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Guar Meal as a Substitute for Conventional Soyabean Meal: Impact on Blood and Serum Profile of Nagavali Ram Lambs

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ABSTRACT

The experiment was conducted during 2024 from April to June for a period of 90 days, at Livestock Research station, Garividi, Vizianagaram district, Andhra Pradesh, India. The research was focused on guar meal, a non-conventional feed ingredient for substituting soyabean meal in sheep concentrate feed and its effect on haematology and serum profile. A 90-day trial was conducted using 24 Nagavali ram lambs, with an average body weight of 7.4 kg and ages ranging from 3 to 6 months. The lambs were randomly assigned to four dietary treatments. The control diet was formulated with concentrate mixture and super napier green fodder. In the treatment diets, guar meal replaced soybean meal at 50%, 75%, and 100% levels. Blood and serum samples were collected in EDTA and serum vials at the beginning (0th day) and end (90th day) of the trial for analysis of various haematological parameters and serum was separated by centrifugation and subjected to various serological tests to analyse lipid profile, mineral profile, liver and kidney function of the guar meal fed lambs. No significant (p>0.05) differences were noticed in both blood and serum parameters before and after feeding with guar meal among the four dietary groups, and all the values were in normal physiological range indicating that guar meal can effectively replace soybean meal as a protein source in sheep diets.

KEYWORDS: Guar meal, non-conventional feed, haematology, serum profile

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1. INTRODUCTION

Sheep are raised by farmers in India, the world's second-largest producer of sheep, for both meat and wool (Sarita et al., 2018). The Anonymous (2019) estimates that there are over 74.26 million sheep in India (Gite et al., 2024). Due to the scarcity of livestock feed and fodder as well as the growing cost of feed ingredients, farmers have found it difficult to produce both high-quality and high-quantity animal products in recent years. Therefore, changing the approach of using feed ingredients for livestock on which the entire output depends is the main objective in order to increase the quality and quantity of the animal products. Even though conventional feeds increase the amount of production, they are more expensive, which drives up the production costs that can be alleviated by non-conventional feed resources. Therefore, unconventional feed ingredients such as guar meal are investigated. Guar meal was chosen in the present research since it is less costly than soybean meal, dry distiller grains, and cotton seed cake (Etman et al., 2014).

As a drought-tolerant legume (Mishra et al., 2013) and a key crop in India, guar (Cyamopsis tetragonoloba), also known as "gau ahar," which means bovine fodder in Sanskrit (Amarjeet et al., 2014), accounts for 80% of the world's guar seed output (Anonymous, 2021). The fact that the world's guar seed production has increased from 11,00,000 mt to 12,87,000 mt during the last three years highlights its importance. After being removed from guar pods, the guar seeds are cracked to separate into germ and endosperm fractions, which are referred to as undehusked guar splits. Guar gum powder is made by polishing these halves to create polished guar splits, which are then subjected to other processing methods and treatments. Guar is regarded as an industrially significant legume as the guar gum is utilized as a viscosifier in oil and gas drilling, as well as an excipient in medicines and papermaking (Vishwakarma et al., 2012; Kadian et al., 2013). Guar meal (GM), a byproduct made of germ and hull in 1: 3 ratio (Lee et al., 2004) with 42–50% CP (Goswami et al., 2012; El-Monayer, 2015; Abbas et al., 2018; Janampet et al., 2016; Tyagi et al., 2011) is a potential substitute protein source for animals because of its remarkable 88% true protein content and arginine levels that are almost twice as high as those of soybean meal.

Guar meal production had increased recently as the guar gum production approaches commercial scale. It was anticipated that guar meal would eventually replace commonly used protein-rich feed ingredients such as groundnut cake (GNC), cottonseed cake (CSC), soyabean meal (SBM), etc in animal concentrate feed mixtures in coming days. Guar meal was found to replace ground nut cake in earlier studies on calves by Goswami et al. (2012), Jongwe et al. (2014), and Ojha et al. (2013) without affecting blood metabolites; however, when guar meal was fed to buffaloes, the AST and ALT values improved (El-Monayer, 2015 and Etman et al., 2014). The scientific literature on sheep blood metabolites in response to guar meal feeding is limited. In light of previous studies, the current research focused on the utilization of guar meal in place of soybean meal, which was commonly used as a protein source in sheep concentrate feed, and its impact on the blood and serum parameters.

2. MATERIALS AND METHODS

2.1. Location and research protocol

The experiment was conducted during 2024 from April to June for a period of 90 days, the entire experiment was conducted at small animal experimental shed at the Livestock Research Station in Garividi, Vizianagaram district, Andra Pradesh for 90 days. The research area was located at latitude 18.285839° N and longitude 83.536339° E. With an average body weight of 7.4 kg and an estimated age of 3-6 months, twenty-four Nagavali ram lambs were randomly assigned to four groups in order to examine the effect of guar meal on haematology and serum biochemical profiles.

2.2. Dietary regimen

Four iso-nitrogenous diets were formulated using ingredients that were accessible locally, including maize, DORB, along with the conventional soybean meal in concentrate mixture (CM-1), that had been substituted with guar meal at 50%, 75%, and 100% levels in CM-2, CM-3, and CM-4 respectively. The composition of diets were presented in Table 1. These diets were developed based on the lamb weights and adhere to Anonymous (2013) recommendations. During the trial, the lambs were fed Super napier fodder (adlib) and their respective concentrate feeds.

2.3. Sample procurement and biochemical evaluation

At the beginning and end of experiment the blood was collected from jugular vein and serum was separated by centrifugation at 2000 RPM and stored at -20°C to facilitate in-depth examination. The blood parameters like WBC/micro lit, RBC/micro lit, Haemoglobin g dl^{-1}, HCT%, MCVfL, MCH pg, MCHC g dl^{-1}, RDW%, PLT/ micro lit, MPV Fl, PDW, PCT% were evaluated by using Hematology analyser at ADDL, Vizianagaram and the values were compared to that of referral values given by Reece and Swenson, 2004. The serum parameters that include albumin, protein, glucose, Triglycerides, cholesterol, HDL-C, LDL-C, VLDL-C, BUN, creatinine, calcium and phosphorus were estimated utilising techniques given by Doumas (1972), Tietz (1986), Trinder's (1969),

Table 1: Chemical composition of diets

Nutrient (%)	Soyabean meal	Guar meal	CM-1	CM-2	CM-3	CM-4
Dry matter	93.41	93.21	92.12	92.01	92.02	92.34
Organic matter	91.91	95.04	88.65	89.85	90.08	92.73
Crude protein	44.73	51.56	20.14	20.13	20.13	20.16
Ether extract	3.78	6.96	2.20	3.08	3.14	3.16
Crude fibre	8.80	3.62	20.16	17.98	13.92	12.07
Nitrogen free extract	34.61	32.91	46.15	48.66	52.60	57.34
Total ash	8.08	4.95	11.35	10.15	9.92	7.27
Neutral detergent fibre	24.72	30.81	57.30	54.77	52.60	51.78
Acid detergent fibre	17.54	10.51	30.15	27.77	25.74	25.66
Hemi cellulose	7.18	20.29	27.15	27.00	26.86	26.12
Cellulose	13.45	5.58	17.07	13.38	9.26	9.20
Acid detergent lignin	2.15	4.09	8.46	9.30	11.99	12.66
Silica	0.92	0.83	4.60	3.66	4.09	3.06
Calcium	1.00	0.86	0.74	0.63	0.66	0.52
Phosphorus	0.34	0.33	0.37	0.45	0.43	0.31

Burstein (1970), Talke and Schubert (1965), Bowers, 1980, Moorehead and Briggs (1974) and Daly and Ertingshausen's (1972).

2.4. Statistical examination

By applying the variance technique (Snedecor and Cochran 1994) and utilization of Anonymous 2012, version 22.0, the resulting data were examined for statistical relevance. The Duncan test was applied to compare the treatment means $p<0.05$ was used to test for differences.

3. RESULTS AND DISCUSSION

3.1. Haematology of Nagavali ram lambs fed with diets containing guar meal

The blood parameters like WBC/micro lit, RBC/micro lit, Haemoglobin g dl^{-1}, HCT%, MCVfL, MCH pg, MCHC g dl^{-1}, RDW%, PLT/ micro lit, MPV Fl, PDW, PCT% were evaluated before and after the commencement of trail where the GM was included in the diets of Nagavali ram lambs at varied levels and were illustrated in Table 2. The lambs do not show statistically significant variance ($p>0.05$) in their blood components after they were fed with guar meal at upto 100% level. All the parameters remained within the normal physiological range. Nutritional excesses or deficits can affect the production and function of blood cells and thereby overall health of the animal. In the current study, the fresh blood of lambs was tested for all the haematological parameters before and after guar meal consumption to test its effect on health of the lambs. The resulted values of WBC, RBC, Haemoglobin, HCT, MCV, MCH, MCHC, RDW, PLT/ micro, MPV, PDW, PCT before and at the end of the study were similar ($p>0.05$) and were in line with that of the values demonstrated by Reece and Swenson, 2004. The Hb, MCV, MCH, MCHC and WBC of lambs were in accordance with the Anonymous 2011. Jawasreh et al., 2009 reported comparatively lower WBC and RBC count and higher Hb in Awassi sheep however the MCV, MCH and MCHC were similar to present observations. The values were also comparable with the values reported by Oyeyemi and Ajani (2014) in rams. The present haematological parameters were comparable with the range of WBC, RBC, Haemoglobin, HCT, MCV, MCH, MCHC reported by various authors. This indicated that all the haematological parameters of the study were within the normal range. Additionally, there was no noticeable difference ($p>0.05$) in the lambs given guar meal indicating it as a safer protein feed.

3.2. Serum biochemical profile of Nagavali ram lambs fed with diets containing guar meal

3.2.1. Effect of inclusion of guar meal on liver function tests

The effect of incorporating Guar meal in the concentrate mixture on ram lamb liver function tests was displayed in Table 3. Incorporating guar meal in the concentrate mixture at levels up to 100% had no significant effect ($p>0.05$) on serum total protein, albumin, globulin, A:G ratio, ALT, and AST levels in lambs of the T_2, T_3, and T_4 groups compared to the control group. Furthermore, all these parameters remained within the normal physiological range. According to the results, which showed constant protein

Table 2: Haematology of Nagavali ram lambs fed with diets containing guar meal

Parameter	Control (0%)	50%	75%	100%	SEm±	*p*-value
WBC/microlit ($\times 10^3$)	12.06	11.28	11.33	11.68	0.15	0.57
	12.11	11.31	11.06	11.78		
RBC/microlit ($\times 10^6$)	10.56	10.04	9.89	11.69	0.07	0.29
	10.64	10.09	9.97	11.74		
Haemoglobin g dl^{-1}	9.33	9.58	9.40	9.53	0.09	0.49
	9.38	9.63	9.45	9.60		
HCT %	26.26	25.75	25.90	26.16	0.09	0.47
	26.31	25.80	25.93	26.23		
MCVfL	28.71	28.43	28.68	28.78	0.47	0.66
	28.93	28.55	28.83	28.93		
MCH pg	10.90	11.05	10.95	11.10	0.13	0.45
	11.03	11.11	11.01	11.05		
MCHC g dl^{-1}	33.93	34.13	34.10	34.05	0.16	0.41
	34.00	34.23	34.18	34.13		
RDW %	17.23	17.13	17.35	17.05	0.16	0.33
	17.36	17.20	17.41	17.16		
PLT/micro lit ($\times 10^3$)	1005.33	1019.33	1014.17	1016.67	1.5	0.47
	1012.67	1029.33	1022.50	1021.67		
MPV Fl	4.03	4.05	4.01	4.05	0.08	0.67
	4.05	4.08	4.05	4.08		
PDW	29.93	29.96	30.03	30.06	0.15	0.53
	30.00	30.08	30.11	30.11		
PCT%	0.38	0.34	0.37	0.36	0.01	0.57
	0.39	0.34	0.37	0.37		

Table 3: Effect of inclusion of Guar meal on liver function tests

Parameter	Control (0%)	50%	75%	100%	SEm±	*p*-value
Total protein (g dl^{-1})	6.67	6.59	6.87	6.42	0.39	0.46
	6.97	6.94	7.15	6.66		
Albumin (g dl^{-1})	2.69	2.62	2.64	2.64	0.19	0.91
	2.71	2.66	2.66	2.65		
Globulin (g dl^{-1})	3.97	3.96	4.22	3.77	0.47	0.55
	4.25	4.28	4.49	4.01		
A: G ratio	0.70	0.76	0.66	0.77	0.40	0.51
	0.64	0.63	0.60	0.69		
ALT (IU dl^{-1})	22.51	22.68	22.18	22.95	1.51	0.77
	23.48	23.01	22.60	22.93		
AST (IU dl^{-1})	103.89	104.84	104.84	103.25	1.13	0.81
	103.80	104.54	104.54	103.39		

metabolism in all treatment groups, adding guar meal up to 100% substitution did not change liver function. There was no appreciable change (p>0.05) in these parameters when guar meal was added to the diets of crossbred calves, according to Goswami et al. (2012) and Sharma et al. (2015). Following the addition of guar meal to the diets of HF cows and male calves, respectively, Ojha et al. (2013) observed no discernible changes in blood biochemical indicators including protein fractions. When calves and lactating cows were fed diets based on guar meal, Abbas et al. (2018) and El-Monayer (2015) also observed no appreciable increase (p>0.05) in blood levels of albumin, globulin, or total protein. On the other hand, Shwerab et al. (2015) found that adding guar meal that had undergone particular treatments to the diet caused significant (p<0.05) increases in the serum levels of albumin, globulin, and total protein in lambs. Guar korma meal's high-quality protein content and improved digestibility may have contributed to Etman et al. (2014) found that adding it to rations considerably (p<0.05) raised total blood protein and albumin levels. Unaltered serum protein fractions from the current investigation give credibility to the idea that guar meal can be utilized as an unconventional source of protein without negatively impacting liver function.

As indicated in Table 3, the substitution of 50%, 75%, and 100% of conventional soybean meal with guar meal in the concentrate feed did not significantly (p>0.05) change serum ALT (IU dl^{-1}) and AST (IU dl^{-1}) in comparison to the control. These findings were consistent with those of Sharma et al. (2015), who found that guar meal had no discernible (p>0.05) impact on the levels of blood ALT and AST in calves given diets based on guar meal. According to Ojha et al. (2013), adding 10% guar meal to the concentrate combination had no significant effect (p>0.05) on the levels of SGOT (AST) and SGPT (ALT) in crossbred calves. Additionally, Abbas et al. (2018) discovered that adding guar meal did not substantially change (p>0.05) the serum levels of liver enzymes, indicating that it can be used as a protein source without impairing liver function. Similarly, Goswami et al. (2012) and Shwerab et al. (2015) found no significant impact (p>0.05) on the levels of ALT and AST in lambs and buffalo calves fed diets containing guar meal.

Nonetheless, other research has revealed the contrary, showing that adding guar meal did raise the levels of liver enzymes. Etman et al. (2014) found that rations containing guar korma meal had significantly higher blood ALT and AST levels (p>0.05), which may indicate a mild hepatotoxic effect. This could be because of the variation in processing method. El-Monayer (2015) discovered that higher levels of guar korma meal in concentrate feeds were linked to higher AST and ALT concentrations. They related this to the higher protein content and ruminal fermentation properties of guar meal. As seen in the ram lambs, unchanged blood ALT and AST levels, in this investigation illustrated that adding guar powder to the concentrate mixture in place of soybean meal did not negatively impact liver function.

3.2.2. Effect of inclusion of Guar meal on lipid profile

The effect of incorporating Guar meal in the concentrate mixture of ram lambs on lipid profile was presented in Table 4. The inclusion of Guar meal in the concentrate mixture of ram lambs up to 100% did not show any deleterious effect (p>0.05) on serum glucose, triglycerides, total cholesterol, HDL-C, LDL-C and VLDL-C concentration as compared to control. The results of Shwerab et al. (2015), who likewise found no significant change (p>0.05) in glucose levels in ram lambs fed diets containing guar meal, were in agreement with the readings of glucose in our investigation.

Table 4: Effect of inclusion of Guar meal on lipid profile

Parameter	Control (0%)	50%	75%	100%	SEm±	p-value
Glucose (mg dl^{-1})	53.38	51.40	52.85	52.98	1.08	0.47
	54.73	52.09	53.37	53.59		
Triglycerides (mg dl^{-1})	43.77	44.69	43.38	43.18	0.88	0.70
	44.69	43.87	43.12	43.09		
Total cholesterol (mg dl^{-1})	54.34	54.44	53.85	53.50	0.96	080
	54.26	54.09	53.36	53.47		
HDL-C (mg dl^{-1})	38.32	38.43	38.41	38.13	1.01	0.82
	38.44	38.14	38.20	38.02		
LDL-C (mg dl^{-1})	24.78	24.95	24.12	24.01	1.33	0.91
	24.75	24.72	23.78	24.07		
VLDL-C (mg dl^{-1})	8.75	8.93	8.67	8.63	0.24	0.70
	8.93	8.77	8.62	8.61		

Furthermore, when guar meal substituted the cottonseed meal, Salehpour et al. (2012) found no discernible alterations (p>0.05) in the glucose levels of Holstein lactating cows. Similarly, Sahiwal cows fed guar meal showed no discernible change (p>0.05) in serum glucose levels, according to Jongwe et al. (2014). Abbas et al. (2018) found that feeding guar meal treated with acetic acid to crossbred Friesian cows did not significantly alter their serum glucose levels (p>0.05). Similarly, there was no significant difference in serum triglyceride and total cholesterol levels across treatments (p>0.05). In the same way, Salehpour et al. (2012) discovered no discernible changes in the lipid profiles (HDL, LDL, and VLDL) of lactating cows given guar meal. Furthermore, in crossbred Friesian lactating cows, Abbas et al. (2018) found no discernible impact (p>0.05) by guar meal on blood triglycerides and cholesterol. In contrast to our results, Shwerab et al. (2015) found a significant drop (p<0.05) in serum cholesterol levels. Thus, the study found that providing a diet that included up to 100% guar meal in place of soya bean meal in the concentrate mix had no effect (p>0.05) on the serum concentrations of HDL, LDL, and VLDL cholesterol (mg dl^{-1}) in ram lambs compared to the control.

3.2.3. Effect of inclusion of Guar meal on kidney function tests

The effect of inclusion of Guar meal in the concentrate mixture of ram lambs on kidney function tests in ram lambs was displayed in the Table 5. The serum urea and creatinine levels of ram lambs before and after the trail did not show significant difference (p>0.05) by including the guar meal in the concentrate mixture up to 100% level. Both creatinine and BUN were filtered by the kidney and then removed in the urine. BUN and creatinine are combined and examined to evaluate renal function. Serum urea (mg dl^{-1}) and creatinine (mg dl^{-1}) levels in ram lambs were unaffected by feeding diet consisting of varying amounts of guar meal in the concentrate mixture (p>0.05). These results were in line with those of Jongwe et al. (2014), who found that even at a 75% substitution rate, Sahiwal cows did not exhibit a significant change (p>0.05) in BUN levels. Similarly, crossbred calves fed diets containing 5% guar meal did not exhibit a significant change (p>0.05) in serum urea levels, according to Sharma et al. (2015). Additionally, El-Monayer (2015) found that the urea concentrations in lactating buffalo cows were unaffected by the addition of guar meal to the concentrate combination. In a similar manner Abbas et al. (2018) observed that feeding guar meal to lactating cows did not significantly alter (p>0.05) their urea levels. Additionally, Abbas et al. (2018) found no discernible variations (p>0.05) in urea levels among the experimental groups in a study including nursing cows. Another crucial indicator of renal function, serum creatinine levels, did not alter significantly (p>0.05) across treatment groups. Similarly, guar meal had no discernible impact on crossbred calves blood creatinine levels, according to Sharma et al. (2015). Apart from the present findings, Salehpour et al. (2012) found that when the amount of guar meal in the diet got higher, Holstein cow BUN levels significantly decreased (p>0.05). Additionally, in contrast to the present findings, Parmar et al. (2023) showed elevated levels of urea nitrogen and creatinine (p>0.05) in developing dairy buffalo calves fed formaldehyde-treated guar meal (FTGM). Differences in animal species, experimental circumstances, and guar meal processing techniques, such as the use of formaldehyde-treated guar meal in studies, might be the cause of the discrepancy in results (Parmar et al., 2023).

3.2.4. Effect of inclusion of Guar meal on serum mineral profile

The effect of incorporation of Guar meal at varying levels in the concentrate mixture on serum mineral profile in ram lambs is displayed in Table 6. The serum calcium and phosphorus levels did not differ significantly (p>0.05) by inclusion of guar meal in the diet up to 100%. All treatment groups (T_2, T_3, T_4) and the control group had identical serum calcium levels, which are important for bone health, muscle function, and other metabolic functions. The results were in line with those of Salehpour et al. (2012), who found that feeding guar meal instead of cottonseed meal to Holstein nursing cows did not significantly alter (p>0.05) serum calcium levels. The lack of noticeable change in calcium levels indicated that guar meal did not negatively impact ruminant calcium metabolism, even at greater inclusion levels. Similarly, adding guar meal to the diet had no effect

Table 5: Effect of inclusion of Guar meal on kidney function tests

Parameter	Control (0%)	50%	75%	100%	SEm±	p -value
Urea (mg dl^{-1})	18.98	19.28	19.27	19.20	0.63	0.92
	18.94	19.19	19.25	19.14		
Creatinine (mg dl^{-1})	1.53	1.60	1.75	1.63	0.21	0.75
	1.51	1.57	1.65	1.63		

Table 6: Effect of inclusion of Guar meal on serum mineral profile

Parameter	Control (0%)	50%	75%	100%	SEm±	p -value
Calcium (mg dl^{-1})	11.33	11.46	11.68	11.60	0.13	0.40
	11.28	11.48	11.34	11.33		
Phosphorus (mg dl^{-1})	6.47	6.30	6.28	6.30	0.24	0.35
	6.69	6.59	6.52	6.52		

on the levels of serum phosphorus, which are essential for bone development and energy metabolism. This outcome was consistent with Salehpour et al. (2012), who discovered that Holstein cows given guar meal rather than cottonseed meal did not exhibit any appreciable change (p>0.05) in serum phosphorus levels. The results of this study showed that, even at different inclusion rates, guar meal had no effect on phosphorus homeostasis when fed to ram lambs. At the levels examined in this study, guar meal did not affect ruminant mineral uptake or metabolism. It was also possible that guar meal lacks several of the substances that could bind minerals and altered their bioavailability. In view of this, adding it to the concentrate mixture seemed to be a nutritionally safe way to keep the right balance of calcium and phosphorus in ram lambs.

4. CONCLUSION

Both blood and serum parameters before and after feeding guar meal at varying levels (50%, 75%, and 100%) proved statistically (p>0.05) non-significant in which suggested that guar meal was safe for sheep diets. All haematological and serum values remained within the normal physiological range, indicating no adverse effects on the health and well-being of the lambs.

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