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Bioevaluation of garlic on growth, haematological and serum characteristics of growing pigs

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A total of 18 grower pigs aged 70 days were used in an eight weeks feeding trial to evaluate the biological importance of feeding varying dietary levels of sun dried garlic to pigs. The 18 pigs were randomly assigned to three dietary treatments (T_1, T_2 and T_3) with 0, 100 and 200 g of garlic powder incorporated per 100 kg of feed, respectively. Each treatment was replicated twice with three pigs per replicate in a completely randomized design. The pigs received 6% of their body weight as feed whereas water was provided *ad libitum*. Initial body weights of the pigs were measured at the start of the experiment. Average initial body weight for the treatments was 10 ± 0.65 kg. Subsequently, body weight was measured every week. Other response parameters evaluated included body weight gain, feed conversion ratio (FCR), serum and hematological parameters. Results show that feeding varying dietary levels of sun dried garlic powder to growing pigs had significant effect on all performance indices (final body weight (FBW), body weight gain (BWG), average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (feed/gain)) of the pigs (P <0.05). Alanine aminotransferase and bilirubin values of pigs on the test diets showed significantly (P <0.05) lower values than that of the control pigs. Cholesterol value of the test pigs showed marginal reduction than the control pigs. It is concluded that sun dried garlic powder can be used in feed formulation to enhance the growth performance of pigs

Key words: Bioevaluation, haematological, serum.

INTRODUCTION

Pork (meat from pig) is gaining prominence as the most widely consumed meat in the world. In 2010, world production of pork stood at 88.2 m tonnes as against 53.9 m tonnes of poultry, 53.2 m tonnes of beef and 7.0 million tonnes of mutton (Warriss, 2010). Use of antibiotics during all phases of growth benefits the rate and efficiency of body weight gain, reduces mortality and morbidity, reduces subclinical disease and improves health in pigs (Cromwell, 2012). Over the last two decades, development of antimicrobial resistance resulting from agricultural use of antibiotics that could impact treatment of diseases affecting the human population that require antibiotic intervention has become a significant global public health concern (Oliver et al., 2011).

There is a growing body of evidence spotlighting the over-use of antibiotics and the antibiotic resistant bacteria it breeds in pork production (Ronallo, 2012). It is thus

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Abbreviations: EDTA, Ethlenediaminetetracetic acid; **AST,** aspartate amino transferase; **ALT,** alanine amino transferase; **Hb,** haemoglobin; **PCV,** packed cell volume; **RBC,** red blood cell; **WBC,** white blood cell; **AFBW,** average final body weight; BWG, body weight gain; **ADG,** average daily gain; **ADFI,** average daily feed intake; **FCR,** feed conversion ratio; **TRP,** transient receptor potent.

Table 1. Percentage composition of the experimental diet on as-fed-basis.

Ingredient (Kg)	Control (T1)	T2	T3
Maize	3.40	3.40	3.40
Wheat offal	24.00	24.00	24.00
PKC	51.45	51.40	51.30
GNC	17.14	17.00	17.00
Garlic	0	.10	.20
Methionine	0.17	0.15	0.15
Lysine	0.17	0.15	0.15
VMP[1]	0.17	0.25	0.25
Salt	0.05	005	.05
Limestone	1.71	2.00	2.00
Bone meal	1.71	1.50	1.50
Total	100	100	100
Calculated			
Crude protein (%)	17.00	17.08	17.21
Crude fibre (%)	8.06	8.92	8.87
Energy (kcal/kg)	2600	2620	2650

[1]Vitamin mineral premix provided the following per kg of feed: Vitamin A, 10,000 iu; vitamin D, 2000 iu; vitamin E, 6 iu; vitamin K 2 mg; riboflavin, 4.2 mg, vitamin B12, 0.01 mg, pantothenic acid, 5 mg; nicotinic acid, 20 mg; folic acid, 0.5 mg; choline, 3 mg; Fe, 20 mg; Cu, 56 mg; Zn, 1.0 mg; Co, 5.0 mg; iodine 0.8 mg.

evident that there is antimicrobial resistance in the human population that utilize pork fed with antibiotics. There is therefore a need for a paradigm shift from feeding pigs antibiotics to giving them herbal remedies that can equally promote growth without having the negative effect of antiniboical resistance in the human population. It is in this regard that garlic (*Allium sativum*) is gaining ground as an additive in pig nutrition. Garlic incorporation in the diet of birds enhanced villus height and crypt dept, and decreased epithelial thickness and goblet cell numbers in duodenum, jejunum and ileum (Adibmoradi et al., 2006). These morphological changes in the birds gut proclaim improvement in its digestive capacity. Ramakrishma et al. (2003) reported that garlic supplementation probably enhanced the activities of the pancreatic enzymes and provided microenvironment for better utilization of nutrient. Garlic has also been accredited with effective antioxidant action (Yang et al., 1993) and ability to stimulate immunological responsiveness in animals (Reeve et al., 1993). Onibi et al. (2009) observed that garlic supplementation of broiler chicken diets marginally improved weight gain (P>0.05) and it was better at higher levels of supplementation. Stanacev et al. (2011) reported that chicks treated with garlic and copper have achieved better production results than the control. In a study with pigs, Jost (1996) observed that the inclusion of 0.05% garlic in the diet maintained the efficiency of feed utilization, reduced the incidence of scouring and the number of pigs that died, compared to an antimicrobial growth enhancer. It is on the basis of this literature evidence on the ability of garlic to enhance growth that the present study was conducted. The ability of sun dried garlic powder to enhance the growth of growing pigs forms the major research thrust this study addressed.

Location of the study

The study was carried out at the piggery unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka, Nigeria. Nsukka lies in the derived savannah region. Average diurnal minimum temperature ranges from 22 - 24.7°C while the average minimum temperature ranges from 33 - 37°C. Annual rainfall ranges from 168 - 1700 mm (Energy Research Centre, UNN, 2011).

MATERIALS AND METHODS

Animal and feeding

The experiment was carried out in conformity with the guidelines of the ethical committee of the University of Nigeria Nsukka on the use of animals for scientific investigations. Garlic bulbs were purchased from the Local Ogige market in Nsukka. They were ground and allowed to dry. The sun dried garlic powder was incorporated at 0, 100 and 200 g/100 kg of feed in treatments 1, 2 and 3, respectively (Table 1). Eighteen (18) landrace X Largewhite crossess growing pigs aged 70 days were used for this study. The pigs were randomly assigned to the three dietary treatments with six pigs per treatment. Each treatment was replicated twice with three pigs each in a completely randomized design. Each pig received an

Table 2. Effect of garlic on performance of growing pigs.

Parameter	T1	T2	T3
Initial body weight (kg)	10.67±0.17 ^{Ns}	10.25±0.34^{Ns}	10.25±0.34^{Ns}
Final body weight (kg)	22.67±0.94^{b}	25.25±0. 89^{b}	28.33±0.97^{a}
Av daily gain (kg)	0.21±0.02^{b}	0.25±0.02^{b}	0.32±0.02^{a}
Av daily feed in take (kg)	0.99±0.12^{a}	0.75±0.09^{ab}	0.64±0.08^{b}
Feed conversion ratio (feed/gain)	4.71±0.06^{a}	3.00±0.06^{b}	2.00±0.06^{c}

^{a,b,c}Rows means with different superscripts are significantly different (P<0.05).

equivalent of 6% of its body weight as feed/day whereas water was served *ad libitum.*

Parameters measured

The initial body weight IBW (kg) of all the pigs was determined at the commencement of the study. Thereafter body weight measurement was taken every other week. Each pig received 6% of its body weight as feed. Average daily gain (ADG) (kg), average daily feed intake (ADFI) (kg) and feed conversion ratio (FCR) (feed/gain) were calculated.

Haematolgoical test

Blood samples for haematological examination were collected from the ear vein of the pigs by humane puncture. A 5 ml syringe fitted with a sterile needle was carefully inserted into the vein after manual ligation and about 2 ml of blood was withdrawn and quickly added to sample bottles containing ethlenediaminetetracetic acid (EDTA). The sample bottle was shaken gently to mix up the blood with the EDTA to prevent clotting. The following haematolgoical indices were determined: haemoglobin Hb (g/dl), packed cell volume PCV (%), red blood cell RBC (x 10^6/mm^3), white blood cell WBC (mm^3), lymphocytes (%) and neutrophils (%).

Serum biochemistry determinations

Two (2) ml of blood was collected from the ear vein of two pigs per treatment and put in sample bottles without anticoagulant. The blood was allowed to clot for 30 min after which it was centrifuged at 3000 revolutions per min in order to separate the serum from the clot. After the centrifugation, the serum was carefully collected and transferred into a clean sample bottle and the blood chemistry determination performed thereafter. The following blood chemistry indices were determined: blood urea (mg/dl), serum creatinine (mg/dl), aspartate amino transferase, AST (IU/L), alanine amino transferase ALT (IU/L), serum bilirubin (mg/dl).

Experimental design and analytical procedure

The experimental design was a completely randomized design (CRD) with the model $X_{ij} = \mu + T_i + e_{ij}$. Where, X_{ij}, Observed value of dependent variable; μ, overall mean; T_i, treatment effect of different levels of garlic; e_{ij}, random error associated with observation.

All data were subjected to a one way analysis of variance (ANOVA) in a completely randomized design as outlined by Steel and Torrie (1982) using SAS (2004). Significantly, different means were separated using the method of Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The results of the effects of feeding varying dietary levels of garlic powder on the performance of the pigs are presented in Table 2. Results show that feeding varying dietary levels of sundried garlic on growing pigs had significant (P<0.05) effects on the average final body weight (AFBW), ADG, ADFI and FCR of the pigs. Highest AFBW of 28.33 ± 0.97 kg recorded for pigs on treatment 3 differed significantly from values of 22.67 ± 0.94 and 25.25 ± 0.89 kg recorded for pigs on the control and treatment 2, respectively. The same trend was observed in the values of ADG with the same pigs on treatment 3 having significantly higher value (P>0.05). The inclusion of garlic in the diet significantly (P<0.05) reduced ADFI. FCR was significantly (P<0.05) better with the incorporation of garlic in the diets.

Allicin, a phytochemical in garlic has the potential to inhibit the growth of pathogenic bacteria. This action guarantees a favorable gut environment for nutrient digestion and utilization with the net effect of enhanced growth rate observed in the pigs as evidenced in the increased AFBW and ADG values recorded as level of garlic supplementation increased. Ameh et al. (2013) reported that the most active components of fresh garlic are allin and an enzyme called allinase. When garlic is chewed, chopped, bruised or cut, these components mix to form allicin, which is responsible for the antimicrobial effect of garlic. Our earlier investigation showed that finishing broilers with highest level of garlic inclusion had significantly superior performance (Onyimonyi et al., 2012). Samanta and Dey (1991) observed that quails fed dried garlic powder gained more weight than their counterparts without garlic inclusion. The present finding agrees with these earlier reports.

Adibmoradi et al. (2006) reported that garlic administration enhanced villus height and crypt depth and decreased epithelial thickness and goblet cell numbers in duodenum, jejunum and ileum of birds. Ramakrishma et al. (2003) also observed that garlic supplementation probably enhanced the activities of the pancreatic enzymes and provided micro-environment for better utilization of nutrients. These activities of garlic as reported by these scholars further explains the improvement in the performance characteristics observed

Table 3. Effect of garlic on the haematological indices of the experimental pigs.

Parameter	T1	T2	T3
HB (g/dl)	12.90±0.49^{Ns}	12.75±0.29^{Ns}	12.90±0.49^{Ns}
PCV (%)	36.50±0.22^{Ns}	36.50±0.67^{Ns}	37.00±0.89^{Ns}
RBC (x10^6/mm^3)	6.21±0.13^{Ns}	6.08±0.02^{Ns}	6.37±0.21^{Ns}
WBC (/mm^3)	15366.67±850.75^{Ns}	16650.00±1364.00^{Ns}	16300.00±983.87^{Ns}
Lymphocyte (%)	52.00±0.89^{c}	60.50±0.67^{b}	67.00±3.13^{a}
Neutrophil (%)	32.50±2.91^{c}	38.67±0.67^{b}	46.00±0.45^{a}

^{abc}Rows means with different superscript are significantly different (P<0.05).

Table 4. Effect of garlic on serum biochemistry characteristics of the pigs.

Parameter	T1	T2	T3
Urea (mg/dl)	16.50±0.67^{Ns}	18.00±0.89^{Ns}	16.00±0.89^{Ns}
Creatinine (mg/dl)	1.10±0.04^{Ns}	1.15±0.11^{Ns}	1.15±0.07^{Ns}
AST(IU/L)	26.00±4.47^{Ns}	29.83±1.47^{Ns}	26.00±4.47^{Ns}
Cholesterol(mg/dl)	150.00±7.47^{Ns}	141.700±6.22^{Ns}	141.70±16.14^{Ns}
LDL(mg/dl)	107.00±4.02^{Ns}	101.00±2.68^{Ns}	91.00±9.39^{Ns}
HDL(mg/dl)	42.97±3.47^{Ns}	41.20±3.76^{Ns}	45.70±6.36^{b}
ALT (IU/L)	17.00±0.045^{a}	10.83±0.98^{b}	12.50±0.22^{b}
Bilirubin(mg/dl)	0.25±0.02^{a}	0.20±0.04^{ab}	0.15±0.02^{b}

^{a,b,c}Row means with different superscripts are significantly different (P<0.05).

in the present study with the incorporation of garlic in the diet.

The reduction in ADFI observed in the present study with increasing levels of garlic is likely associated with the pungent flavour of garlic. Garlic contains sulphuric compounds, allyl methyl sulphide that renders the pungent flavour. Macpherson et al. (2005) observed that when raw garlic is cut and placed on the tongue or lips, it elicits painful burning and pricking sensations which activate TRPAI and TRPVI, two temperatures activated ion channels that belong to the transient receptor potential (TRP) family. These TRPs are present in the pain-sensing neurons that innervate the mouth. Allicin has been implicated as the chemical responsible for TRPAI and TRPVI activation and is therefore likely to cause garlic pungency. Pigs have a great sense of smell. Their powerful but sensitive snout is a highly developed sense organ. This attribute will enable the pig on the test diet to quickly and easily pick the pungent smell of the garlic in the test diets. This explains their reluctance in feeding hence, the reduced ADFI as levels of garlic in the diets increased. Houpt (1998) viewed that olfactory rather than visual stimuli in pigs is used in the identification of conspecifics. The observed improvement in FCR following garlic supplementation could be traced to the efficient utilization of nutrients and reduced feed intake in the pigs on the garlic diet.

Haematolgoical characteristics of the experimental pigs

The results of the effect of garlic on the haematological indices of the pigs are presented in Table 3. Result show that only lymphocyte and neutrophil values were significantly (P<0.05) affected by incorporation of garlic in the test diets. Garlic improves the activation of natural killer cells T-lymphocytes and greatly stimulates the imnmune system. This agrees with the earlier report of Tang et al. (1997) and Sumiyoshi (1997).

Serum biochemistry indices of the pigs

The results of the effect of garlic supplementation on the serum biochemistry of the pigs are presented in Table 4. Results show that garlic inclusion had significant effect on the ALT and bilirubin values of the pigs. ALT and bilirubin values were significantly higher (P<0.05) in the control pigs (treatment 1). ALT and bilirubin activities are useful indices in assessing the histological severity of liver disease (Aranda-Michel and Sherman, 1998). This enzyme is released when tissue damage is more severe. Bilirubin is the ultimate breakdown product of haemoglobin and serves as a diagnostic marker of liver and blood disorders (Johan, 2008). ALT levels give a

day- by-day account of the hepatocellular injury whereas the bilirubin level is the best test of overall liver function. The significantly low values of these enzymes in the garlic incorporated diets are an indication of the hepatoprotective function of garlic. Increasing amount of ALT or AST which are released from liver to blood stream is an indicator of liver damage. This is in agreement with the earlier views of Chatila and West (1996).

Conclusion

It is concluded from the findings of this study that incorporation of sun dried garlic at 100 or 200 g/100 kg of feed will enhance the growth of pigs and dispense with the need to include antibiotics in the feed.

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