2012; Welboren et al., 2019).

The body dimensions of the female calf when weaning are very important because the female calf which from the start already has the ideal body dimensions, will also be an ideal breeder. In addition to body weight gain, the increase in body dimensions (heart girt, withers height, body length) in weaning calves is also a measure of the calf's appearance or performance (Hardiono et al., 2016; Rotondo et al., 2021). The calf when post-weaning should have a heart girt of 96 cm and a withers height of 75 cm so that later it can meet the target of a heart girt of 155 cm and withers height of 115 cm at the time of entering the age of 15 months for first mating (Alim and Hidaka, 2002). The formation of body dimensions is influenced by the adequacy of nutrient needs. Weaning calves are usually fed high-quality forage and concentrates formulated to meet nutritional needs and increase body weight (ASAS, 2020).

However, in practice in the field, the provision of feed for post-weaning female calves has not been well considered by small farmers. Generally, smallholder farms provide lactation cow concentrates to calves with the consideration of cheaper concentrate prices. At least lactation cow concentrate has a crude protein CP content is 16-21% and TDN of 70-80% (BSN, 2017). Whereas the nutritional needs of female calves from post-weaning to heifers are different from those of adult cattle, so calves need to be given different feeds from adult cows.

The substitution of calf starter in lactation cow concentrate was carried out with the aim of improving the nutritional quality of the concentrate feed given to weaning calves. Calf starter is different from lactation cow concentrate both physically and in quality (Mukodiningsih et al., 2012). Post-Weaning calves that receive higher-quality feed will produce better performance in body dimensions as well. Larger body weight and body dimensions at the same age indicate better growth (Turiello et al., 2016; Nemati et al., 2016).

This study aimed to determine and examine the increase in body dimensions of post-weaned female Holstein Friesian (HF) calves fed with dairy cow concentrate with different levels of substitution of calf starter.

MATERIAL AND METHOD

Materials

The materials used were 4 post-weaning female Holstein Friesian (HF) calves aged 4-5 months with an average weight of 101.38±14.21 kg. The calves were kept in metabolic cages for the duration of the study. 300 cm long measuring tape with 0.1 cm accuracy and a 1.5 m stainless steel measuring stick with 0.1 cm accuracy were used to measure the body dimensions of livestock. The feed used was elephant grass (*Pennisetum purpureum)*, lactation cow concentrate (LCC), and calf starter (CS) produced by Teaching Farm FPP Undip.

Methods

The feed provided was forage and concentrate treatment which was adjusted to the dry matter (DM) needs of the calves. Treatment concentrate (in DM) was given as much as 1% body weight (BW) in two doses, i.e. in the morning at 06.00 and in the afternoon at 15.00. Forage and drinking water are provided on a measured ad libitum basis. The forage was given one hour after the concentrate was given. The treatment concentrates consisted of P1 (75% CS and 25% LCC), P2 (50% CS and 50% LCC), P3 (25% CS and 75% LCC), and P4 (100% LCC). The nutritional content of the feed given is shown in Table 1. The research design used was the Latin Square Design (LSD) with 4 treatments and 4 periods.

Feeding and residues of feed and drinking water to livestock were recorded in a logbook on a regular basis. The study was conducted in 4 periods, each period was carried out for 30 days of observation. The parameters measured were heart girth (HG), body length (BL), and withers height (WH). Measurement of body dimensions was carried out at the beginning and end of the period based on Welboren et al. (2019) and Lardy et al. (2020), followed by a break for 5 days and continued to the next period.

Statistical Analyses

All data were analyzed using analysis of variance (ANOVA) based on the Latin Square Design. If there was a treatment effect, then Duncan's test was continued to determine the difference between treatments.

Table 1. Nutrient content of feed

Feed	Water	Ash	EE	CF	CP	NFE	TDN
	--(%)--		---------- (% DM) ----------				
Lactation Cow Concentrate (LCC)	9.42	9.90	6.42	26.87	16.40	40.41	64.91
Calf Starter (CS)	11.17	12.32	5.25	8.74	19.70	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	17.80	18.05	47.21	70.52
P3	9.86	10.50	6.13	22.33	17.25	43.79	67.71
P4	9.42	9.90	6.42	26.87	16.40	40.41	64.91

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

RESULTS AND DISCUSSION

The results of the study on the effect of substitution of calf starter on lactating cow concentrate on body dimensions increase in post-weaning HF female calves are presented in Table 2. Treatment of calf starter substitution on lactating cow concentrate (P1, P2, P3, and P4) had no significant effect ($p>0$ 0.05) on the average body size at the end of the study and the increase in body dimensions of livestock which includes heart girth, body length, and withers height. These results have the same phenomenon as the research of Purwadi (2017) that giving concentrates with different protein content, i.e. 10.23% and 13.79% in post-weaning female calves aged 3.5 months gave no significant effect on body dimensions increase.

The increase in body size that did not differ between treatments could be caused by the relatively same amount of daily consumption so that the nutrients digested by the calves were also the same. The average DM consumption was also not significantly different, i.e. P1 3.43 kg/day, P2 3.54 kg/day, P3 3.58 kg/day and P4 3.34 kg/day. The substitution of calf starter was intended to make the nutritional content of concentrate feed for post-weaning calves better at smallholder farms when compared to feed from lactation cow concentrate alone. Forage feed was given in a measurable ad libitum with the aim of the calves being able to meet the nutritional deficiencies from the consumption of concentrates by obtaining them from forage consumption. However, giving a concentrate that was 1% of body weight or with a forage: concentrate balance of 70:30 in this study, it was assumed that if the consumption of DM was relatively the same, the consumption of other nutrients was relatively the same as well. Nutrients from the feed digestion process in the form of energy, protein, fat, minerals, and so on will be used by the calf to meet the nutritional needs for calf growth. Imran et al. (2012) stated that the nutrients digested by the calf will be used to meet the needs to support the growth of the calf according to its genetics. Research by Kargar et al. (2019) also shows the body dimensions of post-weaning calves that were not different because the amount of DM consumption and the nutritional content consumed were relatively the same. According to Winarti and Widyastuti (2016), almost the same DM consumption will result in calf growth between treatments, there was no difference because the consumption of nutrients was almost the same, both from consumption of crude protein, crude fat (ether extract) and crude fiber.

The growth of the post-weaning calves is indicated by the increase in body dimensions. Calf body dimensions were strongly influenced by feeding, feed consumption and digestibility. The results of this study showed that the increase in body dimensions of post-weaning calves between treatments was relatively the same. This was presumably because during post-weaning the rumen conditions and functions have developed perfectly, so that the results of fermentative digestion of feed in the rumen that can be used for the growth of the post-weaning calves in each treatment were relatively the same, resulting in relatively the same body dimensions even though the calf starter has the better quality than lactation dairy cow concentrate. This can be caused by the condition of the rumen in post-weaning calves that are ready to digest solid feed. McCurdy et al. (2019) stated that when the calf has been weaned, the calf rumen is ready to digest solid feed and the rumen becomes much more sensitive to food fermentability. Rumen microbes were thought to have been able to ferment concentrates and forage well, so that sufficient microbial protein was available for post-weaning calves at P1, P2, P3 and P4. Pramita et al. (2016) stated that rumen microbes are the main source of protein for the host, besides that rumen microbes play an important role in digesting feed because they can produce enzymes that can digest fiber in low-quality feed.

The rumen of the post-weaning calves had a fairly complete set of microorganisms. Xiao et al. (2016) stated that in the rumen of the calf there are fungi, protozoa, and bacteria which include fiber-digesting bacteria such as *Fibrobacter succinogenes*, *Ruminococcus albus*, and *Ruminococcus flavefaciens*, as well as other bacteria such as Prevotella, Butyrivibrio fibrisolvens, Shuttleworthia, and Desulfovibrio. In addition, there are two groups of protozoa that are abundant in the rumen, i.e. entodiniomorphid (oligotrich) and holotrich (Yanuartono et al., 2019). With a ready-made rumen condition, post-weaning calves are able to properly utilize forage and concentrates to meet their nutritional needs. This resulted in the administration of lactation cow concentrate with a CP content of 16.40% and TDN of 64.91% (P4), which resulted in an increase in body dimensions that was relatively the same as the concentrate substituted of calf starter (P1, P2, P3) if accompanied by the administration of optimal forage. In this study, post-weaning female HF calves received concentrate as much as 1% of BW and forage given ad libitum.

Table 2. Average body dimensions of post-weaning female HF calves

Variables	Treatments			
	P1	P2	P3	P4
Initial Body Dimensions (cm)				
Heart Girth	116.92±8.45	115.25 ±13.58	114.55 ±9.84	115.40 ±6.30
Body Length	96.33 ±8.68	97.27 ±10.82	98.95 ±7.93	99.25 ±3.30
Withers Height	70.40 ±4.62	70.92 ±4.83	71.50 ±3.76	71.20 ±2.48
Final Body Dimensions (cm)				
Heart Girth	119.23 ±7.82	119.48 ±12.25	119.15 ±7.46	119.50 ±6.46
Body Length	101.08 ±7.89	101.65 ±9.72	103.33 ±7.67	102.73 ±4.22
Withers Height	72.35 ±3.92	73.15 ±3.67	73.85 ±3.23	73.38 ±1.60
Increase in Body Dimensions (cm/month)				
Heart Girth	2.31 ±1.36	4.23 ±1.85	4.60 ±2.81	4.10 ±1.13
Body Length	4.75 ±3.10	4.38 ±1.80	4.38 ±1.41	3.48 ±1.83
Withers Height	1.95 ±1.08	2.23 ±1.58	2.35 ±2.16	2.18 ±1.48

Increase in Heart Girth (HG)

The increase in heart girth of calves treated with calf starter substitution on lactation cow concentrates was 2.31±1.36 cm/month (P1), 4.23±1.85 cm/month (P2), 4.60±2.81 cm/month (P3), and 4.10±1.13 cm/month (P4). These results were lower than the study results of Manthey et al. (2016) with the addition of DDGS treatment in concentrates with different concentrations in Holstein's calves, i.e. an average of 5.22 cm/month, also the results of research by Wang et al. (2017) who gave a concentrate with a different physically effective neutral detergent fiber (peNDF) content in Holstein's calves, i.e. 5.36 cm/month. Differences in the results of these studies can be caused by genetic influences, environmental climate, feed given, and maintenance management. This is in accordance with the statement of Ratnasari et al. (2019) that differences in growth in livestock can be caused by climate, the genetic capabilities of each animal, maintenance, and feed management.

Giving calf starter substitution in lactation cow concentrate had no effect on the increase in heart girth of post-weaning female HF calves ($p>0.05$). This condition may occur because the nutrition from the feed consumed by the calf has been used for bone growth, organ growth, and meat growth. This was in accordance with the opinion of Parsons et al. (2020) who stated that body size is closely related to body weight which is influenced by bone growth and then fat deposition. The growth of meat and bones affects the size of the heart girth, chest width, abdominal girth, and body weight of livestock, while bone growth affects body length, withers height, and body weight of livestock. The increase in the size of the heart girth occurs because the heart girth is closely related to the body weight of the cattle, so when the weight of the cattle increases, the heart girth will be even bigger, including in HF calves (Sulistyowati et al., 2009; Hardiono et al., 2016; Rotondo et al., 2021). Syaiful et al. (2020) stated that the bigger the heart girth, the bigger the organs in the chest cavity such as the heart and lungs, therefore heart girth can be used as an indicator of the calf body capacity.

Increase in Body Length (BL)

Giving calf starter substitution to lactation cow concentrate had no effect on the increase in body length for post-weaning female HF calves ($p>0.05$). The results of each treatment were 4.75±3.10 cm/month (P1), 4.38±1.80 cm/month (P2), 4.38±1.41 cm/month (P3) and 3.48±1.83 cm/month (P4). This result was higher than the average result of Anderson et al. (2015) in the treatment of concentrates from grains with different fat and protein content in Holstein calves, which was an average of 3.93 cm/month, but lower than the average results of Wang et al. (2017) on concentrate treatment with different physically effective neutral detergent fiber (peNDF) content in Holstein's calves, i.e. 6.15 cm/month. The results of these studies differ because they are caused by several factors, i.e. livestock age, genetics, feed quality, and maintenance management (Vavrisinova et al., 2019).

The size of the calf's body length did not differ, this was a result of the treatment with calf starter substitution on lactation cow concentrate, which could be due to genetic influences and almost the same age. This is in accordance with the research results of Senevirathne et al. (2016) that there was no difference between treatments for calf body dimensions, indicating that calves were in the same period so that the growth rate of their body skeletons did not differ. At the time the research was carried out, the calf was in the growth

acceleration phase so that the feed consumed by the calf would be used maximally for the growth of its body frame. Putra and Fajrina (2020) stated that the maximum growth rate occurs when the calf is 4-8 months old. This was reinforced by the opinion of Nugraha et al. (2016) who stated that livestock growth is influenced by the feed given, if the feed provided is of good quality and in sufficient quantity, then livestock growth will also be good.

Increase in Withers Height (WH)

Giving calf starter substitution to lactation cow concentrate did not have a different effect on the increase in withers height of post-weaning female HF calves ($p>0.05$). The treatment concentrate gave an increase in the size of the wither's height by 1.95±1.08 cm/month (P1); 2.23±1.58 cm/month (P2); 2.35±2.16 cm/month (P3) and 2.18±1.48 cm/month (P4). This result was lower than the results of the study by Manthey and Anderson (2018) by giving corn and soybean-based concentrates (with ad libitum forage) to Holstein's calves which resulted in an average increase in withers height of 3.03 cm/month. Differences in the results of this study can be influenced by factors such as the age of livestock, environmental climate, feed given, and maintenance management (Place & Mitloehner, 2010).

The results of the increase in wither height which did not differ from all treatments with calf starter substitution in lactation cow concentrate were also due to the age of the calf which was in the early stages of growth so that the nutrients from the feed consumed were used for bone growth, including the forefoot bones that greatly affect the value of withers height. This was in accordance with the opinion of Syaiful et al. (2020) which stated that at the age of 0-6 months the calf experiences faster growth in its forelegs because the forelegs are used to actively move when the calf is suckling on its mother, in addition, the forelegs are used to support the calf body weight. The increase in wither height is closely related to the growth of the calf's skeletal bones. This was in accordance with the opinion of Maluhima et al. (2019) who stated that withers height is influenced by several factors, including feeding management, genetics, the condition of the livestock itself, and having a close relationship with the size of the calf frame.

CONCLUSION

The substitution of calf starter on lactation cow concentrate did not have a different effect on the increase in body dimensions (heart girth, body length, withers height) of post-weaning female HF calves. Lactation cow concentrate with PK 16.40% and TDN 64.91% followed by good quality forage in sufficient quantities was able to meet the nutritional needs of weaning calves seen from the performance of increasing body dimensions.

CONFLICT OF INTEREST

There is no conflict of interest with financial, personal, or other relationship with other people or organizations associated with material discussed in the manuscript.

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