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Guar (*Cyamopsis tetragonoloba* L.) Meal in the Diet of Growing Karan-Fries Cattle: Effect on Certain Blood Metabolites

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Abstract

The raising costs of conventional feed ingredients warrant a search for untapped alternative feedstuffs. In the present experiment, the effect of incorporation of graded levels of guar *(Cyamopsis tetragonoloba* L.*)* meal (GM) on some blood metabolites was studied in twenty male Karan-Fries growing cattle of 6-12 months of age (average body weight: 96.58 kg), randomly divided into four groups of five animals each. All the animals were offered an isonitrogenous and isocaloric hand-mixed total mixed ration comprising of concentrate mixture, green maize, and wheat straw in a 40:40:20 ratio on a dry basis. The control group contained groundnut cake (GNC) in the concentrate mixture (T0), whilst in groups T1 and T2, GM replaced 50 and 75% of GNC, respectively. In addition to the T2 ration, animals in T3 were supplemented with commercial sweetener and flavour, each at 0.025% in the concentrate mixture. Over 90 days of the feeding trial, blood samples were drawn at the beginning and end of the trial. Results revealed that the concentrations of glucose, blood urea nitrogen, as well as total immunoglobulins were statistically non-significant ($P > 0.05$) in animals belonging to all four groups. Therefore, it was concluded that incorporation of GM at 50 and 75% replacement of GNC, corresponding to 10.5 and 15.75% in the concentrate mixture, respectively, had no adverse effect on blood metabolites in the growing cattle.

Keywords

Alternative feedstuffs, blood metabolites, guar meal, groundnut cake, Karan-Fries cattle, unconventional feedstuffs

Introduction

Protein is one of the most expensive nutrients in growing cattle diets (Gami et al., 2017). Increasing cost of conventional protein feed ingredients like soybean meal, groundnut cake (GNC), etc. has entailed ruminant nutritionists to formulate cost-effective rations based on locally available non-conventional feed resources (Kumar et al., 2016; Mahesh and Thakur, 2018). Guar/cluster bean (*Cyamopsis tetragonoloba* L.) is a drought-resistant leguminous crop, predominantly cultivated in India (Amarjeet, 2014). Processing of guar seeds to extract high-viscosity endosperm called guar gum (galactomannan hydrocolloid) leaves behind protein-rich material known as guar meal (GM; often also referred to as guar *korma*), which is a mixture of germs (25%) and hulls (75%) (Mahesh and Thakur, 2015; Tran, 2015). GM contains around 40-48% crude protein (CP) with excellent amino acid profile having lysine (1.72% DM) and sulfur containing amino acids (0.96% DM) at a concentration higher than that of GNC protein (Tran, 2015) with comparable methionine content (Goswami et al., 2012; Jongwe et al., 2014) and energy value (80% total digestible nutrients). Incriminating factors like trypsin inhibitors, haemagglutinins, saponins and phytic acid, besides 18-20% of residual gum, are also present in GM, which may cause palatability issues as well as digestive upsets, albeit its inclusion up to 10-25% has been reported satisfactory for growth (Goswami et al., 2012) and lactation (Jongwe et al., 2014) of dairy cattle. Moreover, when crushed guar seeds were fed at 150 g/d, Thakur et al. (1985) documented a higher intake as well as digestibility of nutrients in Marwari sheep.

Blood metabolites have been used to monitor and evaluate health and nutritional status of livestock (Sharma et al., 2014; Rashmi et al., 2025), and it becomes even more important to assess them when an unconventional feedstuff is introduced in the diet. Therefore, the objective of the present experiment was to study the effect of incorporation of GM replacing GNC on blood glucose, urea nitrogen, and total immunoglobulin levels in growing Karan-Fries cattle.

Materials and Methods

This experiment was conducted at ICAR–National Dairy Research Institute, Karnal, Haryana, India. During this experiment, daily minimum and maximum temperatures averaged 8 °C and 30 °C, respectively.

Twenty male Karan-Fries (Tharparkar × Holstein-Friesian) growing cattle aged 6-12 months with an initial average body weight of 96.58 kg were randomly allocated to four groups of five animals each and were housed in a well-ventilated stall having a cement floor (minimum of 1.5 m × 1.5 m per animal) with facilities for individual feeding and watering. Animals were dewormed with oral dosing of Fenbendazole (Panacur®, 10 mg/kg) prior to experimental feeding. All animals were offered a hand-mixed total mixed ration consisting of concentrate mixture, green maize (African tall variety, chaffed to 2-4 cm) and wheat straw (threshed to 2-3 cm) in the ratio of 40:40:20 on a dry basis. The major protein source in the concentrate mixture of the control group (T0) was GNC, whereas it was replaced up to 50 and 75% with GM in the concentrate mixture of groups T1 and T2. In addition, concentrate mixture of group T3 was supplemented with sweetener (Sucram®) + flavour (Lactovanilla®), each at 0.025%, both of which were manufactured by Pancosma, Switzerland.

The DM, organic matter, crude protein, ether extract, and ash in the offered feeds were estimated as per AOAC (2005). Cell wall constituents like neutral detergent fiber and acid detergent fiber were assayed by the standard procedures of Van Soest et al. (1991). Total carbohydrates and non-fibrous carbohydrates were calculated by difference (Mahesh and Thakur, 2018). The predicted energy values such as apparent total digestible nutrients as well as metabolisable- and net energy were calculated using the equations exemplified in Owens et al. (2010) and Singh et al. (2022), respectively. Blood samples were drawn (10 mL) from each animal twice, i.e., at the beginning (zero day) and the end (90th day) of the experiment via jugular venipuncture before offering morning feed and water. Plasma was separated upon centrifugation of blood (Heraeus, Germany) at 4500 rpm for 15 min. at 4 °C, which was stored at -20 °C for subsequent analyses. The glucose and blood urea nitrogen (BUN) in the plasma were analysed using Autopak kits, procured from Span Diagnostics Ltd., Surat, India. Total immunoglobins in the plasma were estimated by zinc sulphate turbidity method.

Experimental data on various blood metabolites among the groups were analysed by simple one-way analysis of variance using Sigmastat for Windows version 3.10 (Systat Software Inc., USA). Means were judged significant when P-values for the null hypothesis were ≤ 0.05 and post-hoc comparison was made using Tukey's *b* test.

Results and Discussion

Ingredient and chemical composition of experimental concentrate mixtures and other feedstuffs are presented in Table 1 and 2, respectively. On a physical basis, the test protein source—i.e., GM— constituted 10.5 and 15.75% of the concentrate mixture of T1 and, T2 and T3, respectively. All the compositional values for the individual feedstuffs were within the normal range, as reported earlier (Goswami et al., 2012; Jongwe et al., 2014; Mahesh and Thakur, 2018).

Levels of various blood metabolites in the experimental animals are furnished in Table 3. It was observed that blood glucose concentration ranged between 49.02 and 50.74 mg/dL at zero day, while on the 90th day, it was 50.22 and 53.13 mg/dL. These were not statistically different ($P > 0.05$). In line with our findings, Jongwe et al. (2014) documented no difference in blood glucose levels in Sahiwal cows when fed GM at 50 and 75% of GNC replacement. Recently, Sharma et al. (2015) also found no difference in blood glucose levels in crossbred calves fed with compressed complete feed blocks containing 5% GM.

Concentration of BUN remained unaltered among the animals across the four groups, both at the beginning and end of the experiment. The values are slightly higher than those reported to be normal for Karan-Fries calves (15 mg/dL; Sai et al., 2014; Kumar et al., 2016), which could be attributed to the highly degradable nature of both GNC and GM to the extent of over 70% (Mahesh et al., 2017), thereby facilitating passive transfer of excess ruminal ammonia into the bloodstream. Although our BUN levels remained within the physiological range, these were slightly higher than those reported by Sharma et al. (2015)**,** possibly due to the higher inclusion of GM in the present study (6.3% of the overall diet in T2 and T3) compared with 5% in complete feed blocks. Furthermore, our results are consistent with those of Salehpour and Qazvinian (2011), who observed no changes in BUN levels in Iranian Holstein cows fed with GM replacing 100% of cottonseed meal. In contrast, Yadav et al. (2000) found a reduction in BUN in buffalo calves fed with 1.5% formaldehyde-treated (rumen-protected) GM, which they ascribed to the lowered ruminal degradability.

Plasma immunoglobulin concentrations did not differ among the groups, both at zero and 90th day. As it is clear that altered immunoglobulin levels are an indication of stimulation of the immune system by the antigen (Tizard, 2024), it could be inferred that at 50 and 75% levels of replacement of GNC, GM exhibits no deleterious effect on the immunity of growing cattle. Nonetheless, measuring humoral and cell-mediated immune response needs pathogen-challenged animals and phytohaemagglutinin-P, respectively (Mohanta et al., 2014), which were not performed in the present study.

Conclusion

Under the conditions of the present study, it was demonstrated that incorporation of GM in the concentrate mixture at 50 and 75% of GNC replacement was safe, as it did not influence any of the measured blood metabolites (glucose, BUN and total immunoglobulins) in growing Karan-Fries cattle.

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This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval

All experimental animals were cared for and handled according to the protocols approved by the Institutional Animal Ethics Committee of ICAR–NDRI, Karnal.

Data Availability Statement

All the data pertaining to this article have been presented in the Tables. One may contact the corresponding author for further details.

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Table 1: Ingredient composition of experimental concentrate mixtures (% as mixed)

Ingredient	**T0**	**T1**	**T2 and T3**
Yellow maize	33	33	33
Groundnut cake	21	10.5	5.25
Guar meal	0	10.5	15.75
Mustard cake	12	12	12
Wheat bran	20	20	20
De-oiled rice bran	11	11	11
Mineral mixture[†]	2	2	2
Salt (NaCl)	1	1	1

[†]Comprising of both macro- and micro-minerals

The concentrate mixture containing groundnut cake (GNC) without guar meal (GM) (T0), isonitrogenous substitution of GNC by GM at 50% (T1) and 75% (T2); T3 additionally contained 0.025% each of sweetener and flavour

Table 2: Chemical composition (% dry matter) of green maize, wheat straw and four concentrate mixtures

	Forages and major protein sources				**Concentrate mixture**		
Particular	**Green maize**	**Wheat straw**	**Guar meal**	**Groundnut cake**	**T0**	**T1**	**T2 and T3**
Organic matter	91.28	91.31	93.50	93.70	91.29	91.38	91.78
Crude protein	10.50	3.50	42.63	44.63	21.00	21.22	20.78
Ether extract	1.67	0.33	5.60	9.0	3.75	4.24	3.99
Ash	8.12	8.68	6.50	6.3	8.71	8.62	8.22
Neutral detergent fibre	65.01	81.19	30.29	23.01	34.36	35.43	39.72
Acid detergent fibre	39.52	52.81	23.28	15.78	10.15	10.73	10.67
Hemicellulose[†]	25.49	28.38	7.01	7.23	24.21	24.70	29.05
Total carbohydrates[‡]	79.71	87.49	45.27	40.07	66.54	65.92	67.01
Non-fibrous carbohydrates[⸸]	14.70	6.30	14.98	17.06	32.18	30.49	27.29
TDNa[⁋]	52.82	39.14	69.55	77.28	83.08	82.54	82.54
ME (MJ/kg)[¶]	7.92	5.87	10.43	11.59	12.46	12.38	12.38

NE_M (MJ/kg)[#]	4.40	2.34	6.70	7.70	8.43	8.36	8.36
NE_G (MJ/kg)[*]	2.08	0.14	4.18	5.05	5.68	5.63	5.63

[†]Neutral detergent fibre–acid detergent fibre; [‡]Total carbohydrates=100–crude protein–ether extract–ash; [ǂ]Non-fibrous carbohydrates=Total carbohydrates–neutral detergent fibre; [⁋]Total digestible nutrients (%)=93.53–1.03×acid detergent fibre (%); [¶]Apparent total digestible nutrients (%) × 0.15
[#]Net energy for maintenance={1.37×ME(Mcal/kg)−0.138×[ME(Mcal/kg)]^2+0.0105×[ME (Mcal/kg)]^3−1.12}×4.184
[*]Net energy for gain={1.42×ME (Mcal/kg)−0.174×[ME (Mcal/kg)]^2+0.0122×[ME (Mcal/kg)]^3−1.65}×4.184

The concentrate mixture containing groundnut cake (GNC) without guar meal (GM) (T0), isonitrogenous substitution of GNC by GM at 50% (T1) and 75% (T2); T3 additionally contained 0.025% each of sweetener and flavour

Table 3: Effect of replacing groundnut cake with guar meal on glucose, blood urea nitrogen and total immunoglobulins (n=5/treatment)

Particular	**Day of sampling**	**T0**	**T1**	**T2**	**T3**
Blood glucose	(0 day)	50.47±0.80	49.02± 2.99	49.98±3.25	50.74±1.99
(mg/dL)	(90 day)	52.82±1.80	50.51±1.88	50.22±3.17	53.13±0.56
Blood urea nitrogen	(0 day)	28.97±1.48	27.24±1.48	26.21±1.76	27.86±1.22
(mg/dL)	(90 day)	27.81±0.91	30.81±1.10	28.63±1.68	30.25±1.56
Total immunoglobulins	(0 day)	26.60±1.16	30.67±1.08	29.34±1.45	29.68±1.13
(mg/dL)	(90 day)	29.51±2.76	32.46±1.19	30.17±2.31	31.48±1.83

The concentrate mixture containing groundnut cake (GNC) without guar meal (GM) (T0), isonitrogenous substitution of GNC by GM at 50% (T1) and 75% (T2); T3 additionally contained 0.025% each of sweetener and flavour