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Research Article

Effects of Feeding Glucogenic and Lipogenic Diets on Performance and Blood Parameters of Transition Dairy Cows and Their Calves

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ABSTRACT

Introduction: Several studies have explored the impact of diet type on energy sources. The current study aimed to evaluate the impact of feeding glucogenic versus lipogenic diets to Holstein dairy cows during the close-up period on cows' performances and their calves' growth parameters.

Materials and methods: Twenty-four Holstein dairy cows with an average parity of 3 selected for the study, starting 21 days before expected calving. The cows were divided into three groups based on a randomized complete block design including a control diet (glucogenic diet, Glu), a low lipogenic diet (Llip) with 25% barley grain replaced by beet pulp, and a high lipogenic diet (Hlip) with 50% barley grain replaced by beet pulp. Daily recording of dry matter intake (DMI) was conducted, with blood samples collected on the day of parturition in cows and days 1, 2, 7, and 21 of calves age. In dairy cows, both the quality and quantity of colostrum were determined. Additionally, performance variables including feed intake, average daily gain, and skeletal parameters such as shoulder height, hip height, and body length were measured. Blood parameters, such as glucose, triglyceride, and concentrations of certain liver enzymes, including alkaline phosphatase (ALP), serum glutamic-pyruvic transaminase (SGPT), and serum glutamate oxaloacetate transaminase (SGOT) were recorded.

Results: The increase of beet pulp in the prepartum diet led to a significant increase in DMI. Colostrum yield and constituents (protein, lactose, and solids nonfat percentage) decreased with an increase in beet pulp level and the differences between Glu and Hlip were significant. Performance parameters of the calves were similar across all treatments, except skeletal growth. Calves that were fed the Hlip diet showed a lower shoulder height compared to those fed the Glu diet. Blood glucose was significantly higher in cows and their offspring that were fed Llip diets compared to other groups. The concentration of liver enzymes, including ALP, SGPT, and SGOT was not affected by treatments.

Conclusion: Substituting barley grain with beet pulp as a lipogenic component may enhance dry matter intake in periparturient dairy cows. However, it did not show a notable impact on offspring performance.

1. Introduction

High-producing dairy cows have high metabolic needs after calving. Due to milk production and a sudden increase

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in energy needs compiled with a decrease in dry matter intake (DMI) up to 40%[1], which cannot be met by consumed feed alone and compel them to mobilize body fat and predispose them to fatty liver and ketosis[2]. According to previous studies, increasing energy intake from sources of grains in the periparturient period to improve energy balance (EB) is the most important strategy to reduce the rate and severity of metabolic disorders in early lactation[1,3,4]. However, it may increase the risk of some other metabolic problems, including acidosis, displaced abomasum, and other diseases around parturition. Some grains, such as corn and barley, which are the main energy sources of almost all concentrates, are directly edible to humans, reducing grains in dairy cattle diets and may improve sustainability in addition to cow health effects[5,6].

In ruminants, the sources of lipogenic nutrients are either the fermentation of fiber to acetate and butyrate or dietary-originated fatty acids that accumulate as body reserves. Beet pulp, a byproduct of beet-related industries, is recognized as a lipogenic substance with the ability to stimulate bacteria that produce acetate[7] and contains high levels of digestible neutral detergent fiber (NDF, 40.6% of DM) and pectins (23% of DM)[8]. Similar to some cereals in total DM digestibility and produces higher molar proportions of acetate than grains[9,10]. The replacement of beet pulp as a lipogenic component in the diet for cereal grains proves to be efficient in reducing the starch content of the diet and enhancing ruminal health[10] without adverse effects on milk production[10-13]. Researchers have reported that cows fed a lipogenic diet allocated more energy into milk production compared to cows fed a glucogenic diet. Additionally, cows on a lipogenic diet showed higher levels of energy mobilized from body fat stores than those on a glucogenic diet[13].

Despite numerous studies comparing the impact of feeding glucogenic and lipogenic diets to prepartum cows on their postpartum performance, there is a lack of research on the long-term effects of diets incorporating beet pulp as a lipogenic ingredient. Specifically, there are no reports examining the growth rate and skeletal development of the progenies, which is referred to as developmental programming in the references[14,15]. The objective of the present study was to examine the effect of feeding beet pulp as a lipogenic ingredient versus barley grain as a glucogenic ingredient on dry matter intake, blood metabolites, and quantity and quality of colostrum of dairy cows, and besides examining this replacement effects on progeny growth performance and blood parameters.

2. Materials and Methods

2.1. Ethical approval

All animals were treated by the regulations on the guidelines of the Iranian Council of Animal Care (1995), and the experiment was approved by the Iranian Ministry of Agriculture (experimental permission no. 1828).

2.2. Experimental design

A total of twenty-four multiparous (mean parity=3) Holstein cows (254-259 days pregnant and BCS 3.5 ± 0.3) were randomly assigned to 1 of 3 dietary treatments (8 cows per treatment) as a randomized complete block design during the close-up period. The treatment's diet consisted of glucogenic (control, Glu), a low lipogenic diet (25% of barely grain replaced by sugar beet pulp, Llip), and a high lipogenic diet (50% of barely grain replaced by sugar beet pulp, Hlip). The ingredients (% DM) and chemical composition of close-up diets are presented in Table 1. Diets were fed as total mixed ration *ad-libitum* twice a day at 0800 and 1600 h. The feed offered was adjusted daily to yield 5-10% orts.

Samples of feeds and orts (about 0.5 kg) were taken daily to put in storage at −20°C and weekly composite samples from feeds and orts were dried at 60°C for 48 hours to analyze DM, NDF, CP, EE, and ash[16].

Blood samples (10 ml) were withdrawn from the coccygeal vein of cows on the day of parturition 3-4 hours after morning feeding using evacuated tubes with and without anticoagulant (Heparin). Blood samples (2 ml) were taken from newborn calves immediately after birth before colostrum feeding and 2, 7, and 21 days after birth. Plasma was separated by centrifuging the blood samples at 3000 × g for 15 minutes and stored at −20°C until further analysis. Serum separated after blood was allowed to clot for 1 hour at room temperature. After the experiment, plasma samples were thawed and concentrations of glucose, albumin, and total protein, urea, triacylglycerol were determined using commercial kits (Pars Azmoon Company, Tehran, Iran) employing the method of spectrophotometry (UNICCO, 2100; Zistchemi Co., Tehran, Iran). The concentration of plasma globulin was determined by subtracting the amount of albumin from the total protein. Sera samples were analyzed for liver enzymes, including Alkaline phosphatase (ALP), serum glutamic-pyruvic transaminase (SGPT), and serum glutamic-oxaloacetic transaminase (SGOT).

Table 1. Ingredients and chemical composition of experimental diets in the close-up period in Holstein dairy cow

	Treatments[1]		
	Glu	**Llip**	**Hlip**
Corn silage	32.65	32.65	32.65
Alfalfa hay	12.24	12.24	12.24
Barely grain	39.38	29.39	19.59
Cottonseed meal	2.04	2.04	2.04
Soybean meal	6.35	6.53	6.55
Canola meal	2.04	2.04	2.04
Vit-permix[2]	1.22	1.22	1.22
Anionic premix[1]	4.08	4.08	4.08
Beet pulp dry	0	9.80	19.59
Chemical composition[2]			
DM (%)	52	45	45
CP (%)	15.4	14.3	14.2
EE (%)	2.40	2.30	2.10
NFC (%)	41.30	37.50	35.40
NDF (%)	34.60	38.20	40.80
NEl (Mcal/Kg DM)	1.62	1.56	1.54

[1]: Anionic premix contained 150 g Calcium chloride, 200 g Ammonium chloride, 200 g Magnesium sulfate, and 300 g carrier. [2]: 150,000 IU/kg of vitamin A, 25,000 IU/kg of vitamin D, and 1,500 IU/kg of vitamin E, DM: Dry matter; CP: Crude protein; EE: Ether Extract; NFC: None fiber carbohydrates; NDF: Neutral detergent fiber, NEl: Net energy for lactation

Table 2. Ingredients and chemical composition of the calf starter

Ingredient (%)		Chemical composition	
Alfalfa	6.6	DM (%)	93
Barely grain	15.7	CP (%)	19.3
Corn grain	50	EE (%)	3.6
Soybean meal	24.8	Ca (%)	0.67
Calcium carbonate	0.80	P (%)	0.46
Salt	0.50	NDF (%)	15.3
Calcium phosphate	0.50	ME (Mcal/Kg DM)	2.7
Sodium bicarbonate	1		
Min-vit premix [1]	0.1		

[1] Composition: 120 g/kg of Ca, 20 g/kg of Mg, 2.25 g/kg of Mn, 7.7 g/kg of Zn, 1.25 g/kg of Cu, 0.056 g/kg of I, 0.013 g/kg of Co, 0.010 g/kg of Se, 250,000 IU/kg of vitamin A, 50,000 IU/kg of vitamin D, and 1,500 IU/kg of vitamin E.

Colostrum yield was recorded on the day of calving and colostrum samples were collected from all cows to assay its components and parameters related to its quality (IgG, pH, SCC, and Specific Gravity). Calves received their dam-specific colostrum during the first 3 days of life and thereafter were supplied with 4 liters of milk replacer twice a day and a similar starter (Table 2). The daily measurement of calves' feed intake was conducted, and they were subsequently weaned once they had consistently consumed 1 kg of starter feed for a period of three consecutive days. Calves were weighed on a weekly basis, while skeletal characteristics, such as body height, body length, hip height, hip width, and size were assessed on day 30 and again on day 56.

Statistical analysis

Data were analyzed in a randomized complete block designed by the analysis of variance (ANOVA) using the MIXED procedure of SAS software V9.1 (SAS Inst., Inc., Cary, NC)[17]. Means were compared using Duncan's new multiple-range test.

$$yijk=\mu+Ti+Wj+TWij+Bk(Xi-X)+eijk$$

Where yijk= each observation, μ= overall mean, Ti= fixed effect of treatment, Wj= effect of week, TWij= interaction effect of treatment × week, Bk= covariate factor of initial weight, and eijkl= random error term.

3. Results

The results of the present study indicated that cows fed the lipogenic diets (Hlip and Llip) had significantly higher DMI than those fed the glucogenic diet in the prepartum period ($p < 0.05$, Table 3); Colostrum yield significantly was lower in the Hlip diet than Llip or Glu diets ($p < 0.05$, Table 4). Although treatments had no significant effect on the IgG concentration of colostrum, other constituents including protein, lactose, solid-not-fat, and total solid percent decreased significantly, and fat percentage tended to decrease as the level of sugar beet pulp increased in Llip and Hlip diets ($p < 0.05$). Colostrum produced in lipogenic treatments (Llip and Hlip) had a higher somatic cell count (SCC) compared to the Glu diet ($p < 0.05$).

Calves performance parameters, including feed intake, average daily gain (ADG), and feed efficiency were not affected by treatments (Table 5). As there were no significant differences among treatments with respect to DMI and ADG, the lack of difference in relation to feed efficiencies was logical.

Weaning weight is one of the most important parameters in evaluating the calves' performance and the

Table 3. Effect of feeding lipogenic versus glucogenic diets in the close-up period on feed intake of Holstein dairy cows

Items	Treatments [1]			SD	P value
	Glu	Llip	Hlip		
-30 to -15	11.16[b]	12.07[ab]	15.05[a]	0.89	0.01
-15 to 0	11.74[b]	13.74[ab]	14.57[a]	0.75	0.04
-30 to 0	11.54[b]	13.12[ab]	14.65[a]	0.65	0.01

[1] Glu: control diet, Llip: replacing 25% beet pulp with barley, Hlip: replacing 50% beet pulp with barley

[2] a and b superscripts in the same row show a significant difference in the means ($p < 0.05$), SD: Standard deviation

Table 4. Effect of feeding lipogenic and glucogenic diets before parturition on colostrum quality and quantity in Holstein dairy cows

Items	Treatments[1]			SD	P value[2]
	Glu	Llip	Hlip		
Colostrum (Kg)	8.2	7.1	5.2	0.66	0.04
Fat (%)	5.96	3.39	3.97	0.79	0.07
Protein (%)	24.16[a]	17.44[b]	19.28[b]	1.33	0.005
Lactose (%)	5.48[a]	4.92[ab]	4.15[b]	0.23	0.002
SNF (%)	36.24[a]	28.51[b]	29.84[b]	1.46	0.002
Total solid (%)	43.02[a]	32.71[b]	34.71[b]	1.67	0.006
IgG (mg/dl)	144.49	150.59	129.75	25.21	0.83
SCC	652875[a]	1083205[ab]	2342857[b]	479067	0.05

[1] Glu: control diet, Llip: replacing 25% beet pulp with barley, Hlip: replacing 50% beet pulp with barley, SD: Standard deviation

[2] a and b superscripts in the same row show a significant difference in the means ($p < 0.05$), SNF: Solid non-fat content, SCC: Somatic cell count

Table 5. Effect of lipogenic and glucogenic diets before parturition on dry matter intake, average daily gain, and feed efficiency of calves

Items	Treatments[1]				P value
	Glu	Llip	Hlip	SD	
Feed intake					
0-4 wk	0.38	0.38	0.41	0.01	0.62
4-8 wk	1.00[b]	1.10[a]	1.01[b]	0.12	0.69
0-8 wk	0.80	0.85	0.81	0.06	0.81
Average Daily Gain (Kg)					
0-4 wk	0.29	0.19	0.11	0.06	0.22
4-8 wk	0.56	0.75	0.60	0.08	0.30
0-8 wk	0.45	0.47	0.38	0.058	0.55
Feed efficiency					
0-4 wk	0.44	0.31	0.20	0.10	0.31
4-8 wk	0.62	0.64	0.66	0.09	0.96
0-8 wk	0.54	0.46	0.43	0.07	0.56

SD: Standard deviation, wk: Week

calves fed the Hlip diet in comparison with the control group (GLU) significantly had the lowest weaning weights ($p < 0.05$, data not shown). However, weaning weights were not significantly different between calves on Glu and Hlip diets. Table 6 Presents the parameters related to skeletal growth of calves aged 30 days and weaning at day 30. Except for shoulder height, other skeletal growth-related traits were not affected by treatments. On day 30 and at weaning age, calves whose mothers had received a glycogenic diet (Glu) had higher shoulder height than those fed the Hlip diet ($p < 0.05$). Hip width was greater in the control treatment (GLU) than in other treatments (LKG and HKG), although these effects were not significant ($p > 0.05$).

Blood metabolites of cows and calves are presented in Tables 7 and 8, respectively. As indicated in Table 7, there was no significant difference among treatments in relation to blood parameters of cows including TG, cholesterol, HDL, LDL, Alb, and TP, except plasma glucose concentration in cows fed the Llip diet. There was a significantly higher concentration of glucose rather than those fed the Hlip diet ($p < 0.05$). Moreover, the concentration of hepatic enzymes, including SGOT, SGPT, and ALP did not differ among treatments. Similar to dams, except for the blood glucose concentration of calves before colostrum intake, other blood parameters including, BUN, cholesterol, TG, HDL, and LDL, before and after feeding colostrum were not affected by treatments (Table 8). Following parturition but before colostrum intake, calves born to cows that were on a Llip diet before giving birth exhibited notably elevated blood glucose levels compared to calves from other treatments ($p < 0.05$). However, this difference in blood glucose concentration disappeared once the calves started consuming colostrum.

Table 6. Effect of lipogenic and glucogenic diets before parturition on skeletal growth of calves

Items	Treatments[1]			SD	P value[2]
	Glu	Llip	Hlip		
Body size					
30 days	81.88	85.88	88.72	5.19	0.70
Weaning	90.50	89.50	90.83	4.89	0.93
Shoulder height					
30 days	82.56[a]	81.09[ab]	78.58[b]	0.52	0.01
Weaning	86.36[a]	84.19[ab]	82.94[b]	0.80	0.02
Hip height					
30 days	84.63	83.13	82.56	0.90	0.25
Weaning	88.61	86.61	86.44	2.1	0.66
Hip width					
30 days	14.50	14.01	13.82	0.44	0.70
Weaning	15.01	14.88	14.46	0.30	0.52
Body length					
30 days	40.15	39.80	40.86	0.94	0.86
Weaning	40.83	41.33	40.95	0.44	0.76

[1] Glu: control diet, Llip: replacing 25% beet pulp with barley, Hlip: replacing 50% beet pulp with barley

[2] a and b superscripts in the same row show a significant difference in the means ($p < 0.05$), SD: Standard deviation

Table 7. Effect of feeding lipogenic versus glucogenic diets before parturition on blood metabolites of cows at parturition

Item[2]	Treatmens[1]			SD	P value[3]
	Glu	Llip	Hlip		
G (mg/dl)	74.66[ab]	88.64[a]	68.68[b]	4.48	0.02
BUN (mg/dl)	29.21	21.25	23.25	10.18	0.43
Chol (mg/dl)	56.66	62.62	51.14	7.52	0.59
TG (mg/dl)	18.33	15.75	18.33	2.12	0.60
HDL (mg/dl)	44.40	50.25	40.10	5.62	0.44
LDL (mg/dl)	10.66	9.19	10.50	3.86	0.93
Alb (g/dl)	3.92	3.55	3.25	0.24	0.19
Glu (g/dl)	3.47	3.80	3.77	0.29	0.70
Alb/Glu	1.14	0.94	0.86	0.18	0.22
TP (g/dl)	7.40	7.35	7.02	0.50	0.85
SGOT (iu/l)	63.12	58.66	61.33	3.69	0.71
SGPT (iu/l)	17.33	17.21	17.34	1.23	0.97
ALP (iu/l)	141.5	114.33	110.60	61.32	0.55

[1] Glu: control diet, Llip: replacing 25 % beet pulp with barley, Hlip: replacing 50 % beet pulp with barley
[2] G: Glucose, BUN: Blood urinary nitrogen, Chol: Cholesterol, TG: Triglyceride, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, Alb: Albumin, Glu: Globulin, Alb/Glu: Albumin/Globulin, TP: Total Protein, SGOT: Serum glutamate oxaloacetate transaminase, SGPT: Serum glutamic-pyruvic transaminase, ALP: Alkaline phosphatase, SD: Standard deviation
[3] a and b superscripts in the same row show a significant difference in the means ($p < 0.05$)

Table 8. Effect of feeding lipogenic and glucogenic diets before parturition on some blood metabolites of calves

Item[2]	Treatmens[1]			SD	Pvalue[3]
	Glu	Llip	Hlip		
Glucose					
Before colostrum intake	62.25[b]	82.56[a]	60.30[b]	3.42	0.001
After colostrum intake	104.51	108.75	102.41	16.41	0.93
BUN					
Before colostrum intake	21.50	20.10	21.25	1.77	0.81
After colostrum intake	36.31	35.50	39.50	6.72	0.90
Chol					
Before colostrum intake	28.75	25.25	24.61	3.56	0.63
After colostrum intake	47.07	47.25	46.25	5.30	0.99
TG					
Before colostrum intake	23.13	21.71	15.28	4.86	0.53
After colostrum intake	57.25	41.25	41.25	4.61	0.06
HDL					
Before colostrum intake	7.81	6.55	8.10	1.10	0.59
After colostrum intake	30.25	25.50	28.75	4.73	0.77
LDL					
Before colostrum intake	16.95	15.20	13.15	2.91	0.66
After colostrum intake	8.75	13.45	9.50	1.41	0.12

[1] Glu: control diet, Llip: replacing 25 % beet pulp with barley, Hlip: replacing 50 % beet pulp with barley
[2] BUN: Blood urinary nitrogen, Chol: Cholesterol, TG: Triglyceride, HDL: High density lipoprotein, LDL: Low density lipoprotein, SD: Standard deviation
[3] a and b superscripts in the same row show a significant difference in the means ($p < 0.05$)

4. Discussion

In the present study feeding cows by lipogenic diets (Hlip and Llip) significantly increased DMI. In agreement with Voelker and Allen[12]'s study, the use of lipogenic ingredients in ration, such as sugar beet pulp promoted feed intake due to an increase in apparent digestibility of dry matter and organic matter, which in turn increases the digestibility of soluble natural detergent fiber. Additionally, in some studies, replacing barley with beet pulp increased DMI in prepartum dairy cows[18,19]. Conversely, contrary to the findings of the present study, one can increase the quantity of beet pulp while simultaneously reducing an equivalent portion of grain (barley or corn)[20] and in the another study replacing corn grain with beet pulp in the ration of dairy cows did not affect DMI[20]. Increased DMI in cows consuming beet pulp diets may be attributed to the enhanced digestibility of fiber in beet pulp, as well as the promotion of rumen health and fibrolytic activity. These factors can lead to improved nutrient availability from forages and a subsequent increase in feed intake[11,12]. In addition, the higher DMI might be attributed to the palatability (smell, taste, or texture) of the beet pulp in the current study. Although the DMI increased in prepartum, surprisingly colostrum yield was decreased by the replacement of barley with beet pulp. There exists limited empirical support regarding the variables that impact the quantity of colostrum generated by dairy cows. According to National Research Council[8], there was no statistical difference in colostrum volume among different dietary levels of energy treatments, although cows fed energy-controlled diets produced numerically less colostrum than cows fed high-energy diet. Although colostrum production has traditionally been negatively correlated with Ig concentration[21]. Despite the decrease in colostrum production, no significant effect was observed on the amount of IgG.

Results for milk are reported here, as there is a scarcity of experiments examining the impact of a lipogenic diet on colostrum quantity in prepartum cows. Although feeding beet pulp promotes ruminal production of lipogenic acetate[22], the increased beet pulp feeding was accompanied by a decrease in the milk fat content[23]. Opposite to the present study, the replacement of corn grain with beet pulp in the ration of dairy cows did not affect milk yield or compounds, including fat, protein, or lactose percent[22]. In several studies, Substituting beet pulp for grains increased milk fat content[10,18-20,24]. In order to minimize energy loss through milk production, it has been proposed that inhibiting the synthesis of milk fat could be an effective mechanism[25] in early lactation and therefore indirectly reduce adipose tissue lipolysis. It has been proposed that suppression of milk fat synthesis in early lactation cows is a mechanism to limit energy loss through milk[25], thereby indirectly reducing adipose tissue lipolysis. An explanation for the conflicting results in the present study, as opposed to previous studies, could be attributed to the timing of colostrum sample collection immediately after parturition. During this period, there is a significant reduction in DMI, leading to body fat mobilization that may obscure the true impact of milk diet on milk fat content[22].

There have been varying reports on the impact of substituting grain with beet pulp on the milk protein content in dairy cows. Different studies have yielded conflicting results in this regard. Mansfield et al.[9] reported decreases and no effect in milk protein content with dietary beet pulp was reported by Voelker and Allen[19]. According to van Knegsel[24], the lipogenic diets have a negative effect on milk protein production. The decrease in milk protein probably can be attributed to changes in fermentation pattern and changes in volatile fatty acids ratios (propionate reduction), productions[10,12] or reduction in rumen microbial protein synthesis[26]. Furthermore, the findings of the current study on lactose concentration is consistent with previous studies which observed that lipogenic diets could reduce milk lactose[13,18,22]. Probably, lower glucogenic substances in lipogenic diet have led to decreased milk lactose content.

When evaluating performance parameters, it was observed that there were no notable variances among treatments in terms of DMI and ADG. Therefore, the absence of distinctions in feed efficiencies between the treatments was deemed reasonable. Limited information is available regarding the effects of manipulating the carbohydrate level and source in prepartum transition cow diets on the performance of their calves. Small et al.[27] did not report any significant effect of fat supplementation during the transition period on feed intake and weight gain of calves. In contrast to the findings of these studies, it was demonstrated that incorporating fat supplements into the diet of cows in the close-up stage resulted in an increase in average daily gain (ADG) in their calves.

providing a high versus low energy diet during late gestation in beef cattle increased calf birth weight and subsequent weaning weight[28]. There was no correlation between the nutrient restriction in cows and the birth weights or postnatal growth of their calves[29]. In contrast, Underwood et al.[30] reported greater postnatal growth and feed efficiency in steers born from cows that were nutrient-restricted during a similar period of gestation (day 31-120) at the expense of the dam's tissue because nutrient partitioning during pregnancy favors the fetus at the expense of the dam and the placenta efficiency may be different[31]. In the current study, the difference between the treatments in relation to the energy of the diet before parturition was insignificant, although there was no significant difference among the treatments in terms of birth weight.

Several studies have examined the impact of altering the diet of cows in close proximity on the skeletal development of their offspring. Based on a study by Robinson et al.[32] nutrient restriction in beef cattle can decrease birth weights and result in slower postnatal growth, however, there was no limitation in feed delivery in the present study, so the calves' birth weights were similar among treatments. Surprisingly the calves from dams fed the beet pulp significantly had lower weaning weights. It was found that adding fat supplement to the periparturient diet (close up) had a significant effect on the skeletal growth of calf after birth to weaning and they declared this effect was probably due to meeting the metabolic demands for elongated polyunsaturated fatty acid (PUFA) [33]. Although prenatal feeding did not change birth weight, a potential epigenetic effect of maternal diet (lipogenic versus glucogenic) on postnatal calf metabolism cannot be ruled out.

Regards to blood metabolites, only plasma glucose in Llip diet exhibited a notable rise. In contrast to the findings of the current study, other studies did not observe any significant alteration in blood glucose levels when cows were given varying amounts of sugar beet pulp[18,22]. Furthermore, it is reported that blood glucose concentration decreases in consuming lipogenic diets and increases when glucogenic diets is consumed[13]. Plasma glucose levels may be influenced by dietary intake, ruminal fermentation byproducts, and the absorption of metabolites along the gastrointestinal tract. Higher plasma glucose concentration in cows fed the Llip diet may be related to improved rumen stability and better use of propionate without falling into subclinical acidosis and other metabolic problems. In agreement with the obtained results, the replacement of barley grain with beet pulp had no significant effects on the concentration of blood metabolites, including cholesterol, TG, and BUN during the prepartum period[18]. In addition, no effect on blood cholesterol concentration was observed when corn grain was replaced with beet in the diet of dairy cows[22]. In accordance with the current study, Münnich et al.[22] mentioned, diets had no significant effects on the liver enzymes AST, Glutamate dehydrogenase, and γ Glutamyltransferase.

Cholesterol has been reported to be transported across the placenta, reach the fetal circulation, and thus contribute significantly to the fetal cholesterol pool[34] and it may carry over the first weeks of life. Since maternal plasma cholesterol concentrations were similar, It was logical that the cholesterol concentration in the plasma of the calves was similar. In the present study, the calves that were born from dams, which fed the lipogenic diets had numerically lower blood total protein concentration. In a relatively other study, the calf blood total protein was related to breed, age, lactating number of mothers, calving situation, season, and stress[35]. The ratio of albumin to globulin in calves is reported as one, and if this number was greater than one, it indicated increased liver function, and the lower number, indicated increased immune activity[36].

4. Conclusion

The results of the present study indicated that using sugar beet pulp in the diet of periparturient dairy cows (close-up period) significantly increased dry matter intake. Although the treatment that incorporated sugar beet pulp resulted in increased feed intake, it did not yield any favorable outcomes in terms of colostrum quantity. In fact, the amount of colostrum exhibited a linear decrease as the proportion of sugar beet pulp in the diets increased. Additionally, in the present study cows on Llip had significantly higher blood glucose concentration at the time of parturition and their respective calves also had higher blood glucose concentration after birth before colostrum feeding, however, soon after colostrum feeding this effect was disappeared and there were no significant differences in blood glucose concentration of calves among different treatment after colostrum feeding. The dry matter intake of calves was not affected by the treatments. The weaning weight of the calves was significantly reduced by the presence of sugar beet pulp in their mothers' diet, resulting in a lower live weight for these calves at the end of the study. The shoulder height of calves born to mothers who were not given sugar beet pulp was greater compared to the other two treatments (Llip and Hlip). The obtained results of the current study indicated that the relationship among prepartum diet, colostrum composition and yield, and calf health, and performance need further investigation.

Declarations

Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

The authors contributed to writing the initial manuscript almost equally. Masoud Alikhani, Mohsen Mardan Zadeh, Ahmad Riasi, Mahdi Eftekhari, and Mehdi Bahrami Yekdangi conceptualized the review idea, strategized the topic development, and did the ultimate writing and analysing of data. The final manuscript was checked by all authors.

Authors' relationships and activities

Authors are responsible for disclosing all relationships and activities that might bias or be seen to bias their work.

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Availability of data and materials

Data from the present study are available by reasonable request from the corresponding author.

Ethical considerations

The authors have made necessary ethical considerations (e.g., plagiarism, consent to publish, misconduct, datafabrication, and/or falsification, double publication and/or submission, and redundancy).

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