



Performance of Ram Lambs Fed Guava Waste Meal

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## Effect of Feeding Concentrate Mixture Containing Varying Levels of Guava Waste Meal on Growth and Nutrient Digestibility in Ram Lambs

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### ABSTRACT

The present study was conducted to assess the effect of feeding varying levels of guava waste meal (GWM) on growth and nutrient digestibility in ram lambs. Eighteen ram lambs (were randomly divided into three equal groups of six each and allotted to one of the dietary treatments (T1 to T3) comprising of green fodder viz., Super Napier and concentrate mixture (20% CP) containing GWM at 0, 10 and 20%, respectively for a period of 90 days. The average DMI of ram lambs was comparable among the treatments. Data revealed higher ( $P<0.05$ ) final weight gain, ADG and better FCR ( $P<0.05$ ) in T2 compared to other treatments. Further, the feed cost/kg gain was lower in T2 compared to control. Significantly higher ( $P<0.05$ ) digestibility (%) of DM, OM, CP, CF and NDF was observed in ram lambs of group T2 compared to other treatments, while the difference in CP, EE, NFE, ADF, hemicellulose and cellulose was non-significant. The TDN content expressed as % in diet consumed was higher ( $P<0.05$ ) in T2 compared to other treatments, while the difference in DCP (%) in the diet consumed was not significant. Similarly, the estimated DE and ME intakes (Mcal/d) were higher ( $P<0.05$ ) T2, while there was no significant difference in the intakes of DM, DCP, TDN and ME per KgW<sup>0.75</sup>. It was concluded that GWM incorporated up to 10% in the concentrate of ram lambs evinced better performance.

**KEYWORDS:** Guava waste meal, Growth, Nutrient utilization, Ram lambs

Article received: 03 July 2023; Article accepted: 25 July 2023

### INTRODUCTION

Livestock farmers in developing countries face various challenges due to high cost of conventional feed ingredients, which adversely affects ruminant commercial production. Adequate feeding of animals in terms of quality and quantity is the main aim of animal production to produce high-quality protein in the form of meat, milk and eggs for human consumption. The attempt to mitigate high cost of feed has prompted the continuous search for alternatives or additional feedstuffs. Increased awareness of health benefits of fruit consumption, the processing industry is expanding (Ayala et al., 2011) and the wastes generated as a result pose a problem of environmental pollution which is of great concern. Among the fruits processed by agribusiness, guava is widely used in the manufacture of

beverages, syrup, ice cream, jam, jellies, juice and dehydrated products. Processing of guava into a valuable product generates numerous wastes and by-products such as skin, seeds, pomace etc. which can be used as animal feed or fertilizer (Gupta et al., 2019).

Guava (*Psidium guajava* L.) belongs to family Myrtaceae, is widely distributed in the tropical and subtropical regions of the world (Luiz et al., 2011). India is the world's leader in guava production with 55 million tonnes in 2019, contributing 45% of total production in the world (FAOSTAT, 2019). It is commonly referred to as the 'apple of the tropics' and contains high amounts of vitamins C, A, B<sub>1</sub> and B<sub>2</sub> and good amount of minerals (Omayio et al., 2019). The guava fruit also contains sucrose, glucose and fructose and other bioactive components viz. â-

carotene, lycopene, pectin, antioxidants and dietary fibre (Bhat et al., 2015). During the processing of guava, a residue is produced, consisting of peel, seed and pulp known to be guava waste meal (GWM) which can be processed into valuable product for livestock feeding (Chang et al., 2014). It contains nutrients, bioactive antioxidants that are capable of preventing the oxidative damage caused by free radicals (Melo et al., 2011) and may provide beneficial effects on protein metabolism of ruminants (Costa et al., 2018). Guava residues obtained after juice extraction contain about 90.81% moisture, 10% crude protein, 11.71% ether extract, 75% carbohydrates, and 1.25% ash content (Muniz et al., 2020). Guava fruit waste is one of such locally available agro-industrial waste that can be used to reduce the cost of livestock feeding (Kamel et al., 2016). Hence, the present study was undertaken to

evaluate the effect of feeding varying levels of GWM on growth and nutrient digestibility in ram lambs.

## MATERIALS AND METHODS

The study was carried out at small animal experimental shed, Department of Animal Nutrition, NTR College of Veterinary Science, Gannavaram, Andhra Pradesh, India. Dried guava waste meal was procured from M/s Vijaya Krishna Agro Food Processing Pvt Ltd, Remalle village, Bapulapadu Mandal, Krishna (District), Andhra Pradesh. Feed ingredients like maize, DORB, gingelly cake, cotton seed cake, mineral mixture and salt were procured from the local market. Green fodder *viz.*, Super Napier was procured from Livestock Farm Complex, NTR College of Veterinary Science, Gannavaram. The ingredient and chemical composition of super napier, GWM and experimental concentrate mixtures fed to ram lambs is furnished in Table 1.

Table 1. Ingredient and chemical composition (% DM basis) of experimental diets fed to ram lambs

Nutrient	Super Napier	GWM	T1	T2	T3
Ingredient composition					
Maize			36	33	31
De-oiled rice bran			34	24	13
Gingelly cake			10	13	14
Guava waste meal			0	10	20
Cottonseed cake			17	17	19
Mineral mixture			2	2	2
Salt			1	1	1
Chemical Composition (% DM basis except for DM)					
DM	28.9	93.1	93.2	93.1	92.2
OM	90.5	97.4	90.9	91.7	92.9
TA	9.46	2.57	9.02	8.30	7.06
CP	9.10	9.32	19.9	19.9	19.9
EE	2.98	9.61	1.60	4.06	4.01
CF	38.0	57.1	10.7	15.8	18.4
NFE	40.4	21.4	58.8	51.9	50.4
NDF	77.8	74.5	55.9	56.2	56.8
ADF	46.0	54.6	13.9	22.4	25.1
Hemicellulose	31.7	19.9	41.9	33.7	31.6
Cellulose	34.6	19.1	6.97	8.69	10.5
ADL	7.71	18.5	5.39	11.7	11.5
Silica	3.66	0.21	1.49	0.98	0.59
Calcium	0.55	0.06	0.75	0.83	0.97
Phosphorus	0.23	0.10	1.16	0.98	0.76

Each value is a mean of 3 observations

In a completely randomized design, 18 ram lambs (3 months old and 9-11 kg) were randomly allotted to three treatments of six each. The ram lambs were offered diets (T1, T2 and T3) containing 0, 10 and 20% dried and ground GWM in the standard feed, respectively, twice daily at 9.00 am and 3.00 pm. The total supplemented concentrate was 1% of the body weight in each group. Super Napier was provided between 9.00 am and 3.00 pm and made available all through the day in *ad libitum*, during growth trial of 90 days. Fresh, clean drinking water was provided to the animals throughout the day. Animals were not allowed for grazing and were fed to meet the nutrient requirements (ICAR, 2013). The animals were weighed before the start of the experiment early in the morning before offering feed and water for two consecutive days and the average was taken as the initial body weight. Thereafter, the animals were weighed at weekly intervals, early morning before offering feed and water till the end of experiment to evaluate the growth performance.

After 45 days of the preliminary feeding period, a 6-day collection period was carried out to assess the digestibility of nutrients. Animals harnessed with faeces collection bags were kept in well-ventilated hygienic stalls two days prior to collection for adaptation so as to reach their normal feed consumption. During the digestion trial, daily feed intake, residue, and faeces voided during 24 hours was recorded. Representative samples of the feeds, residues and faeces were collected and pooled for 6 days and later ground separately in a laboratory Wiley mill and preserved in air tight bottles for subsequent analysis. Samples of feed and faeces were analyzed for proximate constituents (AOAC, 2007) and fibre constituents (Van Soest et al., 1991). The data were analyzed and tested for significance by Duncan's multiple range test using SPSS (Snedecor and Cochran, 1994).

## RESULTS AND DISCUSSION

The CP content of super napier green fodder was 9.10 per cent and is lower than the findings of Devika et al. (2021) and Sravani et al. (2021). Similarly, the CF, EE and NFE contents of the fodder

in the present study (Table 1) were higher, while NDF and ADF were lower compared to the values (Madesh et al., 2021). The CP, EE and CF content of GWM in the present study was 9.32, 9.61 and 57.07 per cent, respectively. The variation in EE and CF content in various guava by-products as given by several authors (Kamel et al., 2016; Costa et al., 2019; Barman et al., 2020 and Martins et al., 2021) might be attributed to guava variety, storage conditions and different processing methods employed in pulp extraction etc. The NDF, ADF and lignin contents of GWM in the present study (74.52, 54.64 and 18.47 percent), respectively, were lower than the values reported by Ghoneem and Mahmoud (2015). The concentrate mixtures, T1, T2 and T3 were iso-nitrogenous (Table 1). Increased levels of inclusion of GWM from 0 to 20% in the concentrate mixtures resulted in increased OM, CF, EE and decreased TA and NFE content as compared to the control (T1). Further, the study indicated increased levels of NDF, ADF, cellulose and ADL with increasing levels of GWM in the concentrate mixtures (T1 to T3).

The data on the growth performance and economics of ram lambs fed concentrate mixtures containing 0 to 20% GWM was presented in Table 2. The body weight gains and ADG were highest ( $P < 0.05$ ) in T2 compared to other treatments, but the differences between T1 and T3 were not statistically significant. The increased weight gains in the present study, might be attributed to antioxidant vitamin C (Bikrisima et al., 2014) in guava waste that is capable of preventing oxidative damage caused by free radicals and the presence of antioxidant dietary fibre (AODF) with methoxylated pectin (Uddin et al., 2002). Also, it is rich in tannins which have a great antioxidant activity and provide beneficial effects on protein metabolism of ruminants (Costa et al., 2018). Furthermore, the synergic effect of EE and CF in GWM have improved the gastrointestinal transit and consequently improved body weight gain (Lira et al., 2009). Similar findings were observed by Mahmoud et al. (2013) in broilers and Morsy et al. (2019) in rabbits fed various guava by-products. In contrast, Costa et al. (2020) reported

an inverse relationship in final body weight, daily weight gains with increasing levels of guava agro-industrial by-product in lambs. Similarly, Costa et al. (2019) reported decreased ( $P < 0.01$ ) final weight and ADG in sheep fed guava by-product. Further, several authors (Ghoneem and Mahmoud, 2015; Hassan et al., 2016 and Nobre et al., 2020 in sheep and goats; Lira et al., 2009 in broilers) reported no effect ( $P > 0.05$ ) in body weight gain and ADG among the

dietary treatments fed different guava by-products. However, at higher rates of inclusion of guava waste product in the present study had inverse effect on the body weight gains and ADG (Table 2). This reduction is related to lower NFC dietary levels, increased NDF and ADF contents and increased indigestibility of nutrients due to increased levels of addition of guava by-product leading to decreased animal performance (Regadas Filho et al., 2011).

Table 2. Growth performance and economics of ram lambs fed concentrate mixture containing varying levels of guava waste meal

Particulars	T1 (n=6)	T2 (n=6)	T3 (n=6)	SEM	P-Value
Growth performance					
Initial BW (kg)	10.6	10.8	10.7	0.49	0.949
Final BW (kg)	16.9	18.1	16.9	0.69	0.506
Weight gain (kg)*	6.30 <sup>a</sup>	7.29 <sup>b</sup>	6.25 <sup>a</sup>	0.78	0.040
ADG(g/d)*	70.0 <sup>a</sup>	81.0 <sup>b</sup>	69.4 <sup>a</sup>	2.45	0.042
DMI (g/d)	668	669	659	8.77	0.750
FCR ( g feed/ g gain)*	9.55 <sup>a</sup>	8.26 <sup>b</sup>	9.49 <sup>a</sup>	0.26	0.046
Economics					
Green fodder intake (kg/d)	1.35	1.35	1.34	0.12	0.482
Concentrate intake (kg/d)	0.30	0.30	0.29	-	-
Total DM intake (kg/d)	0.67	0.67	0.66	-	-
Cost of green fodder (₹/per kg)	2.00	2.00	2.00	-	-
Cost of Concentrate (₹/per kg)	23.5	23.4	23.2	-	-
Total cost of feed/day	9.68	9.71	9.54	0.18	0.912
Weight Gain (kg)*	6.30 <sup>a</sup>	7.29 <sup>b</sup>	6.25 <sup>a</sup>	0.78	0.040
Cost of feed/kg gain (₹)*	138.38 <sup>a</sup>	119.90 <sup>b</sup>	137.11 <sup>a</sup>	1.42	0.051

<sup>ab</sup>Values in the rows bearing different superscripts differ significantly ( $P < 0.05$ )

The present study indicated that the feed conversion ratio (FCR) was improved ( $P < 0.05$ ) with increased level of inclusion of GWM with T2 performing the best, but the differences between T1 and T3 were comparable (Table 2). Similarly, improved ( $P < 0.05$ ) FCR was observed in rabbits fed guava leaves extract (Morsy et al., 2019) and in lambs (Nobre et al., 2021) fed guava agricultural waste compared to control. In contrast, Costa et al. (2019) reported poor FCR ( $P < 0.01$ ) among the treatment diets in sheep fed guava by-product. However, Camelo et al. (2015) in quails and Hassan et al. (2016) in lambs fed guava waste reported no

differences ( $P > 0.05$ ) in FCR between the treatment groups. Increased level of inclusion of GWM from 0 to 20% resulted in decreased ( $P < 0.05$ ) cost of feed/kg gain by Rs. 18.48 in T2 compared to T1, with no differences ( $P > 0.05$ ) between T1 and T3 (Table 2). Similar results were reported by Ghoneem and Mahmoud. (2015) in growing goat kids; Kamel et al. (2016) in rabbits and Barman et al., 2020 in grower pigs fed various guava by-products.

The data on apparent nutrient digestibility (%) and plane of nutrients in ram lambs fed concentrate containing GWM at different levels is presented in Table 3. The data revealed no difference ( $P > 0.05$ )

in dry matter intake (% BW) among the three groups indicating that the diets are palatable. Also there is no significant difference in intake of nutrients (DM, DCP, TDN and ME) per  $\text{KgW}^{0.75}$  indicating that the ram lambs were maintained at same plane of nutrition. Similarly, Pathak et al. (2013) reported no effect on TDN and DCP intake/  $\text{KgW}^{0.75}$  in sheep fed guava leaf meal. The DCP and TDN intakes ( $\text{g/kgW}^{0.75}$ ) reported in the present study were similar to the values recommended by (ICAR, 2013). Nutritive values (%) of TDN, DE and ME were found significantly higher in T2 group as compared to T1 and T3. However, there is no significant change in DCP per cent among the different treatment groups. The increase in TDN content in the treatment group (10%) reflects the improved digestibility of gross nutrients (DM, OM and CF) in the ram lambs compared to other groups. The higher TDN values could be an indication of better proportion of energy and protein sources in the diet which may enhance growth performance in lambs. However, decreased TDN, DE and ME content at high levels (20%) of GWM is recorded in ram lambs. Similarly, Costa et al. (2019) in sheep and Nassr-Allah (2006) in rabbits reported decreased TDN and DE content fed guava by-product up to 15% in the diet. However, Ghoneem and Mahmoud, (2015) reported no significant difference in TDN % in growing kids fed guava by-products.

Nutrient digestibility of Dry Matter, Organic Matter, Crude Fibre and Neutral Detergent fibre were found to be significantly higher in T2 group (10 % GWM) as compared to T1 and T3 group animals (Table 3). There was an apparent increase in Crude Protein, Ether Extract, Nitrogen Free extract and Hemi-cellulose digestibility but statistically non-significant. Barman et al. (2020) reported significant increase ( $P<0.05$ ) in DM and

OM digestibility in pigs fed guava fruit waste. Contrary to our findings, Costa et al. (2019) reported decreased DM digestibility in pigs, while, several authors (Pathak et al., 2017; Sati et al., 2020 and Zargar et al., 2021) reported no effect ( $P>0.05$ ) in DM and OM digestibility among the treatment groups fed various guava by-products compared to control. Higher CF digestibility in the present study corroborated with the findings of Barman et al. (2020) in pigs fed guava fruit waste, however, Hassan et al. (2016) reported decreased ( $P<0.05$ ) CF digestibility in Ossimi lambs fed guava waste compared to control. Our findings on CP, EE and NFE recorded in ram lambs fed GWM corroborated with the findings of Costa et al. (2019) in sheep and Diang et al. (2021) in broilers fed various guava by-products. Increased digestibility of DM, OM and CF in lambs fed GWM (10%) might be due to presence of vitamin C in guava which improved nutrient digestibility through its antioxidant property (Sahin et al., 2002). Further, decreased nutrient digestibility (20% level of GWM) might be due to high fibre levels (Frank et al., 2005) and high percentage of seeds (Azevedo et al., 2011) in guava by-products reduce the digestibility of dietary nutrients by increasing digestion time. The improved NDF digestibility might be attributed to the adequate microbial efficiency stimulated by various guava by-products. Further, non-significant differences were observed in sheep fed guava leaf meal mixture (Pathak et al., 2017). Our findings on ADF, hemi-cellulose and cellulose digestibility is in agreement with the findings of Pathak et al. (2013), however, increased ADF digestibility was reported in rabbits fed guava waste (Kamel et al., 2016). No changes in DMI (%) were observed in GWM fed animals, it indicates that there is no adverse effect on palatability after the addition of GWM in the feed. Further addition of GWM to the concentrate mixture was economically cheaper.

Performance of Ram Lambs Fed Guava Waste Meal

Table 3. Plane of nutrition in ram lambs fed concentrate mixtures fed varying levels of guava waste meal

Parameter	T1 (n=6)	T2 (n=6)	T3 (n=6)	SEM	P-Value
DM intake (% BW)	4.18	4.18	4.08	0.23	0.090
Intake of nutrients (g/Wkg0.75)					
DM	83.4	82.1	81.8	0.98	0.124
DCP	9.94	9.91	9.53	0.69	0.248
TDN	49.6	50.6	49.8	1.12	0.051
ME (Mcal)	0.18	0.18	0.18	0.34	0.615
Plane of nutrients (%)					
DCP	11.9	12.0	11.6	1.45	0.742
TDN	58.5 <sup>a</sup>	61.6 <sup>b</sup>	57.9 <sup>a</sup>	0.12	0.049
DE (Mcal/kg)	1.75 <sup>a</sup>	1.81 <sup>b</sup>	1.76 <sup>a</sup>	0.45	0.051
ME (Mcal/kg)	1.43 <sup>a</sup>	1.48 <sup>b</sup>	1.44 <sup>a</sup>	1.58	0.00
Nutrient Digestibility (%)					
Dry matter	58.9 <sup>a</sup>	60.9 <sup>b</sup>	56.2 <sup>a</sup>	1.88	0.049
Organic matter	64.9 <sup>a</sup>	66.3 <sup>b</sup>	61.7 <sup>a</sup>	2.12	0.046
Crude protein	59.6	60.4	58.3	1.64	0.456
Ether extract	62.1	63.8	61.6	2.48	0.092
Crude fibre	51.2 <sup>a</sup>	54.5 <sup>b</sup>	49.1 <sup>a</sup>	1.91	0.052
Nitrogen free extract	63.1	64.2	62.2	2.01	0.657
Neutral detergent fibre	60.8 <sup>a</sup>	62.9 <sup>b</sup>	59.3 <sup>a</sup>	1.84	0.045
Acid detergent fibre	54.1	53.2	50.2	3.12	0.458
Hemi cellulose	63.9	64.1	63.4	2.24	0.647
Cellulose	58.3	59.1	57.6	1.64	0.789

<sup>ab</sup> Values in the rows bearing different superscripts differ significantly (P<0.05)

## CONCLUSION

Inclusion of GWM at 10% level in the concentrate mixture resulted in better growth and feed efficiency in ram lambs. Further, no adverse effect on palatability was recorded and improved digestibility of nutrients and performance of ram lambs. Hence, GWM can be incorporated up to 10% in the diet of ram lambs.

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