

Research Application Summary

Effect of replacing soybean meal with dried rumen digesta on digestibility and growth performance of Djallonké sheep

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Abstract

The experiment was conducted to assess the effect of replacing soybean meal with dried rumen digesta (DRD) in concentrate diet on digestibility and growth performance of Djallonké sheep in the Northern savanna zone of Ghana. The treatments were T0 (0% DRD), T1 (4% DRD), T2 (8% DRD) and T3 (12% DRD). Sixteen (16) Djallonké rams with an initial average body weight of 12.4 ± 2.4 kg of 10-12 months old were randomly assigned to four treatment diets and replicated four times over a 63 day period in a completely randomized design (CRD). The data were subjected to statistical analysis of variance using GenStat 18.2 edition. Concentrate dry matter, organic matter intake (OMI) and crude protein intake (CP) were significantly ($P < 0.05$) affected by the inclusion of dried rumen digesta (DRD). The inclusion of DRD in the rams' diet showed no significant effect on apparent nutrient digestibility. The average daily weight gain (ADWG) of the rams were 56.6 g, 51.8 g, 48.8 g and 47.9 g for T0, T1, T2 and T3, respectively and they were not significantly ($P < 0.05$) different when compared to the control diet. Haematology, serum profile and carcass characteristics of the experimental rams were not significantly affected by the dietary treatments. Feeding rams with concentrate diet containing dried rumen digesta (DRD) did not have any adverse effect on growth performance, health of animals and nutrient digestibility.

Keywords: Blood profile, digestibility, Djallonké rams, dried rumen digesta, weight gain, sheep

Resume

L'expérience a été menée pour évaluer l'effet du remplacement de la farine de soja par des digesta de rumen séchés (DRD) dans un régime concentré sur la digestibilité et la performance de croissance des moutons Djallonké dans la zone de savane du nord du Ghana. Les traitements étaient T0 (0% DRD), T1 (4% DRD), T2 (8% DRD) et T3 (12% DRD). Seize (16) béliers Djallonké d'un poids corporel moyen initial de $12,4 \pm 2,4$ kg, âgés de 10 à 12 mois, ont été répartis au hasard dans les quatre régimes de traitement et répétés quatre fois sur une période de 63 jours dans un plan complètement randomisé (CRD). Les données ont été soumises à une analyse statistique de la variance en utilisant l'édition 18.2 de GenStat. La matière sèche concentrée, l'apport en matière organique (OMI) et l'apport en protéines brutes (CP) ont été significativement affectés ($P < 0,05$) par l'inclusion de DRD. L'inclusion de DRD dans l'alimentation des béliers n'a montré aucun effet significatif sur la digestibilité apparente des nutriments. Le gain de poids quotidien moyen (GJM) des béliers était de 56,6 g, 51,8 g, 48,8 g et 47,9 g pour T0, T1, T2 et T3, respectivement, et il n'était pas significativement différent ($P < 0,05$) du régime de contrôle. L'hématologie, le profil sérique et les caractéristiques de la carcasse des béliers expérimentaux n'ont pas été significativement affectés par les traitements alimentaires. L'alimentation des béliers avec un régime concentré contenant des digesta séchés du rumen (DRD) n'a pas eu d'effet négatif

sur les performances de croissance, la santé des animaux et la digestibilité des nutriments.

Mots clés : Digesta ruminal séché, digestibilité, gain de poids, profil sanguin, béliers Djallonké, moutons.

Introduction

Abattoir wastes create environmental pollution and severe health problems to people nearby due to indiscriminate disposal methods (Agbabiaka *et al.*, 2011; Fearon *et al.*, 2014; Ristianto *et al.*, 2016; Uddin *et al.*, 2018). Recycling rumen digesta as feed may reduce the environmental pollution and also serve as alternative source of protein for ruminants which could minimize feeding cost and the competition that exist between livestock, human beings and industries for available feedstuffs (Sakaba *et al.*, 2017). Rumen digesta contain microbial protein, which is essential to the ruminants as an available source of protein. Ruminant animals require protein for body maintenance, growth, reproduction and production of products such as milk, meat and wool (Yacout, 2016). Most of the proteins rations contain soybean meal as a source of protein (Rufino *et al.*, 2013). High prices and fluctuation in soybean production in recent time has limited its use in animals nutrition (Cherdthong *et al.*, 2011). This has placed emphasis on the search for cheaper local alternative sources of protein that can effectively replace soybean meal. It is against this background that this study was undertaken to investigate the nutritive value of dried rumen digesta in the diet of Djallonké sheep.

Material and methods

Rumen digesta preparation. The rumen digesta (mainly cattle) was obtained from the Tamale abattoir. All cattle were examined by veterinary staff to ensure that no infectious animals were slaughtered. The rumen digesta was collected without contamination of blood and placed in a sack and tied. Heavy object was placed on it for 3 hour to press the liquid out. This reduced the moisture content in the rumen digesta before it was spread on polyethylene to sun-dry for 4 days. The dried rumen digesta was incorporated in the diet at 0, 4, 8 and 12 (T0, T1, T2, and T3), respectively and fed to lambs in ratio 70:30 (70% of rice straw and 30% concentrate).

Experimental design, housing and feeding. Sixteen (16) Djallonké rams with an average weight of 12.4 ± 2.4 kg (10-12 months old) were randomly assigned to four treatment diets and replicated four times over a 63 day period in a completely randomized design (CRD). The animals were individually housed in cages with concrete floor. Wooden troughs and two plastic bowls were fitted to the cages for feed and water. The concentrate diet was first offered at 7:00 am in the morning 15 minutes before the basal diet. Water was also provided *ad libitum*. All animals were weighed weekly before they were fed in the morning. Weekly feed offered were determined by computing 3 % of the rams body weight (RBW) and it was shared between the chopped rice straw and the concentrate diet in a ratio of 70:30 (70% straw and 30% concentrate) respectively. The leftover feed was weighed every morning for each animal and the difference between quantity offered and quantity left was the amount of feed eaten. Daily samples of the concentrate diets offered and leftover were taken and stored in a refrigerator until the experiment was over. After the experiment, the sampled diet was bulked for each treatment replicate and subsample taken for drying in the oven. Duplicates of each subsampled treatment were weighed and oven dried at 60 °C for 48 hours. The DM percentage was computed and used to estimate the total DM intake of the supplement for each treatment group.

Table 1. The ingredients and chemical composition of the dietary treatments and dried rumen digesta (DRD) fed to lambs

Ingredients	DRD inclusion levels (%)				DRD
	T0	T1	T2	T3	
Maize	40	40	40	40	
Cassava peels	10.5	10.5	10.5	10.5	
Rice bran	15	15	15	15	
Shea nut cake	10	10	10	10	
Soybean meal	20	16	12	8	
Dried rumen digesta	0	4	8	12	
Premix	1	1	1	1	
Urea	3	3	3	3	
Salt	0.5	0.5	0.5	0.5	
Total	100	100	100	100	
Chemical Composition					
Dry matter	95.5	96.0	95.0	96.8	96.5
Organic matter	89.53	90.69	90.53	89.71	83.94
Crude protein	23.8	25.2	22.6	26.8	14.01
Ash	10.47	9.31	9.47	10.39	16.06
NDF	58.80	65.40	63.80	65.30	78.3
ADF	24.0	25.0	27.7	41.2	50.0

T0= (0% DRD), T1= (4% DRD), T2= (8% DRD) and T3= (12% DRD)

Statistical Analysis. The data were subjected to statistical analysis of variance using Genstat 18.2 edition. Significant difference among treatment means were tested by using Turkey at 5% using the same software. The initial weight of the animals was treated as a covariate in the analysis of growth parameters.

Results

Feed intake. There was a significant ($P=0.004$) difference in concentrate dry matter intake per day among treatments. The lowest concentrate intake was observed in T1 (112.77g/d) and the highest in T0 (123.20g/d). There was a marginal increase in intake of rice straw with DRD based concentrate relative to the control (T0). The total dry matter intake did not differ among the treatment. There was a significant ($P=0.001$) difference in organic matter intake of rams fed T1 DRD based concentrate compared to the control. Crude protein intake (CPI g/d) was significantly ($P=0.03$) higher in the T3 compared to T2. ADF intake was significantly different ($p<0.001$) in the T0 compared to the DRD based concentrate diet.

Nutrient digestibility. The inclusion of DRD in the diet did not show any significant effect on dry matter digestibility coefficient between the control diet (T0) and DRD based concentrate diets. The crude protein digestibility was similar across the dietary treatments, however, crude protein digestibility increased marginally with increasing levels of DRD. The trend was similar in the OM digestibility coefficient which ranged between 0.89 and 0.91% for T0 and the T2. The NDF digestibility coefficient did not differ among the dietary treatments.

Table 2. Effect of feeding graded levels of DRD based concentrate and a basal diet of rice on dry matter intake, nutrient intake and nutrient digestibility of Djallonké rams

Parameters	DRD inclusion levels (%)					SED	P. value
	T0	T1	T2	T3			
Dry matter intake							
Concentrate intake (g/d)	123.20 ^a	112.77 ^c	119.67 ^{ab}	117.06 ^{bc}	2.26	0.004	
Rice straw intake (g/d)	345.63	360.63	355.24		355.87	25.21	0.944
Total intake (g/d)	468.82	482.73	474.91		472.92	26.85	0.962
Nutrient intake							
Concentrate OMI (g/kg)	69.40 ^c	77.18 ^a	72.06 ^{bc}		73.90 ^{ab}	1.42	0.001
Straw OMI (g/day)	320.5	333.2	330.1		326.9	23.05	0.953
Total OMI	439.7	456.8	451.2		440.2	25.23	0.878
CPI (g/d)	116.89 ^{ab}	127.0 ^{ab}	109.95 ^b		131.43 ^a	6.69	0.030
NDF (g/d)	275.62	315.71	302.96		308.89	16.82	0.143
ADF (g/d)	193.13 ^a	120.68 ^b	131.53 ^b		115.78 ^b	8.60	<.001
ME (MJ/kg DM)	10.26	10.66	9.93	10.71	0.69	0.647	
Nutrient digestibility							
Digestible DM	0.60	0.55	0.63	0.58	0.039	0.327	
Digestible CP	0.79	0.80	0.81	0.82	0.019	0.607	
Digestible OM	0.89	0.90	0.91	0.89	0.011	0.224	
Digestible NDF	0.43	0.42	0.49	0.46	0.058	0.598	

DRD= dried rumen digesta; T0= (0% DRD), T1= (4% DRD), T2= (8% DRD) and T3= (12% DRD)

Table 3. Effect of feeding graded levels of DRD based concentrate and a basal diet of rice on growth, blood profile and Carcass Characteristics of Djallonké rams

Parameter	DRD inclusion levels (%)				SED	P. value
	T0	T1	T2	T3		
Growth performance						
Initial (kg)	12.45	12.45	12.47	12.20	1.902	0.999
Final weight (kg)	15.96	15.67	15.47	15.42	0.580	0.786
Weight gain (kg)	3.56	3.28	3.07	3.03	0.580	0.786
ADWG (g)	56.47	51.69	48.61	48.21	9.424	0.806
FCR gDMI/gADG	8.67	9.45	10.86	10.13	1.832	0.675
Blood haematology and serum profile						
Hb (g/dl)	8.80	8.95	9.50	8.50	1.484	0.918
PCV (%)	32.75	32.55	33.20	32.65	1.027	0.920
WBC (10^9/l)	7.34	7.7	6.87	5.78	1.151	0.463
Albumin (g/dl)	24.8	25.2	24	24.2	1.603	0.863
Glucose (g/dl)	1.06	0.83	1.16	0.77	0.69	0.931
Total Protein (g/l)	66.2	67.3	64.3	63.6	1.693	0.251
Urea nitrogen (mmol/l)	11.15	10.39	8.96	9.84	2.465	0.838
Carcass characteristics						
Dressed weight (kg)	5.33	5.45	5.46	4.78	0.700	0.743
Dressing percentage %	36.72	34.89	34.25	32.87	1.337	0.167
Neck weight %	3.38	3.46	3.30	3.53	0.376	0.933
Shoulder weight %	17.15	13.57	16.18	14.58	1.018	0.079
Thigh weight %	15.98	13.96	14.50	14.50	0.534	0.064

DRD= dried rumen digesta; ADF = ; ADWG= average daily weight gain; FCR= Feed conversion ratio; WBC=

Growth performance. Total live weight gain after the feeding trail (Table 3) was 3.56, 3.28, 3.07 and 3.03 kg respectively, for T0, T1, T2 and T3 but showed no significant difference. The average daily weight gain of rams was not ($P=0.786$) affected by the inclusion of DRD in the diet. There was a decreased in final weight and average daily gain with an increase in DRD inclusion compared to the control diet. Feed conversion ratio (FCR) was not significantly different, however, FCR was better in the control rams compared to the DRD based concentrate rams.

Effect of DRD on blood profile and carcass characteristics. There was no significant difference ($P>0.05$) across the treatments for all haematological and serum profile parameters. The highest Hb (9.50g/dl) was recorded in animals fed T2 concentrate with T3 recording the least value (8.50 g/dl). The packed cell volume was high in T2, while T1 also recorded the highest WBC count. The highest albumin was recorded in T1 while the least was in T2. The highest serum glucose concentration was recorded in T2 with T3 recording the least. The total protein ranged from 63.6 to 67.3 for T3 and T1, respectively. The blood urea levels was in a range of 8.96 to 11.15 for T2 and T0. The dressed carcass weight, dressing percentage and primal cuts did not differ among the treatment groups. The least (32.87%) dressing percentage was obtained in T3 and the highest in T0.

Discussion

All the experimental diets were good enough for the rams since all rams voluntarily consumed the concentrate diets to the end of the experiment without health problems and promoted growth in a similar trend as reported by Salinas-Chavira *et al.* (2007), Fajemisin *et al.* (2010), Olafadehan *et al.* (2014) and Osman and Abass (2015) in lambs fed DRD based diets. There was reduction in concentrate dry matter intake compared to the control diet which is attributed to the inclusion of DRD that affected diet palatability. This confirms the findings of Osman *et al.* (2015) and Al-Wazeer (2016) who fed lambs diet containing DRD. However, lambs fed DRD based concentrate diets had the highest rice straw intake and total dry matter intake compared to the control diet (T0). The reduction in DRD based concentrate intake could have influenced the lambs to consume more of the rice straw to meet their energy requirement. The significant effect on organic matter intake was due to high OM observed in the chemical composition of the DRD based concentrate diets. The high CP content in the chemical composition of the DRD based concentrate diet contributed to the significant increase of CP intake in the DRD based concentrate. Abouheif *et al.* (1999) and Al-Wazeer (2016) observed increase in CP intake when lambs were fed graded levels of DRD based diet. The increase in NDF and decrease in ADF all agrees with earlier reports by Olafadehan *et al.* (2014) when lambs were fed DRD based diets at 0%, 20% and 40% and Al-Wazeer (2016) who observed significant effect in ADF intake when lambs were fed DRD based diets at 10, 20 and 30%.

There was a trend of decreasing rate in final weight and daily weight gain of rams with increasing levels of DRD in the present study which confirms the report of Abouheif *et al.* (1999). Several authors reported no significant effect on weight gain (Salinas-Chavira *et al.*, 2007; Mondal *et al.*, 2013; Osman *et al.*, 2015; Osman and Abass, 2015; Al-Wazeer, 2016; Uddin *et al.*, 2018) when ruminants were fed DRD based diets. However, Osman and Elimam (2015) recorded increase in final weight as levels of DRD increased. The present daily weight gains compared closely with the 16-48 g/d observed by Adu *et al.* (1992) but lower than the 79-91 g/d reported by Baiden *et al.* (2007). The similarity in weight gain implies that the DRD based concentrate diets met the nutrient

requirement of the experimental rams. Feed conversion ratio (FCR) was better in the control rams compared to the DRD based concentrate rams but lack significant difference. Fajemisin *et al.* (2010) recorded similar result when 25% of DRD was included in Djallonké sheep diet.

The crude protein digestibility compared favourably to the 65 to 68% rumen degradable protein required for adequate rumen functions and the synthesis of microbial protein (McDonald *et al.*, 1995). Crude protein digestibility increased as the inclusion levels of DRD increased. The increased digestibility coefficients in the DRD based concentrate diet was due to the partially digested nature of the dietary material. Olafadehan *et al.* (2014) fed graded levels of DRD at 0%, 20% and 40% to lambs and observed increase in CP digestibility in the 20% and 40% DRD based diets than the 0% DRD diet. The lack of significant difference in nutrient digestibility between the control and the DRD based concentrate diets could be due to the smaller DRD inclusion levels used in this study. Several other researchers did not find significant difference in nutrient digestibility when DRD based diets were fed to ruminants (Kamstra *et al.*, 1959; Mondal *et al.*, 2013; Cherdthong *et al.*, 2014; Al-Wazeer, 2016). However, Fajemisin *et al.* (2010) reported significant increase in DM digestibility when Djallonké sheep were fed DRD based diet at 25%. The numerical increase in nutrient digestibility of the experimental diets is attributed to their superior nutritive values.

Dietary treatments have significant effects on blood constituents values which can be used to draw conclusion on nutritive value of a diet offered to an animal (Church *et al.*, 1984). Haematological and serum profile all fell within the normal range for healthy sheep as reported by Jain (1993), Pampori (2003) and Scott *et al.* (2006). Aruwayo *et al.* (2009) observed normal haematological indices and serum metabolite values in lambs fed DRD based diets. The normal levels of haematological indices and serum parameters values suggest that the immune systems of the rams were not impaired by DRD based concentrate diet. Feeding rams with DRD based concentrate diet had no significant effect on carcass characteristics. However, the T0 gained 3.85% more than T3 in dressing percentage. The lack of differences observed in both carcass characteristics might be due to similar effect in weight gain of the experimental rams. Similar trend was observed by Abouheif *et al.* (1999) when lambs were fed DRD and barley mixture in a ratio 4:1.

Conclusion

The study revealed that dried rumen digesta can effectively replace soybean meal (up to 12%) without any effect on digestibility and growth performance of sheep.

Acknowledgement

The facilities provided by the University for Development Studies and Animal Research Institute of Center for Scientific Institutional Research (ARI-CSIR), Nyankpala-Ghana are duely acknowledged. This paper is a contribution to the Fifteenth Ruforum Annual General Meeting.

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