



Growth and Nutrient Utilization in Kids Fed Expander-extruded Complete Feed Pellets Containing Red Gram (*Cajanus cajan*) Straw

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ABSTRACT: A growth and digestibility study was conducted using Osmanabadi goat male kids by feeding complete diets in the form of mash or expander extruded pellets containing different levels of red gram (*Cajanus cajan*) straw (RGS). Two iso-nitrogenous complete diets were prepared by incorporating RGS at 35% and 50% levels. Half the quantity of each complete mash feed was then converted into pellets through expander extruder processing. Thirty two kids of 4 to 5 months age were divided into four groups of eight each and were fed for 150 d with four experimental diets (T1: mash with 35% RGS, T2: mash with 50% RGS, T3: pellets with 35% RGS and T4: pellets with 50% RGS). Pelleting of complete diets significantly ($p < 0.001$) increased the voluntary feed intake (671.45 vs 426.28 g/d) at both levels of RGS in the feeds. Average daily gain (ADG, g/d) also increased significantly ($p < 0.001$) from 48.79 in kids fed mash diet to 71.29 in those fed with pelleted diets. Feed conversion efficiency (dry matter (DM) intake: weight gain) was comparable among all the treatment groups. Digestibility of nutrients was not affected by pelleting of the feeds whereas, increasing the level of inclusion of RGS in feeds from 35% to 50% decreased ($p < 0.05$) the digestibility of DM and crude protein (CP) resulting in lower ($p < 0.001$) metabolizable energy (ME) content (MJ/kg DM) in feeds with 50% RGS (7.93 vs 8.75). Daily intake (MJ/kg BW^{-0.75}) of ME decreased ($p < 0.05$) in feeds containing 50% RGS while pelleting of feeds increased ($p < 0.05$) the intake of DM, CP, digestible crude protein (DCP) and ME. It is inferred that expander extruder pelleting can efficiently utilize RGS up to 50% level in complete diets for growing goat kids. (**Key Words:** Goat, Feed Processing, Red Gram (*Cajanus cajan*) Straw, Expander Extruder Pelleting, Complete Diets)

INTRODUCTION

Availability of feed and fodder, both in quantitative and qualitative terms, is one of the major constraints in sustainable development of the livestock sector. It is well recognized that effective utilization of crop residues as animal feed is an alternative to overcome feed shortages for ruminant feeding (Rangnekar, 2003). Poor palatability and low bulk density apart from low nutritive value are restricting the utilization of the crop residues as animal feeds. Since the mid 1980's there has been much research and development into finding ways of alleviating these short comings (Sundstol and Owen, 1984; Doyle et al., 1986). Incorporation of crop residues as a roughage source in complete diets (total mixed rations) of ruminants and their further densification is one of the practical ways of

their utilization. Pelleting of low grade roughage based feeds improves uniformity, increases density, facilitates ease of handling and reduces wastage (Stevens, 1981). Similarly, physical form of the diet can affect potential rate of consumption with pelletized diets ingested more rapidly than the ones in mash form (Fahey et al., 1993; Berger et al., 1994). Though the argument on ill effect of goat rearing on ecology is a debatable issue, it is widely felt that unrestricted movement of goats should be prevented and goats with high production potential, which are capable of responding to quality feed, should be reared under confinement. Red gram (pigeon pea, *Cajanus cajan*) is a major pulse crop grown in Telangana region of Andhra Pradesh state in India. The straw that remains after harvesting the crop is regarded as wasteful product and is generally burnt out in the fields. Though red gram straw like many other agro industrial by-products is not palatable to animals in its original form, the nutrients present in the straw can potentially be made available to animals after applying suitable processing methods (Salem and Smith, 2008). Few efforts have been made to utilize red gram straw

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in the diets of different ruminant species (Narayanaswamy et al., 1990; Reddy, 1997; Suresha et al., 2006). An attempt has been made in the present study to utilize red gram straw (RGS) by incorporating into complete diets and feeding to goats in the form of mash or expander extruder processed pellets to assess growth and nutrient utilization under stall fed conditions.

MATERIALS AND METHODS

Animals and diets

Two iso-nitrogenous complete mash feeds were prepared by incorporating red gram (*Cajanus cajan*) straw at 35 and 50% level maintaining the total roughage content in both the rations at 60% level. The remaining component of the forage portion comprised of lucaena leaves (Table 1). For preparation of complete feeds in mash form, all the ingredients including roughages were ground in a chopper cum grinder hammer mill using 8 mm sieve. The ground material along with molasses, mineral mixture, salt and vitamin premix was mixed together in a horizontal batch mixer to attain uniform blending of all the ingredients. Half the quantity of each mash feed was then converted into pellets through expander-extrusion processing. For preparation of pellets, the mash with 12 to 13% moisture at room temperature was reconstituted with water to yield 17 to 18% moisture and the reconstituted mash was sent from mixer into the hopper above the expander-extruder from which it passed through the screw in which it attained 90 to 92°C by the time it came out of the die openings in the form

of pellets (Valadez, 2008). Thirty-two weaned male kids of Osmanabadi breed in the age group of 4 to 5 months were divided into four groups of eight animals each and were kept as four groups in well ventilated pens. Care has been taken to have similar average body weights in all the four groups. The experimental feeds (T₁: mash with 35% RGS, T₂: mash with 50% RGS, T₃: pellets with 35% RGS and T₄: pellets with 50% RGS) were randomly assigned to the four treatment groups and the animals in respective groups were offered those feeds for 150 d. Clean drinking water in troughs was kept available *ad libitum* to the animals all the time. Water in the troughs was changed twice daily. All the animals were dewormed at the beginning of the experiment and once again in the middle of the experiment after two and half months. They were vaccinated against Hemorrhagic Septicemia and Enterotoxaemia.

Experimental procedure

Animals in each group were offered weighed quantities of respective rations *ad libitum* at 0900 and 1600 h daily. In order to ascertain *ad libitum* feed consumption, daily feed offered was maintained at 110 per cent of previous day's consumption. The left over residues were weighed on the next day morning to arrive at daily feed consumption. The animals were weighed at fortnightly intervals consecutively for three days in the morning before feed or water was offered.

A digestion trial was conducted at the end of the growth experiment to assess nutrient digestibilities of the four experimental feeds. The animals were kept in well-ventilated hygienic individual metabolism cages with feeding and watering arrangements. Each cage was provided with a feed trough and a water trough. Measured quantity of feed was offered each day and the left over feed was measured the next day morning to arrive at the daily feed consumption. Clean drinking water in a water trough was kept available *ad libitum* to the animals throughout the period. A preliminary period of seven days was allowed for the animals to get acclimatized to the cage environment followed by seven days of collection period. During the collection period, daily feed consumption and faeces voided were measured for each animal and the representative samples of feed and faeces were dried in a hot air oven to estimate the dry matter and pooled for seven days for further analysis. 1/100th part each of the fresh faeces voided daily by individual animal was preserved in diluted sulphuric acid for nitrogen estimation.

Analytical methods

Feed and faecal samples were analyzed for proximate principles as per the procedures of AOAC (1995). Metabolizable energy (ME) values were calculated from TDN as per NRC (1981) formula. The effects of feed

Table 1. Ingredient and chemical composition of complete diets

Component	CF 35	CF 50
Ingredient composition (%)		
Red gram straw*	35	50
Dried lucaena leaves	25	10
Ground nut cake	5	8
Maize	30	14
Wheat bran	0	5
Red gram husk	0	8
Molasses	2	2
Mineral and vitamin mixture ¹	2	2
Salt	1	1
Chemical composition (g/kg DM)		
Crude protein	120.6	123.4
Crude fibre	213.4	265.2
Ether extract	29.5	26.2
Total ash	107.5	108.6
Calcium	13.1	12.6
Phosphorus	7.7	7.0
ME (MJ/kg DM, calculated)	9.4	8.6

¹ Vitamin mixture (Rovimix) added at 20 g per 100 kg.

* Red gram straw contained 9.26% CP, 42.44% CF, 1.24% EE, 38.64% NFE, 8.42% TA, 1.06% Ca, 0.23% P.

processing (mash vs pellet) and level of red gram straw (35% vs 50%) in complete diets on feed intake, growth and nutrient utilization were analyzed using general linear model procedure of Statistical Package for Social Sciences (SPSS) (1996) in a 2×2 factorial arrangement.

RESULTS

On dry basis, red gram straw contained 9.26% crude protein (CP), 42.44% CF, 1.24% EE, 8.42% ash, 1.06% calcium and 0.23% phosphorus. The average daily feed intake during growth period was significantly ($p<0.001$) higher on pelleted diets while the effect of level of RGS in the diets on intake was non significant (Table 2). Goats consumed an average of 671.45 and 426.28 g feed on pelleted and mash diets respectively irrespective of level of RGS. The intake was 552.38 and 545.36 g/animal/d on feeds containing 35 and 50% RGS respectively irrespective of method of processing. Total weight gain and average daily gain (ADG) in kids were also significantly ($p<0.001$) influenced by feed processing while the effect of level of inclusion of RGS was non significant on growth rate. Goats on pelleted feeds gained an average of 10.69 kg in 150 d with an ADG of 71.29 g whereas those on mash feed gained only 48.79 g per day irrespective of level of RGS. The total weight gain (kg) and ADG (g) on feeds with 35% RGS were 9.48 and 63.17 while those on feeds with 50% RGS were 8.54 and 56.92 respectively. Apparent digestibility of nutrients was similar among mash and pelleted feeds (Table 2). Increasing the RGS in feeds decreased the digestibility

of dry matter (DM), CP and CF resulting in lower ($p<0.001$) ME content in feeds containing 50% RGS. Though nutritive value of feeds was not affected due to pelleting, the average daily intake of DM, CP, digestible crude protein (DCP) and metabolizable energy (ME) per unit metabolic body weight were significantly ($p<0.01$) higher in pelleted diets. The Feed conversion efficiency (DMI:wt gain) was comparable among all the treatment groups.

DISCUSSION

Red gram straw used in the present study contained slightly lower CP and EE and higher CF and total ash contents when compared to the reports of Raut et al. (2002) and Rekhate et al. (2007) whereas, Kishore et al. (1997) reported slightly lower CP and CF and higher EE and total ash contents in red gram straw. Varietal differences among red gram crops might be the reason for this variation in proximate composition of straw. During the preparation of pellets, the procedure of reconstitution with water was followed instead of directly adding steam to the feed while passing through the screw to simplify the procedure for small scale production with minimal power consumption under field conditions wherein it may not always be possible to maintain boilers for steam generation (Valadez, 2008). The significantly ($p<0.001$) higher feed intake on pelleted diets might be due to the soft, pliable and cooked nature of expander extruded pellets together with natural disinclination of goats towards fineness of feed. The increase in intake due to pelleting of complete diets was in

Table 2. Weight gain, voluntary feed intake, nutrient digestibility and nutrient intake by goats on experimental feeds

	Mash		Pellet		Pooled SE	Significance (p-value)		
	35% RGS	50% RGS	35% RGS	50% RGS		Feed processing (FP)	Straw level (S)	FP×S
Initial weight (kg)	11.03	11.05	11.04	11.04	0.27	1.000	0.983	-
Final weight (kg)	19.00	17.71	22.01	21.45	0.64	0.008	0.439	0.761
ADG (g/d)	53.17	44.12	73.17	69.42	3.23	<0.001	0.234	0.631
Voluntary feed intake(g/d)	432.06	420.50	672.69	670.21	23.94	<0.001	0.724	0.819
DMI to gain ratio	8.39	9.41	8.64	9.24	0.37	0.959	0.299	0.786
Apparent digestibility (%)								
DM	60.25	57.86	59.73	56.52	0.68	0.466	0.043	0.745
CP	72.41	70.34	71.28	69.34	0.49	0.248	0.040	0.939
CF	49.27	44.33	45.53	45.39	0.76	0.329	0.078	0.093
EE	85.54	83.20	83.35	83.09	0.47	0.206	0.158	0.254
Nutritive value								
DCP (%)	8.73	8.68	8.60	8.56	0.05	0.248	0.665	0.945
ME (M J/kg DM)	8.89	7.97	8.61	7.90	0.12	0.203	<0.001	0.432
Nutrient intake per kg BW ^{-0.75}								
DM (g)	66.54	65.82	77.47	77.56	2.16	0.008	0.932	0.912
CP (g)	8.03	8.13	9.34	9.57	0.26	0.008	0.709	0.883
DCP (g)	5.81	5.72	6.65	6.62	0.17	0.010	0.830	0.911
ME (MJ)	0.59	0.52	0.66	0.61	0.017	0.011	0.044	0.830

agreement with the reports of Singhal and Mudgal (1983), Reddy and Reddy (1991a) and Reddy et al. (1992). Hale and Theurer (1972) opined that pelleting of feeds increases acceptability by animals. Pi et al. (2005) reported higher feed intake in goats due to pelletization of complete diets. Gipson et al. (2007) offered alfalfa based complete feeds in pelleted as well as mash forms under stall feeding to meat goats and found significantly higher DM intake on pelleted diets. Similar total roughage level rather than the level of RGS in the diets might be the reason for similarity in intake between complete diets containing 35% and 50% RGS. The average daily gain observed in kids on mash feed was comparable with the reports of Murthy et al. (1995) who observed an ADG of 44.6 g and Chandrasekharaiah et al. (1996) who reported an ADG of 44.7 to 53.4 g when feed was offered in mash form. The higher weight gains on pelleted feeds were in agreement with the findings of Raut et al. (2002) wherein an ADG of 75 g was reported when complete diets containing 60% roughage were offered in pelleted form. The similarity in digestibility of nutrients between pelleted and mash diets was in contrast to the reports of Singhal and Mudgal (1983) who reported slight decrease and Reddy and Reddy (1991b) who reported an increase in digestibility of nutrients due to pelletization of complete diets. The decrease ($p < 0.05$) in digestibility of DM and CP in diets containing 50% RGS was in agreement with the findings of Reddy and Raghavan (1987) and Reddy and Reddy (1984) who also reported a decrease in the digestibility of these nutrients due to an increase of roughage and fiber contents in feeds. The similarity in feed conversion efficiency (DMI: wt gain) among all the treatment groups indicated that the higher weight gain attained on pelleted diets was due to higher feed intake rather than higher nutritive value.

CONCLUSIONS

Expander extruder pelleting of complete diets significantly increased the voluntary feed intake and weight gain in goats and enabled effective utilization of red gram straw up to 50% level in complete diets.

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