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Nutrient Degradability and Performance by the West African Dwarf Goats Fed Rumen Epithelium-based Diets

O. A. Isah[1], and O. J. Babayemi[2*]

ABSTRACT

Nutritive value of Rumen Epithelial Scraping (REP) was assessed using *in sacco* and *in vivo* procedures. Concentrates were so formulated that 0% (A), 35% (B), 70% (C), and 100% (D) of Soybean Meal (SBM), were replaced (weight for weight) with REP. In a completely randomized design, 16 West African Dwarf (WAD) goats were randomly allocated to the experimental diets to assess feed intake and digestibility. In a second trial, the concentrates, SBM and the REP were degraded in the rumen of fistulated goats to determine Dry Matter (DM) and Crude Protein (CP) degradability. No significant difference (P< 0.05) was observed in DM and CP consumption of goats on the various dietary treatments. The variation observed for digestible DM and CP among diets were significant (P< 0.05). The highest value of digestibility coefficients of DM and CP were observed in diet B (77.72% and 79.2% respectively). There were significant differences observed (P< 0.05) in the DM and CP degradation characteristics of the different samples incubated in the rumen of goats. Rumen epithelial waste contained more soluble fractions (30.13% DM and 71.04% CP) than soybean meal (29.82% DM and 18.6% CP), and it was shown that increasing REP in the concentrate increases the soluble DM and CP (P< 0.05). The results indicated that REP is nutritive and can replace SBM at reasonable levels in goat production enterprise.

Keywords: Rumen epithelium, degradability, dietary protein, WAD goats.

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INTRODUCTION

Unconventional feedstuffs as a source of protein are strategic for sustainable ruminant productivity in Nigeria, due to a keen competition between humans and livestock for feed ingredients from crop plant origin. The common protein sources including soybean, groundnut cake and fish meal are unaffordable, being expensive and scarce (Babayemi and Bamikole, 2006). The key to economic and sustainable livestock production in Nigeria is the replacement of feedstuffs that are expensive with inexpensive wastes and by-products of little or no commercial value. Studies have indicated that some proteinaceous abattoir wastes such as blood meal, rumen digesta, meat meal and rumen epithelial scrapings (REP) can, replace the conventional protein sources (Skrede and Nes 1988; Howie *et al.,* 1996; Abubakar 1998; Bawala and Akinsoyinu, 2006).

The rumen epithelial scrappings are from the papillae layer of rumens of cattle slaughtered in Western Nigeria. They are readily available since over 1 million heads of cattle are slaughtered annually. A similar by-product is generated through slaughter of sheep and goats. Being high in protein and mineral contents (Bawala and Akinsoyinu, 2006), a limited quantity of REP may be strategically supplied to augment the nutrient deficient pasture and crop residues during the critical period of dry season in Nigeria. Knowledge concerning REP, as

[1] Department of Animal Nutrition, University of Abeokuta, Abeokuta, Nigeria.
[2] Department of Animal Science, University of Ibadan, Nigeria.
* Corresponding author; e-mail: ojyemi@yahoo.co.uk

animal protein source for feeding ruminants is lacking and therefore, rapid assessment, using both *in vivo* and *in sacco* techniques is prudent. Specifically gaining an understanding of the quality of REP in terms of nutrient composition, release and utilization, with reference to its influence on animal productivity would be invaluable. Feed digestibility and intake for example, determine animal performance and are reflections in weight gain, milk yield, milk quality, litter size etc, (Getachew *et al.,* 2004). On the other hand the *in sacco* technique provides a useful means to estimate rates of disappearance and potential ruminal degradability of feedstuffs and feed constituents whilst incorporating the effects of particulate passage rate from the rumen (Bamikole *et al.,* 2004). The present study was designed to determine the nutritive value of REP as an unconventional protein source for goats.

MATERIALS AND METHODS

Collection of Rumen Epithelial Scraping

Rumen epithelial scrapings (REPs) were collected daily from their disposal site at the major government abattoir, Abeokuta, Nigeria. Having separated some of the extraneous materials from the scrapings, the remaining clean REP was bagged and soon considerably compacted, to lower the moisture content level to a reasonable level for easier transportation. In order to reduce putrefaction, the material was thinly spread on an elevated slab to be sun dried for 2-5 days depending on the climate conditions. Drying was considered as complete when the material crumbled. A fresh sample of REP was then oven dried at 65°C to a constant weight for a determination of DM. The oven dried REP was milled through a 2.5 mm sieve and preserved for further analysis.

Goat Management and Ration Formulation

Sixteen male intact goats aged 4 to 6 monthsm weighing 6 ± 1.5 kg were picked up from some villages neighboring the University. The goats were quarantined and placed on prophylactic treatments for two weeks as outlined by Babayemi and Bamikole (2006). During the adaptation period, the goats were dipped in Di-asuntol for the removal of external parasites. Concentrates were formulated (Table 1) such that 0% (A), 35% (B), 70% (C), or 100% (D) of SBM, was replaced (weight for weight) with REP. Each group of 4 goats (by weight) was randomly assigned to the diets A, B, C, and D in a completely randomized design. Guinea grass (*Panicum maximum*) was cut and fed to the goats in pens as the basal diet. Water was offered *ad libitum.* Any feed refusals were weighed and discarded the following morning. The feeding trial lasted for 84 days.

Intake and Digestibility Study

At the end of the feeding trial, the animals were transferred into individual metabolic cages for separate collection of urine and faeces. Records of daily feed offered, feed refusals (orts) and faecal and urinary outputs were kept for 7 days, following 7 days of physiological adjustment to the cages. A 10% of animal faeces was collected daily. Faecal samples were oven dried at 65°C for 3 to 5 days and bulked for each and everyanimal. Feed and faecal samples were analyzed for proximate composition and fibre fractions as described by AOAC (2000), and Van Soest and Robertson (1985). Voluntary intakes were estimated as the difference between the feed offered and that consumed. Digestibility was determined by the method described by McDonald *et al.* (1987).

Ruminal Degradability Study

The concentrate diet, SBM and REP were employed in the degradability study. Samples to be degraded were oven dried at 65°C for 3 days and ground to pass through a 2.5 mm screen Wiley mill

Table 1. Ingredients and Chemical Composition of Soybean meal, Grass, Rumen Epithelium Waste and Rumen Epithelium Waste-baesd Concentrate.

Ingredients (g/100g DM)				Concentrates treatments			
				A	B	C	D
Soybean meal				15.00	9.75	4.50	-
Rumen epithelial waste				-	5.25	10.50	15.00
Cassava Peel				34.50	35.50	36.50	38.50
Wheat offal				18.00	17.00	17.00	15.00
Corn offal				15.00	15.00	14.00	14.00
Corn cob				6.00	6.00	6.00	6.00
Fermented sorghum waste				6.00	6.00	6.00	6.00
Bone meal				3.00	3.00	3.00	3.00
Oyster shell meal				2.00	2.00	2.00	2.00
Vit/Min Premix [a]				0.25	0.25	0.25	0.25
Common Salt				0.25	0.25	0.25	0.25
Total				100	100	100	100
Chemical composition							
%	Grass	SBM	REP	A	B	C	D
Dry matter	87.60	84.80	89.45	85.55	85.19	84.94	85.53
Crude protein	8.37	51.00	62.49	16.13	16.95	17.82	17.72
Crude fiber	32.07	6.48	1.57	-	-	-	-
Acid detergent fiber	40.40	-	-	20.73	19.84	21.85	21.23
Neural detergent fiber	63.04	-	-	37.38	36.98	38.07	38.30
Ether extract	1.81	6.19	4.98	2.24	5.25	8,16	7.63
Ash	8.08	4.75	3.54	5.00	7.50	11.00	13.00
Calcium	-	-	-	1.98	2.28	2.28	2.31
Potassium	-	-	-	0.86	0.86	0.99	1.91
Magnesium	-	-	-	0.25	0.25	0.26	0.27
Sodium			0.38	0.33	0.43	0.50	0.73
Zinc (ppm)			176.00	35.50	38.15	40.73	46.70
Gross energy (Mcal kg^{-1} DM)	-	4.329	3.500	3.604	3.642	3.390	3.594

[a] Grower's premix containing Vitamin A: 4,000.000 IU, Vitamin B2: 1,500 mg, Vitamin B12: 10 mg, Vitamin D3: 800.000 IU, Vitamin E: 10,000 mg, Vitamin K3: 1,200 mg, Vitamin B1: 1,000 mg, Vitamin B6: 500 mg, Niacin: 10,000 mg, Pantothenate: 4,500, Biotin: 15 mg, Folic Acid: 200 mg, Chlorine: 120,000 mg, Manganese: 60,000 smsg, Iron: 15,000 mg, Zinc: 15,000 mg, Copper: 800 mg, Iodine: 400 mg, Cobalt: 80 mg, Selenium: 40 mg.

(M100AN05828, T. Peppink and Zn, Amsterdam, The Netherlands). Approximately 3 g of the milled samples were weighed in triplicate into nylon bags of the types described by Orskov et al., (1980). The bags were 5×13 cm in size, with a pore size of 41 µm. Bags were inserted *via* permanent ruminal cannulae in 4 WAD goats and left in the rumen for 12, 24, 48 or 72 hours. The 72 hour incubation sample bags were inserted first on the first day of incubation at approximately 8.00 hour. The next day at the same time, the 48 hours sample were incubated. The 24 hours and lastly the 12 hours sample bags followed these. The animals were allowed to graze daily on Guinea grass from 0900 hour to 1430 hour after which they were led back to their pens and supplied with wheat bran and salt lick containing Ca, P, Mg, Fe, S, Na, K, Co, Mo and I. They also had free access to fresh, clean water. At the end of the incubation period, all bags were withdrawn at the same time (Osuji *et al.,* 1993). Bags were washed under running cold water until the rinse water got clear, and were then dried in an oven for 48 hours at 60°C. Determination of washing loss at zero time

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(incubation at 0 hour) was carried out by soaking three of the bags containing each of the samples in warm (about 37°C) tap water for 1hour before the above washing and drying procedure. The dried bags were weighed and DM loss calculated. The various post-incubation residual samples were then ground through a 1 mm screen for crude protein (CP) determination. The results were analyzed electronically by use of the computer package Orskov *et al.,* (1980). Degradation constants were estimated from the non-linear equation suggested by Orskov and McDonald (1979): $PD= a+b\ (1 - e^{ct})$, where *PD* is Potential Degradation of DM and CP at time *t*, *a* is the soluble DM or CP, *b* is the insoluble but rumen degradable DM or CP, and *c* is the rate of degradation of *b* at time *t*. The Effective Degradability (ED) of DM and CP was calculated at an assumed outflow rate (k) of 0.05 h^{-1} according to Orskov and McDonald (1979): $ED= a+[bc/\ (c+k)]$, where *ED* and the constants *a, b* and *c* are as described above while *k* is the fractional outflow rate from the rumen. Chemical composition of samples of feeds, faeces, pre-incubation samples and post-incubation residues were analyzed according to AOAC (2000). Rumen Undegradable Protein (RUP) was determined by subtracting the potential degradability value from 100 (i.e. 100-P)

Statistical Analysis

The data obtained were analyzed in a completely randomized design using the one-way analysis of variance (ANOVA) procedures of SAS (1990) and significantly different (P< 0.05) means were separated through Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Composition and Nutrient Contents of Concentrates, Grass and Tested Ingredient

Table 1 shows the composition and results of the proximate analysis of tested feedstuffs (SBM and REP), concentrate and grass. Sun-cured REP has the highest CP content (62.49%), Guinea grass has the least value (8.37%), while the CP value of SBM was 51%. The CP values of the four concentrates ranged between 12. 82% and 16.13%.

Dry Matter Intake and Digestibility

Table 2 summarizes the voluntary DM intake of the goats. Grass dry matter consumed by the goats on A, C and D was similar, but higher (5.92 g, 6.18 g and 6.21 g $BW^{-0.75}$ day-^{1} respectively), compared with those on diets B (5.06 g $BW^{-0.75}$ day^{-1}). Concentrates and DM intakes were similar among treatment groups (P< 0.05). This suggests that all the diets were palatable to the animals. The percentage of concentrate DM intake per total DM intake ranged from 91.31 to 92.21%. This further supports the notion that the various concentrates accepted were acceptable by the goats, since they had an unrestricted access to both grass and concentrates. Acceptance could be due to the method of processing of the REP before

Table 2. Voluntary dry matter intake and digestibility of goats fed REP–based concentrates.

ITEM	Concentrate treatments				SEM
	A	B	C	D	
DM intake (g DM day^{-1} kg^{-1} 0.75)					
Grass	5.92^{ab}	5.06^{b}	6.18^{a}	6.21^{a}	2.90
Concentrate	64.98	59.87	64.91	66.97	2.90
Total	70.90	64.93	71.09	73.18	10.17
Conc./Total (%)	91.65	92.21	91.31	91.43	0.41
Total as %BW	4.00	3..30	4.00	4.10	0.39
Digestibility(%)	72.72^{c}	77.72^{a}	73.87^{ab}	74.76^{ab}	0.81

a, b, c= Means in the same column with different superscripts were significantly different P< 0.05.

incorporation with other ingredients for a complete diet; this is because sun drying allowed the ingredients to blend well with other feedstuffs when concentrates were being compounded. With this system it was difficult for any selection of a particular ingredient to take place. It could also be due probably to the contribution of other ingredients incorporated into the diets in terms of taste as goats (according to Steele, 1996), can distinguish bitter, sweet, salty and sour tastes. Total DM intake as percent of body weight (BW) ranged from 3.3% to 4.1%. This is slightly higher than that obtained in the tropics, dairy goats eat (DM daily) up to the equivalent of (4-5%) of their body weight while goats raised foe meat consume about 3% (Steele, 1996). The high intake observed may be due to the palatability of the feed or high protein: energy ratio. (Chesworth, 1992).

The variation observed in dry matter digestibility (DMD) among treatments (Table 2) was significant ($P< 0.05$). Highest value of DMD was 77.7% for concentrate B ($P< 0.05$), although this value was not significantly different from the DMD of concentrate C and D. Concentrate B, C, and D containing REP had higher DMD than A (zero REP inclusion). This might be due to better nutrient synchronization. Diet B has the least ADF and NDF values (Table 1). This suggests that the combination of SBM and REP in diet B (65% vs. 35%) might probably be the best in terms of digestibility. A possible reason for this could be as a result of better synchronization of available nutrients (French *et al.,* 2001).

Crude Protein Intake and Digestibility

Table 3 presents the voluntary CP intake and digestibility by goats. Similar mean values were recorded for the total (grass+concentrate) CP intakes of goats on all the treatments. However, animals on rations C and D consumed higher ($P> 0.05$) CP from grass (0.54 and 0.56 g DM^{-1} $W^{-0.75}$ day^{-1} respectively) than those on ration A and B (0.53 and 0.46 g DM^{-1} $W^{-0.75}$ day^{-1} respectively). It is obvious that concentrate diet contributed a larger proportion of the CP consumed by the animals (95.11-95.93%). This is an indication that the acceptability is high. Moreover, the trend observed in CP consumption by goats from grass in rations B, C and D was well correlated with the level of REP inclusion in the various concentrates which probably influenced the CP contents. This is in agreement with other research works (Viponds *et al.,* 1982) where it was noticed that intake of roughages by ruminants increased with increasing levels of CP. This might be because an improvement in the protein status of feed enhances rumen microorganisms' proliferation and so encourages a more rapid thorough digestion of digesta leading to grass intake stimulation.

Crude protein digestibility data are shown in Table 3. Variations observed were significant. Goats on ration B had the highest ($P< 0.05$) but similar to the value of those on ration D (79.2% and 78.1% respectively). Intermediate values were observed in the goats on ration C (75.2%)

Table 3. Voluntary crude protein intake and digestibility of goat fed REP-based concentrates.

ITEM	Concentrate treatments				SEM
	A	B	C	D	
DM intake (g DM day^{-1} kg^{-1} 0.75)					
Grass	0.53^{ab}	0.46^{b}	0.54^{a}	0.56^{a}	0.61
Concentrate	10.51	10.25	11.55	13.19	0.61
Total	11.05	10.71	12.05	13.75	2.40
Conc./Total (%)	95.11	95.70	95.93	0.37	0.37
Digestibility (%)	73.2^{b}	79.2^{a}	75.2^{ab}	78.1a	0.87

a, b, c= Means in the same column with different superscripts were significantly different $P< 0.05$.

while that of A had the least value (73.2%). This suggested that the combination of SBM and RW in ration B (35%:70%) might probably be better in terms of CP digestibility and could be as a result of better synchronization of available nutrients (French *et al.,* 2001). The results suggested that the higher the level of inclusion of REP in the ration, the higher the CP intake from grass.

Dry Matter Degradability

There were significant differences observed (P< 005) in the DM degradation characteristics of the different samples incubated in the rumen of (WAD) goats (Table 4). Rumen epithelial scrappings contained more soluble "*a*" fraction (30.13%), than SBM (29.82%, P< 0.05). This was reflected in the values obtained in rations A to D (31.45-34.16%). Solubility value increased with increasing content of REP. The high solubility value obtained in rumen waste (REP) could be due to its low fibre and lipid content as compared to SBM. A lower value of soluble DM (28.09%) was reported by Devant *et al.* (2000) for SBM. The mean DM disappearance of all samples increased over time, Table 4, as expected. Soybean meal degraded more rapidly (78.2 and 85.4 % at 24 hours and 72 hours, respectively), than REP (36.8 and 50.6% at 24 hours and 72 hours, respectively). The 'b' value indicated that SBM was a richer source of insoluble but degradable DM than REP (54.9 *vs*. 33.28%, respectively). This was also reflected in the 'b' values of the different rations. The potential DM degradation "*a+b*" of SBM (88.70%) was higher (P< 0.05) than REP (63.41%). Higher "*b*" value was probably responsible for the potential degradability estimate of SBM. The values for (ED) of DM showed that SBM had the highest value (54.1%) and REP, the lowest (35.0%) with concentrate mixtures being intermediate when an outflow rate of ` 0.05% h^{-1} is assumed.

Crude Protein Degradability

Rumen epithelial scrappings had more 3.8 times more soluble protein fraction than SBM (71.0 *vs*. 18.6%, P< 0.05, Table 5). The "*a*" value of 20.81%, 20.76%, 20.51% and 20.25% were obtained in rations A, B, C, and D respectively for CP. Ration A was expected to have the least value and D the highest but this was on the contrary. This observation suggests that the "*a*" value of crude protein of a single feed ingredient (SBM or REP) could not be used as a sole parameter for the determination of the "*a*" value of a particular ration containing many ingredients. Other factors such as the "*a*" values of other ingredients in the ration and the combining effect of two or more ingredients are also worth notice. The remarkably high "*a*" value of CP observed in REP might probably be as a result of its crispy nature when properly air-dried in the sun. Rumen epithelial scrapping was also low in fibre and ether extract (Table 1). Similar values of "*a*" were reported by Harstad and Prestlokken (2000) and Ljokjel *et al.* (2000) for CP of SBM (17.4% and 18.0% respectively). Lower values of 27.7% and 44.4% were reported for fishmeal and meat meal respectively by Gonzalez *et al.* (1998) compared to REP. Soybean meal contained the most extensively degraded CP as shown by its "*b*" value. The lower "*b*" value estimate of REP suggested that its crude protein might be resistant to rumen microbial degradation. Nandra *et al.* (2000) reported a higher "*b*" value of CP for SBM (81.60%). Also, a higher Rumen Undegradable Protein (RUP) value was obtained in REP (27.47%) than SBM (19.00%). This RUP might be available as by-pass protein to the animal for a better performance.

CONCLUSIONS

The results obtained from this study indicate that total or partial replacement of SBM with REP in goat ration was not found

Table 4. Dry matter degradation characteristics of rumen wastes (REP), soybean meal (SBM) and formulated concentrates by West African Dwarf goats.

Feed samples	*a* (%) washing-loss	Incubation period (hrs)				*b* (%)	*a+b* (%)	*c* (hrs)	*ED* (0.05) (%)
		12	24	48	72				
SBM	29.82^{f}	58.78	78.18	82.63	85.41	58.88^{a}	88.70^{a}	8.78^{a}	54.10
RW	30.13^{e}	31.39	36.76	44.94	50.61	33.28^{b}	63.41^{d}	1.53^{d}	35.00
Concentrate treatments 0% (A)	31.45^{c}	42.87	50.60	58.59	61.81	32.53^{c}	63.98^{c}	3.81^{b}	45.00
35% (B)	30.75^{d}	42.23	49.99	58.29	61.67	33.55^{b}	64.30^{b}	3.61b^{c}	44.50
70% (C)	33.76^{b}	43.18	50.47	58.36	61.74	30.51^{d}	64.27^{b}	3.53^{c}	45.50
100% (D)	34.16^{a}	42.81	50.40	58.37	61.63	29.74^{e}	63.90^{c}	3.72^{b}	45.20
SEM	0.41	1.94	3.01	2.71	2.54	2.46	2.24	0.54	1.04

a, b, c= Means in the same row with different superscripts were significantly different ($P< 0.05$).
a (%)= Water soluble fraction; *b* (%)= Insoluble but degradable fraction; *c* (hr)= Rate of degradation of b at time *t*; *ED* (%)= Effective degradability at rumen outflow rate of 0.05% h^{-1}, Incubation Periods (hrs)= The period of incubation of concentrates in the rumen of West African Dwarf goats i.e. 12, 24, 48 and 72 hours.

Table 5. Crude protein degradation characteristics of rumen wastes (REP), soybean meal (SBM) and formulated concentrates by West African Dwarf goats.

Feed Samples	*a* (%) washing loss	Incubation period (hrs)				*b* (%)	*a+b* (%)	*c* (hrs)	*RUP* (%)	*ED* (0.05) (%)
		12	24	48	72					
SBM		57.85.	78.96	95.77	98.99	62.40^{a}	81.00^{a}	8.46a	19.00	62.40
RW	71.04^{a}	71.41	71.90	72.18	72.46	1.49^{d}	72.53^{b}	3.84b	27.47	71.40
Concentrate treatments 0% (A)	20.81^{b}	21.95	23.75	26.60	28.29	10.76^{b}	31.54^{c}	1.82c	68.46	22.03
35% (B)	20.76c	21.27	22.86	22.07	22.33	1.64^{d}	22.38^{e}	3.92b	72.62	21.20
70% (C)	20.51^{d}	21.13	21.74	25.65	27.33	10.21^{c}	30.72^{d}	1.75c	69.28	21.43
100% (D)	20.25^{e}	21.78	21.27	21.97	21.83	1.64^{d}	21.89^{f}	4.06b	78.11	20.70
SEM	4.06	5.14	6.07	7.07	7.22	1.02	4.18	0.98	5.76	5.20

a, b, c= Means in the same row with different superscripts were significantly different ($P< 0.05$).
a (%)= Water soluble fraction; *b* (%)= Insoluble but degradable fraction; *c* (hr)= Rate of degradation of b at time *t*; *ED* (%)= Effective degradability at rumen outflow rate of 0.05% h^{-1}; *RUP (%)= 100-(a+b)*, Incubation Periods (hrs)= The period of incubation of concentrates in the rumen of West African Dwarf goats i.e. 12, 24, 48 and 72 hours.

detrimental to the experimental animals, in terms of dry matter and crude protein intake, as well as degradability and digestibility.

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تجزیه پذیری و وضعیت مواد مغذی در بزهای کوتوله آفریقای غربی تغذیه شده با جیره‌های حاوی ضایعات بافت پوششی شکمبه

و. ا. عیسی و و. ج. بابایمی

چکیده

ارزش غذایی ضایعات بافت پوشش شکمبه (REP) به روشهای *in sacco* و*in vivo* اندازه گیری شد. در آزمایش اول چهار فرمول کنسانتره که در آنها صفر درصد (A)، ۳۵ درصد (B)، ۷۰ درصد (C) و ۱۰۰ درصد (D) ضایعات بافت پوشش شکمبه جایگزین کنجاله سویا شده بودند (براساس وزنی)، در یک طرح کاملاً تصادفی مورد استفاده قرار گرفتند. این جیره ها بصورت تصادفی به ۱۶ بز کوتوله آفریقا غربی داده شد و خوراک مصرفی و قابلیت هضم خوراکها اندازه گیری گردید. در آزمایش دوم تجزیه-پذیری ماده خشک و پروتئین خام ضایعات بافت پوششی شکمبه و کنجاله سویا در بزهای فیستولا دار اندازه‌گیری شد. تفاوت معنی‌داری ($P > 0/05$) در مصرف ماده خشک و پروتئین خام در بزهای تغذیه شده با جیره های مختلف مشاهده نشد. تفاوت بین قابلیت هضم ماده خشک و پروتئین خام جیره های مختلف معنی دار بود ($P < 0/05$). بالاترین مقدار ضریب هضمی ماده خشک و پروتئین خام در جیره B مشاهده شد (به ترتیب ۷۷/۷۲ درصد و ۷۹/۲ درصد). تفاوت معنی دار($P < 0/05$) در خصوصیات تجزیه پذیری ماده خشک و پروتئین خام نمونه های مختلف قرار گرفته در شکمبه بزها مشاهده شد. ضایعات بافت پوششی شکمبه دارای مواد قابل حل بیشتر (۳۰/۱۳ درصد ماده خشک و ۷۱/۰۴ درصد پروتئین خام) نسبت به کنجاله سویا (۲۹/۲۸ درصد ماده خشک و ۱۸/۶ درصد پروتئین خام) بود. با افزایش مقدار ضایعات بافت پوششی شکمبه در جیره، غلظت ماده خشک و پروتئین خام محلول افزایش معنی دار پیدا کرد($P < 0/05$) نتایج این پژوهش نشان داد که ضایعات بافت پوششی شکمبه دارای ارزش غذایی خوبی است و می‌تواند جایگزین سویا در جیره بزها در هر سطح تولیدی شود.

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