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Effect of cottonseed meal on nutrient intake and economics of feeding in male buffalo calves

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Abstract
The present study was conducted to evaluate the effect of inclusion of cottonseed meal (CSM) as an alternate protein source in the diet of male buffalo calves on nutrient intake and economics of feeding. Conventional concentrate mixture was prepared (maize 34, SBM 15, mustard cake 15, wheat bran 10, deoiled rice bran 17, rice polish 6, mineral mixture 2.0 and common salt 1.0 part per 100 parts). Soybean meal (SBM) in the concentrate mixture was replaced by cottonseed meal (CSM) at 75% and 100% level on w/w basis. Twelve buffalo calves were randomly distributed into three groups of four animals each designated as C, T1 and T2. A 120-day growth trial was conducted on male buffalo calves. Intake of nutrients (DM, OM, CP, EE, NDF, ADF expressed as kg/100 kg BW) was reported to be higher ($P<0.05$) in T1 group than C and T2 groups. Cellulose and hemicellulose intake (kg/100 kg BW) of T1 group was similar to C group and higher ($p<0.05$) than T2 group. Replacement of SBM by CSM at 75% and 100% levels resulted in net saving of Rs. 11.67 and 16.65 per kg BW gain in T1 and T2 groups, respectively. It was concluded that CSM was cost effective and could economically replace SBM upto 75% and 100% in the concentrate mixture of buffalo calves without any adverse effect on nutrient intake of animals.

Keywords: Cottonseed meal, buffalo calves, nutrient intake, economics

1. Introduction

India ranks first in the world of buffalo population. Due to inadequate nutrition connected with improper feeding management practices there is poor growth rate and late maturity in buffaloes. Buffaloes are better converter of poor-quality fibrous feeds into milk and meat. Scarcity of feedstuffs for animal feeding in India has compelled animal nutritionists to explore possibilities of feeding agro-industrial by-products to livestock. A greater ruminal degradation of both fiber and protein was noticed in buffaloes than in cattle and sheep. Particularly in Asia, energy and protein demands of buffaloes are being mainly met by feeding them low-quality roughages, agricultural crop-residues and industrial by-products which contain high levels of lignocellulosic materials, low levels of fermentable carbohydrate and protein (Sarwar *et al*., 2009) [1]. This unique ability to better ferment fiber in buffaloes could be the result of adaptation because for years they have been fed on low quality high fibrous feeds (Sarwar *et al*., 2005) [2]. Feed cost constitutes 60-70% of total expenditure incurred on production where concentrate feeding is important in terms of cost of feeding (Barman *et al*., 2018) [3]. Due to increase in cost of conventional protein feed stuffs for livestock had led to decrease in production and animal protein intake. Therefore, the livestock producers had become imperative for source of cheap alternative feedstuffs without decrease in quality of feed and productive performance of animals.

India is one of the largest producers of cotton in the world accounting for about 26% of the world cotton production. The yield per kg hectare which is presently 487 kg/ha is still lower against the world average yield of about 768 kgs /ha. India has the distinction of having the largest area under cotton cultivation which is about 41% of the world area under cotton cultivation between 12.96 million hectares as per National cotton scenario (2021) [4].

India has great potential for cotton by-product production. Soybean meal is the most common source of protein used in supplements for buffalo diets. But it is more expensive than some different protein sources, like cottonseed meal, groundnut oil meal. There is also increase in shortage of protein sources. Cottonseed meal as nontraditional feed ingredient has drawn much attention from the livestock producers and feeding CSM compared to other protein sources provide excellent opportunity to reduce feed costs. Proteins of cottonseed meal are extensively degraded in the rumen (Sadeghi and Shawrang, 2007) [5].

2. Material and Methods

2.1 Selection, distribution and maintenance of animals

Conventional concentrate mixture was prepared (maize 34, SBM 15, mustard cake-15, wheat bran 10, deoiled rice bran 17, rice polish 6, mineral mixture 2.0 and common salt 1.0 part per 100 parts). Soybean meal (SBM) in the concentrate mixture was replaced by cottonseed meal (CSM) at 75% and 100% level on N basis. Twelve buffalo calves were randomly distributed into three groups of five animals each. A 120-day growth trial was conducted on male buffalo calves. The animals in each group were fed as per ICAR (2013) [6] feeding standard. The animals in control group were fed with basal diet consisting of berseem, oats, mustard fodder and SBM based conventional concentrate mixture. The animals in experimental groups 2, 3 were fed green fodder, wheat straw and concentrate mixtures in which crude protein of soybean meal was replaced with CSM at 75% and 100% levels, respectively. The inclusion level of CSM was 11.25% and 15% respectively in the concentrate mixtures. The daily record of feed intake and orts was maintained. The animals were weighed for 3 consecutive days at every fortnight interval and the feeding schedule was revised accordingly. The feed offered and orts left were analyzed for proximate principles as per AOAC (2007) [7], total carbohydrates as per Sniffen *et al.* (1992) [8] and cell wall constituents as per Van Soest *et al.* (1991) [9].

2.2 Economic evaluation

Cost of feeding CSM in experimental groups was taken into account by calculating dry matter intake, cost of concentrate, cost of fodder and cost of CSM. Net profit per kg body weight gain was calculated for all groups.

2.3 Statistical analysis

Data were analyzed by simple ANOVA, as described by Snedecor and Cochran (1994) [10], by using SPSS (2012) [11] version 21. The differences in means were tested by Tukey's b.

3. Results and Discussion

3.1 Chemical composition of feedstuffs offered during trial, % DM basis

The DM was 91.0, 91.0 and 93.0% in concentrate mixtures fed to C, T1 and T2 groups, respectively (Table 1). The DM in green fodder and wheat straw was 17.3 and 86.8%, respectively. OM in concentrate mixtures fed to control, T1 and T2 was 90.45, 90.85 and 90.55%, respectively. Green fodder and wheat straw fed during trial had 88.53 and 92.40% OM, respectively.

The CP content was 20.07%, 20.52% and 20.86% in concentrate mixtures fed to control, T1 and T2 groups, respectively, indicating that concentrate mixtures were isonitrogenous (Table 1). The CP in green fodder and wheat straw was 16.5 and 4.4%, respectively. The EE content in control concentrate was 5.36% and in concentrates fed to T1 and T2 groups was 5.36% and 5.64%, respectively. The EE content in green fodder and wheat straw was 3.35% and 1.14%, respectively. Total ash content ranged from 9.15% (T1 group) to 9.55% (C group). Green fodder and wheat straw fed during metabolic trial contained 11.47% and 7.60%, total ash. NDF content was 31.40%, 30.46% and 30.73% in control, T1, T2 concentrate mixtures. NDF content in green fodder and wheat straw was 48.30% and 84.90%, respectively. ADF content was 16.40%, 16.05% and 14.75% in control, T1, and T2 concentrate mixtures, respectively. Green fodder (berseem, oats, mustard) and wheat straw had 31.9 and 58.65% ADF content. Cellulose content in control, T1 and T2 concentrates was 9.40%, 8.10% and 7.70%, respectively. Green fodder and wheat straw had 20.60% and 46.90% cellulose, respectively.

3.2 Effect of dietary level of CSM on nutrient intake in buffalo calves

The DMI in the current study was highest (p<0.05) in T1 (2.51) group (Table 2). However, Nomeary *et al.* (2021) [12] reported no significant difference in DM intake among sheep groups fed black cumin seed meal, cottonseed meal and sesame seed meal replacing soybean meal in ration. Kannan *et al.* (2013) [13] also reported non-significant difference in DM intake of lambs fed 40% raw CSM, 40% raw CSM supplemented with vitamin E, and 40% CSM with 1.5% calcium hydroxide replacing soybean meal. However, our results are similar to that of Solomon *et al.* (2008) [14] who reported significant difference (p<0.01) in DM intake of goats supplemented with the high level of CSM than those on the control treatment.

The OMI was higher (p<0.05) in T1 (2.25) group and lowest (p<0.05) in C (2.18) and T2 (2.20) groups (Table 3). Our results are contrary to those of Tripathi *et al.* (2012) [15] who reported no significant difference in lambs fed Bt-CSM, C-CSM. The CP intake was highest (p<0.05) in T1 (0.382) group followed by T2 (0.378) group and was lowest (p<0.05) in C (0.366) group. However, Kannan *et al.* (2013) [13] reported no significant difference in CP intake of lambs fed raw CSM, raw supplemented with vit E CSM and treated with 1.5% $Ca(OH)_2$ CSM replacing soybean meal. Tripathi *et al.* (2012) [14] also reported similar CPI among lambs fed Bt-CSM and CSM as a replacement of groundnut meal. However, Solomon *et al.* (2008) [15] reported higher (p<0.01) CPI (g/day) in CSM supplemented goats compared to control group fed hay which is similar to the current study.

The mean EE intake during the whole experimental period was highest (p<0.05) in T1 group and lowest (p<0.05) in control group (Table 3). Our results are contrary to those of Silva *et al.* (2009) [16] who reported no significant difference in EE intake of lactating cows fed cottonseed meal replacing 0, 25, 50, 75 and 100% of soybean meal in the concentrate. The NDF intake was highest (p<0.05) in T1 (1.29) group followed by C (1.26) and lowest (p<0.05) in T2 (1.24) group. Tripathi *et al.* (2012) [14] also reported similar NDFI among groups fed Bt-CSM and CSM which is similar to present study. Our results are in contrary with Solomon *et al.* (2008) [15] who reported higher (p<0.01) NDFI (g/day) in CSM supplemented goats compared to control group. The ADF intake was highest (p<0.05) in T1 group compared to other groups. Our results are similar with Tripathi *et al.* (2012) [14] reported non-significant difference in ADFI among lambs fed Bt-CSM and CSM replacing groundnut meal.

The CL intake was higher (p<0.05) in C (0.59) and T1(0.60) groups than T2 (0.58) group (Table 3). Tripathi *et al.* (2012) [14] also reported no significant difference in cellulose intake among groups fed Bt-CSM and CSM replacing groundnut meal. The HCI in T1 (0.50) group was higher (p<0.05) than T2 (0.48) group, however, it was similar to that in C (0.49) group. Our results are similar with Tripathi *et al.* (2012) [14] who also reported no significant difference in hemicellulose intake in lambs fed conventional and Bt cottonseed meal replacing groundnut oil meal.

3.3 Economics of feeding

The economics of feeding cottonseed meal (CSM) replacing soybean meal (SBM) at graded levels in the diet of buffalo calves during 120 days is given in Table 4. At the time of experiment, the cost of CSM and SBM was Rs. 3524/Q and Rs. 5000/Q, respectively.

The cost of concentrate mixtures fed to buffalo calves was worked out to be Rs. 22.77/kg, Rs. 21.11/kg and Rs. 20.55/kg for control, T1 and T2 groups, respectively. Replacement of SBM by CSM reduced the cost of concentrate mixtures fed to T1 and T2 groups by 7.29% and 9.75%, respectively as compared to concentrate mixture fed to control group. CSM inclusion at 75% and 100% levels replacing SBM resulted in net saving of Rs. 11.67 and 16.65 per kg BW gain in T1 and T2 groups, respectively. Thus, based on the results of the present study, it could be concluded that feeding of CSM to male buffalo calves was cost effective.

The results obtained in the present study are in tune with those of Nomeary *et al*. (2021) [12] who reported that CSM has higher values of revenue and relative efficiency i.e., it was more economical in lambs compared to black cumin seed meal and sesame seed meal replacing soybean meal. Attanayaka *et al*. (2016) [17] also reported that least cost of production per bird was observed in the diet containing 15% CSM when SBM was replaced at the levels of 0%, 5%, 10% and 15% CSM. They concluded that CSM could be used to replace SBM up to 10% of the diet safely and would be significant in commercial perspective especially when the price of SBM is unusually high. Fadel and Ashmawy (2015) [18] reported that the protected linseed meal and cotton seed meal (treated with quebracho tannin) at 2% resulted in better economics in goats when compared to untreated linseed and cottonseed meal. Ojewola *et al*. (2006) [19] observed least cost when soybean meal was excluded completely and replaced by CSM in broilers. Khan *et al*. (2002) [20] reported economic efficiency was better on CSM based diets with and without lysine and methionine compared to control diet in 14-21 d old crossbred calves.

Table 1: Chemical composition of feedstuffs offered during trial, % DM basis

Parameter	C (0%CSM)	T1 (75%CSM)	T2 (100%CSM)	Green fodder	Wheat straw
DM	91.00	91.00	93.00	17.30	86.80
OM	90.45	90.85	90.55	88.53	92.40
CP	20.07	20.52	20.86	16.5	4.40
EE	5.36	5.36	5.64	3.35	1.14
Total ash	9.55	9.15	9.45	11.47	7.60
NDF	31.40	30.46	30.73	48.30	84.90
ADF	16.40	16.05	14.75	31.90	58.65
Cellulose	9.40	8.10	7.70	20.60	46.90
Hemicellulose	15.00	14.41	15.98	16.4	26.25
TCHO	65.02	64.97	64.05	68.68	86.86

DM- Dry matter, OM- Organic matter, CP- Crude protein, EE- Ether extract, NDF- Neutral detergent fibre, ADF- Acid detergent fibre, TCHO- Total carbohydrates

Table 2: Effect of dietary level of CSM on nutrient intake (kg/100 kg BW) in buffalo caves

Parameter	C (0% CSM)	T1 (75% CSM)	T2(100%CSM)	SEM
DMI	2.42^{a}	2.51^{b}	2.44^{a}	0.01
OMI	2.18^{a}	2.25^{b}	2.20^{a}	0.06
CPI	0.366^{a}	0.382^{c}	0.378^{b}	0.001
EEI	0.078^{a}	0.085^{c}	0.081^{b}	0.0002
NDFI	1.26^{b}	1.29^{c}	1.24^{a}	0.004
ADFI	0.76^{b}	0.79^{b}	0.76^{a}	0.003
CLI	0.59^{b}	0.60^{b}	0.58^{a}	0.002
HCLI	0.49^{b}	0.50^{b}	0.48^{a}	0.002

DMI- Dry matter intake, OMI- Organic matter intake, CPI- Crude protein intake, EEI- Ether extract intake, NDFI- Neutral detergent fibre intake, ADFI- Acid detergent fibre intake, CLI- Cellulose intake, HCLI-Hemicellulose intake; Means bearing different superscripts in a row differ significantly (P<0.05)

Table 3: Comparative cost of feeding graded levels of CSM as a replacement of soybean meal to buffalo calves over 120 days experimental period

Parameter	C	T1	T2
Amount of fresh feed given, kg			
Concentrate mixture	1191.20	1207.13	1222.25
Green fodder	6253.06	6338.62	6412.24
Wheat straw	912.60	924.78	936.14
Feed cost (Rs/kg)			
Concentrate mixture	22.77	21.11	20.55
Green fodder	2.50	2.50	2.50
Wheat straw	4.50	4.50	4.50
Total feed cost for 120 days (Rs)	46860.59	45487.59	45365.40
Total BW gain in 120 days/ group (Kg)	355.84	379.00	394.33
Feed cost (Rs/kg BW gain)	131.69	120.02	115.04

4. Conclusion

The present study in buffalo calves revealed that DMI, OMI, CPI, EEI, NDFI, ADFI (kg/100 kg BW) was reported to be higher (P<0.05) than C and T2 groups. CSM inclusion at 75% and 100% levels replacing SBM resulted in net saving of Rs. 11.67 and 16.65 per kg BW gain in T1 and T2 groups, respectively. Therefore, from the present study, it was concluded that CSM could economically replace SBM upto 75% and 100% in the concentrate mixture of buffalo calves without any adverse effect on nutrient intake of animals and was cost effective.

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