EFFECT OF FEEDING DIETS CONTAINING GRADED LEVELS OF SWEET POTATO (*Ipomoea batatas*) ROOT MEAL ON PERFORMANCE OF BROILER CHICKENS

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DECLARATION

I hereby declare that this work is the product of my research efforts undertaken under the supervision of Dr. Nuhu Bello Rano and has not been presented anywhere for the award of a degree or certificate. All sources have been duly acknowledged.

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CERTIFICATION

This is to certify that the research work for this dissertation and the subsequent write- up (Auwal Ismail Jibril SPS/15/MAS/00010) were carried out under my supervision.

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DEDICATION

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Abstract

The experiment was conducted at Poultry Unit of the Teaching and Research Farm of Abubakar Tafawa Balewa University Bauchi to evaluate the effect of feeding diets containing graded levels of sweet potato (*Ipomoea batatas*) root meal on performance of broiler chickens. A total of one hundred and eighty (180) Anak strain broiler chickens were fed varying levels of sweet potato meal at 0, 5, 10 and 15% inclusion levels. The birds were randomly allotted to four dietary treatments which were replicated three times with fifteen birds per replicate in a completely randomized design. Feed and water were provided *ad libitum* and the experiment lasted for eight weeks. The result of the experiment showed that at both starter and finisher phases, there were significant ($p<0.05$) differences in live weight gain (g/b/d). However, significant ($p<0.05$) differences were observed in feed efficiency only at the starter phase. In terms of carcass characteristics, the result showed significant ($p<0.05$) differences only in dressing percentage which range from 62.46 to 68.49% while no significant ($p>0.05$) differences were observed for all the other parameters measured across the treatments. Haematological indices showed significant ($p<0.05$) differences for Red Blood Cells (RBC) count which range from 1.85 to 2.53 $x10^6/mm^3$ while White Blood Cells (WBC) count, Haemoglobin (Hb) concentration, Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC) and Lymphocyte (LYM) revealed no significant ($p>0.05$) differences across the treatment groups. It was concluded that inclusion of up to 15% sweet potato meal can be done in the diets of broiler chickens at both starter and finisher phases without compromising performance.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

The scarcity and exorbitant cost of commercial energy sources like maize and sorghum for poultry rations has been the main cause of the high cost of poultry products especially in developing countries. To arrest this situation, poultry farmers all over the world and particularly those of the developing countries are forced to think of those plants that can be easily grown and yield more per unit area as compared to maize for inclusion in poultry rations. This will subsequently lead to a reduction of the cost of production of poultry products (meat and egg) Nazmus (2013). Sweet potato (*Ipomea batatas*) readily comes to mind as a promising alternative which is produced in large quantity in Nigeria and form important energy source for human and livestock feeding. The sweet potato meal is readily available at cheap cost in many parts of the country, because it has limited value to some human and for industrial uses.

The bulk of proteins consumed in most developing countries are of plant origin (Dafwang, 2006).While these sources lack certain essential amino acids, proteins of animal origin are more balanced and complete in amino acids (Fasuyi & Aletor, 2005). Nigerians consume less than 10g of protein per person per day out of which only about 3.2g is animal protein, this falls short of the FAO (2010) recommended daily intake of 30g per caput per day (Dafwang, 2006). The high cost of animal protein in developing countries is the major constraint militating against the availability of the much-needed high quality protein food for the low income people. An increase in the standard of living almost inevitably calls for an increase in demand for animal protein. This situation calls for the production of fast growing animals like poultry (Balogun, Adeniji & Azua, 2003).

The principal problem facing the broiler industry today, particularly broiler production, remains the high costs of broiler feeds resulting from the soaring costs of grains (Mmereole, 1996; Mmereole, 2008). The grains are known to constitute 60-70% of broiler feeds, (Ekenyem, 2007). The high cost of grains is due to the competition on grains between livestock feeds and other large scale demands such as for human consumption and industrial uses as in the case of breweries and confectionaries (Ekenyem, 2007). Presently, most of the broiler farms dotted in developing countries and some other low-income, food deficit countries (LIFDC) have shut down due to high costs of broiler feeds (Ekenyem, 2007), there by escalating the animal protein deficiency crisis existing in such countries (Sonaiya, Atumbi & Dare, 1997). Moreover, the prices of poultry products, especially the eggs and meat keep on rising as a result of the rise in the costs of feed, which constitute between 60 and 80% of the total production costs (Nuhu, Abba & Aminu, 2008). The conventional energy feed sources constitute between 40 and 65% of formulated poultry diets and have high price tags as a result of their numerous alternative uses (Afolayan, 2010). Among these sources, maize is the most widely used for poultry feed formulation (Vantsawa, 2001; Afolayan, Dafwang, Tagbe & Shekoni, 2012). In order to step down the problem of high and unstable price situation and save the collapse of the poultry industry, there is need to broaden the energy source base by assessing unconventional feed stuffs (Afolayan *et al.*, 2012).

Sweet potato is one of the world's most important food crops; its main nutritional importance has been its starch content. However, sweet potato can also be a source of other nutritionally important dietary factors such as Vitamin A, Ascorbic acid, Thiamin, Riboflavin and Niacin (Dominguez, 1991). The few available reports agree that sweet potato can be incorporated into diets of chickens but should not be made the sole source of energy (Lee & Yang 1979; Tewe, 1991) as cited by Afolayan (2010). Sweet potato meal (SPM) can be used with an energy value of more than 2830 ME kcal per kg. According to proximate composition values, potato meal (PM) contains more than 65% starch, 6.74% ash, 12.72% CP, 23.48% CF, and 0.99% EE on a DM basis. SPM has been reported to be cheaper than maize and wheat (PAN, 1995). Thus, they reduced feed cost and maintain production.

1.2 STATEMENT OF PROBLEM

In the developing countries, poultry have great potentials in ameliorating animal protein malnourishment but is faced with serious challenges mainly due to expensive nature of their feeds resulting in decrease of livestock production which may be attributed to the scarcity and high cost of energy sources, especially maize. Maize is one of the most expensive feedstuff with a unit cost of ₦170 per kg as at December, 2018 while sweet potato was ₦2000 per bag (personal market survey) and constituting about 35 - 60% of poultry feeds. Feed gulps more than 80% of the total cost of running any poultry enterprise (Bamgbose *et al.,* 2004; Ayuk & Essien, 2009). Therefore, reduction in the cost of poultry feeds is by far the most important focus of researchers at least in the developing countries today (Oyedeji, Atteh & Adedeji; 2003).

1.3 JUSTIFICATION OF THE STUDY

Poultry industry is described by Apantaku (1998) as the fastest means of bridging the gap of protein deficiency prevailing in Nigeria. Most African diets (including Nigeria) are deficient in animal protein which results in poor and stunted growth as well as increase in spread of diseases and consequently death. The expansion of the industry has been hampered by fluctuation in supply of good quality feed (Balogun, 2001).

The conventional protein feedstuff continue to be scarce and expensive as they suffer from severe competition with human, animals and other industrial uses (Garba, Doma, Iliyasu & Saidu, 2006). Hence, the search for alternative feed resources appears to be an unending one in the developing countries of the world if more meat must be available for the teeming human population (Mathew, Berhann & Wude., 2010).

Potato is an unconventional feed ingredient for broiler. Potato has a high production potential (fresh tuber yields about 20 tons/ha) whereas maize and wheat yielded 5tons/ha and 7 tons/ha, respectively and can adapt to different types of soils. It is an energy source which could substitute maize or other cereals used for feeding broiler.

1.4 OBJECTIVES OF THE STUDY

The objectives of the study were:

i. To determine the levels of inclusion of sweet potato root meal in broiler chickens diets.
ii. To evaluate growth performance of broiler chickens fed diets containing difference levels of sweet potato root meal replacing maize.
iii. To examine the haematological indices of broiler chickens fed diets containing graded levels of sweet potato root meal replacing maize.
iv. To determine carcass and internal organs characteristics of broiler chickens fed the experimental test material.

CHAPTER TWO

2.0 LITERATURE REVIEW

Cereal grains based energy feed sources (maize, wheat, millet, rice and sorghum) are expensive feedstuff, constituting about 50-55% of the formulated poultry diets, Maize as a major component of feed is expensive and the productivity is low which means it cannot meet its demand (Agbede,Ajala & Aletor, 2002: Hamzat; Tiamiyu & Raji. 2003; Okereke, Ukachukwu & Nsa, 2006). The poultry producer appears most hit in terms of serious scarcity and high cost of feed (S.R.P.P, 1975). With the present trend of rising prices of animal feedstuff all over the world, greater attention is being paid to the search for safe and cheap local feedstuffs (including unexplored feedstuff by products of agriculture and industry), especially in the developing countries that cannot afford the expensive diets for livestock. Nigeria, like most other developing countries suffer greatly from a constant shortage of livestock feeds, especially those supplying protein and energy. Limitation imposed by scarcity of maize and competition with human consumption have forced many farmers into employing alternative sources of energy for poultry feed formulation, Such alternatives include feeding of farm by products (maize straw, cocoa meal, husk, maize-cob) and effort had also been geared towards the utilization of relatively cheaper and available roots and tubers in recent years.

2.1 MORPHOLOGY OF SWEET POTATO

Sweet potato is a perennial plant mainly grown as an annual. The roots are adventitious, mostly located within the top 25 cm of the soil. Some of the roots produce elongated starchy tubers that vary largely in shape, colour and texture depending on the variety. The flesh of the tubers can be white, yellow, orange and purple whereas their skin can be red, purple, brown or white. The stems are creeping slender vines, up to 4 m long. The leaves are green or purplish, cordate, palmate veined, borne on long petioles. Sweet potato flowers are white or pale violet, axillary, sympetalous, solitary or in cymes. The fruits are round, 1-4 seeded pods containing flattened seeds (Ecocrop, 2010; Duke, 1983).

2.2 DISTRIBUTION OF SWEET POTATO

The sweet potato is thought to have originated between the Yucatán Peninsula of Mexico and the mouth of the Orinoco River, in Venezuela. Sweet potatoes varieties as old as 8000 years have been found in Peru. They then spread to the Caribbean and Polynesia. They are now widely cultivated between 40°N and 32°S, up to an altitude of 2000 m (and up to 2800 m in equatorial regions) (Ecocrop, 2010; Paneque Ramirez, 1992). The main sweet potato producers are China, Indonesia, Vietnam, India, Philippines and Japan in Asia, Brazil and the USA in the Americas and Nigeria, Uganda, Tanzania, Rwanda, Burundi, Madagascar, Angola and Mozambique in Africa. The area under cultivation was 8.5 million ha in 2009. It is one of the seven food crops with an annual production of more than 100 million t (FAO, 2010).

Sweet potatoes are cultivated wherever there is enough water to support their growth: optimal annual rainfall for growth ranges between 750 and 2000 mm. Where the rainfall is below 850 mm irrigation may be necessary, but it should be stopped before harvest in order to prevent the tubers from rotting. The sweet potato is a warm-season annual, requiring 20-25°C average temperatures and full sunlight for optimal development. It needs a frost-free period of 110-170 days and growth may be hampered with an average day temperature below 20°C. Sweet potatoes thrive in well-drained loamy soils with a high humus content that provides a warm and moist environment for the roots. Optimal soil pH is between 5 and 7 (Ecocrop, 2010; Ecoport, 2010; Paneque Ramirez, 1992). Sweet potatoes are mildly drought-tolerant and can survive dry spells during the summer. However, low humidity impairs crop quality even if the plant resumes growth after water stress (Ecoport, 2010; Paneque Ramirez, 1992).

2.3 UTILISATION OF SWEET POTATO

Sweet potatoes are cultivated for food in more than 100 countries, sometimes as a staple food but usually as an alternative food. Because of their fast growing period and low input and work requirements, sweet potatoes are often planted in Africa as a security crop or famine prevention crop (Scott & Wiersema, 1993). The starchy tubers are used as a vegetable and can be boiled, baked, fried (to make chips), dried and ground into flour to make biscuits, bread and other pastries. They can be cooked and frozen. Leafy tops are eaten as a vegetable (Duke, 1983). Some orange sweet potato tubers grown in the USA are used as a natural source of dye, or valued as a healthy food due to their high beta-carotene content. Their very high-grade starch is appreciated for food and by the pharmaceutical industries (Chittaranjan, 2007).

Sweet potato are also a very valuable source of feed for all classes of livestock (Woolfe, 1992). The tubers are relished by pigs and cattle. In 2007, half of the sweet potato tuber production went to animals or to the starch industry (Lebot, 2009; Chittaranjan, 2007). Sweet potatoes can be used on-farm or as an ingredient in commercial compound feeds (Scott, 1992;

Gupta et al., 2009). The economic value of the sweet potato as animal feed used to be debatable because producing them at 30% DM was as costly as importing grain at 89% DM (Woolfe, 1992). However, new varieties now produce more edible energy per ha per day than any other major food crop and 30% more starch/unit area than maize (Ecocrop, 2010; Chittaranjan, 2007). Sweet potato tubers are used as an energy crop: the tubers can be fermented to produce alcohol, and the plant grows in areas where maize does not (Woolfe, 1992). Other sweet potato products are suitable for livestock: see the datasheets on Sweet potato by-products and Sweet potato forage.

2.4 EFFECTS OF POTATO MEAL (PM) ON BROILER PRODUCTION

Under normal economic condition, it is not probably feasible to consider potatoes as a feed stuff for poultry. At the present time, surplus potatoes for feeding purposes may be obtained at a very low cost, and the question of their feeding value for poultry has been asked many times. Cooked potatoes are used as a feed for chickens in Europe, often as the principal carbohydrate source in the ration. There has been little work reported in which potatoes have been fed to turkeys. An experiment was conducted by Kratzer, Blanche and Williams (1987) both turkeys and chickens in which comparisons were made of the growth and feed efficiency of chickens fed diets containing potatoes prepared in various ways. Four procedures were used for preparing the potatoes. For the first method, whole potatoes were ground in a food chopper and spread on trays to dry in the sun. For the second method the potatoes were ground in a food chopper and dried in an oven at 50 ^{0}C. The third procedure was similar to the second except that the drying temperature was increased to 85 ^{0}C. The last method used was to boil the potatoes in water heated by steam followed by sun-drying. He indicated that raw potatoes, when sun-dried or oven-dried, are not a satisfactory feedstuff for growing turkeys or chickens and dried cooked potatoes caused a slight reduction in growth and feed efficiency of poults and chicken.

2.5 EFFECTS OF PARTIALLY COOKED SWEET POTATO MEAL (PCSPM) ON BROILER PRODUCTION

Another feeding trial was conducted by Muhammad, Adegbola & Oyawoye (2012) to investigate the effect of partially cooked (PCSPM) sweet potato meal on the performance of broiler chickens.

The results showed that daily weight gain was significantly (P<0.01) affected by dietary treatments. Increase in the proportion of PCSPM in the starter diet negatively influenced weight gain. Feed conversion ratio was also significantly (P<0.01) affected, however, FCR increased with increase in the proportion of PCSPM. In the finisher phase, there were also significant (P<0.0) difference in daily weight gain and feed conversion ratio. In the pooled performance, daily feed intake was significantly (P<0.05) influenced by dietary treatments. There were however, no significant (p.0.05) differences in feed consumption between the broilers fed diet V (80% PCSPM) and those on control diet (0% PCSPM). They concluded that, PCSPM could be fed to broiler chicken at up to 80% level with promising growth performance.

The inclusion of PCSPM had a negative effect on broiler's performance in terms of daily weight gain and feed conversion ratio only during the starter phase. Daily weight gain consistently decreased with increasing level of inclusion of PCSPM. The FCR, however, increased with increasing levels of inclusion of PCSPM. This is in agreement with the report (Maphosa,Ganduza, Kusina & Mutungamiri, 2003; Ayuk, 2004) that inclusion of sweet potato had a negative effect on performance. It is also similar to the report of Obeh and Tewe (1992) when broilers were fed sundried and oven dried sweet potato meals. This finding could be linked to the nutritional characteristics peculiar to sweet potato. This corroborates the report of Esonu, Okparaji, Anyanwu and Emelanom, (2000) that inclusion of wild aerial yam bulbils meal depressed the performance of broiler. Feed intake of broilers on the finisher diets was lower than the control at inclusion levels of 20, 40 and 60%. However, at the highest level of inclusion (80%), feed intake was similar to the control. The dietary effect observed in this study agrees with the report of Obeh and Tewe (1992) and Adeline (2002), Maphosa *et al*. (2003). It is however, disagrees with observations with broilers (Dominguez, 1991; Agwunobi, 1999; Guigui, 2006) and rabbits (Ngodigha & Okejim, 1999; Shoremi *et al*., 2001). Dietary influence was not statistically observed on the daily weight gain and feed conversion ratio. This trend disagrees with the reports of Adelina (2002), Obeh and Tewe (1992), Guigui (2006) and Maphosa *et al*., (2003) but is similar to the report of Dominguez (1991). The finding suggests that, as an energy source and at these levels of inclusion, the sweet potato meal is as efficiently used as maize. It is also clear as suggested by Dominguez (1991) that cooking does not significantly affect the utilization of energy but increased the digestibility of nutrients. This agrees with the reports with broilers by Garba *et al*, (2006) who found no significant difference in performance parameters and linked this to the inactivation of trypsin inhibitors found in sweet potato meal and is said to impair protein digestion and reduce body weight gain. Daily feed intake was depressed at 60% level of inclusion of cooked sweet potato meal when compared to the control. This is attributed to dustiness (Adelina 2002) and anti-nutritional factors (Adelina, 2002; Dominguez, 1991, Maphosa *et al*; 2003 and Ayuk, 2004). Daily weight gain consistently decreased with increasing levels of inclusion of PCSPM. However, there was similarity in value between the control and the other diets containing PCSPM with only a slight increase at higher levels of inclusion.

2.6 EFFECTS OF SWEET POTATO ROOT MEAL (SPM) ON BROILER PRODUCTION

There was good performance a of broiler chickens when SPM was used which was attributed to the excess (3.6 %) fibre in the diets. Tewe (1986) reported that inclusion of fibre in diets containing high sugar levels reduces gastro intestine disorder. The costs of feed per kilogram consistently decreased with increasing level of inclusion of FCRM and report disagree with the report of Tewe (1994). This could be as a result of the cost of the various feed ingredients at the time of the feeding trial. The cost per kilogram gain obtained progressively decreased with increasing levels of inclusion of FCRM. This trend was reported by Adelina (2002). The cost of producing a kilogram of broiler meat was lowest (#29.22k) in diet 5 (80% FCRM) cheaper than in the control diet (#33.24k). The uncooked starch of the sweet potato is very resistant to hydrolysis by amylase (Cerning & Le Dividich, 1976). Amino acid analysis of sweet potato tubers indicates that they are of good nutritional quality but deficient in total sulphur amino acids and lysine (Fuller and Chamberlain 1982). Sweet potato tuber and foliage have been evaluated as feed for poultry. Turner et al (1976) examined various diets consisting of cooked sweet potato as a supplement for poultry. Chicks fed on a starter feed reached slaughter weight earlier than when fed on sweet potato diets. However, with the later, the broilers had a higher dressing out percentage. Yoshida and Morimoto (1958) reported the carbohydrate fraction in sweet potato to be about 90 % digestible in chicks. Tewe (1994) reported that using sun-dried and oven-dried sweet potato replacing maize at 0, 50, and 100% in broiler diet reduced body weight gain and nutrient utilization when compared to the maize-based control diet. The broiler performance was better with the oven-dried diet, and it can replace maize at up to 50% in broiler diet. Performance was optimal at 30% replacement of maize with sweet potato. Sweet potatoes contain trypsin inhibitors, ranging from 90 % in some varieties to 20 % in others (Lin and Chen 1985) which may reduce the ability of animals to utilize protein if eaten raw. These anti-nutritional factors also cause low dry matter digestibility and low metabolizable protein and energy values, even when the diet contained adequate and high quality proteins in animal feed (Gerpacio, 1978). However, these trypsin inhibitors do not survive cooking and are of no consequence in cooked tubers (Collins 1995). Preheating can also destroy or reduce these trypsin inhibitors. Therefore, cooking is necessary on account of two factors, starch digestibility and the presence of trypsin inhibitor. Kiran and Padmaja (2003) reported that when sweet potato tuber was cooked, between 17 and 31 % trypsin inhibitor activity remained and when it was prepared into flour, only 5-12 % trypsin inhibitor activity was found. A decrease in feed intake of broilers with increasing levels of sweet potato concurred with observations made by Tewe (1991). Feed intakes of broilers on 25%, 50% and 75% maize replacement levels were lower than intake of broilers on the control diet, which could have been a reflection of poor palatability and acceptability of sweet potato by broilers as reported by Banser *et al* (2000). Feed conversion ratio deteriorated with increasing level of sweet potato flour in the diet of broiler chickens which agrees with the report of Tewe (1991). The decrease in the efficiency of utilization of feed was attributed by Agwunbi (1991) to the increased rate passage. Tewe (1991) reported that sweet potato tuber was not efficiently utilised by young chicks of less than two weeks of age. Ravindran (1995) attributed this to the presence of anti-nutritional factors like trypsin inhibitors in sweet potatoes. The degree of recovery of broilers growth on the 50% maize replacement level suggests that the broilers had undergone a period of compensatory growth after digestive tract adaptations had occurred (Banser et al 2000). The lower feed intake at 75% maize replacement could be due to smaller gut size at the start of the finisher phase since there is a physical limit to the gastro intestinal tract capacity resulting in reduced feed intake. The feed conversion ratio at 100% maize replacement was poor than the control, which is consistent with other reports (Tewe 1991; Agwunobi 1999). The feed conversion was generally poorer for broilers on the finisher diets compared to those on the starter diets, which is a normal phenomenon according to Mutetwa (1996). Pancreatic hypertrophy is caused by the presence of trypsin inhibitors in the diet (Nishino et al 2001). This has frequently been observed in rats (Nishino et al 2001) and chicks (Viveros et al. 2001). The increase in size of the pancreas can be used as a crude indicator of trypsin inhibitor levels in a feed. Suppression of trypsin in the intestine increases pancreatic secretion of the enzymes through a feedback mechanism, which is mediated by cholecystokinin (CCK) and, consequently induces pancreatic hypertrophy and hyperplasia (Nishino et al. 2001). Trypsin inhibitors increase the loss of endogenous proteins such as digestive enzymes, which can be rich in essential amino acids (Viveros et al 2001). The increase in the weight and length of the lower parts of the guts can be attributed to the bulkiness of the diets with sweet potato as a direct substitute of maize. Bulkiness of a diet results in the bird taking in a large volume of the feed in order to satisfy its nutrient requirements ultimately exerting a pressure, which stretches the intestines (Hetland and Svihus 2001). The increase in the weight of digestive organs of broilers can be attributed, to some extent, to the presence of a high concentration of indigestible materials in the intestine of the animal (Viveros et al 2001). Tewe (1991) and Ravindran and Sivakanesan (1996) showed that the level of sweet potato meal in broiler diets had no effect on mortality rate in their studies. Post-mortem results revealed that the broilers in the present experiment had an erosion of the gizzard and this is when the cuticle of the gizzard separates from the *mucosa*. Woolfe (1992) observed that the fat content of broilers fed with sweet potato meal was significantly lower than that of those fed with maize meal at 10 weeks of age. The difference in these findings may be due to differences in age since older animals deposit more fat compared to young animals (Kusina 1988). Agwunobi (1999) also reported that carcass quality was significantly improved due to a significant reduction of abdominal fat in the broilers fed on 45% sweet potato finisher diets and the broilers on the sweet potato diet continually passed wet droppings, resulting in the reduction in body weight and feed conversion efficiency. The decline became significantly different from that of the control diet when levels of SPM exceeded 10% in starter diets and 20% in finisher diets. This is in contrast to Lee and Yang (1979) report who did not observe any adverse effect on performance when corn was substituted with about 24% SPM in broiler diet. Agwunobi (1999) also reported no adverse effect when SPM was fed at 27 and 30% levels respectively in broiler starter diets. The significant decline in body weight, weight gain and feed consumption in the two studies may be due to the progressive decline in dietary energy and protein levels as well as increase in dietary fibre with increasing levels of dietary SPM. The higher levels of SPM used by Lee and Yang (1979) and Agwunobi (1999) was probably a result of the use of isocaloric and isonitrogenous diets in their experiments. A decline in weight gain was also observed in growing pigs (35-60 kg) by Gonzalex *et al*. (2002) when sweet potato root meal was fed beyond 50% replacement level of maize, indicating that SPM cannot be fed as a sole source of energy in growing pig ration. Yoshida and Morimoto (1958) reported that the carbohydrate fraction in sweet potato to be about 90% digestible in chicks, while Fetuga and Oluyemi (1976) obtained a coefficient of metabolizable digestibility energy of 90 9 or 872 in diets where the tuber replaced 25 or 40% of the glucose in a basal diet. At both levels, rate and efficiency of gain were best for the sweet potato diets. These results suggests that, as an energy source, and at these levels of substitution the tuber is as efficiently used as maize by chicks.

2.7 EFFECTS OF YAM-SWEET POTATO PEELS MIXTURE (YSPPM) ON BROILER PERFORMANCE

Diarra (2012) conducted an experiment with yam-sweet potato peels mixture (YSPPM) as replacement for maize in broiler chickens diets. They reported that YSPPM could replace maize up to 15 and 45% in broiler starter and finisher diets respectively without adverse effects on the growth, haematological profile and carcass measurements. Festus (2009) conducted a study to test the effects of Sweet Potato Leaf Meal (SPLM) as a supplement in broiler diet with or without enzyme treatment. He revealed that the broilers fed with diets containing 20% enzyme treated SPLM proved superior in all parameters evaluated. Based on these observation the study recommended that farmers should be encouraged to include 20% SPLM treated with enzyme in their feed formulation for improved broiler production. Fernando *et al.* (2011) conducted to compare and explain the incidence of spontaneously occurring subclinical necrotic enteritis in broiler chickens that were fed on 2 practical broiler diets that differed in the major protein concentrates (soya bean meal or potato protein concentrates). There was a significant increase in the incidence of hepatic lesions in the broilers fed on the potato protein diet compared with the broilers fed on the soya diet. The mean incidence of intestinal necrosis tended to be greater in the broilers fed on the potato protein diet (23.6%) compared to the broilers fed on the soya-based diet (15.3%). There was a significant linear relationship between ileac digestal sialic acid concentration and serum alpha toxin antibodies, although there were a considerable number of outliers to this relationship. Measurement of sialic acid concentration may be a useful variable to indicate the severity of necrotic enteritis in broilers.

Table 1. Chemical Composition of Sweat Potato Meal

Micronutrient %	SPM
Moisture	5.30
Dry Matter	94.70
Crude Protein	7.10
Crude Fibre	12.82
Nitrogen	1.14
Digestible Protein	3.30
NDF	19.89
ADF	10.42
TDN	63.00

Source: Jiwuba *et al*, (2016)

Table 2. Minerals Composition of Sweet Potato Meal

Minerals	SPM
Ca (%)	0.27
K (%)	2.04
M2 (%)	0.30
P (%)	0.17
Cu (PPM)	9.47
Fe (PPM)	136.4
Mn (PPM)	86.18
Zn (PPM)	16.10
Ca/P	1.56

Source: Jiwuba *et al*, (2016)

Table 3. Amino Acid Composition of Sweet Potato Meal

Amino Acids	Sweet Potato Meal (%)
Cysteine	0.08
Methionine	0.10
Lysine	0.43
Alanine	0.38
Arginine	0.23
Aspartic acid	1.46
Glutamic acid	0.71
Glycine	0.28
Isoleucine	0.28

Leucine	0.41
Serine	0.28
Threonine	0.29
Valine	0.40
Histidine	0.13
Phenylalanine	0.13
Tyrosine	0.15
Taurine	0.01
Tryptophan	0.08

Source: Jiwuba *et al*, (2016)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 SITE OF THE EXPERIMENT

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm of the Abubakar Tafawa Balewa University Bauchi. Bauchi state is one of the states in the northern part of Nigeria that span two distinctive vegetation zones, namely, Sudan savannah and the Sahel savannah. The state is located between latitude 9° 3' and 12° 3' North and longitudes 8° 50' of the equator with a total land area of 49,119 km² representing about 5.3% of Nigeria's total land mass, the state has an average high temperature of 29.6°c (85.3°F) and low temperature of 21.4°c (70.5°F) and also with 15% humidity. The state is bordered by seven states, Kano and Jigawa to the north, Taraba and Plateau to the South, Gombe and Yobe to the East and Kaduna to the West. The climate is characterised by wet and dry seasons with the raining season spanning the period of May to September (BSADP 2007).

3.2 DESIGN OF THE EXPERIMENT

One hundred and eighty (180) day-old Anak strain broiler chicks were randomly allotted to four dietary treatments comprising forty five (45) chicks per treatment which were replicated three times, with fifteen chicks per replicate in a completely randomized design (CRD).

3.3 EXPERIMENTAL DIETS

Four experimental diets were formulated and designated as A, B, C and D to contain sweet potato meal (SPM) at 0, 5, 10 and 15% levels of inclusion. Treatment one (A) did not contain the test ingredient, thereby serving as the control as presented in Table 4. The diets were formulated to meet the 23% and 20% crude protein requirements of broiler chickens for starter and finisher phases respectively.

Table 4. Composition of the Experimental Diets at Starter Phase (23% CP) (1-4 Weeks)

	Replacement of Maize With Sweet Potato Meal (SPM) (%)			
Ingredients	T A (0)	T B (5)	T C (10)	T D (15)
Maize	46.08	40.58	35.71	35.90
Soybeans	34.72	35.22	35.10	29.89
SPM	0	5	10	15
Wheat offal	10	10	10	10
Fish meal	5	5	5	5
Limestone	1.5	1.5	1.5	1.5
Bone meal	2	2	2	2
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Lysine	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
ME (kcal/kg)	2808.04	2878.04	2850.24	2836.69
CP (%)	22.41	23.01	23.00	21.20
CF (%)	3.78	3.67	3.62	3.36
EE (%)	8.67	8.45	8.38	7.66
Ca (%)	1.65	1.65	1.64	1.63
TP (%)	0.73	0.73	0.73	0.70

ME = Metabolizable Energy, CP = Crude Protein, CF = Crude Fibre, EE= Ether Extract, Ca = Calcium and TP = Total Protein.

Table 5. Composition of Experimental Diets at Finisher Phase (20%Cp) (5-8 Weeks) of Age

	Replacement of Sweet Potato with Maize (SPM) (%)			
Ingredients	T A (0)	T B (5)	T C (10)	T D (15)
Maize	52.40	46.62	40.86	35.06
Soybean	24.40	25.18	25.94	26.74
SPM	0	5	10	15
Wheat offal	15	15	15	15
Fish meal	4	4	4	4
Limestone	1.5	1.5	1.5	1.5
Bone meal	2	2	2	2
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Lysine	0.1	0.1	0.1	0.1
Methionine	0.1	0.1	0.1	0.1
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
ME (Kcal/kg)	2857.57	2856.58	2857.72	2857.30
CP (%)	20.00	20.00	20.01	20.01
CF (%)	3.75	3.71	3.63	3.58
EE (%)	7.19	7.13	7.06	7.00
Ca (%)	1.56	1.56	1.56	1.56
TP	0.66	0.67	0.67	0.66

ME = Metabolizable Energy, CP = Crude Protein, CF = Crude Fibre, EE= Ether Extract, Ca = Calcium and TP = Total Protein.

3.4 PROCESSING OF EXPERIMENTAL MATERIAL (SWEET POTATO MEAL)

Fresh sweet potato roots were obtained from potato vendors in Ningi L.G.A of Bauchi State. The roots were washed, chopped using kitchen knife and sun dried for about three (3) days on concrete floor to reduce enzymatic and microbial reactions which may lead to spoilage. The dried sweet potato was milled and used during feed mixing at different levels.

3.5 EXPERIMENTAL BIRDS AND THEIR MANAGEMENT

Prior to the arrival of the day-old chicks, the brooding room and pens were thoroughly cleaned, washed and disinfected using Z-Germicide and the opened sides of the pens were also covered with the use of empty cement bags. The brooder and pens were fumigated using 35g of potassium permanganate crystals and 2 ml of 40% formaldehyde solution (per pen). The room was locked for three days. All equipment including feeding trays, feeding troughs, drinkers, brooding guard and canopies were also disinfected. Three days to the arrival of the chicks, fresh, dried and cleaned wood shavings were spread in each pen and used as litter material. Ceiling boards were used as brooder guard in the brooder, and heat was provided in the day time by the use of 200 Watt bulbs which placed in strategic points in the brooder. During the cool night, heat from charcoal was used together with 200 Watts electric bulbs to provide heat. Light was provided in the absence of power by two big hurricane lanterns.

On arrival, the day-old chicks were counted and placed on the litter material in the brooding room which was pre- warmed/heated with burnt charcoal to 35ºC temperature. The chicks were brooded for seven days. Anti-stress (glucose) was given in their drinking water for the chicks to overcome stress. Chicks were weighed after the brooding. Using tray feeders and chick drinkers, the compounded experimental diets (starter and finisher) were fed *ad libitum*. Fresh clean drinking water with multivitamins (vitalyte) were given *ad libitum* throughout the days of the experiment. Routine medications and vaccinations were also observed.

3.6 DATA COLLECTION

The experiment started after one week brooding lasted and for eight weeks. Within the experimental period, birds were given the experimental diets and the following parameters were recorded:

3.6.1 Feed Intake (g)

A known quantity of feed for each replicate group were offered and recorded daily. The left over feed after each day's meal, were measured and recorded for each replicate on a daily basis. Feed consumption for each day were obtained from the differences between the feed given per day and the left over.

Total feed intake (kg) = Total feed given (kg) – Total feed left over (kg)

3.6.2 Body Weight Gain (g)

The body weights of birds in each replicate were taken prior to the commencement of the experiment to obtain initial weight (7 days). The birds were then weighed weekly thereafter. The weight gain for each week was calculated by subtracting the weight at the beginning of the week from the body weight at the end of the week. Total weight gain for each replicate on a weekly basis was calculated.

Body weight gain (g) = Final body weight (g) – Initial body weight (g)

3.6.3 Feed Conversion Ratio

This is the ratio of feed intake to weight gain

Feed Conversion Ratio (FRC) = feed intake (kg)/weight gain (kg)

3.6.4 Haematology

At the end of the experiment (8th week), two birds were randomly selected from each replicate for collection of blood samples for haematological analysis. The birds were fasted overnight and blood samples was collected early in the morning through the wing veins into sample tubes containing anti-coagulant. Haemoglobin (Hb), Packed Cell Volume (PCV) and Red Blood Cells (RBC) count and leucocyte count, White Blood Cells (WBC) and absolute erythrocyte indices {Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), and Mean Corpuscular Volume (MCV)} were determined using the methods described by Bush (1991).

3.6.5 Carcass Measurements

At the termination (8 weeks) of the experiment, two bird per replicate whose weight are true representation of mean body weight of birds in each pen were selected for carcass analysis. The birds were deprived of feed overnight before slaughter but have access to water. The birds were slaughtered by a ventral neck cut with a sharp knife. After thorough bleeding, the birds were manually de-feathered by a ventral scalding in hot water as described by Hann and Spindler (2002). De-feathered birds were weighed, labelled and eviscerated with the head, neck, shank, and viscera removed to obtain the dressed weight. Heart, empty gizzard, lungs, pancreas, intestines, liver and abdominal fat were weighed and expressed as percentages of the slaughter weight.

Dressing percentage = Dressed weight (g)/Live weight x100

3.7 PROXIMATE ANALYSIS

Proximate compositions of the experimental diets were determined at the Laboratory of the Department of Animal Science, Abubakar Tafawa Balewa University Bauchi, according to the procedures described by AOAC (1995).

3.8 STATISTICAL ANALYSIS

Data collected on feed intake, body weight gain, feed conversion ratio and haematological indices were subjected to analysis of variance using Steel and Torrie (1980) and Duncan Multiple Range Test (DMRT) was used to separate the means.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULT

4.1.1 Proximate Composition of the Experimental Diets

The proximate composition of the experimental diets is shown in Table 6. There were no significant differences in all the parameters although, all the values obtained for both dry matter and crude protein did not follow any definite trend across the treatments in starter diets. For crude fibre, values obtained was slightly higher in diet B (5% SPM) while the lowest value was recorded in diet A (0). Ether extract Values ranged from 8.62 – 9.89 and the slighter lower value was recorded in diets C (10% SPM) and D (15% SPM) respectively in the starter experimental diets. Highest values for Ash was obtained in diet D (15% SPM) while the lowest was from diet B (5% SPM) of starter experimental diets

In the finisher diets, the highest dry matter content of 89.11 was obtained from diet B (5) and the lowest was recorded from diet C (10) while the highest crude protein value were obtained from diet C (10) while the lowest was from diet D (15). The crude fibre values ranged from 6.89 to 7.23 and the lowest was obtained from diets C (10) and the highest was in diet D (15), The Ether extract and the Ash values showed the highest in diet C (10) and the lowest value for Ether extract was recorded from diet A (0) and that of Ash was from diet B (5). However, all the values obtained for all the parameters in the experimental finisher did not follow any definite trend.

Table 6. Proximate Composition of the Experimental Diets

	Replacement of Maize With Sweet Potato Meal (SPM) (%)			
Parameters	T A(0)	T B (5)	T C (10)	T D (15)
STARTER DIETS				
Dry Matter	89.24	88.59	89.11	89.20
Crude protein	23.02	22.74	22.69	23.01
Crude Fibre	6.09	6.13	6.11	6.11
Ether Extract	9.79	8.62	8.59	9.89
Ash	9.65	8.93	9.74	10.26
FINISHER DIETS				
Dry Matter	88.63	89.11	88.19	88.61
Crude Protein	19.63	19.51	20.14	19.22
Crude Fibre	7.09	7.18	6.89	7.23
Ether Extract	6.81	6.93	7.11	6.89
Ash	7.39	7.16	8.23	7.39

4.1.2 Productive Performance of Broiler Chickens Fed Diets Containing Graded Levels of Sweet Potato Root Meal Replacing Maize

The performance of broiler chickens at starter phase (0-4 weeks) and finisher phase (5-8 weeks) are presented in Table 7. The result showed highly significant ($p<0.001$) differences among the treatment groups for live weight gain and feed efficiency (g/b/d) for the starter phase with the values ranging from16.87 to 22.70 and 0.29 to 0.34 for live weight gain and feed efficiency respectively. However, there were no significant ($p>0.05$) differences recorded in terms of feed intake (g/b/d) and feed conversion ratio among the treatment groups in starter phase. The values recorded for feed conversion ratio increased steadily as the level of SPM increased in the diet.

In the finisher phase (5 - 8 weeks), there were no significant ($p>0.05$) differences for feed intake (g/b/d) and feed efficiency. However, live weight gain (g) and feed conversion ratio values were highly significant ($p<0.001$) across the treatment groups.

Overall performance of broiler chickens fed different levels of sweet potato meal diets (0-8 weeks) showed no significant ($p>0.05$) differences for feed intake (g/b/d), feed conversion ratio and feed efficiency among all the experimental groups. However, live weight gain (g) overall differed ($p<0.001$) significantly with the values ranged 15.75 to 23.94.

Table 7. Performance of Broiler Chickens Fed Different Levels of Sweet Potato Meal Diets

	Levels of Sweet Potato Roots Meal Replacing Maize %				
Parameters	T A (0)	T B (5)	T C (10)	T D (15)	SEM
STARTER PHASE (0-4 WEEKS)					
Feed intake (g/bird/day)	61.67	61.36	60.71	58.64	1.00^{NS}
Weight gain (g/bird/day)	22.70^{a}	21.79^{a}	20.53^{a}	16.87^{b}	0.63***
Feed conversion ratio	2.73	2.81	2.96	3.48	0.10^{NS}
Feed efficiency (g)	0.37^{a}	0.36^{a}	0.34^{ab}	0.29^{b}	0.01**
FINISHER PHASE (4-8 WEEKS)					
Feed intake (g/bird/day)	92.20	103.33	92.38	100.85	7.02^{NS}
Live weight gain (g/bird/day)	21.07^{bc}	26.09^{c}	19.88^{b}	14.65^{a}	1.22***
Feed conversion ratio	4.37^{a}	3.99^{a}	4.65^{a}	6.70^{a}	0.28***
Feed efficiency (g)	0.23	0.26	0.21	0.15	0.02^{NS}
OVERALL/POOLED (0-8 WEEKS)					
Feed intake (g/bird/day)	76.94	82.28	76.54	79.75	3.39^{NS}
Live weight gain (g/bird/day)	21.89^{b}	23.94^{a}	20.21^{b}	15.75^{c}	0.51***
Feed conversion ratio	3.55	3.41	3.81	5.12	0.16^{NS}
Feed efficiency (g)	0.30	0.31	0.28	0.22	0.01^{NS}

abc = means within the same row bearing different superscripts differ significantly (p<0.05),NS = Not Significant, SEM=Standard Error of Mean, *= Significant (p<0.05), ** = Significant (p>0.01), *** = Significant (p<0.001)

4.1.3 Carcass Characteristics of Broiler Chickens Fed Diets Containing Different Levels of Sweet Potato Meal Replacing Maize.

Data obtained for carcass characteristics of broiler chickens pre dress containing SPM is presented in Table 8. The result of carcass characteristics showed that there were no significant ($p>0.05$) difference in final weight (kg), pluck weight (kg), eviscerated weight (kg), dressed weight (kg). However, significant ($p<0.05$) difference were observed for dressing percentage. The values declined steadily as the level of SPM increased in the diets. No significant ($p>0.05$) differences were also observed for organs{Head (g), Legs (g), Lungs (g), Gizzard (g), Liver (g), pancreas (g), Abdominal fat (g) kidney (g) heart (g), Spleen (g), Caecum (g), Small intestine (g) and Large intestine (g)}.

Table 8.Carcass Characteristics of Broiler Chickens Fed Graded Levels of Diets Containing Sweet Potato Meal

	Levels of SPM Replacing Maize (%)				
Parameters	T A (0)	T B (5)	T C (10)	T D (15)	SEM
Final weight (kg)	1.87	2.00	2.03	1.98	0.13[NS]
Pluck weight (kg)	1.73	1.83	1.87	1.82	0.12[NS]
Eviscerated weight (kg)	1.42	1.44	1.38	1.40	0.10[NS]
Dressed weight (kg)	1.28	1.28	1.28	1.18	0.10[NS]
Dressing percentage (%)	68.49[a]	64.23[ab]	62.73[b]	62.46[b]	2.22*
Head (g)	2.98	2.70	2.82	2.74	0.17[NS]
Legs (g)	4.71	4.37	4.53	4.58	0.25[NS]
Lungs (g)	0.56	0.48	0.49	0.52	0.06[NS]
Gizzard (g)	2.23	2.02	2.06	1.95	0.24[NS]
Liver (g)	2.28	2.15	2.22	1.95	0.17[NS]
Pancreas (g)	0.35	0.36	0.33	0.35	0.04[NS]
Abdominal fat (g)	2.26	2.18	2.36	1.94	0.32[NS]
Kidney (g)	0.25	0.24	0.25	0.26	0.03[NS]
Heart (g)	0.48	0.44	0.44	0.48	0.05[NS]
Spleen (g)	0.12	0.10	0.12	0.09	0.02[NS]
Caecum (g)	1.19	0.91	0.72	0.70	0.17[NS]
Small Intestine (g)	4.96	4.68	5.08	4.457	0.43[NS]
Large Intestine (g)	0.13	0.18	0.17	0.16	0.03[NS]

abc mean within the same row bearing different superscripts differ significantly (p<0.05), NS = Not Significant, *=Significant (p<0.05), SEM= Standard Error of Mean

4.1.4 Haematological Characteristics of Broiler Birds Fed Diets Containing Sweet Potato Meal at Different Levels of Inclusion.

The effect of different inclusion levels of sweet potato meal replacing maize on haematology of broiler chickens (0-8 weeks) is presented in Table 9. Significant ($p<0.05$) differences were observed for RBC but the values for RBC count did not follow any definite trend across the treatment groups. However, no significant ($p>0.05$) differences were observed for WBC, PVC, Hb, MCV, MCH, MCHC and LYM across all the experimental groups, RBC value obtained was highest in birds fed on diet D (15) and (SPM) inclusion levels while the lowest values were recorded in birds fed on diets C (10) and B (5% SPM) however, the values obtained for RBC were below the normal range (4.21 to 4.84x106/mm^3) for RBC of chickens.

Table 9. Haematological Characteristics of Broiler Birds Fed Different Inclusion Levels of Diet

Containing Sweet Potato Meal

	Level of SPM Replacing Maize (%)				
Parameters	T A (0)	T B (5)	T C (10)	T D (15)	SEM
RBC $x10^6/MM^8$	2.37^a	1.88^b	1.85^b	2.53^a	0.15*
WBC (10^{12}/ml)	121.43	105.87	90.07	132.93	12.99^{NS}
PVC (%)	34.43	32.17	26.93	30.83	13.08^{NS}
Hb (g/dl)	16.03	14.00	12.70	15.20	1.58^{NS}
MCV (fl)	145.03	143.17	145.53	144.43	1.86^{NS}
MCH (pg)	67.53	70.73	68.63	70.83	2.10^{NS}
MCHC (%)	46.57	49.40	47.10	49.07	1.62^{NS}
LYM (%)	67.20	64.33	45.63	4.63	25.18^{NS}

A,b,c= mean within the same row bearing different superscripts differ significantly (p<0.05), NS = Not Significance, *= Significant (p<0.05), SEM= Standard Error of Mean, RBC= Red blood cell, WBC= White blood cell, PCV= Pack Cell Volume, HB= Haemoglobin, MCV=Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC= Mean Corpuscular Haemoglobin Concentration, LYM = Lymphocyte.

4.2 DISCUSSION

4.2.1 Proximate Compositions of the Experimental Diets

The result of proximate composition of the experimental diets containing graded levels of sweet potato meal is presented in Table 6. The dry matter (DM) ranged from 88.59 to 89.24% while the crude protein (CP) values obtained ranged from 22.69 to 23.02 while crude fibre (CF) and ether extract (EE) ranged from 6.09 to 6.13% and 8.59 - 9.89% respectively and Ash content ranged from 8.93 to 10.26% at starter phase. At the finisher phase, the dry matter (DM) content ranged from 88.19 - 89.11%, the crude protein (CP), crude fibre (CF) and ether extract (EE) ranged between 19.22 and 20.14%, 6.89 and 7.18% and 6.81 and 7.11 respectively. Ash values ranged from 7.16 to 8.23. The protein values at the finisher phase are slightly higher than the recommended range of 18.20% for broiler finisher diet reported by Kekeocha (1984). However, Olomu (1995) recommended a range of 18- 21% for broiler finisher diets. The EE range obtained in the present study (6.82 – 7.23%) is within the recommended range of 5- 7% by NRC (1996). The crude fibre levels obtained in this study for the finisher diets correspond with the findings of Jiwuba *et al.*(2016) who reported 7.31- 8.01% as the recommended CF and also comparable with the ranges 6.77- 8.85% as reported by Agbabiaka (2012) but was higher than the level of 4.30 recommended by Olomu (1995). Ash content of the diets are comparable with the ranges 6.85- 8.78 and 5.56- 8.15% reported by Jiwuba *et al.* (2016) and Agbabiaka *et al.* (2012) for broiler finishers fed varying levels of tiger nut (*Cyperus esculentus L)* meal as dietary supplement. The value reported for Ash in this study can provide the necessary minerals such as calcium and phosphorus needed for development of bones. The dry matter and crude protein are within the recommended nutrient requirement for the broiler finisher chickens. However, the observed variation in the proximate composition in this study is not surprising as this may have resulted from chemical composition of the different test ingredient used in the experiment and the different processing methods. The proximate composition of this study is somewhat compared with the findings of Jiwuba *et al.* (2016) and Ukom *et al.* (2009).

4.2.2 <u>Performance of Broiler Chickens Fed Diets Containing Graded Levels of Sweet Potato Meal Replacing Maize</u>.

The growth performance of broiler chickens at the starter phase (0- 4 weeks) as influenced by sweet potato meal is presented in Table 7. The daily feed intake (58.64- 61.67g) obtained on all the four diets were similar. This result agrees with the findings of Set'le *et al.* (2012).However, birds fed on the control diet slightly consumed more feed than those fed sweet potato based diets (2, 3 and 4). The lower feed intake observed in the bird fed on the tested diets could be attributed to higher anti nutritional factors like oxalates, trypsin inhibitors and solanine present in sweet potato (Ayuk *et al.* 2009). Daily feed intake decreased with increased inclusion levels of sweet potato meal. Daily weight gain of (16.87g- 22.70g) were significantly ($p<0.01$) affected by the levels of sweet potato meal. This result is in line with what was obtained by Set'le *et al.* (2012).The feed conversion ratio was also significantly ($p<0.05$) affected by the dietary treatments.

The growth performance of broiler bird at the finisher phase (5- 8weeks) as affected by sweet potato meal is presented in Table 7. In the finisher phase, no significant dietary effect on daily feed intake was established and this corresponds with the findings of Jiwuba *et al*. (2016) and Set'le *et al*. (2012). However, diet B (103.33g) and diet A (92.20g) were recorded as the highest and the lowest among the treatments over the period. This could be attributed to the acceptability of the diets (Olomu *et al*, 1995). Birds are known to eat more when diets are acceptable and coarse than when they are finely ground and acceptable (Leeson *et al*.2000). The birds consumed higher quantity of the diet B, C and D indicating that the levelS of the anti- nutritional factors were not high enough as to depress feed intake, hence it did not lower the feed intake as is usually the case with the anti -nutritional factors (Agwunobi *et al*, 2002). The value for weight gain reported in this research correspond with the finding of Set'le *et al*. (2012). Moreover, the diets became dusty with the increasing levels of the test ingredient and this may have negative influence on growth performance (Jiwuba *et al*, 2016).The values for weight gain ranged from 14.65g for diet D to 26.09g for diet B. However, there were significant ($p<0.01$) differences among the treatments means which agrees with the finding of Jiwuba *et el*. (2016) who also recorded highly significant difference in broiler bird fed diets containing sweet potato root meal. The feed conversion ratio values (3.99- 6.70g) varied among the treatments groups and were significant by ($p<0.01$) difference which is in line with the finding of Set'le *et al*. (2012).

The overall daily weight gain (23.94) for diet 2 as the highest and (15.75) of diet 4 as the lowest showed significant ($p<0.01$) differences observed amongst the treatment groups. The reason for the numerical improved performance in daily weight gain for diets A and B inclusion levels of sweet potato meal could be due to the low crude fibre which cannot cause depression in mineral availability, trace mineral retention and increased metabolic nitrogen excretion (Hedge *et al,* 1979) for which sweet potato meal is implicated resulting to lower weight gain as observed in diet D. This suggested that nutrients in the sweet potato meal at 15% inclusion were not as available as compared to other treatment diets. Sweet potato is implicated with anti- nutritional factors like oxalate, trypsin inhibitors and solanine among others (Ayuk *et al,* 2009) which has been reported to affect nutrient availability and utilization by monogastric animals (Kochar *et al,* 2002). The poor body weight gain of the broiler chickens in diet 4 could be due to the poor feed intake, digestibility and absorption of nutrients and possible cases of anti- nutrients. The overall feed conversion ratio (5.12) indicated that of diet 4 had the highest and 3.41 for diet B as the lowest while the other treatments were the same and significantly ($p<0.01$) affected by the dietary treatment. This study agreed with the finding of Set'le *et al.* (2012).

4.2.3 Carcass Characteristic of Broiler Chickens Fed Graded Levels of Diets Containing Sweet Potato Meal.

The result of carcass and organs characteristics of broiler chickens fed diets containing sweet potato meal is summarized in Table 8. The result revealed that there were no significant ($p>0.05$) differences in the final weight, pluck weight, eviscerated weight and carcass weight between the control and the sweet potato meal based-diets and the above result is in line with the finding of Beckford *et al*. (2015) who reported no significant difference in pre-slaughter weight and carcass weight in an experiment conducted to investigate the "inclusion levels of sweet potato root meal in the diet of broiler chickens". However, significant ($p<0.05$) differences were recorded on dressing percentage of the broiler chickens fed diets A, C and D. There were no differences between the groups fed diets A and B and between diets B, C and D. Diet A recorded the highest dressing percentage. This result agree with the finding of Jiwuba et al, (2016) who fed diets containing sweet potato (*Ipomoea batatas*) Root Meal" However, all other organs (Head, lungs, gizzard, liver, pancreas, abdominal fat, kidney, heart, spleen, caecum, small intestine and large intestine) showed no significant ($p<0.05$) differences among the treatment groups.

The decrease in dressing percentage at 10 and 15% inclusion levels of SPM could be due to the impaired utilization of nutrients occasioned by reduced feed intake and decreased body weight (Jiwuba *et al*, 2016). However, decrease in dressed weight of birds fed sweet potato meal diets beyond 10 and 15% inclusion levels though not statistically significant could be attributed to increase in weight of internal organs instead of muscle and bone formation as reported by Ndubuisi and Okorie (2010).The dressing percentage observed in this present study are all below the dressing percentage of 73.15- 89.49% reported by Ogbu *et al*. (2015) for broiler chickens fed raw and processed pigeon pea (*Cajanus cajan*) seed meal. The weight of head and legs were higher in the control diets than the birds fed on the experimental diets though not statistically significant. High fibre inclusion has been reported to increase lean meat yield of poultry (Leeson, 2000).This may be the reason for the higher dressing percentage yield on the control diet than the sweet potato meal based-diets.

The similarities in the weight of the internal organs (heart, liver, pancreas, gizzard, kidney, spleen, caecum, small intestine and large intestine) amongst treatments are indications that feeding sweet potato meal did not cause nutritional stress. The numerically steady decrease in gizzard, liver, caecum and small intestine on the control diet compared to the SPM diets was attributed to the decrease in feed intake of the groups on these diets compared with the control throughout the period of the experiment. However, the result is in contrast to the finding of Diarra *et al*. (2012) who reported increase weight of the above mentioned organs when they evaluate yam-sweet potato peels mixture as a source of energy in broiler chickens diets". The slightly lower abdominal fat recorded for the bird fed on diet 4 was attributed to the fibre level of this diet compared to those on the control because fibre and metabolizable energy (ME) in the diet act inversely proportional, therefore, birds on this diet might have fed strictly to meet their energy requirement for maintenance sparing no extra energy for fat deposition Diarra *et al*. (2012).

4.2.4 <u>Haematological Characteristics of Broiler Birds Fed Graded Levels of Sweet Potato Meal Replacing Maize.</u>

The result of haematological characteristic of broiler chickens fed graded levels of SPM replacing maize is presented in Table 9. The result showed RBC value of 2.531 and 2.37 indicate units recorded for diet D and A as the highest while the lowest were 1.8767 and 1.85 for diets B and C respectively. The values for RBC were significantly ($p<0.05$) lower for diets B and C compared to diets A and D. The values obtained for RBC of birds in this study all were lower than the range of 3.07 - $7.05x10^6/mm^3$ reported by Fudge (1999) and also lower than 5.0 – 8.0 x106mm³ reported by Anon (1980). Hackbath *et al*., (1983) reported that increased RBC values were associated with high quality dietary protein and disease free animals. RBC is responsible for the transportation of oxygen and carbon dioxide in the blood as well as manufacture of haemoglobin hence higher values indicates a greater potentials for this function and a better state of health (Olugbemi *et al*., 2010b).However, the result of RBC in this experiment corresponds with the findings of Onu and Aneibo (2011) when they conducted a study on the influence of moringa oleifera leaf mealon the performance and blood chemistry of starter broiler. The values for PCV, WBC, Hb, MCV, MCH, MCHC AND LYM were statistically similar ($p<0.05$) among the treatment groups. The comparable WBC values of the birds suggest that the animals were healthy because decrease in number of WBC below the normal range is an indication of allergic condition, anaphylactic shock and certain parasitism or presence of foreign body in circulating system (Ahamefule *et al*., 2008).The general non-significant differences of the values of WBC across the treatments indicates that the experimental diets neither impaired nor enhanced the birds ability to wade off infection (Olugbemi *et al*., 2010b). The PCV value from birds on diet A seem to be the highest with the value of 34.43% followed by diets B and D with the values of 32.167 and 30.83% respectively while the least PCV value was from diet C with 26.93% value. The PCV values recorded in this experiment is in line with the finding of Diarra *et al*. (2012).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The present study was designed to determine the effect of feeding graded levels of sweet potato meal on performance of broiler chickens. The result for starter phase showed that 15% replacement of maize supported optimum performance in terms of final weight, daily weight gain, feed conversion ratio and feed efficiency. Bird fed control diet (0%) recorded the highest daily feed intake followed by diet 2 (5%) at starter phase,

At finisher phase, the control diet did not performed significantly better than the SPM based diets in terms of carcass evaluation. No significant differences were noticed in most parameters. Dietary treatments significantly influenced apparent digestibility of DM, CP, CF, EE and Ash. Feed conversion ratio was lowest in birds fed sweet potato diets. This will result to lower feed cost to the producer. With the increasing cost of corn, feeding sweet potato meal could increase the profit margin of the producer. This is because sweet potatoes that would be used as a feed ingredient are generally those that are unsalable and would otherwise be discarded. Based on feed cost, sweet potato meal could be an effective alternative feed ingredient in the diet of broiler chickens. Recourse to a low priority energy source like sweet potato meal could be a way out of the rising prices of livestock feed due to the use of corn as a biofuel source. If diet can be formulated using this ingredient, farmers would be able to pay less for their feed, hence reducing their overhead cost. However, more work needs to be done to determine the level of inclusion that will allow for the best performance and the most cost effective solution.

5.2 CONCLUSION

The result of this study concludes that sweet potato meal can replace maize up to 10% in starter diets and up to 15% in finisher diets of broiler chickens diets without negative effects on their performance, carcass characteristics and haematology.

5.3 RECOMMENDATIONS

From the results of this study, sweet potato root meal could be recommended as a suitable dietary feed component for broiler chickens since they can tolerate up to 10% at the starter phase and up to 15% at finisher phase without alter growth performance, carcass characteristics and haematology. Further studies is suggested to evaluate sweet potato meal processed differently on performance of broiler chickens. Other classes of poultry could also be used.

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