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Article

Effect of different level of energy on growth performance of crossbred bull calves

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Abstract: An experiment was conducted to determine the effects of different levels of energy on growth performance of crossbred (Indigenous × Holstein Friesian) bull calves. Feeding trial was conducted for sixty days long with twelve numbers of crossbred bull calves having almost similar body weight (115±5 kg) and age (1 year and 9 months). The parameters of energy requirements for crossbred bull calves were feed intake (DM), nutrient intake, changes in body weight, daily live weight changes, feed conversion efficiency, co-efficient of digestibility of different nutrients, nutritive value and requirements of energy for maintenance and growth. Four levels of dietary energy (T_0, T_1, T_2 and T_3) were supplied to the experimental animals for this purpose. The level of ME was T_0 = 17.4 MJ/d as maintenance ration, T_1 = 20.22 MJ/d for 200 g/d targeted LWG, T_2 = 23.37 MJ/d for 400 g/d targeted LWG, T_3 = 27.29 MJ/d for 600 g/d targeted LWG. It was found that the average daily live weight gain in T_1 (290 g) fulfills against the targeted live weight gain (200 g/d). On the other hand, the expected live weight gain for T_2 and T_3 (400 g/ d and 600 g/d) were not fulfill at the end of experiment. The energy requirement for 100 kg body weight of crossbred bull calves was 17.4 MJ d^{-1} as maintenance and 15.44 MJ d^{-1} required for growth of 200g/ d.

Keywords: crossbred; dry matter; energy requirement; growth performance

1. Introduction

Bangladesh is one of the most densely populated countries in the world where the population growth is increasing at the rate of 3% of the total population as a result the rate of food production is lagging behind that of the population growth. Consequently, to fulfill the nutrient requirement of the huge population becomes tough to tougher. Side by side the consumption of animal protein in the form of meat, milk and eggs is inadequate. The total production of meat was 3.99 million tons in 2014-15 (BER, 2015). The availability of meat is 21 g/d per head against the requirements of 120 g/d per head (DLS, 2005). Therefore, it is clearly indicate that there is a huge shortage of meat production in Bangladesh for human consumption. Livestock play a vital role to the economics of many developing countries especially for Bangladesh. For low income producers, livestock can serve as a store wealthy, provide drought power and organic fertilizer for crop production. In Bangladesh, most of the farmers do not have enough scientific knowledge and unable to afford proper nourishment to the crossbred bull calves as a result severe economic losses. For proper growth and development, adequate nutrients must be supply to the crossbred bull calves. Nutrient requirements of cattle changes based upon stage of production cycle, age, sex, breeds, level of activity, pest load and environment. Nutrition plays a major role to attain the proper weight at proper time (Martson *et al.*, 1995). Though all nutrients are necessary, energy is the most critical nutrient influencing the growth of calves (Bhatti *et al*., 2007). The trend of increasing energy intake bears a positive propensity of increasing live weight gain in bull calves.

The daily ME requirements for bull is 42.2 MJ; of which 23.9 MJ and 18.3 MJ are required for maintenance and production (Das, 1991). The livestock production industry in Bangladesh has been using the feeding standards and management techniques prescribed by the scientific organizations of western countries which are based on data adapted to their existing climate and condition. The use of feeding standards from temperate region in the context of tropical region might not be accurate and hence animal cannot perform adequately. So, feeding standards, particularly nutrient requirements, developed through research by using local cattle is of high importance. However, reports on the nutrient requirements of local bull calves are scanty and limited information is available particularly on the contribution of dietary energy to the growth performance of these animals under Bangladesh condition.

2. Materials and Methods

2.1. Location and duration

The whole experiment was divided into two phases, 1) feeding trail and 2) laboratory analysis. Feeding trail was conducted at the BAU Dairy Farm and laboratory analysis for chemical composition of feed and faeces were done in the laboratory of the Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh. The experiment was carried out for a period of 60 days.

2.2. Layout of the experiment

Layout of the experimental animals is shown in Table 1.

Table 1. Layout of the experimental animals.

Block	Dietary treatments			
	T_0	T_1	T_2	T_3
	Initial live weight (kg)			
A	136 (369)	135 (659)	138 (16)	109 (370)
B	104 (21)	115 (50)	89 (22)	87 (661)
C	116 (336)	98 (669)	119 (660)	151 (18)
Average (kg)	118.67±16.17	116.00±18.52	115.33±24.70	115.67±32.52

T_0 = 17.4 MJ/d (ME) for maintenance ration
T_1 = 20.22 MJ/d (ME) for 200 g/d targeted LWG
T_2 = 23.37 MJ/d (ME) for 400 g/d targeted LWG
T_3 = 27.97MJ/d (ME) for 600 g/d targeted LWG

Figure in the parenthesis indicates the tag number of the animal.

2.3. Housing

The animals were kept individually in a well ventilated "face out stanchion barn" and sufficient space was provided to keep them comfortable.

2.4. Preparation of concentrate mixture

The concentrate mixture was prepared by mixing crushed maize, rice polish, mustard oil cake, wheat bran and common salt. All ingredients were mixed uniformly and kept in polythene bag for future uses.

2.5. Feeding

Twelve male crossbred (Indigenous × Holstein Friesian) bull calves around 115±5 kg live weight (1 year and 9 months of age) were selected for the experimental purposes on the basis of their body condition. Each animal was tagged to maintain individual identity. The requirements of ME were calculated according to MAFF (1993) and AFRC (1993). The four levels of dietary energy (T_0, T_1, T_2 and T_3) were supplied to the experimental animals. German (*Echinocloracrusgalli*) and Para (*Brachiriamutica*) grass along with rice straw were supplied as maintenance ration to the animal throughout the experimental period. But T_1 to T_3 diets contained different rates of concentrates (rice polish, wheat bran, mustard oil cake and salt) which were purchased from Shah Poran poultry feed, Morakhola, Mymensingh. Animals of each treatment group were fed with specified formulated ration twice a day at 7.00 am and 4.00 pm. The mixed concentrate was added with fresh water before feeding to avoid the residual loss and fresh clean water was supplied *ad-libitum*. Measured quantity of diets were offered individually to the animals of above mentioned groups daily and left over were measured individually

throughout the study period using portable digital weighing balance.

2.6. Live weight measurement

Live weight of each animal was measured and recorded before feeding with the help of digital weighing balance. The weight gain was calculated by subtracting the initial weight from the final weight.

2.7. Measurement of body changes (height, body length and heart girth)

The body length, heart girth and height of crossbred bull calves were measured at 15 days interval with the help of measuring tape and measuring scale in centimeter throughout the experimental period. Height, body length and heart girth gain was measured by subtracting the initial height, body length and heart girth from the final height, body length and heart girth. The daily height, body length and heart girth gain was estimated by dividing the total height, body length and heart girth gain by total number of days.

2.8. Digestibility trial

In order to find out the digestibility of proximate components, a conventional digestion trial was conducted for a period of 7 days towards the end of the experiment. Daily feed supply and refusal amount of feed were recorded. The voided faeces were measured in kg and recorded.

2.9. Collection of feed samples

A representative part of roughage (straw and grass) and concentrate mixture were collected for 7 days. Some portion of collected samples was taken to the Animal Nutrition Analytical Laboratory for dry matter determination and the other parts were sundried, grinded and pass through 20 mm screen sieve. Finally the grinded samples were preserved in to air tight polythene bags for chemical analysis.

2.10. Collection of feed refusal samples

They refused feed mainly rice straw by individual animals during the period of 24 hours were weighed and recorded. From the total refusal, a representative portion was taken to the laboratory for DM analysis and 10% of well mixed residue was dried in the sun, grinded and passed through the 20 mm screen sieve. Finally, the samples were preserved into the air tight polythene bag for chemical analysis.

2.11. Collection of faeces

The total quantity of faeces voided daily was recorded against each animal for 7 days. Faeces were collected separately in earthen pots and then kept in polythene bags to avoid the losses of volatile nitrogen and contamination with dirt and urine. About 5 percent of well mixed faeces of each animal was collected everyday and sun dried and stored in polythene bags. About 50 g faeces sample was kept into deep freeze (-20^0 C) from each animal and feed samples were taken for chemical analysis. After finishing the collection period, the total collected faeces samples of 7 days were mixed well after thawing and finally representative samples were taken from the composite one for final analysis after drying these samples. At the end of collection period, all the sun dried faeces were mixed, oven dried and then ground. The portion of fresh sample collected everyday from individual animal was used for determination of dry matter and nitrogen. All other managerial tasks were attempted regularly. Digestibility was calculated by the following formula:

$$\text{Digestibility} = \frac{\text{Intake} - \text{outgo}}{\text{Intake}} \times 100$$

2.12. Chemical analysis

Samples of feeds, residues left, straw and faeces during feeding trial were collected for chemical analysis. Chemical composition was determined according to the method described in AOAC (2000). All the samples were analyzed duplicate and mean values were recorded.

2.13. Statistical analysis

Collected data was analyzed by using Statistical Analysis System (SAS, 2007) version 9.1.3 statistical computer package. Randomized Block Design (RBD) was used to compute the analysis.

3. Results and Discussion

3.1. Feed intake

Effect of different levels of energy on feed and nutrient intake in crossbred bull calves are shown in Table 2. The crossbred bull calves are affected by different levels of energy on feed (DM) intake. Total dry matter intake increased significantly ($P<0.01$) with the increasing levels of energy in the diets. The daily consumption of dry matter also increased with the increased levels of energy. Result shows that, daily dry matter intake was significantly higher in T_3 diets followed by the diets T_2, T_1 and T_0. These results are in agreement with the reports of Mohan and Ranjhan (1985). They reported that, there was a highly significant ($P<0.01$) difference in daily dry matter intake between energy levels. Ahmed (2003) reported that animals consumed more feed to reach the target weight which supports the present findings. Total feed intake per 100 kg live weight of different groups of animals differed significantly among the groups of animal. The diet (T_3) containing higher amount of rice straw along with green grass and concentrate mixture was slightly higher in DM intake than the other three diets (T_0, T_1 and T_2). The higher dry matter intake in group T_3 might be due to more energy was given in this group. The present findings are in agreement with the Rabelo *et al.* (2003), who found that animals fed high energy diet had greater dry matter intake than that of those fed on low energy diet (11.3 vs. 10.5 kg/day). Average dry matter intake was affected by the dietary energy concentration. From these results, it is indicated that supplementation of straw based diet with higher level of energy together increased DM intake.

Crude protein intake differed significantly ($P<0.01$) among the groups of animals receiving different energy diets. The results indicated that crude protein intake was higher (290.00±0.00) in T_3 followed by T_2, T_1 and T_0.

Crude fiber intake of different dietary treatments is presented in Table 2. There were significant differences ($P<0.01$) among the groups where T_3 was the highest. These results indicated that crude protein and crude fiber intake were higher with the increased level of energy. Present findings are in the agreements with Krohn *et al*. (1983), who observed that CF intake increased by increasing energy concentration. There was significant effect of Metabolizable Energy (ME) intake of different experimental diets among the groups of animals. When the values of different groups were compared with each other, it was found that diet T_3 gave higher ME intake than other energy diets.

3.2. Live weight changes

The live weight changes of crossbred bull calves on different diets are presented in the Table 2. The average initial live weight before the commencement of the experiment were 118.67±16.17, 116.00±18.52, 115.33±24.70 and 115.67±32.52 kg for the dietary treatment of T_0, T_1, T_2 and T_3, respectively while after the end of the experiment (60 days), the animals reached to 120.67±16.80, 133.67±20.50, 135.33±27.50 and 140.00±35.37 kg, respectively. Final live weight is not significantly affected among the dietary treatments.

There was significant differences ($P<0.01$) in live weight gain due to dietary energy levels. Result shows that the average live weight gains were significantly increased at T_2 and T_3, than T_0 and T_1. This statement was in agreement with the findings of Limea *et al.* (2009).

The result of body weight changes of local growing bull calves are in agreement with Natthamon (2012), who stated that average daily gain and average body size gain were increased with the increasing metabolizable energy intake. The present findings are in agreement with the Grgor'ev and Gaganov (1991), who reported that average daily live weight gain was decreased with decreasing energy level in the diet.

Table 2 also shows that dietary treatments T_0 and T_1 almost maintained the targeted live weight gain of 0 g/d and 200 g/d, respectively. On the other hand, dietary treatments T_2 and T_3 were failed to maintain 400 g/d and 600 g/d targeted live weight gain. So, it is not possible to make an exact comparison with the results of the present findings. Animals of the present study were fed with the green grass and low quality straw which may be a reason for poor growth response of groups T_2 and T_3 compare to expected daily live weight gain. The nutritive values of traditional roughage and straw were not satisfactory to obtain a high live weight gain of crossbred bull calves. The experiment was conducted during the winter season when growth rate is expected to be poor in general. This may be another reason for poor growth of groups T_2 and T_3. Meanwhile, the overall feed conversion efficiency was not satisfactory. Animals in this group maintained live weight gain at the end of the experiment.

3.3. Feed conversion efficiency

Feed conversion efficiency of different dietary treatments of crossbred bull calves are presented in the Table 2. Feed required per kg live weight gain on diets T_0, T_1, T_2 and T_3 were 81.25±68.02, 11.19±1.61, 10.14±2.20 and 9.06±1.12 kg, respectively.

There was significant (p<0.01) differences among the dietary treatment groups which indicated that different levels of dietary energy had effect on the feed conversion efficiency. Feed conversion efficiency linearly increased with the elevating rate of concentrate intake. The present findings agree with that of Singh *et al*. (1994), who reported that there was improvement in feed conversion efficiency due to high digestibility of nutrient. The results of the present experiment agree with the findings of Ryan *et al*. (2007).

The energetic efficiency of the animals of different groups fed on different diets is shown in Table 2. There was a significant difference (P<0.01) among the dietary group for energy efficiency. It is observed that treatment T_0 gave higher values of both parameters compared to that of other diets. The energetic efficiency was increased in T_2 with the increased amount of energy concentration. The present findings are in agreement with Giger-Reverdin, (2007) who suggested that increased energy supplements can improve energetic efficiency compared to animals fed at maintenance level.

Table 2. Effect of different levels of energy and protein on feed and nutrient intake and live weight changes in crossbred bull calves.

Parameters	Dietary treatments				P Value	Level of sig.
	T_0	T_1	T_2	T_3		
Feed intake:						
Total DM intake (kg/d)	3.25^{b}±0.01	3.25^{b}±0.01	3.27^{b}±0.01	3.63^{a}±0.02	0.0001	**
DM intake (kg/100kg LW)	2.75±0.37	2.65±0.43	2.69±0.58	2.97±0.73	0.889	NS
CP intake (g/d)	240.00^{d}±0.00	247.00^{c}±2.65	270.00^{b}±0.00	290.00^{a}±0.00	0.0001	**
CF intake (g/d)	1306.67^{a}±5.77	1030.00^{b}±0.00	796.67^{c}±5.77	633.33^{d}±5.77	0.0001	**
ME intake (MJ/d)	17.40^{d}±0.00	20.22^{c}±0.00	23.37^{b}±0.00	27.97^{a}±0.00	0.005	**
Live weight changes:						
Initial LW (kg)	118.67±16.17	116.00±18.52	115.33±24.70	115.67±32.52	0.998	NS
Final LW (kg)	120.67±16.80	133.67±20.50	135.33±27.50	140.00±35.37	0.822	NS
Total LWG (kg)	2.00^{c}±1.00	17.67^{b}±2.31	20.00^{ab}±4.58	24.33^{a}±3.21	0.0001	**
LWG (kg/d)	0.04^{c}±0.02	0.29^{b}±0.04	0.33^{ab}±0.08	0.41^{a}±0.05	0.0001	**
LWG (g/kg $W^{0.75}$)	1.23^{b}±0.72	11.08^{a}±2.56	12.63^{a}±4.56	15.59^{a}±5.15	0.007	**
FCR (DMI/LWG)	81.25^{a}±68.02	11.19^{b}±1.61	10.14^{b}±2.20	9.06^{b}±1.12	0.009	**
PCE (CPI/LWG)	8.80^{a}±5.00	0.85^{b}±0.13	0.84^{b}±0.18	0.72^{b}±0.09	0.01	**
Energetic efficiency (MJMEI/kg LWG)	435.00^{a}±362.2	69.53^{b}±9.83	72.51^{b}±15.81	69.73^{b}±8.64	0.011	**

T_0 = 17.4 MJ/d (ME) for maintenance ration, T_1 = 20.22 MJ/d (ME) for 200 g/d targeted LWG, T_2 = 23.37 MJ/d (ME) for 400 g/d targeted LWG, T_3 = 27.97 MJ/d (ME) for 600 g/d targeted LWG, Sig. = Significance, ** = Significant (p<0.01), * = Significant (p<0.05), NS = Non-significant, ^{abcd} means with the different superscripts differed significantly within the row (P<0.05), LWG = Live Weight Gain

3.4. Average body measurements changes (height, body length and heart girth)

Table 3 shows that the total height gain among the dietary treatments T_0, T_1, T_2 and T_3 were 6.99±2.29, 9.31±2.64, 6.33±4.98 and 6.02±1.12 cm, respectively. Analysis showed that there was no significant difference (p>0.05) among the treatments. The results of the present experiment agree with the findings of Firoza (2009) who reported that the average body height of Group-A (green grass, 500 g concentrate mixture and rice straw), Group-B (green grass, 600 g concentrate mixture and rice straw) and Group-C (green grass, 700 g concentrate mixture and rice straw) were 39.43, 39.51, and 39.97 cm, respectively. Statistically they differ none significantly. The average daily height gain increments of the dietary treatments T_0, T_1, T_2 and T_3 were 0.12±0.04, 0.16±0.04, 0.11±0.08 and 0.10±0.02 cm, respectively. Statistical analysis showed that body height gain per day was not significant (p>0.05) difference between the groups. The average body length gain among the dietary treatments T_0, T_1, T_2 and T_3 were 6.56±6.42, 11.43±5.08, 7.62±5.54 and 9.31±4.08 cm, respectively (Table 3). Statistical analysis showed that there was no significant difference (p>0.05) between the treatments. The same results were obtained with the findings of Firoza (2009). She reported that the average body length of Group-A, Group B and Group C were 37.83, 38.14 and 38.60 cm respectively. Statistically they differ none significantly.

The average heart girth gain and per day gain among the dietary treatments T_0, T_1, T_2 and T_3 were 4.33±1.53, 8.33±1.15, 4.00±0.00 and 7.00±2.00 cm and 0.07±0.03, 0.14±0.02, 0.07±0.00 and 0.12±0.03 cm, respectively. Statistical analysis showed that there were a significant difference (p<0.05) between the treatments. Fatema *et al*. (1988) conducted an experiment to study the growth performance of baby calves as influenced by milk

replacers. They reported an average daily gain in heart girth of local × shahiwal cross calves were 0.18 cm/day. This result agrees with the heart girth increment of present experiment. The result of present study also with the result of Khan (2000) who studied on 15 crossbred dairy heifers with various nutrition level and found average daily increases in heart girth were 0.04, 0.04 and 0.12 cm in the treatments.

Table 3. Effect of different levels of energy and protein on body measurements changes (height, Body length and heart girth) in crossbred bull calves.

Parameters (cm)	T_0	T_1	T_2	T_3	P value	Level of sig.
Total height gain	6.99±2.29	9.31±2.64	6.33±4.98	6.02±1.12	0.58	NS
Height gain/day	0.12±0.04	0.16±0.04	0.11±0.08	0.10±0.02	0.578	NS
Total body length gain	6.56±6.42	11.43±5.08	7.62±5.54	9.31±4.08	0.709	NS
Body length/day	0.11±0.11	0.19±0.08	0.13±0.09	0.16±0.07	0.708	NS
Total heart girth gain	4.33^{b}±1.53	8.33^{a}±1.15	4.00^{b}±0.00	7.00^{a}±2.00	0.013	*
Heart Girth/day	0.07^{b}±0.03	0.14^{a}±0.02	0.07^{b}±0.00	0.12^{a}±0.03	0.013	*

T_0 = 17.4 MJ/d (ME) for maintenance ration, T_1 = 20.22 MJ/d (ME) for 200 g/d targeted LWG, T_2 = 23.37 MJ/d (ME) for 400 g/d targeted LWG, T_3=27.97 MJ/d (ME) for 600 g/d targeted LWG, ** = Significant ($p<0.01$), * = Significant ($p<0.05$), NS = Non-significant, ^{abcd} means with the different superscripts differed significantly within the row ($P<0.05$), LWG = Live Weight Gain

3.5. Apparent digestibility and nutritive value of diets

The effect of feeding different levels of energy on apparent digestibility of proximate components is shown in Table 4. There was no significant difference was recorded for the parameter among rations T_0, T_1, T_2 and T_3. It is evident that the digestibility of DM increased with increasing level of energy. Grigor'ev and Gaganov (1991) found digestibility of nutrients was highest in the high energy level and lowest in the low energy level.

The digestibility of crude protein (CP) was higher in T_3 (68.97±2.15) while others were moderate. The digestibility of CP was not significantly affected ($P>0.05$) by increasing levels of energy. For soluble carbohydrate (NFE), rate of digestibility increased with a rate of quality and quantity. Similarly, the digestibility of NFE was not significantly ($P>0.05$) differed among the different dietary groups. The result from this study are in good agreement with report of Walsh *et al.* (2008), who found that digestibility of crude protein and NFE fiber were not affected by increasing energy intake. The daily metabolizable protein absorption through the gut was also rising in trend among the entire increased CP supplemented groups. Dietary CP utilization vary with breed, feed and growth phase (Negesse *et al.*, 2001).

Table 4 shows that the digestibility of crude fiber (CF) was significantly differed ($P<0.05$) among different levels of energy. The digestibility of CF was in peak for T_0 and T_1 while others were moderate. On the other hand, the digestibility of crude fat (EE) was differed significantly ($P<0.05$) by increasing levels of energy. It may be concluded that nutrient digestibility was influenced by different levels of energy intake. These above results agreements in Lohakare *et al.*, (2006) who carried out an experiment with thirty crossbred (*Bos Taurus* × *Bos indicus*) calves aged 3-5 months were divided into 3 equal groups of 10 each and fed graded levels of crude protein, namely 100 (NP), 75 (LP) and 125 (HP) percent of the Kearl recommendations for 105 d. The digestibility of crude fiber and nitrogen free extract was significantly higher ($p<0.05$) in high protein diet compared with low protein diet. At the same time, Reddy and Reddy (1988) also stated that supplementation (energy and protein) of diet increased the digestibility of DM, CP, EE and NFE for crossbred calves.

Table 4 shows the digestible crude protein (DCP) contents of different diets was 3.92±1.09, 4.63±0.15, 5.17±0.61 and 5.32±0.35 for diet T_0, T_1, T_2 and T_3, respectively. There was no significance difference among the different dietary groups. The digestible crude fiber (DCF) and digestible ether extract (DEE) was significantly ($p<0.01$) difference and digestible nitrogen free extract (DNFE) was also differed significantly ($p<0.05$) among the different dietary groups. The total digestible nutrient was higher in T_3, but there were no significance effects among the different dietary treatments. Similarly, ME values were not differed significantly among the values of different dietary treatments. It is clear from the result that dietary levels of energy level affect the nutrient value. The present findings are in agreement with Sugimoto *et al.* (2004), who reported that increased total digestible nutrient intake resulted in increased average daily gain. Again energy rich diets (T_0, T_1, T_2 and T_3) significantly ($p<0.05$) increased DCP, DNFE, DCF and TDN in ruminant that was supported by Ibrahim *et al.* (1998).

Table 4. Apparent digestibility and nutritive value of different experimental diets.

Parameters	Dietary treatments				P Value	Level of sig.
	T_0	T_1	T_2	T_3		
Apparent digestibility (%)						
DM	55.53±4.52	61.13±8.22	61.81±9.85	69.28±6.86	0.254	NS
CP	54.17±15.02	59.77±3.98	62.96±7.41	68.97±2.15	0.281	NS
CF	74.76^{a}±5.30	66.02^{ab}±7.33	51.88^{b}±3.13	48.93^{b}±17.61	0.042	*
EE	30.68^{b}±13.41	61.11^{a}±25.46	63.33^{a}±5.77	68.12^{a}±10.59	0.067	*
NFE	61.25±9.33	49.56±10.03	49.71±6.10	66.33±13.81	0.185	NS
Nutritive value (%)						
Digestible crude protein	3.92±1.09	4.63±0.15	5.17±0.61	5.32±0.35	0.106	NS
Digestible crude fiber	26.71^{a}±1.93	20.87^{b}±2.32	12.74^{c}±0.77	9.58^{c}±3.44	0.0001	**
Digestible ether extract	0.32^{c}±0.14	1.14^{b}±0.50	1.94^{a}±0.18	1.93^{a}±0.30	0.001	**
Digestible nitrogen free extract	22.75^{b}±4.60	26.38^{b}±3.24	28.32^{b}±4.31	40.35^{a}±8.40	0.021	*
Total digestible nutrients	48.80±4.38	51.34±8.61	58.20±13.07	60.39±6.46	0.375	NS
Estimated ME (MJ/kg DM)	7.11±0.64	7.48±1.26	8.48±1.91	8.80±0.94	0.375	NS

T_0 = 17.4 MJ/d (ME) for maintenance ration, T_1 = 20.22 MJ/d (ME) for 200 g/d targeted LWG, T_2 = 23.37 MJ/d (ME) for 400 g/d targeted LWG, T_3 = 27.97 MJ/d (ME) for 600 g/d targeted LWG, ** = Significant ($p<0.01$), * = Significant ($p<0.05$), NS = Non-significant, ^{abcd} means with the different superscripts differed significantly within the row ($P<0.05$), LWG = Live Weight Gain

3.6. Requirement of energy

From Figure 1 we can see that the relationship between energy intake and live weight gain of cross bred bull calves. There was a very linear increasing relationship of gain with energy intake. Maintenance group (T_0) took around 17.40 MJ ME d^{-1} and, other different targeted (200, 400 and 600) daily gain groups T_1, T_2 and T_3 took increasing rate of ME up to 27.97 MJ as maximum limit.

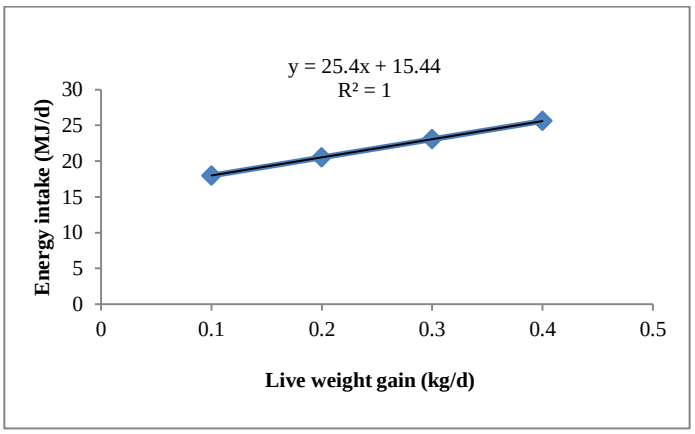

Figure 1. Relationship between live weight changes and energy intake of crossbred bull calves.

Daily energy requirements of 100 kg growing bull was detected from emitted regression equation, (y=25.40x +15.44, R^2=1). The intercept (15.44 MJ d^{-1}) showed the maintenance requirement of ME for 100 kg LW crossbred bull calves. The Y is the dependent variable (ME) strongly correlated (R^2=1) with live weight change.

4. Conclusions

The animals were distributed in three blocks according to live weight and randomly assigned to four dietary treatments in a Randomized Block Design (RBD). The diets T_0, T_1, T_2 and T_3 contained 7.11±0.64, 7.68±1.26, 8.48±1.91 and 9.09±0.94 MJ ME Kg^{-1} DM. The live weight gain of crossbred bull calves differed significantly ($p<0.01$) among the dietary treatments. The average daily gains in live weight of calves fed diets were 0.04±0.02, 0.29±0.04, 0.33±0.08 and 0.41±0.05 kg in diets T_0, T_1, T_2 and T_3, respectively. The present findings show that dietary treatments T_1 almost maintained the targeted live weight gain of 200 g/d. The performance of T_1 group was better than T_0, T_2 and T_3 group, respectively.

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Conflict of interest
None to declare.

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