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Effects of sugar beet pulp based total mixed ration on growth performance and blood profile status in male Nili Ravi buffalo calves

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Abstract: Sugar beet pulp is comprised of highly digestible fibre that improves the growth rate in calves. The research was conducted to explore the effects of varying levels of sugar beet pulp (SBP) based total mixed ration (TMR) on growth performance and blood metabolites in buffalo male calves. Three TMRs were formulated based on quantity of SBP added i.e. 0% (TMR1), 15% (TMR2), 30% (TMR3) and assigned to 3 different groups (n = 6) of calves for a period of 60 days under a completely randomized statistical design. Calves were fed iso-nitrogenous and iso-caloric ration as 3% of BW/day on dry matter (DM) basis. Data regarding dry matter intake (DMI), body weight (BW) gain, nutrients digestibility, body condition scoring (BCS), feed efficiency (FE) and selected blood metabolites were collected. It was found that DMI, BW, BCS, blood glucose, blood urea nitrogen and digestibility of DM, protein (CP) and crude fibre (CF) were significantly higher ($P < 0.05$) in calves fed with TMR3 compared to other groups. It was concluded that 30% SBP supplementation can enhance growth rate and nutrient digestibility in Nili Ravi buffalo male calves.

Key words: Buffalo calves, sugar beet pulp, growth performance, digestibility

1. Introduction

Globally population and urbanization are increasing day by day resulting in an increased demand of livestock products. The flow of feedstuffs for livestock will also be increased and it could be a challenge to meet this demand over the next few years [1]. Nutritive requirements of animals are generally met by crops, grasses, shrubs, fodder, cereal grains and agro-industrial wastes. Total feed cost in livestock production is estimated to be 60–70% [2]. Intensive animal production has been developed with high-energy yields such as cereals and other industrial by-products like sugar cane molasses. Globally, maize grain is used as a staple food for energy source but it is quite expensive. Alternatively, cheap source of energy like industrial by-products like cane or beet molasses, dry and wet forms of sugar beet pulp (SBP) are also available. Beet pulp is extracted left over fibrous material produced from sugar producing industry. It is reported that about 30% of world sugar is derived from sugar beet [3]. In European countries, sugar beet cultivation is at the top agriculture activity and it provides about 70% of the world sugar beet production and is also exported across the world [4]. In the past, SBP has been conventionally fed to livestock due to its outstanding feeding value for all classes of livestock including ruminants, pigs and horses as well as dairy cattle [5]. Large fraction of sugar beet pulp is composed of Neutral Detergent Fibre (NDF). Due to high cation exchange capacity of NDF, it tends to endorse the pH maintenance and thereby helps in maintaining the rumen environment [6,7]. Two types of SBP are produced by the industry like dry or pressed and wet beet pulp. It is also available either in dried flakes or as compressed pellets [4]. The proportion of dry substance is thus raised to 87–92% in wet SBP. Nutritionally, beet pulp pellets mixed with an amount of molasses and chopped hay have the comparable level of energy characteristics as of corn. Beet pulp pellets may serve as an appreciable feed for cattle feed, dairy and lamb industry. Sugar beet pulp has been used as a suitable energy source in ration for growing and fattening of ruminants [4].

Nili-Ravi buffalo which is one of best buffalo breed in Pakistan, primarily inhabited in the irrigated areas and

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alongside rivers with the potential of providing more than 5000 litres of milk production per lactation [8].

The purpose of this study was to estimate the effects of various levels of beet pulp based TMR as a replacer to corn grains on feed intake, growth performance, blood metabolites and economics in buffalo male calves. It was assumed that replacement of corn with SBP as another energy source in the ration of buffalo calves has no effects on growth rate of the animals but could have progressive economic effects by decreasing the cost of feed production.

2. Materials and methods

2.1. Animals management

The study was conducted at Buffalo Research Institute, Pattoki and animal care and welfare issues were monitored under established approved ethics of the research institute. All samples were analyzed at the Laboratory of Department of Animal Nutrition, Faculty of Animal Production and Technology, University of Veterinary and Animal Science (UVAS), Lahore.

Nili Ravi buffalo male calves (n = 18) having average body weight of 230 ± 10 kg and average 9 ± 0.5 months age were selected. During the study semiopened pens (5 × 12 m2) with muddy floor (6 animals/group) were allotted. Pens were supplied with individual manager for each animal and water tubs were constantly available. The calves were dewormed for ecto and endo-parasites during the adaptation period and vaccinated according to the farm routine practices.

2.2. Experimental design

The duration of the research was 60 days excluding 15 days of an adaptation period. The animals (n = 6/group) were assigned to 3 different groups i.e. A, B, and C, respectively under a completely randomized design. Equal quantity of TMR having different levels (0, 15%, and 30%) of SBP was offered once daily to each animal of the respective group. The TMRs formulated were iso-nitrogenous containing 12% CP and 2.5 Mcal ME/kg were fed as 3% body weight on dry matter basis. To prepare TMR dry ingredients of concentrate were mixed. The required amount of concentrate was added with required amounts of silage and prechopped hay into a double ribbon horizontal mixer and then mixed them properly. The concentrate was medium ground, the size of silage was 1 inch and Rhode grass was chopped for 3 inch in size. The TMR was prepared for 6 animals and fed on individual animal basis. Ad libitum fresh and clean water was ensured to the calves during the entire experimental period. Nutrient composition of dry and wet SBP and the rations prepared and used in the study are shown in Tables 1 and 2.

2.3. Determination of dry matter intake and body weight gain

The data regarding individual feed offered and feed refusal, if any, were collected on daily basis. Samples of feed offered and feed refusal were collected on weekly basis and were frozen at –20 °C until further analysis during the experiment. Animals were weighed on weekly basis at 5 h post feeding. Dry matter intake and body weight gain were calculated by using following formulae:

Dry matter intake (kg) = Dry matter offered (kg) – Dry matter refused (kg)

Body weight gain = Final body weight (kg) – Initial body weight (kg)

Table 1. Nutrient composition of dry sugar beet pulp as feed commonly used in the Pakistan.

Nutrients	Percentage (%)
Dry matter	92.2
Ash	15.9
Organic matter	84.1
Crude protein	12.0
Crude fiber	20.7
Ether extract	2.04
N-free extract	40.3
ME (Mcal/kg)	2.83

2.4. Determination of digestibility of nutrients

During the last 5 days of the experiment, a digestibility trial was conducted. The fecal material was collected from the ground with the help of spade then mixed the manure in the bucket thoroughly to ensure a representative subsample may be obtained. Fecal collection was matched to feed intake for the previous 24 h and consisted of subsamples (approximately 400 to 500 g) of freshly expelled feces at 900, 1200, and 1600 daily. Daily feed samples were stored in a freezer until analysis. Orts, if present, were collected daily for each animal and later were analyzed. Daily total fecal material was collected, weighed, and the samples of feces were analyzed for determination of digestibility of dry matter, ether extract (EE), ash, crude protein and crude fiber [9]. Formalin was added in the polythene bags for preservation of fecal samples with proper labeling and stored at –20 °C until further analysis. Digestibility of fecal samples was determined by proximate analysis.

2.5. Estimation of body condition score

Body condition score (BCS) was recorded by using BCS 1 to 9 system wherein according to the body condition of the animals with 1 being very thin and 9 being extremely obese [10]. Initial and final BCS regarding condition of briskets, ribs, pins, hooks, back and tail head of each animal was recorded according to the guideline of BCS of Nili Ravi buffalo [11].

Table 2. Ingredients and chemical composition of the TMRs on dry matter (%).

Ingredients, %	Total mixed rations		
	TMR1	TMR2	TMR3
Corn silage	50.0	50.0	43.0
Rhodes grass hay	10.0	5.00	2.00
Corn grain	15.0	5.00	0.00
Dry sugar beet pulp	0.00	15.0	30.0
Sugar cane molasses	9.00	9.00	12.0
Soybean meal	6.00	6.00	6.00
Canola meal	8.00	8.00	5.00
Mineral mixture	2.00	2.00	2.00
Chemical composition, %			
Dry matter	60.9	61.0	64.4
Crude protein	12.1	12.2	12.1
Neutral detergent fiber	36	36.2	36.3
Acid detergent fiber	22.2	20.5	17.6
Ash	8.20	8.90	9.50
Metabolizable Energy (Mcal/kg DM)	2.50	2.51	2.52
Cost per kg feed Rs	19.8	19.5	18.5

TMR1 = 0% SBP; TMR2 = 15% SBP; TMR3 = 30% SBP
Each kg mineral mixture contains percentage of Dicalcium phosphate 70.81, sodium chloride 18.91, magnesium sulphate 8.64, ferrous sulphate 0.89, manganese sulphate 0.49, zinc sulphate 0.22, copper sulphate 0.03, potassium iodide 0.008, cobalt sulphate 0.0089, and selenium 0.0015.

2.6. Determination of blood metabolites

Blood samples of the animals were collected at 0 day and then at the end of the experiment from the jugular vein in 20 mL sterilized disposable syringes and was transferred to EDTA coated tubes for biochemical analysis. Plasma was collected from the samples by centrifugation of tubes at 3000 rpm for 5 min and stored at –20 °C until further analysis. Blood glucose (mg/dL) and blood urea nitrogen (mg/dL) were determined in the Laboratory of Department of Biochemistry, Ravi campus Pattoki, UVAS, Lahore as previously described [12].

2.7. Economic analysis

The economic analysis was calculated by the cost of feed ingredients in the local market and the price of live body weight gain of calves. The economic analysis was done by using the following equation:

Cost for 1 kg gain = Total cost of feed intake/total weight gain (kg).

2.8. Statistical analysis

The data was analyzed through one-way ANOVA [13] under completely randomized design CRD (SAS Institute Inc, 2002-03). Comparison among the means was made through Least Significant Difference. Data was presented as mean±standard error of mean (SEM). The level of significance was set at $P < 0.05$.

3. Results

The results revealed that 30% SBP based TMR diet significantly increased ($P < 0.01$) DMI and digestibility (Table 3). A significant difference ($P < 0.05$) was observed in the digestibility of DM, CP, and CF (%) and a nonsignificant difference ($P > 0.05$) was observed regarding EE (%) among the buffalo calves of different dietary supplementation groups. The results showed that TMR3 significantly increased the body weight gain ($P < 0.01$), blood glucose ($P < 0.01$), blood urea nitrogen ($P < 0.01$) compared to other groups (Table 3). The level of 30% SBP based TMR diet produced linear effects on all these parameters except BCS. Regarding the results for economic parameters, it was found that the group having 30% SBP is more feed efficient ($P < 0.01$) than other groups (Table 4).

Table 3. Effects of varying levels of sugar beet pulp on nutrient intake, digestibility, and physiological body parameters in male buffalo calves.

Parameters	TMR1	TMR2	TMR3	P-value
Dry nutrient intake (kg/day)				
Dry matter	6.97^{b}	7.32^{ab}	7.55^{a}	0.030
Crude protein	0.84^{b}	0.89^{a}	0.91^{a}	0.030
Crude fiber	2.13^{c}	2.35^{b}	2.56^{a}	<0.01
Ether extract	0.13^{a}	0.13^{a}	0.13^{a}	0.920
Digestibility (%)				
Dry matter	65.3 ± 2.5^{c}	72.2 ± 1.1^{b}	82.7 ± 1.1^{a}	<0.01
Crude protein	73.3 ± 1.8^{b}	73.3 ± 1.8^{b}	80.8 ± 0.7^{a}	<0.01
Crude fiber	79.9 ± 3.1^{b}	79.9 ± 3.1^{b}	87.2 ± 0.9^{a}	<0.01
Ether extract	54.5 ± 7.5	54.5 ± 7.5	48.2 ± 5.0	0.460
Blood parameters				
Blood glucose (mg/dL)	45.5 ± 2.10^{b}	58.5 ± 1.32^{a}	60.5 ± 1.55^{a}	<0.01
Blood urea (mg/dL)	32.5 ± 1.19^{b}	43.0 ± 1.35^{a}	46.8 ± 1.03^{a}	<0.01

TMR1= 0% SBP; TMR2 = 15% SBP; TMR3 = 30% SBP
*Means with different superscript in a row are significantly different

Table 4. Effects of varying levels of sugar beet pulp based TMRs on economics of male buffalo calves.

Parameters	TMR1	TMR2	TMR3	SEM	P-value
Average daily gain (kg)	0.88^{c}	1.03^{b}	1.13^{a}	0.03	<0.01
FCR (kg feed intake/kg wt gain)	8.18^{a}	7.28^{ab}	5.52^{b}	0.04	<0.01
Cost per kg weight gain	130.5^{a}	110.3^{b}	100.2^{b}	2.95	<0.01
Body weight gain (kg)	53.0 ± 3.07^{b}	59.5 ± 2.72^{ab}	67.5 ± 1.91^{a}	< 0.01	Body weight gain (kg)
Body condition score	5.75 ± 0.48^{b}	6.75 ± 0.63^{b}	8.0± 0.41^{a}	0.03	Body condition score

*Means with different superscript in a row are significantly different.

4. Discussion

The increase in DMI, WG, on TMR3 might be due to better palatability and more NDF contents of SBP as previously described [14] where the authors found a significant difference in feed intake in a trial conducted on male growing sheep (Ossimi X Rahmani) by supplementing different levels of beet pulp and DMI was increased in the treatment group. This might be due to smaller particle size of SBP that resulted in an increased rate of passage of particulate material from the rumen, a reduction in the digestibility of organic matter and an increase in DMI.

Researchers studied the effect of 2 different TMR (without and with 20% beet pulp silage addition on dry matter basis) and noted significant reduction in DM intake in cows subject to TMR with beet pulp addition i.e. 23.0 v. 24.5 kg/day [15]. The results of the current study, however, partially coincide with our findings as researchers replaced part of high-moisture shelled corn (HMSC) with beet pulp and noted decrease in dry matter intake in early lactating Holstein Friesian cows [16]. Moreover, others found that a nonsignificant slight increase in DMI (kg/d) in the sugar beet tubers treated group was observed [17]. It might be due to higher palatability and greater NDF contents of SBP. In another study, DMI of cows fed with beet pulp resulted in an increase in ADF and NDF intake and hence, feed efficiency was enhanced in these cows compared to control group [4]. Similarly, the effect of beet pulp was studied in weaned Holstein Friesian calves for their digestibility as well as growth and decrease in DM intake was noted [18]. It was reported that growth performance of buffalo calves was better comparing with native breeds of west Azerbaijan-Iran due to high

conversion of their feed for their body growth and the fattening program in buffalo calves may be economical [19]. It was reported that a higher weight gain in buffalo was recorded as these animals have a higher digestibility of fiber contents than that of cows. It might be due to the fact that buffalo calves have an adequate capability in digestive tract and eat greater amount of diets high in NDF [20]. It was noted that body condition scoring may be improved with high energy diet as dairy cows were fed with low energy and high energy diet and improved BCS was noted in cows fed with high energy source TMR. [21]. However, insignificant difference ($P > 0.05$) was noted in body condition score of weaned Holstein calves fed with 3 dietary treatments containing 0%, 15%, and 30% beet pulp on an as-fed basis [18].

Moreover, supplementation of SBP based diets to fattening lambs enhanced the ruminal environment, maintained pH, and protected from ruminal acidosis [22]. Furthermore, supplementation of SBP improved digestibility and regular intake of DM, CP, NDF, ADF, and cellulose that may be associated to the tendency of increasing the dietary DMI [23]. In this study, a significant difference was observed in blood glucose concentration in male buffalo calves fed under different dietary levels of dried SBP. These findings are similar to those of the previous study that mentioned a higher concentration of plasma glucose concentration in Surti buffalo fed with SBP supplementation compared to control group [17]. Similarly, insulin responds to intake of energy (glucose) and its means of energy utilization in various tissues like liver, muscles, adipose tissue and mammary glands in those cows consumed extra SBP [24]. It was noted that the buffalo calves have a greater potential to achieve daily weight gain and better fattening performance than cow calves [25]. Higher concentration of blood glucose is also in agreement with the higher production of ruminal propionate in cows offered SBP supplementation. Higher concentration of glucose was observed in biochemical profile of Surti buffalo fed dried SBP compared to the control group [17]. Average daily weight gain was also increased in the group fed on 30% SBP based TMR. Economic efficiency (cost of feeding) of TMR3 was reported as more efficient ($P < 0.01$) than the control group (Table 4). A better FCR was observed in that group having a feed supplementation of up to 30% SBP.

It is concluded that total mixed ration with 30% beet pulp supplementation has ability to improve growth performance and digestibility of nutrients in buffalo calves. This SBP product is recommended as a high-quality animal feed for buffalo calves and hence, could be used as a best alternate to replace the costly feed ingredients.

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Conflict of Interest
The authors declare no conflict of interest.

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