Nutrients utilization, nitrogen dynamics and weight gain in growing buffalo calves fed graded replacement of urea by corn steep liquor

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ABSTRACT: The study was planned to examine the influence of graded replacement of urea by corn steep liquor (CSL), a corn industry by-product, on growth performance of growing male buffalo calves. Fifty male buffalo calves of 9 months of age were randomly divided into five groups. Five iso-nitrogenous and iso-caloric diets were formulated. The control diet was without CSL (CSL0) while in CSL20, CSL40, CSL60 and CSL80 diet CSL replaced 20, 40, 60 and 80% urea nitrogen, respectively. Dry matter intake (DMI) by calves fed diets containing varying levels of CSL differed significantly. Maximum and minimum DMI was recorded in calves fed CSL40 and CSL 80 diets, respectively. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) digestibilities also differed significantly in calves fed diets with varying CSL concentration, however, DM and crude protein (CP) digestibilities remained unaltered across all diets. Calves fed CSL40 diet gained more weight than those fed CSL80 diet. Cost of feed per Kg live weight produced was higher in calves fed CSL0 diet than those fed CSL40; however feed conversion ratio was better in calves fed diets containing higher concentration of CSL. Hemaotological characteristics remained unchanged across all diets. The outcome of the study suggest that CSL can be used upto 40% as replacement of urea, on the basis of nitrogen supply, without any detrimental effects on growth performance of growing calves.

Key words: growth, corn steep liquor, buffalo calves

INTRODUCTION

Corn steep liquor (CSL) is a by-product of wet corn milling industry and is high in protein which makes it an excellent protein source for ruminant animal feeds. It also provides essential amino acids, peptides, organic compounds, Mg, P, Ca, K, Cl, Na, S and myo-inositol phosphates (Hull *et al.*, 1996). The CSL when mixed with distiller soluble is equal to soybean meal and equal or superior to urea as a crude protein source in feedlot diets. A pelleted combination of raw soybean hulls and condensed CSL successfully replaced a portion of the forage, grain and soybean meal in diets for lactating dairy cows without decreasing lactation performance (DeFrain *et al.*, 2002). It was fed at 10 % levels in concentrate mixtures without affecting the production and efficiency of lactating cows with an economic advantage (Talpada *et al.*, 2002). However, scientific information regarding the potential use of CSL to replace urea in beef and dairy diets is limited. Therefore, the present project was planned to nutritionally evaluate CSL as replacement of urea in the diet of growing buffalo calves to examine its impact on growth.

MATERIALS AND METHODS

The experiment was conducted at Animal Nutrition Research Centre, University of Agriculture, Faisalabad, Pakistan. Fifty male buffalo calves of 9 months of age were randomly divided into five groups. Five iso-nitrogenous and iso-caloric experimental diets were formulated. The control diet was without CSL (CSL0). The CSL replaced 20, 40, 60 and 80% urea on nitrogen equivalent basis and these diets were termed as CSL20, CSL40, CSL60 and CSL80. Animals were fed twice a day at *ad libitum* and feed intake was recorded. Calves were weighed fortnightly. Feces and urine were collected by total collection methods as described by Nisa *et al.* (2004). Faces were dried at 55^0C, bulked and mixed by animal and were stored for further analysis. Urine was acidified with 50%

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H_2SO_4 and stored at -20 ºC for laboratory analysis. Feed and faecal samples were analyzed for neutral detergent fiber (NDF) and acid detergent fiber (ADF) by the methods described by Van Soest *et al.* (1991) and crude protein (CP) using method described by AOAC (1990). Nitrogen (N) balance was calculated by using NRC (1989) equations.

Blood samples were collected six hours post feeding. Blood sample (10 ml from each animal) was collected by puncturing jugular vein; 2ml was collected into the vacutainer each containing 81μL of 15% EDTA (anticoagulant) solution, while 8mL was collected in test tube to harvest the serum for further analysis. Plasma samples were separated and frozen at -20°C.

Blood samples were used for the determination of red blood cells (RBC) count, white blood cells (WBC) count, packed cell volume (PCV) and haemoglobin by using their respective procedures as described by Benjamin (1978).

Erythrocytes were counted in a counting chamber using the technique described by Benjamin (1978). Packed cells volume percentage was determined by filling the microhaematocrit capillary tubes (Benjamin, 1978). Blood was taken in plain 75 × 1 mm haematocrit capillary tubes which were sealed by heating and centrifuged in a microhaematocrit centrifuge at 1500 rpm for 5 minutes. Afterward each tube was placed vertically along with the haematocrit reader chart and the packed cell volume was recorded in percentage. The hemoglobin concentration was determined by cyanmethemoglobin method. The 20 µl whole blood of each animal of each group was mixed in 5mL Drabkin's solution; color was developed after at mixing the blood in the solution. The absorbance was noted by using spectrophotometer (Benjamin, 1978).

Statistical Analysis

The data collected were analyzed using Randomized Complete Block Design and means were separated by Tukey's Test for treatment differences using software SPSS (1996).

RESULTS AND DISCUSSION

Nutrient Ingestion, Digestibility and Nitrogen Balance

Significant difference in dry matter intake (DMI) in calves fed varying levels of CSL as replacement of urea was observed. Maximum and minimum dry matter intake was recorded in calves fed CSL40 and CSL80 diets, respectively (Table 1). Similar results were noticed for CP, ADF and NDF intake. Dry matter and CP digestibilities remained unaltered; however, ADF and NDF digestibilities differed significantly with gradual replacement of urea by CSL (Table 2.). Higher N balance was noticed in calves fed CSL40 diets than those fed CSL60 and CSL 80 diets (Table 3)

Higher nutrient intake by calves fed CSL40 might be attributed to efficient capturing activity of rumen microbes due to its gradual degradation which might have ensured enhanced feed degradation due to better rumen microbial enzyme and microbial number leading to increased nutrient digestibility and thereby enhanced nutrient intake (Sarwar *et al.,* 1991). Enhanced rumen fermentation and microbial activities have been reported to increase nutrient intake (Sarwar *et al.,* 1991). In present study, the replacement of urea with CSL was assumed to ferment at a rate which might have ensured sufficient and consistent availability of nitrogen unit (i.e rumen ammonia), a vital requisite for microbial multiplication. This might have enhanced rumen microbial enzyme production leading to increased nutrient intake and digestibility (Sarwar and Nisa, 1999; Sarwar *et al.,* 2004). The marked increase in N balance for calves fed CSL40 was due to increased intake of this diet. Availability of ammonia N, peptides and amino acids along with fermentable energy source in CSL60 and CSL80 diets might have geared up rumen microbial multiplication and enzyme synthesis leading to improved crude protein degradability at ruminal level and microbial protein proportion at post ruminal level.

Growth Performance

Calves fed CSL40 diet gained more weight than those fed CSL80 diet (Table 4). Maximum and minimum weight gain was recorded in calves fed CSL40 and CSL80 diets, respectively (Table 4).

Cost of feed per Kg live weight gain produced was higher in calves fed CSL0 diet than those fed CSL40diet. However, feed conversion ratio was better in calves fed diets containing higher CSL concentration.

Increased weight gain with gradual replacement of CSL by urea might be attributed to either better volatile fatty acid production by rumen microbes or post rumen supply of amino acids or both due to better feed utilization by efficient rumen microbial activities (Sarwar and Nisa, 1999; Sarwar *et al.*, 2004).

Hematological Characteristics

Hematological characteristics remained unchanged across all diets varying in CSL contents (Table 5).

Table 1. Ingredients and chemical composition of experimental diets representing use of different concentrations of corn steep liquor as a substitute of urea for fattening calves

	Experimental Diets[1]				
Ingredients, %	CSL0	CSL20	CSL40	CSL60	CSL80
Wheat Straw	15.0	14.0	17.0	33.5	33.0
Corn Grains	35.0	20.0	20.0	15.0	5.0
Urea	4.0	3.0	2.0	1.0	0.0
CSL	0.0	5.0	10.0	15.0	20.0
Canola Meal	0.0	0.0	3.0	4.5	6.0
Sunflower Meal	0.0	0.0	3.0	4.5	6.0
Corn Glutten 60%	0.0	0.0	2.5	4.5	5.5
Rice Polishing	24.0	28.0	15.0	4.0	4.0
Maize Bran	15.0	26.0	10.0	4.0	3.0
Enzose	3.0	0.0	13.5	10.0	13.5
Sod Bicarbonate	1.0	1.0	1.0	1.0	1.0
Salt	1.0	1.0	1.0	1.0	1.0
DCP	2.0	2.0	2.0	2.0	2.0
Chemical Composition, %					
Dry Matter	91	90.1	89.9	89.8	88.8
Crude Protein	19	19	19.1	19.1	19.1
Total Digestible Nutrients	70.1	70.0	70	70	70
Neutral Detergent Fiber	23.0	26.5	23.4	34.7	34.2
Acid Detergent Fiber	13.5	14.6	14.7	23.5	23.6
Non Structural Carbohydrates	40	35	30	25	20

[1]CSL0, CSL20, CSL40, CSL60 and CSL80 diets contained corn steep liquor as replacement of urea at the rate of 0, 20, 40, 60 and 80% on the basis of nitrogen supply by corn steep liquor, respectively.

Table 2. Effect of varying levels of corn steep liquor when replaced with urea on nutrient intake and their digestibilities in fattening calves

Parameters	Diets[1]					
	CSL0	CSL20	CSL40	CSL60	CSL80	SE
Nutrient intake, g/day						
Dry matter	3241^{bc}	3214^{c}	3325^{a}	3296^{ab}	3165^{c}	11.83
Crude protein	638.48^{a}	610.66^{b}	628.43^{a}	609.76^{b}	582.36^{c}	3.20
Neutral detergent fiber	745.43^{e}	851.17^{c}	778.05^{d}	1143.71^{a}	1082.43^{b}	23.27
Acid detergent fiber	437.54^{e}	469.25^{d}	488.78^{c}	774.56^{a}	746.94^{b}	20.89
Nutrient digestibilities, %						
Dry matter	62.6	65.6	66.3	67.7	69.7	1.8
Crude protein	76.6	76.5	77.2	77.3	78.0	2.2
Neutral detergent fiber	55^{b}	59^{a}	60.2^{a}	60.2^{a}	61.1^{a}	1.7
Acid detergent fiber	47^{b}	56^{a}	55^{a}	56^{a}	57^{a}	1.4

Means within row bearing different superscripts differ significantly ($p<0.05$)
[1]CSL0, CSL20, CSL40, CSL60 and CSL80 diets contained corn steep liquor as replacement of urea at the rate of 0, 20, 40, 60 and 80% on the basis of nitrogen supply by corn steep liquor, respectively.

Table 3. Effect of varying levels of corn steep liquor when replaced with urea on nitrogen balance in growing calves

	Diets[1]					
Parameters, g/d	CSL0	CSL20	CSL40	CSL60	CSL80	SE
N intake	102.16[a]	97.7[b]	100.55[a]	97.56[b]	93.18[c]	3.81
Faecal N	24.47[a]	23.5[b]	23.0[a]	22.5[b]	21.50[c]	1.23
App. Absorption	77.69[a]	74.70[b]	77.05[a]	75.06[b]	71.68[c]	1.55
Urinary N	19.50[a]	18.50[b]	19.2[a]	18.2[b]	17.50[c]	2.11
N balance	58.19[a]	56.20[b]	57.85[a]	56.86[b]	54.18[c]	3.14

[1]CSL0, CSL20, CSL40, CSL60 and CSL80 diets contained corn steep liquor as replacement of urea at the rate of 0, 20, 40, 60 and 80% on the basis of nitrogen supply by corn steep liquor, respectively.

Table 4. Effect of varying levels of corn steep liquor when replaced with urea on growth performance in fattening calves

Parameters	Diets[1]					
	CSL0	CSL20	CSL40	CSL60	CSL80	SE
Wt. gain (g/day)	672[d]	677[c]	756[a]	706[b]	637[e]	10.61
Cost (Rs) of feed to produce one kg live weight	80.79[a]	70.30[b]	64.40[c]	59.10[d]	58.12[d]	2.24
Feed Conversion Ration	5.30[b]	5.27[c]	4.89[e]	5.20[d]	5.59[a]	0.06

Means within row bearing different superscripts differ significantly (p<0.05)
[1]CSL0, CSL20, CSL40, CSL60 and CSL80 diets contained corn steep liquor as replacement of urea at the rate of 0, 20, 40, 60 and 80% on the basis of nitrogen supply by corn steep liquor, respectively.

Table 5. Effect of varying levels of corn steep liquor when replaced with urea on hematological characteristics in fattening calves

	Diets[1]					
Blood Parameter	CSL0	CSL20	CSL40	CSL60	CSL80	SE
RBC /µL	9.3×10^6	9.3×10^6	9.5×10^6	9.5×10^6	9.4×10^6	0.27
WBC /µL	8.9×10^3	8.8×10^3	$8.\ 8\times10^3$	8.8×10^3	8.9×10^3	0.19
PCV %	29	29	30	30	30	0.44
Hb mg/dL	10	11	11	11	11	0.31

Means within row bearing different superscripts differ significantly (p<0.05)
[1]CSL0, CSL20, CSL40, CSL60 and CSL80 diets contained corn steep liquor as replacement of urea at the rate of 0, 20, 40, 60 and 80% on the basis of nitrogen supply by corn steep liquor, respectively.

The RBC, WBC, PCV and hemoglobin remained statistically non-significant. Hematological findings of the present study have also been supported by Bednarek *et al.* (1996), who observed that the erythrocytes count, haemoglobin and PCV values didn't change due to dietary alterations in calves.

CONCLUSION

The findgs of the present study suggest that CSL can be used upto 40% as successful replacement of urea, on the basis of nitrogen supply, without any detrimental effects on growth performance of growing calves.

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