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Potential Impact of Non-conventional Protein Resources *Cyamopsis tetragonoloba* (Guar Meal) in Lamb's Diet

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Abstract

The objective of this study was to evaluate the effect of using non-conventional protein sources of plant origin (guar meal) as a promising strategy for improving feed efficiency in Awassi sheep. This study included: (i) investigation of the nutrient intake and productive performance of lambs, (ii) appraisal nutrients digestibility and ruminal parameters (pH, N-H3 and volatile fatty acids), where experiment 1 used 18 Awassi lambs (age 2.5-3 months) distributed and assigned into three groups (randomly), and experiment 2 used nine lambs in randomized block design with three replicates. Three experimental concentrate diets were formulated to be isonitrogen (crud protein [CP] content 15.6%) and isoenergy (metabolic energy [ME] content 2.4 Mcal/kg). The results showed that the final body weight and dry matter intake (kg/day and g/kg of body weight) were not significantly affected ($p = .05$) despite the improvements occurring. In addition, the guar meal significance increased ($p \leq .05$) of average daily gain than total weight compared to the other experimental diets. The guar meal affected NH_3 concentration ($p = .037$), total volatile fatty acids (TVFAs) ($p = .001$), and molar proportions of acetate and propionate ($p = .027$). The molar proportions of valerate ($p < .05$) and caproate ($p < .05$) were significantly reduced when replacing traditional sources of protein. No difference ($p > .05$) in the dry matter, ether extract, and crude protein digestibility was observed among the three diets. In conclusion, guar meal could replace traditional conventional protein sources in ruminant diets with no adverse effects on feed intake, or digestibility.

Keywords: Awassi lambs, digestibility, guar meal, non-conventional protein resources

Introduction

The Iraq livestock industry is witnessing growth and development owing to an increased focus on looking for protein-rich and cheaper non-conventional resources for making a variety of ingredients available in the livestock feed industry (Annongu et al., 2010), with a growing feeding competition. Hence, using non-conventional feed ingredients in lamb diets is an economical interest used by livestock nutritionists. Guar meal (GM) is one such feed that may be useful in alleviating this problem. Guar meal, an agro-industry by-product after guar gum extraction is complete, contains germs and hulls (25% and 75%, respectively) (Lee et al., 2004). To enhance the nutritional value and digestibility of guar feed, the seeds are roasted to remove anti-nutrients. Guar meal contains 35%-47.5% crude protein, 5-8 lysine contents (1.72% of dry matter (DM)), methionine, and cysteine (0.96% of DM), which were lower than those of soybean meal. The non-protein nitrogen (NPN) concentration ranged from 21% to 32% and about 88% of it represents true protein (Jahani-Azizabadi et al., 2010). Guar meal can replace costly conventional protein sources and protein supplements such as groundnut oil cakes up to 100% in ruminant animals, but its use in monogastric animals has its limitations (Mahdavi et al., 2010). Feeding in balanced diets does not cause digestive disorders; however, feeding GM as the sole concentrate can induce chronic diarrhea in growing calves (Ali et al., 2004).

At the economical side, using GM showed that the nitrogen content is approximately twice that of soybean meal and NPN concentration is higher, making it generally a cheaper feed ingredient than meal of soya (Tripathi et al, 2014).

Guar meal is used as a feed in dairy cattle, resulting in an increase in the amount of milk and fat content of milk (Shahbazi, 2012). Guar hay feed improved goat's milk production, and meat production increased nearly threefold as weight gain. Also, GM has characteristics of antimicrobial activity because galactomannan and saponin content may aid in gut health (reduced colonization and shedding of pathogenic bacteria in the gut) (Zahid et al., 2012).

In poultry, Milczarek et al. (2022) reported that 4% of GM in broiler chicken can be used enough to maintain performance and carcass. Çalislar (2020) showed that 16% of GM might be used in laying hen feed as maximal without effect on laying performance and egg quality.

In pigs, Hasan et al. (2020) found the replacement of soya meal (SM) with GM at levels (75%) reduces average daily feed intake (ADFI), average daily gain (ADG), and feed conversion ratio (FCR) in young pigs. Lyu et al. (2018)reported that GM diets had no significant effect on ADFI in growing–finishing pigs.

The aim of this study is the use of non-conventional protein sources (GM) as a promising strategy for improving feed efficiency in Awassi sheep.

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Materials and Methods

Ethical Considerations and Location

During the experiment, all animal handling practices and welfare considerations were performed according to the General Rules of Veterinary Services for the Care of Animals and in compliance with the ethics committee of the Baghdad University (Approval no: 1049/P. G, Date: January 5, 2022). This experiment was conducted at the sheep breeding farms in the private sector, located in the municipality of Kut City, Wasit province, Iraq from March 2022 to May 2022. An adaptation period of 14 days was allowed before the experimental period of 60 days. Lambs were treated against parasites (ecto and endo) with ivermectin and vaccinated (Co-Baghdad) against clostridiosis.

Experimental Diets

The ingredients of the ration and alfalfa hay are presented in Table 1. The experiment lasted for 60 days, preceded by a 14-day adaptation period. The GM used in this experiment was purchased from a commercial firm and toasted at a higher temperature of 190°C for 80 minutes in Oven UF 450 plus to inhibit anti-nutrients in GM, and the analysis results of GM are given in Table 2.

The experimental concentrate diets were formulated to be isonitrogen (CP content 15.6%) and isoenergy (ME content 2.4 Mcal/kg). Three experimental concentrate feed mixtures were formulated to contain sources of protein, two diets as traditional SM and sunflower cake meal (SFM), and another formula was offered as a diet replacing conventional protein source 100% with GM. A complete random block was designed using Awassi lambs of 2.5–3 months of age having a body weight (BW) of 19.9 ± 1.27 kg. All lambs were divided into three groups (six lambs in each group randomly) and homogeneous for age and initial live BW and were used in two experiments: a feeding trial and a digestibility trial. The lambs were fed an experimental diet at 3% of their live BW; each animal also received 1000 grams of alfalfa per day throughout the experimental period. The BW was recorded for each lamb before the start of the trial, and thereafter, every week for the adjustment of the offered diet, feeds were offered twice a day (8:30 a.m., 3:30 p.m.).

Table 1.
Ingredients of Experimental Diets

	Concentrated			Roughage
Ingredients %	**SM**	**SFM**	**GM**	**Alfalfa Hay**
Wheat bran	22.5	22.5	22.5	1 kg/day
Yellow corn	55	50	55	
Soya meal	20	–	–	
Sunflower cake	–	25	–	
Guar meal	–	–	20	
Salt	1	1	1	
Vitamin and mineral premix*	0.7	0.7	0.7	
Limestone	0.8	0.8	0.8	
Total	100	100	100	

Note: GM = Guar meal; SFM = Sunflower cake meal; SM = Soya meal.
*Ingredients per kg: sulfur (30 g), zinc (600 mg), copper (34 mg), selenium (2.5 mg), sodium (75 g), manganese (200 mg), calcium (30 g), phosphorus (21 g), cobalt (1.8 mg), iron (300 mg), magnesium (4 g), iodine (10 mg), chromium (3.5 mg), fluorine (200 mg), and molybdenum (40 mg). D3 2000000 IU, vitamin A 9000000 IU, vitamin K3 18g, vitamin E 2 g, riboflavin 6.6 g, thiamine 1.8 g, vitamin B6 3 g, pantothenic acid 10 g, and niacin 30 g.

Table 2.
Chemical Composition of Guar Meal

Item	Contents
Basic nutrients (g kg^{-1})	
DM	902.8
Ash	47.3
CP	481.6
EE	34.1
CF	71.3
NFE	265
Gross energy (kcal/100 g)	421.04

Note: DM = Dry matter; CA = Crude ash; CP = Crude protein; EE = Ether Extract; CF = Crude fiber; DM = Dry matter; CA = Crude ash; CP = Crude protein; EE = Ether Extract; CF = Crude fiber; NFE = Nitrogen Free Extract.

Animal Management and Experimental Design

Lambs were kept in individual booths (3 × 2 m) complete with dirt coverage, a covered shed, and free access to clean drinking water. A complete random block was designed using Awassi lambs of 2.5–3 months of age having a BW of 19.9 ± 1.27 kg. All lambs were divided into three groups (six lambs in each group randomly) and homogeneous for age and initial live BW and were used in two experiments: a feeding trial and a digestibility trial.

Experiment 1: Feeding Trial, Parameters, and Sample

The chemical analysis of GM and diets is presented in Tables 2 and 3. Feedstuff samples were taken and analyzed for DM, ether extract (EE), CP, Ash, and crude fiber (AOAC, 1997), neutral detergent fibers

Table 3.
Chemical Composition of the Experimental Diets and Alfalfa Hay

Chemical Composition, g/kg of Feed	SM	SFM	GM	Alfalfa Hay
Dry matter	89.7	90.02	89.12	88.6
Crude protein	15.44	15.55	15.82	8.7
EE	3.6	3.53	3.28	13.1
Ash	3.29	3.16	3.9	16.4
Crude fiber	4.9	5.46	4.58	16.5
NDF	16.26	20.7	21.78	50.07
ADF	8.69	13.21	11.24	37.5
Nitrogen free extract %	62.23	61.71	60.71	33.8
Metabolizable energy (Mcal/kg)	2.480	2.456	2.399	1.67

Note: ADF = Acid degradant fiber; EE = Ether extract; GM = Guar meal; NDF = Neutral detergent fibers; SFM = Sunflower cake meal; SM = Soya meal.

(NDF), and acid degradant fibers (ADF) (Goering and Van Soest, 1970). This experiment used 18 Awassi lambs distributed into three experimental groups with six lambs in each group for 60 days.

The BW was recorded for each lamb before the start of the trial and thereafter every week for the adjustment of the offered diet during the feeding trial. Feeds were offered twice a day (08:30 a.m., 03:30 p.m.). The residues from the previous day were weighed to calculate the amount of feed consumed (offered − refused) and FCR. Dry matter intake (DMI) was calculated as (feed offered − refused feed on a DM basis). The DMI relative to BW was calculated by the formula.

Dry matter intake g/kg of BW = mean overall DMI / initial + final BW

The average daily gain was calculated.

On day 45 of the experimental period, [he/she] was assigned to draw ruminal liquor (after 2 hours of feeding) by a stomach tube, rumen pH was measured by hand-held pH meter (immediately).

The samples were filtered, then 10 mL of the rumen liquor was acidified by metaphosphoric acid (25%) and stored at (−20°C) until analysis by gas chromatography for determination of the volatile fatty acids levels (VFA) (Martínez et al., 2010). After pH measurement, aliquots of ruminal liquor (50 mL) with 1 mL of 9MH2SO4 were placed in a freezer at −20°C for rumen ammonia nitrogen (NH_3-N) analysis according to Fenner (1965) by a micro-Kjeldahl system.

Experiment 2: Digestibility Trial
Three lambs were used for each group to determine apparent digestion coefficients. Lambs were housed in individual metabolic cages. The diets were fed twice per day, at 8:30 a.m. and 3:30 p.m. The residues from the previous day were weighed to calculate the amount of feed consumed (offered − refused) and the FCR. Each animal was provided with bag for total feces collection, and these bags were emptied daily before the morning feeding and the total amounts of fresh feces were weighed. Seven-day collections of fecal samples were mixed, and 10% were collected in a labeled polythene bag and stored at −10°C until analyzed.

Statistical Analysis
The data were analyzed using the (analysis of variance) according to the Steel and Torrie (1980) for the completely randomized block design and the least significant difference procedure was used for mean separation.

Results

Effect of Non-conventional Protein Resource (Guar Meal) on the Composition of Experimental Rations
Data in Table 3 illustrate the chemical composition of the diets. The formulas of experimental diets were almost similar in their chemical composition and would not be negatively affected by replacing 100% with GM. However, GM recorded the highest CP content followed by SM and SFM. Also, Data indicated decreases in DM and EE and crude fiber. Guar meal chemical composition can vary, depending on the processing method. Replacement guar tended to increase CP, ash, and NDF contents and decreased NFE contents.

Experiment 1: Nutrient Intake and Performance
The final BW of lambs fed with GM diet was higher than other groups but not significant ($p > .05$). Results clearly indicated that the unconventional feed protein source was equally palatable to that of the conventional protein source (Table 4). The DM intake (DMI) (kg/day and g/kg of BW) of the experimental diets during the experiment was not impacted ($p > .05$) by the replacement of protein source. The average DM intake (kg/d and g/kg of BW) of experimental diets was recorded 1.62, 1.64, and 1.57; 30.4, 30.7, and 28.9 respectively. No significant difference ($p > .05$) was found among the three groups. However, DMI was numerically lower in the GM diet. The total gain revealed for lambs fed diets of GM showed a significant difference ($p < .05$) compared to other groups. Over the entire trial, a maximum ($p < .05$) ADG and G:F daily BW gain was observed in SFM group compared to GM group and non-significant effect with SM group, respectively. There were significant effects observed in the feed conversion ratio of lambs fed non-conventional protein resources compared with SFM diets and non-significant effects with SM diet.

Table 4.
Mean Values of Gain Body Weight, Total Fed Intake, and Feed Conversion Efficiency As a Function of Use of Non-conventional Protein Resources (Guar Meal) in Lamb Diets

Item	Concentrated Diet			SEM (stander error mean)	*p*
	SM	SFM	GM		
Initial body weight (kg)	19.86	20.10	20.02	1.02	.78
Final body weight (kg)	33.4	33.31	34.19	1.42	1.08
Total gain (kg)	13.54[ab]	13.21[b]	14.17[a]	0.42	.021
Average daily gain (g)	225[ab]	220[b]	236[a]	16	.023
Average daily gain: gain feed (g/kg)	148[ab]	151[a]	144b	8.6	.044
Dry matter intake kg/day	1.62	1.64	1.57	0.04	.08
Dry matter intake g/kg of BW	30.4	30.7	28.9	0.62	1.8
FCR	7.17[ab]	7.44[a]	6.64[b]	0.21	.047

Note: Different lowercase letters (a, b) indicate statistically significant difference.
BW = Body weight; FCR = Feed conversion ratio; GM = Guar meal; SFM = Sunflower cake meal; SM = Soya meal.

Ruminal Parameters (Ammonia Nitrogen, Ruminal pH, and Concentration of Total Volatile Fatty Acids)
Table 5 illustrates the effect of feeding non-conventional protein resources on rumen activity in Awassi lambs (NH_3-N, ruminal pH, and concentration of TVFAs). The results showed replacing traditional sources of protein with GM in the diet significantly ($p < .05$) NH_3-N value. Also, data showed that values of pH showed no significant differences between all diets (6.24 ± 0.21, 6.32 ± 0.32, and 6.40 ± 0.17), respectively. Higher values in a diet containing GM, then tended to decrease in a diet containing SFM and gradually decreased in a diet containing soybean meal. The diet containing the non-traditional sources of protein caused an increase in the total VFA concentration of the fermentation liquid but not significant ($p > .05$) compared to other diets, and sunflower cake diets had moderate values. The level of acetate was increase ($p < .05$) in the GM diet, while the propionate level was higher in the SM diet. A non-significant difference was observed for the level of butyrate, where the soybean meal and sunflower cake diets resulted in

Table 5.
Effect of Feeding Non-conventional Protein Resources on Rumen Parameters

Item	Concentrated Diet			p
	SM	SFM	GM	
Fermentation parameter	Means ± SE	Means ± SE	Means ± SE	
NH_3-N (mg/d)	13.30 ± 0.74[b]	13.10 ± 0.67[b]	13.71 ± 0.31[a]	.037
pH	5.92 ± 0.21	5.94 ± 0.32	6.10 ± 0.17	.16
Total volatile fatty acids (mmol/d)	91.1 ± 0.33	92.3 ± 0.27	92.5 ± 0.21	1.5
Molar proportions (mol/100 mol)				
Acetate	49.70 ± 0.27[b]	48.6 ± 0.31[b]	52.53 ± 0.53[a]	.002
Propionate	23.30 ± 0.92[a]	22.3 ± 0.76[b]	21.8 ± 0.71[b]	.004
Butyrate	15.00 ± 0.06	14.4 ± 0.07	14.1 ± 0.06	.83
Isobutyrate	0.51 ± 0.21	0.45 ± 0.23	0.47 ± 0.41	.10
Isovalerate	1.93 ± 0.02	2.48 ± 0.04	2.23 ± 0.54	.62
Valerate	4.98 ± 0.88	4.78 ± 0.92	4.45 ± 0.58	.7
Caproate	4.50 ± 0. 21[a]	3.73 ± 0.33[b]	3.10 ± 0. 22[c]	.031
Acetate/propionate (mol/mol)	2.13 ± 0.07[b]	2.19 ± 0.36[a]	2.42 ± 0.02[a]	.027

Note: Different lowercase letters (a, b) indicate statistically significant difference.

minor higher values than the GM diet, while the level of valerate was higher ($p > .05$) in the soybean meal than in the other diets. In addition, the molar percentage of acetate/propionate was higher ($p < .05$) in the GM diet than with SM diet.

Experiment 2: Digestibility Trial

The nutrients digested from the diets used in the experiment are also presented in Table 6. The digestibility coefficients of DM, CP, and EE were not impacted by ($p > .05$) replacement with GM. The digestibility of DM in the lambs fed GM was lower than those in the SM and SFM. No significant differences were found in crude protein and EE digestibility among the different experimental diets.

Table 6.
The Nutrients Digested from the Experimental Diets

Item	Concentrated Diet			SEM	p
	SM	SFM	GM		
Dry matter	72.95	71.6	71.1	0.31	2.3
Crude protein	67.75	66.5	65.90	0.43	3.5
EE	63.53	62.28	61.5	0.82	4.23
Ash	30.50	38.2	42.83	1.21	.051
Crude fiber	64.17[a]	58.6[b]	57.50[b]	0.75	.013
NDF	52.62[b]	60.5[a]	61.43[a]	0.34	.026
ADF	63.60[a]	54.1[b]	55.00[b]	0.67	.005

Note: Different lowercase letters (a, b) indicate statistically significant difference.
Note: ADF = Acid degradant fiber; EE = Ether extract; NDF = Neutral detergent fibers.

Digestibility coefficients (%) for acid detergent fiber and crude fiber showed a significant ($p < 0.05$) increase in lambs fed with SM ration compared to SFM and GM ration, but NDF was significantly ($p < .05$) higher in lambs fed with SFM and GM ration compared to SM ration.

Discussion

Effect of Non-conventional Protein Resources (Guar Meal) on the Chemical Composition of Experimental Rations

For livestock industries, insufficient nutrient supply often results in decreased production and growth performance. The bulk of the feed cost is due to the cost of protein sources (high prices) (Esonu et al., 2001). Replacing soybean meal and SFM (traditional protein resources) with non-conventional protein resources (GM) resulted in the chemical composition of the diet similar to that in the soybean meal and sunflower meal, which means that the higher crude protein and ash contents (GM) of them did not affect the chemical composition of the experimental ration. Onunkwo and George (2015) show that non-conventional feedstuff often reduces feed cost and hence higher profitability. Data indicated that there are higher CP, ash, and NDF percentages and lower percentages of DM and EE by replacing soya and SFM to guar. This may be due to the ingredient of GM.

The results were supported by Turki et al. (2011), Salehpour et al. (2012), and Suliman et al. (2017) who reported that GM is a good source of protein and has no adverse effect during use in ruminants' ration.

Further, it was observed that the toasting process denatures the trypsin residue and enhances its nutritive value. Sadagopan and Talapatra (1968) revealed that GM as a balanced ration did not produce any effect on the digestive system. Tyagi et al. (2011) concluded that guar treated with steam heat contained 31.09% NFE, 5.32% EE, 50.17% protein, 7.08% total ash, and 6.24% crude fiber. Grewal et al. (2014) revealed that roasted guar has 11.9 MJ/kg of metabolic energy, 95% organic matter, 46.9% protein, 4.9% ash, 31.6% NDF, and 8.7% ADF.

Experiment 1: Nutrient Intake and Performance

The variation of body weight gain may go back to the degree of degradable protein, dietary protein source, and enhanced microbial biomass that improve the ability of the rumen to hold contents and increase digestion rate and more flow of amino acids. These results agree with (Weisbjerg et al., 1992). Sharif et al. (2014) did not observe a significant increase in Sahiwal calves' weight gain when feeding on GM at levels 7.5% and 15% as an alternative to cottonseed cake. The lack of effect of GM on the average daily intake (ADI) is most likely attributed to the similar DMI between the diets and their ingredients. Similar results were observed by Goswami et al. (2012) and Jongwe et al. (2014), but the results disagreed with those of Makki (1998) and Salehpour et al. (2012) who observed that increase of GM percentage in the diet led to decrease in DMI. Also already known, the palatability and adaptation to feed components can influence on feed intake (Gilani et al., 2005).

The slight differences in DMI can be attributed to the fact that the roasting treatment can remove the gum and odor, making it more palatable with improved nutrient values. Similar responses were reported by Rajput et al., 1998, Lee et al., 2004, and Hassan et al., 2010. However, Suliman and Babiker (2007) reported that no difference in feed intake in fattening lambs fed different protein sources, while there were significant effects shown in feed conversion of lambs fed with non-conventional protein resources compared to SFM diets and non-significant effects with SM diet. The difference in feed conversion ratio is likely related to the guar treated methods employed to lower anti-nutritional content or increase the decomposition of carbohydrates present in GM, which is accessible to the rumen microorganisms. The high digestible protein content in the diet, which leads to an increase in nutrient intake and the speed of digestion, and this reflected positively on the efficiency of feed conversion ratio, might be the reason behind this improvement.

Ruminal Parameters (Ammonia Nitrogen, Ruminal pH, and Concentration of Total Volatile Fatty Acids)

Ruminal parameters are reported in Table 5. It is evident that different protein sources have induced different concentrations of ammonia nitrogen in rumen fluid and are the end-product of microorganism metabolism. The concentration depends on the degradation of CP by ruminal microorganisms. The peak of NH_3-N is probably at 2 hours post feeding because of increased protein degradable or deamination of amino acids and hydrolysis of NPN substances in the rumen. These results are in agreement with Soliman et al. (2014) and El-Monayer et al. (2015), who showed that NH_3-N concentrations significantly ($p< .05$) increased with increasing levels of guar korma in experimental diets. The results were in disagreement with Goswami et al. (2012) where NH_3-N decreased when groundnut cake (GNC) was replaced with GM (in vitro). On the other hand, ruminal pH (a major factor affecting rumen fermentation) was not affected by the source of protein. ($p > .05$). El-Monayer et al. (2015) reported a direct relationship between pH and guar korma levels in experimental rations. The reduction in pH after 2 hours of feeding could be due to the rumen lactic acid due to an increase in microbial rumen activity. However, some authors reported a slight effect of protein concentrate or source on ruminal pH (Bargo et al., 2001). rumen fermentation is mostly associated with an ecosystem that breaks up carbohydrates and releases a lower release proportion of hydrogen ions (H+). The highly fermentable carbohydrates, an important substrate for VFA production when diets are rich in rumen-degradable protein. Chibisa et al. (2012) and Benchaar et al. (2013) reported significant ($p < .05$) differences in ruminal total VFAs concentration with increasing guar level from 10 to 17.7%. In addition, the improvement in TVFAs may be due to the NFE content of diets enhancing the development of amylolytic bacteria in the rumen, resulting in a greater proportion, resulting in an intense production of propionic acid as the final fermentation product at the expense of acetate or the increasing of digestibility of organic matter. These results agree with Kholif et al. (2005), but Grewal et al. (2014) found no significant differences in the concentration of VFAs (acetic, propionic, and butyric acid) in animals fed with roasted guar korma.

Besides, there is a negative relation between VFA concentration and the pH and a positive relationship between NH_3-N and TVFA concentrations that are probably connected to the optimum utilization of the dietary energy and positive fermentation because GM contains high fermented carbohydrates. These results are consistent with previous studies conducted on sheep (Soliman et al. 2014) and male buffaloes (Chhikara et al., 2020).

Digestibility Trial

Digestibility is a major aspect of evaluating the efficiency of feedstuffs. The digestibility of OM and CP was significantly improved by the use of guar as a source of protein. The significant increase could be related to the high CP content in GM that enhanced the digestibility of these nutrients, in addition, to the fact that gum guar increased the quantity of nondigested digesta by reducing the passage rate of digesta (increased contact between nutrients and microorganisms). Results are in agreement with those reported by (Asad et al., 2005; Salehpour et al., 2012). Etman et al. (2014) reported improved digestibility coefficients of all nutrients and feeding values of growing buffalo calves when using guar as a source of protein.

Walaa et al. (2016) reported a linear increase in the digestibility of nutrients, and ME values also followed a similar trend. Goswami et al. (2012) and Grewal et al. (2014) observed non-significant differences in digestibility in calves and buffaloes, respectively.

This meal also contains a lot of fibers including crude fibers, NDF, and lignin. The proportion of crude fibers is 12.7%, which makes it easier to digest, thus improving the digestive system of the lambs. Grewal et al. (2014) reported there was no change in the digestibility, when SFM is replaced with treated guar korma up to 70% in growing male buffalo calves. Soliman et al. (2014) showed that digestibility values of DM, OM, and CP were highest ($p < .05$) when SM is replaced with guar (100%) in the ration of sheep.

Conclusion and Recommendations

This study showed that diets with GM have no adverse effect on performance and nutrient digestibility coefficients. These results support the idea that the sustainability of fattening lamb production systems can be greatly improved using non-conventional protein resources as alternatives to traditional protein resources, and its inclusion in sheep diets can be a viable option.

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