USMANU DANFODIYO UNIVERSITY, SOKOTO
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EFFECTS OF GRITS INCLUSION ON THE UTILIZATION OF WHOLE MILLET IN THE DIET OF BROILER CHICKENS

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BY

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CERTIFICATION

This dissertation by Kabiru, Muhammad Yusuf (Reg. No. 01211604007) has met the requirements for the award of the Degree of Master of Science (Animal Science) of the Usmanu Danfodiyo University, Sokoto, and is approved for its contribution to knowledge.

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DEDICATION

This research work is dedicated to my parents and the society in general.

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ABSTRACT

A 56 day feeding trial was conducted using 300 Marshal Strain of day old broiler chicks to evaluate the effects of different dietary inclusion levels of grit (0, 1.5, 2.5 and 3.5%) in the diet containing of whole millet grain as main energy source in a completely randomized design. Each of the five dietary treatments was further replicated four times. The treatments contained ground millet with 0, whole millet with 1.5, whole millet with 2.5, whole millet with 3.5 and whole millet with 0 grit kg/100kg designated diet 1, 2, 3, 4 and 5, respectively. There were two controls in the experiment, a negative control which contained ground millet (treatment 1) without grits and a positive control containing whole millet (treatment 5) without additive grits. Routine vaccination were offered as at and when due. Weight gain, feed intake, water intake, feed conversion ratio, mortality and carcass characteristics were determined. Results showed that, dietary grit inclusion had effect on the performance of broiler chicken and it improved apparent nutrient digestibility. No significant difference ($p>0.05$) was however observed in most of the parameters in terms of performance parameters between birds fed diets with grit. There was significant difference ($p<0.05$) between birds on diets with and without grit inclusion (2, 3 and 4) and (1 and 5), respectively. Gizzard and proventriculus weight were improved with grit inclusion. Significance difference ($p< 0.05$) was also observed between birds fed diet 4 and 1 with regard to apparent dry matter, crude fiber, nitrogen free extract and potassium digestibility. The study recommended 2.5% level of grit inclusion in diets containing whole millet grain for effective utilization by broilers.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

One of the unique aspects of the avian digestive system is the presence of gizzard, where a combination of muscular contraction, grinding action and enzymes help to reduce feed material into absorbable portion (Adeniji, 2010). Grit, a kind of angular and hard crushed rock preferentially derived from granite, is used by the birds in place of "teeth" and hence enhances mechanical digestion by the gizzard (Ali *et al.*, 2006). For this reason, it is important in poultry nutrition when high fiber diets are used or when whole grains are fed.

Birds commonly ingest and maintain grits in their muscular gizzard to help grind up feed (Gionfriddo and Best, 1999). The incorporation of whole grain into poultry feeds has become a more common practice especially in European countries as a way of reducing feed cost due to handling and processing. This practice has resulted in some beneficial effects associated with increased gizzard activity, such as improvement in feed conversion ratio (Plavnik *et al.,* 2002), increased starch digestibility (Hetland *et al.,* 2002) and greater apparent metabolizable energy (Svihus *et al.,* 2004).

Among the ingredients available for poultry feeding in the study area is pearl millet (*pennisetum glaucum*). It is an annual grass that stands erect and reaches up to 3m high with a profuse root system. The inflorescence is a panicle size 12 to 30cm long. The shape of the grains differs according to cultivars and it uses C4 carbon fixation during photosynthesis (Andrews and Kumar, 2006).

Whole pearl millet can be readily broken down by young broilers and thus could be incorporated into their diets (Hidalgo *et al.,* 2004). The inclusion of pearl millet in poultry diets has gained interest due to the favorable nutritional characteristics of this grain. The metabolizable energy is comparable to that of corn (Davis *et al.*, 2003). Furthermore, pearl millet has higher crude protein (12 to 14%) and lysine (0.38 to 0.41%) concentration than either corn or sorghum (Adeola *et al.,* 1994). Ojewola and Oyin (2006) reported that millet has higher crude fiber (7.92%) and ash (3.83%) than maize or sorghum. Pearl millet also has higher oil content than other common cereal grains (Hill and Hanna 1990), and it is a better source of linolenic acid (Rooney, 1978). Based on the performance of broilers fed pearl millet, it appears that pearl millet is equivalent or superior to corn as a grain source for poultry rations (Collins *et al.,* 1994).

It is a good alternative source of energy for broilers up to seven weeks. Broilers can be fed pearl millet-soybean based diets since it can replace maize in a maize-soybean based diet. The proposed replacement rates range from 10 to 100%, though most authors suggest replacing 50% of maize or more (Davis *et al.,* 2003; Raju *et al.,* 2003; Choudhary *et al*., 2005; Udeybir *et al*., 2007; Udeybir *et al*., 2009). When compared to maize or sorghum, pearl millet is reported to have equal or higher nutritive value (Healy *et al.*, 1991; Evans and Singh, 2005; Vasant *et al.,* 2008).

1.2 Justification of the Study

Poultry production forms an important commercial enterprise involving thousands of birds. However, there is the need to further improve the efficiency of poultry in terms of feed preparation and utilization to maximize profit margin (Eduvie, 2002).

To aid the action of the gizzard, the average local chicken picks up a few stones while scavenging for food. It is thought that, these stones aid the digestion of materials which the local chicken picks up (Salverson, 1996). Birds reared under intensive management have no access to such stones. There is possibility that, incorporation of grit (stones) into the diet of intensively reared birds may increase the amount of nutrients extractable from these diets (Adeniji, 2009). Besides, the use of whole grains saves the farmer additional cost of grinding the grains into powder or amorphous state. Grinding exposes some nutrients to air and light resulting in loses due to oxidation. Examples of such nutrients are vitamins. The cost of grinding of grains which form the bulk of the diet can be enormous especially in large farms where thousands of birds are reared.

The increase in the price of maize has adversely affected the cost of production of poultry and pigs in Nigeria as these animals depend almost entirely on concentrate feeds.

Therefore there is the need for exploitation of other energy sources alternative to maize if the growth of the poultry enterprise in the country is to be sustained (Udeidibie *et al.*, 2004).

Most of the sub- Sahara communities grow millet as source of grains because of its tolerance to low rainfall and high ambient temperature, which does not favour the cultivation of maize and much of sorghum. Sokoto state is one of the highest millet producing states. It is grown by almost every farmer during the short rainy season resulting in higher tonnage that is surplus for human consumption and hence available for poultry feeding. Hence, it is pertinent that poultry farmers use millet as source of energy in a more economical form that cut cost and increase the profit margin of the enterprise.

Intensively managed birds are fed predominantly on low fiber diet without access to grit and as a result, their gizzards are small and the proventriculi may be dilated. This results in food passing very quickly arriving in the duodenum still in a particulate form. Recent research indicates that fine grinding of ingredient for diet formulation does not improve the nutritional value of grain and may even be detrimental to performance (Tim, 1999).

1.3 Aim and Objectives of the Study

1.3.1 Aim

The aim of the study is to assess the effect of the different inclusion levels of grits in the diet of broilers fed whole millet grain on performance characteristics and nutrients retention.

1.3.2 Objectives

1. To determine the impact of different levels of grit inclusion on general performance of broilers at the starter and finisher phase.

2. To evaluate the carcass characteristics of broilers fed different grit levels in whole millet based diets at starter and finisher phases.

3. To determine the apparent nutrient digestibility of broilers fed different additive grit levels in whole millet diets at starter and finisher phases.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Energy and Protein Requirements of Broilers

Research work so far conducted on the energy and protein requirement for poultry indicated that the National Research Council (1994) recommendation for nutrient requirements (1994) could be safely applied in Nigeria, like any other tropical countries with little adjustments (Scott, 1999 and Olorede, 1990). Broiler feeds are high energy; high protein containing feeds designed to promote rapid growth. There are two types of broiler feeds available commercially, the broiler starter which should be fed for the first 1-4 weeks and the broiler finisher which should be fed from 5 weeks to finish. Although both feeds can have the same energy level (3000 ME Kcal/kg), broiler starters should have a higher protein (22-24%) than finisher (20%) (NAPRI, 2002). Oluyemi and Roberts (2000) recommended 23% crude protein and 3200 kcal/kg (13.386MJ/kg) for broiler starter of 0 to 5 weeks old. This will give feed utilization efficiency of 2.21 kg/kg broiler. On the other hand, 20% crude protein and 3200 kcal/kg (13.386 MJ/kg) was recommended for broiler finishers giving 2.44 kg feed/kg broiler feed utilization efficiency.

The requirement for protein depends on the amino acid composition of that protein and the rate at which it is being produced (Gous, 1998). The sum of each amino acid required for the maintenance and growth of feathers and body protein constitute the daily requirement for each amino acid (Gous, 1998). The retention of lipid, water and ash had no protein requirement. However, the scale on which the amino acid required by the animals are measured and on which the amino acid in the feed are described most the same (Gous, 1998). The conventional wisdom is to express this in terms of digestibility. The marginal efficiency with which the first limiting amino acid is used for protein retention above maintenance is not necessarily constant, but can be modified by the supply of other amino acids (Burnham, *et al*. 1992) and by the supply of energy (Kyriazakis and Emmans, 1992).

Amino acids are the building components of protein which also account for the differences among them. Dietary amino acids mostly needed by the animals some of which are limiting in most ingredients could be added in the diet to meet requirements (Edgar, 1994). The order of amino acids limitation in poultry is methionine, lysine, threonine, tryptophan, isoleusine and arginine. Methionine and lysine are now available in synthetic form and used to correct deficiency in diets (Oluyemi and Roberts, 2000).

2.2 Sorghum as Source of Energy

Sorghum has been used as source of energy in poultry feeds to a limited extent, but there are apprehensions regarding the use of sorghum in formulating poultry feeds. Farmers have the notion that sorghum contains tannins and lower energy (2650 kcal/kg) compared to maize (3300 kcal/kg) (Seshaiah, 2000). Sorghum was reported to contain 0.2 to 2.0% tannin and when used as replacement for maize could adversely affect growth and feed efficiency in broilers (Douglas *et al.*, 1993). However, Medugu *et al.* (2010) reported that final body weight, average daily weight gain and feed conversion ratio (FCR) were similar when maize, millet, low and high tannin sorghum varieties were fed to broiler chickens. Similar results were reported by Adamu *et al.* (2001) when millet, maize and sorghum were fed to broiler chickens.

2.3 Maize as Source of Energy

Maize is the major source of energy in poultry diets and constitutes about 60% of broiler diets (Udeidebie *et al.*, 2004). According to Cowieson, 2005, maize is the main source of energy for broiler chickens because it contains considerable amount of digestible nutrients. The ingredient contains 3300 kcal/kg metabolizable energy, 9% crude protein, 0.2% methionine and 0.2% lysine (Seshaiah, 2000). Nutrient utilization of maize grain by broilers is high and it influences final body weight as well as feed conversion ratio (Zenella, 1999). Adamu *et al.* (2001) reported that, final body weight, average daily weight and feed conversion ratio were similar when maize, millet, low and high tannin sorghum varieties were fed to broiler chickens. Nutrient and energy digestibility of maize grain depend on its chemical composition (Bertezko *et al.*, 2008).

2.4 Use of Millet as an Energy Source

Literature on the use of millet as an energy source for poultry appears to be very limited in semi-arid zones. Pearl millet is a cheaper energy source compared to maize, sorghum and wheat and could serve as ready choice to provide energy for rural poultry (Reddy and Qudratullah, 1996). Results from feed experiment involving pearl millet with maize or sorghum from literature review by Serna-Saldivar *et al*. (1990) and Bramel-Cox *et al*. (1995) indicates that pearl millet is at least equivalent to maize and generally superior to sorghum in protein content and quality, protein efficiency ratio value and metabolizable energy levels. In chicks feeding experiment, Hancock *et al*. (1990) have shown that weight gain and feed /gain ratios obtained with pearl millet based diets were equal to that of maize and some sorghum.

However, (Cromwell and Coffey, 1993) exonerated millet from the anti-nutritional properties (phytate and tannin) associated with wheat and sorghum. NRC (1996) reported that millet has no tannin and it contains higher protein and mineral content compared to maize and sorghum. Studies conducted by Singh and Barsoul (1976), Sharma *et al*. (1979) and Medugu *et al.* (2010) have shown that millet could be compared with maize in poultry diets. The report of Flurharty and Loerch (1996) showed that higher energy finisher diet results in high performance with no detrimental effect on poultry in the tropics, when millet is used in their diets.

Davis *et al*. (2003) demonstrated that millet inclusion rate of 500g/kg of diet has no adverse effects on the performance of broiler chickens. Similarly, Singh *et al.* (2000) reported that inclusion of millet up to 600g/kg diet gave excellent egg production and better feed conversion ratio. Ojewola and Oyim (2006) reported that millet had higher crude protein (11%), crude fibre (7.92%) and ash (3.83%) than maize and sorghum.

In earlier studies, Artkinson *et al.* (1975) reported that little or no differences were observed in body weight, feed efficiency or percent mortality when either maize or millet was fed to birds. Similarly the report of NRC (1996) concluded that millet neither reduces feed efficiency nor rate of gain and can fully replace maize in chicken rations with no adverse effects on their performance.

2.5 Feeding Whole Grains in Poultry Diet

The incorporation of whole grains into poultry feeds has become a more common practice, especially in European countries, as a way of reducing feed cost due to handling and processing. Moreover, this practice has resulted in some beneficial effects associated with increased gizzard activity such as improvement in feed conversion ratio (Plavnik, *et* *al.,* 2002) and greater apparent digestibility (Svihus *et al.,* 2004). Hetland *et al.* (2002) reported that, feed consumption and weight gain were significantly reduced when ground cereals were replaced by whole cereals ($P<0.05$). However feed conversion efficiency was not affected by inclusion of up 400g/kg of whole wheat and up to 300g/kg of whole oats and barley. Starch digestibility was improved ($P<0.05$) by replacing ground wheat or barley with whole wheat or barley.

Tim (1999) reported that, fine grinding does not improve the nutritional value of grains and may be detrimental to performance. There is mounting evidence that whole grain stimulate development of a healthy functional digestive track. Abnormal digestive track development has been reported in broilers fed finely ground and low fiber diets (Tim, 1999). However, in later research conducted by Hidalgo *et al.* (2004) with broilers, moderate levels of whole pearl millet can be incorporated into the feed without detrimentally affecting growth performance or carcass trait.

2.6 Uses of Grits

Ali *et al*. (2006) described grit as a kind of angular and hard crushed rock preferentially derived from granite it is used by the birds in place of “teeth’’ and hence enhances mechanical digestion by the gizzard. Another author, Atteh (2003) showed that grits are hard bits of stones, sand and small particles utilized by birds in their gizzard to aid abrasion. Birds digestive enzymes work well in digesting the inner portion of the seeds, but have difficulty with their fibrous hulls which act as a barrier, preventing digestive enzymes from reaching the nutritious seed within. Grit in the proventriculus, aids in grinding and wearing away the outer shell of the seeds, enabling the digestive enzymes to reach the valuable inner portion (Branson *et al.,* 1994).

Today, poultry are generally fed an easily digestible mash or pelleted diet. These diets improve performance of birds but also cause their digestive system to grow lazy. Moreover, Hill (1971) reported that, when birds were fed mash diet, the transport of ingested nutrient through the gizzard to the intestine, which is the translocation place rather than mill, were faster. The utilization of the nutrients may adversely be affected because the feeds were not well mechanically digested and not mixed adequately with enzymes and reached the intestine with high pH (Rutrowski and Wiaz, 2001). Such a situation may cause stressful condition for birds and thus allow locating unwanted microorganism population, such as E. coli (Cumming, 1994) and coccidia (Cumming, 1992) in the intestine causing some illness. On the other hand, grit is necessary if a scratch feed is used (Kermanshahi and Classen, 2001; Bennett *et al.*, 2002), since it is expected that the grit will help to grind the whole grains and result in better utilization of the feed stuff by the birds. Atteh (2003) reported that birds could tolerate 5% grit in the diet and it also improves efficiency of feed utilization by the birds. However, Jones and Taylor (1999) and Silva junior *et al.* (2003) used insoluble granite grit in broiler diets and found that there was no significant effect on the broiler performance.

2.7 Types of Grit

The term grit applies to two different groups of substances. Namely soluble and insoluble grit **(**Branson *et al.,1994***)**.

2.7.1 Soluble grits

Soluble grit is organic and includes crushed shells (such as oyster shells) or tuttlebone. Soluble grit is mostly limestone (calcium carbonate). Since it is easily digested by acid in the proventriculus (Branson *et al.*, 1994). Atteh (2003) reported that, soluble grit includes limestone and oyster shells, which dissolves in the gizzard. While soluble grit is a source of calcium, it does little in aiding the digestion of whole seeds. Further more instances of heavy metal toxicity have been reported with the feeding of insoluble grit which has come from areas with polluted water (Branson *et al.*, 1994).

2.7.2 Insoluble grits

This type is composed of minute stones. Such as silicate and sand stone and is used by the birds in digesting unhulled seeds. Insoluble grit cannot be digested and will remain in the body until expelled (Branson *et al.*, 1994). Insoluble grit includes silica and mica, they are non digestible and are retained in the gizzard (Atteh, 2003).

2.8 Factors Affecting Nutrients Utilization

Current commercial livestock and poultry breeds/strains are more efficient in utilizing nutrients and the commercial feeds are better formulated to meet the requirements of the rapidly growing animal (Havenstein *et al.*, 1994). For example, nitrogen (N) and phosphorus (P) excretion per unit of live weight were 55 and 69% less, respectively from a 1991 commercial broiler strain versus a 1957 commercial broiler strain fed the same diet. Considerable variation exists in literature, however, for utilization of different nutrients. Much of the variation can be attributed to feeding of different ingredients and differences in age or health status.

Numerous factors can influence amino acid digestibility and utilization by the bird. High processing temperatures can cause the binding of sugar moieties with lysine (maillard reaction) making it unavailable to the animal (Toddy, 2008).

2.8.1 Anti- nutritional factors

Anti-nutritional factors are compounds mainly organic, which when present in a diet, may affect the health of the animal or interfere with normal feed utilization (Frederick, 2010). Anti-nutritional factors may occur as natural constituents of plant and animal feeds, as artificial factors added during processing or as contaminants of the ecosystem (Barnes and Amega, 1984). Ingestion of feed containing such substances induces, in some cases, chronic intoxication and in others, interferance with digestion and utilization of dietary protein and carbohydrate and also with the availability of some minerals, thus feed efficiency and growth rate and consequently, production. Although anti-nutritional factors are present in many conventional feeds, they are more common in most of the non-conventional feeds (Frederick, 2010). Nityanand (1997) classified the various anti-nutritional factors in feed stuffs according to their chemical nature and their activity in animals as: 1. Chemical nature, in this category are acids, enzymes, nitrogenous compounds, saponins, tannins, glucosinolates and phenolic compounds. 2. Factors interfering with the digestion and utilization of dietary proteins and carbohydrates, for example, tannins, trypsin or protease inhibitors, saponins, and haemagglutinins. 3. Factors interfering with the availability of minerals are for example, phytates or phytic acid, oxalates or oxalic acid, glucosinolates and gossypol.

Tannins, which are complex polymeric phenols having molecular weight greater than 500 are natural constituents of many plants, and grouped into two forms thus: hydrolysable and condensed tannins (Nityanand, 1997). Hydrolysable tannins are potentially toxic and cause poisoning if large amounts of tannin-containing plant material such as leaves of oak (Quercus *spp*.) and yellow wood (*Terminalia oblongata)* are consumed (Garg *et al*., 1982). Tannins form complexes with protein, cellulose, hemicelluloses, lignin and starch and interfere with their optimum utilization in the digestive tract (Frederick, 2010). Protein sources of plant origin containing high amounts of tannins in particular hydrolysable tannins should be used with caution (Becker and Makker, 1999). Ranjhan (1999) reported that soaking and washing removes substantial amount of tannins in feeding stuffs for both ruminants (Kumar and Singh, 1984) and non-ruminants (Okai *et al*., 1984).

Saponins are bitter in taste and hence reduce palatability; they are also haemolytic and alter the permeability of cell membranes they produce toxic effects on organized tissues when ingested. Lucerne, white and red clovers, mahua seed cake and soyabean are rich sources of saponins. Soaking and washing in water is quite effective in removing a greater proportion of saponins (Nityanand, 1997). Saponins have been reported to cause depression in feed intake (Cheeke, 1976). According to Ranjhan (2001) ruminants can breakdown saponins but monogastrics cannot.

Phytates (salts of phytic acid) are found in almost all feeds of plant origin. They are present in association with protein and are therefore high in protein feeds e.g. groundnut cake, soyabean cake and sesame cake. Phytic acid possesses high chelating ability and in plants, it is found as phytates of many minerals which are mostly not available to monogastrics as they lack the enzyme phytase. The use of the enzyme phytase can make minerals such as phosphorus available to monogastrics (Nityanand, 1997).

According to Nityanand (1997) anti-vitamin activities against vitamins A and D have been observed in soyabean, against vitamin E in kidney bean (*Phaseolus vulgaris),* against vitamin K in sweet clover and against pyridoxine in linseed cake. Akinmutimi (2004) had observed that most processing methods employed in improving the food value of non-conventional or alternative feedstuffs do not completely eliminate anti-nutritional factor substances, but only reduce their concentrations to tolerable levels. It is a common practice in feeding trials to use the weights of some internal organs like liver and kidney as indicators of toxicity. Bone (1979) reported that if there are toxic elements in the feed, abnormalities in weights of liver and kidney would be observed. The abnormalities will arise because of increased metabolic rate of the organs in an attempt to reduce these toxic elements or anti-nutritional factors to non toxic metabolites.

2.8.2 Effect of Particle Size on Nutrient Utilization

Although particle size reduction is said to improve digestion of nutrients by increasing the surface area available to digestive enzymes, Studies, which relate particle size to digestibility of nutrients are limited and, in the case of grains, equivocal. Kilburn and Edwards (2001) reported that fine grinding of maize increased the true metabolizable energy values in mash diets, but the opposite effect was observed with pelleted diets. Peron *et al*. (2005) found that finely ground wheat improved starch digestibility and the apparent metabolisable energy (AME) compared to coarsely ground one. On the other hand, coarse grinding of maize has been reported to increase the efficiency of nitrogen and lysine retention in broilers fed mash diets (Parsons *et al.*, 2006). Amerah *et al.* (2007) reported that coarse grinding tended to improve the AME in wheat-based diets, but not in maize-based diets. In contrast, Svihus *et al*. (2004) found no effect of wheat particle size on the AME.

A negative relationship between wheat hardness and the digestibility of starch in pelleted diets has been reported (Carre *et al.*, 2002; 2005). This effect of hardness was attributed to larger particulate size reducing the surface area and accessibility to digestive enzymes (Carre *et al.*, 2005). Conversely, Uddin *et al*. (1996) found that AME of pelleted

Wheat diets were not affected by endosperm hardness. Lack of relationship between grain hardness and AME or starch digestibility in wheat-based mash diets has been reported by other workers (Rose *et al*., 2001; Pirgozliev *et al.*, 2003). The results for dicotyledonous seeds are less equivocal.

Coarse grinding of grain legumes has been shown to lower energy utilization and, digestibility coefficients of nutrients. A discussion on the effects of particle size on starch digestibility in grain legumes has been published (Carre, 2004). In general, fine grinding of peas was reported to improve the total tract digestibility of starch and protein when fed as mash diets (Carre, 2000). Similarly, fine grinding of peas has been shown to improve apparent ileal protein digestibility (Crevieu *et al.*, 1997).

These effects may be attributed to the basis of increased accessibility of nutrients in fine legume particles. Fine grinding of faba beans had no effect on the total tract digestibility of protein (Lacassagne *et al.*, 1991), but these contradictory results on the effect of feed particle size on nutrient digestibility are possibly related to differences in the site of measurement (ileal versus total tract). The variable and modifying effects of caecal microflora on protein digestion have been recognized in recent years (Ravindran *et al.*, 1999) and it is now generally agreed that the analysis of ileal digesta rather than excreta is the preferred method for assessing nutrient digestibility in poultry (Ravindran and Bryden, 1999).

Interestingly, in terms of mineral availability, coarse grinding appears to be more preferable over fine grinding. Large maize particle size has been shown to significantly improve calcium, total phosphorus and phytate phosphorus utilisation in broilers It was hypothesised that larger particle size led to longer transit time allowing more time for mineral digestion and absorption (Kasim and Edwards, 2000; Kilburn and Edwards, 2001).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted at the Poultry Production and Research Unit of the Department of Animal Science, Usmanu Danfodiyo University Sokoto, which is located at the Sokoto State Veterinary Centre, Aliyu Jodi Road, Sokoto. It lasted for eight weeks.

Sokoto state is located between latitudes 12^{O} and 13^{O} N and between longitudes 4^{O} and 6^{O} E in the northern part of Nigeria and at an altitude of 350m above sea level (Mamman *et al*., 2000). The State falls within the Sudan savannah vegetation zone to the south and Sahel savannah to the north with alternating wet and dry seasons. The hot dry spell extends from March to May and sometime to June in the extreme northern part. A short, cool, dry period (Harmattan) occurs and lasts between late October and late February (Malami *et al.,* 2001). Mean annual temperature is 34.9^{O} C with the highest in April ranging from 38 to 41^{O}C and lowest in January ranging from 13 to 16^{O} C (Reuben, 1981).

3.2 Experimental Design

A total of 300 day old Marshal Strain broiler chicks were used. The birds were randomly alloted to five dietary treatment groups of different levels of grits, with each treatment having four replicates of 15 birds in a completely randomized design (CRD). The diets contained ground millet with 0 grit, whole millet with 1.5 grit, whole millet with 2.5 grit, whole millet with 3.5 grit and whole millet with 0 grit kg/100kg inclusion for diet 1, 2, 3, 4 and 5, respectively. There were two controls in the experiment, a negative control which contained ground millet (Diet1) and a positive control containing whole millet

(Diet 5) without additive grits. The ingredient composition of the experimental diets fed at starter and finisher phases are shown in Tables 3.1 and 3.2.

3.3 Management of the Birds and Data Collection.

The birds were housed on a deep litter with open sided walls. The housed pens were cleaned, washed and disinfected prior to the arrival of the birds. They were also fed with diet that meets their nutrients requirement during the period. Routine medication was provided according to the recommendation of Oluyemi and Roberts (2000). Records of feed intake and water consumption were taken daily while weight gain was recorded on weekly basis. Data for feed intake and weight gain were used to compute feed conversion ratio of the birds for each treatment. Mortality was recorded as it occurred throughout the period of the experiment.

Table 3.1: Gross composition of the starter diet (0-4 weeks)

	Diets				
Grit (kg/100kg)	0	1.5	2. 5	3.5	0
Ingredients (%)	1	2	3	4	5
Millet	62.25	62.25	62.25	62.25	62.25
GNC	28.50	28.50	28.50	28.50	28.50
Wheat offal	3.00	3.00	3.00	3.00	3.00
Blood meal	2.30	2.30	2.30	2.30	2.30
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Salt	0.30	0.30	0.30	0.30	0.30
*Vitamin-mineral Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Total	100	100	100	100	100
Cost of diet (₦/kg	67.10	66.00	66.10	66.20	65.85
Calculated Nutrient Composition of the diet					
Energy (MEKcal/kg)	2865.24	2865.24	2865.24	2865.24	2865.24
Crude protein (%)	22.65	22.65	22.65	22.65	22.65
Crude fibre (%)	6.65	6.65	6.65	6.65	6.65
Ether extract (%)	4.34	4.34	4.34	4.34	4.34
Calcium (%)	1.17	1.17	1.17	1.17	1.17
Phosphorous(%)	0.43	0.43	0.43	0.43	0.43
Methionine (%)	0.46	0.46	0.46	0.46	0.46
Lysine (%)	1.20	1.20	1.20	1.20	1.20

*Vitamin A 30,000,000.00 i.u, Vitamin $D_3$6,000,000.00 i.u, Vitamin E 30,000.00 mg, Vitamin K 2,000.00 mg, Vitamin $B_2$3,000.00 mg, Vitamin C30.00 g, Niacin40,000.00 mg, Pantothenic acid 12,000.00 mg, Vitamin B61,500.00 mg, Vitamin B1210,000.00 mg, Folic acid 1,000.00 mg, Biotin 400.00 mg, Choline chloride 300,000.00 mg, Cobalt 200.00 mg, Copper 1,200.00 mg, Lodin 20,000.00 mg, Iron 40,000.00 mg, Manganise100,000.00 mg, Selenium 150.00 mg, Zink 30,000.00 mg, Antioxidant 1,250.00 mg,

Table 3.2: Gross composition of the finisher diet (5-8 weeks)

	Diets				
Grit (kg/100kg)	0	1.5	2.5	3.5	0
Ingredients (%)	1	2	3	4	5
Millet	66.05	66.05	66.05	66.05	66.05
GNC	26.00	26.00	26.00	26.00	26.00
Wheat offal	4.00	4.00	4.00	4.00	4.00
Grit (kg/100kg)	0	1.5	2.5	3.5	0
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Salt	0.30	0.30	0.30	0.30	0.30
*Vitamin-mineral Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Total	100	100	100	100	100
Cost of diet (₦/kg)	66.67	65.57	65.67	65.77	65.42
Energy (MEKcal/kg)	2874.80	2874.80	2874.80	2874.80	2874.80
Crude protein (%)	20.30	20.30	20.30	20.30	20.30
Crude fibre (%)	6.92	6.92	6.92	6.92	6.92
Ether extract (%)	4.34	4.34	4.34	4.34	4.34
Calcium (%)	1.16	1.16	1.16	1.16	1.16
Phosphorous (%)	0.51	0.51	0.51	0.51	0.51
Methionine (%)	0.46	0.46	0.46	0.46	0.46
Lysine (%)	1.10	1.10	1.10	1.10	1.10

*Vitamin A 30,000,000.00 i.u, Vitamin $D_3$6,000,000.00 i.u, Vitamin E 30,000.00 mg, Vitamin K 2,000.00 mg, Vitamin $B_2$3,000.00 mg, Vitamin C30.00 g, Niacin40,000.00 mg, Pantothenic acid 12,000.00 mg, Vitamin B61,500.00 mg, Vitamin B1210,000.00 mg, Folic acid 1,000.00 mg, Biotin 400.00 mg, Choline chloride 300,000.00 mg, Cobalt 200.00 mg, Copper 1,200.00 mg, Lodin 20,000.00 mg, Iron 40,000.00 mg, Manganise100,000.00 mg, Selenium 150.00 mg, Zink 30,000.00 mg, Antioxidant 1,250.00 mg,

3.4 Carcass Evaluation

At the end of the finisher phase, one bird per replicate (4 birds per treatment) was slaughtered and dressed for carcass evaluation. Live weight, dressed weight, weight of prime cuts, organs and abdominal fats were recorded. Weights of parts relative to dressed weight were also determined.

3.5 Apparent Nutrient Digestibility by Broiler Chicks

During the fourth and eight week of the experiment, a seven day faecal collection from four birds per treatment (one per replicate) was carried out to determine the apparent nutrient digestibility of the proximate components. During this period, birds were housed individually in metabolic cages and weighed quantity of feed (90% of the daily feed intake) was offered to each bird daily. The birds were allowed two days to adjust to the cage environment before droppings were collected. Faecal samples were collected from separate cages on wrapping sheath placed beneath the wire mesh floor of the cages, weighed and oven- dried. Feed and faecal samples were weighed and oven dried in the laboratory at 105^0C. The samples were later analyzed for proximate composition according to the methods of AOAC (1990). Calcium was analyzed by EDTA titration method. The Bray number 1 method was used to determine phosphorous, while sodium and potassium content were determined by the flame photometric method.

Apparent nutrient digestibility (C) can be defined as follows: Amount of nutrient consumed (A) –Amount of nutrient in the faeces(B) Multiplied by 100, divided by the amount of nutrient consumed (A). That is (C = A – B x 100 / A).

3.6 Data Analysis

Data collected from the trial were subjected to ANOVA using Start View Analytical Computer Package (SAS, 2002).

CHAPTER FOUR

4.0 Results

4.1 Performance Characteristics of Experimental Birds.

The performance characteristics of broiler fed diets containing graded levels of grit as an additive to whole millet is shown in Table 4.1.

Table 4.1: Performance parameters of broilers fed diets with different levels of grits. (0-8 weeks)

	Diets					
Parameters	1	2	3	4	5	SEM
Initial weight/b (g)	47.10	47.02	46.85	46.98	46.77	0.15
Final body weight, g/b	1982.70^{ab}	2192.09^{a}	2045.72^{ab}	2222.63^{a}	1780.82^{b}	93.30
Weight gain, g/b	1935.69^{ab}	2144.97^{a}	1998.87^{ab}	2175.65^{a}	1734.05^{b}	93.35
Daily feed intake, g/b/d	89.17^{ab}	92.66^{ab}	85.49b^{c}	97.91^{a}	76.44^{c}	2.71
Feed conversion ratio	2.74^{b}	2.35^{a}	2.43^{ab}	2.53^{ab}	2.51^{ab}	0.26
Daily water intake, ml/b/d	204.11^{a}	220.81^{a}	196.68^{a}	212.26^{a}	165.00^{b}	8.98
Mortality (%)	26.67	33.33	36.67	35.00	21.67	5.61
Feed cost/gain (₦/b)	172.56^{e}	159.15^{b}	157.81^{a}	166.30^{d}	162.56^{c}	0.44

abcde: Means within the same row with different superscript are significantly different ($p<0.05$).

Final body weight differed significantly ($p<0.05$) between those fed the control diet of whole millet without grit (1780.82g/b) compared to the broilers fed 1.5 and 3.5% grit in whole millet based diet (2192.09 and 222.63g/b, respectively). The average final body weight of experimental birds fed the control diet of whole millet without grit was similar to those fed 2.5% grit in whole millet (2045.72g/b) and those fed ground millet without grit based diet (1982.70g/b) ($P>0.05$) . Birds fed unground millet without grit diets had statistically similar final body weight.

Daily feed intake values ranged from 76.44 to 97.91g/bird/day. Broilers fed diets 1, 2 and 4 were similar ($p>0.05$) in feed intake but differed significantly from birds fed diets 3 and 4. Birds on diet 3 and 4 did not show any significant differences ($P>0.05$) in feed intake.

Water intake was similar for broilers fed ground millet without grit (204.11ml/b/d), whole millet with 1.5% grit (220.81ml/b/d), whole millet with 2.5% grit (196.68ml/b/d) and whole millet with 3.5% grit (212.26ml/b/d) ($p>0.05$). However, birds in the control diet, consumed the least quantity of water (165.00ml/b/d) compared to birds in the remaining treatment groups ($P<0.05$).

Weight gain followed similar trend with the result of the final body weight. Birds on whole millet without grit diet had the lowest body weight gain (1734.05g/b) which was similar to the weight gain of those fed 2.5% grit in whole millet diet (1998.87g/b) and those fed the ground millet diet (1935.69g/b) the highest body weight gain was obtained by birds fed 3.5% grit in whole millet diet (2175.65g/b) which was similar to those fed 2.5% grit (1998.87g/b), 1.5% grit (2144.g/b) and the control diet of ground millet (1935.69g/b).

Birds fed grit supplemented diets had significantly ($P<0.05$) better feed conversion ratio compared to those fed the control diet devoid of grit. However, the feed conversion ratio for birds fed diet 2, 3, 4 and 5 were statistically similar ($P>0.05$).

There was no significant difference ($p>0.05$) in mortality of the birds. Values for mortality ranged from 21.67 to 36.67%.

There was significant difference ($P<0.05$) in feed cost per gain among broilers on the four treatment groups. The values of feed cost per kg gain of broilers feed diet 1, 2, 3, 4 and 5 were 172.56, 159.15, 157.81, 166.30 and 162.03, respectively. However, birds on diet 1 have the least feed cost per kg gain followed by birds on diet 2, 3, 4 and 5.

4.2 Apparent Nutrients Digestibility of Broilers at Starter Phase

The apparent nutrient digestibility of experimental broilers at starter phase is shown on table 4.2.

Table 4.2: Apparent nutrients digestibility of broiler starter fed diet with different levels of grits. (0-4 weeks).

Parameters (%)	Diets					
	1	2	3	4	5	SEM
Dry matter digestibility	70.52[b]	71.41[ab]	72.80[ab]	73.20[a]	73.80[a]	0.08
Crude protein digestibility	65.35	65.60	67.20	67.30	67.38	1.57
Crude fibre digestibility	47.75[b]	49.25[b]	55.60[a]	56.80[a]	59.65[a]	1.62
Ether extract digestibility	72.45	72.82	71.95	70.92	71.87	0.78
Ash retenton	68.90	69.30	69.70	69.25	69.55	1.15
Nitrogen free extract retenton	74.30[b]	79.77[ab]	80.55[ab]	82.15[a]	83.00[a]	2.00
Calcium retenton	75.50	76.20	75.85	75.30	75.50	1.14
Phosphorous retenton	95.80	95.38	95.50	94.93	94.75	0.90
Magnesium retenton	96.30	94.20	95.35	95.20	95.33	1.12
Sodium retenton	95.15	95.16	95.25	95.10	95.15	0.90
Potassium retenton	92.8[b]	94.87[ab]	85.30[ab]	95.67[a]	95.20[ab]	0.88

a b: Means within the same row with different superscript are significantly different ($p<0.05$).

Apparent dry matter digestibility was similar ($p>0.05$) across treatments except for the negative control (ground millet without grit) which had significantly ($p<0.05$) lower dry matter compared to retention of treatment 4 and 5 (whole millet with 3.5% grit) which had 73.20% and positive control whole millet without grit which had 73.80% respectively. Apparent dry matter digestibility of broilers fed whole millet with 1.5% grit (treatment 2) and whole millet with 2.5% grit (treatment 3) were similar ($p>0.05$) (71.41 and 72.80%, respectively).

Grit inclusion did not affect the apparent digestibility of crude protein. The values obtained were 65.35, 65.60, 67.20, 67.30 and 67.38%, respectively for birds fed diet 1, 2, 3, 4 and 5, respectively.

Broiler starter fed diet containing whole millet with 2.5, 3.5 and 0% grit had similar apparent crude fibre digestibility (55.60, 56.80 and 59.65%, respectively) which significantly differed ($p<0.05$) from the apparent crude fibre digestibility of birds fed whole millet with 1.5% grit (49.25%) and the diet containing ground millet without grit (47.75%).

Apparent ether extract digestibility was not affected by grit inclusion as values obtained were 72.45, 72.82, 71.95, 70.92 and 71.87% for birds fed treatment 1, 2,3, 4 and 5, respectively

Apparent ash retention did not differ significantly ($p>0.05$) across the dietary treatment. The values obtained were 68.90, 69.30, 69.70, 69.25 and 69.55% for birds fed treatment 1, 2, 3, 4 and 5, respectively.

The apparent nitrogen free extracts digestibility for birds fed treatment 4 and 5 were also statistically similar ($P<0.05$) to values obtained for broilers fed ground millet without grit.

Apparent calcium retention was also not affected by grit inclusion as the values obtained did not differ significantly ($P>0.05$). Though not significant , the birds fed 1.5% grit recorded the highest value 76.20% followed 75.85, 75.50, 75.50 and 75.30% for treatment 2, 1, 5 and 4, respectively.

Apparent phosphorous retention was also not affected by grit inclusion as the values obtained did not differ significantly ($P>0.05$). The values were 75.80, 95.38, 95.50, 94.93 and 94.75% for birds fed treatment 1, 2, 3, 4 and 5, respectively.

Apparent magnesium retention was similar for all the treatment. The values obtained were 96.30, 94.20, 95.25, 95.20 and 95.335 for birds fed treatment1, 2, 3, 4 and 5, respectively.

Broiler starters fed ground millet without grit (negative control), 1.5, 2.5, 3.5% grit and whole millet 0% grit (positive control) recorded values which did not show significant difference ($P>0.05$) for apparent sodium retention. The values obtained were 95.15, 95.16, 95.25, 95.10 and 95.15% for birds fed treatment 1,2, 3, 4 and 5, respectively. Significant effect ($P<0.05$) was observed in between the apparent of potassium retention by broilers fed diet 1 and those fed diet 4 (92.80 and 95.67%, respectively). Both values were similar with those obtained for broilers fed diet 2 (94.87%), diet3 (95.30%) and diet 5 (95.20%). Except for broilers fed diet 1 and those fed diet 2 which had 75.15 and 73.89% apparent dry matter digestibility ($P<0.05$), all other values did not show any significant effect.

4.3 Apparent Nutrients Digestibility of Broilers at Finisher Phase

The nutrient retention of experimental broilers at starter phase is shown on Table 4.3

Table 4.3: Apparent nutrients digestibility of broiler finisher fed diet with different levels of grits. (5-8 weeks).

	Diets					
Parameters (%)	1	2	3	4	5	SEM
Dry matter digestibility	74.38^{ab}	73.89^{b}	74.50^{ab}	75.10^{ab}	75.15^{a}	0.42
Crude protein digestibility	68.60	71.10	71.50	72.50	72.53	1.49
Crude fibre digestibility	55.47	59.60	58.67	60.18	59.50	2.27
Ether extract digestibility	82.30^{b}	88.65^{ab}	89.34^{a}	92.31^{a}	88.50^{ab}	2.20
Ash retention	69.20^{c}	70.33^{bc}	73.30^{abc}	75.00^{a}	69.48^{c}	1.39
Nitrogen free extract retention	61.00	63.00	65.00	65.75	65.35	2.25
Calcium retention	77.45^{b}	82.50^{a}	84.00^{a}	84.25^{a}	82.00^{a}	1.34
Phosphorous retention	92.30^{c}	95.00^{ab}	95.31^{a}	95.35^{a}	93.51^{b}	0.60
Magnesium retention	95.70	96.00	95.85	95.30	96.10	0.25
Sodium retention	92.35	92.40	93.01	93.25	92.67	0.90
Potassium retention	93.50	93.20	95.00	95.67	95.50	1.75

abc: Means within the same row with different superscript are significantly different ($p<0.05$).

Broiler finishers fed diet 1, 2, 3 and 4, retained 74.38, 74.50 and 75.10% apparent dry matter respesctively (p>0.05). Grit inclusion did not affect the retention of crude protein as values obtained were 68.60, 71.10, 71.50, 72.50 and 72.53% respectively for birds on treatment 1, 2, 3, 4 and 5 respectively (P>0.05).

Broiler finisher had apparent crude fibre digestibility value of 55.47, 59.60, 58.67, 60.18 and 59.50% for birds fed treatment 1, 2, 3, 4 and 5, respectively.

Apparent nitrogen free extract digestibility did not differ significantly (P>0.05). The values obtained were 61.00, 63.00, 65.00, 65.75 and 65.35% for birds fed on treatment 1, 2, 3, 4 and 5, respectively. Apparent ether extract digestibility was similar for broiler finishers fed diets 2, 3, 4 and 5 (88.65, 89.34, 92.31 and 88.50%, respectively). The apparent digestibility of those fed 2.5 and 3.5% grits (diet 3 and 4) were significantly different from apparent ether extract digestibility of birds fed diet 1, (82.30%). Inclusion of grit was effective on broiler finishers fed diet 2 and 4 with regards to apparent ash retention. Both groups had 73.30 and 75.00% apparent ash retention (P>0.05). Both values differed significantly (P<0.05) from values obtained for broilers fed diet 2 (70.33%), 5 (69.48%) and 1 (69.20%) which were similar. Apparent calcium retention was significantly lower (P<0.05) for broiler finishers that were fed diet 1 (77.45%) compared with those fed diet 2, 3, 4 and 5 (82.50, 84.00, 84.25 and 82.00%, respectively) that were similar. Similarly, apparent phosphorous digestibility was lower (P>0.05) for broiler finishers on diet 1 (92.30%) compared with the other treatment groups. Broilers on 2, 3 and 4 had similar apparent phosphorous retention of 95.00, 95.31 and 95.35%. The retention of broilers fed diet 1 (93.41%), was also significantly lower (p<0.05) than those fed diet 3 and 4, but similar to those fed diet 2. Apparent magnesium retention was similar for all the treatment. The values obtained were 95.70, 96.00, 95.85, 95.30 and 96.10% for birds fed diet 1, 2, 3, 4 and 5. Apparent sodium retention was not affected by grit inclusion as the values did not differ significantly ($p>0.05$). The values obtained were 92.35, 92.40, 93.01, 93.25 and 92.67% for birds fed diet 1, 2, 3, 4 and 5, respectively. Apparent potassium retention was also similar for all the treatments. The values recorded were 93.50, 93.20, 95.00, 95.67 and 95.50% for birds fed diet 1, 2, 3, 4 and 5, respectively.

4.4 Effect of Grit Inclusion in whole Millet Diets on Carcass Characteristics of broiler chicken.

The effect of the inclusion of grits in whole millet diet for broilers on carcass characteristics is shown in Table 4.4

Table 4.4: Effect of dietary grits inclusion in whole millet diet on carcass characteristics of broilers.

Parameters	Diets 1	2	3	4	5	SEM
Live weight (g)	1875.00^{ab}	1912.50^{a}	2012.50^{a}	2037.49^{a}	1750.00^{b}	246.24
Dressed weight (g)	1625.00	1655.250	1735.750	1732.00	1567.00	48.25
Dressing percentage (%)	63.65^{bc}	64.95^{bc}	65.91^{ab}	67.05^{a}	62.18^{c}	1.53
Prime cut expressed as a percentage of the dressed weight (%)						
Breast	32.37^{b}	35.15^{ab}	36.47a	37.74^{a}	34.38^{b}	0.90
Back	14.42	15.15	13.71	14.02	14.65	0.64
Thigh	30.68	30.88	31.92	33.20	31.30	0.92
Wing	10.61^{b}	10.79^{ab}	11.03^{ab}	11.75^{ab}	11.90^{a}	0.33
Neck	7.83^{ab}	6.99^{ab}	6.64^{b}	8.41^{a}	7.77^{ab}	0.37
Shank	6.32	6.10	5.78	6.97	6.86	0.47
Head	3.57^{ab}	3.55^{ab}	3.27^{b}	$3.54a^{b}$	4.01^{a}	0.16
Fats	2.81^{ab}	3.30^{ab}	2.86^{ab}	3.85^{a}	2.76^{b}	0.29
Organ weight expressed as percentage of live weight (%)						
Gizzard	3.08^{b}	3.12^{ab}	3.16^{a}	3.41^{a}	2.68^{b}	0.20
Heart	0.61	0.59	0.62	0.58	0.64	0.04
Kidney	0.22	0.20	0.20	0.21	0.20	0.05
Lungs	0.68	0.61	0.71	0.64	0.64	0.04
Proventriculus	0.54^{b}	0.56^{ab}	0.56^{ab}	0.60^{a}	0.60^{a}	0.02
Spleen	0.15	0.16	0.18	0.22	0.23	0.03
Intestine	5.37	5.40	4.80	5.30	5.34	0.42

abc: Means within the same row with different superscript are significantly different ($p<0.05$).

Live weight showed significant difference ($p<0.05$) between broilers fed 3.5% grit (2037.49 and 2012.50g) and those fed 0% grit whole millet (1750.00g) However, these values were similar with those fed diet 1 (1875.00g) and 2 (1912.50g).

Dressed weight did not show significant difference ($p>0.05$) between the treatment groups. Broilers on diet 4 (whole millet with 3.5% grit) and 3 (whole millet 2.5% grit) had the highest dressing percentages of 67.05 and 65.91%, respectively ($p>0.05$) while those on treatment 1, 2 and 5 had 63.65, 64.95 and 62.18% dressing percentages, respectively ($p>0.05$). The values obtained for broilers on diet 4 are significantly higher ($P<0.05$) than those obtained for broilers on diet 1, 2 and 5.

Breast weight expressed as a percentage of carcass weight for birds fed diet 2, 3 and 4 were higher ($P<0.05$) than those fed diet containing ground millet and whole millet without grit. However, breast weight for birds fed 1.5% grit in their diet was similar to breast weight for those that were fed on diets without grits.

Back weight expressed as a percentage of carcass weight was not affected by grit inclusion as the percentage values obtained did not differ significantly ($P>0.05$). The values were 14.42, 15.15, 13.71, 14.02 and 14.65% for birds fed diet 1, 2, 3, 4 and 5, respectively.

Weight of thigh expressed as a percentage of carcass weight was not affected by grit inclusion as the values obtained did not differ significantly ($p>0.05$). The values were 30.68, 31.92, 30.88, 33.20 and 31.30% for birds fed diet 1, 2, 3, 4 and 5, respectively.

There was significant difference ($p<0.05$) in wing weight between broilers fed ground millet, 0% grit and those fed whole millet without grit inclusion (10.61 and 11.90%, respectively).

Broilers fed diet containing 1.5, 2.5 and 3.5% grits (10.79, 11.03 and 11.75%) compared favourably with either those fed ground or whole millet without grits.

Broilers fed 3.5% grit whole millet based diet had the heaviest neck (8.41%) followed by those fed ground millet (7.83%), whole millet, 0% grit (7.77%) and those fed 1.5% grit (6.99%). Significant difference ($P<0.05$) was observed between neck weight of broilers fed 2.5% grit (6.64%) and those fed 3.5% grit (8.41%) ($P<0.05$).

Weight of shank did not differ significantly ($p>0.05$). However, broilers fed 3.5% grit had the heaviest shank (6.97%) followed 6.86, 6.32, 6.10 and 5.78% for positive control (0% grit), negative control (0% grit), treatment 2 (1.5% grit) and 3 (2.5% grit), respectively.

Weight of intestine expressed as a percentage of live weight did not show significant difference ($p>0.05$) between the dietary treatments. The values recorded were 5.37, 5.40, 4.80, 5.30 and 5.34% for the negative control of ground millet without grit, treatment 2, 3, 4 and positive control of whole millet without grit, respectively.

The weight of gizzard expressed as a percentage of live weight showed significant difference ($p<0.05$) between broilers fed ground and whole millet without grit (3.08 and 2.68%) and those fed diets containing whole millet with 2.5% and 3.5% grit.

Abdominal fats expressed as a percentage of live weight were all statistically similar ($P>0.05$) except for birds fed whole millet with 3.5% grit (3.85%) which was significantly different ($p<0.05$) from birds fed whole millet without grit (2.76%). Other values were 2.81, 3.30 and 2.86% for birds on ground millet, whole millet with 1.5 and 2.5% grits, respectively.

Weight of head expressed as a percentage of live weight showed significant difference (p<0.05) between broiler fed 0% grit whole millet (4.01%) and those fed whole millet 2.5% grit (3.27%) which is similar without significant difference compared with birds fed 0% grit whole millet (3.57%), 1.5% grit whole millet (3.55%) and 3.5% grit whole millet (3.54%).

Weight of crop expressed as a percentage of live weight did not differ significantly (P>0.05). The values obtained were 0.41, 0.30, 0.38, 0.44 and 0.39% for birds fed diet 1, 2, 3, 4 and 5, respectively. Weight of heart expressed as a percentage of live weight did not differ significantly (P>0.05). The values obtained were 0.61, 0.59, 0.62, 0.58 and 0.64% for birds fed diet 1, 2, 3, 4 and 5, respectively. Weight of the kidney expressed as a percentage of live weight was not affected by dietary grit inclusion. The values obtained did not differ significantly (P>0.05). The values obtained were 0.22, 0.20, 0.20, 0.21 and 0.20% for birds fed diet 1, 2, 3, 4, and 5, respectively. Weight of lungs expressed as a percentage of live weight was not affected by dietary grit inclusion as the values did not differ significantly (P>0.05). The values were 0.68, 0.61, 0.71, 0.64 and 0.64% for birds fed diet 1, 2, 3, 4, and 5, respectively. Weight of spleen expressed as a percentage of live weight did not differ significantly (P>0.05). The values obtained were 0.15, 0.16, 0.18, 0.22 and 0.23% for birds fed diet 1, 2, 3, 4, and 5, respectively. Broilers fed diet 1 had the smallest (P<0.05) proventriculus (0.54%) compared to birds fed diet 5 (0.60%) and birds fed diet 4 (0.60%). Broilers fed diet 2 and 3 had 0.56 and 0.56% proventriculus which were not significantly different from birds fed other diets.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Performance Characteristics

The differences observed for final body weight of experimental birds could be due to different levels of grit included in the diets. Adeniji (2009) reported that the local chicken pick up stones while scavenging, and could be responsible for increased activity of gizzard in grinding of feed. Similarly, Moore (1998) asserted that feeding grit to poultry birds help to facilitate the breakdown of feed materials in the gizzard thereby influencing digestibility. It was also reported by Idachaba *et al.* (2013) that feed utilization improved with incorporation of grit in the diet of broiler chicken.

Feed intake of broilers fed positive control and those for 1.5 and 3.5 grit based diet did not follow a particular pattern. However, Ali (2006) reported reduced feed intake for birds fed grits supplemented diet.

The significant difference in feed conversion ratio of birds fed 2.5% grit and those with 0% grit supported the findings of Adeniji (2010) who reported better ($p<0.05$) feed to gain ratio for chicks fed 5% grit compared to those fed diets without grit.

Water intake and feed conversion ratio were not affected by dietary grit inclusion between those fed whole millet with 1.5, 2.5 and 3.5%grit. This result was in line with the findings of Bennett and Classen (2003) who reported that feeding grit had no effect on performance of birds fed similar levels of whole barley or mash diet.

The higher mortality values recorded could be due to disease known as sudden death syndrome which affected heavier birds in the flock. Mahmood (2012) reported that poultry nutritionist suggested that the higher growth rate in modern broiler chicks could be the main reason for the problem. The mortality rate was above the normal recommended or accepted level of 5% (Oluyemi and Roberts, 2000). Ali *et al*. (2006) reported that, mortality showed no significant difference ($p<0.05$) on birds fed acid insoluble granite grit (AIGG) and the control diet without grit.

There was significant difference ($P<0.05$) in feed cost per gain among treatment. This could be attributed to the increase levels of grits, daily feed intake and cost of grinding. Nsa *et al.* (2009) reported similar values of feed cost per gain when maize offal was used as a replacement for maize in broiler diet. However, better significant cost of feed per kg gain came from broilers on diet 3.

Apparent nutrient digestibility of broilers fed whole millet grain based diet with or without dietary grit inclusion showed no significant difference ($p>0.05$) in most of the parameters. There was however, gradual increase in apparent nutrient digestibility for most of the nutrient as level of grit inclusion increased. This is in line with the findings of Rawland and Hooge (1980) who observed that apparent nutrient digestibility improved with the incorporation of grit in diet of poultry. Adeniji (2009) reported similar observation when pullet chicks were fed palm kernel cake based diets with grit inclusion. Adeniji (2010) reported that, chicks fed 5% grit had better ($p<0.05$) crude fibre and fat retention of 43.99 and 78.64% as against 32.80 and 75.23% for the 0% grit fed chicks.

The gradual increase in weight of the gizzard and proventriculus between negative control of whole grain 0% grit and those fed whole millet with 1.5, 2.5 and 3.5% grit could be as a result of level of grit inclusion. This result is in line with the findings of Silva Junior *et al.* (2003) who reported that insoluble granite grit in broiler diet increase gizzard and proventriculus weight. Ali *et al*. (2006) reported that, bird fed grit had better

($p<0.05$) gizzard weight of 1.30 as against 0.97g for the 0% grit fed chicks. Live weight, dressed weight and dressing percentage recorded no significant difference. This result supported Ali *et al.* (2006) who stated that, feeding granite grit had little or no effect on carcass weight and dressing percentage. The non significant difference in percentage carcass weight and cut up parts supported the result obtained by Davis *et al*. (2003) who fed pearl millet grain to broilers. The slight increase in organs weight with grit inclusion in the diets in some parameters may have resulted from heavy live weight as reported by Broadbent *et al.* (1989) since the surface area and live weight determine the amount of feathers and visceral organs required.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

It could be concluded that

- Dietary grit inclusion has effect on the performance of broiler chicks as it improves digestibility.
- It increases gizzard and proventriculus weight.
- No significant difference was observed in most of the performance parameters of birds fed 1.5, 2.5 and 3.5% grit, but there was significant difference between treatment with and without grit inclusion (2, 3 and 4) and (1 and 5), respectively.

6.2 Recommendations

- Research should be conducted with different strains of broilers and with different levels and size of grit to ascertain the effect of dietary grit inclusion and also to reveal it cost effectiveness in feeding broilers.
- The study recommended 2.5% level of inclusion as it has intermediate values between the different levels (1.5, 2.5 and 3.5% grit) and with better feed conversion ratio.

REFERENCES

Adamu, S. B., Yahaya, N. and Alade, N. K. (2001). Effect of different energy sources on finishing carcass characteristics of broiler chickens under a semi-arid condition. *Journal of Sustainable Agriculture and Environment,* 3(2):232-238.

Adeniji, A. A. (2010). Effect of dietary grit inclusion on the Utilization of Rice husk by pullet chicks. *Tropical and Sub Tropical Agro Ecosystem 12 (1) 175-180.*

Adeniji, A. A. (2009). Effect of dietary grit inclusion on the utilization of palm kernel cake by pullet chicks. *Animal Nutrition and Feed Technology (9) 29-36.*

Adeola, O. and J. C. Rogler (1994). Pearl millet in diet of white peckin duck. *Poultry Science, 73: 425-435.*

Akinmutimi, A. H. (2004). Evaluation of sword bean (*Canavalia gladiata*) as an alternative feed resource for broiler chickens. Ph. D. Thesis, Department of Non-ruminant Animal Production, Michael Okpara University of Agriculture, Umudike, Nigeria.

Ali, B. G., E. Guray and O. Nuh (2006). Voluntary intake of insoluble Granite-grit offered on free-choice by broilers. *Asian-Australian Journal of Animal Science 19(4) 549-553.*

Amerah, A. M., Ravindran, V., Lentle, R. G. and Thomas, D. G. (2007). Influence of particle size on the performance, digesta characteristics and energy utilization of broilers fed maize and wheat based diets. Proceedings of the *Australian Poultry Science Symposium 19: 89-92.*

Andrews, D. J. and Kumar, K. A. (2006). *Pennisetum glaucum* (L.) R. Br. Record from protabase. Brink, M. and Belay, G. (Editors). PROTA (Plant Resource of Tropical Africa), Wageningen, Netherlands.

AOAC. (1990). Association of Official Analytical Chemists. *Official Methods of Analysis.* 15th Edition. Washington D.C.

Artkinson, R. L., Bradley, J. W. and Kruerger, W. F. (1975). Wheat, millet and corn as ingredients in feed for young turkeys. *Nutrition Report International,* 11:345-349.

Atteh, J. O. (2003). *Principles and practices of livestock feed manufacturing* (33rd ed.) Adeleke, Publishers, Ilorin, Nigeria.

Barnes, A. R and Amega, W. K. (1984). Utilization of cocoa pod husk meal by growing-finishing pigs. Proceedings 9th International Cocoa Research Conference, Lome, Togo, pp 449-454.

Becker, K. and Makkar, H. P. S. (1999). Effects of dietary tannic acid and quebracho tannin on growth performance and metabolic rates of common carp. *Aquaculture, 175:327-335.*

Bennett, C.D., Classen, H. L. and C. Riddell (2002). Feeding broiler chickens whole wheat and barley diet containing whole, ground and pelleted grain. *Poultry Science* 81:995-1003.

Bertezko, J., Lasek, O. and Augustyn, R. (2008). Energy utilization and nutritive value of maize grain cultivars for broiler chickens. *Journal of Central European Agriculture.* 9 (1) 225-228.

Bone, F. J. (1979). Anatomy and Physiology of Farm Animals. Printice–Hall, Inc., New Jersey, U.S.A.

Bramel-cox, P.J., K.A. Kumar, J.D. Hancock and D.J. Andrews (1995). Sorghum and millet Chemistry and Technology. *American Association of Cereal Chemistry.* St. poul, MN.

Branson, R., Greg, J. H. and Linda, R. H. (1994). *Avian Medicine: Principles and Application.* Wingers publication, Lake Worth, Florida. Pp 1-14

Broadbend, L. A., B. J. Wilson and C. Fisher (1989). The composition of broiler chicken at 56 days of age: Output components and chemical composition. *British Poultry Science*. 22 Pp 4-10.

Burnham, B., G. C. Emmans and R. M. Gous (1992). Isoleucine responses in broiler chickens. Interaction with leucine and valine. *British Poultry Science. 33:71-87.*

Carre, B. (2000). Effects de la taille des particules alimentaires sur les processus digestifs chez les oiseauxìélevage. *INRA Productions Animales* 13: 131-136.

Carre, B. (2004). Causes for variation in digestibility of starch among feedstuffs. *World's Poultry Science Journal* 60: 76-89.

Carre, B. Maisonnier, Melcion, J. P., Ouryt F. X, Gomez, J. and Pluchard, P. (2002). Relationships between digestibilities of food components and characteristics of wheats (Triticum aestivum) introduced as the only cereal source in a broiler chicken diet. *British Poultry Science 43: 404-415.s*

Carre, B., Muley, N., Gomez, J., Ouryt, F. X. Laffitte, E. Guillou, D. and Signoret, C. (2005). Soft wheat instead of hard wheat in pelleted diets results in high starch digestibility in broiler chickens. *British Poultry Science 46: 66-74.*

Choudhary, R. S., Singh, S. Nehra, R. and Singh, R. D. (2005). Effect of replacement of Maize by graded levels of Pearl millet (*Pennisetum typhoides*) on broiler performance. *Indian Journal of Animal Science, 75 (9):1092-1093.*

Collins, V. P., Cantor, A. H., Pescatore, A. J. Straw, M. L. and Ford, M. J. (1994). Evaluation of pearl millet as feed ingredient for poultry. *Poultry Science* (1): 34. (Abstr.).

Cowieson, A. J. (2005). Factors that affect the nutritional value of maize for broilers. *Animal. Feed Science Technology*. 199:293-305.

Crevieu, I., Carrc B., Chagneau, A. M., Gueguen, J. and Melcion, J. P. (1997). Effect of particle size of pea flours on the digestion of proteins in the digestive tract of broilers. *Journal of the Science of Food and Agriculture 75: 217-226.*

Cromwell, G. L. and Coffey, R. D. (1993). An assessment of the availability of phosphorus in feed ingredients for non-ruminants. *Proceedings of the Maryland Nutrition Conference for feed Manufacturers.* Pp. 146-158.

Cumming, R. B. (1992). The advantage free-choice feeding for village chicken. In: *Proceeding* of the 19th world Poultry Congress, The Netherlands, Pp. 627-630.

Cumming, R. B. (1994). Opportunities for whole grain feeding. *Proceeding* of the 9th European Poultry Conference, *World Poultry. Science.* 2:219-222.

Davis, A. J., N. M. Dale and F. J. Ferreira (2003). Pearl millet as an alternative feed ingredient in broiler diets. *Journal of Applied Poultry Research, 12 (2): 137-144.*

Douglas, J. H., Sullivan, T. W., Gonzalez, N. J. and Beck, M. M. (1993). Differential age response of turkeys to protein and sorghum tannin levels. *Poultry Science, 72: 1944-1951.*

Edgar, A. O. T. T. (1994). Animal Nutrition, Non-ruminant. *Encyclopedia of Agricultural Science* Vol. 1A-D Academic press-inc. Califonia.USA Pp. 93-96.

Eduvie, L. O (2002). *Poultry production in Nigeria, a training manual*. Published by National Animal Production Research Institute, Shika ABU, Zaria, Nigeria. Pp4

Evans, M. and Singh, D. N. (2005). An economic evaluation of three varieties of pearl millet compared to grain sorghum in diets for hens and broilers. Proceedings of the 17th Australian Poultry Science Symposium, Sydney, New South Wales, Australia, 7-9 February 2005: 301-302.

Flurharty, F. L. and Loerch, S. C. (1996). Effect of diatary energy source and levels of performance of newly arrived feedlot calves. *Journal of Animal Science,* 74:504-513.

Frederick, N. (2010). Effect of Moringa Leaf meal (Molm) on nutrient digestibility, growth, carcass and blood indices of weaner rabbits. MSc. Thesis. Faculty of Agriculture and Natural Resources, Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Pp. 1-122.

Garg, S. K.,Makkar, H. P. S., Nagpal., K. B, Sharma, S. K., Wadhwa, D. R. and Singh, B. (1982). Toxicological investigation into oak leaf poisoning in cattle. *Vetenary and Human Toxicology, 34: 161-164.*

Gionfriddo, J. P. and Best, L. B. (1999). Grit use by birds: A review. *Curr. Ornithol.* 15, 89-148.

Gous, R. M. (1998). Making progress in the nutrition of Broilers. *Poultry Science.* 77:111-117.

Hancock, J. D., P. J. Bramel-Cox, K. R. Smith, B. J. Healy, C. F. Klopfenstein and M. D. Witt (1990). Selection for increased in vitro digestibility improves the feeding value of sorghum grain. *Journal of Animal Science.* 90 (1): 320 (Abstr.)

Havenstein, G. B., P. R. Ferket, S. E. Scheidler, and B. T. Larson.(1994). Growth, livability, and feed conversion of 1991 vs 1957 broilers when fed "typical" 1957 and 1991 broiler diets. *Poultry Science*, *73:1785-1794*.

Healy, B. J., J. D. Hancock, P. J. Bramel-cox, B. T. Richert, C. F. Klopfenstein and M. D. Witt (1991). Selection for increase in vitro digestibility improves feeding value of sorghum grains . Kansas State University, USA. Swine Day 1991. Report of progress 641: 94-96.

Hetland, H., B. Svihus and V. Olaisen (2002). Effect of feeding whole cereal on performance, starch digestibility and duodenal particle size distribution in broiler chickens. *British Poultry Science.* 43: 416-423.

Hill, K. J. (1971). *Physiology and Reproduction of the Domestic Fowl.* (Ed. D. J. Bell and B. M. Freeman). Academic press. London. United Kingdom.

Hills, G. M. and W. W. Hanna (1990). Nutritive characteristics of pearl millet grain in beef cattle diets. *Journal of Animal Science.* 68: 2061-2066.

Hidalgo, M. A., A. J. Davis, N. M. Dale and W. A. Dozier III (2004). Use of whole pearl millet in broiler diets. *Journal of Applied Poultry Research*, 13: 229-234.

Idachaba, C. U., F. O. Abeke, T. S. Olugbemi. K. U. Anoh and L. A. Ademu (2013). Effect of graded levels of stone grit on the utilization of rice offal based diet by broiler chickens. *International Journal of Applied Research*. 13: 125- 131.

Jones, G. P. D. and R. D. Taylor (1999). Performance and gut characteristics of grit-fed broilers. Proceedings: Australian Poultry Science Symposium 11, University of Sydney, Australia. NSW, Pp 57-60.

Kasim, A. B. and Edwards, H. M. (2000). Effect of sources of maize and maize particle sizes on the utilization of phytate phosphorus in broiler chicks. *Animal Feed Science and Technology 86: 15-26.*

Kermanshashi, H. and H. L. Classen (2001). Feeding whole wheat with or without a dietary enzyme or grit to laying hens. *Journal of Agricultural Science and Technology* 3:193-198.

Kilburn, J. and Edwards, H. M. (2001). The response of broilers to the feeding of mash or pelleted diets containing maize of varying particle sizes. *British Poultry Science 42: 484-492.*

Kumar, R. and Singh, B. (1984). Antinutritional adverse role in ruminant nutrition. *Journal 0f Agricultural Food Chemistry, 32:447-453.*

Kyriazakis, I. and G. C. Emmans, (1992). The effect of varying protein and energy intakes on the growth and body composition of pigs. The effect of the energy intake at constant, higher protein intake. *British Journal of Nutrition* 68:603-613.

Lacassagne, L., Melcion, J. P., DE Monredon, F. and Carre, B. (1991). The nutritional values of faba bean flours varying in their mean particle size in young chickens. *Animal Feed Science and Technology 34: 11-19.*

Mahmood, S. (2012). Feed restriction in broiler chicks production. A review: IDOSI publication Iran. *Global Vetrinaria* 8 (5): 449-458.

Malami, B. S., U. G. Rambo and M. Nasirudeen (2001). A note on indigenous knowledge on treating Camel (*Camelus dromedary*) disease among farmers in Sokoto State, Nigeria. *Journal of Agriculture and environment* 2 (1): 159-163.

Mamman, A. B., J. O. Oyebanji and S. W. Peters (2000). In: Nigeria A people united, a future assured (survey of state). Calaba, Gabumo Publishing Company. Pp 6-7.

Medugu, C. I., Kwari, I. D., Igwebuike, J. U., Nkama, I., Mohammed, I. D. and Hamaker, B. (2010). Performance and economics of production of broiler chickens fed sorghum or millet as replacement for maize in semi-arid zone of Nigeria. *Agriculture and Biology Journal of North America*, 1 (3): 321-325.

Moore, S. J. (1998). Use of an artificial gizzard to investigate the effect of grit on the breakdown of grass. *Journal of Zoology*. 246: 119-124.

N A P R I (2002). *Poultry Production in Nigeria*. A training manual. Federal Ministry of Agriculture and Rural Development, Ahmadu Bello University, Shika Zaria. Pp 1-165.

N R C (1994). Nutrient Requirement of Poultry. 9th Revised Edition National Academy Press, Washington, DC, USA.

N R C (1996). Nutrient Requirement of Poultry. *The Nutrient Requirement of farm Animals.* 9th Edition. National Academy of Science press,Washington DC, USA.

Nityanand, P. (1997). *Textbook of Feed Processing Technology*. Vikas Publishing House PVT Ltd., New Delhi, India.

Nsa, E. E., B. Okon, I. A. Akpan, M. I. Anya, G., Wogar, G. D. Edet, C. O. Okereke and v. i. Joubi (2009). Growth performance and economy of maize offal as a replacement for maize in broiler finisher chicken diet. Proceedings of the 14th Annual Conference of Animal Science Association of Nigeria (ASAN), September, 14th-17th , Lautech, Ogbomoso, Nigeria. Pp: 418-420.

Ojewola, G. S. and S. Oyim (2006). Comparative evaluation of maize, sorghum and millet in growing cockerels ration. *Agricultural Journal*, 1 (3): 176

Okai, D. B., Easter, R. A. and Frank, G. R. (1984). The nutritive value of some non-conventional Ghanaian feed ingredients: Nutrient composition and effects on performance of weaning rats. Wld. Rev. *Animal Production*, 20:11-16.

Oluyemi, J. A. and F. A. Robert (2000). *Poultry Production in warm wet Climate.* Second Edition, Macmillan Publishers London. United Kingdom. Pp 77-80.

Parsons, A. S., Buchanan, N. P., Blemings, K. P., Wilson, M. E. and Mortiz, J. S. (2006). Effect of corn particle size and pellet texture on broiler performance in the growing phase. *Journal of Applied Poultry Research 15: 245-255.*

Peron, A., Bastianelli, D., Oury, F. X., Gomez, J. and Carre, B. (2005). Effects of food deprivation and particle size of ground wheat on digestibility of food components in broilers fed on a pelleted diet. *British Poultry Science 46: 223-230.*

Pirgozliev, V. R., Birch, C. L., Rose, S. P., Kettlewell, P. S. and Bedford, M. R. (2003). Chemical composition and the nutritive quality of different wheat cultivars for broiler chickens. *British Poultry Science 44: 464-475.*

Plavnik, I., B. Macovsky and D. Sklan (2002). Effect of feeding whole wheat on performance of broiler chickens. *Animal Feed Science Technology*, 96:229-236.

Ravindran, V. and Bryden, W. L. (1999). Amino acid availability in poultry - in vitro and in vivo measurements. *Australian Journal of Agricultural Research 50: 889-908.*

Ravindran, V., Hew, L. I., Ravindran, G. and Bryden, W. L. (1999). A comparison of ileal digesta and excreta analysis for the determination of amino acid digestibility in feed ingredients for poultry. *British Poultry Science 40: 266-274.*

Raju, M. V. L. N., G. Shyamsunder, A. V. Elangovan, M. R. Reddy, V. R. Sadagopan and S. V., Ramarao (2003). Sorghum, bajra and ragi vis-vis maize as energy source in broiler chicken diets. *Indian Journal of Animal Nutrition*, 20 (2): 185-192.

Ranjhan, S. K. (1999). *Animal Nutrition and Feeding Practices,* 5th Edition. Vikas Publishing. House PVT Ltd.,New Delhi, India,pp 159-167.

Ranjhan, S.K. (2001). *Animal Nutrition in the tropics*, 6th Edition. Vikas Publishing House. PVT Ltd., New Delhi India, Pp. 209, 466.

Reddy, C. V. and S. Qudratullah (1996). Strategic feeding supplementation through locally available resources. In: Rural Development with a focus on Enployment, Income and role of women. Vol. 1, New Delhi, India. September 25, 1996. *World Poultry Congress.*

Reuben, K. U. (1981). *Geographical Region of Nigeria*. Published by Heinemann, London, U.K

Rooney, L. W. (1978). Sorghum and pearl millet lipids. *Cereal Chemistry.* 55:584-590.

Rose, S. P., Tucker, L. A., Kettlewell, P. S. and Collier, J. D. A. (2001). Rapid tests of wheat nutritive value for growing chickens. *Journal of Cereal Science 34: 181-190.*

Rowland, L. O. and D. M. Hooge (1980). Effect of dietary sand on the performance of young broiler chickens. *Poultry Science*. 59: 190-191.

Rutrowski, A. and M. Wiaz (2001). Effect of feeding whole or ground wheat grain on the weight of the gizzard and pH digest in broiler chickens. *Journal of Animal Feed Science* 10:285-289.

Salverson, C. A. (1996). Grit feeding in caged layers. *Poultry Science, 75:112.*

SAS (2002). Stat View Statistical Package (English version). Inc. SAS Institute New York, USA.

Scott, M. L. (1999): Poultry Feeding and Management in the Tropics, *Animal Production in Tropic.* Haemeangh Publishers, Ibadan, Nigeria Pp 200-212.

Serna-Saldivar, S. O., C. M. Mc Donough and L. W. Rooney (1990). The millet. In: K.J. Lorenz and K. Kulp (eds.). *Hand book of Cereal Science Technology*. Markel Dekker, New York, USA. Pp. 271-300.

Seshaiah, M. P. (2000). Sorghum grain in poultry feed. In: Technical and Institutional option for sorghum grain and mold management. Proceedings of the International Consultation, 18th-19th May 2000, ICRISAT, Chandrashekar, A., Bandyopadhyay, R. and Hall, A.J. (eds). Patancheru, India. Pp:240-241.

Sharma, B. D., Sadagopan, V. R. and Reddy, V. R. (1979). Utilization of different cereal in broiler chickens ration. *British Poultry Science,* 20: 371-388.

Silva-Junior, V. L. de, J. T.de B. Cotta and A. I. G. de Oliveira (2003). Effect of the forms of presentation of corn and the use of grit in the ration on performance in broiler. *Cienciae Agriculture.* 27:1165-1171.

Singh, D. N., Perez-Maldonado, R., Manion, P. E., Martin, P. and Palmer, C. P. (2000): Nutritive value of pearl millet grown in Australia. Proceedings of *Australian Poultry Science Symposium*. 12:204-205

Svihus, B., E. Juvik, H. Hetland and A. Krogdahl (2004). Causes for improvement in nutritive value of broiler chicken diet with whole wheat instead of ground wheat. *British Poultry Science* 45:55-60.

Svihus, B., Klovstad, K. H., Perez, V., Zimonja, O., Sahlstrom, S. and Schuller, R. B. (2004). Physical and nutritional effects of pelleting of broiler chicken diets made from wheat ground to different coarsenesses by the use of roller mill and hammer mill. Animal *Feed Science and Technology 117:281-293*.

Tim, W. (1999). Physical aspects of grain and effect of feed texture on Animal performance. ASA Technical Bulletin (22) 1-9.

Toddy J. (2008). Variation in Nutrient Utilization by poultry and ingredient composition. Applegate-Purdue University, Roselina Angel, University of Maryland, College Park, USA. Pp. 1-11.

Uddin, M. S., Rose, S. P., Hiscock, T. A. and Bonnet, S. (1996). Acomparison of the energy availability for chickens of ground and whole grain samples of two wheat varieties. *British Poultry Science 37: 347-357.*

Udeidibie, A. B. I., B. C., Anyaegbu, G. C. Onyechekwa and O. C. Egbuokporo (2004). Effect of feeding different levels of fermented and unfermented Cassava tuber meals on performance of broilers. *Nigerian journal of Animal. Production 31 (2): 211.*

Udeybir, K. R. Yadav, B. S. Tewatia, K. Sanjay, and A. Mahesh (2007). Nutrient utilization, excreta moisture and intestinal viscosity of digesta in broiler chickens fed pearl millet based diet. *Animal Nutrition and Feed Technology,* 7 (2): 197-204.

Udeybir, P. S. Niranjan and K. R. Yadav (2009). Effect of pearl millet based diet with or without enzyme supplementation on broilers. *Indian Veterinary Journal,* 86 (2): 210-211.

Vasan, P., D. Narayan, A. B. Mandal and K. Sharma (2008). Effect of grinding on apparent and true digestibility of amino acids of pearl millet (*Pennisetum typoides*) in adult roosters. *Animal Nutrition and Feed Technology,* 8 (1):111-114.

Zenella, I., Sakomura, N. K., Silversides, F. G., Fiqueirdo, A., Pack, M. (1999). Effect of enzyme supplementation of broiler diet based on corn and soybeans. *Poultry Science,* 78:561-568.

APPENDICES

Appendix 1.0: Anova for final body weight

Source	DF	Sum of Square	Mean Square	F-Value	P-value
Treatment	4	507416.561	126854.140	3.181	0.0443
Residual	15	598096.456	39873.097		

Appendix 2.0: Anova for weight gain

Source	DF	Sum of Square	Mean Square	F-Value	P-value
Treatment	4	506839.505	126709.876	3.174	0.0446
Residual	15	598800.537	39920.036		

Appendix 3.0: Anova for daily feed intake

Source	DF	Sum of Square	Mean Square	F-Value	P-value
Treatment	4	1042.355	260.589	3.943	0.0221
Residual	15	991.219	66.081		

Appendix 4.0: Anova for feed conversion ratio

Source	DF	Sum of Square	Mean Square	F-Value	P-value
Treatment	4	0.342	0.86	1.422	0.2745
Residual	15	0.903	0.60		

Appendix 5.0: Anova for daily water intake

Source	DF	Sum of Square	Mean Square	F-Value	P-value
Treatment	4	507416.561	126854.140	3.181	0.0443
Residual	15	598096.456	39873.097		

Appendix 6.0: Anova for mortality

Source	DF	Sum of Square	Mean Square	F-Value	P-value
Treatment	4	635.556	158.889	1.153	0.700
Residual	15	2066.667	137.778		

Appendix 7.0: Anova for feed cost/gain

Source	DF	Sum of Square	Mean Square	F-Value
Treatment	4	535676.332	107135.266	1.417
Residual	15	11.341	0.756	