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Nutrient utilization and nitrogen metabolism by West African dwarf goat-bucks fed molasses-treated biodegraded rice husk

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***Target audience:** Ruminant Farmers*

Abstract

The quest for meeting animal protein demand in the tropics with the use of unconventional feed resources without compromising the quality led to this study. Thus, the study was conducted to assess the nutritional potentials of biodegraded rice husk treated with or without molasses. Rice husks were incorporated with molasses at 0% (Diet 1 – control diet), 1% (Diet 2), 2% (Diet 3), 3% (Diet 4) and 4% (Diet 5) respectively and were mixed thoroughly with 1% salt and 3% yeast thereafter fermented anaerobically for 5days. Consequently, the diets were fed to twenty-five (25) WAD goat-bucks of five (5) replicates per treatment in a Completely Randomized Design experiment for 84 days. Parameters assessed included; nutrients and anti-nutrients composition, feed intake, weight gain, nitrogen utilization, digestibility and feed conversion ratio. Results showed that, inclusion level of molasses significantly ($P<0.05$) influenced the dietary treatments. Dry matter (DM) contents ranged from 90.58% (Diet 5) to 92.91% (Diet 1). Crude protein (CP) content of the diets and feed intake increased progressively with increased inclusion of molasses in the diets as Diet 5 had the highest CP content (11.29%) and bucks fed, had the highest CP intake (57.69 g/day). However, crude fibre (CF) declined as CP increases; the least CF (26.51% CF) was recorded for Diet 5. DM intake varied from 452.47 g/day (Diet 1) to 466.86 g/day (Diet 5). Fibre fractions and the anti-nutrients considered in this study were tolerable by goats and Diet 5 was better utilized. Nitrogen intake (9.97 g/day) and highest nitrogen retained (9.29 g/day) were highest in bucks' fed Diet 5. Hence, the better average daily weight gain (68.00 g/day) and as well as the least feed/gain ratio (6.86). In conclusion, rice husk treated with molasses at 4% inclusion level fermented with 3% yeast improved the palatability, nutrient intake and weight gain of WAD goat-bucks and are therefore recommended.

***Keywords:** Molasses, Fermentation, Yeast, Nutrient intake, Agro-industrial waste, Ruminant farmers.*

Description of Problem

Goats are cloven-footed animals which are called small ruminants, and belong to the genus, Capra. They were domesticated over 8000 years ago, in Africa (along river Nile), Asia (along Tigris and Euphrate rivers), and India (Idus). This attribute may partly be due to their lower feed requirements compared to cattle, because of their body size. This, however, allows for easy integration of small ruminants into different farming systems (1, 2, 3). In South West Nigeria, goats are used for customary rites in addition to meat production and religious purpose and the males (goat-bucks) are mainly raised for meat and breeding purpose (4). The animals are highly priced in the area as they provide household meat for consumers and skin for the local leather industry. Goats have been reported to contribute 16.0% of total domestically produced meat in Nigeria (3).

Effective reduction in the cost of livestock production must be considered and this can be achieved by improving the nutritive values of unconventional feed ingredient such that the toxic substances present are reduced to safe level and the inclusion level could be increased in ration formulation. Rice is a primary source of food for billions of people all over the world (5) and during milling of paddy, about 78% of weight is received as rice, broken rice and bran, while the rest 22% of the paddy is received as rice husk (6, 7). The husk has been nutritionally reported to contain 92.5 - 96.4% of dry matter (DM), 2.1 - 3.6% crude protein (CP), 1 - 12% ether extract (EE), 39 – 48.55% crude fibre (CF), 15-18% silica and 15 - 22% ash (8, 7). Traditionally, the husk has been used with other feed ingredients to feed cattle and buffaloes in the past. Due to high fibre content, high silica/ash content and abrasive characteristics of rice husk, it is not easily digested by monogastric animals but can be degraded by microorganisms in the rumen of ruminants though will require to stay a longer time in the rumen to be degraded because of its poor quality (high lignin content). So, in a bid to increase the utilization of rice husk in livestock nutrition, various methods have been researched into and they include grinding, soaking in water, irradiation, acid and alkaline hydrolysis, use of enzymes and antibiotics (8, 9, 7).

Molasses is the major by-product of sugar production, coming mainly from sugar cane but also from sugar beets. Most molasses in commercial use is adjusted to contain 25% water. While molasses is a good source of trace minerals, the protein and vitamin level is quite low. It is used often to stimulate eating, to reduce dustiness in feeds, as a pellet binder, and when fortified with a nitrogen source, as a ruminant feed known as a liquid protein supplement (10). It nutritionally contains 83.5% DM, nitrogen 0.44%, ash 9.8%, total sugar 58.3%, sucrose 40.2%, glucose 8.9%, fructose 9.2%, nitrogen free extract 87.4%, non-identified organic matter 29.1% and metabolizable energy 13.5% all these in % of the DM (11). Ensiling feed materials with molasses have proven to be efficiently used for strategic off-season feeding, feed resources availability and a form of insurance (12). Ensiling maize or grass with molasses at 4 - 6% improved palatability, reduced significantly toxic substances present in plant by-products to safe level concentrations, increased utilization / digestibility of crude protein of ensiled material by breaking linkages between protein and fibre thereby increasing digestibility (13, 14). The rice husk could be harnessed to improve and sustain goat production, control environmental pollution arising from its production in Nigeria such that “waste” could be converted to “wealth”. Hence, this study established the potentials of rice husk as ruminant feed, seeks to evaluate the response of West Africa Dwarf goat-bucks to biodegraded rice husk ensiled with or without molasses.

Materials and Methods

Experimental site

The research was carried out at the Small Ruminant Unit of the Teaching and Research Farm of the Federal University of Technology, Akure (Latitude 7^0 18’ and Longitude 5^0 10’E) (15) while the chemical analyses were carried out at the Nutrition Laboratory of the Department of Animal Production and Health of the same University after the approval of the Departmental Research Ethics Committee.

Collection and processing of feed materials

Rice husk was collected from rice milling industry in Ogbese, Ondo State, Nigeria and molasses, salt and yeast were sourced from a reputable feedmill industry in Ibadan, Oyo State, Nigeria.

Acquisition and adaptation of WAD bucks

A total number of twenty five West African Dwarf goat-bucks with 2 years age range, with an average live-weight of 12.99 ± 0.08kg were purchased from an open market in Itaogbolu, Akure North Local Government Area, Ondo State. The goats were quarantined and acclimatized for a period of twenty-one (21) days during which routine managements like feeding of concentrate and grasses were done. The animals were stabilized and vaccinated against *Pestes des Petit Ruminants* (PPR/Kata) using PPR vaccine at the rate of 1ml per animal to confer immunity to the goats, treated against ecto- and endo- parasites using ivermectin and were also treated against infections using oxytetracycline LA® at the rate of 1 ml per 10 kg of body weight of the animal before data collection.

Feeding trial

Diet formulation

Five experimental diets were formulated such that molasses were incorporated in the rice husk based-diets at 0, 1, 2, 3 and 4% (*v/w*) respectively and were fermented for five (5) days under anaerobic condition to nutritionally upgrade the diets (Table 1).

Table 1: Gross composition of experimental diets fed to WAD bucks

Ingredients (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Rice Husk	96.00	95.00	94.00	93.00	92.00
Molasses	0.00	1.00	2.00	3.00	4.00
Salt	1.00	1.00	1.00	1.00	1.00
Yeast	3.00	3.00	3.00	3.00	3.00
Total	100.00	100.00	100.00	100.00	100.00

Diet 1 – 0% molasses, Diet 2 – 1% molasses, Diet 3 – 2% molasses, Diet 4 – 3% molasses, Diet 5 – 4% molasses.

Table 2: Nutrient composition of the experimental diets fed to WAD bucks

Nutrients (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	±SEM
Dry matter	92.91^{a}	92.62^{a}	92.08^{a}	91.18^{b}	90.58^{c}	3.03
Crude Protein	6.88^{e}	7.47^{d}	8.49^{c}	9.99^{b}	11.29^{a}	0.02
Crude Fibre	30.99^{a}	29.52^{b}	28.71^{c}	27.88^{c}	26.51^{d}	0.04
Ether Extract	4.14^{e}	4.89^{d}	5.30^{c}	5.37^{b}	5.65^{a}	0.03
Ash	19.84^{a}	19.54^{a}	17.25^{b}	14.33^{c}	11.29^{d}	0.03
Nitrogen free extract	31.06^{c}	31.20^{c}	32.33^{bc}	33.61^{b}	35.84^{a}	0.85
Neutral detergent fibre	56.44^{a}	56.04^{a}	54.13^{b}	50.45^{c}	45.45^{d}	1.01
Acid detergent fibre	39.04^{a}	38.73^{a}	36.72^{b}	35.91^{c}	33.48^{d}	0.03
Acid detergent lignin	13.09^{a}	10.11^{b}	9.18^{c}	8.36^{d}	6.29^{e}	0.02
Hemicellulose	17.40^{a}	17.31^{a}	15.41^{b}	14.54^{c}	11.97^{d}	0.08
Cellulose	25.95^{c}	28.62^{a}	27.54^{b}	27.54^{b}	27.19^{bc}	1.03
Gross energy (KJ/100gDM)	13.12^{c}	13.21^{bc}	13.62^{b}	13.96^{b}	14.43^{a}	1.08

^{abcde}*Mean values within rows with different superscripts are significantly different ($p<0.05$)*

Experimental animal management

The bucks were allotted to the five (5) diets with five (5) replicate per treatment. The animals were housed individually in pen measuring 1.8 x 0.5m. After introduction of the test diets, an acclimatization period of 7 days was allowed before data collection. The animals were fed 3.5 – 5% of their body weight in the morning (8:00am) and supplied potable water *(ad libitum)* during the experimental period of eighty-four (84) days. The daily feed intake was determined by subtracting the leftover from the quantity supplied.

Criteria of response by goats

Growth performance

The animals were weighed before the beginning of the experiment and were repeatedly weighed weekly in the morning before feeding to monitor any weight change using spring balance (hanging scale).

Faecal and urine collection

Total faeces voided by each buck were collected in the morning before feeding and watering during last 7 days of the experiment. The faeces was weighed fresh and 10% of the total faeces collected from each animal was taken and oven dried at 105^0C for 48 hours to determine the moisture content of the faeces. The faecal sample was thoroughly mixed and milled to pass through a 2mm sieve and sealed up in polythene bags. These were all stored at room temperature until required for analysis.

Urine was collected in a bucket placed under the cages, into which 25% of concentrated H_2SO_4 was added to immobilize ammonia from being volatized from the urine. The volume of urine expelled by each animal per day was recorded. Ten per cent (10%) of the total urine excreted by each animal was collected and subjected to chemical analysis.

Digestibility trial

Apparent digestibility of the diets was calculated as difference between nutrient intake and excretion in the faeces expressed as percentage of nutrient intake while nitrogen retained by the animals was calculated as difference between nitrogen intake and nitrogen excreted as follows:

$$N_{retained} = N_{intake} – (Faecal\ N + Urinary\ N)$$

The gross energy of the diets was determined by the methods of 16 as follows:G.E. (KJ/100GDM) = %CP × 16.7 + %lipids × 37.7 + %CHO × 16.7

CHO = Carbohydrate; G.E. = Gross Energy

Proximate analysis of feed, faeces and urine

Air-dried sample of feed sample and feaces from all the experimental bucks were analysed for dry matter, crude protein, crude fibre, ash, ether extract, fibre fractions and anti-nutrients while urine were analysed for nitrogen according to standard procedures of 17.

Experimental design and statistical analysis

The design of the experiment is Completely Randomized Design and all data collected were subjected to one –way analysis of variance (ANOVA) and significant differences means were separated using Duncan Multiple range Test using 18.

Table 3: Anti-nutrient composition (%) of experimental diets fed to WAD bucks

Anti-nutrients (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	±SEM
Alkaloid	5.54[a]	5.11[b]	4.56[c]	4.07[d]	3.69[e]	0.04
Oxalate	0.63[a]	0.54[b]	0.45[c]	0.45[c]	0.36[d]	0.02
Phenol	16.75[d]	16.94[d]	17.54[c]	19.67[b]	23.66[a]	1.12
Phytate	21.42[a]	20.67[b]	18.84[c]	17.30[d]	16.48[e]	1.07
Saponin	5.72[a]	5.02[a]	4.72[b]	4.42[b]	3.15[c]	0.05
Tannin	0.08[a]	0.07[b]	0.06[c]	0.06[c]	0.05[d]	0.01

[abcde]*Mean values within rows with different superscripts are significantly different (p<0.05)*

Table 4: Nutrient intake (g/day) by WAD bucks fed experimental diets

Nutrients	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	±SEM
Dry matter	452.47[d]	455.69[c]	463.06[b]	463.19[b]	466.86[a]	0.04
Crude protein	32.53[d]	36.75[d]	42.71[c]	50.75[b]	57.69[a]	0.02
Crude fibre	149.91[a]	145.28[b]	141.40[c]	140.62[d]	134.46[e]	0.01
Ether extract	19.13[e]	23.02[d]	25.62[c]	26.27[b]	28.87[a]	0.03
Ash	96.60[a]	96.11[a]	86.74[bc]	72.77[c]	57.67[d]	0.02
Nitrogen free extract	150.21[c]	152.48[c]	161.57[b]	169.68[b]	182.09[a]	0.05
Neutral detergent fibre	272.67[a]	265.44[b]	250.72[c]	229.21[d]	183.85[e]	0.04
Acid detergent fibre	190.06[a]	186.60[b]	184.88[c]	153.46[d]	143.52[e]	0.01
Acid detergent lignin	62.72[a]	48.72[b]	45.16[c]	41.45[d]	31.13[e]	0.02
Hemicellulose	99.79[a]	98.26[b]	86.28[c]	85.69[d]	79.89[e]	0.03
Cellulose	142.33[b]	144.41[a]	124.87[c]	113.38[d]	109.30[e]	0.03
Gross energy (KJ/100gDM)	63.89[c]	65.00[c]	68.51[bc]	70.91[b]	84.10[a]	0.04

[abcde]*Mean values within rows with different superscripts are significantly different (p<0.05)*

Results

Nutrient composition

The result of proximate composition of the experimental diets fed to West African Dwarf bucks is shown on Table 2. All the parameters observed were significantly (*P<0.05*) influenced by the dietary treatment. Diet 1 had the highest dry matter content of 92.91%, though statistically (*P>0.05*) similar to Diets 2 and 3. The crude protein (CP) content of the diets increased with increasing inclusion levels of molasses in the diets. 11.29% CP was the highest value recorded for Diet 5 which varied significantly from other diets. Crude fibre of the diets decreased with increased level of molasses and ranged from 26.51% (Diet 5) to 30.99% (Diet 1). The ether extract content was highest in Diet 5 (5.65%) while the ash content of the diets ranged from 11.29% (Diet 5) to 19.84% (Diet 1). The nitrogen free extract (NFE) value was highest in Diet 5 (35.84%) which was significantly (*P<0.05*) different from other diets. Neutral detergent fibre recorded varied from 45.45% (Diet 5) to 56.44% (Diet 1), meanwhile values gotten for Diet 1 and 2 were statistically (*P>0.05*) similar. The acid detergent fibre contents ranged from 33.48% (Diet 5) to 39.04% (Diet 1). The acid detergent lignin was least in diet 5 (6.29%).The hemi-cellulose content of the diets was highest in Diet 1 (17.40%) although statistically (*P>0.05*) similar to diet 2 (17.31%). The least value (25.95%) was observed in Diet 1 while the highest value (28.62%) was recorded for Diet 2. The gross energy ranged from 13.12 KJ/100gDM (Diet 1) to 14.43 KJ/100gDM (Diet 5).

Anti-nutrient content of the experimental diets

The result of the anti-nutrients content of the experimental diets fed to West African Dwarf bucks is presented in Table 3. The anti-nutrients determined were alkaloid, oxalate, phenol, phytate, saponin and tannin. The results from the table showed all the anti-nutrients determined were statistically (*P<0.05*) influenced by the inclusion levels of molasses. Alkaloid was observed to decrease with increasing levels of molasses. The highest value (5.54%) was recorded for Diet 1 and the least in Diet 5. The oxalate content of the experimental diet was lowest in diet 5 (0.36%). The phenol content of diets was highest in Diet 5 (23.66%), this was significantly (*p<0.05*) different from Diets 1 - 4 (16.75, 16.94, 17.54, 19.67 and 23.66%) respectively. Though, values observed for Diets 1 and 2 were statistically (*p>0.05*) similar. The phytate level of the experimental diets reduced across the treatments, diet 1 had the highest value (21.42%) while diet 5 had the lowest value (16.48%). The saponin content also decreases across the treatments, the highest value was recorded for Diet 1 (5.72%) while the lowest value was found in Diet 5 (3.15%). The tannin content of experimental diets reduced as the molasses content increased. Diet 5 had the lowest value of 0.05% and Diet 1 that had the highest value (0.08%).

Nutrient intake (g/day) of WAD bucks

Table 4 shows the nutrient intake by the West African Dwarf (WAD) bucks fed experimental diets. The nutrient intakes were significantly influenced by the dietary treatment and progressively increased with increased molasses in the diets except crude fibre (CF). The dry matter intake (DMI) of the WAD bucks ranged from 452.47g/day-466.86g/day (Diet 5). Bucks fed Diets 3 and 4 were statistically (*p>0.05*) similar. The crude protein intake (CPI) ranged from 32.53g/day (Diet 1) to 57.69g/day (Diet 5). The crude fibre intake was highest in Diet 1(149.91g/day) and least in Diet 5 (134.46g/day). The bucks fed Diet 5 had the ether extract intake value (28.87g/day) which was significantly higher (*P<0.05*) than bucks fed other diets. The nitrogen free extract (NFE) intake increased across the treatments, the NFE intake was highest in Diet 5 (182.09g/day) and least in Diet 1 (150.21g/day). The neutral detergent fibre (NDF) was highest in Diet 1 (272.67g/day) which was significantly (*P>0.05*) different from the NDF intake of other bucks fed the experimental diets. The acid detergent fibre (ADF) was least in bucks fed diet 5 (143.52g/day) but significantly (*P>0.05*) different from bucks fed diets 1, 2, 3 and 4 (190.06, 186.60, 184.88, 153.46g/day) respectively. The acid detergent lignin (ADL) decreased with increased levels of molasses across the treatments. The bucks fed diet 5 had the lowest value (31.13g/day) while the highest value was 62.72g/day. The hemi-cellulose intake of the WAD bucks fed the experimental diets was highest in bucks fed Diet 1 (99.79g/day) and least (79.89g/day) among bucks fed Diet 5. The cellulose intake of bucks fed Diet 2 (144.41g/day) was the highest value recorded and least in Diet 5 (109.30g/day). The gross energy intake of bucks fed experimental diets increased as the molasses inclusion increased. The highest intake was observed among bucks fed diet 5 (84.10g/day) but least value (63.89g/day) was observed in bucks fed Diet 1.

Anti-nutrient Intake of WAD bucks

The anti-nutrient intake of WAD buck fed the experimental diets is presented in Table 5. The alkaloid intake by the experimental animals was significantly (*P<0.05*) influenced by the dietary treatment. The lowest intake of alkaloid was observed in bucks fed diet 5 (18.76%) and highest in those fed Diet 1. Oxalate intake decreased with increased inclusion level of molasses and the highest intake (3.07g/day) was reported for bucks fed Diet 1. Bucks fed diet 5 had the highest intake of phenol (120.40g/day). The intake of phytate, saponin and tannin decreased as the molasses level increased though there was significant variation (*P<0.05*) in the values obtained. Meanwhile, bucks fed Diet 5 had the least values (84.21, 16.07 and 0.26g/day) recorded accordingly.

Table 5: Anti-nutrient intake (g/day) of WAD goats fed the experimental diets

Anti-nutrients	Diet 1	Diet 2	Diet3	Diet 4	Diet 5	±SEM
Alkaloid	26.87[a]	25.04[b]	22.83[c]	20.57[d]	18.76[e]	0.10
Oxalate	3.07[a]	2.66[b]	2.26[c]	2.28[d]	1.83[e]	1.04
Phenol	81.57[e]	83.00[d]	87.22[c]	100.03[b]	120.40[a]	0.50
Phytate	104.30[a]	101.69[b]	94.76[c]	87.88[d]	84.21[e]	4.01
Saponin	27.81[a]	24.69[b]	23.72[c]	22.48[d]	16.07[e]	0.02
Tannin	0.40[a]	0.33[b]	0.30[c]	0.30[c]	0.26[d]	0.01

[abcde]*Mean values within rows with different superscripts are significantly different (p<0.05)*

Table 6: Nutrient Digestibility (%) of WAD goats fed experimental diets

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	±SEM
Dry matter	76.02[e]	79.42[d]	81.08[c]	84.43[b]	88.01[a]	1.73
Crude protein	78.15[e]	81.07[d]	84.72[c]	87.81[b]	91.42[a]	3.81
Crude fibre	73.02[e]	75.44[d]	78.12[c]	80.02[b]	83.06[a]	5.10
Ether extract	68.17[e]	71.15[d]	74.81[c]	77.88[b]	81.13[a]	0.02
Nitrogen free extract	74.04[e]	77.12[d]	79.14[c]	82.08[b]	84.92[a]	0.04
Neutral detergent fibre	76.13[e]	79.07[d]	82.14[c]	85.01[b]	87.94[a]	0.87
Acid detergent fibre	70.29[e]	72.03[d]	74.51[c]	77.02[b]	79.11[a]	0.01
Acid detergent lignin	69.98[e]	72.92[d]	75.71[c]	78.07[b]	81.39[a]	0.44
Hemicellulose	82.14[e]	83.19[d]	85.02[c]	86.03[b]	88.01[a]	3.65
Cellulose	71.08[e]	74.26[d]	77.11[c]	80.21[b]	83.44[a]	1.66
Gross energy	83.41[e]	84.23[d]	84.89[c]	85.79[b]	86.47[a]	0.57

[abcde]*Mean values within rows with different superscripts letters are significantly different (p<0.05)*

Nutrients digestibility of WAD bucks

Table 6 shows the apparent digestibility co-efficient values of WAD bucks fed the test diets. Results showed that diet 5 had the highest digestibility values for all the nutrients. The dry matter digestibility (DMD) values increased as the molasses inclusion increased. The highest DMD value was observed in bucks fed Diets 5 (88.01%). The crude protein digestibility of WAD bucks fed Diet 5 had the highest value (91.42%) and least value was observed in those fed Diet 1 (78.15%). The crude fibre digestibility of WAD bucks was highest in bucks fed Diet 5 (83.06%) and least among those fed Diet 1 (73.02%). The ether extract digestibility was lowest in bucks fed Diet 1 (68.17%) and highest among those fed diet 5 (81.13%). The NFE digestibility values ranged from 74.04% (Diet 1) to 84.92% (Diet 5). The digestibility value of neutral detergent fibre, acid detergent fibre and acid detergent lignin was significantly (*p<0.05*) influenced across the treatments. The digestibility value for hemi-cellulose and cellulose were highest in bucks fed diet 5 and were lowest among those fed Diet 1. The gross energy digestibility varied from 83.41% (Diet 1) to 86.47% (Diet 5).

Nitrogen utilization (g/day) by WAD bucks

From Table 7, the intake of nitrogen and its retention were significantly ($p<0.05$) influenced by the molasses inclusion level in the test diets. Bucks fed Diet 5 had the highest nitrogen intake (9.97g/day) while the lowest nitrogen intake was observed among those fed Diet 1. Nitrogen in the faeces was highest among bucks fed Diet 5, this was significantly ($p<0.05$) different from animals fed Diets 1 - 4. Bucks fed experimental Diet 1 had the least urinary nitrogen output while the highest urinary nitrogen output was observed among those fed Diet 5. The highest nitrogen retention value was recorded among bucks fed Diet 5 and those fed Diet 1 had the lowest nitrogen retained.

Table 7: Nitrogen utilization (g/day) by WAD bucks fed experimental diets

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	±SEM
Dry matter	452.47^{d}	455.69^{cd}	463.06^{c}	463.19^{b}	466.86^{a}	2.12
Crude protein	32.53^{d}	36.75^{d}	42.71^{c}	50.75^{b}	57.69^{a}	1.02
Nitrogen intake	5.61^{e}	6.20^{d}	7.16^{c}	8.64^{b}	9.97^{a}	0.04
Faecal nitrogen	0.17^{d}	0.22^{cd}	0.27^{c}	0.35^{b}	0.51^{a}	0.03
Urinary nitrogen	0.06^{c}	0.07^{c}	0.09^{c}	0.13^{b}	0.17^{a}	0.01
Nitrogen retained	5.37^{e}	5.91^{d}	6.80^{c}	8.16^{b}	9.29^{a}	0.11

^{abcde}*Mean values within rows with different superscripts letters are significantly different ($p<0.05$)*

Table 8: Performance characteristics of WAD bucks fed experimental diets

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	±SEM
Dry matter intake (g/day)	452.47^{d}	455.69^{cd}	463.06^{c}	463.19^{b}	466.86^{a}	2.12
Initial weight (kg)	12.99	13.00	13.00	12.98	12.98	0.08
Final weight (kg)	15.70^{d}	15.83^{d}	16.28^{c}	16.82^{b}	17.74^{a}	1.04
Weight (kg)	2.71^{d}	2.83^{d}	3.28^{c}	3.84^{b}	4.76^{a}	0.02
Weight gain(g/day)	38.69^{e}	40.43^{d}	46.86^{c}	54.86^{b}	68.00^{a}	0.07
Feed/ gain ratio	11.69^{d}	11.27^{d}	9.88^{c}	8.44^{b}	6.86^{a}	0.09

^{abcde}*Mean values within rows with different superscripts letters are significantly different ($p<0.05$)*

Performance characteristics of WAD bucks

Table 8 presents the growth performance of the WAD bucks fed the experimental diets. There was no significant ($p>0.05$) difference in the initial weights of the WAD bucks but significant ($p<0.05$) variations were observed in the final weights of all the animals fed the experimental diets. The daily weight gain was observed to increase as the molasses inclusions in the diets increased. Therefore, the bucks fed Diet 5 (4% inclusion of molasses) had the best daily weight gain. The feed gain ratio had significant ($p<0.05$) variations as the figures ranged from 6.86 - 11.69, animals fed diet 5 had the lowest figure (6.86) while those fed Diet 1 had the highest value (11.69).

Discussion

Nutrient composition

The different nutrient contents are judged to be the result of mixing ratio of molasses coupled with the silage effect. The dry matter contents of the diets were improved due to the effect of yeast as feed additive to optimize anaerobic fermentation by maintaining the fermentation environment. Molasses could serve as a substrate to hasten fermentation by easily converting the carbohydrate content into lactic acid and this corroborates the findings of (14, 19) that fermentation could improve dry matter content of a feed.

The nutrients were enhanced as the crude protein levels increased with inclusion levels of molasses and yeast which aid in effective fermentation of the diets and this agreed with the reports of (7, 20) that nutrient contents of rice husk were improved by fermentation. The crude protein content from diets 3, 4 and 5 were above the minimum CP requirement (8% CP) for maintenance as recommended by (21). It was observed that the crude fibre decreases as the crude protein increases and the reduction in the level of crude fibre in this study also agreed with the findings of (7) when rice husk was treated with microbiological inoculants. (22) also reported a gradual decrease in crude fibre level as the crude protein level increases.

The reduction in the ash content of the rice husk was due to fermentation which helped in the breaking down of the silica content of the rice husk because ash content of rice husk contains 85-90% amorphous silica which makes it so abrasive. Molasses also contributed to the easy fermentation of the rice husk due to high dry matter content of the molasses. Reduction in ether extract value can be attributed to conversion of ether extract to energy.

A reduction in fibre fractions i.e. Acid detergent lignin (ADL), neutral detergent fibre (NDF) and acid detergent fibre (ADF) was noticed after fermentation and the contributory effect of yeast in the diets. Report has it that yeast contains high level of protein (23), (24) reported that ensiling rice husk with molasses at 5% caused a reduction in the fibre content and hence, improved the dietary protein.

Anti-nutrient composition

The concentration of the anti-nutrients was low except phytate; the reduction in the anti-nutrients might be as a result of the processing method (fermentation) adopted. 25 reported that different processing methods such as sun drying, fermentation, boiling and autoclaving are able to reduce anti-nutritional factors. This was found true as the anti-nutritional factor of the rice husk reduced as a result of fermentation with molasses. Research has revealed that addition of molasses as additives improves fermentation and the nutritive value of non-conventional feedstuffs (26); this was confirmed by the reduction in the anti-nutrients as the molasses inclusion increases.

Nutrient intake by WAD buks

Molasses was added to increase energy density, increases feed intake. 27 reported that feeding ground rice hulls improved the feed intake and digestibility of sheep by the addition of molasses and urea. This was manifested in the high feed consumption by all the experimental animals, the level of molasses inclusion seemed to have favourable and beneficial effects on the feed intake as the calculated nutrient intake increased with the increase in molasses inclusion.

The high nutrient intake of the WAD bucks was also as a result of the quality of feed i.e. the nutrient availability of the feed. The high dry matter intake observed in this study agreed with (28), who reported that higher level of crude protein content of the feed stimulates high dry matter intake. This was observed true as the highest dry matter intake was observed in animals fed diet 5 which had the highest crude protein content. Research has shown that ensiling mulberry forage with molasses increased the total nitrogen from 9% to 11% as this is indicative of breakdown of protein, which in turn affected their crude protein intake (29). This was also found true as the crude protein intake increased with an increase in molasses inclusion, also the protein intake of the experimental bucks fed diets 3, 4 and 5 were higher than the minimum recommendation of 41.50g/day for goats (30). There was decrease in the crude fibre intake of the WAD bucks as the molasses inclusion level increased. The decrease in the crude fibre intake was a result of reduction in crude fibre content of the experimental diets as the crude protein content increased. The high energy intake of the experimental bucks fed Diet 5 might be as a result of high amount of fermentable energy available to the rumen bacteria. This in turn influenced their growth rate by enhancing digestibility (31).

Anti-nutrients intake of WAD bucks

Addition of molasses up to 6% inclusion in silages increases palatability and utilisation of the ensiled materials (14). This was found true as the anti-nutrients level in the experimental diets decreased as the molasses inclusion level increased. Furthermore, the high sugar content of molasses reduces the anti-nutrient level in the feed thereby reducing the anti-nutrients intake as the molasses inclusion increased. The tannin and oxalate level was reduced by 79% in taro giant by increasing the molasses level (32). They also reported that fermenting taro giant with molasses was effective in breaking linkages of anti-nutrients on fibre and protein. This agreed with the result of this study as the intake of the tannin was lowest in the animals fed Diet 5 which had the highest level of molasses (4%).

Nutrient Digestibility of WAD bucks

(33) reported that ensiling of rice straw with 6% molasses with or without monensin (5 ppm) increased its digestibility and nutritive value. The TDN% values were 55.03 and 52.83% when rice straw was ensiled with molasses and monensin respectively. From this present study, the trend of diets' digestibility was in line with the trend reported by 33, that molasses increase digestibility of feed. 34 reported that fermenting *Tithonia diversifolia* with sugar cane molasses increases intake and digestibility of the dry matter content of the diets when fed to pigs. This was found true in this study as the dry matter digestibility coefficients obtained for animals fed the experimental diets increased as the molasses inclusion level increased to 4%. Nutrient digestibility increases with dry matter intake (35), this was also confirmed in this study as the dry matter digestibility of the animals fed the experimental diets was highest in bucks fed Diet 5 which had the highest dry matter intake.

(22) revealed that there is a positive relationship between digestibility of feed and protein intake. This study agreed with the report as protein intake and digestibility in this experiment was highest in bucks fed Diet 5 as yeast aid in the digestion of starch. 36 reported high nutrient digestibility of rice husk as a result of microbial treatment.

This agreed with the findings from this study as the digestibility of crude protein was found highest in Diet 5 which had the highest crude protein content and intake.

(31) reported that higher protein intake may increase the digestibility of the crude fibre of feeds because the activities of microorganism are increased and this consequently attacks the crude fibre the more. A large portion of the ration energy intake for ruminants comes from the fermentation of plant cell walls, this is the fraction called neutral-detergent fibre. In the effective degradation of plant tissue, NDF is primarily digested via rumen microbial enzymes secreted during microbial adhesion on accessible plant

tissue. A primary chemical factor determining microbial progress with respect to NDF digestibility and rate is the presence and amount of indigestible lignin, or plant maturity. Rumen fibre-digesting bacteria (which are anaerobic) are sensitive to oxygen in the rumen as they do not possess the enzymes to detoxify it. Oxygen readily enters the rumen via water, feed and the oxygenated capillary blood supply wrapped around the rumen. Oxygen's presence reduces rumen cellulolytic bacteria numbers and limits plant fibre adhesion by bacteria and some fungi.

Treating leaves and plant by-products reduce the toxic or harmful components of the materials thereby increasing the digestibility of the anti-nutrient by making it less harmful and breaking their linkages (37). In this study rice husk which is a fibrous plant by-product was treated by fermenting with molasses and the result agrees with the findings of (37).

Nitrogen Utilization of WAD bucks

There was superiority in the nitrogen indices of WAD goats fed diet 5; it is noteworthy that, the consumption of the fermented rice husk treated with molasses (4%) in measured quantities may not have a negative nitrogen digestibility index. The nitrogen intake and retention by the goats fed the experimental diets was considerably high in WAD bucks fed diet 5. This result was in consonance with the findings of (38), who reported an increase in nitrogen utilization as the nitrogen intake increased in animals fed maize offal and sorghum brewer grain. This might be due to the abundance of nitrogen availability in the feed and rumen for microbial growth and protein synthesis. 22 reported that ruminants show higher nitrogen intake when fed feed high in crude protein contents. This study agrees with this finding as crude protein content of the feed was highest in diet 5 thus leading to high nitrogen retention. The positive nitrogen retention obtained shows that the diets were adequate in their supply of nitrogen to the rumen.

Performance characteristics

Animals fed diet 5 had the highest weight gain; this might be attributed to palatability of the diet fed, crude protein content and intake, high dry matter intake, better digestibility of the diet and best nitrogen utilization. This is in consonance with the findings of 39. They reported that weight gain is dependent on dry matter intake, protein intake and the digestibility of the nutrients by the animals.

The highest weight gain of animals fed diet 5 can also be due to improved nitrogen intake and retention, which might have improved the microbial population in the rumen, microbial protein available to bucks, improved energy-nitrogen ratio and improved growth of the bucks

Fermented rice straw (treated or not) with berseem (*Trifolium alexandrinum*) resulted in a clear improvement in the performance and daily live-weight gain of fattening sheep (40). This was confirmed in this study as the highest daily weight gain was observed among animals fed diet 5. The effective utilization of fermented rice husk based diets by the WAD bucks without any visible side effect or mortality showed that the fibre content of the fermented rice husk was within tolerable level for the experimental animals and the treatment of the rice husk by fermenting with molasses was effective in breaking the linkages between the fibre and protein (32); this was confirmed in this study as no mortality was recorded.

Conclusion and Application

1. The study revealed that rice husk fermented with yeast and molasses could meet the protein and nutrient requirement of WAD goats.
2. It was further concluded that diet 5 (92% Rice husk + 4% Molasses + 3% yeast +1% salt) could be a good source of

protein and energy that will enhance nutrient utilization by ruminants supporting its production especially during difficult months of the dry season.

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