Feeding value of shrimp waste meal for West African Dwarf sheep fed soybean stover basal diet

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Abstract

A degradability and feeding trial was carried out to estimate the utilization of soybean stover (SBS), Shrimp waste meal (SWM) and their mixtures (SBS+SWM) in West African Dwarf sheep. Sole samples of SBS, SWM and mixture of SBS+SWM were incubated in the rumen of castrated West African Dwarf rams. Degradation lasted 48 hrs. Feeding trial entailed feeding graded levels (0%, 5%, 10%, 15%) of SWM to a sole SBS diet. The growth study lasted for eight weeks. Results obtained in the degradability trial showed that there were significant ($p < 0.05$) differences in the dry matter (DM), crude protein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADF) degradability parameters for the feedstuffs. The effective DM degradability 'ED' was highest in SBS (343.0g/kg) and lowest in SWM (250.0g/kg). Crude protein effective degradability 'ED' ranged between 101.0 and 301.0g/kg for SBS and SBS+SWM respectively. NDF 'ED' ranged between 398.6g/kg for SWM and 815.7g/kg for SBS. ADF degradation characteristics for the constituents were also significantly ($P < 0.05$) different with the soluble fraction 'a' values ranging between 126.0 and 624.0g/kg. When graded levels of shrimp waste meal was used as supplement to soybean stover, there were significant ($P < 0.05$) differences in the average daily weight gain, which ranged from 9.52 to 22.85g/d. The mean live weight gain was highest at 10% level of inclusion. Average daily DM intake decreased significantly ($P < 0.05$) with increasing level of SWM in the diet. The sole soybean stover diet however had the least DMI. DM, OM, NDF and ADF apparent digestibility coefficients were not significantly affected by the treatment imposed. CP digestibility increased ($P < 0.05$) with increasing level of SWM to peak at the 15% level of inclusion (0.766) compared to the sole SBS treatment (0.593). Nitrogen balance was significantly ($P < 0.05$) increased as the level of inclusion of SWM increased. Results suggest that feeding soybean stover as roughage along with up to 10% SWM to sheep may be sufficient to meet the requirements for weight gain and proper nutrient utilization.

Key words: Degradability, soybean stover, shrimp waste meal, sheep

Introduction

Shrimp waste meal has generated a lot of interest as animal protein source in Nigeria. There is a significant amount of waste generated from the shrimp industry because large percentage of its head, exoskeleton and soluble components are lost during the various processing operations (Fanimó *et al.*, 1996). The increase in shrimp farming in Nigeria has led to the concomitant production of shrimp waste. Significantly large amount of shrimp are sold as peeled or unpeeled tail after cropping, beheading and washing. Shrimp waste meal is basically the dried milled waste of shrimp industry consisting of the head, appendages and exoskeleton of the shrimp (Fanimó *et al.*, 1996). Crustacean waste has been incorporated in the diets of growing lambs to comprise of 35-40% of protein intake (Bunting *et al.*, 1994) to realize a positive growth response. SWM can partially or totally replace the use of soybean in livestock feed (Rosenfeld *et al.*, 1997). However, chitin a homopolymer of N-acetyl-P-D glucosamine joined together by β (1-4) glycosidic linkage is abundant in the exoskeleton of the shrimp (McDonald *et al.*, 1998). This chitin is similar to cellulose, which is also a structural material. There is possibility, therefore, of providing two sources of protein one directly through the production of protein and other indirectly through a bioconversion process of the chitin to produce single cell protein (Freer *et al.*, 1996). The use of protein sources whose nutrient escapes rumen degradation improves considerably the performance of the animals. As forages are deficient in ruminally degradable protein, supplementation strategies should maximize microbial protein production

in the rumen in order to enhance production. Previous works indicated that shrimp by-products have intrinsic properties useful for mono-gastric animals (Oduguwa *et al.*, 1998, Toan and Ngoan, 2003, Fanimó *et al.*, 2004). However, little work has been done on its use in feeding sheep. This study was therefore designed to provide insight into the ruminal degradability characteristics and performance of sheep fed sun-dried shrimp waste meal as a supplement.

Materials and Methods

Degradability Studies

Experimental site

The study was carried out at the International Livestock Research Institute (ILRI) farm in Ibadan, South-Western Nigeria. The station is located between latitude 6°10 North and longitudes 3° and 6°East. The vegetation in this area is made up of derived guinea savanna and humid forest zone (Ezenwa, 1995) and mixed farming had been practiced in the area for several decades.

Animals and their management

Three West African Dwarf castrated rams about 2 years old, tagged 150, 160 and 170 with an initial live-weight of 24, 25 and 26kg respectively, were used for the studies. Each animal was under general anaesthesia fitted with permanent cannula (75mm internal diameter) in the dorsal sac of the rumen. Each animal was kept in separate pen (3m x 2.5m) where there was a free access to water and trace mineralized salt lick daily. They were also allowed to graze freely occasionally in the paddock grown with

Panicum maximum grass. They were fed with cowpea husk and sorghum residue with water *ad libitum*. The area of the cannulae was cleaned regularly.

Experimental diets

The samples used for the degradability study were soybean stover (SBS), Shrimp waste meal (SWM) and mixture of SBS+SWM (in ratio 8:2 basis).

Determination of degradation characteristics

The DM degradability of the samples was determined using the nylon bag technique (Orskov *et al.*, 1980). The samples were oven-dried at 60°C to constant weight and the dry weight taken. Samples were then ground through a laboratory hammer mill with a 2.0mm screen size. About 5g of each feed was weighed into nylon bags (pore size 40 – 50 micron im). Each bag was then inserted into the rumen of the animals through the cannula. Bags were attached to carrier weight to prevent them from floating above the rumen contents. The incubation period was 6, 12, 24 and 48 hours. The 48-hour samples were the first to be inserted followed by 24, 12 and 6 hours respectively. The bags were removed at the same time from the rumen at the end of incubation period. They were then, together with those not subjected to any rumen fermentation representing 0hr washed under running tap water at 37°C for 30 minutes until the water colour became clear. All washed bags and their contents were placed on metal trays and oven dried at 60°C for 48hours in forced air oven, cooled in a desiccator and weighed to determine DM loss.

Disappearance of DM was measured as the loss in weight of the bag content. The results were fitted to the exponential equation.

$P = a + b (1 - e^{-ct})$ (Orskov and McDonald, 1979), where P = DM degraded (g/kg) from the bag after time 't' (hr), a = the intercept of the degradation curve at time zero that is the soluble fraction, b = The portion of the sample which will in time 't' be degraded, c= The rate constant for the degradation of 'b', t = time of degradation (a + b) = the potential extent (asymptote) of degradation.

ED= effective degradability= $a + bc/(c+k)$

Where k is rumen out flow rate of 2%/h⁻¹

The effective degradability (ED) was estimated according to the method of Mc Donald (1981).

Chemical analysis

Dry matter (DM) of the samples was determined by drying in an oven at 60°C to constant weight ground through a 1mm screen and used for chemical analysis. Nitrogen concentration was analysed by the Kjeldahl method (A.O.A.C., 1990) and crude protein content was calculated (N*6.25); Cell Wall disappearance was estimated by determining neutral detergent fibre (NDF) and Acid detergent fibre (ADF). Neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) were measured by methods of Goering and Van Soest (1970). Ash was the residue after ashing the samples at 550-600°C. Chitin was determined according to Stelmock *et al.* (1985). Gross energy of the samples was determined with adiabatic bomb calorimeter.

Statistical analysis

A completely randomized design for DM, N and NDF, ADF, ADL degradation was applied. All data were subjected to analysis of variance (ANOVA), Statistical Analysis System (SAS) (1989).

Trial 2

Description of study site

The study was conducted in the Experimental Unit, Small Ruminant Section of the College of Animal Science and Livestock Production (COLANIM) Teaching and Research farms, University of Agriculture, Abeokuta (South Western Nigeria), which falls under the derived savanna transition zone. The altitude of the region is of 70 meters above sea level and falls within latitudes 7°5 – 7°8 and longitudes 3°11.2 – 3°2.5'E. The climatic condition is humid with a mean annual rainfall of 1037mm. The annual mean temperature and humidity are 34.7°C and 82% respectively.

Experimental diet preparation

The soybean (*Glycine max* Merrill) stover (mixed varieties) used in the study was procured from the University of Agriculture, Abeokuta (UNAAB), model extension villages. They were threshed with Vogel type mechanical thresher obtained from IITA, Ibadan. The stover was thereafter subjected to further deseeding process, to ensure the pods were properly stripped of the raw seeds which is detrimental to the animals. It was spread out and sun dried for 7 days. After drying the stover were baled into bundles in jute bags and stored in a well-ventilated room till required for feeding. All stover collected were fed to the sheep as threshed.

Experimental animals and their management

Twelve West Dwarf (WAD) sheep were used for this study. The animals were about 7-9 months old with mean body weight of 14.51 ± 0.15 kg. They were randomly allocated to four experimental treatments of 100:0, 95:5, 90:10, 85:15 graded levels of soybean stover (SBS) and Shrimp waste meal (SWM). Weighed SBS and SWM were offered to animals in separate feed troughs twice a day, at 0800 and 1600 hours in equal proportion such that each animal received a quantity amounting to recommended daily allowance of 50g DM/kg LW/day. Growth and dry matter intake study lasted for eight weeks. The animals were transferred into metabolic cages at the end of eight weeks for the digestibility study which lasted for 7 days. The sheep were housed in individual metabolism crates where the quantity of feed intake, faecal and urinary output were monitored over the period, during which 10% aliquot of the total faeces and urine were bulked and kept for chemical analysis of the proximate components. Determination of the different components in the feed, faeces and urine was through the standard method of analysis as described in Trial 1.

All data generated were subjected to analysis of variance in a completely randomised design using general linear models procedure (SAS, 1989). The mean separation was done using the Duncan Multiple Range Test (Duncan, 1955)

Results

Chemical composition of samples

Both soybean stover and shrimp waste meal had similar levels of DM, OM and gross energy, while

shrimp waste meal contained twice the level in CP. The Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and lignin contents were higher in soybean stover (SBS) than in SWM (Table 1). Soybean stover had a crude protein content of 92.6g/kgDM, NDF of 703g/kg DM, ADF of 542.7g/kg DM and lignin content of 245.0 g/kg DM. Shrimp waste meal had a crude protein content of 273.4g/kg DM, a NDF value of 422.8g/kg DM, ADF of 437.7g/kg DM and lignin content of 21.0g/kg DM.

The dry matter degradability characteristics for the samples depicted that the soluble fraction ($P<0.05$) ranged from 155.1 in shrimp waste meal to 251.9 in soybean stover and the degradable fraction ($P>0.05$) ranged from 105.3 in SBS and 109.4 in mixture. (Table 2)

There were significant ($P<0.05$) differences in the degradability characteristics of crude protein. (Tables 3). Effective degradability (ED) of crude protein was generally low with a range of 101.0 in SBS and 301.1% in SBS+SWM. The CP degradability characteristics of the feedstuffs differed in water solubility (33.1–134.7), rate of degradation (6.0 to 8.0/h) and lag time (39.0 to 65.0h).

The NDF degradability of the feedstuffs also differed ($P<0.05$) significantly in water solubility, with values ranging from 267.6 to 785.6. The rate of degradation of the degradable fraction ranged from 4.85 to 9.0 per hour. There was a distinct superiority in this constant in soybean stover over the other feeds. Moreover, effective degradability (ED) was highest in SBS followed by SBS+SWM (Table 4)

Performance, nutrient intake, nitrogen utilization and digestibility of WAD sheep fed graded levels of SWM

Total weight gain of the animals increased progressively with increasing level of inclusion of SWM up to 10% beyond which the weight gain declined (Table 6). Daily weight gain ranged from 9.52 to 22.85 gd^{-1} for sole SBS and 10% SWM treatments respectively.

Treatments had significant influence ($P<0.05$) on the nutrient intakes of DM, OM, CP ($\text{gd}^{-1}\text{W}^{0.75}$). Total DM intake was highest at 5% shrimp waste meal inclusion. The lowest DM intake was recorded in the sole soybean stover diet. The intake of CP increased slightly as the inclusion of SWM increased. However, the sole feed of stover significantly reduced in CP intake resulting in a significant difference among the treatments.

Apparent digestibility coefficient values were high generally and did not show any much variation among the treatments, except for crude protein digestibility which was lowest in the sole soybean stover diet. Dry matter digestibility value ranged between 0.738 and 0.7460 for 10% SWM and SBS diets respectively. Crude protein digestibility values ranged between 0.593 and 0.766. Organic matter digestibility values ranged between 0.761 and 0.802. The fibre fractions (ADF and NDF) did not show significant differences across treatments (Table 6).

Nitrogen intake increased but not significantly ($P>0.05$) among the diets as the level of SWM inclusion increased. Sole SBS treatment induced the lowest nitrogen intake in the sheep which ranged from 7.32 to 10.78

Table 1: Proximate composition of soybean stover and shrimp waste meal.(g/kg)

Constituents	Soybean stover	Shrimp waste meal
Dry matter	942.6	844.7
Organic matter	919.0	921.9
Crude protein	92.6	273.4
Ash	81.0	178.1
Neutral detergent fibre	703.0	422.8
Acid detergent fibre	542.7	437.7
Acid detergent lignin	245.0	21.0
Gross energy (Kcal/g)	4.64	3.2
Chitin	-	111.0

Table 2: Dry matter degradability coefficients of soybean stover (SBS), shrimp waste meal (SWM) and mixture of SBS+SWM (g/kg) in the rumen of West African Dwarf sheep

	Soybean stover	Shrimp waste meal	Soybean stover + Shrimp waste meal	SEM
a	251.9 ^a	155.1 ^c	197.0 ^b	0.14
b	105.3	109.1	109.4	0.02
p	351.7 ^b	264.2 ^c	373.0 ^a	0.43
c	1.29 ^b	1.34 ^a	1.0 ^c	0.01
Lag time	27.3	27.3	31.0	0.25
ED	343.0 ^a	250.0 ^c	310.0 ^b	3.56

a, b, c: Means on the same row with different superscripts are significantly ($P < 0.05$) different where P = DM degraded (g/kg) from the bag after time 't' (hr), a = the intercept of the degradation curve at time zero that is the soluble fraction, b = The portion of the sample which will in time 't' be degraded, c = The rate constant for the degradation of 'b', t = time of degradation
 (a - b) = the potential extent (asymptote) of degradation
 ED = effective degradability = a + b/c/k
 Where k is rumen outflow rate of 2%/h⁻¹

Table 3: Crude protein degradability coefficients of soybean stover (SBS), shrimp waste meal (SWM) and mixture of SBS+SWM (g/kg) in the rumen of West African Dwarf sheep

	Soybean stover	Shrimp waste meal	Soybean stover + Shrimp waste meal	SEM
a	34.9 ^{ab}	134.7 ^a	33.1 ^{ab}	1.62
b	85.2 ^{ab}	88.6 ^a	28.3 ^c	0.11
p	120.1 ^b	223.3 ^a	61.4 ^c	1.79
c	6.5 ^b	6.0 ^c	8.0 ^d	0.01
Lag time	39.0 ^c	46.7 ^b	65.0 ^a	0.19
ED	101.0 ^c	201.1 ^b	301.0 ^a	1.62

a,b,b,c: Means on the same row with different superscripts are significantly ($P \leq 0.05$) different

where P = DM degraded (g/kg) from the bag after time 't' (hr), a = the intercept of the degradation curve at time zero that is the soluble fraction, b = The portion of the sample which will in time 't' be degraded, c = The rate constant for the degradation of 'b', t = time of degradation

(a + b) = the potential extent (asymptote) of degradation

ED = effective degradability = $a + b/c/(c+k)$

Where k is rumen outflow rate of $2\%h^{-1}$

Table 4: Neutral detergent fibre degradability coefficients of soybean stover (SBS), shrimp waste meal (SWM) and mixture of SBS+SWM (g/kg) in the rumen of West African dwarf sheep

	Soybean stover	Shrimp waste meal	Soybean stover + Shrimp waste meal	SEM
a	785.6 ^a	267.6 ^c	398.6 ^b	0.62
b	37.5 ^b	49.5 ^a	28.1 ^c	0.11
p	823 ^a	317.4 ^c	610 ^b	1.79
C	8.3 ^a	4.85 ^b	9.0 ^a	0.11
Lag time	42.7 ^b	65.0 ^a	21.0 ^c	0.38
ED	815.7 ^a	300.9 ^c	453.1 ^b	1.62

a,b,c: Means on the same row with different superscripts are significantly ($P \leq 0.05$) different

where P = DM degraded (g/kg) from the bag after time 't' (hr), a = the intercept of the degradation curve at time zero that is the soluble fraction, b = The portion of the sample which will in time 't' be degraded, c = The rate constant for the degradation of 'b', t = time of degradation

(a + b) = the potential extent (asymptote) of degradation

ED = effective degradability = $a + b/c/(c+k)$

Where k is rumen outflow rate of $2\%h^{-1}$

Feeding value of shrimp waste meal for WAD sheep

Table 5: Acid detergent fibre degradability coefficients of soybean stover (SBS), shrimp waste meal (SWM) and mixture of SBS+SWM (g/kg) in the rumen of West African Dwarf sheep

	Soybean stover	Shrimp waste meal	Soybean stover + Shrimp waste meal	SEM
a	62.4 ^a	29.9 ^b	12.6 ^c	1.60
b	71.4 ^a	44.2 ^b	27.2 ^c	0.17
P	69.0 ^b	34.4 ^c	39.7 ^b	0.11
C	9.0 ^b	4.0 ^c	11.0 ^a	0.02
Lag time	44.1 ^b	16.3 ^c	87.0 ^a	0.11
ED	68.0 ^a	33.1 ^c	35.4 ^b	1.65

a,b,c: Means on the same row with different superscripts are significantly ($P < 0.05$) different

where P = DM degraded (g/kg) from the bag after time 't' (hr), a = the intercept of the degradation curve at time zero that is the soluble fraction, b = The portion of the sample which will in time 't' be degraded, c = The rate constant for the degradation of 'b', t = time of degradation

$(a + b) =$ the potential extent (asymptote) of degradation

ED = effective degradability = $a + b/(c + k)$

Where k is rumen outflow rate of $2\%h^{-1}$

Table 6: Nutrient intake, performance and apparent digestibility coefficients of West African Dwarf sheep fed graded levels of Shrimp waste meal (SWM) and soybean stover as basal feed

Treatments	0	5	10	15	SEM
Average weight gain (kg)	0.2	0.42	0.48	0.4	0.07
Average daily weight gain (g/d)	9.52 ^d	20.00 ^b	22.85 ^a	19.05 ^c	1.51
DM intake (g/KgW ^{0.75} /day)	66.32 ^b	77.02 ^a	72.10 ^{ab}	73.83 ^a	1.48
OM intake (g/KgW ^{0.75} /day)	60.77 ^b	70.82 ^a	66.32 ^{ab}	67.89 ^a	1.36
CP intake (g/KgW ^{0.75} /day)	6.13 ^b	8.39 ^a	8.40 ^a	8.78 ^a	0.33
ADF intake (g/KgW ^{0.75} /day)	35.98	40.86	37.90	38.66	0.71
NDF intake (g/KgW ^{0.75} /day)	46.62	51.64	47.89	48.15	0.84
Digestibility coefficients					
Dry matter	0.743	0.746	0.738	0.745	0.82
Organic matter	0.763	0.802	0.761	0.784	0.91
Crude protein	0.593 ^b	0.723 ^a	0.764 ^a	0.766 ^a	2.50
Acid detergent fibre	0.780	0.808	0.759	0.739	1.39
Neutral detergent fibre	0.662	0.706	0.686	0.680	5.59

a,b,c,d: Means on the same row with different superscripts are significantly ($P < 0.05$) different

Table 7: Nitrogen utilization by West African Dwarf sheep fed graded levels of Shrimp waste meal (SWM) using soy bean stover as the basal feed

Parameters	Treatments				
	0	5	10	15	SEM
Nitrogen intake (g/d)	7.32 ^b	10.04 ^a	10.7 ^a	10.78 ^a	0.42
N intake (g/d/Wkg ^{0.75})	0.98	1.39	1.34	1.40	0.12
Faecal N output (g/day)	2.35	1.89	1.69	1.77	0.11
Urinary N output (g/day)	0.76 ^b	1.69 ^a	1.62 ^a	1.43 ^a	0.12
Total N output (g/day)	3.11	3.58	3.31	3.20	0.14
Nitrogen retained (g/day)	4.17 ^c	6.45 ^b	7.05 ^{ab}	7.60 ^a	0.01
Nitrogen retention (%)	57.17 ^b	64.26 ^{ab}	68.14 ^a	69.36 ^a	1.84

a., ab, b., c: Means on the same row with different superscripts are significantly ($P < 0.05$) different

(gd⁻¹) (Table 7). The urinary N output decreased as the level of inclusion increased while faecal nitrogen output was highest in the animals fed sole SBS with a range of 1.69 – 2.35 (gd⁻¹). Increase in the level of shrimp waste meal increased the level of N retained, with the sole feed significantly lower than the others. The values of the percent nitrogen retained ranged from 57.17% to 69.36%. It followed the same trend as N retention above.

Discussion

The crude protein content of the shrimp waste meal (SWM) is lower than 395gkg⁻¹ reported by Fanimo *et al.* (2004) and 397g kg⁻¹ by Oduguwa *et al.* (2000). The reason for the low crude protein value could be due to the variation in the proportion of components of the waste, the source or processing methods used or the storage age.

The dry matter composition of the shrimp waste used in this study was expectedly so as it was collected and sun cured before the feeding trial commenced. The composition of shrimp

waste varies with the proportion of shrimp heads to shells and the type of processing. The crude protein content of the shrimp waste used in this study is lower than 33.4% reported by Evers and Carroll (1998). This can be adduced to the reasons stated above. Also storage of the meal may also be a factor for contributing to the differences in CP. The energy and ash values obtained are quite moderate for an animal protein source. The ash content is about twice the content in SBS, probably due to high exo-skeleton content of the meal which is mainly made of minerals. This value is lower than 39.2% (Abazinge *et al.*, 1993) for crab waste meal. NDF and Acid detergent fibre were higher than 22.2 and 17.0% reported by Abazinge *et al.* (1993) for crab waste meal.

The protein requirement for growing sheep as recommended by ODNRI (1988) is between 12 and 13%. The CP content of the experimental diets as determined were adequate for meeting the requirement of the animals since it is still within the recommended range. NDF content was higher than ADF content in all the feedstuffs.

Crude protein disappearance was low in all the feedstuffs used. The low effective degradation (ED) of CP for the feeds may be as a result of some factors. The nylon bag data indicated that approximately 10% of the original crude protein (CP) in the feedstuff samples disappeared in the rumen. This may infer that at 48hr most of the nitrogenous materials were not degradable.

The low CP effective degradation in SWM indicated a very slow adaptation of ruminal microorganism to diets containing chitinous compounds. This is congruent with the reports by Cobos *et al.* (2002). The rate of degradation (c) in this study (0.060h^{-1}) was higher than 0.014h^{-1} reported for chitin (Fadel El-Seed *et al.*, 2002). Though chitin is degradable in the rumen, it may not be an effective resource for ruminant feed. Chitin might have exerted some adverse effect on the fermentation of SWM. The microflora may not be adapted to SWM which is an animal product.

Lower CP content of proximate composition was reported for feed mixtures when compared with their sole feed counterpart. This adversely affected the effective degradability (ED) of crude protein, which was further lowered than the sole feed. It can be explained that the basal feed (soybean stover) negatively affected the CP characteristics by diluting the nitrogen release adversely. The significantly increased lag time indicated that the rumen microbes did not colonise the feed adequately. The generally low CP degradation in the mixtures of the feed-stuffs is in sharp contrast to the findings of Flachowsky and Schnider (1992), who reported that feed combinations of straw/concentrate were enhanced from 42.3 to 66.9% when concentrate

component of straw/ concentrate mixtures increased from 20 to 80%. However, it has a bearing with Akinlade *et al.* (2001) report that mixture of rice stover and *A. cordifolia* had a depressive effect on the soluble fraction of the feeds. The type of protein source seems to influence the CP degradability characteristics, though the values were generally low. Rooney (1997) reported differences in the combining ability for protein degradability in alfalfa, recording relative ratio of additive to non-additive effects ranging from 0.86 for crude protein, 0.70 for soluble protein, 0.74 for insoluble protein, and 0.80 for proportion of undegradable insoluble protein/insoluble protein. Therefore within different combinations there will be negative or positive associative effects. Moreover, it could be that the proportion of bound N in form of ADF-N, NDF-N is high, this could adversely affect the degradability of the components because most Acid detergent insoluble-N (ADF-N) is resistant to microbial and mammalian enzymes (Huhtanen and Hristov, 2001).

The values obtained in the present study for shrimp waste cannot be compared with 0.03/h reported by Evers and Carrol (1998). This may be due to the differences in the process of estimation used. Morphological fraction might have affected fibre degradation in the diets. This is due to the high (a) fraction for NDF and ADF above the other feed-stuffs.

It also compares favourably with the reports of Orden *et al.* (2000) who stated that degradation parameters for NDF were not affected by supplementing rice straw with rice bran in sheep and ADF potential degradability

when two types of protein, soybean meal and fish meal were fed as supplements to *Panicum maximum* grass.

The dried shrimp waste meal used in this study is not very palatable when fed as sole ingredient in the diets. As the inclusion level increased, total dry matter intake decreased at the expense of the shrimp waste meal. Although, slight improvements in feed intake have been reported for cattle fed crayfish-crustacean waste meals (Velez *et al.*, 1991), cattle fed crab-based crustacean waste meal have generally been observed to eat less than those fed soya-bean meal (Brundage *et al.*, 1984; Laflamme, 1988; Velez *et al.*, 1991).

In this study increasing the level of shrimp waste meal in the diets did not influence the total CP intake among the diets. There were no observed differences in the intakes of NDF, ADF. The inclusion of SWM improved the liveweight gain of sheep fed on these diets as opposed to the unsupplemented ones. SWM used in this study had presumably made their relative nutritional contribution in terms of animal protein requirement (Bunting *et al.*, 1994). Therefore, it will be reasonable to assume that the observed reduction in the growth efficiency of sheep fed 15% SWM may be more related to the inefficient usage of feed protein in the form of chitin rather than to reduced organic matter fermentation. This assumption would support the studies of Velez *et al.* (1991) and Cobos *et al.* (2002) using crab waste and shrimp waste respectively.

Apparent digestibility of nutrients was generally high but best in supplemented diets. This observation is consistent with previous studies involving graded levels of shrimp shell

waste fed to sheep (Cobos *et al.*, 2002). The digestibility of the crude protein value obtained were higher than a range of 59.2 – 74.9 obtained by Ayangbile *et al.* (1998), though these workers fed crab waste -straw silage to sheep.

The N retention value was higher in the supplemented diet and reflected the potential of SWM to enhance N utilization. Nitrogen intakes increased linearly with increased levels of shrimp waste meal (Cobos *et al.*, 2002). Faecal, urinary and total N excretion did not follow the trend above. Faecal N output was highest in the sole SBS diet as well as the least N urinary output. Van Soest (1982) stated that when the requirement of N is met, additional dietary N increases urinary N output. There was an observed reduction in N loss in the urine of animals on all the diets. The values of N retention, expressed as percentage of intake were similar in all the supplemented diets and also in agreement with Ayangbile *et al.* (1998). The results of the study reveal that the feeding value of soybean stover can be enhanced with further supplementing with SWM. The potential of SWM however at levels higher than 10% may be detrimental to performance of the animal. With more efforts targeted at further research into processing treatments that could further degrade chitin in SWM, it may be possible to increase its feeding value for sheep.

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