
Sjournals
CODEN (USA): SJASAB
Scientific Journal of
Animal Science
S
J
A
S
ISSN 2322-1704
Sjournals Publishing Company | www.sjournals.com

Sjournals
Scientific Journals
Scientific Journal of Animal Science (2017) 6(7) 428-435
ISSN 2322-1704
doi: 10.14196/sjas.v6i7.2413

CODEN (USA): SJASAB

Contents lists available at Sjournals

Scientific Journal of **Animal Science**

Journal homepage: www.Sjournals.com

Original article

Growth, morphostructural and haematological performances of West African Dwarf male sheep fed garlic powder additive diets

Maria Kikelomo Adegun*, Oluwatoyin Folake Alamuoye, Pius Amoka Aye

Department of Animal Production and Health Sciences, Ekiti State University, PMB 5363, Ado-Ekiti, Ekiti State, Nigeria.

*Corresponding author; patrickikelomo@yahoo.com

A R T I C L E I N F O

Article history,
Received 17 June 2017
Accepted 11 July 2017
Available online 18 July 2017
iThenticate screening 19 June 2017
English editing 08 July 2017
Quality control 15 July 2017

Keywords,
Yearling
West African Dwarf (WAD) rams
Additive
Basal diet
Morphostructural parameters
Haematology

A B S T R A C T

An experiment was carried out to investigate the additive effect of garlic powder on growth, morphostructural and haematology of West African Dwarf (WAD) rams fed *Panicum maximum* basal diet supplemented with concentrate. Forty Yearling WAD rams with average initial live weight of 12.41kg were randomly allotted to five dietary treatments of garlic powder additive (GPA) at 0%, 0.2%, 0.4%, 0.6% and 0.8% (0 mg/kg, 2000 mg/kg, 4000 mg/ kg, 6000mg/kg and 8000mg/kg respectively) of the supplements for 12 weeks. Results revealed that inclusion of 4000 mg/kg garlic powder additive in experimental diets showed better weight gain and feed conversion ratio for WAD rams than the control (0% GPA) and the other treatments (P<0.05). The morphometric measurements gains correlate with the pattern of body weight gain reported in the treatment groups. Haematological findings showed better packed cell volume in animals fed GPA compared with the control (P<0.05). However, all investigated haematological parameters had values within normal limits for healthy sheep. Addition of garlic powder to sheep diet improved body weight gain up to 4000mg/kg of supplemental diet while also enhancing the health status of the animals.

1. Introduction

Sheep production is an integral part of the social and economic lives of the vast majority of subsistence farmers who mainly practice mixed farming in the developing countries (Devendra, 2001). Sheep can convert fibrous biomass into desirable products such as meat, milk and fibre. They are means of storing wealth in times of agricultural plenty, they provide cash reserves during emergencies such as paying hospital bills or defraying school fees costs and they are slaughtered during marriage, naming ceremonies and other festivities (Smith, 1992). Despite the contribution of sheep to rural development, its current contributions falls short of full productivity potential due partly to the low nutritional quality of feed resources offered to these animals (Bamaiyi, 2013). They are mainly fed on natural pastures and some low quality supplements such as cassava peels, yam peels, plantain peels when available (Asaolu and Odeyinka, 2006). These eventually result in low productivity in terms of slow growth and predisposition to diseases among other deleterious effects.

In order to improve the productivity of sheep, quality supplements such as concentrate and additives must be supplied with the basal diets which are mainly forages (Foidl et al., 2001). Feed additives are products used in animal nutrition to improve quality of feed and quality of food from human origin or to improve the animals' performance and health (Wanapat et al., 2008). These feed materials help to equilibrate both protein and energy utilization in the animals, thereby resulting in improved production and may play significant role in altering the rumen environment by influencing specific microbial population in the rumen for improved productivity (Pirmohammadi et al., 2014). Although, in the past, antibiotics such as ionophores were used as growth promoters, but their use is highly objectionable due to residual effects. Consequently, the European Union (EU) has banned their use in animal feeds and is now being replaced with natural plant products like garlic and ginger, which are safer for human consumption. Garlic (*Allium sativum*) is a natural plant with antimicrobial, anti inflammatory, anti oxidative and anti parasitic properties that are beneficial to man and animals (Tatara et al., 2008). It has an added advantage that microorganisms in the rumen do not develop resistance to it (Bampidis et al., 2005).

Garlic is a complex mixture of many secondary metabolites which include allicin, diallylsulphide, diallyldisulphide, allylmercaptan, volatile oils, good amount of proteins (10 to 17%) and a rich source of minerals (Kamra et al., 2012). Garlic as growth promoter and its beneficial effects on livestock were reported by some researchers on lambs, piglets and goats (Nolte and Provenza, 1992; Bampidis et al., 2005; Tatara et al., 2008; Anassori et al., 2011; Pirmohammadi et al., 2014). Finally, based on several *in-vivo* experiments, it has been concluded that garlic powder as a feed additive possesses good potential for rumen manipulation for eco-friendly and improved livestock production (Kamra et al., 2012). Therefore, this study was undertaken to determine the growth performance, morphometric and haematological performances of Yearling WAD rams fed garlic as an additive.

2. Materials and methods

2.1. Experimental site

The study was conducted at the Ruminant Unit of the Teaching and Research Farm, Ekiti State University, Ado-Ekiti. It is located between latitude $07^{0}31^{1}$ 15^{11} N and longitude 05^{0} 13^{1} 17^{11} E with a temperature range of 21 ^{0}C to 28 ^{0}C and high humidity situated in the humid zone of Nigeria. It is characterized with a tropical climate and a bimodal rainfall distribution between April and October accompanied by a break in August and the peaks during June and September.

2.2. Experimental diets

Garlic cloves were peeled, washed and sliced to pieces of 3 to 4 mm, sun dried and ground to powder to formulate five experimental diets with garlic inclusion at 0 mg/kg, 2000 mg/kg, 4000 mg/kg, 6000 mg/kg and 8000 mg/kg of experimental diets (Table 1).

2.3. Chemical analysis

Dried samples of garlic powder and experimental diets were ground and passed through a 2mm sieve before analysis. The crude protein (CP) of each of the samples was determined using the automated Kjeldahl method (AOAC, 2005). The dry matter was determined by drying at 65 ^{0}c for 48 hours in an oven while ash was measured by burning further at 500 ^{0}C for 4 hours. The neutral detergent fibre (NDF) and acid detergent fibre (ADF) composition were analyzed using the method described by Goering and Van Soest (1970).

Table 1
Composition of experimental diets (kg 100kg^{-1}).

	Level of garlic inclusion				
Ingredients	**Diet 1 (0%)**	**Diet 2 (0.2%)**	**Diet 3 (0.4%)**	**Diet 4 (0.6%)**	**Diet 5 (0.8%)**
Soybean meal	10.0	10.0	10.0	10.0	10.0
Maize	35.0	35.0	35.0	35.0	35.0
Rice bran	15.0	15.0	15.0	15.0	15.0
Brewer's dry grain	37.0	37.5	37.5	37.5	37.5
Bone meal	1.0	1.0	1.0	1.0	1.0
Salt	1.0	1.0	1.0	1.0	1.0
Vitamin/mineral	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated protein	16.07	16.07	16.07	16.07	16.07
Calculated energy (kcal/kg)	2605.7	2605.7	2605.7	2605.7	2605.7

Table 2
Proximate composition of experimental diets (kg 100kg^{-1}).

	Level of garlic inclusion					
Parameters	**Diet 1 (0%)**	**Diet 2 (0.2%)**	**Diet 3 (0.4%)**	**Diet 4 (0.6%)**	**Diet 5 (0.8%)**	**Panicum maximum**
DM	87.80	87.98	87.80	88.16	88.62	88.50
CP	15.45	15.75	15.95	15.34	17.01	14.05
CF	6.82	6.54	7.01	7.78	7.92	34.74
EE	5.78	5.49	5.36	5.01	4.78	5.20
ASH	8.22	8.41	8.45	8.70	9.45	11.50
NFE	51.55	51.69	51.03	50.33	49.46	23.01
CHO	58.37	58.23	58.04	58.11	57.38	55.75
GE(Kj/100g)	1444.9	1442.4	1437.4	1432.2	1422.5	1392.1

DM; Matter, CP; Crude Protein, CF; Crude Fiber, EE; Ether Extract, NFE; Nitrogen Free Extract, CHO; Carbohydrate, GE; Gross Energy.

2.4. Experimental animals and experimental design

A total of forty (40) Yearling WAD rams were used for the study. The rams were randomly assigned to five (5) dietary treatments of eight rams per treatment under completely randomized block design. The experiment lasted for 12 weeks.

2.5. Feeding of experimental animals

The animals were allowed a 14-day adaptation period after which they were offered their respective diets at about 0800 hours and 1700 hours for the 12 weeks the experiment lasted. Fresh drinking water was provided *ad libitum*.

2.6. Data collection

Data were collected on growth performance, morphostructural and hematological parameters of the rams.

2.6.1. Growth parameters

Equation 1: Body Weight Gain = Final body weight – Initial weight
Equation 2: Daily Feed Intake = Quantity of feed fed – Quantity of feed left each day

$$\text{Equation 3: Feed Conversion Ratio} = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

2.6.2. Morphostructural parameters

Data were collected on body length, height at withers, pelvic width, tail length, heart girth, ear length and chest depth using a measuring tape graduated in centimeters as described by Fajemilehin et al. (2008).

2.6.3. Hematological parameters

Blood samples were drawn from each animal through the jugular vein using a 10ml gauge (5cm) needle to draw 4ml of blood from each animal at the 4^{th}, 8^{th} and 12^{th} week of the study. The blood samples were emptied into heparinized packs containing about 40mg of anticoagulant components. Packed cell volume (PCV), White Blood Cell (WBC) and differential counts of WBC (Neutrophils, Eusinophils, and Lymphocytes) were determined according to the methods described by Coles (1986). Mean Corpuscular Volume, Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobiin Concentration (MCHC) were calculated as:

$$\text{Mean Corpuscular Volume (MCV) } (U^3) = \frac{\text{Haematocrit (PCV) x 10}}{\text{RBC in millions/mm}^3}$$

$$\text{Mean Corpuscular Haemoglobin (MCH) (pg)} = \frac{\text{Hb in g/100ml blood x 10}}{\text{RBC in millions/mm}^3}$$

$$\text{Mean Corpuscular Haemoglobin Concentration (MCHC) \%} = \frac{\text{Hb in g/100ml blood x 10}}{\text{Haematocrit (PCV)}}$$

2.7. Statistical analysis

All the data collected were subjected to one way analysis of variance (ANOVA) and means were separated using Tukey's Pair Wise Comparison of Minitab Release 11.12 edition at probability level of 5%.

3. Results and discussion

3.1. Growth performance of WAD sheep fed experimental diets

The growth performance of WAD Sheep fed garlic powder as an additive (GPA) is presented in Table 3. Feed intake increased significantly as the level of garlic powder inclusion increased in the treatments up to 0.4%, but decreased thereafter. Rams on diet 3 (0.4% garlic powder additive) recorded significantly highest ($p<0.05$) mean feed intake, while rams on diet 1 and 5 (0 and 0.8% garlic powder) had the lowest feed intake values that were statistically similar ($p>0.05$). The mean body weight gain of WAD rams on Diets 1, 2, 3, 4 and 5 (0, 0.2, 0.4, 0.6, and 0.8% GPA respectively) were obtained at 2.93 ± 0.15kg, $3.00\pm.25$kg, 3.70 ± 0.37kg, 2.85 ± 0.32kg and 2.79 ± 0.29kg respectively. There were significant differences ($p<0.05$) in mean live weight gain of WAD sheep fed different levels of garlic powder as an additive. Rams on diet 3 (0.4% GPA) had the highest mean live weight gain. Rams on diet 1 (0%), 2 (0.2%) and 4 (0.6%) were not significantly different ($p>0.05$) while rams fed diet 5 (0.8%) had the lowest mean live weight gain. The feed conversion ratios were 10.13 ± 0.63, 9.96 ± 1.43, 8.74 ± 1.53, 10.48 ± 2.65 and 10.75 ± 2.12 in diets 1, 2, 3, 4 and 5, respectively. Rams on diet 3 had the best feed conversion ratio of 8.74 which was significantly different ($p<0.05$) from the values obtained for rams on other diets. Rams on diet 5 had the poorest feed conversion ratio at 10.75.

3.2. Morphostructural parameters of WAD ram sheep fed experimental diets

Table 4 showed the linear body measurement gains of WAD rams fed garlic powder as an additive. There were significant differences in the body linear measurements parameters measured. The values of linear body measurements gain in body length, heart girth, height at withers, ear length, width of pelvic, chest depth and ear length were highest ($p<0.05$) in animals fed 0.4% garlic powder as an additive at 8.84±0.55, 6.11±0.85, 8.58±0.76, 1.83±0.06, 4.89±1.91, 4,29±0.84 and 3.17±0.69cm respectively. There were no significant differences ($p>0.05$) in the pelvic width of WAD sheep fed 0, 0.2, 0.6, and 0.8% garlic powder additive. However, WAD sheep fed 0.8% garlic powder showed lowest values in all the parameters measured.

Table 3

Growth performance of West African Dwarf sheep fed garlic powder as an additive.

Parameters	Diet 1 (0%)	Diet 2 (0.2%)	Diet 3 (0.4%)	Diet 4 (0.6%)	Diet 5 (0.8%)
Feed intake(gd^{-})	530±36.3^{c}	543.7±35.4^{b}	577.5±37.3^{a}	539.7±53.2^{b}	526±36.6^{c}
Initial live weight (kg)	11.45±2.17	11.01±1.40	10.36±0.31	10.40±0.43	10.98±0.71
Final live weight (kg)	14.38±2.17^{a}	14.01±1.48^{b}	14.06±0.92^{b}	13.25±0.68^{d}	13.72±0.65c
Mean live weight gain (kg)	2.93±0.15^{b}	3.00±0.25^{b}	3.70±0.37^{a}	2.85±0.32^{b}	2.74±0.29^{c}
Metabolic live weight gain ($W_{kg}^{0.75}$)	2.19	2.25	2.77	2.14	2.06
Average daily weight gain (g)	52.37±7.02^{b}	53.57±5.16^{b}	66.07±7.10^{a}	50.89±7.10^{b}	48.93±3.81^{b}
Feed conversion ratio	10.13±0.63^{b}	9.96±1.43^{b}	8.74±1.53^{a}	10.48±2.65^{c}	10.75±2.12^{d}

a, b, c, d – Means with different superscripts in the same row were significantly different ($P<0.05$).

Table 4

Body linear measurement gain of WAD sheep fed garlic powder as an additive.

Parameters	Diet 1 (0%)	Diet 2 (0.2%)	Diet 3 (0.4%)	Diet 4 (0.6%)	Diet 5 (0.8%)
Body length (BL)	6.37±0.76^{b}	7.39±0.74^{b}	8.84±0.55^{a}	7.14±0.71^{c}	6.13±0.56^{c}
Heart girth (HG)	5.95±0.09^{c}	6.06±0.54^{b}	6.11±0.85^{a}	6.03±0.63^{b}	5.82±1.0^{d}
Ear length (EL)	1.27±0.74^{b}	1.31±1.17^{b}	1.83±0.66^{a}	1.27±0.89^{b}	1.14±0.22^{c}
Height at wither (HW)	7.84±0.63^{c}	8.12±0.41^{b}	8.58±0.76^{a}	7.75±0.58^{c}	7.72±1.19^{c}
Width of pelvic (PW)	3.38±0.82^{b}	3.20±0.73^{b}	4.89±1.91^{a}	3.02±0.67^{b}	3.06±0.56^{b}
Chest depth	3.13±1.09^{c}	3.28±0.52^{b}	4.29±0.84^{a}	3.18±1.02^{c}	3.09±0.62^{c}
Tail length (TL)	2.74±0.51^{b}	2.64±0.97^{b}	3.17±0.69^{a}	2.38±0.27^{c}	2.35±0.41^{c}

a, b, c, d – Means with different superscripts in the same row were significantly different ($P>0.05$).

Table 5

Haematological variables of WAD sheep fed garlic powder as an additive.

Parameters	Diet 1 (0%)	Diet 2 (0.2%)	Diet 3 (0.4%)	Diet 4 (0.6%)	Diet 5 (0.8%)
PCV (%)	37.33±5.86^{b}	40.33±5.86^{a}	41.00±4.58^{a}	40.33±4.16^{a}	40.33±2.08^{a}
HB (g/dl)	13.00±2.16	13.17±0.61	14.03±1.67	13.53±0.95	13.10±0.70
RBC ($10^{6}\mu l$)	6.68±0.62	6.77±0.38	6.74±0.54	6.76±0.52	6.76±0.36
WBC ($10^{6}\mu l$)	9.28±0.50^{c}	10.67±0.76^{a}	10.03±1.00^{b}	9.67±1.36^{c}	9.58±1.38^{c}
Neutrophil (%)	59.00±3.61	68.00±6.93	70.83±1.00	69.67±4.04	69.67±8.74
Lymphocyte (%)	31.33±1.16^{a}	23.33±1.53^{b}	32.00±2.0^{a}	32.00±7.94^{a}	31.67±6.51^{a}
Monocyte (%)	2.67±1.16	1.33±0.58	1.33±0.58	1.00±0.00	2.00±0.00
Eosinophil (%)	3.00±0.00^{a}	2.00±0.00^{b}	2.00±0.0^{b}	2.33±0.58^{b}	3.33±0.58^{a}
MCV (μl^{6})	55.88±3.05	59.57±0.69	60.83±1.99	59.67.54±0.5	59.67±2.18
MCH (pg)	194.61±13.51	202.51±6.99	208.16±7.97	200.15±2.66	193.61±1.51
MCHC (%)	34.82±0.63	32.65±0.79	34.21±0.45	33.54±0.42	32.48±1.10

a,b,c, d – Means with different superscript in the same row were significantly different ($p<0.05$). PCV; Packed Cell Volume, HB; Hemoglobin, RBC; Red Blood Cell, WBC; White Blood Cell, MCV; Mean Corpuscular Volume, MCH; Mean Corpuscular Hemoglobin, MCHC; Mean Corpuscular Hemoglobin Concentration.

3.3. Haematological parameters of WAD sheep fed experimental diets

Table 5 showed the haematological parameters of WAD sheep fed the experimental diets. Packed cell volume (PCV) was significantly reduced ($p<0.05$) in rams diet 1 on 0% GPA (37.33±5.86%) while rams on other diets 2, 3, 4, and 5 (0.2%, 0.4%, 0.6% and 0.8% GPA respectively) were statistically similar ($p>0.05$). White blood cells were significantly different ($p<0.05$) for rams in all the diets ranging from 9.28±0.5010^{6}µl in rams on diet 1 to 10.67±0.7610^{6}µl in rams on diet 2. The result of lymphocytes reduced significantly ($p<0.05$) in rams on diet 2 (23.33±1.53%) but the values obtained in diets 1, 3, 4, and 5 were statistically similar ($p>0.05$). Rams on diet 1 and 5 had significantly increased ($p< 0.05$) eosinophil counts (3.00±0.00 and 3.33±0.00% respectively) than rams on diets 2, 3 and 4 (2.00±0.00, 2.00±0.00, and 2.33±0.00% respectively). The values of haemoglobin was lowest in animals on diet 1 (13.00±2.16 g/dl) and highest in rams fed diet 3 (14.03±1.67g/dl). MCH ranged from 193.61±1.51pg in rams fed diet 5 to 208.16±7.97pg in rams on diet 3.

The animals fed garlic powder (GP) as an additive recorded higher feed intake compared with the animals fed 0% GP (Without garlic powder additive). This indicates that garlic as an additive may have beneficial effects on animals which include stimulation of appetite and feed intake which is in line with the findings of Kamra et al. (2012). The reduced feed intake when GP additive exceeded 0.4% may indicate that palatability is reduced when garlic was introduced at higher levels. This finding agreed with the results of Nolten and Provenza (1992) in lambs that flavour inclusion at the rate of 0.05g/kg improved acceptability while inclusion at higher levels (5-25% DM) reduced palatability.

The highest weight gain in rams fed 0.4% GPA could be attributed to the effects of some secondary products in garlic powder which were capable of rumen manipulations such as defaunation of the rumen environment, decreased methane production, reducing the proportion of acetate and increasing that of propionate due to better nutrient utilization. These assertions are in agreements with the findings of Anassori et al. (2011) and Pirmohammadi et al. (2014). The result also agrees with the report of Tatara et al. (2008) who reported garlic as an alternative growth promoter in livestock production. However, the result of this study disagreed with the study conducted by Bampidis et al. (2005) who reported that addition of garlic did not affect growth performance, feed conversion ratio and carcass characteristics of growing lambs. The linear body measurements gains correlate with the pattern of body weight gain reported in the treatment groups. This is in agreement with the work of Sowande and Sobola (2008) and Fajemilehin and Adegun (2015) that a positive relationship exists between body weight and linear body morphometry.

Packed cell volume (PCV) is important in diagnosis of anaemia (Chineke et al., 2006). The PCV values obtained in this study fell within the range of PCV for healthy sheep (27-45%) as reported by Jain (1993). Contrary to the submission of previous study (Banerjee and Maulik, 2002) that the prolonged dietary exposure of rats to garlic resulted in anaemia, the present study indicated that garlic inclusion had no negative bearing in disposition to anaemia as all PCV values were within normal range. The result of haemoglobin was within normal range of (8-16g/dl) for healthy sheep (Green wood, 1997). Red blood cell (RBC) obtained were in line with RBC values of lamb (4.44-8.69g/dl) reported by Njidda et al. (2014). The white blood cell (WBC) values in the study fell within the normal range (6.93-12.66 × 10g/l) of WBC as observed by Fadiyimu et al. (2010). The significantly higher WBC in rams on diets 2 and 3 (0.2% and 0.4% GP inclusion respectively) could be as a result of the antioxidant effect of GP on the animals. According to Oluwole (2001) and Olaniyan et al. (2013), garlic stimulates immune functions and have antibiotic effect which should enable proliferation of circulating white blood cells, which are the mobile units of the body's protective system, Thus, animals with low white blood cells are exposed to high risk of disease infection, while those with high counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases (Soetan et al., 2013). Garlic acts as a mild antibiotic in comparison to modern antibiotics with an added advantage that microorganisms do not develop a resistant against it. It acts as a pre biotic, a nutrition which is not digested, but acts as a stimulant for the beneficial gut microbes leading to improved microbial ecosystem.

The white blood cell differentials (Lymphocytes, Neutrophils, Monocytes and Eosinophil) are within normal limits. These white blood cell differentials are meant to fight infections, defend the body against invasion by foreign organisms and to produce or at least distribute antibodies in immune response while acting as an antioxidant (Vazquez-Prieto et al., 2010). The values of MCV, MCH and MCHC are very important in the diagnosis of anaemia and also serve as useful indices of the capacity of the bone marrow to produce red blood cell (Awodi et al., 2005).

4. Conclusion

There was significant improvement in growth performance (Weight and feed conversion ratio) of the WAD sheep as garlic powder increased particularly at 4000 mg/kg additive level. There was no adverse effect on all investigated haemotological parameters on WAD sheep on the experimental diets including the control diet where GP was absent. There was ample evidence that GPA improved the productivity of WAD sheep while ensuring healthy status.

References

Anassori, E.B.D., Naghadeh, R., Pirmohammadi, A., Taghizadeh, S.A., Razaei, M., Maha, S.F., Azar, P., Farhoomand, P., 2011. Garlic; a potential alternative for monensin as a rumen modifier. Livest. Sci., 142, 276-287.

AOAC, 2005. Association of analytical chemistry. Official method of analysis. 18th edition, Washington DC.

Asaolu, V.O., Odeyinka, S.M., 2006. Performance of West African Dwarf sheep fed cassava peel based diets. Nig. J. Anim. Prod., 33(2), 230-238.

Awodi, S., Ayo, J.O., Atodo, A.D., Dzende, T., 2005. Some haematological parameters and erythrocyte osmotic fragility in the laughing dove (*Streptopellas enegalensis)* and the village weaner bird (*Ploceus cuculattus*): Proceedings of the 10th Annual Conference of Animal Science Association of Nigeria. 384-387.

Bamaiyi, P.H., 2013. Factors militating against animal production in Nigeria-A review. Int. J. Livest. Res., 3(2), 54-66.

Bampidis, V.A., Christodoulou, V., Christaki, E., Florou-Pameri, P., Spais, A.B., 2005. Effect of dietary garlic bulb and garlic husk supplementation on performance and carcass characteristics of growing lambs. Anim. Feed. Sci. Technol., 121, 273-283.

Banerjee, S.K., Maulik, S.K., 2002. Effect of garlic on cardiovascular disorders: A review. Nutr. J., 1, 4-14.

Chineke, C.A., Ologun, A.G., Ikeobi, C.O.N., 2006. H aematological parameters in rabbit breeds and crosses in humid tropics. Pak. J. Biol. Sci., 9(11), 2102-2106.

Coles, E.H., 1986. Veterinary Clinical Pathology (4th EDITION). Philadelphia, Pa,: Saunders.

Devendra, C., 2001. Small ruminants: Imperatives for productivity enhancement, improved livelihoods andrural growth- A review. Asian-Aust. J. Anim. Sci., 10, 1483-1496.

Fadiyimu, A.A., Alokan, J.A., Fajemisin, A.N., 2010. Digestibility, nitrogen balance and haematological profile of West African Dwarf sheep fed dietary levels of *Moringaoleifera* as supplements to *Panicum maximum*. J. Am. Sci., 6(10).

Fajemilehin, O.K.S., Salako, A.E., 2008. Body measurement characteristics of the West African Dwarf (WAD) Goat in deciduous forest zone of Southwestern Nigeria. Afr. J. Biotechnol., 7(14), 2521-2526.

Fajemilehin, S.O.K., Adegun, M.K., 2015. Effect of sex on live weight and body dimensions of pre-weaned West African Dwarf Goat (WADG). Int. J. Agr. Food. Sci., 5(1, 2), 691-699.

Foidl, N., Makkar, H.P.S., Becker, K., 2001. The potential of Moringa oleifera for agricultural and industrial uses. In: Proceedings of the International workshop "What development potential for Moringa products", Dar-es-Salaam, Tanzania, 45-76.

Goering, H.K., Van Soest, P.J., 1970. Forage fibre analysis (Apparatus, reagents procedures and some applications). Washington DC. US Agric. Research Service. Vol, 379.

Greenwood, B., 1997. Haematology of sheep and goat. In: R.K. Archer and L.B. Jeffcoat Eds. Comparative clinical haematology, Blackwell, Oxford. 305-344.

Jain, N.C., 1993. Essentials of Veterinary Haematology. 4th Ed. Lea and Febriger Publishers Malvern, Pennysylvania, USA.

Kamra, D.N., Agarwal, N., Sakthival, P.C., Chaudhary, L.C., 2012. Garlic as a rumen modifier for ecofriendly and eco livestock production. J. Appl. Anim. Resour., 40(2), 90-96.

Njidda, A.A., Shuai'bu, A.A., Isidahomen, C.E., 2014. Haematology and serum biochemical indices of sheep in semi-arid environment of Northern Nigera. Glob. J. Sci. Front. Res., 14.

Nolte, D.L., Provenza, F.D., 1992. Food preferences in lambs after exposure to flavours in solid foods. Appl. Anim. Behav. Sci., 32, 337-347.

Olaniyan, O.T., Meraiyebu, A.B., Arogbonlo, A., Dare, J.B., Shekins, O., Shafe, M.O., 2013. Effects of aqueous extract of Garlic (*Allium sativum*) on blood parameters in adult Wistar rats (*Rattus novergicus*). Int. J. Pharm. Sci. Invention., 2(3), 42-45.

Oluwole, F.S., 2001. Effects of garlicon somehaematological parameters. Afr. J. Biomed. Res., 4, 139-141.
Pirmohammadi, R., Anassori, E., Zakari, Z., Tahmouzi, M., 2014. Effects of garlic supplementation on energy status of Prepartum mahabadi goats. Vet. Res. Forum., 5(3), 207-212.
Smith, O.B., 1992. Small ruminant feeding systems for small scale farmers in humid West Africa. In: The complementarity of feed resources for animal production in Africa: Proceedings of the Joint Resources Networks Workshop held in Gaborone, Botswana, 4-8 March 1991, 363- 369.
Soetan, K.O., Akinrinade, A.S., Ajibade, T.O., 2013. Preliminary studies on the haematological parameters of cockerels fed raw and processed guinea corn (*Sorghum bicolor*). Proceedings of 38th annual conference of Nigerian Society for Animal Production. 49-52.
Sowande, O.S., Sobola, O.S., 2008. Body measurements of West African Dwarf sheep asparameters for estimation of live weight. Trop. Anim. Health. Prod., 40(6), 433-439.
Tatara, M.R., Sliwa, E., Dudek, K., Gawron, A., Piersak, T., 2008. Aged garlic extract and allicin improve performance and gastro intestinal tract development of piglets reared in artificial sow. Ann. Agr. Environ. Med., 15, 63-69.
Vazques Prieto, M.A., Gonzalez, R.E., Renna, N.F., Galmarini, C.R., Mistello, R.M., 2010. Aqeous garlic extracts prevent oxidative stress and vascular remodeling in an experimental model of metabolic syndrome. J. Agr. Food. Chem., 9:58(11), 6630-6635.
Wanapat, M., Khajonsart, P., Pardee, P., Wanapat, S., 2008. Effect of supplementation of garlic powder on rumen ecology and digestibility of nutrients in ruminants. J. Sci. Food. Agr., 88(13), 2231-2237.

How to cite this article: Adegun, M.K., Alamuoye, O.F., Aye, P.A., 2017. Growth, morphostructural and haematological performances of West African Dwarf male sheep fed garlic powder additive diets. Scientific Journal of Animal Science, 6(7), 428-435.