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Table of Contents

Rumen Parameters of West African Dwarf Sheep Fed *Panicum maximum* Supplemented with Varying Levels of *Gmelina arborea* Leaves

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Abstract

This experiment was carried out to assess the rumen characteristics of West African dwarf sheep fed varying level of *Panicum maximum* supplemented with *Gmelina arborea* leaves. Twenty (20) healthy West African Dwarf sheep with average weight of 10+0.55kg and were randomly allotted to five (5) diet with four (4) animals per treatment in a completely randomized design. The diets compared were A (100% *Panicum maximum*); B (75% *Panicum maximum* + 25% *Gmelina arborea* leaf); C (50% *Panicum maximum* + 50% *Gmelina arborea* leaf); D (25% *Panicum maximum* + 75% *Gmelina arborea* leaf); and E (100% Dried *Gmelina arborea leaf*). The diet samples were analyzed for chemical composition and anti-nutritive components. At the end of feeding trial, rumen liquor from the experimental animals were collected for rumen fermentation characteristics Data were collected on volatile fatty acids (VFAs) production rumen pH and ammonia nitrogen. The results obtained showed that the chemical composition and the anti-nutrient content in the diets were significantly ($P<0.05$) different. Dry matter was highest in diet E (82.50%) and lowest in diet A (36.50%). The crude protein ranged between (9.75%) in diet A and (18.33%) in diet E. the Neutral detergent fibre, Acid detergent fibre and Acid detergent lignin was highest in diet B (63.30%), A (31.50%) and C (16.60%) respectively. the anti-nutrient content of the diet showed no any negative effect on the animals. The acetic acid (5.93%), propionic acid (5.65%), butyric acid (5.40%), valeric acid (5.37%), total volatile fatty acids (34.37mmol/liter), lactic acid (7.37%) and pH (8.25) of the rumen were significantly ($p<0.05$) higher in animals on diet B than those on diets A, C, D and E. Animals on diet D had the highest values in terms of rumen ammonia concentration (0.53mg/100ml) followed closely was diet C and E with the value (0.48mg/100ml). It can be concluded that feeding West African Dwarf (WAD) sheep with *Panicum maximum* supplemented with *Gmelina arborea* leaves offers potential results in supplying fermentable

nutrients needed to enhance favourable rumen environment for effective microbial activities without any adverse effect on the rumen parameters status of the animals.

Keywords: *Panicum Maximum, Gmelina arborea, WAD Sheep, Rumen Parameter*.

INTRODUCTION

Ruminant animals play an important role in the economic development of Nigeria in terms of feeding the steadily growing population and providing the investible resources for national development (Bolaji *et al.,* 2016). Most commonly reared ruminants in Nigeria include cattle, sheep and goat. The supply of adequate nutrition is germane for optimum livestock production. One of the most challenging factors in achieving this is the scarcity of feed both in quantity and quality especially during the dry periods of the year, thus resulting in animal's low productivity and even death (Ibhaze *et al.,* 2014). Feed accounts for 60 – 70% of total cost of livestock production and it's inadequacy in quality and quantity could lead to a situation of low nutritional status, poor weight gain, poor reproductive ability, poor production, poor health condition and poor conversion ratio (Fajemisin *et al*., 2015). It therefore, becomes important to supply adequate feed in quantity and quality for optimal performance by livestock.

Panicum maximum (Guinea grass) is one of the most naturally occurring grasses in the tropics and subtropics of Africa which has high yield and regenerating ability. They are very responsive to nitrogenous fertilizer and highly palatable to livestock at all stages of growth which makes it one of the best fodder grasses (Crowder and Chhenda, 1982; Eyoh *et al.,* 2019). *Panicum maximum* is considered one of the most valuable fodder plants, producing high yields of palatable fodder, but its nutritive value rapidly declines with age. There is a need to supplement *Panicum maximum* with other forages that have high nutritive value and available all year round.

Gmelina aborea is a multipurpose tree, a leguminous browse plant, which has been identified as one of the cheapest way in reducing feeding cost in ruminant production in the tropics (Okpara *et al.,* 2012). It is a fast-growing deciduous tree that even though it sheds some of its leaves when the dry season is approaching, the regrowth of new leaves could serve as animal feed. The leaves are unconventional materials that can be explored for the production of feedstuff. They are high in nutrient, previous records (Ahamefule, *et al.*, 2006; Osakwe and Udeogu, 2007; Okafor, *et al.,* 2012) have shown that the leaves contain as much as 10.01-38.4% crude protein and 3.10-30.46 % crude fibre with low level of antinutritional compounds.

Ruminant animals are unique in there feeding status based on the physiology thereof rumen; it is the largest muscular organ in the fore-stomach. The rumen plays a central role in the ability of ruminants to produce human edible food

from resources that are otherwise not available for consumption by mankind. 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. The populations of rumen microorganisms are affected by several factors like quality and quantity of feed, feeding frequency and feed additives (Hungate 1966; Varga and Kolver 1997; Vercoe *et al* 2009).Therefore, adequate feeding to meeting the nutritional need of the rumen microbes plays vital role in ruminant animal nutrition.

Ahamefule (2002) reported that Forages and feedstuffs containing less than 7 % CP are poorly digested by ruminants due to insufficient nitrogen to stimulate rumen microbial functions; although the value of CP content of *Gmelina arborea* as reported by many authors are more than the minimum protein requirement adequate for microbial functions Studies have shown that *Gmelina arborea* leaf can be used as cheap protein supplements which can improve voluntary intake, digestibility and the general performance of animals fed low quality feeds (Kakengi *et al*., 2001).

Similarly, the rumen metabolites concentration viz., volatile fatty acids and different nitrogen fractions are affected by nature and quality of feed (Santra and Karim 2001; Samanta *et al.*, 2003). Mohammed and Chaury, (2008) indicated that rumen fermentation products such as volatile fatty acids are essentials nutrients to meet the demand of rumen microbes and animals body build up. This study was carried out to evaluate rumen parameters of growing West African Dwarf goats fed *Panicum maximum* (Guinea grass) supplemented with varying levels of *Gmelina arborea leaves*

METHODOLOGY

Experimental Site

The research was carried out at Sheep and Goat unit, Ladoke Akintola University of Technology (LAUTECH) Teaching and Research farm, Ogbomosho, Nigeria.

Sample Collection and Processing Technique

Panicum maximum (Guinea grass) was obtained from already existing pasture plot at LAUTECH Teaching and Research farm and *Gmelina arborea* was obtained from within the university premises.

The test ingredients were harvested, weighed and processed as Air-dried sample

Air-dried: A fresh sample of *Gmelina arborea* leaves was obtained and spread on a drying platform in a ventilated pasture house for five (5) days to air dried. The leaves were turned occasionally to ensure even drying. The Air-dried sample was bagged until when used.

Feeding and Housing Management of Experimental Animals

Twenty West African Dwarf (WAD) Sheep were assigned into five groups of four animals each on the basis of average body weight in a completely randomized design. Each group was offered one of these five diets. The diets offered consist of Guinea grass (*Panicum maximum*) and processed *Gmelina arborea* leaves (GAL) in the following proportion:

- Treatment A: 100% of *Panicum maximum*
- Treatment B: 75% *Panicum maximum* + 25% Dried GAL
- Treatment C: 50% *Panicum maximum* + 50% Dried GAL
- Treatment D: 25% *Panicum maximum* + 75% Dried GAL
- Treatment E: 100% Dried GAL

Sheep were housed individually in pens provided with feeder and drinker. Sheep were treated against external and internal parasites using ivomec injection; vaccinated against peste-de-petit ruminant (PPR). The Sheep were subjected to 4weeks acclimatization period and 2weeks adaptation period before the commencement of the feeding trial.

Chemical Analysis

The diets samples was taken, oven dried, milled, labeled and taken for dry matter, crude protein, ether extract, Ash determination according to A.O.A.C (2000) while Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), and Acid Detergent Lignin (ADL) analysis was determined using the procedure of Van Soest *et al.* (1991). Hemicellulose was calculated as differences between NDF and ADF while cellulose is the differences between ADF and ADL.

Antinutritional Component

Analysis was carried out to determine the presence of Tannin, Alkaloid, Saponin, Phytate, Oxalate, depicting the potential toxicity of the feed resources. The anti-nutritional factors were determined using folin ciocatteu as

described by Makkar (2000), while saponin and alkaloids was determined according to A.O.A.C (2000).

Rumen Study

Rumen fluid sample (40ml) was taken at the end of feeding trial. The rumen fluid sample was collected by means of suction tube thrust into the rumen compartment. As soon as the sample was obtained, rumen fluid temperature and pH were determined within two minutes of collection by using thermometer and digital pH meter, respectively. The digital pH meter was stabilized in distilled water with specific pH recommendation before used for the reading. 20ml of the rumen fluid samples was stored in 40ml 10% formal saline prior to the direct microscopic counts of rumen bacteria. While the other 20ml sample of rumen fluid was bulked for each animal before made free of coarse particle by filtration with cheese cloth. Thereafter, 5ml sample of the filtrate was then acidified with 1ml of a 5% (v/v) orthophosporic acid solution and stored frozen in the airtight plastic bottle container for determination of volatile fatty acid concentration and its fractions. The other 15ml of the filtrate sample was added to 10% sulphuric acid solution before they were stored freeze for analysis of ammonia nitrogen concentration.

Rumen Parameters

Rumen ammonia nitrogen concentration was measured using the method of Mebrahtu and Tenaye (1997). Total volatile fatty acids production was determined by steam distillation process using Markham micro-distillation apparatus as reported by Yusuf *et al*. (2013). Individual volatile fatty acids production was determined using gas chromatography (Mebrahtu and Tenaye, 1997).

Experimental Design and Statistical Analysis

The experimental design adopted in this study was Completely Randomized Design (CRD). Thus, data obtained from the study was subjected to one-way analysis of variance (ANOVA) and means was separated by adopting Duncan's Multiple Range test at 5% level of probability using the procedures of SAS (2000).

FINDINGS

Chemical composition of *Panicum maximum* supplemented with varying level of *Gmelina arborea* leaves fed to West African Dwarf sheep

The Chemical composition of *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves (Table 1) were significantly different ($p<0.05$) across all the diets except for Ether extract ($p>0.05$). Dry matter contents ranged between 36.50-82.50% in the study with diet A (36.50%) having the lowest ($P<0.05$) value while diet E (82.50%) had the highest. Crude protein showed that diet A (9.75%) differed significantly ($p>0.05$) from other diet and diet E (18.33%) other the other hand recorded the highest. Ash contents ranged between 12.00-16.16% with diet B (12.00%) having the lowest value while diet E (16.16%) had the highest value. Ether Extract contents ranged between 2.602.90%. Neutral Detergent Fibre showed 57.15% to 63.30%, diet A, B and C were similar ($P>0.005$) while Diet D and E were also similar. Acid Detergent fibre which ranged between 23.30% and 31.50%. Acid detergent lignin value was highest in diet D with the value 16.60%. The hemicellulose content varied from 27.20-36.15%, with the least value (27.20%) recorded in Treatment D while the highest value (36.15%) was recorded in Treatment B. The cellulose value ranged from 10.00% in diet E to 16.65% in diet A.

Table 1: Chemical Composition of *Panicum maximum* Supplemented with Varying Level of *Gmelina arborea* leaves (GAL) Fed to West African Dwarf Sheep

PARAMETERS (%)	A	B	C	D	E	SEM
Dry matter	36.50^{e}	48.85^{d}	63.30^{c}	72.89^{b}	82.50^{a}	0.92
Crude protein	9.75^{d}	13.25^{c}	15.18^{bc}	16.60^{ab}	18.33^{a}	0.77
Ash	13.89^{b}	12.00^{c}	12.20^{c}	14.57^{b}	16.16^{a}	0.51
Ether extract	2.90	2.90	2.80	2.60	2.60	0.28
Crude fiber	35.03^{a}	27.73^{b}	26.05^{a}	25.50^{a}	21.05^{b}	0.56
NDF	62.20^{a}	63.30^{a}	61.62^{a}	57.70^{b}	57.15^{b}	1.03
ADF	31.50^{a}	27.15^{ab}	28.20^{ab}	30.50^{a}	23.30^{b}	1.41
ADL	13.85^{ab}	13.30^{b}	15.50^{ab}	16.60^{a}	13.30^{b}	0.97
Hemicellulose	31.70^{ab}	36.15^{a}	33.42^{ab}	$27.20b^{c}$	33.85^{ab}	2.13
Cellulose	16.65^{a}	13.85^{ab}	12.70^{ab}	13.90^{ab}	10.00^{b}	1.43

$^{a, b, c, d, e}$: Means on the same row with different superscripts were significantly different ($P < 0.05$)

SEM: standard error of mean; DM: Dry matter content; NDF: Neutral detergent fibre; ADF: acid detergent fibre; ADL: Acid detergent lignin; HEMI: Hemicellulose; CELLO: Cellulose

A: 100% *Panicum maximum*; B: 75% *Panicum maximum* + 25% Dried (GAL); C: 50% *Panicum maximum* + 50% Dried GAL D: 25% *Panicum maximum* + 75% Dried GA; E: 100% Dried GAL

Levels of Anti-Nutritional Factors of *Panicum maximum* Supplemented with Varying Level of *Gmelina Arborea* Leaves

The anti-nutritional content of *Panicum maximum* supplemented with varying level of *Gmelina arborea* leaves fed to West African Dwarf sheep is presented in Table 2. Significant differences ($P<0.05$) were observed among diet for all the parameters assessed. The tannins concentrations in the diets varied from 42.27mg/100g in diet A to 62.25mg/100g in diet E. Phytate value ranged from 53.36 mg/100g in diet A to 84.14 mg/100g in diet B. The lowest value recorded for saponin was in diet B (11.71 mg/100g) while the highest value was in diet E (20.60 mg/100g). The highest value of Oxalate was recorded in diet B (14.98 mg/100g) and the lowest value was recorded in diet E (9.17 mg/100g). Alkaloids value ranged from 3.87-7.27% with the lowest value obtained in diet E and highest value obtained in diet B. Phytate, oxalate and alkaloids decrease as inclusion of GAL increases, while Tanin and saponin increased as proportion of GAL increased.

Table 2: Levels of Antinutritional Factors of *Panicum maximum* Supplemented with Varying Level of *Gmelina arborea* Leaves (GAL)

Parameter	Tannin (Mg/100g)	Phytate (Mg/100g)	Saponin (Mg/100g)	Oxalate (Mg/100g)	Alkaloids (%)
A	42.27^{d}	53.36^{d}	16.65^{c}	13.39^{ab}	5.03^{c}
B	53.03^{c}	84.14^{a}	11.71^{d}	14.98^{a}	7.23^{b}
C	57.78^{b}	82.02^{a}	17.15^{c}	12.25^{b}	7.27^{b}
D	58.69^{b}	72.84^{b}	18.89^{b}	12.24^{b}	4.64^{cd}
E	62.25^{a}	63.71^{c}	20.60^{a}	9.17^{c}	3.87^{d}
SEM	0.83	1.52	0.46	0.78	0.35

$^{a, b, c, d, e}$: Means on the same row with different superscripts were significantly different ($P < 0.05$)

SEM: standard error of mean.

A: 100% *Panicum maximum*; B: 75% *Panicum maximum* + 25% Dried (GAL); C: 50% *Panicum maximum* + 50% Dried GAL D: 25% *Panicum maximum* + 75% Dried GA; E: 100% Dried GAL

Rumen Volatile Fatty Acid (VFAs) Parameters of West African Dwarf Sheep Fed *Panicum Maximum* Supplemented With Varying Levels of *Gmelina Arborea* Leaves

Presented in Table 3 are the rumen volatile fatty acid (VFAs), lactic acid, pH and Ammonia Nitrogen (NH_3-N) parameters of West African dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves. No Significant differences (P>0.05) were observed among diet for all the VFAs assessed. The molar proportion of acetic acid values observed ranged from 3.57 to 5.93% with the highest value recorded in diet B and lowest in diet E. The propionic, butyric, valeric acid, lactic acid and the rumen total volatile fatty followed the same trend as obtained in acetic acid.

Table 3: Rumen Volatile Fatty Acid (VFAs) of West African Dwarf Sheep Fed *Panicum maximum* Supplemented with Varying Levels of *Gmelina arborea* Leaves

Parameters	A	B	C	D	E	SEM
Acetic acid (%)	5.21	5.93	5.60	5.09	3.57	0.70
Propionic acid (%)	4.97	5.65	5.34	4.86	3.40	0.66
Butyric acid (%)	4.75	5.40	5.10	4.64	3.25	0.63
Valeric acid (%)	4.73	5.37	5.07	4.62	3.24	0.63
Total volatile fatty acid (mmol/litre)	31.22	34.37	30.01	28.31	23.69	3.32

[a, b. c, d]: means with different superscript along the same row differ significantly ($p<0.05$)

SEM: Standard error of mean

A: 100% *Panicum maximum*; B: 75% *Panicum maximum* + 25% Dried (GAL); C: 50% *Panicum maximum* + 50% Dried GAL D: 25% *Panicum maximum* + 75% Dried GA; E: 100% Dried GAL

Lactic Acid, pH and Ammonia Nitrogen (NH_3-N) Parameters of West African Dwarf Sheep Fed *Panicum maximum* Supplemented with Varying Levels of *Gmelina arborea* Leaves

Presented in Table 4 are Lactic acid, pH and Ammonia Nitrogen (NH_3-N) parameters of West African dwarf sheep fed *Panicum maximum* supplemented with varying levels of *Gmelina arborea* leaves. No Significant differences (P>0.05) were observed among diet for all the VFAs assessed.

The molar proportion of acetic acid values observed ranged from 4.44 to 7.37% with the highest value recorded in diet B and lowest in diet E. The pH of the rumen fluid was observed to be significant (P<0.05) and the values were 8.70, 8.59, 8.25, 7.95 and 7.86 for diets A, B, C, D and E respectively. Apparent rumen ammonia nitrogen concentration levels in sheep ranged from 0.42-0.53mg/100ml with animals on diet E (0.53mg/100ml) being the highest, diet B (0.42 mg/100ml) recorded the least.

Table 4: Lactic Acid, Ph and Ammonia Nitrogen (NH_3-N) Parameters of West African Dwarf Sheep Fed *Panicum Maximum* Supplemented with Varying Levels of *Gmelina arborea* Leaves

Parameters	A	B	C	D	E	SEM
Lactic acid (%)	6.48	7.37	6.97	6.34	4.44	0.87
pH	8.70[a]	8.59[a]	8.25ab	7.86[b]	7.95[b]	0.15
NH_3-N (mg/100ml)	0.45	0.42	0.48	0.48	0.53	0.05

[a, b. c, d]: means with different superscript along the same row differ significantly (p<0.05)

SEM: Standard error of mean

A: 100% *Panicum maximum*; B: 75% *Panicum maximum* + 25% Dried (GAL); C: 50% *Panicum maximum* + 50% Dried GAL D: 25% *Panicum maximum* + 75% Dried GA; E: 100% Dried GAL

Discussion

The dry matter contents of the experimental diet ranged between 36.50 and 82.50%, the dry matter content recorded in diet C, D and E were relatively high but similar to 70% to 80% reported by Okoruwa (2015) suggesting the feeds can be stored for a longer period of time without spoilage. The crude protein content of a browse fodders is an indication of their nutritional quality since crude protein content is a very important index of nutritional quality of a feed (Okunade *et al.*, 2014). The crude protein value of the experimental feedstuffs ranged between 9.75% and 18.33%.

Crude protein values increased with decrease ratio of GAL supplementation. The crude protein level of all the experimental diet except diet A which is slightly low exceed the 10% crude protein level recommended by Bengaky *et al*. (2007) for maximum growth in ruminant animals. The lower value of crude protein observed in diet A is in agreement with Leng (1997) who stated that roughages such as grasses contain greater quantities of structural components

and therefore more fibre than other livestock feed resources. The CP contents of these browses were higher than the minimum of 7- 8% necessary to provide the minimum ammonia levels required by rumen micro-organisms to support optimum rumen activity Norton (1994). This implies that the feedstuffs are adequate to provide nitrogen requirement for rumen microbes to maximally digest the components of dietary fibre leading to the production of volatile fatty acids (Okoruwa and Igene, 2014).

The ash contents were considerably different in values, ranging from 12.00% to 16.16%. Diet E having the highest value of ash implies that the mineral content present in the diet is highest compared to the rest of the experimental diets. Also the fibre fraction level obtained in this study was within the safe upper limit of 60% reported by Oni *et al.*, (2010) for NDF (57.70%-63.30%), but relatively low in ADF (23%-31%) and ADL (13%-16%) for guaranteed forage intake by ruminant. Meissner *et al*. (1991) observed that NDF level of forage above 65% can limit feed intake.

The result of the fibre fractions obtained in this study was also lower than the value reported by (Fasae *et al.*, 2014). The fibre fractions showed that the diets have the potentials to support intestinal movement and proper rumen function. This may imply that the fibre fractions of the diet have the potential to improve fermentation in the fore stomach of the animals (Ajagbe *et al.,* 2020). Adegbola *et al*. (1990) stated that excess fibre fractions especially NDF reduces the rate of fermentation and feed intake, but little fibre leads to rapid rumen fermentation. The hemicellulose value ranged between 27.20% and 36.15% in this study. The value was higher than the 14% - 26% reported by Okunade *et al*. (2014) who quoted Humphreys (1991) who opined that the higher the hemicellulose fraction, the higher is the feed value. The range of cellulose concentration from this study 10%-16.65% was within the 11% to 26% reported by Okunade *et al. (*2014) who opined that fodders of this range have the potentials to support intestinal movement, proper rumen function and promote dietary efficiency. 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 was harvested and other factors such as climatic factors of the location etc.

Anti-Nutritive Factors are compounds which are produced by different mechanisms and affect the utilization of nutrients. These are produced by inactivation of some nutrients and through normal metabolism and affect the utilization of nutrients and digestion of feed. These anti-nutrients also play role

in defense mechanism in plants by producing tannin. Levels of antinutrients reported in this study was lower compared with the study of Abegunde *et al*. (2021) whose value were below the threshold levels permissible in ruminant animals (Umar *et al.,* 2014).

A threshold concentration of 5% tannin had been reported above which there is rejection of browse plants (Ologhobo 1989). Min and Hart (2003) also reported that the action of condensed tannins in forages markedly reduced rumen proteolytics bacterial growth and some bacteolytic populations measured *in vivo*. However, ruminants are known to tolerate a threshold level of about 9% dietary tannin.

Phytates is considered as a most effective anti-nutrient in foods, and a cause of mineral ions deficiencies in animal and human nutrition. Phytate is actually the organically bounded form of phosphorus. Phytate binds with various minerals such as magnesium, calcium, zinc and iron and thus cause increase in the mineral deficiency in digestive tract of animals (Bello *et al*., 2008). The concentration of phytate in this study varied from 53.836-84.14mg/100g. The values observed in this study are similar to the values of 0.84-1.14mg/g reported elsewhere for dried *Gmelina arborea* as substitute for groundnut haulms (Okafor *et al*., 2012). The low level of phytate in the diets indicates the potential of the experimental diets to make mineral available for the animals since phytates bind minerals like Ca, Mg, Fe and Zn (Bakare *et al*., 2019). The low phytate value recorded from this study is an indication of a good diet as reported by Abegunde *et al.* (2021) that high concentration of phytate greatly lowers the ability of intake of minerals in animals.

Saponins have been found to be detrimental to protozoa and have been identified as defaunating agents in the rumen (Newbold *et al* 1997). The saponins contents from this study ranged from 11-21mg/100g in all diet. These values were slightly similar to 9-13mg/100g reported by Abegunde *et al.* (2021). The concentration of saponin in this study is still within tolerable level of 1.5 - 2% (Onwuka, 1983). Tannins and saponins have been reported to be a critical factor in ruminant nutrition. They are important ingredients in feed for ruminants, particularly for methane mitigation strategy owing to their natural origin as opposed to chemical additives (Wanapat *et al*., 2013). Evidence from experiments have shown suggests that tannins bind to proteins, forming a tannin coating of the protein through a surface adsorption mechanism, and this can lead to precipitation of the tannin-protein complex (Dobreva *et al*., 2011). This undermines the importance of ensuring that the secondary metabolites,

particularly tannin, are consistent with the threshold levels recommended for ruminant.

The value 42-62mg/100g observed from this study was lower compare the range of 60 to100g Kg DM that is considered to depress feed intake and growth (Barry and Duncan, 1984). However, in ruminants, dietary condensed tannins of 2 to 3% have been shown to have beneficial effects because they reduce the protein degradation in the rumen by the formation of a protein-tannin complex (Barry, 1987).

It was observed that ruminants can consumed certain quantity of feeds with a high level of oxalate without any deleterious effect [Oke, 1969]. The concentration of alkaloid ranges from 3-7% in all the experimental diet. Some types of alkaloids show very dangerous effects on animals. Development of fetal in sheep could be affected by alkaloids and sometime it leads to the death of fetal (Zafar *et al.,* 2015).

The values of acetic obtained in this study (3.57-5.93%) were highest for diet 2. The values were however similar to 42.03mol/100ml- 46.65mol/100ml reported by Okoruwa *et al.* (2016). Butyric acid values were higher than 8.80-12.47mol/100ml reported by Adebayo *et al.* (2017) for their study on rumen fermentation characteristics of West

The acetic acid production value recorded from this experiment was within the range of. The values was very low compared to the (42-47%) recorded by Okoruwa *et al.* (2016). There were differences in acetic acid value across all the diets. These differences observed in acetic acid values might be due to the varying level of the diets (Okoruwa *et al.,* 2016). Propionic acid has been classified as the major precursors of glycogenic fatty acid in ruminants (Vasta *et al.,* 2009). The propionic acid values recorded from this study was within the range of (3.40-5.65%). Values of propionic acid obtained were lower than 21.6mol/100ml -28.8mol/100ml reported by Suarez *et al* (2006) in their study on effects of different levels of roughage- concentrate dietary treatments on rumen fermentation characteristics of sheep.

Butyric acid values were lower than 16.77mol/100ml-18mol/100ml reported by Puga *et al.* (2001) for sheep fed controlled release urea supplements. Variations in the values might be attributed to physical fibrousness, levels of starch content and carbohydrate solubility of the different dietary treatments used in different studies conducted. The highest proportion of propionic and butyric acids was recorded in diets E which revealed the better rumen fermentation of the diets by the microbial activity and good nutrient utilization

to yield energy (Okoruwa *et al.,* 2016). Acetic acids obtained indicate that acetic acid predominates the volatile fatty acid production followed by propionic and butyric acid.

Volatile fatty acids contribute about 70% of the energy requirement for ruminants; hence they are classified as one of the universal end-product of anaerobic microbial fermentation of carbohydrates in the rumen and the proportion of major partials of volatile fatty acid concentration in the rumen depends largely on the type of feed consumed by the animals (Dung *et al.,* 2011). The total volatile fatty acid values of 23.69-34.37 mol/litre recorded from this experiment was lower than the 66.00-72.00 mmol/litre recorded by Okoruwa *et al.* (2016). Okoruwa (2015) reported that, if volatile fatty acids production rate exceeds the clearance rate, they will accumulate in the rumen and this may lower the rumen pH and cause metabolic disturbance known as rumen acidosis. The lactic acid values recorded from this experiment were between the range of 4.44% and 7.37%, these was lower than 5-21mol/100ml reported by Suarez *et al.* (2006). Aside from lactic acid, values acetic acids obtained indicate that acetic acid predominates the volatile fatty acid production followed by propionic and butyric acid. The difference in values obtained by different authors might be attributed to nature of the diets fed to the animals as well as the chemical composition

Rumen pH is an important factor that measure the acidity and alkalinity of rumen content in ruminants and an acceptable physiological pH for maintaining a well-balanced rumen population is between 5.8 and 6.4 (Ishler *et al.,* 1996; McDonald *et al.,* 2002). The values of rumen pH (7.86-8.70) were above the reported values (6.00-7.20 pH) suitable to facilitate optimum growth and activities of rumen microbes (Kamra, 2005; Jallow and Hsia, 2011; Petrovski, 2017). This was also higher than 5.92-6.60 reported by Okoruwa *et al.* (2016) on rumen metabolites of WAD sheep. The higher rumen pH observed in animals on the experimental diets could probably be due to less fermentable feed components that were consumed by the animals. The implication of these higher rumen fluid pH values observed was that ciliate protozoa population might established well in such rumen environment and encourage fauna and faunation in the rumen. Ranjhnan (2001) reported that diets which are very high in protein also give alkaline reaction which brings about high pH in the rumen. Factors affecting rumen pH are salivary buffer secretion, the endogenous buffering capacity of feeds or digestion and volatile fatty acid (VFA) synthesis and absorption rates (Allen, 1997).

The NH3-N levels of animals in this study were in the normal range of the optimum ammonia level for growth and microbial activity (5-25 mg/dL), according to Preston and Leng (1987). The rumen ammonia concentration levels were highest (0.53 mg/100ml) in animals on diet E. This could be a reflection of the extent of crude protein degradability and nitrogen uptake by the rumen microbes in preference to amino acid in the animals. Cabrita *et al*. (2006) stated that one of the most intriguing problems in rumen ecology is the extent to which ammonia serves as nitrogenous materials for synthesis of microbial cells. The minimum ammonia-nitrogen level of 2–5mg/100ml rumen fluid has been suggested to maximize rumen microbial synthesis, 15mg/100ml to maximize fibre digestion and 20mg/100ml to maximize intake (Yashim *et al.*, 2014). Nonetheless, the rumen ammonia levels obtained in this study were within the normal ranged of 0 to 130mg/100ml reported by Yusuf *et al*. (2013).

These findings suggested that an increase in nutrient intake, especially CP intake, of sheep fed with *P. Maximum* with varying level of GAL may provide a better environment for rumen bacterial activity. Previous studies have reported that dietary CP is important to promote nutrient digestibility and ruminal fermentation. An Increase in CP intake tends to improve apparent digestibility. Animals receiving a high CP level diet produce a significantly higher bacterial population and microbial protein synthesis in rumen fluid, thus resulting in an improved ruminal fermentation (Norrapoke *et al*., 2012; Kang *et al*., 2015; Xia *et al*., 2018).

CONCLUSION AND RECOMMENDATION

The study revealed that feeding varying level of *P. maximum* supplemented with *Gmelina arborea* leaf (GAL) to WAD sheep posed no negative effects on rumen ecology of the animals. The result of rumen parameters obtained was in harmony with optimum characteristics of the rumen ecology. Based on the results obtained in this study, supplementing the diets of growing West African Dwarf sheep with *Gmelina arborea* leaf has the potentials of meeting the nutritional needs of the animals without adverse effects on the rumen parameter.

Gmelina arborea leaf has the nutritive potential as a supplements to poor quality roughages for ruminant feeding. Therefore, farmers can incorporate *Gmelina arborea* leaf in the diets of their sheep to help alleviate the challenge of feed availability all the year round.

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Growth Performance, Carcass Yield and Cost Implications of Broilers Fed with Spent Grain and Enzyme Supplemented Diets

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Abstract

This study was aimed at investigating growth performance, carcass characteristics and cost of feed consumption of broilers fed with enzyme fortified diet containing high fibre content. One hundred and forty-four broilers of 7 d old were randomly assigned into nine treatments (SN1 to SN9) with each treatment replicated twice at eight birds per replicate. The experimental design used was a 3 x 3 factorial arrangement involving three levels of enzyme supplementation of 0 g, 0.5 g and 0.8 g per kg diet and three levels of spent grain inclusion of 0%, 6% and 12% in starter's diet and 0%, 7% and 12% in finisher's diets. Results obtained proved that DFI, FW, WG, FCR and FC were affected ($p < 0.05$) in starter and finisher birds across treatments. Carcass traits (CW, TW, SW, WW, LW and HW) of finisher broilers were also affected ($p < 0.05$) in all treatments. Starter broilers fed SN3 diet had the best growth traits of the highest ($p < 0.05$) FW (1300.50 g) and WG (1149.58 g) value and the lowest ($p < 0.05$) DFI (73.03 g) and FCR (1.98) means. Finisher broilers fed SN3 diet expressed the highest ($p < 0.05$) FW (3221.54g), WG (1920.54 g) and DFI (177.23 g) means and the lowest ($p < 0.05$) FCR (2.71) value, while finisher broilers fed SN9 diet had lowest ($p < 0.05$) DFI value of 148.43 g. However, finisher broilers fed SN6 diet exhibited moderate growth performance and carcass yield at the lowest FC value of ₦362.50, while finisher broilers in treatment SN3 had the highest ($p < 0.5$) value of each carcass traits investigated. In conclusion, SN3 starter diet and SN6 finisher diet are therefore recommended to farmers because the diets showed better growth performance of broilers at low cost of feed consumption and SN6 diet showed good carcass traits of finisher broilers.

Keywords: *Broilers, Spent Grains, Enzyme, Diet, Growth, Carcass.*

INTRODUCTION

Poultry industry in Nigeria is fast growing (FAO, 1989) and the production of broilers is a fast means of bridging the gap of animal protein intake in the country. However, the poultry industry has been unable to tackle its numerous challenges in which high cost of feed is the most paramount challenge the industry is currently facing (Gbenga, 2021). Madubuike (2012) reported that 70 to 75% of total cost of poultry production accounts for the cost of feed production. The high cost of feed has also been attributed to high cost of poultry products which affected the quality and quantity of animal protein intake of Nigerians. Gbenga (2021) further reported that the high cost/shortages of maize have forced many farmers out from the poultry business. However, the country has struggled, over the years, to encourage local production of maize as a means of solving this challenge, but to no avail.

However, the replacement of expensive ingredients with alternatives that are cheap and available is a practicable technique to minimize the cost of feed production. Ideally, maize is most suitable ingredient to be substituted because it constitutes about 50 to 60% of poultry feed (NRC, 1994). This will go a long way to reduce the quantity of maize used and the amount of money invested in feeding birds. For instance, by-products of cereal milling and brewery industries such as wheat offal, rice offal, wheat bran and spent grains may be supplemented with energy-source ingredients. Spent grains are predominantly available in brewery industries as byproduct or waste which may be supplemented with maize and/or other energy-based feedstuffs (Igwebuike *et al*., 2001). However, spent grains are low energy-base ingredient with high fibre level and non-starch polysaccharides (NSPs). This high level of NSPs causes high rate of viscosity in small intestine, sticky droppings, and also induces reduction in nutrient utilization and metabolizable energy (Bedford, 1997; Alam *et al*., 2003). These side-effects of spent grains consequently impede the growth performance and carcass traits of broilers.

The use of NSP-degrading enzymes in animal feed industries is basically to improve the efficiency of feed utilization, increase the rate of growth, and enhance the health conditions and functions of the gastrointestinal tract of animals as well as to reduce environmental pollution by decreasing output of droppings (Acamovic, 2001; Carsten, 2013; Oyeagu *et al*., 2015). NSP enzymes is also used to break the anti-nutritional factors like phytate molecules that bind phosphorous and some other mineral elements in spent grain and other plant based feedstuff (Bedford and Patrige, 2010). Nutrizyme is an

exogenous NSP enzymes that contain synthesized complex compounds (viz: carbohydrases, phytase, xylanase, glucanase, pectinase and hemicellulase) which collectively hydrolyze a broad spectrum of carbohydrate polymers such as hemicelluloses, pectin and glycan into low molecular weight fractions. Despite, the benefits of spent grain and feed enzyme, the use of these ingredients is not widespread among farmers due to lack of relevant information required in our local environments to improve the poultry sector of Nigeria. Therefore, this study was aimed at investigating the growth performance and carcass yield of broiler birds fed diets containing different levels of spent grains and feed enzyme when reared in deep litter system.

METHODOLOGY

Location and Duration of the Study

This study was conducted in the Poultry Unit of the Teaching and Research Farm of the University of Nigeria Nsukka, Enugu State. Nsukka lies in the derived savannah region located on longitude 6^{o} 25^{1} N and latitude 07^{o} 24^{1} E, at an altitude of 430 m above sea level (Ofomata, 1975). The climate is a tropical humid type with a relative humidity and annual rainfall ranging from 34 to 78% (Momoh *et al*., 2010) and 1567.05 mm to 1846.98 mm (Energy Centre UNN, 2008) respectively. The natural day length for Nsukka is between 11hr: 44 min. to 12hr: 31min. (Elile *et al*., 2020; Weather Spark, 2019) and average annual maximum and minimum temperatures is 29.7^{o}C and 21.0^{o}C (Energy Centre UNN, 2008) respectively. The study lasted for 56 days which included 7days of pre-experimental period when the chicks were brooded.

Management of Birds and Treatments

A total of one hundred and forty-four (144) unsexed Acre broiler chicks were randomly allocated into nine treatments of sixteen birds each after one week of brooding. Each treatment was replicated twice with eight birds per replicate. The treatments were randomly assigned in a 3 x 3 factorial arrangement involving three levels of enzyme supplementation of 0 g, 0.5g and 0.8g per kg diet in both starter and finisher diets; and three levels of spent grain inclusion of 0%, 6% and 12% in starter diet and 0%, 7% and 12% in finisher diet as shown in Table 1. These diets were formulated to meet the nutrient requirements of broilers recommended by NRC (1994). Starter and finisher diet was given *ad libitum* between 7 d to 28 d and between 29 d to 56 d age of the birds respectively. Representative feed samples were assayed for their proximate composition using AOAC (2001) method. The birds were reared in deep litter system and clean cool water was given *ad libitum.* The basic

medications and vaccinations were administered and other procedures carried out in this study were in compliance with the provisions of the University of Nigeria, Nsukka Research Policy (2013).

Measurement of Growth and Carcass Traits

Weight gain (WG) (final body weight – initial body weight) in grammes; average daily feed intake (DFI) [(total feed consumed by birds ÷ the number of the birds) ÷ number of days of the diet was given] in grammes; feed conversion ratio (FCR) (quantity of feed consumed ÷ weight gain); and feed cost per weight gain (FC) (cost of total feed consumed ÷ total weight gain) in naira (Nigerian currency) were calculated for starter and finisher broilers. At the end of the experiment (56 d), a total of eighteen finished broilers were randomly selected (i.e. two birds from each replicate). The birds were put off from feed for 10 h, weighed and then slaughtered. After slaughtering and bleeding, the birds were scalded, defeathered, the heads and shanks were removed. The shanks were weighed and recorded as shank weight (SW), while the remaining carcasses were individually weighed and recorded as carcass weight (CW). Each carcass was further dissected into various parts viz: thigh, breast, wing, liver, heart and they were weighed and recorded in grammes as TW, BW, WW, LW and HW respectively using electronic weighing scale.

Table 1: Composition of Experimental Diets Containing Different Levels of Spent Grain and Enzyme

Treatment		SN1	SN2	SN3	SN4	SN5	SN6	SN7	SN8	SN9
	Ingredient (%)									
	Maize	33.30	33.30	33.30	28.42	28.42	28.42	23.28	23.28	23.28
	Wheat offal	22.21	21,71	21.41	22.41	22.91	21.61	23.00	22.05	22.00
	Spent grain	**0.00**	**0.00**	**0.00**	**6.00**	**6.00**	**6.00**	**12.00**	**12.00**	**12.00**
	Soybean meal	15.79	15.79	15.79	15.27	15.27	15.27	14.72	14.72	14.72
	GNC	15.79	15.79	15.79	15.27	15.27	15.27	14.72	14.72	14.72
	Fishmeal	7.89	7.89	7.89	7.63	7.63	7.63	7.36	7.36	7.36
	Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	*Vit-min. premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Starter	Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Nutrizyme	**0.00**	**0.05**	**0.08**	**0.00**	**0.05**	**0.08**	**0.00**	**0.05**	**0.08**
	Total	100	100	100	100	100	100	100	100	100
	Calculated analysis									
	Crude protein (%)	24	24	24	24	24	24	24	24	24
	Crude fibre (%)	5	5	5	7	7	7	9	9	9
	ME (kcal/kg)	3200	3200	3200	3120	3120	3120	2950	2950	2950
	Proximate composition									
	Dm (g)	91.00	90.40	89.25	91.10	89.90	88.40	91.92	91.95	91.90
	Cp (%)	23.70	24.04	23.50	23.00	23.03	23.30	23.00	23.01	23.00
	Cf (%)	5.03	5.02	5.01	7.07	7.09	6.90	8.98	9.02	8.99
	Ee (%)	5.45	5.33	5.35	5.20	5.05	5.00	4.96	5.01	4.98
	Ash (%)	7.2	7.60	7.70	8.80	8.70	8.75	9.01	9.04	9.01
	Nfe	57.31	56.43	56.30	55.95	51.04	50,58	52.68	49.67	52.00
	Ingredient (%)									
	Maize	20.27	20.27	20.27	13.84	13.84	13.84	10.50	10.50	10.50
	Wheat offal	47.29	47.29	47.05	48.37	47.87	47.57	47.62	47.12	46.82
	Spent grain	**0.00**	**0.00**	**0.00**	**7.00**	**7.00**	**7.00**	**12.00**	**12.00**	**12.00**
	Soybean meal	19.21	19.21	17.47	18.05	18.05	18.05	17.47	17.47	17.47
	GNC	5.49	5.49	4.99	5.16	5.16	5.16	4.99	4.99	4.99
	Fishmeal	2.74	2.74	2.49	2.58	2.58	2.58	2.49	2.49	2.49
Finisher	Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	*Vit-min. premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Nutrizyme	**0.00**	**0.05**	**0.08**	**0.00**	**0.05**	**0.08**	**0.00**	**0.05**	**0.08**
	Total	100	100	100	100	100	100	100	100	100
	Calculated analysis									
	Crude protein (%)	20	20	20	20	20	20	20	20	20
	Crude fibre (%)	7	7	7	9	9	9	11	11	11
	ME (kcal/kg)	2950	2950	2950	2850	2850	2850	2720	2720	2720
	Proximate composition									
	Dm (g)	91.00	90.40	89.25	91.10	89.90	88.40	91.92	91.95	91.90
	Cp (%)	23.70	24.04	23.50	23.00	23.03	23.30	23.00	23.01	23.00
	Cf (%)	5.03	5.02	5.01	7.07	7.09	6.90	8.98	9.02	8.99
	Ee (%)	5.45	5.33	5.35	5.20	5.05	5.00	4.96	5.01	4.98
	Ash (%)	7.2	7.60	7.70	8.80	8.70	8.75	9.01	9.04	9.01
	Nfe	57.31	56.43	56.30	55.95	51.04	50,58	52.68	49.67	52.00

GNC = Groundnut cake; ME = Metabolizable energy; Dm = Dry matter; Cp = Crude protein; Cf = Crude fibre; Ee = Esther extract; Nfe = Nitrogen free extract; *Vitamin and mineral premix (commercial source B.p max), each diet was supplied with 2.5 kg ton^{-1} and each 2.5kg contains, vit A 10,000,000 MIU, Vit. D 2,000,000 MIU, Vit. E 1,000 mg, Vit. K_3 1,000 m, Vit. B1 1,000 mg, Vit. B2 5,000 mg,Vit. B6 1,500 mg, Biotin 50 g, BHT 1,000 mg, Pantothenic 10,000 mg, Folic acid 1,000 mg, Nicotinic acid 30,000 mg, Mn 60 g, Zinc 50g, Fe 30 g, Cu 4 g, Selenium 0.1g and Co 0.1 g.

Experimental Design

The experimental design used was a completely randomized design (CRD) with the following model:

$\mathbf{X_{ijk} = \mu + S_i + N_j (SN)_{ij} + \epsilon_{ijk}}$, where:

$\mathbf{X_{ijk}}$= overall observations of the birds fed diets containing (i^{th}) spent grain and (j^{th}) enzyme at different

(k^{th}) levels;

$\boldsymbol{\mu}$ = overall mean of the experiment;

$\mathbf{S_i}$ = effect of the (i^{th}) spent grain on the individual bird;

$\mathbf{N_j}$ = effect of the (j^{th}) enzyme on the individual bird;

$\mathbf{(SN)_{ij}}$ = interaction effect of the (i^{th}) spent grain and the (j^{th}) enzyme on the individual bird; and

$\boldsymbol{\epsilon_{ijk}}$= experimental error associated with the (i^{th}) spent grain and (j^{th}) enzyme at different (k^{th}) levels.

Statistical Analysis

Data collected were subjected to analysis of variance for factorial experiments in a completely randomized design (CRD) as described by Steel and Torrie (1980) using a statistical computer package (SPSS, 2007) model. Means were separated using Duncan's New Multiple Range Test and accepted at the level of $p < 0.05$.

FINDINGS

The results of the study are presented in Table 2 and 3. Analyses of variance of the data revealed that body weight (BW), weight gain (WG), feed intake (FI), feed conversion ratio (FCR) and feed cost (FC) were significantly ($p < 0.05$) affected in the starter and finisher birds subjected across the dietary

treatments. The weight of carcass (CW), thigh (TW), breast (BW), shank (SW), wing (WW), liver (LW) and heart (HW) were also affected ($p < 0.05$) among finisher birds in the treatments.

Table 2: Interaction Effects of Different Levels of Spent Grain and Enzyme on Growth Performance and Cost of Feed Intake of Starter Broilers

Trts	SN1	SN2	SN3	SN4	SN5	SN6	SN7	SN8	SN9	
LS (%)	0	0	0	6	6	6	12	12	12	
LE (g/kg)	0	0.5	0.8	0	0.5	0.8	0	0.5	0.8	SEM
Growth indices and feed cost										
IW (g)	164.29	150.00	151.58	150.00	152.15	150.00	161.56	161.87	161.58	4.38
FW (g)	1123.44^{b}	1194.46^{b}	1300.50^{a}	1038.22^{c}	1125.43^{b}	1138.22^{b}	988.22^{cd}	1075.43^{c}	973.44^{d}	6.32
WG (g)	959.15^{c}	1044.46^{b}	1149.58^{a}	886.43^{d}	975.06^{c}	987.21^{c}	827.4^{d}	913.30^{d}	812.02^{e}	7.2
DFI(g)	74.01^{a}	74.07^{a}	73.03^{a}	77.01^{b}	75.4^{ab}	74.05^{a}	76.10^{b}	84.11^{c}	83.04^{c}	1.63
FCR	2.10^{d}	2.0.03^{d}	1.98^{e}	2.54^{c}	2.50^{cd}	2.43^{d}	3.22^{a}	2.65^{b}	2.62.12^{b}	0.33
FC (₦)	282.19^{f}	292.50^{e}	282.03^{f}	336.20^{b}	318.54^{d}	338.25^{b}	322.03^{cd}	397.30^{a}	326.84^{c}	1.62

$^{a, b, c, d, e}$ = Means with different superscripts significantly different at $p < 0.05$; Trts = Treatments; SEM=Standard error of mean; LS=Level of spent grain; LE = Level of enzyme; IW = Initial weight; FW = Final weight; WG = weight gain, DFI = Daily feed intake; FCR = Feed conversion ratio; FC = Feed cost per kg weight gain.

Table 3: Interaction Effects of Different Levels of Spent Grain and Enzyme on Growth Performance and Carcass Characteristics of Finisher Broilers

Trts	SN1	SN2	SN3	SN4	SN5	SN6	SN7	SN8	SN9	
LS	0	0	0	7	7	7	12	12	12	
LE	0	0.5	0.8	0	0.5	0.8	0	0.5	0.8	SEM
Growth indices and feed cost										
IW (g)	1123.44	1194.46	1300.50	1038.22	1125.43	1138.22	988.22	1075.43	973.44	5.51
FW (g)	3000.07^{a}	3065.66^{a}	3221.54^{a}	2500.10^{c}	2575.43^{b}	2645.89^{b}	2100.01^{d}	2150.09^{c}	2450.87^{c}	7.34
WG (g)	1878.44^{a}	1886.46^{a}	1920.54^{a}	1375.43^{c}	1507.33^{bc}	1537.01^{b}	1105.22^{c}	1125.43^{d}	1478.43^{c}	6.71
DFI (g)	164.49^{b}	173.58^{d}	177.23^{d}	169.64^{c}	163.14^{b}	158.14^{ab}	154.14^{a}	151.14^{a}	148.43^{a}	3.38
FCR	3.07^{c}	2.92^{d}	2.71^{e}	3.56^{b}	3.20^{bc}	3.12^{c}	3.84^{a}	3.69^{a}	3.53^{b}	0.96
FC (₦)	410.43^{c}	390.50^{c}	365.25^{b}	456..02^{d}	399.87^{c}	362.50^{c}	493.32^{e}	429.62^{c}	342..04^{a}	23.06
Carcass traits										
CW (g)	232.55^{b}	235.89^{b}	256.44^{a}	173.43^{d}	196.73^{c}	197.66^{d}	146.77^{e}	160.89^{de}	193.14^{c}	12.89
TW (g)	560.29^{b}	570.29^{b}	640.07^{a}	425.29^{c}	494.29^{bc}	493.44^{bc}	351.58^{d}	381.58^{d}	483.02^{c}	18.93
BW (g)	607.87^{b}	657.87^{b}	715.29^{a}	420.00^{d}	510.87^{cd}	515.29^{c}	354.58^{e}	417.02^{d}	543.73^{c}	31.19
SW (g)	95.29^{ab}	95.00^{ab}	103.50^{a}	70.00^{cd}	79.19^{c}	80.29^{c}	65.29^{d}	67.58^{d}	77.87^{c}	3.44
WW (g)	230.00^{ab}	235.29^{ab}	250.00^{a}	181.58^{c}	190.00^{c}	196.87^{c}	150.00^{d}	159.29^{d}	190.00^{c}	16.70
LW (g)	60.29^{a}	58.00^{a}	65.29^{a}	45.00^{c}	50.29^{b}	50.00^{b}	40.00^{c}	41.29^{c}	47.87^{bc}	2.42
HW (g)	14.00^{b}	14.06^{b}	15.12^{a}	11.00^{cd}	12.63^{c}	12.05^{c}	9.05^{d}	10.16^{d}	11.12^{cd}	1.95

$^{a, b, c, d, e}$ = Means with different superscripts significantly different at $p < 0.05$; SEM = Standard error of mean; LS = Level of spent grain; LE = Level of enzyme; IW = Initial weight; FW = Final weight; WG = Weight gain, DFI =

Daily feed intake; FCR = Feed conversion ratio; FC = Feed cost per kg weight; CW = Carcass weight; TW = Thigh weight; SW = Shank weight; WW = Wing weight; LW = Liver weight; HW = Heart weight.

Growth Performance

At the starter stage of development, the birds fed enzyme supplemented diet of 0.8g/kg (SN3) had the lowest ($p < 0.05$) DFI of 73.03 g; and the highest ($p < 0.05$) WG of 1149.58 g and FW of 1300.50 g when compared to the broilers fed with enzyme-free diets (SN1) and diet containing 0.5g enzyme (SN2) at the same 0% level of spent grain. This implies that starter broilers fed enzyme-fortified diets tends to adapt to the high level of enzyme introduced into the diet by increasing the digestive secretions and the weight and size of the gastrointestinal tract (Brenes et al., 1993). This increase in the rate of digestion and absorption of nutrients may in turn improve weight gain at low feed intake in starter broilers (Ani and Omeje, 2007; Oyeagu et al., 2015).

FW and WG means were significantly ($p < 0.05$) improved among the birds fed enzyme-fortified diets containing 6% and 12% of spent grain (SN5, SN6 and SN8 diets) compared to birds fed enzyme-free diet containing 6% and12% spent grain (SN4 and SN7 diets), with the exception of SN9 diet that had lowest ($p < 0.05$) FW (973.44 g) and WG (812.02 g) at starter phase. These results indicated that enzyme supplementation had beneficial impacts on the utilization of diets by improving the energy digestibility (Pourreza et al., 2007; Ramesh and Chandrasekaran, 2011) through the increase of degradation of high fibre (as shown in Table 1) and NSP content (Tufarelli et al., 2007; Hosseini and Afshar, 2017).

According to Caspary (1992) and Ritz et al. (1995), enzyme supplementation promotes nutrient absorption by increasing the length of villi within the jejunal and ileal sections. Wang et al. (2005) further observed that starter broilers fed with enzyme supplemented diet increases the length and weight of ileum and cecum within the first 21days of age. However, birds in treatment SN9 were relatively retarded ($p < 0.05$) in their growth indices. This may be as a result of the incapacity of the microflora and enzymes in digestive tract of young birds to breakdown the complex chemical composition of spent grain taken in large quantity by the birds (Vranjes and Wenk, 1995; Choct et al., 1996). Thus, starter broilers fed diet SN3 (0.8 g enzyme/kg and 0% spent grain) had the best ($p < 0.05$) growth traits of lowest daily feed intake (73.03 g), highest feed conversion ratio (1.98), highest final body weight (1300.50 g) and weight gain (1149.58 g) at lowest feed cost per weight gain (N282.03).

At the finisher stage of development, it was observed that broilers fed SN1, SN2 and SN3 diet had better ($p < 0.05$) FW means of 3000.07 g, 3065.66 g, 3220.54 g; and WG ($p < 0.05$) values of 1878.44 g, 1886.46 g and 1920.54 g respectively than broilers fed diets containing high levels of spent grain (i.e. diet SN4 to SN9). This may be attributed to the high metabolizable energy and low crude fibre content of diet SN1, SN2 and SN3, as shown in Table 1. This argument is in line with the findings documented by Adebiyi et al. (2010) on the nutritional potentials of enzyme-treated and enzyme-free diets with different levels of cowpea seed hulls inclusion.

Furthermore, looking at each level of spent grain inclusion (i.e. 0%; 7% and 12%), birds fed with 0.5 g or 0.8 g of enzyme per kg diets had improved growth traits than birds fed with enzyme-free diets. This indicates that enzyme supplementation promotes digestion and absorption of nutrients which concur with the observations reported by Pourreza et al., (2007), Tufarelli et al. (2007), and Hosseini and Afshar (2017), as earlier discussed. The birds in SN7 treatment had the lowest ($p < 0.05$) WG of 1125.22 g and FW of 2100.01 g. This therefore showed high NSP concentration inhibits the growth performance of birds at finisher stage of development. This adverse-effect of high NSP concentration may be moderately controlled by increasing the level of enzyme supplement in finisher diets. Broilers in treatment SN3 had highest ($p < 0.05$) mean of FW (3220.54 g), WG (1923.54 g) and DFI (177.23 g) as well as the best ($p < 0.05$) FCR (2.71), while birds fed SN9 diet had the lowest ($p < 0.05$) DFI (148.43 g) and the highest ($p < 0.05$) FCR (3.53) mean.

These observations showed that enzyme supplementation improves feed utilization (Gunal and Yasar 2004) and spent grain inclusion reduces feed efficiency (Zhou, 2009). Economically, in finisher broilers, enzyme-free diet containing high level of spent gain incurred high cost of feed consumption and exhibited retarded growth traits when compare to poor growth indices and cost of feed intake of birds subjected to enzyme-fortified diet. For instance, broilers in treatment SN7 had the lowest ($p < 0.05$) body weight of 2100.01 g but incurred the highest ($p < 0.05$) feed cost per kg weight gained of N493.50, while birds in treatment SN9 obtained an improved ($p < 0.05$) final body weight of 2450.87 g and weight gain of 1478.43g at cheapest cost of feed per kg weight gain of N342.04 due to the increased level of 0.08g/kg enzyme supplementation.

Carcass Performance

The dressed carcass of broilers fed diet SN3 had the highest ($p < 0.5$) values in

all the carcass traits, while carcass of broilers in SN7 treatment exhibited the lowest ($p < 0.5$) values of carcass traits investigated, expect in the shank weight (SW) of the broilers fed SN8 diet that showed lowest ($p < 0.5$) mean of 65 g. This showed that enzyme supplementation improves carcass characteristics. These results are in agreement with the findings reported by Wang et al. (2005) and Alam et al. (2003) that enzyme supplementation increases carcass yield and carcass fat deposit. On the other hand, these results contradicted the recent findings of Abdelrahim et al. (2018) that carcass traits of birds fed with enzyme treated diets were almost the same with the carcass traits of birds given non-treated diets.

CONCLUSION AND RECOMMENDATION

It is evident from the results obtained in this study that inclusion of exogenous enzyme to broilers' diet improves growth and carcass performance and consequently reduces cost of feed consumption of the birds. Inclusion of 0.8g enzyme per kg starter diet that was free from spent grain improves the growth of young broilers at favourable cost of feed consumption. Finisher birds fed enzyme-free diets that contained 7% (SN4) or 12% (SN7) spent grain retarded growth and carcass traits and also incurred high cost of feed. The inclusion of 7% spent grain and 0.8g enzyme supplement in finisher diet (SN6) moderately improves growth and carcass yield at minimal cost of feed consumption. Therefore, SN3 (starter) and SN6 (finisher) diets are recommended to poultry farmers in order to increase profit and production of broilers.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Evaluation of Blood and Histological Indices of Broiler Birds Fed Diet Containing Mango Kernel, Watermelon and Parkia Seeds Fermented Using *Lactobacillus plantarum*

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Abstract

The work evaluated blood and histological indices of broiler birds fed diets containing mango, watermelon and parkia seeds fermented using *Lactobacillus plantarum.* The experiment was carried out under the supervision of Microbiology department of Kaduna State University with the 4 set of diet containing; no fruits seed inclusion (T_1) mango inclusion (T_2) watermelon inclusion (T_3) and parkia inclusion (T_4). 96 birds were used for the experiment which was laid in Randomized Block Design (RBD) having 3 replicates with 12 birds per replicate and fed for 6 weeks after which blood sample was taken for analysis and birds slaughtered for internal organs evaluation. Result obtained showed blood parameter of broiler birds fed diet T_3 had highest levels of PVC (78.3%), and Haemoglobin (26%) with impressive Lymphocytes (189%), Platelets (162.6×10^9/l) & Heterophil (13.66%) compared to birds fed the other experimental diets and also the internal organs such as lungs, heart, intestine, spleen, gizzard & kidney of the bird fed T_3 diet were all Normal compared to birds fed the others diet. It is therefore concluded that the use of *Lactobacillus plantarum* in fermentation of watermelon lowered anti nutritional factors and gave broiler birds overall good health. It is therefore recommended that further research be carried out to ascertain the appropriate inclusion level of watermelon seeds that would give the best result.

Keywords: *Blood, Histological Indices, Broiler Birds, Mango, Watermelon, Parkia, Lactobacillus plantarum.*

INTRODUCTION

Lactobacillus plantarum are amongst the diversified lactic acid bacteria (LAB) species which are being utilized abundantly in the food industry. Numerous *L. plantarum* strains have been reported to produce several antimicrobial compounds. According to Muhammad, Ramzan, Abdelazeez, Amjad, Afzaal, Zhang and Pan (2019) due to the probiotic characteristics of *Lactobacillus plantarum* it is considered as the most important species of *Lactobacilli* as it is able to biosynthesize substrates to produce bioactive peptides, enzymes, organic acids, exopolysaccharides and vitamins. The probiotic properties and antagonistic features of the *L. plantarum* strains are the unique characteristics which enable them to be utilized as bio-control agents against potentially dangerous microbes during processing and storage of the food as it also elongates the shelf-life and safety of the fermented food products. The presence of these probiotic strains in fermented food systems can possibly contribute to the reduction of chemical compounds and can increase the health and wellbeing to consumers. The *L. plantarum* strains have been found to possess the best probiotic properties like acid and bile salt tolerance, the ability to adhere Caco2 cells, the surface hydro-phobicity properties which lead to significant hypo-chlesterolemic and antioxidant activities.

Mango kernel (*Mangifera indica)*, watermelon (*Citrullus lanatus)* and parkia (*Parkia biglobosa)* seeds contain significant amount of anti nutritional factors namely; tannins, phytate, cyanide, antitrypsin, oxalate and saponins which limit their utilization if not first processed through various methods in order to make them usable. Various proximate analysis has shown that these seeds contain good amount of protein, carbohydrate, crude fibre and important mineral components which are required in animal diets (Diarra, 2014; Shazili, El-Zubeir, & Abdelhadi, 2013; Yahaya, Adamu, Salau and Sambo, 2018). Through fermentation processes these anti nutritional factors could therefore be eliminated and the substrates from these seeds become usable in livestock feed formulation thereby lowering the dependence on highly priced grains consumed by humans. According to Gro-intelligence (2018), forecast for Sub Sahara Africa protein chart looks alarming, as the region's net protein availability seem to be sharply on the declines as its livestock industry grows. This is worrisome considering that efforts have been made to grow the livestock industry for over the decade owning to previous report on protein deficiency and malnutrition (Hettie & Nicolette, 2012). The need to work towards meeting the nutritional deficient gap in humans gave rise to various researches geared toward producing livestock at lower cost prompting the

search for cheaper feed ingredients. However, the continuous increase in cost of conventional feeds ingredients such maize (carbohydrate), soybean (protein), groundnut and other materials has posed a serious challenge to the industry making it imperative to search for feed ingredients of lower cost which are not necessarily competed for by man and livestock. This forms the basis for this research the possibility of bio-utilization of mango kernel, watermelon and parkia seeds to produce broiler birds.

METHODOLOGY

The experiment was carried out under Microbiology Department of Kaduna State University, Nigeria. Cultures of isolates (*Lactobacillus plantarum*) were obtained prepared and sterilize by autoclaving at 121^0C for 15minutes. Aseptically the pure cultures of both isolates were separately incubated at 37^0C for 48hours, they were sub-cultured repeatedly on a fresh media of De Man Rogosa and Sharpe (MRS) medium.

The prepared mango, watermelon and parkia seeds powder were inoculated with the isolate and mixed then allowed to ferment for 5 days after which the mixture was oven dried at 60^0c for 45 minutes. The dried powder for each seed was used to prepare different broiler diet with T_1 (control with no inclusion), T_2 (Mango inclusion), T_3 (Watermelon inclusion) and T_4 (Parkia inclusion).

A total of 96 broiler birds were obtained from a reputable hatchery brooded and divided into 4 groups and replicated 3 times. Birds were fed with 4 different diets containing control feed (T_1), fermented mango seeds (T_2), fermented water melon seeds (T_3) and fermented Parkia seeds (T_4). At 6 weeks the birds were selected from each cage, blood sample was taken for analysis and slaughtering done for evaluation of the internal organs and the following result was obtained.

FINDINGS

The result of Table 1 below shows that poultry birds fed diets containing Control diet (T_1) had highest Heterophil (29%) and Moncystes (6%) while those fed with diets containing Mango (T_2) had highest Red Blood Cell (12.2), Platelets (172.66×10^9/l), Total protein (10.2) and Lymphocytes (195.66) with those fed diet containing Watermelon (T_3) having highest PCV (78.3%) and Haemoglobin (26 g/d). Least PCV, Haemoglobin, RBC, Platelets and Lymphocytes was observed in birds fed diets containing Parkia (T_4) with figures of 29%, 9.2 g/d, 4.76 and 84.3 % respectively while those fed diet T_1 had lowest platelets (158.66×10^9/l), T_4 had lowest Total protein (4.2), T_2 had

lowest heterophils (11.66%) and both T_2 & T_3 had lowest Monocytes (3%) each. The result implies that diets containing Watermelon (T_3) gave the birds' higher volume of blood and oxygen carrying capacity.

Table 1: Blood Parameter of Birds across Treatments

Parameters	T1	T2	T3	T4
Packed Cell Volume (PVC) %	66.3	76.6	78.3	29
Haemoglobin (g/d)	22.1	25.5	26	9.6
Red Blood Cell (10^6/ul)	11.20	12.2	5.4	4.76
Platelets (%)	158.66 × 10^9/l	172.66 × 10^9/l	162.6 × 10^9/l	369 × 10^9/l
Total protein (mg/dl)	9.53	10.2	4.2	4.8
Heterophil (%)	29	11.66	13.66	12.3
Lymphocytes (%)	195.3	195.66	189	84.3
Monocystes (%)	6	3	3	3.33

Source: 2019 Experimental Work

The result of Table 2 below shows that broiler birds fed diets T_3 and T_4 had normal lungs while those fed with diet T_1 had enlarged lungs while those fed diet T_2 had congested lungs. All birds fed diets T_1, T_3 and T_4 had normal heart while those fed diet T_2 had INF. Birds fed diets T_3 and T_4 had normal intestine while those fed diet T_1 had necrosis intestine and those fed diet T_2 had INF. Birds fed diets T_1, T_2 and T_3 had normal spleen while those fed diet T_4 had congested spleen. Birds fed diets T_1, T_2 and T_3 all had congested liver with only those fed diet T_4 having normal liver. Birds fed across all diets had normal gizzard. Birds fed diets T_1, T_3 and T_4 all had normal kidney while only those fed diet T_4 had INF. The overall result indicates that birds fed diets containing watermelon (T_3) and Parkia (T_4) had better indices of internal organs implying that watermelon and parkia diets have no adverse effect on broiler bird's internal organs.

Table 2: Histological Indices of Broiler Birds across Different Treatments

Treatment	Lungs	Heart	Intestine	Spleen	Liver	Gizzard	Kidney
T_1	Enlarged	N	Necrosis	N	Congested	N	N
T_2	Congested	INF	INF	N	Congested	N	INF
T_3	N	N	N	N	Congested	N	N
T_4	N	N	N	Congested	N	N	N

Source: 2019 Experimental Work

Discussion

The blood parameter shows the highest Heterophil and Moncystes were obtained with birds fed the control diet (T_1), the highest Red Blood Cell, Platelets, Total protein and Lymphocytes were obtained with birds fed Mango diet (T_2), the highest PCV and Haemoglobin were obtained with birds fed watermelon diet (T_3) while the least PCV, Haemoglobin, RBC, Platelets and Lymphocytes were observed in birds fed diets containing Parkia (T_4). This result is consistent with findings of Lawan, *et al.,* (2018) in terms of blood parameters of birds fed diet T_2. The result however contradicted findings of Aderemi *et al.,* (2016) on blood parameter obtained from birds fed parkia diet. This contrast may be due to difference in methods used in processing parkia seeds which were roasted by the researchers whereas in this research parkia seeds were boiled. The result obtained from birds fed T_3 diet (watermelon) which showed higher levels of PCV and Haemoglobin is an indication that the fed gave the birds higher blood volume and oxygen carrying capacity which would naturally make these birds show good physical appearance and strength. This result agrees with findings of Bou, Sola-Ojo, Olorunsanya & Adekola (2011) on efficacy of watermelon seeds as a valuable fed component in enhancing blood parameter of broiler birds.

On histological indices of birds the result shows birds fed diets containing watermelon (T_3) and Parkia (T_4) had more impressive indices of internal organs which is consistent with findings of Lawan *et al.,* (2018) and Aderemi *et al.,* (2016) implying that watermelon and parkia diets have no severe negative effect on the birds internal organs. It is also an indication that watermelon and parkia seeds utilization in livestock feed would give impressive health of farm animals. Interestingly the proximate analysis of both seeds shows high amount of protein meaning these seeds when well processed could easily replace soybean in livestock feed formulation.

CONCLUSION AND RECOMMENDATION

The quest to increase animal protein consumption and reduce malnutrition in Sub Sahara Africa in line with WHO recommendation would be achieved when focus it placed on utilizing cheap materials that are in abundant within African but considered as waste such as mango kernel, watermelon and parkia seeds as feed materials to produce livestock. Through fermentation process the anti-nutritional factors of these seeds can be eliminated hence making them good replacement for highly priced soybean or other protein sources thereby reducing the competition with human food materials in producing livestock.

It is therefore important that more research be carried out to determine the right levels of watermelon and parkia that can be included in broiler birds feed to obtain the best result and eliminate any possible adverse effects in their utilization as livestock feed materials.

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Nutritional Value of Dried Rumen Digesta from Cattle, Sheep and Goat: A Case of Bolgatanga Abattoir, Ghana

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Abstract

The work evaluated the nutritive value of dried rumen digesta (DRD) from cattle (CRD), sheep (SRD) and goat (GRD) in Bolgatanga Abattoir, Ghana. Rumen digesta (RD) was collected from twenty-seven (27)) animals, nine each from cattle, sheep and goat at the Bolgatanga Municipal Abattoir and sundried for 4 days. Proximate analysis, cell wall component and metabolizable energy were estimated after which the data was subjected to analysis of variance for statistical difference at 0.05% level. Result obtained showed significant differences ($P< 0.05$) in proximate compositions. Goat Rumen Digesta (GRD) had highest organic matter (90.81%), Crude protein (12.17%) and metabolizable energy (ME) (374.24 Kca/100g) compared to the other experimental digesta from cattle. The Neutral detergent fibre (NDF), acid detergent fibre (ADF) and cellulose were not significantly different across the rumen digesta obtained from the species of animals. The values for organic matter and crude compositions obtained from the Sun-dried rumen digesta from cattle, sheep and goat indicated the ability of rumen digesta to provide the nutrients particularly protein required by animals for normal physiological activities. Farmers can process the digesta and include it in livestock feeds.

Keywords: *Sun Dried Rumen Digesta, Cattle, Goat, Sheep, Proximate Analysis*

INTRODUCTION

Nutrition of ruminant livestock in most developing countries is often derived entirely from natural pasture with very little supplementation (Ansah and Issaka, 2018). The main challenge nowadays in livestock production is to reduce feeding cost globally. Animal feeds are not readily available and where they are, affordability for an average farmer is a challenge (Ruzic-Muslic et al., 2014). The cost of protein concentrate for livestock production has increased due to competition between humans and animals, production instability, distribution of protein feedstuffs, etc. Increasing reliance on imported proteins has also exposed farmers to unstable prices, currency movements and supply shortages. All these factors limit farmers' access to protein for livestock production (Merry et al., 2001).

The livestock sector plays a crucial role in meeting the nutritional needs of Ghanaians (meat, eggs and milk), the demand for these livestock products is still at a greater rate than production especially in the cities due to increasing incomes of consumers (Osei, 2012). The attempt to meet this demand has been met with unavailability of feed resources, most especially, when the dry season period sets in (Awuma, 2012). The low ruminant livestock production in Ghana is attributed to the lack of adequate nutrition during the dry season period.

In the Northern parts of Ghana, the weather becomes very dry and hot from November to April. This period comes with its challenges such as very poor feed quality low in nitrogen, scarce grazing material and shortage of drinking water for ruminant livestock on natural pasture. The lack of quality feed resources during the dry season is a prime concern of livestock farmers in Northern Ghana. This result in loss of weight of animals which affects their market value and other production indices. Considering these challenges, alternative source of non-conventional feeds needs to be evaluated and produced to augment feed supply. Rumen digesta is one of such protein sources which could enhance livestock production to ensure efficient and sustainable animal production.

Rumen digesta is waste generated from ruminant animals in slaughterhouses (cattle, sheep and goats). It is a partially digested forage mainly found in the rumen of ruminant animals that contains gas, fluid, bacteria, protozoa and fungi and is fairly rich in crude protein (Agbabiaka et al., 2011; Okere, 2016). This waste, is usually discarded on the environment to become pollutants and breeding sites of both parasites and vectors of human and animal diseases.

Meanwhile, scarcity of feed is a limiting factor to the production of animals for food (meat and milk) industrial raw materials (hides, fur, hooves, etc.) and labour. However, if properly evaluated, rumen digesta could be processed into animal feed to enhance animal production and eliminate the hazards of its disposal on the environment as well as the concomitant the public health risks. Hence the need to evaluate the nutritional value of rumen digesta from cattle, sheep and goat in the Bolgatanga Abattoir, Ghana.

Various reports on the chemical composition of rumen contents suggests a high degree of variability. This variation is attributed to the type of forage consumed by the animal, environment in which the experiment took place, health condition of the animal, season, the number of microbes present in the rumen and the duration of the forage in rumen of the animal before slaughter (Togun et al., 2010; Togun et al., 2010; Sakaba et al., 2017).

The nutritional composition of dried rumen digesta has actually revealed its relevance in the livestock feed industry by nutritionists as inexpensive feedstuff (Togun et al., 2010; Elfaki et al., 2014 and Osman and Elimam, 2015). It is fairly rich in crude protein (CP) (18.52%) and microflora such as fungi, protozoa and bacteria (Dairo et al., 2005; Esonu et al., 2006; Agbabiaka et al., 2011). Dried rumen digesta contains 13.36 to 98.4% of dry matter (DM), 11.38 to 19.6% CP and 15.3 to 41.84% crude fibre (CF) (Togun et al., 2010). According to Agbabiaka et al. (2011), dried rumen digesta has 5.41% moisture, 18.58% CP, 3.77% crude fat, 34.44% CF, 24.81% nitrogen free extract (NFE) and 18.4% ash. Al-Wazeer (2016) reported a CP composition of 14.22% for dried rumen digesta, Rios-Rincon et al. (2010); Nasser et al. (2012); Olafadehan et al. (2014) and Talib et al. (2016) reported the range of 13.3-16.4% for cattle rumen digesta while Mondal et al. (2013) reported CP of 12.57%. These reports show variation in the chemical composition of the dried rumen digesta and they were all limited to rumen digesta from cattle neglecting sheep and goat rumen digesta which could also contain high levels of nutrient composition.

Rumen Digesta is used as feed ingredient for both ruminants and non-ruminant animals in many parts of the world (Okere, 2016). It can be used as a feed substitute for forage basal feed (Yitbarek et al., 2016). Currently, researchers are making great efforts to properly processed rumen digesta from slaughterhouses as alternate source of nutrient to support the shortage of feed resource (Adedipe et al., 2005; Amata, 2014). This is of economic value for the livestock industry (Amata, 2014). According to Ra and Iliyasu (2017)

several studies have shown that dry rumen digesta had been fed to various animals as feedstuff at different levels. A mixture of blood and dried rumen digesta has shown no adverse effect on diet of poultry, catfish, quail, lamb and cattle (Osman and Elimam 2015; Mishra et al., 2015).

The use of rumen digesta in livestock feed can improve the flexibility of feed formulation and reduce the environmental hazards associated with abattoir waste. However, differences in species and forages ingested by slaughtered ruminants in different agro-ecological zones may significantly affect the quality of rumen digesta. Furthermore, evaluating the nutritional value of rumen digesta from cattle, sheep and goat will add to the current literature on the potential value of rumen digesta.

METHODOLOGY

Research Design

The design used for the studies was a complete randomized one with three treatments {Cattle Rumen Digesta (CRD), Sheep Rumen Digesta (SRD) and Goat Rumen Digest (GRD)}, each sample replicated thrice for the proximate composition and cell wall component.

Study Area and Sample Collections

This research was conducted at Ecological Agriculture Department, School of Applied Science and Arts, Bolgatanga Technical University. Samples of Cattle Rumen Digesta (CRD), Sheep Rumen Digesta (SRD) and Goat Rumen Digesta (GRD) were collected from 9 each of slaughtered cattle, sheep and goat from the Bolgatanga Abattoir in the Upper East Region of Ghana. The digesta was collected from animals examined by veterinary staff to ensure that they were healthy before being slaughtered and sundried for 4 days. The Sun-dried rumen digesta (SRD) was then milled through 2 mm and then 1 mm sieves respectively, screened sequentially using a Hammer mill (Brabender, Germany) for chemical analysis.

Proximate Analysis

Dry matter (DM), crude protein (CP), fat content, crude fibre and ash were determined according to AOAC (1990). The Nitrogen Free Extract (NFE) and carbohydrates were calculated as follow: NFE (%) = 100 - (% moisture + % fat + % crude fibre% + % Protein + % ash) and Carbohydrates (%) = 100 – (% moisture + % fat + % protein + % ash). The metabolizable energy (Kcal/100g)

was determined by using Atwater method at the Kwame Nkrumah University of Science and Technology.

Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF)

NDF and ADF were determined exclusive of residual ash by sodium sulphite and α- amylase following the procedure of Van Soest *et al.* (1991) and was run on the Ankom200 fibre analyser.

Statistical Analysis

All data were subjected to statistical analysis of variance using Genstat 18.2 edition. With the following model: Yij=μ+Ti+eij, where Yij: observed variation, μ: population means, Ti: nutritional values i the digesta and eij: error term. Significant difference among treatment means were tested by using Turkey at 5% ($p<0.05$) using the same software.

FINDINGS

Chemical Composition

The results in Table 1 show that dried Cattle Rumen Digesta (CRD) had the highest dry matter content (96.34%), Carbohydrate (70.64%), ash (14.40%) and nitrogen free extract (NFE) (40.79%) while Goat Rumen Digesta (GRD) had highest organic matter (90.81%), Crude protein (12.17%) and metabolizable energy (ME) (374.24 Kca/100g). Least dry matter, Carbohydrate and nitrogen free extract were observed in Sheep Rumen Digesta (SRD) with figures of 94.68%, 66.39% and 33.90% respectively while CRD had lowest organic matter (85.60%), Crude protein (8.49%), Fat (2.81%) and ME (341.78 Kca/100g) and GRD had the lowest ash (9.19%). The results imply that goat rumen digesta GRD organic matter and crude protein can support livestock production.

Table 1: Chemical Composition of Dried Rumen Digesta from Cattle, Sheep and Goat (%)

	Species of Animals				
Nutrients	**CRD**	**SRD**	**GRD**	**± SED**	**P. value**
Dry matter	96.34[a]	94.68[c]	95.88[b]	0.052	<.001
Organic matter	85.60[c]	89.78[b]	90.81[a]	0.180	<.001
Crude protein	8.49[b]	11.37[a]	12.17[a]	0.314	<.001
Carbohydrate	70.64[a]	66.39[c]	69.02[b]	0.411	<.001
Ash	14.40[a]	10.22[b]	9.19[c]	0.180	<.001
NFE	40.79[a]	33.90[c]	37.51[b]	0.370	<.001
Fat	2.81[c]	6.70[a]	5.50[b]	0.213	<.001
ME (Kca/100g)	341.78[b]	371.36[a]	374.24[a]	1.667	<.001

CRD= Cattle Rumen Digesta, SRD= Sheep Rumen Digesta, GRD= Goat Rumen Digesta, NFE = nitrogen free extract, ME = metabolizable energy. Means within the same row with different superscripts are significantly different (P< 0.05). Those with same superscripts are not significantly different (P> 0.05)

Fiber Composition

The result of Table 2 illustrate that sheep rumen digesta had highest Crude fibre (32.49 %) while cattle rumen digesta had highest Neutral detergent fibre (66%) and Cellulose (20%) and Goat rumen digesta had highest Acid detergent fibre (46.96%). Lowest crude fibre (29.85%) was observed in cattle rumen while sheep rumen digesta had lowest Neutral detergent fibre (61.32 %) and Acid detergent fibre (42.45%) and goat rumen digesta had lowest cellulose (16.9%). The high content of cell wall fractions in the rumen digesta implies low feed intake, since a major factor regulating forage intake is NDF content due to its effects on rumen fill.

Table 2: Fiber Composition of Dried Rumen Digesta from Cattle, Sheep and Goat (%)

	Species of Animals				
Nutrients	**CRD**	**SRD**	**GRD**	**± SED**	**P. value**
Crude fibre	29.853[a]	32.49[c]	31.51[b]	0.045	<.001
Neutral detergent fibre	66.00	61.32	63.95	3.206	0.446
Acid detergent fibre	46.00	42.45	46.96	1.851	0.175
Cellulose	20.00	18.87	16.99	3.128	0.663

CRD= Cattle Rumen Digesta, SRD= Sheep Rumen Digesta, GRD= Goat Rumen Digesta. Means within the same row with different superscripts are significantly different (P< 0.05). Those with same superscripts are not significantly different (P> 0.05)

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Discussion

The chemical composition shows the highest dry matter was obtained in cattle rumen digesta. The dry matter content was significantly (P<.001) different among the species of animals. The DM of the dried rumen digesta was sufficient to support an appreciable amount of DM intake in ruminant animals. High dry matter content is good for the rumen function of ruminants as they act as substrate for fermentation by the microbes (Oni *et al*., 2008). This result

is consistent with Mahmoud et al. (2015) and Al-Wazeer (2016) for dried rumen digesta obtained from cattle, sheep and goat.

The CP content of the dried rumen digesta obtained from species of animals fell within the 7-8% requirement for satisfactory rumen function to enhance feed intake in ruminant animals. The result however contradict findings of Rios-Rincon *et al*., (2010), Nasser *et al.,* (2012), Olafadehan *et al*., (2014), Mahmoud and Khadiga (2015), Talib *et al*., (2016) and Sakaba *et al.*, 2017) on crude protein obtained from rumen digesta. This contrast may be due to the nutritive quality of the pastures, season and the holding time between feeding and slaughter. The CP obtained from goat rumen digesta is consistent with findings of Togun *et al*., (2010) and Mondal *et al.,* (2013) for rumen digesta. The CP content of all the rumen digesta are superior to the commonly used crop residues like rice straw. Ansah *et al.* (2017) reported crude protein content of 45.9, 47.3, 65.7, 53.4 and 45.1 g/kgDM for Hybrid, Exbaika, Jasmine 85, IR841 and Long grain ordinary 2 varieties of rice respectively. The nutritional composition (dry matter, organic matter, carbohydrate, fat and the ME values of dried rumen digesta has actually revealed its relevance in the livestock feed industry. Cattle rumen digesta had highest NDF and cellulose while goat rumen digesta had highest value in ADF. The crude fibre values were comparable to the report of Mahmoud and Khadiga (2015) for similar speecies of animals.

Conclusion

The values for organic matter and crude compositions obtained from the Sun-dried rumen digesta from cattle, sheep and goat indicated the ability of rumen digesta to provide the nutrients particularly protein required by animals for normal physiological activities.

Recommendations

Farmers can process the rumen digesta and include it in livestock feeds.

Limitations

To obtain excellent result for the study, there had been some constraints which have to do with source of funding for the research, to conduct feeding trial.

Areas of Further Research

The study recommends further investigations on minerals and anti-nutritional compositions of the digesta from cattle, sheep and goats. Also, further

investigations on feeding the digesta to poultry to assess its effect on growth performance.

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A Review of Effects of Vaccination Failures on Poultry Production in a Climatic Conditions of the Sudan Savannah

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Abstract

The review was aimed to access the effect of vaccination failure in poultry production. The most of the causes of vaccination failure such as use of expired vaccine, improper storage of vitamin, health status of the flock, poor quality of water, constitution of vaccines, lack of anti-stress after vaccine administration, improper route of vaccine administration, vaccine break, and poor nutrition significantly contribute to vaccine failure in poultry. Furthermore, strict adherence to vaccination schedule together with good management practice reduces vaccination failure to an economic level. These revealed that strict adherence to recommended concluded that maintenance of hygiene, improved nutrition, use of potent vaccines and proper constitution can drastically reduce the rate of mortality on poultry production. Farmers should strictly adhere to manufacturers' instruction on the vaccine labels as this reduces the dangers of vaccination failure. Government should encourage private agencies in the field of vaccine production and make sure that the vaccines produced meet the approved standard. Poultry farmers Association of Nigeria should be organizing seminars and workshop to poultry farmers on vaccine handling and administration. More researches are expected to be conducted in the field of vaccine failure to test antibody titter level of the treatment set for the investigation. Good management practices should also be adopted in order to reduce the mortality rate on the poultry farmers. Poultry farmers should adhere strictly to vaccination schedule as this will reduce the rate of mortality on their poultry farms.

Keywords: *Poultry, Vaccination, Climate, Sudan Savannah*

INTRODUCTION

Poultry is used to describe any domesticated bird kept for meat or eggs production such as fowls, or chickens, ducks, geese, turkeys, guinea fowls, pigeons etc. (Akinsanmi 1975). Poultry is also defined as any birds reared or hunted for a useful purpose is a member of the bird group collectively known as poultry. Most of the birds are domesticated and managed on the same basic principles as the domestic fowl (Oluyemi, 1983). In the past, poultry keeping was a side- line occupation. That is chickens were kept to ohtain some money and in some cases for the pastime of cock fighting. In some communities, the fowl growing cock still depended upon for determining the approach of daybreak (Oluyemi et al., 1985). The poultry industry has many branches; the two main branches are eggs and table meal production. The other branches include the production of chicks, point of lay pullets or ready to lay birds and of poultry feed (Oluyemi et al., 1985). In very recent times, over a span of no more than thirty years, there have been greater changes in methods of keeping poultry than probably in any other sector of the world's livestock agricultural production. It has now become the most intensive of all branches of livestock farming (Sainsbury, 1980).

Vaccination

Vaccination programmes are designed to prevent or reduce losses caused by discuses in vaccinated birds and or their progeny (Jordan et al., 1999). There are now a large number of vaccines available for poultry. Disease control by vaccination is more effective for some diseases than others and programmes and requirements may vary considerably im different parts of the world. Vaccines work best under considerable of good biosecurity (Jordan et al., 1999). The vaccine is only as effective as the service that uses it, the ability to manufacture vaccine for some specific disease agents varies considerably. Some discase agents generate high levels of protective antibody and exhibit little variation in field types, a single vaccine strain thus protecting livestock against any filed challenge (Payne, 1999). Vaccination which is the administration of vaccine into the body for the purpose of enhancing acquired immune response is very important in safeguarding the health of poultry stocks. Ilene every effort to minimize vaccination failure which results in the appearance of the disease against which birds are vaccinated is worth practicing by any commercial poultry stock owner (Sparrow, 1994). The objectives of this study were to assess the effects of vaccination failures in poultry production.

Significance of Vaccines on Poultry Production

The importance of vaccines and their roles in disease control cannot therefore be overemphasized looking at the economic implication recorded in the last twu decades. The situation of Newcastle disease worsened and some of the poultry establishments suffered severe losses due to frauk diseases in layers. On an average 200-250 out breaks are reported annually in which chickens and growers were involved. Involvement of layers was marked with temporary drop in egg production. Although, the mortality is indicative of vaccination failures (Lamido, 2002). Allan et al. (1981) reported that Gambaro. Marcks and Aflatoxic disease should be controlled not as much as for their sake but for the immunosuppressant they cause.

A large number of diseases affect domestic animals worldwide, but some are more prevalent and more damaging than others. Infectious diseases of livestock in different continents may he different depending on prevalence climatic condition, animal breeds and animal husbandry methods. Climate influences the vegetation, the culture of the people, and the species of breeds of animals they keep. Climate also affects the survival and proliferation of infectious agents and their vector (Lamido, 2002). The common discases and disorders of free-range poultry may be wide range of organisms or deficiencies (Adesiyun et al., 1984). The disease control measures include non-medical disease control and medical disease control. The non-medical disease control is the most economical and effective means of preventing non vital disease and involves improved management and nutrition. of which the most important aspects are hygiene, housing (ventilation proper spacing and separation of species), flock structure, young chicks care and feeding. Medical diseases controls include vaccination, deworming from internal parasite and treatment for external parasites (NAPRI 1979).

Although, nearly all poultry discuses are found under all types of management conditions, the pattern of diseases in free - range birds are different among species of all ages, and constantly exposed to weather, environment and seasonal outbreak of disease. as well as to germs and parasites found with soil and wild birds and animals. In a 15 years study of the incidence of poultry disease in Northern Nigeria, Saidu et al. (1994) found viral infections (such as ND in chickens and pox in Turkeys) to be the common cause of diseases, although; concurrent viral infection, parasite with parasites constituted about half of the cases studied. They concluded that viruses and parasites caused the most important diseases in indigenous chickens and that they were seasonal in

their onset. Vaccination plays an important part in the health management of the poultry flock. There are numerous diseases that are prevented by vaccinating the birds. The purpose of using a vaccine to prevent a particular disease is to trigger or boost the bird immune system to produce antibodies that return light the invading caused organisms a natural invasion. Unfortunately, the damage to the bird suffering such disease is usually too great and the bird either dies or hecame unauthority and nonproductive (Adel and Mehrdad, 2011). Vaccines contain either live or killed microorganism live virus vaccines reproduce in the host to increase their numbers. A killed virus product is dependent upon the number of antigen Units (c.g virus particles) present in the vaccine dose to stimulate antibody production. Most poultry vaccine is live types. Bacteria vaccines are live or inactivated preparation of bacteria (IF AS, 2009). Some common poultry diseases that are vaccinated are as follows:

Marek's Disease Vaccine**:** Marek's disease vaccine is usually administered to chickens at the hatchery on the day of hatching. It is given subcutaneously at the back of the neck. It is best to order chicks already vaccinated at the hatchery.

Newcastle Disease Vaccine**:** Chicken and turkeys can be immunized against Newcastle disease. Low virulence live virus vaccine are administered by a variety of routes such as drinking walker, intraocular (cye drops) intranasal (nose drops), spray. Killed virus oil emulsion vaccines are administered pullets intramuscularly or subcutaneously as a final vaccine prior to the onset of egg production.

Fowl Cholera: Fowl cholera effect most birds including domestic fowls, game birds ducks, cage birds, wild bird and bird in zoological collections and a varies. Oil emulsion bacteria required a series of the injects given at 4 weeks intervals.

Infectious Bronchitis**:** This is a primarily respiratory disease of chickens. Modified live virus vaccine (usually contained the Massachusetts serotypes) are administered in young chickens. Vaccines are effective only if they contain the right Sero-type of virus for a given arca. Do not vaccinate during an outbreak.

Fowl Pox: There are six closely related strains of pox virus these are fowl pox, canary pox, psittacoses pox, pox can be prevented in chickens, turkeys and pigeons by vaccinated at 9 day of age, pullets at 10 12 weeks, and turkeys at 8 14 weeks of when moved lo range.

Larygotracheitis: Larygotracheitis (L.T) affects both chickens and pheasants. Vaccination against 1.T is not as successful as far other diseases, but is an excellent preventive measure for use in outbreaks and in epidemic areas. State approval is required prior to vaccination. Do not vaccinate unless you have a problem on your farm or in your area.

Avian Encephalomyelitis: Avian encephalomyelitis (AE) is a viral infection of poultry, primarily chickens, turkeys, pheasants and coturnix quail. Quils life time immunity is acquired through vaccination: Breeder chickens are vaccinated at 10- 16 weeks of age and administered in their drinking water. It is important not to vaccinate against the diseases that are not present in the area (I1'AS, 2009).

Vaccination Schedule in Poultry: Vaccination schedule is a series of vaccination including the timing of all doses which may be either recommended of compulsory, depending on the country of residences.

Vaccination Schedule for Layers

Table 1: Vaccination Schedule for Layers

S/n	Age	Vaccine	Route
1.	5-7TH day	lasota	D/W OR 110
2.	14 – 16th day	IBD	I/O or DW
3.	24 – 16th day	IBD (booster)	DW
4.	30th – day	Lasota (booster)	DW
5.	7th week	Fowl Pox	I/M
6.	9th week		-
7.	10th week		I/M
8.	15th week		-
9.	17th week	Lasota	DW

Vaccination Schedule for Broilers

Table 2: Vaccination Schedule for Broilers

S/n	Age	Vaccine	Route
1.	3 – 5th day	Lasota	I/O or DW
2.	7 – 9th day	IBD	I/O or DW
3.	16 – 18th day	IBD (booster)	DW
4.	24 – 26th day	Lasota (booster)	DW

Source: http//citizens/vaccines sch.htm

Note: I'N. Intra Nasal, i/0- intra ocular; D/W - Drinking water; I/M Intra muscular.

Constraints/Problems of Vaccination in Poultry

Vaccination of commercial chickens against Newcastle disease is relatively successfully under taking. Village chickens, by contrast, have proved very difficult key labile, and it is Vaccinate. Conventional Newcastle disease vaccines are relatively heat difficult to retain viability during transport to remote areas and storage in undeveloped village's conventional vaccination Required physical control over the chickens and near feral village. Flocks prove very difficult to catch. Conventional vaccine is sold in large dose vials, usually 1000 doses, which are unsuitable for small family flocks. Village flocks are small, scattered and multi aged, placing them beyond the reach of technical vaccination. Any method of vaccination that is proposed must be suitable for application by the owner of the chickens (Spread brow, 1994).

Alders et al. (2007) stated that the challenges and constraints to vaccinating poulıry in areas where - adequate infrastructure and human resources are lacking are addressed in both a technical and a socioeconomic (framework. The key issues area: -

- Selection of an appropriate vaccine and vaccination technique.
- Vaccine conservation and distribution.
- Evaluation of the flocks to be vaccinated in terms of their discuses status, immune competence and production systems,
- Design of effective information, education and communication materials and methods with and for veterinary and extension staff as well as commercial and small holder producer and community vaccinators in rural area.
- Evaluation of mooring systems for technical and socioeconomic factors that affect vaccination.
- Support and co-ordination of and by - relevant public and private agencies.
- The role of simultaneous implementation of oilier control activities in addition to vaccination.
- The importance of assessing the costs and cost effectiveness of various approaches to the control of highly pathogenic Avian influenza (IIP AI), including the prevention of other endemic killer disease and options for cost - sham,

- Evaluation of the incentives for poultry - holders, vaccinators and vaccine producers to contribute Lo and participate in effective vaccination campaigns.
- Policy development and the organizational frame work for short- and long-term implementation and communication to decision- makers.

Discussion

Most of our poultry farmers blame vaccine when it fails but it is mostly the fault of the farmers themselves Aini, (1990). It was further observed that many farmers lack the knowledge of vaccine, which comes as a result of good extension services. Farmers perceived vaccination failure to occur when the chicks did not develop the antibody titre level or when they are susceptible to filed diseases outbreak. These findings are in agreement with that of Adene, (1990). Farmers perceived vacating sick bird or that incubation a disease as one of the causes of vaccination failure. Vaccinating such chicks is associated with high mortality, Aini (1990). The use of anti-stress by farmers he fore and after vaccination is a means of reducing vaccination failure. This was in agreement with suggestion image by Adene (1990). Among the other factors perceived by the farmers as a cause of vaccination failure are improper handling use of expired vaccine, and vaccine strains. These perceptions were supported by the report of (Aini, 1990).

The success of any vaccination depends not only on the vaccines and the knowledge of the farmers on vaccination but also on several factors most especially immune response of the host to the vaccine. The street adherence to vaccination schedules can reduce: mortality rate in poultry production. This is in agreement with the findings of Butcher and Miles (1994). The mortality rate in poultry may be attributed to poor management practices as this can also contribute to vaccine failure. This was similarly reported by Zander, (1997). Good management and adherence to vaccination schedule have high relationship in reducing mortality in poultry farm. This current observation also agrees with several literature reports (Butcher and Miles, 1994; Owen, 1994). The frequency of the farms that did not practice cither medication or vaccination on is very high. This was also reported by Gingeriest, (1997) who stated that commercial poultry companies try to reduce cuts by criminating vaccine or administering partial dose.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The review was aimed at finding out the causes of vaccination failure in poultry production. Which revealed that the main causes of vaccination failure are use of expired vaccines, improper storage of vaccine and health status of the flocks, poor quality of water and poor vaccine constitution. These revealed that strict adherence to recommended vaccination schedule can reduce mortality rate on any poultry production.

Conclusion

The most of the causes of vaccination failure such as use of expired vaccine, improper storage of vaccine, health status of the flock, poor quality of water, constitution of vaccines, lack of anti-stress after vaccine administration, improper route of vaccine administration, vaccine break, and poor nutrition significantly contribute to vaccination failure in sultry. Furthermore, strict ad hence to vaccination schedule together with good management practice reduces vaccination failure to an economic level. Finally, it was concluded that maintenance of hygiene, improved nutrition, use of potent vaccines and proper constitution can drastically reduce the rate of mortality on poultry production.

Recommendations

The following recommendations were made;

- Farmers should strictly adhere to manufacturers' instruction on the vaccine labels as this reduces the dangers of vaccination failure.
- Government should encourage private agencies in the field of vaccine production and make sure that the vaccines produced meet the approved standard.
- Poultry farmers Association of Nigeria should be organizing seminars and workshop to poultry farmers on vaccine handling and administration.
- More researches are expected to be conducted in the field of vaccine failure to test antibody titter level of the treatment set for the investigation.
- Good management practices should also be adopted in order to reduce the mortality rate on the poultry farmers.
- Poultry farmers should adhere strictly to vaccination schedule as this will reduce the rate of mortality on their poultry farms.

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Performance of Growing Rabbits Fed Graded Levels of *Ziziphus mauritiana* Leaf Meal in a Diets

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Abstract

An eight weeks feeding trail was conducted to evaluate the performance of growing rabbits fed graded levels of Zizipus mauritiana leaf meal in a diet. Dietary treatment were designated A, B, C and D which were made up to 100% concentrate, 15%, 30% and 45% Ziziphus mauritiana leaf meal inclusion levels respectively, twenty cross bred growing rabbits of both sexes averaged 72.8g, balanced for weight and were used in a completely randomized experimental design. They were tattooed and randomly allocated to four dietary treatments replicated with seven rabbits. The rabbits were allowed one week preconditioning (adaptation) period during which the animals were collected for feed intake, weight gain, and feed conversion efficiency was calculated. There were significant ($p<0.05$) differences in all the parameters considered. Diet D had the highest significant ($p<0.05$) effect in terms of weight gain with value of 648g compared to others while the control diet recoded the least value with 436g. Similarly, diet D was the most consumed and a significant ($p<0.05$) difference was observed between diet B and C, with the former having a higher value of 124.86g. The result further revealed that as the level of Ziziphus Mauritian leaf increased in the diets lower values for feed conversion efficiency were obtained. This indicates that supplementation with the test ingredient increases the efficiency with which the dies were utilized. Thus, diet D, with the most favorable results among the treatments groups is superior to others. It is therefore recommended for growing rabbits.

Keywords: *Rabbits, Leaf Meal, Feed Intake, Weight Gain, Feed Conversion Efficiency*

INTRODUCTION

The acute shortage of animal protein in the diet of the average Nigeria has been reported and one of the ways of solving the problem is by increasing the production of fast growing and early maturing animals like the rabbit (FAO, 1970). In the present economic condition of the country where there is a great increase in the scarcity of animal protein, as well as the high cost of commercial feed, forages now play an important role by being converted into meat as well as being available almost throughout the year (Aduku *et al*, 1986). The need now arises to change from feeding only concentrate rations as the main diets to supplementing with forages. This would not only reduce the most of feeding but the total cost of production, especially for the small-scale producers who could make a substantial contribution to animal protein supplies in developing countries (Adeosun, 2005).

Feeding is very important in any livestock production industry as it constitutes 60-70% of the total cost of production. There is need to produce low input system with locally available feed stuffs such as, maize offal, wheat bran, and crop residues from legumes that have no nutritional value to man. Most forage feeds for rabbits are garden or farm crops whose leaves could be available for feeding when the crops are harvested (Aduku and Olukosi, 1990).

The domesticated rabbit descended from European wild rabbit *Orvctolo is cuniculus*. They are micro livestock that are kept mainly for meat. There are about 66 different breeds of rabbits that are evenly distributed throughout the world. Rabbits were introduced into England in '. He late eleventh to twelfth century. Basically, rabbits are classified into fur, fancy and meat breeds Cheeke *et al.*, 1987).

The main breeds of rabbits are Chinchilla New Zealand white, California, Dutch, Angora, flemish Giant etc. Rabbits are characterized as small furry animals with long ears and short tails are cheap to purchase, easy to manage no much taboos against eating or keeping them, the animal are quite friendly and can be raised in the back yard or empty room. They do not usually bite and they are not potential health hazards to raisers (Lebas et al., 1586).

Accoding to Iyeghe- Eraktopobor., et a1. (2003) rabbit rearing does not involve heavy capital outlay, therefore, with a little capital a pair of rabbits (male and female) can be bought and multiplied to supply meat for the family and also cash.

Akinmutumi (2004) stated that rabbits are herbivores, monogastric and pseudoruminant animals that can effectively and efficiently convert fodder to food, Rabbits have a unique digestive tract that coverts fibrous material to animal protein (Lebas, et al., 1997). Rabbits can thrive and do very well on cheap food materials such as kitchen wastes, roughages grass and other green vegetable. Rabbits are traditionally raised on high roughage diets (Iyeghe-Erakpotobor, et al., 2002). Lukefahr and Cheeke (1991) advocate raising rabbits on forages with an energy supplement. There are various important constraints associated with keeping rabbits in the tropics. These are inadequate nutrition, poor management, and low reproduction efficiency prevalence of diseases, shortage of pure breeding stock and marketing problems associated with the consumption of rabbit meat (Aduku and Olukosi, 1990). Based on the afore-mentioned, this feeding trial was designed to evaluate the performance of growing rabbits fed a complete diet with *Ziziphus mauritiaria* leaf meal included at different levels in diets.

Justification

Inadequate supply of feed both in quality and quantity is one major factor responsible for the low productivity of livestock in the tropics (Ojebiyi et al., 2008). In many developing countries majority of the population suffers from protein deficiency. It is therefore necessary to look for iaeaper and faster ways of getting necessary protein required for normal body growth and functions. Animal protein source have the nutritional advantage of being rich in amino acids hich are readily useful to human body than those of plant origin (Amuefule *ct al.,* 2004). â.abbits are used for research and medical purposes. They are easy to rear, occupy small portion land, and require small capital when compared with other livestock. But with all these there are problems with keeping rabbits in large number. Such constraints include lack of awareness, problem of adoption or reluctance of people to the acceptance of rabbit meat (Aduku and Olukosi, 1990).It was further stated that the ability of rabbits to thrive on forage made their production comparatively cheaper than other livestock. They are good scavengers on home roughage or kitchen waste. Rabbits fed a mixture of legume and concentrates had better performance due to high content of digestible protein and energy of legume (Lukefarh and Goldman, 1985). The objectives of the study were to determine the proximate composition of experimental diets containing graded levels of *Ziziphus mauritiana* leaf and growth performance of growing rabbits on graded levels of *Ziziphus mauritiana* leaves in diets.

METHODOLOGY

Study Area

The study was conducted at the rabbitary unit of the Animal Science Department, Bayero University Kano. Kano State partly lies in the Sudan and Northern guinea vegetative zone (Olopin, 1985) between longitudes 9^0 30' and 12^0 30' North and latitudes 90 30' and 8^0 42' East (KNARDA, 2001) and about 1, 578 feets (481m) above sea level.

Period of the Study

An eight weeks feeding experiment was conducted to evaluate the performance of growing rabbits fed graded levels of Ziziphusmauritiana leaf in diets. Twelve (12) weeks old crossbred grower rabbits of both sexes averagely weighing 12.kg were balanced for weight before random distribution to four (4) dietary treatments replicated with seven rabbits per treatment. The rabbits were allowed one week per conditioning period (adaptation) during which a formulated feed was offered prior to the commencement of the experiment hence they were also treated with ivomec injection.

Experimental Designs

The Ziziphusmauritiana leaves were included in concentrate-based diets at o,15,30 and 45% levels to form complete diets. Four dietary treatments were designated where 100% of the concentrate as A (control), 85% of concentrate and 15% of *Ziziphus mauritiana* leaves as B, 70% of concentrate and 30% of *Ziziphus mauritiana* leaves as C and 55% of concentrate and 45% of *Ziziphus mauritiana* leaves as D respectively. The feeding strategy employed was that 100g feed was offered to rabbits individually in the morning around 8:00am and clean water was offered ad libitum, in plastic containers. The feed left over and wastage were daily recorded before feeding.

Data Collection

Data on feed intake and weekly weight change were collected. Daily feed intake was estimated by weighing the leftover. At the end of every week rabbits were weighed and the values recorded.

Statistical Analysis

Data collected were subject to analysis of variance using general linear system. Least significant difference test was used to separate means at ($P<0.05$) using the SAS (1999) software.

Table 1: Components of the Concentrate Meal Fed to the Experimental Rabbits

Ingredient	Proportion (%)
White Maize	32.70
Rice Brand	24.53
Wheat Offal's	24.53
Groundnut Cake (GNC)	9.75
Fish Meal	6.50
Salt	0.50
Premix	0.50
Bone Meal	1.00
Total	**100.00%**

Growth Performance

Data were collected with respect to the initial and final weight of the animals, feed intake and weight gain in each replicate. The values obtained were used to obtain the following:

- Feed intake/rabbit/day in (grm) = quantify of feed given refusal (g)

  Number of rabbit x total days of trail

- Daily weight gain/rabbit/day (grm) = final live weight-initial weight (g)

  Number of rabbit x total days of rail

- Feed conversion ratio (g) feed gain= quantity of feed consumed (g)

  Weight gain

FINDINGS

The result of the proximate analysis of the graded of Ziziphus mauritiana supplemented diets fed the growing rabbits are shown in Table 2. The results obtained show that ash content is significantly higher in diets D compared to others. The result of the moisture content however indicates that diets. A content the higher amount while diets D is a very dry feed. In terms of try matter content diets D had the highest value which may indicate the possibility of it being more nutritious. This is because most nutrients are contained in the try matter component of the feed. The result of the crude protein (CP) analysis shows that diet D contained in the highest amount (24.06%CP). This is adequate as per the physiological state of the experiment animals, i.e growth. The crude fibre (CF) contents of the experimental diets showed similar trend

as that of crude protein by increasing as the level of Ziziphus mauritiana leaf was increased, the highest value obtained in diet D (37.47%CF). the extra extract (EE)content of the experimental diets also increased as more amounts of Ziziphus mauritiana lesfs was added across the treatment, the highest content was also recorded in die D (11.78% EE). However the nitrogen free extractives (NFE) content of the diets decreases as levels of Ziziphus Mauritiana leafs increased across the treatments. The highest value obtained in diet A indicates that it content the largest amount of concentrate. Diet D with the least value of NFE shows that it had the highest amount of plant cell well components.

Table 2: Proximate Composition of Graded Levels of *Ziziphus mauritiana* Leaf in Diets Fed to Growing Rabbits

Parameters	Diet A	Diet B	Diet C	Diet D
Moisture	9.42	8.89	8.07	7.70
Dry Matter	90.59	91.11	91.93	92.31
CP	9.84	12.03	16.41	24.06
CF	25.14	28.62	29.15	37.47
EE	4.6	6.51	7.04	11.78
NFE	53.80	44.84	36.61	14.14
ASH	6.62	8.00	10.8	12.55

Table 3 Shows the growth performance of growing rabbits graded fed levels of Ziziphus mauritiana in diets. There is significant ($P<0.05$) difference in the final weight, diet D recorded to be superior to other, and the same weight gain was observed in diets B while diets C and A was the least. In terms of total weight gain the result shows that diet D had the highest weight compared to others and diet B is significantly ($P<0.05$) higher than diet C while diet A has the lowest weight gain. However, a significantly ($P<0.05$) higher different was recorded in the daily feed intake of diet D compared to others. Similarly, a significant ($P<0.05$) difference was observed between diet B and C with the former having a higher value, diet A the control was the least consumed.

Furthermore, the results of the feed conversion efficiency revealed that as the level of Ziziphus Mauritiana leaf was increased in the diets lower values were obtained. This indicates that supplementation with the test ingredient increases the efficiency with which the diets were utilized.

Table 3: Growth Performance of Growing Rabbits Fed Graded of *Ziziphus mauritiana* Leaves in Diets

	Diets				
Parameter	**A**	**B**	**C**	**D**	**LSD**
Initial weight (g)	3.60^{a}	500.0^{a}	620.0^{b}	482.0^{b}	62.00
Final weight (g)	790^{a}	1099^{b}	1090^{b}	1130^{c}	96.4
Total weight (g)	436^{a}	590.0^{a}	470.0^{ab}	649.0^{c}	63.5
Daily feed intake	106.43^{c}	110.71^{bc}	118.86^{ab}	124.86^{a}	11.103
Feed conversion efficiency	0.64	0.59	0.42	0.41	0.49^{a}

$^{a, b, c,}$ means in the same the row with different superscript are significantly ($P< 0.05$) different; LSD =least significant differences.

The results of weight gain of the growing rabbits fed varying levels of Ziziphus mauritiana leaf supplemented diet in this study showed appreciable difference with values obtained from previous findings (Aduku and Olukosi, 1990, Akinmutini, 2004, and Ojebiyi et al; 2008). The result of the current study showed a higher final weight. The result is however lower than that of Owen, (1976). The difference observed may be due to the utilization of varying ingredients, mode of feeding and place of the feeding trails. The trend in the total weight gain of the experimental animals also showed similar trend. The values obtained in this study are higher than those of other researchers (Amuefele et al; 2004, Biobaku et al., 2003, and Cheese et al 1990). It is however lower than that of Aduku and Olukosi (1990)

The differences may be due to the effect of randomization, temperature and ratios of concentrates to the experimental test feed ingredient. Similar trend in weight gain was however observed by Ezea (2004) who fed Verona leaf meal to rabbits in diets. Omole and Onwudike (1983), Aduku (1988), Adeosun (2005) and Arneta and Bratt, (2008) also reported similar findingss as that of this study. The result of feed in take showed a wide variation in this study. This is in agreement with the finding of Adeosun (2005) and Akinmutini et al., (2008) with 96.08 - 146.57g per day much higher than 48.79, 78.2 and 67.0g variation was reported by Aduku et als (1986) when groundnut and cowpea haulms were included at varying levels in the diets of weaner rabbits. The value of feed intake of 79.5g per head per day obtained by Otaru (1994) was appreciably lower that the result of the current study probably because Mucuna was fed at a higher ratio (75:25g). Akinmutumi et al., (2008) also fed Mucuna, Lablab or groundnut haulms and obtained lower value of 36.5g. Growing rabbits were similarly fed soybeans cheese waste meal and Lablab by

Akinmutumi (2004) in diets and a range of 96.95 - 118.95g per day were obtained. The variation observed in the studies reviewed may be due to the fibre levels in the experimental diets. The trend in the feed conversion efficiency of growing rabbits in the current study was similar to that reported by Biobaku and Oladipo (2002) when cooked Leucaena leaf was fed in the diets Rabbit in both experiments showed better utilization of the diets as the experimental test ingredient Ziziphus mauritiana and Leucana leaf were increased.

CONCLUSION AND RECOMMENDATIONS

In conclusion, it is an evident from the result of this study that cross bred growing rabbits can tolerate and perform very well on diet D with 45% *Ziziphus mauritiana* leaf. Considering the growth performance, daily weight gain, feed conversion efficiency and feed intake diet D is therefore recommended for growing rabbits.

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Stability of Fractured End of Femur in Young Dogs Affecting the Status of the Hip Joints Using Intramedullary Pinning

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Abstract

In the study 10 dogs were sourced from 2 litters, and were randomly assorted into 3 experimental groups. The intramedullary pinning of the femur of the young dogs were evaluated to know the status of the hip joints. Fractures were created on the femur of the experimental dogs and attempts were made to oppose or align then using the retrograding and normograding techniques. It showed that retrograding techniques with multiple intramedullary pinning provide stability to the corrected fractured limb, and frequent evaluation of the radiographic status of the hip and bones in managing femoral fracture repair by intramedullary pin fixation in young dogs to determine when it is soonest and best to remove the pins.

Keywords: *Intramedullary Pins, Femur, Hip Joint, Dogs, Status.*

INTRODUCTION

Intramedullary bone pinning has become a very popular method of bone fracture repairs among clinicians all over the world since after the Second World War. It has an edge over other methods of repair because it is the most economical, the least laborious and can be applied, in some cases without opening through the entire tissues. It is a well-accepted common technique for repairing femoral fractures. The subject has been reviewed by several authors viz: [1] [2] [3] [4].

This work on effect of intramedullary pinning on the status of hip joints of young dogs is necessitated by the fact that cases of femoral fractures are very common when there are more cars on the streets and more people are becoming interested in keeping dogs, either as watchdogs or as pets.

In Nigeria, many dog owners prefer to leave their dogs to move about the streets and come back home later in the day. The practice of chaining a dog down throughout the day does not appear humane to average Nigerian. Dogs are therefore more prone to automobile accidents, in such accidents; the pelvic limbs are more exposed to fracture because it is the pelvic limb, most of the time that is too late to escape the accidents. When a dog suddenly sees a car close to it, an attempt is made to escape, where the car is too close, the forelimb, head and the loin area escape leaving the hind limb which is then hit by the car, leaving the dog with either a fracture of dislocation depending on the impact of the collision. This fact is supported by [3] [5].

Since intramedullary pin fixation has been recognized as the most economical method of reduction, because there had been reported cases of hip luxation following intramedullary pinning in young growing dogs, it is pertinent to examine the possible effect or complications of intramedullary pins on the coxofemoral joint in puppies. [3] [6] outlined the advantages of intramedullary pin fixation to include economy, speed, decreased surgical exposure, easy implant removal and minimal stress protection of the bone to avoid loss of bone strength in accordance with Wolff's law. This work seeks to highlight the untoward effect of this method of repair particularly in young dogs.

METHODOLOGY

Included in this survey were the 10 dogs from 2 litters, acquired at 6weeks and kept in experimental animal kennels for 6 weeks before commencement of experiment. Fed on dogs feed formulation.

The dogs were randomly assorted into 3 experimental groups, and no consideration for sex. Preoperative radiographic evaluation of the hip joints and femurs of experimental animals were carried out under general anesthesia. The epiphyseal growth plates were still open showing that the animals were still young and that the bones were still undergoing longitudinal growth.

Surgical Procedures: After the animals have been anesthetized using general anesthetic drugs using preanesthetic (Midazolam) and anesthetic (Ketamin-Xylazine), under aseptic preparation. Fracture was created in the long bone used (left femur) using gigli wire, after opening through the skin with a longitudinal incision from the trochanter area to the condylar area anteriolaterally, then cut through the tensor fascia lata longitudinally and by retracting the belly of the vastus lateralis muscle and rectors femoris anteriorly and posteriorly respectively, The gigli wire is passed underneath the shaft of the bone and applying alternatively left and right pull on the wire against the bone from below, the shaft is sectioned transversely, the pins were inserted into the medullary cavity of the femur using the two techniques of pin placement. i.e., Retrograding and Normograding Techniques. The pins were removed from the dogs on day 28.

Control: The individual animal in this experiment serves as its own control, since only one hind leg is treated, the other serves as a basis for comparison between the two legs in the radiograph.

Post-Operative Radiographic Evaluation: This was carried out in all the dogs, including the non-operated ones after 52 days of operation. The ventrodorsal view of the hip area was obtained for all the dogs.

All the dogs involved in this experiment were kept in kennels within the same premise, 2 dogs in each kennel. Movements of the dogs were thus restricted with daily exercise during the course of feeding and cleaning the kennels. The exercise was by way of escaping into the small yard while cleaning was going on in the kennel and running round for a while before going back into the kennel to feed. The runs were spacious enough for adequate exercise.

FINDINGS

All the operated animals did not show any evidence of subluxation in the hip joint of the treated limb while the opposite limb remained normal in the radiograph. It is therefore expected that the joint might proceed to complete luxation later in life; an observation which time does not permit to have.

The following changes were evident from the radiographs in varying degrees, they are: reduction in the size of the femoral head, narrowing of the neck, changes in angulation between the femoral head and the femoral shaft, rare faction of the femoral head.

Of all the complications generally associated with intramedullary pins, (i.e. Osteomyelitis, pin migration, threaded screw breakage, nonunion, mal-union, joint stiffness, and sciatic nerve damage) only pin migration can be associated with this experiment. This was shown in only two of the dogs operated.

Figure 1: Radiograph of Normal Hip of a Young Dog- Control

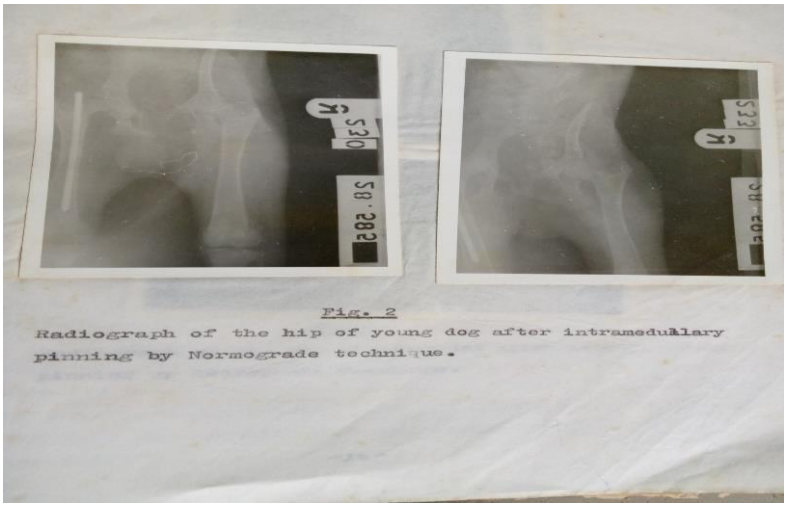

Figure 2: Radiograph of the Hip of a Young Dog after Intramedullary Pinning by Normograde Technique

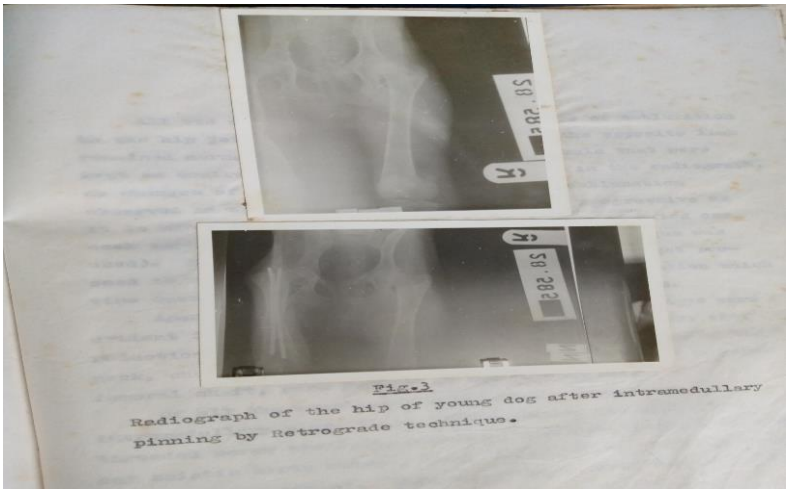

Figure 3: Radiograph of the Hip of a Young Dog after Intramedullary Pinning by Retrograde Technique

The results of this experiment confirm the report by [7] that, femoral pinning of diaphyseal femoral fractures in young dogs appear to alter the coxofemoral joint. It has been proven, however, in this experiment that, it is neither the presence of fracture nor the position of the fracture in the femur that is important in producing these alterations, rather it is the presence of the intramedullary pin in the femur, whether it is there to fix epiphyseal fracture, capital fractures, femoral neck fractures, femoral shaft fractures, supracondylar fractures, intercondylar fractures or no fracture at all. In the series of dogs in which the normograde techniques were used, no fractures were created, yet they produced the same result.

Since these alterations have only been observed in young dogs, the suggestion of [8] that the proximal exit of the pins through the femoral head markedly enhanced coxofemoral luxation by inducing alterations in the development of the femoral head and neck is supported. The exit of the pins in the proximal end of the bone constitutes impedance to the epiphyseal growth plate hence the anatomical bony alterations. The gluteal muscle atrophy referred to by [9] and the quadriceps contracture referred [6] are likely to be the effects of the alterations rather than the cause.

Once these anatomical bony alterations have been produced in a dog, it is doubtful that the aggressive regimen of physical therapy recommended by [8] would be able to reverse these bony changes even when the quadriceps contracture has been reversed. The most acceptable suggestion of that author [8] therefore is that pins should be removed as soon as possible.

CONCLUSION AND RECOMMENDATIONS

Veterinary surgeons should frequently evaluate the radiographic status of the hip and bones in managing femoral fractures repaired by intramedullary pin fixation in young dogs as recommended by (Fox et.al.) determining when it is soonest and besting to remove the pins.

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