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NUTRIENTS INTAKE AND DIGESTIBILITY OF COMMON AGRO-INDUSTRIAL BY-PRODUCTS BY WEST AFRICAN DWARF SHEEP IN SOUTH-WEST NIGERIA

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Abstract

Nutrient intake and digestibility of common Agro-industrial by-products (Maize bran, MZB; Wheat offal WOF and Rice bran RCB) were evaluated with twelve West African Dwarf (WAD) rams of 18kg average body weight. The animals were randomly allocated to three experimental treatments consisting of sole MZB, WOF and RCB. Animals were housed in individual metabolism crates where the quantities of feed intake, faecal and urinary outputs were monitored. Ten percent (10%) aliquot of the total faeces and urine were collected quantitatively and bulked for each animal. The results showed that dry matter of the experimental treatments ranged from 83.30 – 90.00%, RCB had the highest value (90.00%) followed by WOF (86.00%) and MZB (83.30%). Crude protein values recorded were 11.43, 10.39 and 9.42% in WOF, RCB and MZB respectively. There was a significant difference (P<0.05) of feed and water intake across the treatments. Rams fed WOF diet had highest (P<0.05) feed intake, followed by animals fed RBC and MZB with 450, 200 and 150g/day respectively. Animals placed on RCB were significantly higher (P<0.05) in all the physiological status of the nutrients considered than animals fed MZB. Rams placed on MZB and RCB had highest (P<0.05) digestibility coefficients of CP, ADF and NDF. Nitrogen retention percentage was significantly higher (P<0.05) in rams fed WOF followed by RCB (64.33%) and least MZB (56.48%). Conclusively, MZB, WOF and RCB contain nutrients in proportion required by sheep and thus, can be effectively incorporated into the sheep ration. It was recommended that these feedstuffs should be given to WAD sheep together with other feed ingredients, in particular forages so as to improve their digestibility.

Key words: *Agro-industrial Products, Digestibility, Nutrients, and Sheep*

INTRODUCTION

The rapid increase in human population has resulted in inadequate supply of conventional protein feedstuffs like soybean, groundnut cake and fish meal in the livestock feeds (Musalia *et al*., 2005). In addition, conventional feedstuffs are also competed for by humans and industrial users. This has resulted in the search for alternative protein sources for livestock feeding (Dafwang, 2006). Meanwhile, the interest of nutritionists, farmers and other key players in recent years has been directed towards the search for cheaper locally available alternative feed stuffs which are nutritionally viable and non-toxic. These alternatives were found in agro-industrial by-products and farm residues. Such alternative feed ingredients should be easy to be procured and processed, if need be into useable forms and must have comparable cost advantage over the conventional feed stuffs. The feed stuffs must not be a competitive item for Man's food (Okonkwo and Adikpe, 1988). The agro-industrial by-products have been rendered into valuable protein and energy supplements for partial or complete replacement of expensive conventional feed stuffs in the diet of livestock without having adverse effect on growth and productivity of animals, thereby reducing the cost of production.

Agro industrial by products (AIBPs) are waste products arising from the processing of crop or animal products usually by an agricultural firm (Alhassan *et al.*, 1989). This resultant product is considered as waste since they are of little or no nutritional importance to humans. Agro industrial by products are highly abundant in the tropics and they represent a substantial resource for increasing animal production. The use for these by-products for supplementary livestock feeding is justified when the forage supply is inadequate for animal needs either in terms of quantity or quality (Preston and Leng, 1987; Aina, 2012).

Agro industrial by products in Nigeria that can be used as livestock feed include brewer's dry grain, palm kernel cake, maize offal's, wheat offal's, citrus pulp, citrus molasses, citrus seed meal, root and tuber by products, groundnut cake, cotton seed cake to mention but few. All these AIBPs can be utilized by ruminants during the dry season (Gohl, 1988), when forage has been characterised with low quality of nutrients due to lignification which can result to low digestibility and poor performances of the animals. Agro industrial by-products with economic values may contribute immensely to the growth of livestock industry in Nigeria. Utilization of industrial wastes may help reduced high cost of feeding as well as competition on available conventional feed stuffs.Wheat bran, a by-product of the dry milling of common wheat (*Triticum aestivum* L.) into flour, is one of the major agro-industrial by-products used in animal feeding. It consists of the outer layers (cuticle, pericarp and seed coat) combined with small amounts of starchy endosperm of the wheat kernel. Other wheat processing industries that include a bran removal step may also produce wheat bran as a separate by-product: pasta and semolina production from durum wheat (*Triticum durum* Desf.), starch production and ethanol production.

Wheat offal contains 11.80-17.60% CP, about 10% crude fibre and 3.40-6.40% crude ash (Olomu, 1995). Rice bran is obtained from milling or processing of rice. It is high in fibre and also in oil, the latter constituents may cause problem of rancidity of feed during storage. It has a crude protein content of 12.50% and crude fibre of 12.5%.Meanwhile, the nutrients profile of feedstuffs is not enough as a parameter to adjudge the nutritional value of a particular feedstuff. In lieu of this assertion, this study assessed the nutrient intake and digestibility of common Agro-Industrial By-products (Wheat offal, Rice bran and Maize bran) by West African Dwarf Sheep in South-west Nigeria for sustainable production of small ruminant animal especially sheep in the geopolitical and Nigeria as a whole.

MATERIALS AND METHODS

Experimental site

The study was carried out at the Teaching and Research Farm, Federal University of Agriculture, Abeokuta, Ogun-State, Nigeria situated in the humid zone of South Western Nigeria within latitude (7°5.5'N-7°8'N) and longitude (3°11.2'-3°2.5'E) with the annual rainfall of about 1000-1500mm and mean temperature of 34.7°C. Seasonal distribution of rainfall is approximately 44.96mm in late dry season, 259.3mm in late wet season (July-September), 48.1mm in early dry season (October - December) and the yearly average of about 82% relative humidity (Fasae, 2014).

Preparation of the experimental feeds

Rice and maize bran were obtained from commercial milling centres in the city of Abeokuta the capital of Ogun State, Nigeria, while the wheat offal was obtained from the Flourmills Apapa, Lagos State.

Pre-experimental management of sheep

A total number of twelve West African Dwarf (WAD) rams with average body weight range of 16 - 20kg were randomly selected from the villages such as Obete, Araromi Obe, Ikereku, Alabata, Kila, Odeda and Agura. The animals were dewormed with Levamisole® at the beginning of the experiment. They were divided into three groups of four animals in each group balanced for weight in a completely randomised design (CRD). They were transferred into individual metal metabolic cages which consist of a netted slab (i.e. faecal and urinary board) for easy faecal and urine sample collections. The metabolic cages enabled complete separation and easy collection of urine and faeces. The pens, feeding and drinking troughs were thoroughly cleaned. The floor was thoroughly swept, washed and disinfected before the commencement of the study.

Experimental treatments and data collection

The animals were randomly allocated to three experimental treatments consisting of sole Maize bran (MZB), Wheat offal (WOF) and Rice bran (RCB), respectively. The experimental treatments, water and salt lick were offered *ad libitum* throughout the period of the experiment, the feed and water were served twice daily at 8.00am and 4.00pm, the left-over of feed and water were measured and subtracted from the quantity offered to determine the feed and water intake. The trial lasted twenty one (21) days with fourteen (14) days adaptation and for faecal collection.

The rams were housed in individual metabolism crates where the quantities of feed intake, faecal and urinary outputs were monitored for seven (7) days. Ten percent (10%) aliquot of the total faeces and urine outputs were collected quantitatively and bulked for each animal after fourteen (14) days of adjustment period, stored in freezer for analysis following the standard procedure of Aina, (1996) and Lamidi *et al.* (2010). Nitrogen loss from the urine volatilization was prevented by introducing 10ml of 10% H_2SO_4 into the urine samples (Chen and Gomez, 1992).

Chemical and data analysis

All feed and faecal samples were determined according to A.O.A.C. (1995). The NDF and ADF were determined according to Van Soest *et al*. (1991). Samples were analysed in triplicates and also analysed for nitrogen by the macro-kjeldahl method. Data obtained were subjected to analysis of variance and significant means separated using Duncan (1955) Multiple Range Test.

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of the experimental treatments. Dry matter values of the experimental treatments ranged from 83.30 – 90.00%, RCB had the highest value (90.00%) followed by WOF (86.00%) and MZB (83.30%), respectively. Crude protein values recorded were 11.43, 10.39 and 9.42% in WOF, RCB and MZB, respectively. The highest value of EE was recorded in MZB (15%) while RCB and WOF had similar value of EE (13%). Rice bran had highest value of CF (15.78%) compared to MZB (11.85%) and WOF (10.00%). The ADF value range was 52.00-63.00 in the treatments, MZB recorded the highest content. Neutral detergent fibre in RCB was 72% followed by MZB (70%) and WOF (58%). Meanwhile, the NFE in MZB (61.23%) was highest compared to other treatments. Ash contents were between 2.50 - 9.00%, highest and least values were recorded in RCB (9.00%) and MZB, respectively.

The average feed and water intake of West African Dwarf rams placed on common Agro-industrial by-products in South-west, Nigeria were depicted in Table 2. There was a significant difference ($P<0.05$) across the treatments in feed intake. Rams fed WOF had highest ($P<0.05$) feed intake (450g/day), followed by those fed RBC (200g/day) and MZB (150g/day), respectively. Water intake was significantly ($P<0.05$) higher (1000 ml/day) in rams fed RBC, while water intake in MZB and WOF were similar ($P>0.05$).

The physiological status of nutrients in West African Dwarf sheep fed with common Agro-industrial by-products in South-west, Nigeria indicated in Table 3. There was a significant difference (P<0.05) in the physiological statues of the nutrients across the treatments. Rams fed WOF had highest (P<0.05) value of the nutrients except in the faecal EE and faecal CF. Animals placed on RCB were significantly higher (P<0.05) than animals fed MZB factually in all the physiological status of the nutrients.

Table 4 shows the digestibility coefficient of common Agro-industrial by-products fed to West African Dwarf sheep in South-west, Nigeria. Rams placed on MZB and RCB had highest (P<0.05) digestibility coefficients of CP, ADF and NDF while animals fed WOF had the least values of digestibility coefficients of all the nutrients considered.

Nitrogen balance of WAD sheep fed common AIBPs were indicated in Table 5. There was a significant difference (P<0.05) in the N intake of the animals. Animals fed with WOF had highest N-intake (8.23g/day) followed by rams placed on RCB (3.32g/day/) while rams on MZB had least N-intake (2.26g/day). The faecal N, absorbed N and N retention were significantly (P<0.05) higher in rams fed WOF with 1.29g/day, 6.97g/day and 6.83g/day, respectively compared to other animals. Nitrogen retention percentage was significantly higher (P<0.05) in rams fed WOF followed by RCB (64.33%) and MZB (56.48%).

The DM of RCB (90%) was within the range (92%) reported by Aregheore (2005), CP (9.42 – 11.43%) recorded for the experimental treatments were in line with 9.5 and 10% recommendation of ARC (1980) and NRC (1980), respectively which is adequate in meeting the maintenance requirement of sheep and goats. Gatenby (2002) indicated 10 – 12 % CP as moderate level for ruminant production. The CF of WOF is higher than that recorded by Aina *et al.* (2006), while that of MZB (11.86%) and RCB (15.78) were also a bit higher than the recommended 13% CF in the diet of sheep (ODNRI, 1988). The appreciable content of ash recorded for different treatments, is an indication of inherent mineral contents in the experimental treatments which are essential in the formation and function of blood and bones. (Lamidi and Ogunkunle, 2015).

The higher feed intake recorded in animals placed on WOF might be because WOF is richer in CP (11.43%), lower in CF (10.0%), ADF (52%) and NDF (58%) than others. It also contains relative amount of nutrients required by the animals. Wheat offal is not coarse and it is palatable. Moreover, voluntary intake of feed dry matter has been found to closely relate to CP content of diets as slow fermentation in the recticulo-rumen and the associated slow rate of passage through the digestive tract may control the intake of low protein feeds by sheep (Elliott and Topps, 1963; Fasae, 2014). The MZB had the least CP (9.42%), higher EE (15%) and ADF (63%) and least ash content as well as least feed intake. The high EE level could have coated the feedstuff surface in the digestive system and thus, prevented the digestive enzyme from penetrating into the cell wall of the feedstuff. Maize bran is also highly laxative and the fat content is also high which according to Charry *et al*. (1992) begins to heat up about 24hours after it is produced and can cause storage problem and affects it's utilization. The RCB intake was also low though, higher than MZB, this might be due to the fact that RCB is highly coarse, the odour was not too pleasant possibly due to the oxidation of fat during storage and relatively high DM content. Gateby (1991) stated that daily DM intake of coarse feed varies from 1.5% of body weight for poor quality diet to 3% in high quality diet. It has also been documented that as NDF increases, animals will consume less forage and as ADF increases, forage become less digestible. This factor of NDF may also account for variability in feed intake by experimental animals. It is a well documented fact that DM also influence water intake (Bondi, 1987). This might account for higher water intake with experimental animals fed RCB than animals fed WOF and MZB. The water intake also falls within the recommended range for adult sheep. According to Pagot (1993), 2-3 litres of water is required per kg of dry feed.

The higher CP intake recorded in animals fed WOF was in line with the report of Lamidi (2009) who observed higher feed intake in animals fed with highest CP. An increase in the quantity of feed eaten by an animal generally causes a faster rate of passage of digesta. Thus, feed is exposed to the actions of digestive enzymes for a shorter period of time and there may be a reduction in digestibility (McDonald *et al*., 1995; Peacock, 1996). Meanwhile, this may account for the low digestibility of WOF compared to RCB and MZB with relatively higher digestibility. FAO (1995) ranked digestibility as high (>60%), medium (40-60%) and low (<40%). By this ranking, the digestibility of CP was medium, EE was high, CF was medium, ADF was high and NDF was also medium with MZB, the digestibility of CP was low, EE was medium, CF was low, ADF was medium and NDF was low with WOF and the digestibility of CP was medium, EE was high, CF was low, ADF was high and NDF was low in animals fed RCB. Averagely, the digestibility of MZB was medium (55.6%), WOF was low (30.61%), and RCB was medium (51.09%).

CONCLUSION AND RECOMMENDATIONS

This study has shown the significance of the AIBP in the nutrition of sheep. Agro industrial by products in particular MZB, WOF and RCB contain nutrients in proportions required by sheep and thus, can be effectively utilized for sheep production. These feed stuffs are relatively cheap compared to other feed resources and readily available, with proper handling, their utilization could be improved in sheep production.

Based on this study, the followings have been recommended:

i. These AIBPs should be given to WAD sheep with other feed ingredients in order to improve their utilization, digestibility and intake.
ii. The physical condition of rice bran should be improved before incorporating into the diet of sheep. This is because it is coarse and thus, the acceptability is reduced.
iii. Salt can be added to these ingredients before feeding to improve their palatability which will consequently increase feed intake and results in weight gain.

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Table 1: Chemical composition (%) of maize bran, wheat offal and rice bran fed to West African Dwarf sheep

Nutrients	Experimental feedstuffs		
	Maize bran	Wheat offal	Rice bran
Dry matter	83.30	86.00	90.00
Crude protein	9.42	11.43	10.39
Ether extract	15.00	13.00	13.00
Crude fibre	11.85	10.00	15.78
Acid detergent fibre	63.00	52.00	61.00
Neutral detergent fibre	70.00	58.00	72.00
Nitrogen free extract	61.23	60.57	51.83
Ash	2.50	5.00	9.00

Table 2: Average feed intake and water consumption of West African Dwarf sheep placed on common Agro-industrial by-products in South-west, Nigeria.

	Experimental treatments			
Parameters	MZB	WOF	RCB	SEM
Feed intake (g)/day	150^{c}	450^{a}	200^{b}	5.64
Water intake (ml)/day	700^{b}	700^{b}	1000^{a}	2.68

a, b, Means with different superscript on the same row are significantly different (P < 0.05)
MZB- Maize bran; WOF- Wheat offal; RCB- Rice bran; SEM- Standard error of mean

Table 3: Physiological status of nutrients in West African Dwarf sheep placed on common Agro-industrial by-products in South-west, Nigeria

	Experimental treatments			
Parameters	MZB	WOF	RCB	SEM
Crude protein intake (g)/day	14.13^{c}	51.45^{a}	20.78^{b}	2.13
Faecal crude protein(g)/day	5.08^{b}	7.90^{a}	5.98^{b}	0.20
Absorbed crude protein (g)/day	9.05^{c}	43.55^{a}	14.80^{b}	0.61
Ether extract intake (g)/day	22.5^{c}	67.5^{a}	26.0^{b}	1.21
Faecal ether extract (g)/day	10.16^{a}	7.00^{b}	4.00^{c}	0.65
Absorbed ether extract (g)/day	12.34^{c}	60.50^{a}	22.00^{b}	1.61
Crude fibre intake (g)/day	17.77^{c}	45.00^{a}	31.56^{ab}	1.23
Faecal crude fibre (g)/day	6.45^{b}	8.58^{ab}	10.85^{a}	0.40
Absorbed crude fibre (g)day	11.32^{c}	36.42^{a}	20.71^{ab}	1.21
Acid detergent fibre intake (g)/day	63.00^{c}	234^{a}	122^{b}	2.48
Faecal acid detergent fibre (g)/day	21.00^{b}	27.00^{a}	16.00^{b}	1.34
Absorbed acid detergent fibre (g)day	42^{c}	207^{a}	106^{b}	1.65
Neutral detergent fibre intake (g)/day	105^{c}	261^{a}	144^{b}	2.36
Faecal neutral detergent fibre (g)/day	42.00^{b}	50.00^{a}	44.00^{ab}	1.48
Absorbed neutral detergent fibre (g)day	63.00^{c}	211^{a}	100^{b}	2.38

a, b, c Means with different superscript on the same row are significantly different (P < 0.05)
MZB- Maize bran; WOF- Wheat offal; RCB- Rice bran; SEM- Standard error of mean

Table 4: Percentage digestibility of common Agro-industrial by-products fed to West African Dwarf sheep in South-west, Nigeria

	Experimental treatments			
Parameters	MZB	WOF	RCB	SEM
Crude protein	46.07^{a}	30.88^{c}	42.44^{ab}	3.75
Ether extract	80.00^{a}	46.15^{c}	69.23^{b}	2.89
Crude fibre	45.56^{a}	14.20^{c}	31.24^{b}	2.07
Acid detergent fibre	66.66^{ab}	48.07^{c}	73.70^{a}	1.53
Neutral detergent fibre	40.00^{a}	13.79^{c}	38.88^{ab}	2.63
Total average	55.66^{a}	30.62^{b}	51.09^{a}	3.04

a, b, c Means with different superscript on the same row are significantly different ($P < 0.05$)
MZB- Maize bran; WOF- Wheat offal; RCB- Rice bran; SEM- Standard error of mean

Table 5: Nitrogen balance of West African Dwarf sheep fed common Agro-industrial by-products in South-west, Nigeria

	Experimental treatments			
Parameters	MZB	WOF	RCB	SEM
N intake (g)/day	2.26^{c}	8.23^{a}	3.32^{b}	1.71
Faecal N (g)/day	0.81^{b}	1.26^{a}	0.96^{ab}	0.06
Absorbed N (g)/day	1.45^{c}	6.97^{a}	2.37^{b}	1.01
Urinary N (g)/day	0.17^{b}	0.14^{c}	0.23^{a}	0.01
N retention (g)/day	1.28^{c}	6.83^{a}	2.14^{b}	1.41
N retention percentage (%)	56.48^{c}	82.97^{a}	64.33^{b}	3.46

a, b, c Means with different superscript on the same row are significantly different ($P < 0.05$)
MZB- Maize bran; WOF- Wheat offal; RCB- Rice bran; SEM- Standard error of mean