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Rumen characteristics and thermo-physiological response of West African Dwarf goats supplemented with pineapple waste and cassava peel concentrates

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ABSTRACT: The study was conducted to evaluate the rumen characteristics and thermo physiological response of West African Dwarf goats fed pineapple waste and cassava peel concentrate in Anyigba, Kogi State. Twelve growing West African Dwarf goats with average weight 4-5±0.05 kg and approximately 4 to 6 months of age were randomly allotted four (4) dietary treatments with three animals per treatment in a Completely Randomized Design. The rations were 50% ensiled pineapple waste + 50% concentrate, 60% ensiled pineapple waste + 40% concentrate, 70% ensiled pineapple waste + 30% concentrate and 80% ensiled pineapple waste + 20% concentrate respectively. Rumen fluid was collected from the goats at the end of the 60 days feeding trial. The data collected were pH, ammonia nitrogen, acetic acid, butyric acid, propionic acid and total volatile fatty acids (TVFA). Results obtained indicated that rumen parameters; TVFA, propionic acid, acetic acid, and ammonia nitrogen were not significantly different ($p>0.05$) among dietary treatments except pH and butyric acid. Bacteria count was not significantly ($p>0.05$) influenced by dietary treatments while protozoa and fungi count were significantly ($p<0.05$) influenced by dietary treatments with higher values in 60:40 and 80:20 inclusion levels. The result of the thermo-physiological response showed that rectal temperature observed ranged between 32.27 and 38.65°C. Supplemented group fed 60:40 ration had the highest rectal temperature than other treatments. The pulse rate values ranged between 63.25 and 77.75 beats per minute whereby 60:40 fed group also had the highest pulse rate (77.75 beats /min). It can be concluded that the inclusion of pineapple waste supplements and cassava peel concentrate in the diets of West African Dwarf Goat has the potential for optimum rumen ecology with no detrimental effect on the health status of goats. Therefore, ensiled pineapple waste and cassava peel concentrate supplementation of inclusion level at 60:40 to 80:20 levels could be used as an alternative feed material in the diet of growing WAD goats for improved rumen ecology.

Keywords: Cassava, physiological response, pineapple, rumen, WAD.

INTRODUCTION

Ruminants are important livestock sector in virtually every country of the world, due to their contribution as animal protein to the diet of the average human populace. Ruminant livestock is an integral part of most agricultural production systems of developing countries. They are important in maintaining the livelihood status of their keepers by providing food, traction power, manure, raw material, cash, security, social and cultural identity, medium of exchange and means of savings and investments (Ajagbe *et al.,* 2020).

However, one of the major problems facing the holders of small ruminant in Nigeria is how to adequately feed their livestock most especially during the off- season. Arigbede *et al.* (2005) noted that inadequate feed supply in both quantity and quality is responsible for low ruminant animal productivity in the tropics. Though forages are abundant in the tropics, seasonal changes in their nutritive values have been the major problem in ruminant animal production.

Even though natural pastures provide what is regarded as the “cheapest” feed for ruminants (Akinrinde and Olanite, 2014), it has long been recognized that they are incapable of sustaining the animals on a year-round basis as they are often deficient in nutritional quality for most of the year. In Nigeria, as observed by Bamigboye *et al*. (2013), rangelands only blossom in the rainy season while in dry season, they become standing hay. Thus, animals will have abundant feed in the wet season and a shortage of feed in the dry season.

Nevertheless, the use of conventional feed resources in ruminant nutrition are undesirable and further compounded the problem as they become insufficient and put ruminants into direct competition for feeds with human population. Consequently, this become a great interest and concern to the researchers, hence there is need to find alternative ways of improving ruminant nutrition. With a fast growing population, Nigeria is threatened with the problem of food insecurity and poverty which can be addressed with a more developed livestock production sector in addition to other sectors (Fasoyiro and Taiwo 2012). What makes ruminant animals unique in feeding status is their rumen, which is the largest muscular organ in the fore-stomach. The rumen is characterized as the primary site for microbial fermentation of ingested feeds. The management of microbial population in the rumen is achieved by feeds and pH control. The rumen temperature and pH are critical phenomena that depend on the fermentation of ingested feeds in the rumen. Regulation of rumen ecology is achieved through feed and feeding which ranges from natural grazing resources to supplementary feed materials. Parts of these feed materials are ensiled pineapple waste and cassava peels which are believed to contain adequate nutrient for optimum rumen environment (Jetana *et al.,* 2009; Ajagbe *et al.,* 2020)

However, thermoregulatory indices of animals that are often measured as rectal temperature, heart rate and respiratory rate have been found to be valuable in evaluating the health status of livestock animals. Livestocks’ physiological responses cannot only be derived from environmental heat load but also from fermentative and metabolic activities within the body (Adhianto *et al*, 2017). Thus, physiological parameters are important indexes in assessing the body’s ability to respond to metabolic and fermentative actions of the animals which may give some insights as to the potentials of a test diet to meet the productive needs of animals. Therefore, this study was carried out to evaluate the rumen characteristics and thermo-physiological response of West African Dwarf goats supplemented with pineapple waste and cassava peel meal.

MATERIALS AND METHODS

The experiment was conducted at the goat unit of the Teaching and Research farm at Prince Abubakar Audu University, Anyigba lies between Latitude 7° 15' and 7° 29' N of the equator and Longitude 7° 11' and 7° 32' E of the Greenwich meridian with altitude of about 420 m above the sea level. The zone is characterized by 6 to 7months of average rainfall of about 1600 mm and the daily temperature range between 25°C and 35°C (Ifatimehin *et al.,* 2006).

Experimental feed and processing

Processed cassava peel was obtained from Ala cluster livestock feed plant Ejule, Kogi State while pineapple waste was purchased from Anyigba market and its environs. The waste was ensiled at 4:1 (peels and crown) for 21 days before being air dried for milling. Dietary concentrate and pineapple waste meal were fed to the animals at different ratios as indicated in Tables 1 and 2 respectively.

Experimental animals and their management

A total of 12 female growing West African Dwarf goats of about 4.5±.0.05 kg of about 4 to 6 months of age were obtained from goat sellers within Anyigba. They were housed semi-intensively in well- ventilated wooden cages in pens. The cages were built on wooden stands of about 40cm from the floor. Before bringing in the goats, the pen was cleaned and disinfected with izal solution two weeks to arrival. The entire goat house was fumigated using a strong fumigant (Dimethoate 40%) against fleas. Prophylactic treatments and dewormer were given to all the goats. They were also vaccinated against pests des petite ruminant (PPR). Treatment against ecto parasite was done with the use of Amitrax solution. Multivitamin was administered to boost appetite. The goats were distributed randomly into 4 treatments with 3 replicates per treatments. An adjustment period of two weeks was allowed for the goats before data collection commenced. Wilted *Pennisetum purpureum* was offered *ad libitum* daily while supplementary feeding with concentrate and ensiled pineapple waste was fed at 5% body weight. The design of the experiment was a Completely Randomized Design.

Collection and analysis of rumen fluid and determination of physiological response

Rumen liquor was collected from animals using a stomach tube at the end of the experiment as described by Wanapat and Khampa, (2007). Twenty milliliters (20 ml) each of the rumen liquor was collected from two replicates of each treatment into sample bottles and immediately taken to the laboratory for volatile fatty acids analysis according to Cheesebrough (2000). Microbial counts were carried out

Table1. Composition of concentrate diet.

Ingredient (%)	Composition
Cassava peel	53.00
Maize offal	20.59
BGD	20.50
Limestone	5.00
Salt	1.00
Total	100

BDG- Brewers dried grain.

Table 2. Gross composition of pineapple waste and cassava peel concentrate.

Ingredient	Ratio of concentrate and ensiled pineapple waste			
	50:50	60:40	70:30	80:20
EPW (%)	50	60	70	80
Concentrate (%)	50	40	30	20
Total	100	100	100	100

EPW = Ensiled pineapple waste.

using the procedures of Gürelli (2014). The heart rate was taken when the goat was calm early in the morning using a stethoscope and a stop watch to determine the heart beat while the rectal temperature was taken using a glass thermometer. The thermometer was then disinfected with cotton wool and methylated spirit after each use.

Chemical analysis

Sub samples of the experimental diets were taken, bulked and subjected to laboratory analysis for proximate composition determination according to (AOAC, 2005).

Statistical analysis

All data collected were subjected to a One-Way analysis of variance (ANOVA) and means were separated by Least Square Difference in the statistical package for social science (SPSS) version 20.

RESULTS

Proximate composition of experimental diets

The Proximate composition of experimental diets is shown in Table 3. Dry matter ranged between 95.57 and 99.74%, *pennisetum purpureum* had the highest value of 99.74%. The observed value of ether extract ranged from 3.31 to 4.61%. The value obtained for crude protein indicated that concentrate have the highest value of 20.73% while ensiled pineapple wastes had the least value of 12.17%. Ash content was higher in concentrate (11.25%) while ensiled pineapple waste had the least ash content of 4.11%. Crude fiber ranged from 1.67 to 12.51%. Nitrogen free extract (NFE) ranged from 51.60 to 74.73% with the highest value recorded in ensiled pineapple waste while the least content was recorded in *Pennisetum purpurem.* Acid detergent Fibre (ADF) ranged from 44.11 to 72.20% in pineapple waste while acid detergent lignin ranged between 44.11% and 74.20% and cellulose was between 2.42 and 22.62% for pineapple waste.

Rumen parameters and thermo physiological response of WAD goats fed ensiled pineapple waste meal

Rumen parameters of West African Dwarf goats fed graded levels of ensiled pineapple waste and cassava peel are shown in Table 4. Dietary groups fed 70:30 and 80:20 ratios had significantly ($p<0.05$) higher pH values of 6.09 and 6.14 than the other two dietary groups. Total volatile fatty acid (TVFA) value ranged from 13.35 to 14.38% and was not significantly ($p>0.05$) different among the treatments. Propionic acid and acetic acids were not significantly ($p>0.05$) different among the treatments but group fed at 70:30 ratio had higher values than other treatments. The values of butyric acid and ammonia nitrogen (NH_3-N) ranged from 5.24 to 6.47% and 2.05 to 2.65% respectively. The highest value was obtained at ratio of 80:20 than other treatments. Table 5 shows the physiological parameters of West African Dwarf goats supplemented with pineapple waste. Rectal temperature values were observed among treatments ranges between

Table 3. Proximate composition of experimental diet.

Parameters	Ensiled pineapple waste	*Pennisetum purpureum*	Concentrate
Dry matter	95.57	99.74	90.93
Crude protein	12.63	13.13	20.73
Crude fibre	12.51	33.60	1.67
Nitrogen free extract	74.73	57.60	45.23
Ether extract	4.61	3.31	2.05
Ash	4.11	9.11	11.25

Table 4. Rumen parameters of WAD goats fed ensiled pineapple waste and cassava Peel Concentrate.

Parameters	Treatments				SEM	LOS
	50:50	60:40	70:30	80:20		
pH	5.08^{b}	5.09^{b}	6.09^{a}	6.14^{a}	0.19	*
TVFA (%)	13.39	13.35	14.24	14.38	0.18	NS
Propionic acid (%)	3.69	3.63	4.14	3.93	0.28	NS
Acetic acid (%)	3.52	3.83	3.94	3.62	1.13	NS
Butyric acid (%)	5.24^{b}	5.29^{b}	6.21^{a}	6.47^{a}	0.21	*
N-NH_3 (%)	2.05	2.42	2.34	2.65	0.11	NS

^{abc} In the same row, the superscript are significant different($p<0.05$), Ns = not significant, LOS = Level of significant, SEM = Standard error of mean, TVA = Total Volatile Fatty acids, NH_3 = Ammonia Nitrogen.

Table 5. Thermophysiological characteristics of WAD goats fed with ensiled pineapple waste and Cassava Peel Concentrate.

Parameters	Treatments				SEM	LOS
	50:50	60:40	70:30	80:20		
Temp (^{o}C)	38.50	38.65	38.27	38.30	0.28	NS
Pulse (b/min)	63.25^{c}	77.75^{a}	71.00^{b}	75.00^{a}	1.98	*

LOS = Level of significance, SEM = Standard error of means.

Table 6. Rumen microbial count of WAD goats fed ensiled pineapple waste and cassava peel concentrate.

Parameters	Treatments				SEM	LOS
	50:50	60:40	70:30	80:20		
Total bacteria count (cfu/ml)x10^{8}	1.18	1.03	1.29	1.72	0.13	NS
Total Protozoa count (cfu/ml)x10^{3}	4.40^{c}	8.18^{a}	3.70^{d}	7.15^{b}	0.90	*
Total fungi count (cfu/ml)x10^{4}	1.20^{b}	2.13^{a}	1.38^{b}	2.40^{a}	0.22	*

^{abc};In the same row, the superscript are significant different($p<0.05$), Ns = not significant, LOS = Level of significant, SEM = Standard error of means.

38.27 and 38.65°C. Animals fed with 60:40 supplementary diet had the highest rectal temperature, however, the values were not ($p>0.05$) significantly different between the treatments. The pulse rate values ranged between 63.25 and 77.75 beats per minute. Animals in 60:40 ratio were observed to have the highest pulse rate (77.75 beats /minute) followed by 80:20 (75.00) while 50:50 had the lowest 63.25 beats per.

Result of rumen microbial count

The microbial population of West African Dwarf goat fed ensiled pineapple waste and cassava peel concentrate supplement is presented in Table 6. The result shows that protozoa and fungi counts were significantly ($p<0.05$) affected by the dietary treatments while bacteria count were not. In protozoa and fungi counts, values obtained for

60:40 and 80:20 supplementary levels were significantly ($p<0.05$) higher than other treatments while for bacteria count, the highest count (1.72×10^8) was obtained for dietary groups fed diet 80:20; although, it was not significantly different ($p>0.05$) from other treatments.

DISCUSSION

Proximate composition of experimental diet

Dry matter values of the experimental diets ranged from 95.57 to 99.74%. The dry matter content was higher than 89.16 to 89.90% reported by Ajagbe *et al*. (2020) in their study with West African Dwarf goats fed cassava peels and poultry manure concentrate supplement. The dry matter content in this study was also higher than 85.00 to 88.50% reported by Yusuf *et al*. (2013). Protein content varied between 12.63 and 13.13%. These values are higher than 5.27 to 12.44% reported by Ajagbe *et al*. (2020). The values of crude fibre content of pineapple waste were 12.51%. These values were lower than 5.50 to 25.00% reported by Bello and Tsado (2013). Nitrogen free extract (NFE) content values in this study were higher than 75.12 to 86.12% reported by Ajagbe *et al*. (2020) on West African Dwarf goats fed cassava peels and poultry manure concentrate supplement. ADF content in this study was higher than the value obtained by Yusuf *et* al. (2013). Variation in nutrient composition of experimental diets might be attributed to different feed ingredients, processing methods of feed ingredients, soil condition on which the feed materials used were harvested and other factors such as climatic factors of the location.

The Rumen parameters and thermo physiological responses

Rumen liquor pH values of the animals were significantly different ($p<0.05$) between the treatments (a range of 5.08 to 6.14). All the values recorded fell within the reported values (6.00-7.20) suitable for the growth and activities of microbes (Jallow and Hsia, 2011). Ajagbe *et al.* (2020) reported a range of 6.52 to 7.14 on West African Dwarf goats fed cassava peels and poultry manure concentrate supplements. Kamra (2005) also reported a range of 6.0 to 6.9 for optimum growth of rumen bacteria. The pH of the ruminal content is probably the most important ruminal factor affecting microbial population and their activities (Nagaraja, 2012). Rumen ammonia-nitrogen concentration ranged between 2.05 to 2.65% in 50:50 and 80:20 respectively and was not significantly influenced ($p>0.05$) by the dietary supplements. Zareian *et al.* (2013) reported a value of 5 to 20 mg/100ml as suitable for ruminal microbial activities. The values obtained in this study are in contrast to the report of Zareian *et al.* (2013). The Propionic acid and acetic acid were not significantly different ($p>0.05$) for all treatments with the highest value (4.14%) and (3.94%) obtained in 70:30. Butyric acid was significantly ($p<0.05$) affected by the dietary treatments with the highest value (6.47%) obtained at 80:20 supplementation. This indicated that pineapple waste have the potential to improve the level of VFAs production. The Volatile fatty acid is the major end product of microbial degradation of fibre in the rumen. Aluwong *et al*. (2010) reported that volatile fatty acids (acetate, propionate and butyrate) are the products of the anaerobic microbial fermentation of complex carbohydrates in the fore stomach and large intestine. They provide more than 70 % of the ruminants' energy supply. In addition to this, they also serve as the building block of milk synthesis; acetate is a necessary component in the formation of milk fat, propionate is used for glucose production which is needed for the synthesis of milk sugar (lactose) (Aluwong *et al*., 2010). Production of VFAs is generally affected by the type and amount of plant materials as well as pH of the rumen. High roughage diets result in increased proportion of acetate whereas herbage with high levels of water-soluble carbohydrates or concentrate-based diets results in an increased proportion of propionate (Annison *et al*., 2002).

The result of microbial count showed that bacteria count values obtained fell within the range of 1.03×10^8- 1.72×10^8cfu/ml with goats fed at 80:20 diet having the highest bacteria population, while goats fed a diet of 60:40 had the least population. The observed values for bacteria count were higher in comparison with 3.20×10^6 to 5.20×10^6 cfu/ml reported by Adebayo *et al.* (2019) in their study on rumen fermentation characteristics of West African Dwarf goats fed enzyme supplemented total mixed ration in the dry season. However the values are in harmony with 3.80×10^8 to 4.75×10^8 cfu/ml reported by Olajide (2017) for their study of the effects of corncob-based concentrate diet with cobalt supplementation on WAD goat microbial population. Fungi count were significantly ($P<0.05$) varied between the treatments, the values obtained ranged between 1.20×10^4 and 2.40×10^4 cfu/ml which were lower than than 0.05×10^6 to 0.35×10^6 cfu/ml reported by Adebayo *et al.* (2019) in their study on microbial population and blood parameters of WAD goats fed scent leaf as additive. Although observed values for fungi can be compared with 6.85×10^4 to 9.45×10^4 cfu/ml reported by Olajide (2017) for their study of the effects of corncob-based concentrate diet with cobalt supplementation on WAD goat microbial population. Goats fed diet 80:20 had the highest population of fungi 2.40×10^4 cfu/ml, while those on diet 50:50 had the least population (1.20×10^4 cfu/ml). The protozoan population was significantly ($p<0.05$) influenced by the dietary supplements. The highest population 8.12×10^3cfu/ml was obtained in the dietary group fed 60:40 while the least (3.70×10^3 cfu/ml) was obtained in goats fed diet 70:30. Protozoa values observed were higher than 0.25×10^3 to 0.68×10^3 cfu/ml

reported by Adebayo *et al.* (2019) in their study for microbial population and blood parameters of WAD goat fed scent leaf as additive. Variations in values obtained for microbial populations can be attributed to the difference in feed type, feed quality and processing methods of different diets administered in different studies. The thermo physiological parameters, values of rectal temperature were not significantly ($p>0.05$) influenced by the dietary treatments whereas pulse rate was significantly ($p<0.05$) affected with 60:40 and 80:20 having higher values than other treatments. However, the values obtained were within the normal range reported by Ajagbe *et al.* (2020). This indicates that supplementing ensiled pineapple waste and cassava peel in the diets of growing West African Dwarf goats has no adverse effects on the physiological performance of the animals.

Conclusion

The study revealed that rumen parameters of the WAD goat can be improved through ensiled pineapple waste and cassava peel concentrate supplementation. The use of ensiled pineapple waste as a feed resource has the potential of meeting the nutritional needs of the animals without adverse effects on the rumen characteristics as well as physiological response of the animals. Therefore, ensiled pineapple waste and cassava peel concentrate supplementation of inclusion level at 60:40 to 80:20 level could be used in the diet of growing WAD goats for improved rumen ecology.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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