European Journal of Agriculture and Food Sciences
Vol 6 | Issue 5 | October 2024
ISSN 2684-1827

RESEARCH ARTICLE

Influence of Dietary Manipulation on the Blood Biochemical Profile and Growth Performance of Crossbred Dairy Heifer

Md. Sadakatul Bari, Md. Abunaser, Most. Arifa Zannat, Md. Sadman Tahmid, Md. Baktir Uddin Shad, Mohammad Ashiqul Islam, and Md. Harun-ur-Rashid*

ABSTRACT

This study aimed to assess the influence of dietary manipulation with commonly available concentrate sources on the nutritional status and growth performance of crossbred dairy heifer. Concentrates that were used alternatively in three feed preparations were (Wheat bran, rice polish, and maize powder). Twelve crossbred (50% Holstein Friesian (HF) blood) daily heifers; age around 12–13 months; body weight 173–196 kg were chosen from the existing dairy herd of Bangladesh Agricultural University (BAU) Dairy Farm, Department of Dairy Science, BAU. Latin square design was used to conduct the study. The feeding experiment lasted for a duration of 100 days (ten days for the adjustment period and the rest 90 days for the main trial that was divided into three periods). Blood analysis, growth performance measurement, feed efficiency calculation, and feed cost analysis were performed at 15-day intervals. Among the twelve blood biochemical parameters, no significant ($p<0.05$) variation was found except the result of total cholesterol, which was found to be highest in the rice polish-fed group (170.1 mg/dL). Body weight gain per 15 days was significantly higher (9.08 kg/15 days), and dry matter intake per kg of body weight gain (9.56 kg DMI/kg BWG) was significantly lower when heifers were supplied with feed preparation containing wheat bran. The other body growth parameters didn't show any significant difference when fed with three feed preparations.

Keywords: Blood metabolites, Concentrate feeding, Growth performances, Holstein cross.

Submitted: February 29, 2024
Published: October 11, 2024

10.24018/ejfood.2024.6.5.793

Department of Dairy Science, Bangladesh Agricultural University, Bangladesh.

**Corresponding Author:*
e-mail: harunds@bau.edu.bd

1. Introduction

Bangladesh is a densely populated agro-based country gifted with favorable conditions where livestock is an integral part of agriculture that plays an important role in the national economy. The livestock population in Bangladesh is currently estimated to comprise 25.7 million cattle [1], and they survive on inadequate amounts of concentrate with a straw-based diet with limited supplementation of green fodder and vitamin-mineral premix under farm conditions. Different countries have developed their own standards and feeding systems based on experiments conducted with farm animals in the agro-climatic and economic conditions prevailing in the country [2].

Rearing heifers is an essential part of dairy herd turnover. The method of heifer rearing and length of the rearing period determined the cost and quality of heifers entering the dairy herd and replacing surplus or unproductive culled cows. A well-raised heifer with a higher genetic potential is the best substitute for an inadequate cow and does not bring about any economic losses that might be incurred due to high rearing costs or poor performance of fresh heifers. The shortening of the rearing period (non-productive time) would lead to cost reduction. This can be achieved by faster heifer growth, earlier onset of sexual maturity, breeding, and calving [3].

Growth is one of the basic physiological processes that take place during the initial phase of animal life. It is influenced by genetic potential, nutrition, and environmental factors. Generally, heifers do not have constant growth rate. In fact, the most usual pattern is a faster growth between the birth and onset of puberty, followed by a slower growth period [4], [5]. Therefore, the most

efficient way of increasing the growth potential of heifers is to improve nutrition in the pre-pubertal phase [6]. Hence, proper feeding of green and dry fodder along with sufficient concentrates during this phase is of paramount importance, which is generally not given consideration under the field conditions by the farmers. The proper ratio of dry matter intake from both the green and dry fodder can enhance the growth in the initial stage of development in growing animals [7]. The beneficial effects of feeding green fodder are well documented. Green roughages are of great importance in feeding of ruminant animals because of their cooling and slightly laxative action. They help to maintain proper appetite and keep the animal in healthy condition [8]. Green fodders are bulky, palatable, easily digestible, and good sources of β-carotene, minerals, essential amino acids, and peptides. Moreover, green fodder contains certain unidentified factors which stimulate microbial growth in the rumen [9]. On the other hand, dry fodder with better fiber contents and control of gut movement can help the system for better retention time and absorption of nutrients. Apart from the providing energy, crude fiber content in dry roughage is of great importance which plays an important role in giving a feeling of fullness to ruminant animals.

Proper feeding may improve the performances of heifer. Nutrition influences ovarian follicle development in cattle, possibly through changes in metabolic hormones, which are important for a dairy heifer. Proper nutrition can improve the reproductive performance of dairy cattle [10]. Due to inadequate nutrition heifer rearing period and sexual maturity becomes extended [11]. Nutrition is a major determinant of pubertal period of dairy cattle. Nutrition-related infertility in dairy heifer can cause delayed puberty, which ultimately increases the age of 1st calving [12]. Alam *et al*. [13] found that increasing the amount of fish meal in the diet of crossbred heifer improves the dry matter intake, body weight gain, and reproductive responses. Ten to fifteen percent of heifers born do not reach first calving, and improper feeding is one of the major causes [14].

In current livestock feeding practices, wheat bran, maize, rice polish, etc., have become important concentrate sources of Bangladesh. Different studies on nutritional influence on heifer growth performance have been conducted in Bangladesh and over the world [13], [15]–[20]. However, there is still a gap to investigate the influence of dietary manipulation with commonly used and available concentrates on the performances of dairy heifers. Based on the above understanding, this study was carried out to explore the effect of dietary manipulation on the blood biochemical profile and growth performances of crossbred dairy heifers.

2. Materials and Methods

2.1. Experimental Site

The feeding trial of dairy heifers was conducted at Dairy farm, Department of Dairy Science, Bangladesh Agricultural University (BAU), Mymensingh-2202, Bangladesh (GPS coordinates-24.729338, 90.423133).

2.2. Duration of the Experiment

The total duration of the feeding trial was 100 days, of which the first 10 days were the adjustment period and the rest 90 days was the experimental period. The experimental period (90 days) was divided into three periods (P_1, P_2 and P_3).

2.3. Animal Selection, Dietary Ration Formulation and Layout Formation

Twelve crossbred dairy heifers, 50% HF crossbred, aged around 12–13 months, with body weight 173–196 kg were selected for the experimental purpose from an existing dairy herd of Dairy farm, Department of Dairy Science, BAU. The twelve heifers were randomly divided into three groups each containing four heifers. Each heifer was allotted an individual concrete floor stall, manger, and water trough in a face-out stanchion barn. Also, well-ventilation and good sanitary conditions were maintained in the barn to keep the heifer comfortable throughout the study period. German grass *(Echinochloa polystachya)* was given as basal roughage. Maize powder, rice polish, and wheat bran were used as the main ingredients of three concentrate mixtures (CM) that were considered as the treatment.

The ration was formulated by consulting available feeding standards (NRC and BSTI guidelines), previous research findings at the same station, and animals' productivity. During the study, roughage was fixed for all group while feed preparation with three different concentrates was provided as treatment. Wheat bran, rice polish, maize powder, common salt, rock salt and DCP were included at appropriate ratio in concentrate mixture, respectively. The ingredient composition and nutrient content of each of the diets are provided in Table I.

The layout of the experiment was three by three Latin Square Design (LSD) (Table II).

2.4. Feeding and Management of the Experimental Heifer

Adjustment period of 10 days was carried out for habituating the heifers with the experimental diet. Concentrate mixture was supplied in an individual manner to the experimental heifers twice a day at 7.00 AM and 12.30 PM. Each time, 2 kg of concentrate mixture was supplied to each heifer. Roughage was supplied at 1.00 PM to all groups of heifers. All the animals had free access to clean, fresh drinking water for 24 hours. All the animals were moved to open space every morning for free exercise after completing their morning feeding for two hours. During the experimental period, the barn was cleaned twice a day, and the washing of animals was done in the morning and afternoon with the help of a hose pipe. The water remaining in the manger that was supplied the previous day was drained out in the morning, and after cleaning the manger, fresh water was supplied. The dung was collected and stored in the manure pit of Dairy Farm, BAU. Regular supervision of the experimental heifer shed made a better health management of animals and a hygienically clean environment.

TABLE I: Layout of the Experiment

Period of the study	Diet provided to different group		
	Group-1 (A)	Group-2 (B)	Group-3 (C)
Period-1 (0–30) day	BR+CM with WB	BR+CM with RP	BR+CM with MP
Period-2 (31–60) day	BR+CM with RP	BR+CM with MP	BR+CM with WB
Period-3 (61–90) day	BR+CM with MP	BR+CM with WB	BR+CM with RP

Note: BR = Basal roughage, CM = Concentrate mixture, WB = Wheat bran, RP = rice polish, MP = Maize powder.

TABLE II: Ration Formulation with Three Different Concentrate Sources and Nutrient Composition of the Rations

Feed ingredients	Dietary formulation		
	Maize (M)	Rice polish (RP)	Wheat bran (WB)
German	78.36	78.49	78.38
Wheat bran	–	–	10.17
Maize powder	9.11	–	–
Rice polish	–	9.41	–
Mustard oilcake	4.65	4.66	4.23
Soybean meal	5.09	4.65	4.43
Molasses	1.85	1.85	1.85
Dicalcium phosphate (DCP)	0.47	0.47	0.47
Common salt	0.23	0.23	0.23
Rock salt	0.24	0.24	0.24
Total	100.00	100.00	100.00
Nutrient composition (DM basis)			
DM % of fresh matter	33.87	33.65	33.83
CP %	12.07	12.03	12.03
EE %	2.77	3.52	2.91
CF %	26.84	28.96	27.51
NFE %	46.39	42.20	45.37
OM %	87.93	86.57	87.69
Ash %	11.30	12.65	11.54
ME (MJ/Kg of DM)	9.00	9.00	9.00

Note: DM = Dry matter, CP = Crude protein, EE = Ethar extract, CF = Crude fiber, NFE = Nitrogen free extract, OM = Organic matter, ME = Metabolizable energy.

2.5. *Collection of Blood and Serum Separation*

Heifers were restrained in a stall using the halter before collection of blood. The skin on the jugular vein was cleaned by cotton with 70% alcohol solution and approximately 10 mL blood samples were collected from each experimental heifer. Then, the blood samples were kept in blood collection tube until centrifugation. All the blood specimens were centrifuged at 3000 rpm for 10 minutes at 25 °C by a centrifuge machine (Centurion Pro PRP S, UK) at Dairy Cattle Production Laboratory, BAU, Mymensingh-2202, Bangladesh. After centrifugation, serum was harvested from the blood collection tube by using micropipette tips and taken into 1.5 mL tubes which were stored at −20 °C until analyzed. After initial blood collection, the procedure was repeated at 15 days interval throughout the study period.

2.6. *Analysis of Blood Sample*

Blood samples were analyzed for Serum glucose (mmole/L), Serum total protein (g/dL), Serum albumin (g/dL), Serum urea (mmole/L), Serum calcium (mg/dL), Serum phosphate (mg/dL), Serum triglyceride (mg/dL), Total cholesterol (mg/dL), Alanine aminotransferase (U/L), Aspartate aminotransferase (U/L), Alkaline phosphatase (U/L), Enzyme creatinine (mg/dL) by using the Bio Analyzer (Mispa CCXL, Agappe Diagnostics, Switzerland) at Dairy Cattle Production Laboratory, BAU, Mymensingh-2202, Bangladesh.

TABLE III: Mean Value of Initial Body Parameters of Three Group

Parameters	Group-1 (A)	Group-2 (B)	Group-3 (C)
Body weight (kg)	178.0	193.3	187.6
Wither height (cm)	45.74	46.59	45.46
Body length (cm)	50.56	52.32	52.16
Heart girth (cm)	41.36	42.68	42.01

2.7. *Measurement of Growth Performance*

At the starting of the experiment, body weight (kg), wither height (cm), body length (cm) and heart girth (cm) of each heifer were measured and recorded as the initial body weight of each heifer. Mean value of each group of these parameters is given in Table III. These growth parameters of each heifer were recorded at every 15-day interval.

2.8. *Feed Efficiency and Feed Cost Calculation*

Daily dry matter intake by each heifer was recorded. The feed cost of each kg feed in three different feed preparations was calculated. Finally, DMI requirement per kg body weight gain and feed cost per kg body weight gain were calculated.

2.9. *Statistical Analysis*

Data was analyzed by 3-way analysis of variance (ANOVA) in three-by-three Latin Square Design (LSD) using IBM SPSS version 22.0 to examine the influence of dietary manipulation, animal group effect and period effect on growth performance and blood biochemical parameters of crossbred heifers. Tukey's HSD test was done to compare the means of different growth parameters and blood biochemical parameters.

3. Result

3.1. *Blood Biochemical Profile of the Heifer*

Table IV shows the blood biochemical profile of the dairy heifer in various groups, periods, and feed preparations. The results revealed that no significant variation was found in three different feed preparation fed group except the result of total cholesterol, which was found highest in rice polish fed group (170.1 mg/dL). Table IV represents that serum glucose, serum total protein, serum albumin, serum urea, serum calcium, serum phosphate, and alanine transferase did not differ significantly ($p > 0.05$) among the three groups (A, B, and C). On the other hand, serum triglyceride, alkaline phosphatase, and enzyme creatinine were significantly higher in group A than in the other two groups. However, the total cholesterol level was significantly ($p < 0.01$) higher in groups A and B than in group C, but no statistical difference is present between them (groups A and B). Considering the effect of period on blood biochemical parameters of heifer, Table IV revealed that period 3 had significantly ($p < 0.05$) higher serum glucose and alkaline phosphatase levels than in the other two periods. Total protein and total urea were higher in period 1 (6.76 g/dL and 4.40 mmole/L, respectively) than in the rest of the periods. However, serum triglyceride levels did not differ significantly between periods 1 and 2, but they were significantly higher than that of period 3. The rest of the nutritional parameters didn't differ significantly ($p > 0.05$) during the period.

3.2. *Growth Performance of Heifer*

Table V shows the effect of group, period, and feed on growth performances of experimental heifers. BWG was significantly influenced by different feed, where concentrate consisting of wheat bran (9.08 kg/15 days) had better results than the other two. There was no significant difference ($p > 0.05$) among the feed treatment for other parameters. On the other hand, Body weight gain (BWG, kg/15 days), Body length gain (BLG, inch/15 days), Heart girth gain (HGG, Inch/15 days), and Wither height gain (WHG, Inch/15 day) didn't differ significantly ($p > 0.05$) among groups (A, B, and C). However, group C had the highest value in all cases. In the case of a period, a statistical ($p < 0.05$) difference was found for BWG and HGG, where periods 1 and 2 showed higher values than period 3. On the other hand, BLG and WHG weren't influenced by period.

3.3. *Feed Efficiency and Feed Cost*

Table VI shows dry matter intake (kg/day) and dry matter required for per kg of body weight gain of the experimental heifers. Dry matter intake (kg/day) was statistically similar ($p > 0.05$) during feeding three different feed treatments, but a significant difference was found among the feed treatments for dry matter intake per kg of body weight gain. Higher dry matter was required to gain each kg of body weight when heifers were fed the concentrate consisting of maize powder and rice polish. Dry matter intake (kg/day) was significantly ($p < 0.05$) higher in group B (6.01 kg/day) than in groups A and C, where there was no significant difference in DMI (kg/day) between groups A and C. On the other hand, group A (14.68 DMI kg/BWG kg) showed the highest dry matter intake per kg of body weight gain, followed by group B and group C. There was a significant effect of the period for DMI (kg/day) and DMI (kg)/BWG (kg). Though in period 3, DMI (kg/day) was higher than in periods 1 and 2 there was no statistical difference ($p > 0.05$) between periods 3 and 2. DMI (kg)/BWG (kg) was highest in period 3 (15.75 kg/BWG kg) and lowest in period 1 (8.83 kg/BWG kg).

Fig. 1 showed that feed cost (BDT) per kg BWG was higher when heifers received the concentrate made with maize powder (323.3 BDT.) and rice polish (301.11 BDT.) followed by wheat bran (211.38 BDT.).

4. Discussion

4.1. *Blood Biochemical Profile of the Heifer*

From Table IV, we can see the blood biochemical profile of the dairy heifer in various groups, periods, and feed preparations. The results revealed that no significant variation ($p > 0.05$) was found when heifers were fed with feed preparations except the result of total cholesterol, which was found to be highest in the rice polish fed group (170.1 mg/dL). Glucose is a vital nutrient for all higher organisms. It is very important for cattle, especially for heifers, as massive energy is required for them for body maintenance, body growth, reproductive tract development, mammary system development, etc., [21]. Reference value of serum glucose level in cattle is between 2.2 to 5.6 mmole/L (ref). In this study, we have got serum glucose levels between 4.23 and 4.38 mmole/L after feeding three different feed preparations. Total protein in blood serum is the sum of all individual protein present in blood serum, of which more than 50% in serum albumin [22]. In this study, we got serum total protein values for feed preparation with maize powder, rice polish, and wheat bran, which are 6.28 g/dL, 6.46 g/dL, and 6.23 g/dL, respectively. According to the source reference value of the serum total protein of cattle is (6.7–7.5) g/dL [23]. However, Pupple and Kuczynska [24] mentioned the reference value of serum total protein in cattle is (5.83–10.27) g/dL. Albumin is synthesized by liver hepatocytes, but very little amount is stored in the liver. Rather, this albumin is rapidly excreted into

TABLE IV: Blood Biochemical Profile (Mean ± SE) of the Heifer

Parameters	Feed					Group					Period				
	MP	RP	WB	SE	p-value	A	B	C	SE	p-value	P_1	P_2	P_3	SE	p-value
Nutritional status															
Serum glucose (mmole/L)	4.21	4.34	4.38	0.170	0.766	4.38	4.32	4.23	0.170	0.805	4.28^{ab}	3.88^{b}	4.76^{a}	0.170	0.004
Serum total protein (g/dL)	6.28	6.46	6.23	0.149	0.544	5.89	6.55	6.54	0.149	0.005	6.76^{a}	6.28^{ab}	5.92^{b}	0.149	0.002
Serum albumin (g/dL)	3.26	3.30	3.23	0.062	0.731	3.18	3.28	3.32	0.062	0.251	3.30	3.24	3.24	0.062	0.752
Serum urea (mmole/L)	3.86	3.85	3.77	0.245	0.958	3.63	3.99	3.85	0.245	0.587	4.40^{a}	3.01^{c}	4.07^{b}	0.245	0.001
Serum calcium (mg/dL)	8.43	8.68	8.32	0.162	0.278	8.36	8.66	8.42	0.162	0.393	8.78	8.45	8.20	0.162	0.053
Serum phosphate (mg/dL)	7.09	7.51	6.85	0.269	0.223	7.05	7.11	7.28	0.269	0.826	7.81	6.74	6.90	0.269	0.019
Serum TG (mg/dL)	38.77	40.63	36.93	3.660	0.776	52.31^{a}	33.97^{b}	30.06^{b}	3.660	0.000	41.00^{a}	45.83^{a}	29.51^{b}	3.660	0.011
Total cholesterol (mg/dL)	154.2^{b}	170.1^{a}	153.5^{b}	4.990	0.043	168.8^{a}	171.7^{a}	137.4^{b}	4.990	0.000	162.4	155.0	160.5	4.990	0.562
AST (U/L)	58.25	63.78	60.06	2.75	0.362	48.09^{b}	66.63^{a}	67.37^{a}	2.75	0.000	63.20	63.45	55.44	2.75	0.081
ALT (U/L)	23.55	25.58	24.52	1.51	0.643	24.8	25.20	24.17	1.51	0.689	25.33	24.62	23.69	1.51	0.746
AKP (U/L)	151.5	152.3	133.8	7.26	0.142	183.3^{a}	118.4^{c}	135.9^{b}	7.26	0.000	123.5^{c}	151.1^{b}	163.0^{a}	7.26	0.002
E-CRE (mg/dL)	0.69	0.74	0.79	0.032	0.135	0.81^{b}	0.70^{a}	0.71^{a}	0.032	0.025	0.73	0.77	0.72	0.032	0.595

Note: (mmole/L) = millimoles per liter, (g/dL) = gram per deciliter, (mg/dL) = milligram per deciliter, (U/L) = unit per liter, TG = triglyceride, AST = Aspartate aminotransferase, ALT = Alanine transaminase, AKP = Alkaline phosphatase, E-CRE = Enzyme creatinine, P_1 = Period 1, P_2 = Period 2, P_3 = Period 3, MP = Feed preparation with Maize powder, RP = Feed preparation with Rice polish, WB = Feed preparation with Wheat bran, SE = Standard error, letter a, b, and c were used to separate mean values.

TABLE V: Body Parameters (Mean ± SE) of the Heifer

Parameters	Group					Period					Feed				
	A	B	C	SE	p-value	P_1	P_2	P_3	SE	p-value	MP	RP	WB	SE	p-value
Nutritional status															
Body weight gain (kg/15 d)	5.63	7.13	7.79	1.89	0.709	9.00^{a}	8.75^{a}	5.79^{b}	1.89	0.037	5.58^{b}	5.88^{b}	9.08^{a}	1.89	0.003
Body length gain (Inch/15 d)	0.72	0.90	1.07	0.228	0.556	0.83	0.94	0.92	0.228	0.943	1.01	1.03	0.65	0.228	0.434
Hearth girth gain (Inch/15 d)	0.44	0.49	0.55	0.280	0.960	0.93^{a}	0.70^{a}	0.14^{b}	0.280	0.021	0.24	0.28	0.97	0.280	0.119
Wither height gain (Inch/15 d)	0.27	0.42	0.60	0.170	0.403	0.59	0.66	0.72	0.170	0.491	0.45	0.55	0.58	0.170	0.591

Note: (kg/15 d) = kilogram per 15 days, (Kg/d) = kilogram per day, DMI = Dry matter intake, BWG = Body weight gain, P_1 = Period 1, P_2 = Period 2, P_3 = Period 3, MP = Feed preparation with Maize powder, RP = Feed preparation with Rice polish, WB = Feed preparation with Wheat bran, SE = Standard error, letter (a, b and c) were used to separate mean values.

TABLE VI: Feed Efficiency (Mean ± SE) Analysis of Heifers

Parameters	Group					Period					Feed				
	A	B	C	SE	p-value	P_1	P_2	P_3	SE	p-value	MP	RP	WB	SE	p-value
Feed efficiency															
DMI (kg/d)	5.51^{c}	6.01^{a}	5.83^{b}	0.125	0.022	5.30^{b}	5.96^{a}	6.08^{a}	0.125	0.000	5.81	5.73	5.79	0.125	0.903
DMI/kg BWG (kg)	14.68^{a}	12.64^{b}	11.22^{c}	0.252	0.044	8.83^{c}	10.21^{b}	15.75^{a}	0.252	0.000	15.61^{a}	14.61^{a}	9.56^{b}	0.252	0.000

Note: (kg/d) = kilogram per day, DMI = Dry matter intake, BWG = Body weight gain, P_1 = Period 1, P_2 = Period 2, P_3 = Period 3, MP = Feed preparation with Maize powder, RP = Feed preparation with Rice polish, WB = Feed preparation with Wheat bran, SE = Standard error, letter a, b and c were used to separate mean values.

the bloodstream [25]. In our study, serum albumin level was between 3.23 to 3.30 g/DL, which was almost just above 50% of serum total protein level. Serum urea level is widely used as an indicator of specific management and health condition of cattle. High serum urea levels may indicate water deprivation, thirst, diarrhea, urinary diseases, acidosis, and so on [26]. Serum urea level in this study was (3.77–3.86) mmole/L, which lies in the reference range (3.6–8.9) mmole/L [23]. Serum calcium level indicates the Ca level in the body, which is a very important macro mineral having both extracellular and intra-cellular activities. Lower Ca concentraition in blood serum indicates hypocalcemia condition, which can cause delayed ovulation in heifers [27]. Both serum Ca and phosphorus are important for the reproductive performance of heifers. Cow with lower serum calcium and phosphorus level face different fertility problem [28]. Serum calcium and serum phosphorus status of the experimental heifers were satisfactory as compared to the reference values of Ca (8.0–11.4) mg/dL and Phosphorus (5.6–8.0) mg/dL [23]. In cattle, serum triglycerides are a crucial part of blood lipid profiles. The health and metabolic state of the animal can be understood from these levels. Normal range of serum tryglycerides in cattle is (12–31) mg/dL. [29]. In our study serum triglycerides content of all experimental heifers was higher (36.9 mg/dL–40.6 mg/dL) from this reference value. However, in some studies, serum triglycerides contents of cattle were reported (39 ± 12) mg/dL [30]. There is a very close relationship between cholesterol and female reproduction in the case of all species. Cholesterol is essential for the ovary and placenta to synthesize steroids hormones and is essential for the development of cell structure during

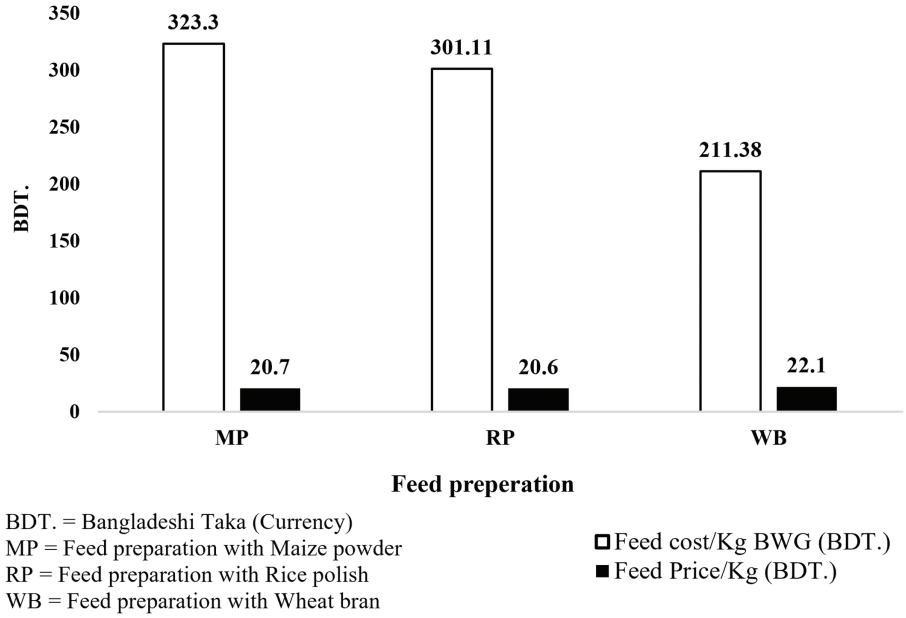

Fig. 1. Feed price and feed cost in different feed preparation.

folliculogenesis [31]. So, cholesterol acts a precursore of reproductive hormones. Therefore, cholesterol level is very important for heifer to have a good reproductive health so that they are able to start folliculogenesis and enter ovulation cycle smoothly. In this study total cholesterol level significantly differed among the three feed preparations fed group where the value was higher (170.1 mg/dL) in feed preparation containing rice polish. Reference level of total cholesterol level is (65–220) mg/dL [32]. Feed preparation containing rice polish had higher ether extract percentage. This high level of dietary fat may be the reason to have higher total cholesterol level. Reiser. [33] also found a positive relation between dietary fat level and blood cholesterol level. Aspartate Aminotransferase (AST) is an enzyme found commonly in the liver, which levels in cattle and is most often used as an indicator of fatty liver syndrome [34]. Increased AST activity in the serum is a sensitive marker of liver damage, even if the damage is of a subclinical nature [35], [36]. AST level of the experimental heifers was (58.25–63.78) U/L, which is around the lower border of the reference value of (60–125) U/L. Like AST, Alanine aminotransferase (ALT) is also a liver enzyme which level is an indicator of liver condition. Reference range of ALT in cattle is (11–40) U/L [32], whereas we have got (23.55–25.58) U/L after feeding three different feed preparation. Serum alkaline phosphatase (AKP) reference range for cattle is (0–500) U/L [32] and we got (133.8–152.3) U/L in our experimental heifers. Serum enzymatic creatinine indicates kidney functionality for organisms. Elevated E-Cre levels indicate loss of kidney functionality. E-CRE level of the experimental heifers lies within the reference range of (0.5–2.2) mg/dL. This result indicates that the quality and quantity of nutrients of these three feed preparations were about similar. For that reason, the blood nutrients were almost similar after feeding three different feed preparation. Besides, calculating the feed effect on blood biochemical profile effect of heifer grouping and period of experiment was analyzed. Serum glucose, serum total protein, serum albumin, serum urea, serum calcium, serum phosphate, and alanine transferase did not differ significantly ($p > 0.05$) among the three groups (A, B, and C). This result indicates very few variations among the groups. On the other hand, Serum triglyceride, alkaline phosphatase, and enzyme creatinine were significantly higher in group A than that of the other two groups. However, the total cholesterol level was significantly ($p < 0.01$) higher in groups A and B than in group C, but no statistical difference is present between them (group A and B). Group B and C (66.63 U/L and 67.37 U/L, respectively) had significantly higher level of aspartate aminotransferase than that of group A (48.09 U/L). Ndlovu *et al*. [37] found more reasons behind the AST levels, such as breed, season, etc. So, different AST level among the group is quite normal. Considering the effect of period on blood biochemical parameters of heifer, Table IV revealed that period 3 had significantly ($p < 0.05$) higher serum glucose and alkaline phosphatase level than in the other two periods. Total protein and total urea were higher in period 1 (6.76 g/dL and 4.40 mmole/L, respectively) than in the two other periods. Serum triglyceride level did not differ significantly between period 1 and 2 but they were significantly higher than that of period 3. Serum triglyceride is higher in periods 1 and 2 may be due to effect of less protein intake in contrast of carbohydrate intake before starting of the experiment. Intake of high carbohydrate enriched feed in comparison to protein feed causes high serum triglycerides [38]. The rest other nutritional parameters didn't differ significantly ($p >0.05$) among the period.

4.2. Growth Performance of Heifer

The effect of group, period, and feed on the growth performances of experimental heifers is shown in Table V. BWG was significantly influenced by different feeds, where concentrate consisting of wheat bran (9.08 kg/15 days) had better results than the other two. This may be due to the higher digestibility of wheat bran than the other two feeds. Wheat bran passes more slowly than maize powder and rice polish after ingestion through the digestive tract,

which provides rumen bacteria with more time to digest the feed. Wheat bran is highly palatable and has water-holding and swelling capacities due to its fiber content, which has a huge effect on the heifer colon [39]. There was no significant difference ($p > 0.05$) among the feed treatment for other parameters. On the other hand, Body weight gain (BWG, kg/15 days), Body length gain (BLG, inch/15 days), Heart girth gain (HGG, Inch/15 days), and Wither height gain (WHG, Inch/15 days) didn't differ significantly ($p > 0.05$) among groups (A, B, and C). However, group C had the highest value in all cases. In the case of a period, a statistical ($p < 0.05$) difference was found for BWG and HGG, where periods 1 and 2 showed higher values than period 3. This may be due to average daily gain with the advancement of age. London *et al*. [40] also found a strong negative correlation between age and average daily gain. On the other hand, BLG and WHG weren't influenced by period.

4.3. *Feed Efficiency and Feed Cost*

Table VI shows dry matter intake (kg/day) and dry matter required per kg of body weight gain of the experimental heifers. Dry matter intake (kg/day) was statistically similar during feeding three different feed treatments, but a significant difference was found among the feed treatments for dry matter intake per kg of body weight gain. Higher dry matter was required to gain each kg of body weight when heifers were fed the concentrate consisting of maize powder and rice polish. As body weight gain was higher in ration containing wheat bran, so DMI/BWG was lower in that group than the other two. Dry matter intake (kg/day) was significantly ($p < 0.05$) higher in group B (6.01 kg/day) than in groups A and C, where there was no significant difference in DMI (kg/day) between group A and C. On the other hand, group A (14.68 DMI kg/BWG kg) showed the highest dry matter intake per kg of body weight gain, followed by group B and group C. There was a significant effect of the period for DMI (kg/day) and DMI (kg)/BWG (kg). Though in period 3, DMI (kg/day) was higher than in periods 1 and 2 there was no statistical difference ($p > 0.05$) between periods 3 and 2. DMI (kg)/BWG (kg) was highest in period 3 (15.75 kg/BWG kg) and lowest in period 1 (8.83 kg/BWG kg). With the advancement of age as average daily gain reduces for that it requires more dry matter for per kg of body weight gain.

Fig. 1 shows that feed cost (BDT) per kg BWG was higher when heifers received the concentrate made with maize powder and rice polish followed by wheat bran. However, this may differ from this study according to region and season as the price of these three concentrate sources may change according to market situation.

5. Conclusion

Proper feeding of dairy heifer ensures better replacing stock for a dairy farm. From our study, we have found that feed preparation with different concentrates (wheat bran, rice polish, and maize powder) has a significant effect on only the total cholesterol level of blood collected from experimental heifers. This cholesterol is important for maintaining good reproductive profile of a heifer. The rest of the blood parameters were almost similar. All the blood biochemical parameters were within the reference range. On the other hand, body weight gain was higher, and dry matter requirements per kg of body weight gain were lower when experimental heifers were provided with the feed preparation containing wheat bran. So, concentrate manipulation has very little effect on blood parameters, but this is very important for body parameters. Moreover, further research is required to find the overall performance of dairy heifers by manipulation of total ration (roughage and concentrate).

Acknowledgment

The authors are grateful to the Ministry of Science and Technology, Bangladesh (Project ID: SRG–221073) for providing funds for this research and the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, for technical support.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

References

[1] BBS. *P denotes Provisional; Prepared by Dr. Hossan Md. Salim, Planning Section*. Department of Livestock Services (DLS); 2022–23.

[2] Mee JF. Reproductive issues arising from different management systems in the dairy industry. *Reprod Domest*. 2012;47:42–50. doi: 10.1111/j.1439-0531.2012.02107.x.

[3] Freeman S. *Biological Science*. U.S.A: Prentice Hall; 2003.

[4] Lyimo HL. Development of dairy calf rearing strategy for smallholder farmers in Turiani division, Mvomero District-Tanzania (Doctoral dissertation, Sokoine University of Agriculture). PhD Thesis; 2006.

[5] Laswai GH, Lyimo HLN, Mtengan LA, Kimambo AE, Mgheni DM, Hvelplund T, *et al.* Effects of local concentrate and weaning age on the performance of crossbred calves. *JAFS, J Anim Feed Sci*. 2007;16(2):419–23. doi: 10.22358/jafs/74572/2007.

[6] Heinrichs AJ, Gabler MT. Dietary protein to metabolizable energy ratios on feed efficiency and structural growth of pre-pubertal Holstein heifers. *JDS*. 2003;86:268–74. doi: 10.3168/jds.S0022-0302(03)73605-4.

[7] Gilbery TC, Lardy GP, Soto-Navarro SA, Bauer ML, Caton JS. Effects of co condensed distiller's soluble supplementation on ruminal fermentation, digestion, and in situ disappearance in steers consuming low-quality hay. *J Anim Sci*. 2006;84:1468–80. doi: 10.2527/2006.8461468x.

[8] Patterson HH, Klopfenstein TJ, Adams DC, Musgrave JA. Supplementation to meet metabolizable protein requirements of primiparous beef heifers: performance, forage intake, and nutrient balance. *J Anim Sci*. 2003;81:800–11. doi: 10.2527/2003.813800x.

[9] Wickersham TA, Titgemeyer EC, Cochran RC, Wickersham EE, Gnad DP. Effect of rumen-degradable intake protein supplementation on urea kinetics and microbial use of recycled urea in steers consuming low quality forage. *J Anim Sci*. 2008;86:3079–88. doi: 10.2527/jas.2007-0325.

[10] Gong J. Influence of metabolic hormones and nutrition on ovarian follicle development in cattle: practical implications. *Domest Anim Endocrinol*. 2002;23(1–2):229–41. doi: 10.1016/s0739-7240(02)00159-5.

[11] LeCozler Y, Lollivierm V, Lacasse P, Disenhaus C. Rearing strategy and optimizing first-calving targets in dairy heifers: a review. *Animal*. 2008 September;2(9):1393–404. doi: 10.1017/S1751731108002498.

[12] Kamal MM. A review on cattle reproduction in Bangladesh. *Int J Dairy Sci*. 2010;5(4):245–52. doi: 10.3923/ijds.2010.245.252.

[13] Alam MS, Rashid MH, Uddin ME, Asaduzzaman M. Effect of supplementation of fish meal on growth and reproductive performance of crossbred heifers. *JBAU*. 2012;10(2):261–6. doi: 10.22004/ag.econ.209332.

[14] De Vries A, Marcondes MI. Overview of factors affecting productive lifespan of dairy cows. *Animal*. 2020 Mar;14(S1):s155–64. doi: 10.1017/S1751731119003264.

[15] Drackley JK. Early growth effects on subsequent health and performance of dairy heifers. Calf and heifer rearing: principles of rearing the modern dairy heifer from calf to calving. *60th University of Nottingham Easter School in Agricultural Science, Nottingham, UK. 23rd–24th March, 2004*, pp. 213–35, 2005.

[16] Abeni F, Petrera F, Le Cozler Y. Effects of feeding treatment on growth rates, metabolic profiles and age at puberty, and their relationships in dairy heifers. *Animal*. 2019;13(5):1020–9. doi: 10.1017/S1751731118002422.

[17] Bazeley KJ, Barrett DC, Williams PD, Reyher KK. Measuring the growth rate of UK dairy heifers to improve future productivity. *Vet J*. 2016 Jun;212:9–14. doi: 10.1016/j.tvjl.2015.10.043.

[18] Le Cozler Y, Peccatte JR, Delaby L. A comparative study of three growth profiles during rearing in dairy heifers: effect of feeding intensity during two successive winters on performances and longevity. *Livest Sci*. 2010 Feb;127(2–3):238–47.

[19] Ghazanfar S, Anjum MI, Azim A, Ahmed I. Effects of dietary supplementation of yeast (Saccharomyces cerevisiae) culture on growth performance, blood parameters, nutrient digestibility and fecal flora of dairy heifers. *J Anim Plant Sci*. 2015 Feb;25(1):53–9.

[20] Islam MS, Habib MR, Islam MA, Rashid MH. Effects of protein concentrate supplementation-based diet on growth and nutritional status in dairy heifers. *JBAU*. 2019;17(1):45–9.

[21] Mair B, Drillick M, Klein-Jöbstl D, Kanz P, Borchardt S, Meyer L, *et al.* Glucose concentration in capillary blood of dairy cows obtained by a minimally invasive lancet technique and determined with three different hand-held devices. *BMC Vet Res*. 2016 Feb 24;12:34. doi: 10.1186/12917-016-0662-3.

[22] Busher JT. *Serum Albumin and Globulin Clinical Methods. Clinical Methods: The History, Physical, and Laboratory Examinations*. 3rd ed. Boston: Butterworth Publisher Emory University School of Medicine; 1990, pp. 497–9.

[23] Susan EF. Serum biochemical analysis reference ranges. Department of Veterinary Pathobiology, College of Veterinary Medicine, Oklahoma State University. 2022. Available from: https://www.msdvetmanual.com/multimedia/table/serum-biochemical-analysis-reference-ranges.

[24] Puppel K, Kuczyńska B. Metabolic profiles of cow's blood; a review. *J Sci Food Agric*. 2016;98(13):4321–8. doi: 10.1002/jsfa.7779.

[25] Moman RN, Gupta N, Varacallo M. Physiology, Albumin [Updated 2022 Dec 26]. In: *StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459198/.

[26] Nozad S, Ramin AG, Moghadam G, Asri-Rezaei S, Babapour A, Ramin S. Relationship between blood urea, protein, creatinine, triglycerides and macro-mineral concentrations with the quality and quantity of milk in dairy Holstein cows. *Vet Res Forum*. 2012;3(1):55–9.

[27] Jonsson N, Pepper PM, Daniel RC, McGowan MR, Fulkerson WJ. Association between non-parturient postpartum hypocalcaemia and the interval from calving to first ovulation in Holstein-Friesian dairy cows. *Anim Sci*. 1999;69:377–83.

[28] Seyfi H, Farzaneh N, Mohri M. Relationships between fertility, serum calcium and inorganic phosphorus in dairy cows. *IJVR*. 2005;6(2):74–8.

[29] Clinical Chemistry Reference Intervals. Veterinary medical teaching hospital university of California, Davis, Available from: https://www.vetmed.ucdavis.edu/hospital/support-services/lab-services/clinical-laboratory-services/forms-and-guidelines.

[30] Khaki Z, Khazraiinia P, Chegini S, Khazraee Nia S. Comparative study of serum lipid profile in chicken, ostrich, cattle, and sheep. *Comp Clin Path*. 2012 Jun;21:259–63.

[31] Dallel S, Tauveron I, Brugnon F, Baron S, Lobaccaro JMA, Maqdasy S. Liver X receptors: a possible link between lipid disorders and female infertility. *Int J Mol Sci*. 2018 Jul 25;19(8):2177. doi: 10.3390/ijms19082177.

[32] Peter GG, Jackson PG, Cockcroft PD, Elmhurst S. *Clinical Examination of Farm Animals*. Blackwell Science; 2002 Jul 12. doi: 10.1002/9780470752425.app2.

[33] Reiser R. Saturated fat in the diet and serum cholesterol concentration: a critical examination of the literature. *Am J Clin*. 1973 May 1;26(5):524–55. doi: 10.1093/ajcn/26.5.524.

[34] Cebra CK, Garry FB, Getzy DM, Fettman MJ. Hepatic lipidosis in anorectic, lactating Holstein cattle: a retrospective study of serum biochemical abnormalities. *JVIM*. 1997 Jul;11(4):231–7. doi: 10.1111/j.1939-1676.1997.tb00096.x.

[35] Meyer DJ, Harvey JW. *Evaluation of Hepatobiliary System and Skeletal Muscle and Lipid Disorders. Veterinary Laboratory Medicine: Interpretation and Diagnosis*. 2nd ed. W.B. Saunders Company; 1998, pp. 157–87.

[36] Kauppinen K. ALAT, AP, ASAT, GGT, OCT, activities and urea and total bilirubin concentrations in plasma of normal and ketotic dairy cows. *Zbl Vet Med A*. 1984 Feb 12;31(1–10):567–76. doi: 10.1111/j.1439-0442.1984.tb01316.x.

[37] Ndlovu T, Chimonyo M, Okoh AI, Muchenje V, Dzama K, Raats JG. Assessing the nutritional status of beef cattle: current practices and future prospects. *Afr J Biotechnol*. 2007 December;6(24):2727–34.

[38] Parks EJ. Effect of dietary carbohydrate on triglyceride metabolism in humans. *J Nutr*. 2001 Oct;131(10):2772S–4S. doi: 10.1093/jn/131.10.2772S.

[39] Islam MS, Khan M, Reza A. Effect of wheat bran substitution for corn and dehydrated alfalfa on finishing lambs. *Bang J Anim Sci*. 2009;38(1–2):61–6.

[40] London ML, Bernard JK, Froetschel MA, Bertrand JK, Graves WM. The relationship between weight, age, and average daily gain to show performance of Georgia 4-H and Future Farmers of America (FFA) commercial dairy heifers. *JDS*. 2012 Feb;95(2):986–96. doi: 10.3168/jds.2011-4599.