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Evaluation of rumen fermentation in buffaloes fed roasted guar korma

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Abstract
The purpose of this study was to determine the impact of feeding buffaloes roasted guar korma in place of groundnut cake (C) at levels of 51% (E1) and 100% (E2) on the rumen fermentation pattern. An abundant source of plant protein (58.8% CP), roasted guar korma is a by-product of the production of guar gum. Using a 3X3 latin square configuration, the rumen fermentation parameters in three rumen fistulated male buffaloes were examined for the three treatments. The bulls were put on a maintenance diet that included wheat straw and a 2.5 kg concentrate combination. The effects of various treatments and the time of sampling on nitrogen fractions, TVFAs, and pH in the rumen liquor of adult male buffaloes were examined. In the C and E1 treatment groups, the total nitrogen increased at 3 hours after feeding and then began to decline at successive intervals, while in the E2 treatment group, it peaked at 6 hours after feeding. At 3 hours post-feeding, it was statistically different for C than E2, although the mean total nitrogen levels in SRL at the various time points were not. Similar trends were observed for the NH3-N level in SRL over time. For various treatments, the mean values of TCA-ppt.-N and NPN of SRL at various time points were also non-significant. Total volatile fatty acid levels in SRL varied significantly between C, E1, and E2, with E2 having the highest values and C having the lowest. At 0 and 9 hours after feeding, there was no difference between the treatments; however, at 3 and 6 hours after feeding, E1 and E2 had significantly higher values than C and there was a significant difference between all the treatments, with E2 having the highest values and C having the lowest. The three treatment groups' median pH values did not significantly differ from one another. As a result of the current study, it is possible to draw the conclusion that buffalo diets can successfully substitute roasted guar korma for groundnut cake at levels of 50 and 100 percent without negatively affecting the rumen fermentation pattern or reducing protein and fibre absorption.

Keywords: Hernia, buffalo bull, umbilical, herniorrhaphy

Introduction
One of the most major economic activity in the country's rural areas, raising livestock has a big economic impact on the entire country. Most households who depend on agriculture receive additional income from it, and for many landless families, the income from activities related to livestock rearing has served as the major source of support (DADH). The price ratio of concentrate feeds to animal products has decreased, thus it is necessary to replace traditional concentrates with some affordable but nutrient-rich agro industrial by-products in order to reduce the cost of producing animal products.

A significant income crop in rain-fed areas, particularly in semi-arid and desert portions of India, is guar (*Cyamopsis tetragonoloba*). It is an annual legume that can withstand drought and is primarily planted in Pakistan and India (Mishra *et al*., 2013) [14]. Its extraction of guar gum, which has a high export value, makes it a crucial legume for industry. Guar seed production varies significantly depending on the pattern of rainfall in India, averaging 7-8 lakh tonnes per year (APEDA). According to Lee *et al*. (2004) [13], guar seeds are composed of three parts: the seed coat (14–17%), the endosperm (35–42%), and the germ (43–47%). Churi Korma (guar meal), which is made from the seed's germ and hull, is a byproduct of guar gum extraction and is high in protein (Sharma & Gummagolmath, 2012) [17]. Guar Split/Gum (29%), Korma (30-35%), and Churi (35-40%) are three extracts from guar seeds (APEDA, 2014) [2]. Guar korma that has been processed often has a lot of proteins and carbs, making it an excellent source of protein for ruminants and other animals. In addition to being a good feed for beef animals, it is mostly used to feed the milking animals in order to boost the milk and milk fat content (Etman *et al*., 2014a) [5]. According to Saeed *et al*. (2017), the CP content of guar korma ranges from 56 to 58 percent; Soliman *et al*. (2014) [18], 55.8 percent; Nidhina

and Muthukumar (2015) [15], 52.7 percent; Etman *et al*. (2014a) [5], 50 percent; and Grewal *et al*. (2014) [9], 46.9 percent. The type of germ fraction and heat treatment used to create the final product affect the CP content of guar korma. Animals are fed guar korma in place of soyabean meal, dried distiller grains, cotton seed cake, and groundnut cake because it is typically a less expensive feed ingredient (Etman *et al*., 2014a) [5]. The main antinutritional components in guar meal are trypsin inhibitor and beta-galactomannan gum residue. Beta-galactomannan gum residue inhibits the growth of chickens, however this impact can be reduced by adding enzymes like pectinase and cellulase, which can hydrolyze the galactomannan gum (Gheisari *et al*., 2011) [7]. Although trypsin inhibitor was thought by some researchers to be the main antinutritional element limiting the use of guar meal in feed (Couch *et al*., 1967) [3], Lee *et al*. (2003) [12] found that guar meal contains very little trypsin inhibitor. According to Fransis *et al*. (2013), saponins reduce the feed's palatability and hinder the digestion of proteins as well as the absorption of minerals and vitamins in the gut. Trypsin inhibitor and phytate levels were significantly reduced when different heat treatments were applied to the antinutritional components of industrial guar meal (Nidhina & Muthukumar, 2015) [15]. Etman *et al*. (2014a) [5] came to the conclusion that adding more guar korma to the experimental diets of developing buffalo calves boosted both daily and total growth. Daily gains, feed efficiency, and DM digestibility all improved when guar meal level increased in ration when groundnut cake was replaced by it in crossbred calves at 0, 50, and 100% levels (Sagar and Pradhan, 1977).

Location of experiment

The experiment was conducted at the animal farm of Animal Nutrition & Feed Technology Division, Central Institute of Research on Buffaloes, Hisar. Hisar city is situated in semi–arid region and climatic conditions are subtropical in nature.

Animals and experimental design

Three fistulated bulls of similar age, body weight and dry matter intake were used in a 3x3 latin square design, so that each animal receives every dietary treatment at different time interval, to study the effect of replacing groundnut cake with roasted guar korma on rumen fermentation pattern.

Housing and feeding of fistulated animals

The animals were kept apart in a roomy, well-ventilated building with separate feeding and rumen liquor collection areas. The bulls were given an ad libitum maintenance diet of 2.5 kg of a concentrate mixture and wheat straw. Additionally, water was freely available. Every morning at 8:00 am, a separate concentrate combination was fed to the animals. Different animals received the concentrate mixture—Control, E1 and E2—for a 21-day adaption period before receiving two days of rumen liquor collection. Table 1 lists the chemical make-up of the food provided to experimental animals.

Table 1: % on a DM basis of the concentrate mixture of several experimental rations and wheat straw

Attributes	Treatments (Concentrate)			Wheat straw
	C	E1	E2	
DM	91.30	91.35	92.64	92.01
OM	91.15	88.82	87.50	89.02
CP	21.96	22.46	21.88	4.32
EE	4.64	5.35	3.97	0.82
CF	12.31	11.05	11.52	38.34
Total Ash	9.84	11.18	10.52	11.97
NFE	51.24	48.96	50.16	43.56
NDF	43.00	43.80	43.43	78.51
ADF	19.80	17.50	18.02	52.61

Each figure is an average of three observations

Collection of rumen liquor

The concentrate combination was supplied to the animals at 5:00 am and wheat straw was given at 2:30 pm five days before to collection. The animals were tied separately. Over the course of two days, samples of rumen liquor were taken at intervals of 0, 3, and 6 and 9 hours.

With the use of a 250 ml plastic bottle, samples were taken using a rumen cannula. To obtain representative samples, the rumen liquor was taken from four distinct locations, and the pH was then determined right away. Four layers of muslin were used to filter the rumen fluid. The rumen liquor that had been strained was employed right away to estimate TVFAs, NH3-N, Total-N, and TCA precipitated N. A few drops of saturated mercuric chloride solution were added to 100 ml plastic bottles containing the leftover filtered rumen liquid, which was then stored at -20 °C.

Statistical analysis

Data was analysed statistically as described by Snedecor and Cochran, (1994). Analysis of variance was used to study the difference among treatment means and they were compared by using Duncan's multiple range test as modified by Kramer, (1956).

Result and Discussion

Nitrogen fraction in rumen liquor

Nitrogen fraction in rumen liquor of adult male buffaloes as affected by different treatments and time of sampling are presented in Table 1.

Total nitrogen

The total nitrogen content in treatments C, T1, and T2 was 53.22.04, 54.602.82, and 55.423.03 mg/dl and 63.72.39, 67.902.89, and 70.233.51 mg/dl at 0 hours before and 6 hours after feeding, respectively. The treatments' differences were not statistically significant. At three hours after feeding, the total nitrogen (mg/dl) concentration of the rumen liquor in treatments C, T1, and T2 was, respectively, 79.802.26, 73.032.3, and 69.383.3 mg/dl. Because rumen degradable protein was higher in GNC than in roasted guar korma, the results were considerably higher for C than T2 but not statistically different from T1 or T2. The results are consistent with those of Mahesh *et al*. (2017), who found that for GNC and guar korma, respectively, the rumen degradable nitrogen

and percent of rumen degradable nitrogen that decomposed rapidly in the rumen were 75.03 and 80.57; 69.13 and 45.97%. The same conclusions were presented by (Mondal *et al*., 2008). Additionally, roasting would have lowered the degree to which the protein in roasted guar korma degraded. At 9 hours after feeding, the total nitrogen (mg/dl) concentration of the rumen liquor in treatments C, T1, and T2 was 56.231.79, 62.303.6, and 67.673.59, respectively. For T2, the numbers were noticeably higher than for C. The mean total nitrogen concentrations in SRL for the various time periods in treatments C, T1, and T2 were, respectively, 63.232.03, 64.452.85, and 65.673.31 mg/dl, which were statistically insignificant. In the C and T1 treatment groups, the total nitrogen increased at 3 hours after feeding and then began to decline at successive intervals, while in the T2 treatment group, it peaked at 6 hours after feeding. This is also related to GNC's fast rumen degradable nitrogen, which causes a sharp rise and fall in C and T1 group levels at 3 and 6 hours, respectively. The outcomes were consistent with studies by El-Monayer *et al*. (2015) on buffaloes and Soliman *et al*. (2014) [18] on sheep, in which total N was increased by substituting guar korma for cottonseed cake and soyabean meal in the concentrate mixture. Because cottonseed cake (48.3) and soyabean meal (68.27) have lower rumen degradable nitrogen contents than guar korma (69.13), the total N content of SRL in guar korma has increased (Mondal and al., 2008). According to Hossein *et al*. (2010), when cotton meal was processed with heat treatment, guar korma meal's effective degradability was decreased.

Ammonia nitrogen

The ammonia nitrogen of the rumen liquor of animals in treatments C, E_1 and E_2 was 9.19±0.25, 9.43±0.12 and 10.03±0.09 mg/dl and 11.36±0.44, 11.81±0.13 and 13.23±0.52 mg/dl at 0 and 9 hours post-feeding, respectively. At 3 hours post-feeding the values of ammonia nitrogen in treatment C, E_1 and E_2 were 20.16±0.74, 18.13±0.67 and 15.7±0.77 mg/dl, respectively. At 3 hours post feeding the values (mg/dl) for ammonia nitrogen were statistically higher in C (20.16) and E_1 (18.13) as compared to E_2 (15.70) treatment group. But, at 0 hours (pre-feeding) and 9 hours post feeding the value for ammonia nitrogen of group E_2 was statistically (p<0.05) higher than that of C and E_1 The sharp rise in C at 3 hours was followed by a rapid decline in values at 6 hours post-feeding. The value of ammonia nitrogen was statistically non-significant at 6 hours post-feeding for C, E_1 and E_2, which was, 13.98±0.61, 13.44±0.56 and 13.93±0.64, respectively. The mean level of ammonia nitrogen in SRL for different time intervals in treatments C, E_1 and E_2 was 13.67±0.43, 13.20±0.30 and 13.22±0.45 mg/dl, respectively, which was statistically non-significant.

The ammonia nitrogen values of SRL depend on the soluble nitrogen, rumen degradable nitrogen and per cent of rumen degradable nitrogen that degrade rapidly of a feed. The protein degrading bacteria utilize the soluble and freely available N and rapidly convert it into NH_3N. The turnover of this NH_3N into microbial protein is slow and thus NH_3N level rises for few hours after feeding and this rise is proportional to amount of the soluble nitrogen and rumen degradable nitrogen content of the feed. Hence, The values of ammonia nitrogen almost doubled at 3 hours post feeding in C and E_1 treatment groups whereas in E_2 it increased to only about one and a half times to its values at 0 hour (pre-feeding) time interval, which is attributed to the rapidly rumen degradable nitrogen of GNC which cause a rapid hike and fall at 3 and 6 hours respectively for E_1 group. This rapid rise and fall in NH_3N of C was because GNC was degraded completely within few hours and the excess NH_3N formed was absorbed into the blood and converted into urea by liver and excreted in urine. The results were in agreement to Goswami *et al*. (2012) [8] where NH_3N decreased *in vitro* when GNC was replaced with guar meal. But, El-Monayer *et al*. (2015) reported higher NH_3 in guar korma group than cottonseed cake and soyabean meal fed group in buffaloes because cotton seed cake and soyabean meal were less degradable than guar korma (Mahesh *et al*., 2017).

TCA precipitated nitrogen

The TCA ppt. nitrogen levels in the rumen liquor of the animals receiving treatments C, T1, and T2 were 33.792.72, 33.792.72, and 34.473.78 mg/dl; 42.082.97, 40.784.53, and 38.253.77 mg/dl; 38.992.41, 40.334.30, and 43.543.16 mg/dl; and 37.132.7, 37.664. When comparing data for TCA precipitated nitrogen across treatment groups and time intervals, there is no statistically significant difference (P>0.05). The mean TCA ppt. nitrogen level (mg/dl) in SRL for various time periods in treatments C, E1, and E2 was 37.122.69, 37.664.27, and 38.673.69, respectively, and these values were also statistically insignificant. In the C and E1 treatment groups, the values peaked at 3 hours after feeding, but in the E2 treatment group, the peak value was reported at 6 hours after feeding. Insignificant differences exist between the readings for TCA precipitated nitrogen in various treatment groups throughout time. The actual protein N, which includes both dietary and microbial origin, is TCA precipitated nitrogen. The value was marginally higher in the E2 group, indicating greater generation of microbial biomass. The outcomes agreed with those in buffaloes by El-Monayer *et al*. (2015).

Non protein nitrogen

At 0, 3, 6, and 9 hours after feeding, the non-protein nitrogen in the rumen liquor of the animals receiving treatments C, E1, and E2 was 19.41, 19.79, and 20.94 mg/dl; 37.72, 32.25, and 31.13 mg/dl; 24.71, 2.69, and 27.57, and 26.69 mg/dl; and 19.11, 18.62, and 28.99 mg/dl, respectively. At 9 hours after the last feeding, there was a discernible difference between the various treatments, with E2 values significantly higher (P 0.05) than C. The variation between various treatments was not significant at subsequent time points. It was also not statistically significant that the mean concentration of non-protein nitrogen (mg/dl) in SRL for the various time intervals in treatments C, E1, and E2 was 25.232.19, 26.052.45, and 26.931.29, respectively. In different treatments, the non-protein nitrogen values were higher 3 hours after eating than they were at other times. The non-protein nitrogen values were statistically comparable between treatment groups and throughout time intervals. The readings were greater in feed that included more nitrogen that is rumen-degradable. Urea, ammonia, nitrates, nitrites, amino acids, amines, and other compounds make up the majority of it. Because E2 contains more slowly rumen degradable nitrogen than C, the value was considerably greater for E2 at 9 hours post-feeding (Mahesh *et al*., 2017).

Table 2: Values of various nitrogen fractions (mg/dl SRL) as influenced by varied feeding regimens and sample time in experimental buffalo bulls

Time Intervals (hrs)	Treatments		
	C	E1	E2
Total-N			
0	53.21±2.05	54.50±2.82	54.42±3.03
3	79.9 [b] ±2.25	73.02 [ab] ±2.30	68.38 [a] ±3.30
6	63.71±2.38	67.91±2.89	71.23±3.51
9	57.23 [a] ±1.78	62.31 [ab] ±3.6	61.67 [b] ±3.59
Mean ± SE	62.23±2.03	63.45±2.85	64.67±3.31
NH3 – N			
0	9.29 [a] ±0.25	9.33 [a] ±0.12	11.03 [b] ±0.09
3	20.26 [b] ±0.74	18.12 [b]±0.67	15.71 [a] ±0.77
6	13.88±0.61	13.46±0.56	13.92±0.64
9	11.37 [a] ±0.44	11.82 [a]±0.13	13.13 [b] ±0.52
Mean ± SE	13.57±0.43	13.30±0.30	14.22±0.45
TCA ppt-N			
0	33.69±2.72	34.81±4.52	33.47±3.78
3	42.18±2.97	40.78±4.43	37.25±3.77
6	38.93±2.41	40.33±4.30	43.54±3.16
9	37.12±2.70	39.66±4.27	38.68±3.70
Mean ± SE	37.11±2.69	38.66±4.27	38.67±3.69
NPN			
0	19.31±1.92	19.78±2.52	21.94±1.21
3	37.72±2.75	32.26±3.37	32.13±2.08
6	24.71±2.68	26.57±2.31	26.69±2.10
9	19.11 [a] ±1.72	24.54 [ab] ±2.00	28.99 [b] ±2.26
Mean ± SE	25.23±2.18	23.05±2.45	26.93±1.29

Total volatile fatty acids

At 0, 3, 6, and 9 hours after feeding, the total volatile fatty acids in the rumen liquor of animals in treatments C, E1, and E2 were 75.331.28, 76.671.23, and 77.331.69; 137.502.14, 146.771.52, and 150.303.44; 91.501.12, 97.501.09, and 103.831.54; and 80.171.30, 81. At 0 and 9 hours post-feeding, there was no difference between the treatments; however, at 3 and 6 hours post-feeding, there was a significant difference (P 0.05) between all the treatments, with the highest values for E2 and the lowest for C. The difference between the treatments was non-significant at 0 and 9 hours post-feeding. For various time intervals in treatments C, E1, and E2, the mean level of total volatile fatty acids (mM/L) in SRL was 96.120.89, 102.500.93, and 107.911.54, respectively. All of the treatments significantly differed from one another, with E2 having the greatest values and C having the lowest. In various treatments, the readings were greater at three hours after feeding. Increased organic matter digestibility is indicated by higher TVFA levels in E2 (Kholif *et al*., 2005). The outcomes were consistent with those of Soliman *et al*. (2014) [18], who fed guar korma to sheep in place of sunflower cake, and Goswami *et al*. (2012) [8], who discovered that guar meal had higher TVFAs than GNC in an in-vitro trial. The mean amount of total volatile fatty acids (mM/L) in SRL for various time periods indicated a significant difference between all treatments, indicating improved protein and energy utilisation.

pH

Table 3 illustrates how different food regimens and the time of sample altered the pH of buffalo bulls' strained rumen fluid. At 0, 3, and 6 hours after feeding, the pH of the rumen fluid of the animals in treatments C, E1, and E2 was 6.870.05, 6.850.05, and 6.760.03; 6.710.03, 6.690.06, and 6.620.03; 6.690.05, 6.690.04, and 6.630.02; and 6.760.05, 6.640.11, and 6.720.01, respectively. The pH variations between the various treatment groups at various time points were statistically (p<0.05) negligible. Because of the fermentation of the carbohydrates and the increased synthesis of TVFAs at three hours after feeding, the pH fell in all the groups. Because E2 group produced more TVFAs and less ammonia than the other two groups, the pH was a little lower in E2 group at 3 and 6 hours post-feeding. These results concur with those of Soliman *et al*. (2014) [18] and El-Monayer *et al*. (2015) in studies of sheep and buffaloes, respectively.

Table 3: TVFA and pH mean values of strained rumen fluid of buffalo bulls as influenced by various dietary regimens and sample time

Time Intervals (hrs)	Treatments		
	C	T_1	T_2
TVFA (mmol/L)			
0	75.33±1.28	76.67±1.23	77.33±1.69
3	137.5 [a] ±2.14	146.77 [b] ±1.52	150.3 [b] ±3.44
6	91.5 [a] ±1.12	97.50 [b] ±1.09	103.83 [c] ±1.54
9	80.17±1.3	81.33±1.20	83.5±1.54
Mean ± SE	96.12[a] ±0.89	102.50[b]±0.93	107.91[c]±1.54
pH			
0	6.87±0.05	6.85±0.05	6.76±0.03
3	6.71±0.03	6.69±0.06	6.62±0.03
6	6.69±0.05	6.69±0.04	6.63±0.02
9	6.76±0.05	6.64±0.11	6.72±0.01
Mean ± SE	6.75±0.04	6.71±0.05	6.68±0.01

Conclusion

We can infer that roasted guar korma is a by-pass protein source and that it is suitable for feeding to high-yielding animals. The korma's bypass protein concentration can be ascribed to roasting, and roasted guar korma was found to be superior than ground nut cake because it has higher nitrogen utilisation due to lower levels of soluble protein.

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