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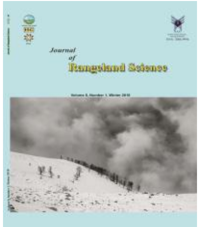

Research and Full Length Article:

Cassava Bran– Fish Processing Waste as Dry Season Feed Resources for Sheep in Nigeria Southern Guinea Savannah

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Received on: 30/12/2016
Accepted on: 18/02/2017

Abstract. Seasonal variability impact on livestock production and management stems from poor pasture quality and quantity as well as shortage of water. During wet season, there is usually sufficient quantity of pasture in good quality for animal consumption; but during dry season, there is always insufficient pasture as well as shortage of water for livestock consumption. As a result of these, exploration of resilience livestock production and management practices capable of enhancing animal performance during dry season becomes highly necessary. Based on the above background, a 12 weeks trial was carried out during January, February and March in 2015 to determine the effects of cassava bran plus fish processing waste supplement on body weight gain, blood composition and meat quality of West African Dwarf sheep at a location within Nigeria Southern Guinea Savannah. Twelve growing lambs were randomly allotted to three Treatments; each fed dried cassava peel *ad-libitum* in addition to 0%, 1.5%, or 2.5% body weight equivalent quantity of the cassava bran-fish processing waste supplement throughout the feeding trial. Sheep fed control (0%) diet had negative body weight change (P<0.05). Sheep fed cassava bran-fish processing waste supplement at 2.5% body weight level had higher (P<0.05) body weight, nutrient composition and carcass yield. Treatment effects on sheep organoleptic properties and meat fatty-acids composition were significant (P<0.05). Our study established that cassava bran and fish processing waste are potential dry season feed resources suitable for growing lambs since it has no negative impact on the health of the animals and it promote growth and performance of the animals. We recommend further studies into full integration and improvement of diets prepare from cassava bran and fish processing waste for sheep feeding during dry season; also investigation into possibilities of incorporating fish processing waste into production of silage for growing lambs.

Key words: Dry season, Cassava bran, Fish processing waste, Sheep

Introduction

Livestock production is mostly under extensive grazing in Nigeria; and there exist poor or little efforts towards preservation of the rangeland, while cost of intensive livestock feeding with factory finished feeds as in the case of poultry feeds has both economic and environmental impediments. Hence, a nutritional manipulation approach becomes necessary using cheap locally available feed resources for supplementing nutrition of range animals for improving integrity of rumen microbiome to better digest and utilize poor or scarcely available range feed resources especially during dry season.

Rangeland is the single largest natural resources that are most important for livestock production in the world especially in resources poor countries of Africa where most livestock production activities are less intensive; and extensive grazing based. Rangelands constitute some 35 million km^2 of the earth's surface, with most in developing countries and some 65% (almost 22 million km^2) in tropical Africa (Ayantunde *et al.*, 2011). On rangeland, there are varied forms of resources utilization depending on factors such as culture, climatic conditions and prevalent economic activities in a given area. In some rangeland use system, there is total dependence of livestock owners on income generation from animals; while in some cases there is a mix of livestock and crop production; and recently there is reasonable generation of off-farm income to the households of livestock owners. In parts of Maasailand (Kenya) for instance, income diversification and remittances can account for more than 50% of the family's income (Nkedianye, 2008).

Rangeland utilization irrespective of how it been use is primarily expected to meet up the requirement of livestock production for optimum productivity; but climatic factors, increasing land for arable crop production, urban development and seasonal variability effect on biomass yield and or quality are changing the face of rangeland utilization. Poor forage use, non-improvement of natural rangeland and over-grazing contribute to the poor productivity of rangeland as a result; nomads, pastoralists and agro-pastoralist are always under pressure of continuous seeking for greener pasture to feed their animals. Unfortunately as they increase efforts to do so, especially in many parts of Nigeria conflicts do arise between the livestock herdsmen and farmers a condition that has been threatening peace all over the country for quite some time. This scenario calls for a nutritional approach to improvement of rangeland productivity.

Rangeland productivity can be achieve not only through increase agronomic yield of the range biomass but also through nutritional approaches such as better use of range feed resources; and concentrates supplemental feeding. Feeding of concentrate supplement diet to grazing livestock is nutritional approach that can contribute to range productivity because supplementing grazing livestock with concentrate diets will lead to better digestibility of the range feed resources which hitherto not digestible. Supplementing with concentrate will also improve livestock rumen environment to better digest forages thereby contributing to better product yield and quality.

Fish meal has general acceptability for improving animals performance and products quality especially in growing or young animals (Thuy, 2010). It is a recognized animal feedstuff known for its high balanced composition of protein, energy, minerals and vitamins. But, high cost of fish meal is a major factor limiting its large scale use in animal feeding. As a result, exploration of fish processing waste as an alternative to conventional fishmeal could lead to reduction in cost to achieve improved animal performance and production of high quality animal products. Fish processing waste- a feedstuff produced from scrap fish meat, fish head, fish visceral and offal is an excellent and cheaper feedstuff that can serve as alternative to conventional fishmeal (Dong, 2005; Kamra, 2005; Jayathilakan *et al.,* 2012).

Cassava is another high energy feedstuff for animals as well as rich source of carbohydrates for man. It is a cheap source of food for animals and man across the world, it was estimated that cassava is a staple food for more than 700 million people across the world especially in the developing countries of Africa, Asia and Latin America (Pandey *et al.,* 2000). While cassava is being process into human foods; lots of wastes are generated which are more suitable as animal feedstuffs among these are cassava bran which primarily is a by-products of cassava processing but can be used in animals feeding considering its high energy composition. Its high energy composition makes it a perfect feedstuff that can be mixed with fish processing waste to produce supplement for sheep feeding. The aim of this research was to determine the effects of cassava bran plus fish processing waste supplement on body weight gain, blood composition and meat quality of West African Dwarf sheep at a location within Nigeria Southern Guinea Savannah.

Materials and Methods

Research location

The research was carried out at the small ruminant unit of the Teaching and Research farms of University of Ilorin, Nigeria. Ilorin is located within the Southern Guinea Savannah agro-ecological zone of Nigeria; the project location has 1217 mm and 26.5^{o} C annual average rainfall and temperature ranges; the location experience rainy season between April and October yearly and sometime extend to November. The research was carried out during dry season between month of January and March 2015. Laboratory analysis and investigation as well as evaluation of meat were done at the laboratory of Animal Production department, University of Ilorin, Ilorin in Nigeria.

Experimental animals and their management

Twelve (12) growing West African Dwarf (WAD) lambs were used for this study; the animals were sourced from open markets within Ilorin (capital State of Kwara in Nigeria) metropolis, before the commencement of feeding the experimental diet; the animals were quarantined and acclimatized for three weeks. During the acclimatization period, the animals were dewormed with ivermectin at dosage dictated by their body weight, antibiotics treatment (Oxytetracycline L.A.), treatment against intestinal worms using albendazole bolus and other prophylactic treatments as well as boosted with multivitamins to make them suitable for the research.

Experimental diets

The animals were divided into three treatment groups of four animals per treatment in a completely randomized design fed prepared concentrated diet on experimental proportion based on their body weight twice daily at 08:00hrs (GMT) and 15:00hrs (GMT), while feeding on dried cassava peel was *ad-libitum*; water was also provided for the animals *ad-libitum*. The experimental diets formulated with cassava bran and fish processing waste is as presented in Table 1 while the animals were put on a feeding arrangement as presented in Table 2.

Table 1. Ingredients composition of the experimental diets fed to the animals

Ingredients	**Quantity (%)**
Cassava bran	60
Fish Processing Waste	40
Analyzed Nutrients Composition	
Dry Matter (%)	89.68
Crude Protein (%)	25.96
Crude Fibre (%)	13.84
Ash (%)	3.84
Energy (Kcal/Kg)	4872.2

Table 2. Feeding arrangement for the experimental animals

Feeds	T1	T2	T3
Dried Cassava Peel	*Ad-libitum*	*Ad-libitum*	*Ad-libitum*
Concentrate (% body weight)	0	1.5	2.5

Body weight changes

All animals were weighed at the beginning of the experiment and weekly throughout the experiment period. Blood samples were also obtained from the animals at the beginning and at the end of the experiment were analyzed for Packed Cell Volume (PCV), White Blood Cell (WBC), Red Blood Cell (RBC), Neutrophil (Neu) and Lymphocytes (Lym) in order to establish effect of the concentrate supplement on health status of the animals.

Slaughtering and collection of meat samples

Nine out of the twelve animals were selected for slaughtering; the selected animals were fasted for 20 hours before slaughtering. During the fasting period, they were provided with water *ad-libitum* but no feeding was carried out. The animals were then moved to the slaughtering slab where they were humanely handled and slaughtered by cutting through the jugular vein and carotid arteries (Fasae *et al.*, 2014). After slaughtering, the carcass characteristics were taken and meat samples were collected for nutrients analysis, organoleptic properties and lipid profiling. Meat samples (100g each) were collected from the *longissimus dorsi* for fatty-acids profile, fat was extracted from the meat samples using n-Hexane. Gas-Chromatography-Mass-Spectrometry (GC-MS) was used for the characterization and quantification of the fatty-acids.

Organoleptic properties evaluation

Samples of meat collected were cut into small chops of average cut of 150g and cooked at 65°C for 30 minutes as described by (Fasae *et al.*, 2014) for the organoleptic evaluation. Upon cooking, the meats were served to a group of twenty (20) man panel that later consumed and score the meats on a nine-point hedonic scale (1 - extremely dislike and 9 - extremely like). Each panel member did individual scoring from which a panel average was determined for each parameter. Parameters scored for in the meats include colour, Flavour, Juiciness, Tenderness and Acceptability (Ademola *et al.*, 2011).

Nutrients composition analysis

Methodological description of (AOAC, 2000) was followed for determination of dry matter, crude protein, fat, crude fibre and ash using electric furnace, Kjeldahl set-up, soxhlet extraction and oven drying equipment.

Statistical analysis

All data collected were subjected to one-way analysis of variance using SPSS version 16.0; comparison of significant means was done using Post Hoc.

Results

All animals were weighed at the beginning of the experiment and weekly throughout the experimental period. There was increase in weight (P<0.05) of animals in Treatments 2 and 3 while the weights of animals in control were reduced. Average daily weight gain were estimated by division of average increase in weight by the total number of days to attain the weight gain. The Average daily weight gain in control, Treatment 2 and Treatment 3 were 6.0g/day, 17.3g/day and 47g/day, respectively (Table 3).

Table 3. Weekly body weights of sheep fed cassava bran plus fish processing waste supplement

Weeks	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
1	8.75^{b}	10.75^{a}	12.00^{a}	0.5150
2	8.75^{b}	10.75^{a}	12.00^{a}	0.5150
3	8.38^{b}	10.75^{a}	12.00^{a}	0.5400
4	7.88^{b}	10.75^{a}	12.00^{a}	0.5950
5	8.12^{b}	11.00^{a}	12.75^{a}	0.6190
6	8.12^{b}	11.00^{a}	13.25^{a}	0.6610
7	8.00^{b}	12.00^{a}	14.00^{a}	0.7720
8	8.12^{b}	12.50^{a}	14.50^{a}	0.8313
9	8.32^{b}	13.12^{a}	15.25^{a}	0.9007
10	8.25^{b}	13.88^{a}	15.75^{a}	0.9830
11	8.25^{b}	14.75^{a}	15.88^{a}	1.0310
12	8.25^{b}	15.75^{a}	16.00^{a}	1.0650

Means of treatment in each rows with different letters are significant (P<0.05)

Blood samples collected from the animals at the beginning and at the end of the experiment were analyzed for Packed Cell Volume (PCV), White Blood Cell (WBC), Red Blood Cell (RBC), Hemoglobin (Hb), Neutrophil (Neu) and Lymphocytes (Lym) (Tables 4 and 5), respectively. The animals fed 1.5% and 2.5% body weight equivalent quantity of the supplement had high packed cells volume (P<0.05) although the control group also had good packed cells volume but below initial level (Table 5). The highest packed cell volume (PCV) was 40.25% and Lymphocytes was 53.00% for the animals fed the supplement at the end of experiment (Table 5).

Table 4. Initial blood composition of sheep fed cassava bran plus fish processing waste supplement

Parameters	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
Packed Cells Volume (%)	36.97	35.97	34.7	0.66
White Blood Cells ($\times 10^3/\mu L$)	6.60	6.07	6.90	0.22
Red Blood Cells ($\times 10^6/\mu L$)	6.12	6.15	6.00	0.12
Hemoglobin (g/dL)	11.57	11.72	12.15	0.30
Neutrophil (%)	18.00^{c}	29.25^{b}	37.25^{a}	2.65
Lymphocytes (%)	30.75^{b}	44.25^{a}	50.0^{a}	2.83

Means of treatment in each rows with different letters are significant (P<0.05)

Table 5. Final blood composition of sheep fed cassava bran plus fish processing waste supplement

Parameters	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
Packed Cells Volume (%)	31.00^{b}	37.00^{ab}	40.25^{a}	1.5606
White Blood Cells ($\times 10^3/\mu L$)	6.12^{b}	6.75^{ab}	7.00^{a}	0.1642
Red Blood Cells ($\times 10^6/\mu L$)	5.32	6.12	6.50	0.2542
Hemoglobin (g/dL)	10.50^{b}	12.25^{ab}	13.50^{a}	0.5289
Neutrophil (%)	18.50^{b}	33.75^{a}	41.00^{a}	3.0780
Lymphocytes (%)	30.75^{b}	48.75^{a}	53.00^{a}	3.2109

Means of treatment in each rows with different letters are significant (P<0.05)

The result of carcass characteristics is presented in Table 6. There was significant differences in cold carcass weight and dressing percentage between the Treatments (P<0.05). Dressing percentage was 83.24%, 89.99% and 90.52% for control, Treatments 2 and 3 respectively.

Table 6. Carcass characteristics of sheep fed cassava bran plus fish processing waste supplement

Parameters	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
Weight Before Slaughtering (Kg)	8.33 [b]	15.33 [a]	16.00 [a]	1.24
Weight After Slaughtering (Kg)	7.73 [b]	14.73[a]	15.40 [a]	1.24
Hot Carcass Weight (Kg)	6.93 [b]	13.88 [a]	14.40 [a]	1.22
Cold Carcass Weight (Kg)	6.43 [b]	13.38 [a]	13.90 [a]	1.22
Carcass Yield (%)	83.24 [b]	89.99 [a]	90.52 [a]	1.20

Means of treatment in each rows with different letters are significant (P<0.05)

The result of internal organs evaluation is present Table 7; it showed higher and significant values in internal organs of the animals in Treatments 2 and 3 compare with animals in control although the rumen and muscle pH are not significantly different.

Table 7. Internal organs of sheep fed cassava bran plus fish processing waste supplement

Parameters	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
Lungs (g)	184.81[b]	200.86 [a]	201.62 [a]	3.40
Kidney (g)	29.05 [c]	37.42 [b]	48.13 [a]	2.86
Heart (g)	48.70 [b]	67.87 [a]	68.50 [a]	3.69
Liver (g)	184.51[c]	234.31[b]	349.21[a]	25.14
Rumen pH	6.26	6.53	6.56	0.06
Muscle pH	6.43	6.70	6.73	0.09

Means of treatment in each rows with different letters are significant (P<0.05)

The result of means comparisons between treatments for organoleptic properties of WAD lambs is presented in Table 8. Results of sensory evaluation showed higher acceptability for Treatments 2 and 3. The same applies to other sensory evaluation parameters of the meats (Table 8).

Table 8. Organoleptic properties of WAD lambs fed cassava bran and fish processing waste

Parameters	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
Colour	4.33 [c]	6.00 [b]	8.00 [a]	0.61
Flavour	5.33 [b]	8.00 [a]	8.33 [a]	0.54
Juiciness	7.00	7.00	8.00	0.33
Tenderness	7.00	7.33	7.66	0.23
Acceptability	6.00 [c]	8.66 [b]	9.00 [a]	0.51

Means of treatment in each rows with different letters are significant (P<0.05)

The result of means comparisons between treatments for Nutrients composition is presented in Table 9. The result showed the crude protein content of the meat in Treatments fed the supplement of 1.5 and 2.5% of diet were 59.15% and 59.37%, respectively. They were significantly higher than control (P<0.05) (Table 9).

Table 9. Nutrients composition of meat from lambs fed cassava bran and fish processing waste

Component	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
Dry matter (%)	21.32[b]	22.54 [a]	22.90 [a]	0.81
Moisture (%)	77.09 [b]	77.46 [b]	78.68 [a]	0.81
Crude protein (%)	57.31 [b]	59.15 [a]	59.37[a]	1.29
Crude fat (%)	7.85 [b]	8.99 [ab]	10.57[a]	1.40
Crude fibre (%)	2.22[b]	2.35 [ab]	2.35 [a]	0.16
Ash (%)	3.45	3.82	3.88	0.56

Means of treatment in each rows with different letters are significant (P<0.05)

The mean comparisons between treatments for saturated fatty-acid profile is presented in Table 10. Result showed that meat samples from sheep fed cassava peel had highest saturated fatty-acids while the sheep fed 2.5% body weight equivalent quantity of the supplement had the lowest saturated fatty-acids except for Myristic (Table 10).

Table 10. Saturated fatty-acid profile of meat from lambs fed cassava bran and fish processing waste (g/100g meat sample)

Fatty-acids	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
C14:0 (Myristic)	0.10[b]	0.35[a]	0.26[a]	0.012
C15:0 (pentadecanoic)	0.18 [a]	0.01 [b]	0.01[b]	0.001
C16:0 (palmitic)	0.61[a]	0.22[b]	0.20 [b]	0.099
C17:0 (margaric)	0.05[a]	0.01[b]	0.01[b]	0.008
C18:0 (stearic)	0.68 [a]	0.12 [b]	0.11[b]	0.094

Means of treatment in each rows with different letters are significant (P<0.05)

The result of means comparison of treatments for Monounsaturated fatty-acid profile is presented in Table 11. Result showed that the higher mono-unsaturated fatty-acids were obtained in treatment 3 that was significantly higher than that of control animals (Table 11).

Table 11. Monounsaturated fatty-acid profile of meat from lambs fed cassava bran and fish processing waste (g/100g meat sample)

Fatty-acids	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
C14:1 (*trans*-Myristelaidic)	0.01	0.01	0.01	0.006
C16:1 (*trans*-Palmitelaidic)	0.68	0.77	0.72	0.002
C18:1 (*trans*-Elaidic)	1.99	2.00	2.02	0.005
C20:1 (*trans*- Eicosenic)	0.01[b]	0.01[b]	0.04[a]	0.005

Means of treatment in each rows with different letters are significant (P<0.05)

The result of polyunsaturated fatty-acid profile is presented in Table 12. Result showed the Poly-unsaturated fatty-acids too were higher (P<0.05) in Treatments 2 and 3 than control.

Table 12. Polyunsaturated fatty-acid profile of meat from lambs fed cassava bran and fish processing waste (g/100g meat sample)

Fatty-acids	T1 (0 control)	T2 (1.5%)	T3 (2.5%)	SEM
C18:2 n-6	0.33[b]	0.35[a]	0.37[a]	0.005
C18:2 n-3	0.10[b]	0.12[a]	0.13[a]	0.003
C20:3 n-6	0.10	0.10	0.12	0.006
C20:4 n-6	0.09[b]	0.09 [b]	0.10 [a]	0.001
C20:5 n-3	0.04[b]	0.07[b]	0.09 [a]	0.007
C22:5 n-3	0.04[b]	0.05 [a]	0.07 [a]	0.005
C22:6 n-3	0.01[b]	0. 02[b]	0.04 [a]	0.028

Means of treatment in each rows with different letters are significant (P<0.05)

Discussion

Reduction in the weight of animals in the control group can be linked to poor feed consumption and utilization by the animals because it was observed that during the course of the experiment the animals refused feeding on the dried cassava peel as a sole diet at initial stage of the study; this is an indication that dried cassava peel which is widely fed to small ruminants in the study area may not be a good sole-feed resources for growing lambs under confined management; although our work could not explain the reasons for the poor consumption, but sole cassava peel definitely is not nutritionally sufficient for growing lambs therefore this may be one of the reasons for the reduced weight of the animals in the control group.

Our observations about the use of cassava peel by the animals in the control group was similar to observations made by (Salami & Odunsi, 2003) who fed dried cassava peel to replace maize in the diet of laying birds; the observation was poor consumption and subsequently reduction in weight of the birds. Although in the same study by these workers, it was discovered that treated cassava peel gave better response by the animals, the Treatments used includes ensiling, soaking in water and retting; these showed that the manipulation through soaking and others actually reduce the effect of cyanide in the peel (Eustace and Dorothy, 2001; Ganiyu, 2006; Olufunke *et al.*, 2010; Dairo, 2011). Apart from the presence of cyanide in the dried cassava peel, poor nutritional quality of the cassava peel can be implicated for the poor performance of the animals because the rumen fermentation of the cassava peel by the animals is sufficient enough to remove the negative impact of the cyanide present in the dried cassava peel therefore if it will be incorporate into feeding of animals such as growing lamb; it can be processed to improve its nutritional quality.

The increase in weight of animals in the Treatment 2 and 3 can be linked to the good nutritional composition of the experimental diets. It also suggest that poor feed resources such as cassava bran is a good animal feed resources when used with rich protein sources such as fish processing waste. The experimental diet is not only nutritionally rich because of its nutrients composition but because of it high protein composition which is capable of providing enough microbial protein for the use rumen ecosystem– a factor highly responsible for ruminant animal performance.

Rumen ecosystem is the major determinant of rumen fermentative efficiency and can be describe as sum total combination of microbial activities of ciliate protozoans, fungi, bacteria and bacteriophages found in the first and largest stomach compartment of ruminant animals. The activities and performance relationships of these organisms result in bioconversion of consumed feed resources into volatile fatty acids (acetate, butyrate and propionate acids) which are energy sources for ruminant animal utilization. Nature of the rumen ecosystem depends on factors including feed types, physical properties of the feeds, type of feed additives used and diversity of microbial population present in the rumen (Lee *et al.*, 1999). The higher growth and weight gain in the animals feed 2.5% body weight equivalent of the supplement diet in our research can be linked to improved activity of the rumen microbes due to abundant availability of protein in the fish processing waste used in the diet that contributed to microbial protein in the rumen which enhance better digestibility of the basal diet – cassava peel.

Earlier investigations on livestock production systems in the Southern Guinea Savanna reported indiscriminate grazing by cattle, sheep owned by nomadic herdsmen who move from one place to another in search of highly nutritious pasture for their animal consumption. These animals are graze daily by the nomads and stop at flowing streams and rivers for the animals to drink water. Major management practices for animal production in the zone include basic provision of veterinary services and sometimes use of mineral supplementation by provision of salt lick as well as bush burning sometimes with an aim for control of Tsetse fly. Animal production practices that promote improved animal performance in the Southern Guinea Savanna zone of Nigeria (Adegbola *et al.*, 1986) are scarce among farmers and herdsmen of the zone especially during dry season which makes herdsmen to buy cassava peel for feeding their animals.

The increase in weight in our study confirm position of (Adegbola *et al.*, 1986) who suggested that lambs can be reared on supplement prepared from cassava by-product and dried poultry manure; on the understanding that dried poultry manure is a waste product high in protein similar to fish processing wastes used in our study. Nutritional composition of the cassava bran offered adequate source of energy for the animals while the blending with the fish processing waste complemented its usefulness; because of supply of protein for rumen microbes utilization which enhance their use of the cassava peel. This also agreed with suggestion that cassava and its by-products are energy rich feed resources which when well-fortified with nitrogen, minerals, vitamins, and roughage, promoted positive and high performance levels in dairy and beef cattle, sheep, and goats. The significant different in the weights of the animals in Treatments 2 and 3 suggested that increasing quantity of the concentrated diet prepared in the experiment can lead to increasing weight gain in growing lambs.

Complete blood count of the experimental animals showed that the Packed Cells Volume (PCV) in Treatment 2 and 3 was higher than that of control animals; the level of the packed cells volume was between 31.00% and 40.25%. The lowest packed cells volume was found in the control group which is lower than the packed cells volume of the same group before the feeding of dried cassava peel to the group. For the animals fed with the concentrated diet produced from cassava bran and fish processing waste; the initial packed cells volume was 35.97% and 34.70 respectively while the final packed cells volume are 37.00% and 40.25% respectively. These packed cells volume fall within the normal range for healthy sheep (Njidda *et al.*, 2014) and a sign that the experimental diet promote animals' healthy conditions. Almost all hematological parameters of animals in the Treatments 2 and 3 were higher in the final blood analysis compare with the initial blood analysis. This is an implication that feeding of the experimental diet to the animals is safe and enhances animal health and production performance. Generally, the results of the hematological parameter gave clear observations that feeding of cassava bran and fish processing waste is normal for growing lambs.

Results from statistical analysis of the carcass traits showed that the Treatments were good for growing lambs given a significant level of difference in cold carcass weight ($P<0.05$) in animals fed the compounded diet. Dressing percentage was 83.24%, 89.99% and 90.52% for control Treatments 2 and 3, respectively; this mean the higher quantity of the feed given to the animals may be responsible for the higher yield. The carcass traits improvements in the Treatments 2 and 3 can be linked with the high energy composition of the cassava bran and presence of rumen undegradable proteins in the fish processing waste which agreed with findings of (Beerman *et al.*, 1986).

Sensory evaluation of the meat showed that the panel generally accepted the meats from Treatments 2 and 3 better than that for control; although the least accepted meats in the control falls within acceptable range of acceptability as reported by (Fasae *et al.*, 2014) in a similar study testing acceptability of West African Dwarf sheep meat. But, the higher acceptability of the animals fed the concentrated supplements may be linked with the better flavour and attractive colors of the meat which can be because of inclusion of the fish processing waste in the diet. With the greater acceptability of the meat fed concentrated supplement through sensory evaluation, it can be postulated that the diet improved quality of the meat. Increasing the presence of unsaturated fatty acids in meat has been identified as a cause for heightened susceptibility to oxidation, a process that leads to undesirable changes in sensory characteristics or even to effects that are harmful to health (Jiménez-Colmenero *et al.*, 2001) but acceptability of meat from animals in this study can be linked to antioxidant potential of the oil in the fish processing waste; the antioxidant activity inhibit rancidity and gives the meat attractive colours; this further support the utilization of fish processing waste as feed resources in animal production.

Proximate composition of the meat collected from the animals show that the dry matter percentage of animals fed the compounded supplement was higher than control group; the same applied to crude protein, fat, ash and fibre; these suggested that the experimental diet compounded for the animals highly influence the nutrients composition of the meat. The crude protein percentage of the meat in the Treatments groups fed the formulated diet was 59.15% and 59.37% respectively which is higher than the crude protein percentage of meat from traditionally grazed West African dwarf lamb reported to have 35.50% crude protein (Fasae *et al.*, 2014), from this differences it can be inferred that the diet used in the experiment highly influenced the nutrients composition of the meat because the animals used in the experiment belongs to the same breed as the ones used in the work of (Fasae *et al.*, 2014) and within the same developmental stage.

Lipid profile of the collected meat sample showed that animals fed supplemented diet have higher values of polyunsaturated fatty acids. Polyunsaturated to saturated fatty acids ratio in control, Treatments 2 and 3 were 0.43, 2.57 and 1.55 respectively. This is an indication that the supplement influenced fatty acid profile of the meats. The little increment is possible because despite escaping rumen biohydrogenation, larger part of the oil still undergo biohydrogenation leading to production of saturated fatty acids. Therefore, to achieve higher levels of polyunsaturated fatty acids through the supplement, it can be feed along with cereals based diet or increase level of the supplement in the animals. This is in agreement with position of (Wood *et al*., 2004) who observed that some studies involving manipulation of fatty acids through feeding of oil based resources resulted into little changes in polyunsaturated fatty acid due to the biohydrogenation in the rumen.

Our study established that cassava bran and fish processing waste are alternative feed resources for growing lambs since it has no negative impact on the health of the animals and it promote growth and performance of the animals during dry season. We also agreed with the position that feeding dried cassava peel alone to growing lambs is not sufficient for the animals nutritional requirements; hence lambs on dried cassava peel should be put on supplemental feeding of other high protein feed resources such as fish processing wastes. We also identified that fish processing waste has potential to improve polyunsaturated fatty acids profile of growing lambs. As a result, we recommend further studies on possibilities of incorporating these two agro-industrial by-products into production of silage for growing lambs and meta-functional genomics rumen of sheep fed supplemental diets use in this study especially diets with higher weight increase for the purpose of identifying roles of rumen microbes in the performance of the sheep under those Treatment groups.

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استفاده از پس ماند فرآیند کارخانجات محصولات غذایی به عنوان منبعی جهت تغذیه گوسفند در فصل خشک در جنوب ساوان گینه کشور نیجریه

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تاریخ دریافت: ۱۳۹۵/۱۰/۱۱
تاریخ پذیرش: ۱۳۹۵/۱۱/۳۰

چکیده. تغییرات فصلی بر روی تولیدات دامی و مدیریت کیفیت و کمیت مراتع فقیر و همچنین کمبود آب تاثیر دارد. در طول فصل مرطوب، مقدار کافی علوفه با کیفیت خوب برای مصرف حیوانات وجود دارد. اما در طول فصل خشک، همیشه مقدار کم و ناکافی علوفه و همچنین کمبود آب برای مصرف دام وجود دارد. در نتیجه، کاوش برای بهبود تولیدات دامی و بکارگیری شیوه‌های مدیریتی که باعث افزایش عملکرد دام‌ها در طول فصل خشک می‌شود، بسیار ضروری است. بر این اساس آزمایشی در طول ۱۲ هفته در ماه‌های دی، بهمن و اسفند در سال ۱۳۹۳، به منظور تعیین اثرات استفاده از پس‌ماند فرآیند کارخانجات محصولات غذایی بر وزن، ترکیب خون و کیفیت گوشت گوسفند در غرب آفریقا در جنوب ساوان از منطقه گینه در نیجریه انجام شد. دوازده بره در حال رشد به طور تصادفی برای سه روش تغذیه دهی (یک تیمار شاهد و دو تیمار تغذیه) بکار گرفته شد. منبع تامین تغذیه از مواد خشک حاصل از پس‌ماند محصولات غذایی به میزان ۰٪، ۱/۵٪ و ۲/۵٪ در نظر گرفته شد. تغذیه کنترل شده گوسفند نشان داد که تیمار شاهد یعنی ۰٪ بر روی وزن بدن گوسفند با سطح اعتماد ۹۵ درصد اثر منفی دارد. گوسفندی که از پس‌ماند تغذیه به میزان ۲/۵ درصد استفاده کرده دارای بیشترین درصد رشد وزن بدن با احتمال ۹۵ درصد اعتماد بوده است. همچنین این میزان تغذیه بر روی بازده حیوان نیز اثر مثبت دارد. این آزمایش نشان داد تغذیه از مواد پس‌ماند غذایی بر روی ترکیب اسیدهای چرب گوشت اثر معنی‌داری داشته است. همچنین این مطالعه نشان داد که پس‌ماند فرآیندهای کارخانجات محصولات غذایی و به خصوص در فصل خشک منابع غذایی مناسب برای رشد بره‌ها است و هیچ تاثیر منفی بر سلامت حیوانات و رشد و عملکرد آن ندارد. توصیه می‌شود مطالعات بیشتر برای کامل کردن و بهبود رژیم غذایی استفاده از پس‌ماند فرآیند کارخانه‌ها برای تغذیه گوسفند در طول فصل خشک انجام شود. همچنین تحقیقی درباره ترکیب پس‌ماند برای تولید علوفه مخصوص بره‌های در حال رشد انجام شود.

کلمات کلیدی: فصل خشک، محصولات غذایی، فرآیند پس‌ماند، گوسفند