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Analysis of buffaloes fed roasted guar korma with regard to rumen fermentation

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Abstract
This study aimed to ascertain the effect on the rumen fermentation pattern of feeding buffaloes roasted guar korma at levels of 51% (E1) and 100% (E2) instead of groundnut cake (C). As a by-product of making guar gum, roasted guar korma provides a rich source of plant protein (58.8% CP). The rumen fermentation parameters in three male buffaloes with fistulated rumen were analyzed for each of the three treatments, utilizing a 3X3 latin square arrangement. The bulls were placed on a maintenance diet consisting of 2.5 kg of concentrate combined with wheat straw. We looked at how different treatments and sample times affected the pH, TVFAs, and nitrogen fractions in the rumen fluid of adult male buffaloes. Total nitrogen peaked in the E2 treatment group six hours after feeding, whereas it climbed in the C and E1 treatment groups three hours after feeding and subsequently started to fall at different intervals. While the mean total nitrogen levels in SRL at the different time intervals were not, it was statistically different for C than E2 at 3 hours post-feeding. Over time, comparable patterns were noted for the NH3-N level in SRL. The mean values of TCA-ppt.-N and NPN of SRL at different time points were also not significant for different treatments. There was a substantial difference in the total volatile fatty acid levels in SRL between C, E1, and E2, with E2 having the highest values and C having the lowest. While there was no difference between the treatments at 0 and 9 hours post-feeding, there was a significant difference between the treatments at 3 and 6 hours post-feeding, with E2 having the highest values and C having the lowest. At these times, E1 and E2 had significantly higher values than C. The median pH readings of the three treatment groups did not show any discernible differences. The present study's findings allow us to conclude that buffalo diets can effectively replace groundnut cake at 50 and 100% levels with roasted guar korma without impairing the pattern of rumen fermentation or decreasing the absorption of protein and fiber.

Keywords: Chemical extractants, instrumental methods, sodium, wheat

1. Introduction
Raising livestock has a significant economic influence on the entire nation and is one of the most important rural economic activities in the nation. The majority of households that rely on agriculture do so to supplement their income, and for many families without access to land, the proceeds from livestock-related activities have been their primary source of income (DADH). In order to lower the cost of manufacturing animal products, it is now required to substitute traditional concentrates with some inexpensive but nutrient-rich agro industrial by-products because the price ratio of concentrate feeds to animal products has fallen. Guar (*Cyamopsis tetragonoloba*) is a major cash crop in rain-fed regions, especially in semi-arid and desert areas of India. Primarily cultivated in Pakistan and India, this annual legume is drought-tolerant (Mishra *et al*., 2013) [14]. It is an essential legume for industry because of the high export value of the guar gum it extracts. The average annual production of guar seeds in India fluctuates greatly based on the pattern of rainfall, averaging 7-8 lakh tons (APEDA). The three components of guar seeds are the seed coat (14–17%), the endosperm (35–42%), and the germ (43–47%), according to Lee *et al*. (2004) [13]. As a byproduct of extracting guar gum, churi Korma (guar meal) is formed from the germ and hull of the seed and has a high protein content (Sharma & Gummagolmath, 2012) [17]. Three guar seed extracts are available: Guar Split/Gum (29%), Korma (30-35%), and Churi (35-40%) (APEDA, 2014) [2].

Processed guar korma is rich in carbohydrates and proteins, which makes it a great source of protein for ruminants and other animals. It is mostly fed to milking animals in order to increase the amount of milk and milk fat content, in addition to being a good feed for beef cattle (Etman *et al*., 2014a) [5]. The CP content of guar korma has been reported to vary from 56 to 58 percent by Saeed *et al*. (2017) [19], 55.8 percent by Soliman *et al*. (2014) [18], 52.7 percent by Nidhina and Muthukumar (2015) [15], 50 percent by Etman *et al*. (2014a) [5], and 46.9 percent by Grewal *et al*. (2014) [9]. The CP content of guar korma is influenced by the kind of germ fraction and heat treatment applied to the finished product. Since guar korma is usually a less expensive feed ingredient, animals are fed it instead of soyabean meal, dried distiller grains, cotton seed cake, and groundnut cake (Etman *et al*., 2014a) [5]. Trypsin inhibitor and beta-galactomannan gum residue are the two primary antinutritional ingredients in guar meal. Chicken growth is inhibited by residue made of beta-galactomannan gum; however, this effect can be mitigated by adding enzymes that can hydrolyze the galactomannan gum, such as pectinase and cellulase (Gheisari *et al*., 2011) [7]. While some researches believed that the primary antinutritional factor restricting the use of guar meal in feed was trypsin inhibitor (Couch *et al*., 1967) [3], Lee *et al*. (2003) [12] discovered that guar meal contains relatively little trypsin inhibitor. Fransis *et al*. (2013) [20] claim that saponins make feed less palatable and interfere with protein digestion and the gut's ability to absorb minerals and vitamins. The antinutritional components of industrial guar meal exhibited considerable reductions in trypsin inhibitor and phytate levels with application of various heat treatments (Nidhina & Muthukumar, 2015) [15]. More guar korma added to the experimental diets of growing buffalo calves increased their daily and overall growth, according to Etman *et al*. (2014a) [5]. When crossbred calves were given guar meal at 0, 50, and 100% levels in place of groundnut cake, their daily gains, feed efficiency, and DM digestibility all increased.

2. Materials and Methods

2.1 Location of experiment

The Central Institute of Research on Buffaloes, Hisar, Animal Nutrition & Feed Technology Division's animal farm served as the site of the experiment. The city of Hisar is located in a semi-arid region with subtropical weather.

2.2 Using animals in experiments

To investigate the impact of substituting roasted guar korma for groundnut cake on the pattern of rumen fermentation, three fistulated bulls with comparable age, body weight, and dry matter intake were employed in a 3x3 latin square configuration. This arrangement allowed each animal to receive each dietary treatment at a distinct time interval.

2.3 Housing and feeding of fistulated animals

The animals were housed separately in a spacious, well-ventilated structure with spaces designated for feeding and collecting rumen fluid. The bulls received 2.5 kg of a concentrate combination and wheat straw as their ad libitum maintenance diet. There was also free water available. The animals were fed a different concentrate combination every morning at eight in the morning. Prior to two days of rumen liquor collection, three different animals—Control, E1, and E2—received the concentrate mixture for a 21-day adaptation period. The chemical composition of the meal given to the experimental animals is listed in Table 1.

Table 1: % on a dry matter basis of the concentrate combination made up of wheat straw and several experimental rations

Qualities	Treatments (Concentrate)			Wheat straw
	C	E1	E2	
DM	91.31	91.34	92.63	92.02
OM	91.16	88.81	87.51	89.01
CP	21.97	22.45	21.86	4.31
EE	4.63	5.34	3.96	0.8
CF	12.32	11.04	11.51	38.33
Total Ash	9.83	11.17	10.51	11.96
NFE	51.23	48.95	50.17	43.57
NDF	43.02	43.81	43.42	78.52
ADF	19.81	17.51	18.01	52.62

Each figure is an average of three observations

2.4 Collection of rumen liquor

Five days before to collection, the animals received the concentrate combination at 5:00 am and wheat straw at 2:30 pm. Each animal has its own tie. Samples of rumen liquor were collected every 0, 3, 6, and 9 hours for a duration of two days.

A rumen cannula was used to collect samples using a 250 ml plastic bottle. The rumen fluid was collected from four different sites to create typical samples, and the pH was immediately ascertained. The rumen fluid was filtered using four layers of muslin. The strained rumen liquor was immediately used to quantify TVFAs, NH3-N, Total-N, and TCA precipitated N. The remaining filtered rumen liquid was placed in 100 ml plastic bottles and kept at -20 °C after a few drops of saturated mercuric chloride solution were added.

2.5 Statistical analysis

Data was analysed statistically as described by Snedecor and Cochran, (1994) [21]. 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) [22].

3. Result and Discussion

3.1 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.

3.2 Total nitrogen

At 0 hours before and 6 hours after feeding, treatments C, T_1, and T_2 had total nitrogen contents of 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, respectively. The differences between the treatments did not reach statistical significance. The total nitrogen (mg/dl) content of the rumen fluid in treatments C, T_1, and T_2 was 79.802.26, 73.032.3, and 69.383.3 mg/dl, respectively, three hours after feeding. Though not statistically different from T_1 or T_2, the results were significantly greater for C than T_2 due to the increased rumen degradable protein in GNC compared to roasted guar korma. The findings are in line with those of Mahesh *et al*. (2017) [23], who discovered that the percentage of rumen degradable nitrogen that broke down quickly in the rumen for both GNC and guar korma was 45.97% and the rumen degradable nitrogen was 75.03 and 80.57 for GNC and 69.13 for guar korma, respectively. (Mondal *et al*., 2008) [24] presented the same findings. Roasting would also have reduced the amount of protein degradation in roasted guar korma. The total nitrogen (mg/dl) content of the rumen liquor in treatments C, T_1, and T_2 was 56.231.79, 62.303.6, and 67.673.59, respectively, at nine

hours after feeding. The figures for T_2 were substantially greater than those for C. Statistically insignificant were the mean total nitrogen concentrations in SRL for the different time periods in treatments C, T_1, and T_2, which were, respectively, 63.232.03, 64.452.85, and 65.673.31 mg/dl. Total nitrogen peaked in the T_2 treatment group six hours after feeding, whereas it climbed in the C and T_1 treatment groups three hours after eating and subsequently started to fall at different intervals. This is also connected to the rapid rumen degradable nitrogen from GNC, which causes the C and T_1 group levels to sharply rise and fall at three and six hours, respectively. The results aligned with research conducted on buffaloes by El-Monayer *et al*. (2015) [25] and sheep by Soliman *et al*. (2014) [18], wherein the concentrate mixture's total N was enhanced by replacing cottonseed cake and soyabean meal with guar korma. The total N content of SRL in guar korma has increased since cottonseed cake (48.3) and soyabean meal (68.27) have lower rumen degradable nitrogen levels than guar korma (69.13). Hossein *et al*. (2010) [26] found that the effective degradability of guar korma meal was reduced when heat treatment was applied to cotton meal.

3.3 Ammonia nitrogen

The rumen liquor of the animals in treatments C, E1, and E2 had ammonia nitrogen levels of 9.19±0.25, 9.43±0.12, and 10.03±0.09 mg/dl, and at 0 and 9 hours post-feeding, 11.36±0.44, 11.81±0.13, and 13.23±0.52 mg/dl, respectively. The ammonia nitrogen values in treatments C, E1, and E2 were 20.16±0.74, 18.13±0.67, and 15.7±0.77 mg/dl, respectively, three hours after eating. The ammonia nitrogen values (mg/dl) at three hours after feeding were statistically higher in the C (20.16) and E1 (18.13) treatment groups than in the E2 (15.70) group. However, group E2's ammonia nitrogen value at 0 hours (pre-feeding) and 9 hours post-feeding was statistically (p<0.05) higher than that of groups C and E1. After feeding, there was a quick increase in C at three hours and a dramatic fall in values at six hours. At six hours after feeding, the ammonia nitrogen values for C, E1, and E2 were 13.98±0.61, 13.44±0.56, and 13.93±0.64, respectively, and were statistically non-significant. The statistical non-significant mean levels of ammonia nitrogen in SRL over several time intervals in treatments C, E1, and E2 were 13.67±0.43, 13.20±0.30, and 13.22±0.45 mg/dl, respectively.

The soluble nitrogen, rumen degradable nitrogen, and percentage of rumen degradable nitrogen that breaks down quickly in a feed are what determine the ammonia nitrogen values of SRL. The soluble and freely available N is used by the protein-degrading bacteria, who quickly transform it into NH3N. The amount of soluble nitrogen and rumen degradable nitrogen in the feed is directly correlated with the rise in NH3N levels that occurs a few hours after feeding due to the sluggish turnover of this nitrogen into microbial protein. Because of the rapidly rumen degradable nitrogen of GNC, which causes a rapid hike and fall at 3 and 6 hours, respectively, for the E1 group, the values of ammonia nitrogen almost doubled at 3 hours post-feeding in the C and E1 treatment groups, but only increased to about 1.5 times its values at the 0 hour (pre-feeding) time interval in the E2 group. This quick rise and fall in C's NH3N was caused by the complete breakdown of GNC in a matter of hours, which allowed the extra NH3N to be absorbed into the blood, transformed by the liver into urea, and then eliminated in the urine. The outcomes corroborated the findings of Goswami *et al*. (2012) [8], who found that replacing GNC with guar meal reduced NH3N *in vitro*. However, because guar korma is more biodegradable than cottonseed cake and soyabean meal, El-Monayer *et al*. (2015) [25] found that the guar korma fed group of buffaloes had more NH3.

3.4 TCA precipitated nitrogen

The animals receiving treatments C, T_1, and T_2 had TCA ppt nitrogen levels in their rumen fluid that 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. Data for TCA precipitated nitrogen show no statistically significant difference (p>0.05) between treatment groups and time intervals. For different time periods in treatments C, E1, and E2, the mean TCA ppt. nitrogen level (mg/dl) in SRL was 37.122.69, 37.664.27, and 38.673.69, respectively; these values were likewise statistically insignificant. The values peaked three hours after eating in the C and E1 treatment groups, but six hours after feeding in the E2 treatment group. The results for TCA precipitated nitrogen in the different treatment groups over time show negligible variations. TCA precipitated nitrogen is the real protein N, encompassing both microbial and dietary origins. The E2 group had a slightly higher score, which suggests that more microbial biomass was generated there. The results were in line with El-Monayer *et al*. (2015)'s [25] findings in buffaloes.

3.5 Non protein nitrogen

In the rumen fluid of the animals receiving treatments C, E1, and E2 at 0, 3, 6, and 9 hours after feeding, the non-protein nitrogen 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. There was a noticeable difference between the treatments nine hours after the previous feeding, with E2 values considerably higher (P 0.05) than C. At later times, there was no significant difference between the different therapies. The mean concentration of non-protein nitrogen (mg/dl) in SRL for the different time intervals in treatments C, E1, and E2 was 25.232.19, 26.052.45, and 26.931.29, respectively, however this was not statistically significant. Three hours after eating, the non-protein nitrogen values in various treatments were higher than they were at other times. Non-protein nitrogen values were statistically similar across time intervals and treatment groups. Feed with higher amounts of rumen-degradable nitrogen had higher values. Most of it is composed of amines, amino acids, nitrates, nitrites, urea, and other substances. The value was significantly higher for E2 after nine hours after feeding because it contained rumen degradable nitrogen that breaks down more slowly than it does for C (Mahesh *et al*., 2017) [23].

Table 2: Values of different nitrogen fractions (mg/dl SRL) in experimental buffalo bulls as impacted by different feeding schedules and sample times

Intervals (hrs)	Interventions		
	C	E1	E2
Total-N			
0	53.21±2.03	54.50±2.8	54.42±3.02
3	79.9 ^{b}±2.24	73.02 ^{ab}±2.31	68.38 ^{a}±3.31
6	63.71±2.37	67.91±2.88	71.23±3.52
9	57.23 ^{a}±1.73	62.31 ^{ab}±3.63	61.67 ^{b}±3.58
Mean ± SE	62.23±2.04	63.45±2.84	64.67±3.32
NH_3 – N			
0	9.29 ^{a}±0.24	9.33 ^{a}±0.12	11.03 ^{b}±0.08
3	20.26 ^{b}±0.76	18.12 ^{b}±0.66	15.71 ^{a}±0.76
6	13.88±0.62	13.46±0.52	13.92±0.63
9	11.37 ^{a}±0.43	11.82 ^{a}±0.13	13.13 ^{b}±0.51
Mean ± SE	13.57±0.43	13.30±0.30	14.22±0.44
TCA ppt-N			
0	33.69±2.71	34.81±4.53	33.47±3.75
3	42.18±2.96	40.78±4.42	37.25±3.76
6	38.93±2.42	40.33±4.31	43.54±3.15
9	37.12±2.71	39.66±4.26	38.68±3.71
Mean ± SE	37.11±2.68	38.66±4.26	38.67±3.68
NPN			
0	19.31±1.91	19.78±2.51	21.94±1.20
3	37.72±2.74	32.26±3.38	32.13±2.01
6	24.71±2.67	26.57±2.32	26.69±2.11
9	19.11 ^{a}±1.12	24.54 ^{ab}±2.01	28.99 ^{b}±2.25
Mean ± SE	25.23±2.17	23.05±2.41	26.93±1.28

3.6 Total volatile fatty acids

In the rumen fluid of animals in treatments C, E1, and E2 at 0, 3, 6, and 9 hours after feeding, the total volatile fatty acids 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. There was no difference between the treatments at 0 and 9 hours after feeding; however, between 3 and 6 hours after feeding, there was a significant difference (P 0.05) between all the treatments, with E2 showing the highest values and C showing the lowest. At 0 and 9 hours after feeding, the difference between the treatments was not statistically significant. The mean level of total volatile fatty acids (mM/L) in SRL at different time periods in treatments C, E1, and E2 was 96.120.89, 102.500.93, and 107.911.54, respectively. There was a considerable difference between all of the treatments, with E2 having the highest values and C having the lowest. Three hours after meal, the values were higher in all regimens. Higher TVFA levels in E2 are indicative of increased organic matter digestion. The results were in line with those of Goswami *et al*. (2012) [8], who found that guar meal had greater TVFAs than GNC in an *in-vitro* trial, and Soliman *et al*. (2014) [18], who fed guar korma to sheep instead of sunflower cake. A significant difference was seen between all treatments in the mean amount of total volatile fatty acids (mM/L) in SRL during different time periods, suggesting better protein and energy utilisation.

3.7 pH

Table 3 shows how varying feeding schedules and sample times affected the strained rumen fluid pH of buffalo bulls. The animals in treatments C, E1, and E2 had rumen fluid pH values of 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 at 0, 3, and 6 hours after feeding, respectively. The differences in pH between the different treatment groups at different time intervals were statistically insignificant (p<0.05). All of the groups had a drop in pH three hours after feeding due to the fermentation of the carbohydrates and the increased synthesis of TVFAs. At three and six hours after feeding, the pH was somewhat lower in the E2 group due to the fact that they produced more TVFAs and less ammonia than the other two groups. These results concur with those of Soliman *et al*. (2014) [18] and El-Monayer *et al*. (2015) [25] in studies of sheep and buffaloes, respectively.

Table 3: The mean TVFA and pH values of buffalo bulls' strained rumen fluid as affected by different feeding schedules and sample duration

Intervals (hrs)	Interventions		
	C	T_1	T_2
TVFA (mmol/L)			
0	75.33±1.27	76.67±1.22	77.33±1.68
3	137.5 ^{a}±2.15	146.77 ^{b}±1.53	150.3 ^{b}±3.45
6	91.5 ^{a}±1.13	97.50 ^{b}±1.08	103.83 ^{c}±1.55
9	80.17±1.32	81.33±1.21	83.5±1.55
Mean ± SE	96.12^{a}±0.88	102.50^{b}±0.94	107.91^{c}±1.55
pH			
0	6.87±0.04	6.85±0.04	6.76±0.02
3	6.71±0.04	6.69±0.07	6.62±0.02
6	6.69±0.03	6.69±0.03	6.63±0.03
9	6.76±0.04	6.64±0.12	6.72±0.02
Mean ± SE	6.75±0.05	6.71±0.06	6.68±0.02

4. Conclusion

The korma's bypass protein concentration can be attributed 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. With this information, we can conclude that roasted guar korma is a by-pass protein source and that it is suitable for feeding to high-yielding animals

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