# EFFECT OF GRADED LEVELS OF STONE GRIT ON THE UTILIZATION OF RICE OFFAL BASED DIETS BY BROILER CHICKENS

**BY**

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**A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN ANIMAL SCIENCE**

**DEPARTMENT OF ANIMAL SCIENCE, FACULTY OF AGRICULTURE, AHMADU BELLO UNIVERSITY, ZARIA**

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## DECLARATION

I hereby declare that this work titled "Effect of Graded Levels of Stone Grit with or without Enzyme Supplementation on the Utilization of Rice Offal Based Diets by Broiler Chickens" was written by me as a record of my research work in the Department of Animal Science, Ahmadu Bello University Zaria and was supervised by Dr. F. O. Abeke and Dr T. S. Olugbemi. Information derived from the literature has been duly acknowledged in the list of references provided. No part of this thesis has been previously presented for another Degree or Diploma at any University.

_____ _____

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## CERTIFICATION

This thesis titled "Effect of Graded Levels of Stone Grit with or without Enzyme Supplementation on the Utilization of Rice Offal Based Diets by Broiler Chickens" by Idachaba, Collins Udagbene meets the regulation governing the award of the Degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

| | |
|---|---|
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## DEDICATION

This project is dedicated to God Almighty who gave me grace and strength to complete this study successfully and to my dear parents Mr. and Mrs. P.I.J. Idachaba who were the engine that propelled me to this platform of success.

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**ABSTRACT**

The research was carried out in two phases/stages to evaluate the effect of graded levels of stone grit with or without enzyme supplementation on the utilization of rice offal based diets by broiler chickens. In the first phase, three hundred and sixty day old broiler chicks and two hundred and seventy finishing broiler birds were used at the starter and finisher phases. The birds were reared on deep litter, in an open sided wire mesh screened poultry house and fed on experimental diets containing rice offal at 10% and 15% inclusion levels for the starter and finisher phases respectively. Stone grit was added to this ration at graded levels of 0.0g, 2.0g, 4.0g, 6.0g, 8.0g and 10.0 grams per bird per month. Each treatment was replicated three times with 20 birds per replicate at the starter phase and 15 birds per replicate at the finisher phase in a completely randomized design. Stone grit significantly improved ($P<0.05$) final body weight, feed intake, feed conversion ratio and feed cost per kg gain thus indicating improvement in feed utilization. Total protein (TP) improved with grit addition while packed cell volume (PCV) and haemoglobin level (Hb) were not significantly affected ($P>0.05$). Crude protein, Crude fibre and Nitrogen Free Extract significantly ($P<0.05$) improved with increasing grit levels. Similarly, breast, back, thigh, shank, gizzard and dressing percentage improved with grit levels. It was concluded that stone grit significantly ($P<0.05$) reduced feed wastage by improving feed utilization as feed intake significantly ($P<0.05$) decreased with increasing levels of stone grit while weight gain, feed to gain ratio, feed cost per kg gain, haematological parameters and nutrient retention improved across the graded levels of stone grit. In the second phase, three hundred and twenty four day old broiler chicks and two hundred and seventy finishing broiler birds were used at the starter and finisher phases respectively. They were fed an experimental diet that contained rice offal at 10% and 15% inclusion levels at both starter and finisher phases

respectively however an Enzyme (maxigrain) was added to the diet at 0.01% across all dietary treatments. Stone grit was also added to this ration at 0.0g, 2.0g, 4.0g, 6.0g, 8.0g and 10.0 grams per bird per month thus making a total of six treatments. Each treatment was replicated three times with 18 birds per replicate at the starter phase and 15 birds per replicate at the finisher phase in a completely randomized design. Final body weight, feed intake, feed conversion ratio and feed cost per kg gain improved ($P<0.05$) with increasing grit levels. No significant difference ($P>0.05$) was observed for PVC, Hb and TP across the graded levels of stone grit. Live weight, dressed weight, dressing percentage, back, thigh, wing and gizzard measurements significantly ($P<0.05$) increased with graded levels of stone grit. Crude protein, Ether Extract and dry matter significantly ($P<0.05$) improved with increasing grit levels. Birds fed diets containing stone grit and enzyme supplementation (phase two) showed a higher final weight compared to birds fed diets containing stone grit alone (phase one) hence the conclusion that feeding stone grit with enzyme supplementation is encouraged to enhance higher final weight.

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# CHAPTER ONE

## 1.0 INTRODUCTION

Feed is the most important input in a poultry enterprise as it represents between 60-70% of the total cost of production (Smith, 2001). The high cost of conventional feed ingredients coupled with inadequate knowledge of alternative feedstuffs is among the factors militating against the increase in commercial poultry production in Nigeria (Olorede and Ajayi, 2005). Consequently, raising poultry birds will demand a greater monetary input from farmers with most of the cost going into feeding. This has led to the search for alternative feed ingredients to reduce the cost incurred in poultry production (Joseph *et al*., 2000; Emenalom, 2004 and Esonu *et al*., 2004). One of such alternative feedstuffs that can be used in poultry production is rice offal (Abeke *et al.,* 2008). Amaefule *et al.* (2006) reported that in order to reduce feed cost and increase profit margin in poultry production, producers should incorporate the use of low cost agro-industrial waste such as rice offal.

Fagade (2000) reported that Nigeria has the potential to produce about 200,000 metric tons of rice offal from the 500,000 metric tons of rice produced annually. However, in spite of the abundance of rice offal in Nigeria, it has been neglected as feed for poultry because it contains high level of fibre and low protein and energy (Ambashankar and Chandresekan, 1998; Oyawoye and Nelson, 1999). Most non-conventional feedstuffs contain high amount of non-starch polysaccharides (NSPs) that limit feed utilization by poultry birds. It was reported by Onyimonyi (2005) that non-conventional feedstuffs when fed to non-ruminants could result into negative responses such as reduction in nutrient utilization, metabolic dysfunction and depression in growth rate. In order to enhance the utilization of non-conventional feedstuffs such as rice offal, nutritionists have resorted to the use of feed additives such as stone grit (Atteh, 2003) and

exogenous enzymes (Tuleun *et al*., 2009). Grits are bits of stone, sand and small particles used by birds to enhance mechanical digestion by abrasion in the gizzard (Atteh, 2003). They are hard, completely inert, neutral in pH and do not absorb water (Abeke *et al*., 2010). Grits are classified into soluble and insoluble grit. The soluble grits are those that dissolve easily in the gizzard and they include cattle bone, oyster shell, limestone etc. The insoluble grits are non-digestible and are retained in the gizzard and they include silica, mica, granite etc. Though arguments abound whether intensively reared birds under deep litter system have need for stone grit in their gizzard, there is however a possibility that the presence of stone grit may result in better digestion and utilization of ingested feed (Abeke *et al*., 2010).

According to Atteh (2003) addition of stone grit to the diet of poultry birds will lead to improved feed utilization and efficiency resulting from mechanical abrasion that occurs in the gizzard which is thought to increase the amount of nutrients that can be extracted from the feed. The importance of stone grit in poultry nutrition stems from the fact that it provides additional surface for grinding in the gizzard, helps to improve the digestibility of coarse and fibrous feed particles and also helps to stimulate motility in the gizzard (Leeson and Summers, 2001). Jeff (2010) reported that feeding poultry birds with grit is essential as it helps to improve gut health by keeping the digestive tract moving thereby reducing the possibility of impaction and enteritis.

Another important way to circumvent the problem limiting the use of non-conventional feed ingredients is by the use of exogenous enzymes. Acamovic (2001) reported that exogenous enzymes increase the digestibility of feed ingredients and reduce the incidence of wet droppings which may result from the presence of fibrous polysaccharides in the diets. Maxigrain is a potent exogenous enzyme that can enhance the breakdown of the non-starch polysaccharide present in rice offal thereby improving its utilization in poultry diets. The array of enzymes in maxigrain

includes amylase, xylanase, Beta-glucanase, pectinase, protease, lipase, phytase and cellulase. Maxigrain is widely used in poultry nutrition and it is readily available. Its potency stems from the fact that it is: important in optimizing the use of non-conventional feedstuffs; it improves weight gain in broiler birds, improves litter quality and dropping consistency, improves feed to gain ratio, improves egg production and shell quality (Acamovic, 2001).

## 1.1 Justification of the Study

In recent times there has been an upward trend in the use of alternative feed resources in broiler ration as a result of the high cost of conventional feed ingredients. However most of these non-conventional feed resources are fibrous in nature and need to be improved upon for better utilization. It was reported by Ensminger *et al.* (1990) that feed materials are usually not utilized properly by broiler birds due to their rapid rate of feed intake, rapid rate of metabolism and faecal output. Therefore it is expected that stone grit will help in mechanical grinding of feed materials thus providing large surface area for endogenous and exogenous enzymes to optimize performance and nutrient digestibility. Similarly, poultry birds instinctively pick up stones when raised in an extensive system. Therefore, there is a need to simulate this natural phenomenon for intensively raised birds.

## 1.2 Objectives of the Study

1. To assess the effect of stone grit at graded levels of 0.0g, 2.0g, 4.0g, 6.0g, 8.0g and 10.0 grams per bird per month on the performance, haematological, nutrient digestibility and carcass characteristics of broiler birds fed rice offal based diets.

2. To determine the effect of stone grit at graded levels of 0.0g, 2.0g, 4.0g, 6.0g, 8.0g and 10 grams per bird per month with enzyme supplementation on the performance, haematological, nutrient digestibility and carcass characteristics of broiler birds fed rice offal based diets

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Nutrient requirement of broiler chickens

This refers to the minimum amount of nutrients required by broiler birds to maximize growth and feed efficiency (Laohakaset, 1997) and also maintain body functions (Chinrasri 2004). Nutrient retention of broiler chickens is found in Table 2.1.

#### 2.1.1 Water:

Water represents about 70 percent of the total body weight of broiler birds, it also makes up about 65 percent of the total weight of eggs (Scott and Kenneth, 2000). It is the least expensive, and usually the most neglected nutrient required in broiler production (Scott and Kenneth, 2000). It performs definite functions in the body such as regulation of body temperature, transportation of feed through the digestive tract, serves as a major component of the blood, helps in waste elimination and plays a vital role in reproduction (Carter and Sneed, 1997).

Amongst other factors, its requirement by broiler birds is mostly related to the nature of feed consumed and also ambient temperature (Ward and McKague, 2007). Talha *et al.* (2008) reported that long periods of water deprivation will affect broiler performance more than its occurrence with long periods of feed starvation. Consequently, for a flock to achieve maximum production, water should be readily available and free of pathogenic microorganisms and toxic levels of minerals (Talha *et al.,* 2008).

**Table 2.1: Nutrient Requirements of Broilers as Percentages or Units per Kilogram of Diet (90% dry matter)**

| Nutrient | Unit | 0-3wks | 3-6wks | 6-8wks |
|---|---|---|---|---|
| Protein/amino acids | | | | |
| Crude protein | % | 23.00 | 20.00 | 18.00 |
| Arginine | % | 1.25 | 1.10 | 1.00 |
| Glysine+serine | % | 1.25 | 1.14 | 0.97 |
| Histidine | % | 0.35 | 0.32 | 0.27 |
| Isoleucine | % | 0.80 | 0.73 | 0.62 |
| Leucine | % | 1.20 | 1.09 | 0.93 |
| Lysine | % | 1.10 | 1.00 | 0.85 |
| Methionine | % | 0.50 | 0.38 | 0.32 |
| Methionine+cyctine | % | 0.90 | 0.72 | 0.60 |
| Phenylalanine | % | 0.72 | 0.65 | 0.56 |
| Phenylalanine+tyrosine | % | 1.34 | 1.22 | 1.04 |
| Proline | % | 0.60 | 0.55 | 0.46 |
| Threonine | % | 0.80 | 0.74 | 0.68 |
| Tryptophan | % | 0.20 | 0.18 | 0.16 |
| Valine | % | 0.90 | 0.82 | 0.70 |
| Fat | | | | |
| Linoleic acid | % | 1.00 | 1.00 | 1.00 |
| Macrominerals | | | | |
| Calcium | % | 1.00 | 0.90 | 0.80 |
| Magnesium | Mg | 600 | 600 | 600 |
| Potassium | % | 0.30 | 0.30 | 0.30 |
| Sodium | % | 0.20 | 0.15 | 0.12 |
| Trace minerals | | | | |
| Iron | Mg | 80 | 80 | 80 |
| Manganese | Mg | 60 | 60 | 60 |
| Selenium | Mg | 0.15 | 0.15 | 0.15 |
| Zinc | | 40 | 40 | 40 |
| Fat soluble vitamins | | | | |
| A | IU | 1,500 | 1,500 | 1,500 |
| $D_3$ | ICU | 200 | 200 | 200 |
| E | IU | 10 | 10 | 10 |
| K | Mg | 0.15 | 0.15 | 0.15 |
| Water soluble vitamins | | | | |
| $B_{12}$ | Mg | 0.01 | 0.01 | 0.007 |
| Biotin | Mg | 0.15 | 0.15 | 0.12 |
| Choline | Mg | 1,300 | 1000 | 750 |
| Niacin | Mg | 35 | 30 | 25 |
| Pantothenic acid | Mg | 10 | 10 | 10 |
| Pyridoxin | Mg | 3.5 | 3.5 | 3.0 |
| Riboflavin | Mg | 3.6 | 3.6 | 3.0 |
| Thiamine | Mg | 1.80 | 1.80 | 1.80 |

Source: National research council (NRC) 1994

### 2.1.2 Vitamins

Vitamins are organic compounds found in food in small quantities. They are very essential in a good nutrition program (Scott and Kenneth, 2000). Vitamins are primarily divided into two classes: fat soluble and water soluble vitamins. The fat soluble vitamins include vitamin A, D, E, and K while the water-soluble vitamins include vitamin C and the B-complex vitamins—vitamin B12, biotin, choline, folacin, niacin, pantothenic acid, pyridoxine, riboflavin, and thiamin. They are required in small amounts and they represent about 0.05% of the total weight of the feed and about 1.5% of the feed cost (Coelho and McNaughton, 1995). Vitamin requirement of poultry is usually affected by several factors such as age, breed/strain, diet composition, disease, minerals – vitamin bioavailability, physiological condition and stress (McNaughton, 1990). Acamovic (2001) reported that optimum vitamin nutrition in broilers diets have shown increased growth rate, improved feed efficiency, increased oxidative stability of meat and better resistance to high density stress conditions.

### 2.1.3 Minerals

Minerals are involved in the formation of structural components in the skeleton. Some minerals are also integral parts of amino acids, vitamins and hormones (Irish, 2009). They are in two types based on level of requirements (macro and trace minerals). Levels of major minerals (macro minerals) are critical, especially for young growing poultry. Calcium and phosphorus are two macro minerals of great importance in poultry production (Underwood and Suttle, 1999). The skeleton accounts for about 99% calcium and 80% phosphorus in the body (Theerachai, 2006). Most cereal grains and their by-products are deficient in calcium though they contain notable quantities of iron ranging between 60-210ppm (Drinceanu *et al.,* 2009). Excess supply of calcium in poultry diets may lead to serious problems of mineral interaction as it would interfere

with the availability of other minerals such as phosphorus, magnesium, manganese, and zinc (NRC, 1994). NRC (1994) recommendation for calcium in broiler diet are as follows: 1.00, 0.90, and 0.80% for the starter (0 to 21d), grower (21 to 42d), and finisher (42 to 56d). Young chicks and pullets require calcium and phosphorus in relatively large amounts for bone growth. A 2:1 ratio of calcium to phosphorus is best for adequate mineral absorption and metabolism (Chiba, 2007). Poultry requirement for calcium and phosphorus are influenced by the amount of vitamin D in the diet (Smith, 1990). In general, the need for calcium and phosphorus increases as the level of vitamin D decreases and vice versa (Smith, 1990).

Mature egg-laying birds have a greater requirement for calcium as it is the nutrient that forms the hard "shell" of the egg (Underwood *et al.,* 1999). Cereal grains are poor sources of manganese with concentration ranging between 0.13-0.23% (Drinceanu *et al.,* 2009). Consequently, nutritionists use trace mineral premixes when formulating diets to supply the required amount of micro minerals needed for maintenance and production (Scott and Kenneth, 2000). Other important minerals in broiler nutrition include chlorine which is necessary in digestion as a component of hydrochloric acid, sodium and potassium which are electrolytes important for metabolic, muscle, and nerve functions; magnesium for metabolic and muscle functions (Scott and Kenneth, 2000). Others are manganese which is essential in egg shell production, iodine necessary for the production of thyroid hormones, zinc which is involved in enzymatic processes and iron for oxygen transportation within the body.

### 2.1.4 Protein

Several studies have been carried out by Olomu and Offiong (1980), Onwudike (1983), Fetuga (1984), Ojewola and Longe (1999) and NRC (1994) to determine the protein requirement of broiler chickens. Olomu and Offiong (1980) reported that 23% CP for broiler starter and 20% CP

for broiler finisher was adequate for optimum performance. Onwudike (1983) recommended 22% CP for broiler starter, Fetuga (1984) recommended 23-24% CP for broiler starter, while NRC (1994) recommended 23% CP for broiler birds of 0-3 weeks of age, 20% CP for birds 3-6 weeks of age and 18% CP for birds 6-8 weeks of age. However, NRC report has been accepted by many nutritionists (Leeson and Summers, 1997). Excess protein in broiler diet has been reported to be dissipated as heat increment after consumption usually in the order of protein-carbohydrate-fat (Musharaf and Latshaw, 1999; Gous and Morris, 2005).

There is a threshold above and below in which protein concentration as a nutrient is not justifiable (Si *et al*., 2001), hence no positive result will be expected in terms of growth and other performance indices if this limit is exceeded. Protein is made up of amino acids and there are about twenty two amino acids in feed ingredients eleven of which are essential and must be provided in poultry diets (Leeson and Summers, 1997). They are referred to as essential amino acids since they are not synthesized in adequate amounts by the host animal (Scott and Kenneth, 2000). Lysine and methionine are the two most critical amino acids in poultry nutrition. A deficiency of these two amino acids would lead to a significant loss in productive efficiency (Irish, 2009).

### 2.1.5 Energy

The energy contribution from poultry diets is usually described in terms of Metabolizable energy (ME) and/or net energy (NE). Metabolizable energy can be accurately determined from the difference between the gross energy of the feed and the gross energy of the excreta derived from such feed (NRC, 1994). The concentration of energy in a diet will greatly influence the intake of all other nutrients, as a result broilers tend to adjust their feed intake as dietary energy concentration changes (Leeson *et al*., 1996a, b). NRC (1994) recommended 2800-3000 kcal/kg

M.E for broiler starter diet and 3200 kcal/kg M.E for broiler finisher diet. Carbohydrate and fat are the major sources of energy in broiler nutrition (Scott and Kenneth, 2000). Carbohydrates common in poultry diets are starch, sugars, cellulose, and other non-starch compounds.

### 2.1.6 Fat and fatty acids

Broilers have a dietary requirement for essential fatty acids (EFA). The main essential fatty acid is linoleic acid which acts as a precursor for other members of the n-6 series such as arachidonic acid and derived prostaglandins (Scott and Kenneth, 2000). Specific lesions, particularly in the skin, can result from essential fatty acid deficiency if the dietary content of linoleic acid falls below the requirement of about 10g/kg (NRC, 1994). This seldom occurs in practice since dietary ingredients contain essential fatty acids but however, supplemental fats and oil are widely used to achieve the high dietary energy requirement of broiler birds. Fat has 2.25 times more energy than carbohydrates on an equal-weight basis (Chiba, 2007). It is important in broiler nutrition as it performs certain physiological functions such as insulation against temperature extremes, protection of vital organs etc. Addition of fat to broiler diet should be accompanied with the use of an antioxidant as it will help to prevent rancidity of the fat (Chiba, 2007). This is mostly important during hot weather.

## 2.2 Factors affecting nutrient requirement of broiler birds

### 2.2.1 Sex

Prior to sexual maturity the sexes have only small differences in their nutrient requirements. Males and females can usually be fed the same diet to achieve acceptable growth rates. Differences in nutrient requirements abound following the onset of sexual maturity hence, different diet formulations are then required for each sex (Irish, 2009).

### 2.2.2 Housing system

The type of housing system will influence the level of activity of the birds and therefore their energy requirements

### 2.2.3 Health status

Birds experiencing a disease challenge may benefit from an increase in the intake of some nutrients, most commonly vitamins (Ferket, 2000).

### 2.2.4 Production aims

Optimum nutrient composition of a diet will vary according to production aims such as optimizing weight gain or carcass composition, egg numbers or egg size etc. Poultry birds raised for breeding purposes may need to have their energy intake restricted to ensure that they do not become obese (Gous, 1998).

### 2.2.5 Ambient temperature

Poultry have increased energy requirement to maintain normal body temperature in cold ambient temperatures and the opposite in hot ambient temperatures. The process of digestion of food produces body heat and the amount of heat produced will vary according to the nutrient composition of the diet. This is called the heat increment of the diet. In cold temperatures it may

be desirable to formulate a diet with a higher heat increment and the opposite in hot temperatures (Gous and Morris, 2005).

### 2.2.6 Reproductive state

The level of reproduction in broiler breeders and sexual activity in males will affect nutrient requirements (Theerachai, 2006).

### 2.2.7 Age

Nutrient requirements of poultry birds are also related to both body weight and the stage of maturity.

## 2.3 Non-traditional feedstuffs in poultry nutrition

Alternative feedstuffs are often referred to as "non-traditional feedstuffs" because they have not been used traditionally in animal feed or they are not normally used in commercial animal diets (Sonaiya, 1995). However, it is difficult to draw a clear distinction between traditional and non-traditional feedstuffs (Kellems and Church, 2010). This is so because some feedstuffs are classified as non-traditional in some regions while in other regions they may have started as non-traditional feedstuffs and gradually gained acceptance as feed for poultry birds and are now being referred to as traditional poultry feed (Velmurugu, 1990).

Non-traditional feedstuffs are known to contain anti-nutritional factors, they have low biological value and have poor digestibility (Tacon, 1992; Dublecz, 2003 and Vieira *et al.,* 2003). The anti-nutrients contained in alternative feed resources are known to interfere with digestion, absorption and utilization of nutrients (Warenham *et al.,* 1994 and Akande *et al.,* 2010). According to Hossain *et al.* (2011) utilization of non-traditional feed materials by poultry birds can be improved by proper processing to enhance its nutritive value. Huisman and Tolman (1992), Sing and Panda (1992) reported that processing methods such as heat treatment, autoclaving, water

extraction, drying, and cooking can be employed to improve the utilization of non-traditional feedstuffs in poultry diets. Other methods include use of enzymes (Classen and Bedford 1991), salting, blanching, ammonia treatment (Classen, 1996) sterilization, ensiling and chemical treatment (Leeson and Summers, 2001).

## 2.4 Factors limiting the use of non-traditional feed ingredients in poultry feed formulation

It is widely recognized that in developing African and Asian countries, existing feed resources in many circumstances are either unutilized and wasted or used inefficiently. Most of these alternative feedstuffs have obvious potential, but their use has been negligible owing to constraints imposed by certain factors that pose negative effects on performance. Two major criteria determine the regular use of non-traditional feedstuffs in poultry diets. These factors can be grouped based on nutritional and technical aspects.

### 2.4.1 Nutritional aspect

Most non-traditional feedstuffs contain anti-nutritional factors that interfere with the utilization of dietary nutrients. Some of such anti-nutritional factors include tannin in sorghum, phytic acid in sesame seed, gossypol in cottonseed, glucosinolate in Indian mustard etc. Also, most non-conventional feedstuffs used in poultry diets contain high amount of non-starch polysaccharides that cannot be hydrolyzed by simple stomach animals (Morgan and Bedford, 1995). These non-starch polysaccharides (NSPs) are polymeric carbohydrates which differ in composition and structure from starch (Morgan and Bedford, 1995). They also possess chemical crosses that link them together thereby making them difficult to hydrolyze by simple stomach animals like poultry birds (Adams and Pough, 1993 and Annison, 1993). Other nutritive factors limiting the use of non-traditional feedstuffs in poultry diet includes variability or inconsistency in nutrient

quality, limited information on the availability of nutrients and the need for nutrient supplementation to improve the nutritive value of the feedstuff used.

### 2.4.2 Technical aspect

Technical limitations to the use of non-traditional feedstuff in poultry diet include seasonality and unreliability of supply of most alternative feedstuffs. This is so because some feedstuffs are not available all year round and as such poultry farmers may have to resort to feeding conventional feed sources for which an ever increasing competition with humans exists. Other technical limitations include the bulky nature of feed materials, limited research and development facilities for determining nutrient composition and inclusion levels in poultry diets and the cost incurred in processing the feedstuff to enhance utilization (Velmurugu, 1990).

## 2.5 Strategies to improve the quality of non-traditional feedstuffs for incorporation in poultry diet

### 2.5.1 Crop breeding

Genetic manipulation of many cereal grains such as maize, sorghum, barley, wheat, soybean etc. can enrich the nutritive quality of the by-products derived from them thereby enhancing their usage in poultry diets (Velmurugu, 1990).

### 2.5.2 Feed processing

Feed processing is important when diets containing anti-nutrients are being fed to monogastric animals (Akande *et al*., 2010). Feed processing can help to reduce the level of anti-nutrients in plant feed sources to innocuous levels that can be tolerated by animals particularly in monogastric nutrition (Fasuyi and Aletor, 2005).

### 2.5.3 Nutrient Supplementation

Diet formulation with non-traditional feedstuffs can increase the crude fibre content in a ration, thereby slowing down digestibility by broiler chickens (Velmurugu, 1990). The use of additives such as stone grit, exogenous enzymes, fats or oil, synthetic amino acids, vitamin mineral premixes and growth promoters can help to enhance the nutritional quality of the feed (Rosen, 2006).

## 2.6 Stone grit

Grits are hard insoluble or soluble particles which remain trapped in the thick-muscled gizzard to facilitate grinding of feed (Chiba, 2009). They are also referred to as hard bit of stone, sand and small particles used by birds to enhance mechanical digestion by abrasion in the gizzard (Ali *et al.,* 2006). Grits are classified into two groups namely (soluble and insoluble grits). The soluble grits are those that dissolve easily in the gizzard and are sources of calcium and minerals, they include cattle bone, oyster shell, seashell and limestone (Atteh, 2003). The insoluble grits are non-digestible and are retained in the gizzard and include silica, mica and granite (Adeniji and Oyeleke, 2008).

Poultry birds raised extensively have a strong affinity to pick up stones when feeding however those raised intensively tend to eat fibre and litter materials which normally pass through their intestine without being ground, often causing bleeding and damage (Jeff, 2010). Most non-conventional feedstuffs used in poultry diets contain high amounts of non-starch polysaccharides that cannot be hydrolyzed by these simple stomach animals (Morgan and Bedford, 1995). These non-starch polysaccharides (NSPs) are polymeric carbohydrates which differ in composition and structure from starch (Morgan and Bedford, 1995). They also possess chemical crosses that link them together thereby making them difficult to hydrolyze by simple stomach animals like

poultry birds (Adams and Pough, 1993 and Annison, 1993). Part of this non-starch polysaccharide is water soluble and it forms a gel-like viscous substance that causes reduction in gut performance (Ward, 1995). Studies have shown that the negative effect caused by the presence of non-starch polysaccharides can be overcome by dietary modifications which include the use of grit materials (Atteh, 2003). Several methods have been employed to improve poultry performance such as good sanitation, provision of adequate feed, good housing, adequate medical care and good management. However, the inclusion of stone grit is not generally practiced as a means of improving performance through better feed utilization (Abeke *et al.,* 2010). The importance of stone grit in poultry nutrition stems from the fact that it provides additional surface for grinding in the gizzard, it helps to improve the digestibility of coarse and fibrous feed particles and it also helps to stimulate motility in the gizzard (Leeson and Summers, 2001).

Jeff (2010) reported that addition of stone grit to poultry diet is beneficial as it helps to keep the digestive tract moving thereby reducing the possibility of impaction and enteritis. Kermanshahi and Classen (2001) and Bennett *et al.* (2002b) also reported that feeding grit to poultry birds will lead to a better utilization of feedstuffs. This according to Ali *et al.* (2006) and Adeniji (2009) is essential for proper extraction of nutrients from fibrous materials as grinding of feed will be thorough. Aganga *et al.* (2000) reported that grit fed to intensively raised poultry birds should be round in shape and not angular stones to prevent damage to the gastrointestinal tract by the sharp edges. Consequently, for better gut health and adequate feed utilization stone grit should be made available to birds that have no access to it (Ali *et al.,* 2006). Adeniji (2009) suggested that at least 5% grit level should be fed to intensively raised birds as this will optimize feed utilization.

## 2.7 Rice offal as an alternative feed ingredient

Rice offal is the by-product obtained from rice mills that process parboiled rice. Dafwang and Shwarmen (1996) reported that rice offal contains the husk, grain polishing and small quantities of broken grains. Fagade (2000) estimated that small scale rice mills process over 80% of the rice produced in Nigeria and that rice offal makes up to 40% of parboiled rice. Dafwang and Damang (1996) also reported that the bulk of rice processing in Nigeria is handled by small scale rice milling machines that produce large quantities of rice offal which until recently were often burnt off to reduce waste pollution. It was also reported by Fagade (2000) that Nigeria has the potential to produce about 200,000 metric tons of rice offal from the 500,000 metric tons of rice produced annually.

Amaefule *et al.* (2006) reported that in order to reduce feed cost and increase profit margin in poultry production, producers should incorporate the use of low cost agro-industrial waste such as rice offal. However, inspite of the abundance of rice offal, it has been neglected as feed for poultry because it contains high level of fibre and low protein and energy (Ambashankar and Chandresekan, 1998; Oyawoye and Nelson, 1999 and Kocher, 2001). Foaster and Smith (2001) reported that incorporation of insoluble grit such as granite can help to improve utilization of non-traditional feed materials when it is fed to poultry birds. This is so because the grit material will help to increase the abrasive action in the gizzard thereby leading to extraction of nutrients.

## 2.8 The gizzard and its unique feature

The gizzard also referred to as the *ventriculus*, gastric mill, and *gigerium* is an organ found in the digestive tract of some animals, including birds, reptiles, earthworms and some fish. It is a modified muscular pouch behind the stomach in the alimentary canal of birds, having a thick lining and often containing ingested grit that aids in the breakdown of feed (Adeniji and Oyeleke,

2008). Birds have a number of unique features in their digestive system that distinguish them from mammals, some of which includes the presence of a muscular gizzard, lack of teeth, presence of a soft palate and a feeding strategy that allows for maximum ingestion of feed in a short time (Abeke *et al*., 2010) and a sandpaper-like grinding action assisted by grit or stones deliberately ingested in the case of local or foraging chicken. However, birds reared under intensive management system have no access to grit stones and hence ability to digest the high fibre content in their regular diets is very low (Adeniji and Oyeleke, 2008).

## 2.9 Enzymes

### 2.9.1 Source of Enzymes

Enzymes were used in the preparation of food long before they were really discovered. The industrial exploitation of microbial enzymes in the western world started about 100 years ago with the patenting of a process for the production of alpha-amylase from the fungus *Aspergillus oryzae* (Khattak *et al.,* 2006). Most enzymes currently used in food and beverage industries are from *Aspergillus*, but hemicellulase and cellulase are derived from *Trichoderma* (Acamovic and McCleary 1996). Currently, gene encoding for different enzymes such as phytases, ß-glucanases, and xylanases, have been cloned and expressed in different commercial systems (Acamovic and McCleary, 1996). It is possible to produce large amounts of cheap enzyme by continually selecting favorable microbes, growing them in advanced fermentation systems and then stream lining the extraction and purification of the enzyme (Wallis, 1996). According to Khattak *et al.,* (2006), microorganisms used in the production of enzymes include the following; Bacteria (*Bacillus subtilis, Bacillus lentus, Bacillus amyloliquifaciens* and *Bacillus stearothermophils*), Fungus (*Triochoderma longibrachiatum, Asperigillus oryzae* and *Asperigillus niger*) and Yeast (*S. cerevisiae*).

### 2.9.2 Benefit of feeding enzymes to poultry

Enzymes are substances having the potential to help in re-living, arising or elevating the kinetic reactive activities of chemical substances in the body of living beings (Altaf-ur-Rahman *et al.,* 2007). Enzymes could either be endogenous or exogenous. Endogenous enzymes are those that are produced within the body of the animal, they include proteases (trypsin, chymotrypsin and rennin) and amylase (Khattak *et al.,* 2006). Enzymes added to feed as supplement are referred to as exogenous enzymes (Classen, 1996). Examples of exogenous enzymes used in poultry nutrition include ß-glucanase, xylanase and other associated enzymes such as phytase, protease, lipase, and galactosidase (Khattak *et al.,* 2006). These enzymes come from microorganisms that are carefully selected for specific task and are grown under controlled conditions (Wallis, 1996).

Exogenous enzymes currently used in monogastric diets are predominantly glycanases, which cleave the non-starch polysaccharides into smaller polymers, thereby removing their ability to form viscous digesta hence, the improvement in nutrient digestibility (Wang *et al.,* 2005). Consequently, it was reported by Friesen *et al*. (1992) and Saleh *et al.* (2003) that the use of exogenous enzymes is of great importance to poultry nutrition as it helps to optimize performance and nutrient digestibility. Exogenous enzyme supplementation in the diet of poultry birds helps to improve production efficiency by increasing the ability of the bird to handle anti-nutrients present in feeds. Also it leads to an increase in the digestion of low quality feedstuffs and reduces nutrient loss through faeces. Exogenous enzymes are beneficial as they allow reduction in diet nutritional levels with likely economic advantages (Costa *et al*., 2008). Exogenous enzymes help to improve litter quality by reducing digestive content viscosity thereby allowing for efficient action on intestinal content. This however will lead to

improvement in nutrient digestion, increase in intestinal transit rate, water reduction in faeces and better litter quality (Opalinski, 2006). Oligosaccharides resulting from enzymatic degradation of non-starch polysaccharide are likely to have a pre-biotic effect at the cecae, thus acting as a substrate for proliferation of beneficial bacteria in the host animal thereby leading to better gut health (Persia *et al.,* 2002). Other advantages in feeding exogenous enzymes to poultry birds include improvement in weight gain and feed to gain ratio (Saleh *et al*., 2003), increased feed intake (Gracia *et al*., 2003) and reduction in beak impaction and vent plugging (Odetallah *et al.,* 2005).

### 2.9.3 Factors affecting the use of exogenous enzymes in broiler diet

Allen *et al*. (1995) reported that the physiology and type of gut micro flora present in poultry birds can affect the use of exogenous enzymes. Similarly, Choct *et al*. (1996) reported that factors such as type and amount of cereal in the diet, level of anti-nutrients present in the feedstuff and spectrum or concentration of exogenous enzymes used are factors to consider when feeding exogenous enzymes to poultry. Other factors to consider include the nature of animal (poultry birds tend to be more responsive to enzyme treatment than pigs) and the age of the animal (Friesen *et al*., 1992).

# CHAPTER THREE

## 3.0 MATERIALS AND METHODS

### 3.1 Experimental site

The research was conducted at the poultry unit of the National Animal Production Research Institute, Shika Zaria. It is located on latitude $11^{o}$ 12' 42'' N and $7^{o}$ 33'14''E at an altitude of 691m above sea level with rainfall ranging from 1102mm to 1904mm and mean temperature of about $31^{o}$C in the dry season and about $18^{o}$C in the wet season (Ovimaps, 2012).

### 3.2 Source of experimental birds

The birds used for the research were purchased from Zam hatchery located in Ibadan, south western Nigeria.

### 3.3 Source of stone grit and rice offal

Stone grit (granite) was obtained from a quarry in Zaria and was sieved to 2mm and 5mm sizes with the aid of a hand sieve. Rice offal was purchased from a commercial feed mill in Samaru Zaria.

### 3.4 Laboratory analysis

Laboratory analysis of blood samples was carried out at the Veterinary Teaching Hospital of Ahmadu Bello University, Zaria according to methods described by (Lamb) 1991 while proximate analysis of feed and faecal samples was carried out at the biochemistry laboratory of the National Animal Production Research Institute, Shika-Zaria according to the methods described by A.O.A.C. (1990).

## 3.5 Phase 1- Starter

### 3.5.1 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit (1-4weeks)

### 3.5.2 Experimental diet

A single diet was formulated for birds across all dietary treatments. The diet was formulated to meet their nutrient requirements according to the recommendation given by NRC (1994). The diet contained 10% rice offal at the starter phase (Table 3.1).

### 3.5.3 Design and management of birds

A total of three hundred and sixty (360) day old broiler chickens were used in this phase. They were brooded together in three pens from day old to one week of age to allow for adequate warmth and protection. At one week of age, the birds were allotted to six experimental treatments. Each treatment was replicated three times with twenty (20) birds per replicate in a completely randomized design. The birds were raised in a deep litter poultry house with feed and water provided *ad libitum* from 1-4weeks of age. The feed formulated contained rice offal at 10% inclusion level at the starter phase. Stone grit was obtained from a quarry in Samaru and sieved to 2mm size before being added extraneously to the diet. The stone grit (granite) was added at graded levels of 0.0g, 2.0g, 4.0g, 6.0g, 8.0g and 10.0g grams per bird per month for the six treatments respectively. Parameters measured included initial weight, final weight, feed intake and mortality records.

**Table 3.1: Composition of Experimental Diet for Broiler Starter (1-4weeks)**

| | Stone grit(g/b/mth) | | | | | |
|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 |
| Maize | 45.32 | 45.32 | 45.32 | 45.32 | 45.32 | 45.32 |
| Full fat soya | 19.60 | 19.60 | 19.60 | 19.60 | 19.60 | 19.60 |
| Groundnut cake | 14.63 | 14.63 | 14.63 | 14.63 | 14.63 | 14.63 |
| Rice offal | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Blood meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Fish meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Limestone | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Common salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |
| Calculated analysis | | | | | | |
| ME Kcal/kg | 2864 | 2864 | 2864 | 2864 | 2864 | 2864 |
| Crude protein (%) | 23.00 | 23.00 | 23.00 | 23.00 | 23.00 | 23.00 |
| Crude fibre (%) | 6.88 | 6.88 | 6.88 | 6.88 | 6.88 | 6.88 |
| Ether extract (%) | 6.90 | 6.90 | 6.90 | 6.90 | 6.90 | 6.90 |
| Available P. (%) | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 |
| Lysine (%) | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 |
| Methionine (%) | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Meth + cystine (%) | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Calcium (%) | 1.09 | 1.09 | 1.09 | 1.09 | 1.09 | 1.09 |
| Cost/kg diet (N) | 71.62 | 71.62 | 71.62 | 71.62 | 71.62 | 71.62 |

Biomix chick premix provide per kg of diet vit A, 10,000 i.u; vit D3, 2000 i.u; vit. E 23mg; vit K, 2.mg; calcium pantothenate, 7.5mg; B12, 0.015mg; folic acid, 0.75mg; choline chloride, 300mg; vit B1, 1.8mg; vit B2, 5mg; vit B6, 3mg; manganese, 40mg; iron, 20mg; zinc, 53.34mg; copper, 3mg; iodine, 1mg; cobalt, 0.2mg; selenium, 0.2mg; zinc, 30mg
g/b/mth= gram per bird per month

## 3.6 Finisher phase

### 3.6.1 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit (5-8weeks)

### 3.6.2 Experimental diet

A single diet was formulated for birds across all dietary treatments. The diet was formulated to meet their nutrient requirements according to the recommendation given by NRC (1994). The diet contained 15% rice offal at the finisher phase (Table 3.2).

### 3.6.3 Design and management of birds:

At the end of the starter phase the birds were pooled together and fed a common diet for one week after which they were randomized for the finisher phase (5-8weeks). A total of two hundred and seventy (270) finishing broiler birds were used in this phase. The birds were allotted to six experimental treatments. Each treatment was replicated three times with fifteen (15) birds per replicate in a completely randomized design. The feed formulated contained rice offal at 15% inclusion level at the finisher phase of the experiment. Stone grit (granite) was obtained from a quarry in Samaru and sieved to 5mm size before being added extraneously to the diet. The stone grit was added at graded levels of 0.0g, 2.0g, 4.0g, 6.0g, 8.0g and 10.0g grams per bird per month for the six treatments respectively. Feed and water were provided *ad libitum*. Parameters measured included initial weight, final weight, feed intake and mortality records.

**Table 3.2: Composition of Experimental Diet for Broiler Finisher (5-8weeks)**

| | Stone grit(g/b/mth) | | | | | |
|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 |
| Maize | 46.15 | 46.15 | 46.15 | 46.15 | 46.15 | 46.15 |
| Full fat soya | 22.90 | 22.90 | 22.90 | 22.90 | 22.90 | 22.90 |
| Rice offal | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 |
| Groundnut cake | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Fish meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Blood meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Palm oil | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Lime stone | 0.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Common salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |
| Calculated Analysis | | | | | | |
| ME Kcal/kg | 2923 | 2923 | 2923 | 2923 | 2923 | 2923 |
| Crude protein (%) | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| Crude fibre (%) | 8.39 | 8.39 | 8.39 | 8.39 | 8.39 | 8.39 |
| Ether extract (%) | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 |
| Available P. (%) | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| Lysine (%) | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Methionine (%) | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| Meth + cystine (%) | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| Calcium (%) | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 |
| Cost/kg diet (N) | 78.63 | 78.63 | 78.63 | 78.63 | 78.63 | 78.63 |

Biomix chick premix provide per kg of diet vit A, 10,000 i.u; vit D3, 2000 i.u; vit. E 23mg; vit K, 2.mg; calcium pantothenate, 7.5mg; B12, 0.015mg; folic acid, 0.75mg; choline chloride, 300mg; vit B1, 1.8mg; vit B2, 5mg; vit B6, 3mg; manganese, 40mg; iron, 20mg; zinc, 53.34mg; copper, 3mg; iodine, 1mg; cobalt, 0.2mg; selenium, 0.2mg; zinc, 30mg
g/b/mth= gram per bird per month

### 3.6.4 Evaluation of some selected parameters post the finisher phase

#### 3.6.4.1 Haematological evaluation

Two chickens were randomly selected from each replicate and 2mls of blood sample was collected from each of them via the wing vein and put into a sample bottle containing anti-coagulant Ethylene Di-amine tetra acetic acid (EDTA) and later analyzed for packed cell volume (PCV), Haemoglobin level (HB) and total protein (TP) at the haematological laboratory, Veterinary Teaching Hospital, Ahmadu Bello University, Zaria according to the methods described by Lamb (1991).

#### 3.6.4.2 Evaluation of carcass characteristics

This involved the selection of 2 chickens from each replicate. The weight of the selected birds was close to the mean weight of each replicate. Feed was withdrawn from the selected chickens while they were allowed access to water *ad libitum*. Their live weights were taken after which they were bled and their feathers were removed by scalding. The head, neck, shank, and viscera were removed to get the dressed weight. Dressing percentage was also calculated. Weight of the breast, thigh, wing and back were also taken. Also internal organs like the heart, kidney, liver and gizzard were weighed and expressed as percentages of the live weight.

#### 3.6.4.3 Digestibility study

Two chickens were randomly selected from each replicate. They were transferred to battery cages for faecal collection. Five days of acclimatization period was observed followed by a day of fasting before the commencement of the trial which lasted for seven days. Feed and water were provided *ad libitum*. Faecal samples collected were preserved in a deep freezer till the trial was over. Faecal samples were then oven dried at temperature of $60^{o}$C for 72hrs after which they

were weighed, ground and samples were taken to the laboratory for analysis according to A.O.A.C. (1990) methods. Nutrient retention was determined for crude protein, ether extract and crude fibre. Nitrogen free extract was also calculated from the result obtained for crude protein, ether extract and crude fibre.

$$\text{Digestibility coefficient (\%)} = \frac{\text{nutrient in feed x FI} - \text{nutrient in faeces x FO}}{\text{\% nutrient in feed x FI}}$$

Where FI =Feed intake (on dry matter basis)

FO = Faecal output (on dry matter basis)

## 3.7 Phase 2- Starter

### 3.7.1 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation (1-4weeks)

### 3.7.2 Experimental diet

A single diet was formulated for birds across all dietary treatments. The diet was formulated to meet their nutrient requirements according to the recommendation given by NRC (1994). It contained 10% rice offal at the starter phase with enzyme (maxigrain) supplemented at 0.01% (Table 3.3).

**Table 3.3: Composition of Experimental Diet for Broiler Starter with Enzyme Supplementation (1-4weeks)**

| | Stone grit(g/b/mth) | | | | | |
|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 |
| Maize | 45.22 | 45.22 | 45.22 | 45.22 | 45.22 | 45.22 |
| Full fat soya | 19.60 | 19.60 | 19.60 | 19.60 | 19.60 | 19.60 |
| Groundnut cake | 14.63 | 14.63 | 14.63 | 14.63 | 14.63 | 14.63 |
| Rice offal | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Blood meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Fish meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Limestone | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Common salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Enzyme | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |
| Calculated Analysis | | | | | | |
| ME Kcal/kg | 2860 | 2860 | 2860 | 2860 | 2860 | 2860 |
| Crude protein (%) | 23.00 | 23.00 | 23.00 | 23.00 | 23.00 | 23.00 |
| Crude fibre (%) | 6.88 | 6.88 | 6.88 | 6.88 | 6.88 | 6.88 |
| Ether extract (%) | 6.89 | 6.89 | 6.89 | 6.89 | 6.89 | 6.89 |
| Available P. (%) | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 |
| Lysine (%) | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 |
| Methionine (%) | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Meth + cystine (%) | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Calcium (%) | 1.09 | 1.09 | 1.09 | 1.09 | 1.09 | 1.09 |
| Cost/kg diet (N) | 81.75 | 81.75 | 81.75 | 81.75 | 81.75 | 81.75 |

Biomix chick premix provide per kg of diet vit A, 10,000 i.u; vit D3, 2000 i.u; vit. E 23mg; vit K, 2.mg; calcium pantothenate, 7.5mg; B12, 0.015mg; folic acid, 0.75mg; choline chloride, 300mg; vit B1, 1.8mg; vit B2, 5mg; vit B6, 3mg; manganese, 40mg; iron, 20mg; zinc, 53.34mg; copper, 3mg; iodine, 1mg; cobalt, 0.2mg; selenium, 0.2mg; zinc, 30mg
g/b/mth= gram per bird per month

### 3.7.3 Design and management of birds

A total of three hundred and twenty four (324) day old broiler birds were purchased for the purpose of this experiment. They were raised together in three pens from day old to one week of age to allow for adequate warmth and protection. At one week of age, the birds were allotted to six experimental treatments. Each treatment was replicated three times with eighteen (18) birds per replicate in a completely randomized design. The birds were raised in a deep litter poultry house with feed and water provided *ad libitum* from 1-4weeks of age. At the starter phase, the feed formulated contained rice offal at 10% inclusion level with supplemental enzyme (maxigrain) at 0.01%. Stone grit obtained from a quarry in Samaru and sieved to 2mm size was added extraneously to the diet at graded levels of 0.0g, 2.0g, 4.0g, 6.0g, 8.0g and 10.0 grams per bird per month for the six treatments respectively. All other routine management practices and medication were strictly observed. Parameters measured include initial body weight, final weight, feed intake and mortality records.

## 3.8 Finisher phase

### 3.8.1 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation (5-8weeks)

### 3.8.2 Experimental diet

A single diet was formulated for birds across all dietary treatments. The diet was formulated to meet their nutrient requirements according to the recommendation given by NRC (1994). The diet contained 15% rice offal at the finisher phase with 0.01% enzyme (maxigrain) supplementation (Table 3.4).

**Table 3.4: Composition of Experimental Diet for Broiler Finisher with Enzyme Supplementation (5-8weeks)**

| | Stone grit(g/b/mth) | | | | | |
|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 |
| Maize | 46.05 | 46.05 | 46.05 | 46.05 | 46.05 | 46.05 |
| Full fat soya | 22.90 | 22.90 | 22.90 | 22.90 | 22.90 | 22.90 |
| Rice offal | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 | 15.00 |
| Groundnut cake | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Fish meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Blood meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Palm oil | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Lime stone | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Common salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Enzyme | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |
| Calculated analysis | | | | | | |
| ME Kcal/kg | 2920 | 2920 | 2920 | 2920 | 2920 | 2920 |
| Crude protein (%) | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| Crude fibre (%) | 8.39 | 8.39 | 8.39 | 8.39 | 8.39 | 8.39 |
| Ether extract (%) | 8.51 | 8.51 | 8.51 | 8.51 | 8.51 | 8.51 |
| Available P. (%) | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| Lysine (%) | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Methionine (%) | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| Meth + cystine (%) | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| Calcium (%) | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 |
| Cost/kg diet (N) | 81.20 | 81.20 | 81.20 | 81.20 | 81.20 | 81.20 |

Biomix chick premix provide per kg of diet vit A, 10,000 i.u; vit D3, 2000 i.u; vit. E 23mg; vit K, 2.mg; calcium pantothenate, 7.5mg; B12, 0.015mg; folic acid, 0.75mg; choline chloride, 300mg; vit B1, 1.8mg; vit B2, 5mg; vit B6, 3mg; manganese, 40mg; iron, 20mg; zinc, 53.34mg; copper, 3mg; iodine, 1mg; cobalt, 0.2mg; selenium, 0.2mg; zinc, 30mg

### 3.8.3 Design and management of birds

At the end of the starter phase the birds were pooled together and fed a common diet for one week and then randomized for the finisher phase (5-8weeks). A total of two hundred and seventy (270) finishing broiler birds were used in this phase. The birds were allotted to six experimental treatments. Each treatment was replicated three times with fifteen (15) birds per replicate in a completely randomized design. The feed formulated contained rice offal at 15% inclusion level and enzyme (maxigrain) supplementation at 0.01%. Stone grit (granite) obtained from a quarry in Samaru and sieved to 5mm size was added extraneously to the diet at graded levels of 0.0g, 2.0g, 4.0g, 6.0g, 8.0g and 10.0g grams per bird per month for the six treatments respectively. Feed and water were provided *ad libitum*. Parameters measured were initial weight, final weight, feed intake and mortality records.

### 3.8.4 Evaluation of some selected parameters post the finisher phase

#### 3.8.4.1 Haematological evaluation

At the end of the finisher phase, two birds were randomly selected from each replicate and 2mls of blood sample was collected from each of them via the wing vein and put into a sample bottle containing anti-coagulant Ethylene Di-amine tetra acetic acid (EDTA) and later analyzed for packed cell volume (PCV), Haemoglobin level (HB) and total protein (TP) at the haematological laboratory, Veterinary Teaching Hospital, Ahmadu Bello University, Zaria according to the methods described by Lamb (1991).

#### 3.8.4.2 Evaluation of carcass characteristics

At the end of the finisher phase, evaluation of carcass characteristics was carried out. This involved the selection of 2 birds from each replicate. The weight of the selected birds was close to the mean weight of each replicate. The selected birds were fasted overnight but the supplied

water *ad libitum*. Their live weights were taken after which they were bled and their feather were removed by scalding. The head, neck, shank, and viscera were removed to get the dressed weight. Dressing percentage was also calculated. Weight of the breast, thigh, wing and back were also taken. Also internal organs like the heart, kidney, liver and gizzard were weighed and expressed as percentages of the live weight.

### 3.8.4.3 Digestibility study

At the end of the finisher phase, two birds were randomly selected from each replicate. They were transferred to battery cages for faecal collection. Five days of acclimatization period was observed followed by a day of fasting before the commencement of the trial which lasted for seven days. Feed and water were provided *ad libitum*. Faecal samples were collected and preserved in a deep freezer till the trial was over. They were then oven dried at temperature of $60^{o}$C for 72hrs after which they were weighed, ground and samples were taken to the laboratory for analysis according to A.O.A.C. (1990) methods. Nutrient retention was determined for crude protein, ether extract and crude fibre. Nitrogen free extract was also calculated from the result obtained for crude protein, ether extract and crude fibre.

$$\text{Digestibility coefficient (\%)} = \frac{\text{nutrient in feed x FI} - \text{nutrient in faeces x FO}}{\text{\% nutrient in feed x FI}}$$

Where FI =Feed intake (on dry matter basis)

FO = Faecal output (on dry matter basis)

### 3.9 Statistical analysis

Data obtained from all the experiments were subjected to analysis of variance using the general linear model procedure of SAS (1993). Significant treatment means were separated using Duncan's Multiple Range Test according to procedures described by Steel and Torrie (1980).

The data obtained was analyzed using the following model.

$Yij = u + a_i + e_{ij}$

Where=

$Y_{ij}$= individual observation

u= overall mean

$a_i$= effect of the $i^{th}$ stone grit on the feed (i= 0.0, 2.0, 4.0, 6.0, 8.0 and 10.0 gram per bird per month).

$e_{ij}$= random error

# CHAPTER FOUR

# 4.0 RESULTS

## 4.1 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit (starter)

Performance of broiler chicks fed graded levels of stone grit is presented in Table 4.1. Feed intake decreased as the levels of stone grit increased in the diet of the birds (0.0g-10.0g). Chicks on the control diet had the highest feed intake of 43.41g per bird per day. However this was comparable ($P>0.05$) to values of 41.28g and 40.38g observed for birds on the 2.0g and 4.0g stone grit. Birds fed 6.0g stone grit showed a significantly ($P<0.05$) lower feed intake of 39.84g compared to the first three levels of stone grit (0.0g, 2.0g and 4.0g). Feed intake for birds fed 8.0g and 10.0g stone grit did not differ significantly ($P>0.05$) from each other as they had the least values of 35.80g and 34.28g respectively.

Birds fed 4.0g, 6.0g, 8.0g and 10.0g stone grit showed no significant difference ($P>0.05$) in weight gain. However, birds fed 2.0g stone grit had a significantly ($P<0.05$) higher weight gain compared to birds without stone grit. Feed to gain ratio FCR and feed cost per kg gain improved with increasing grit levels across all levels of stone grit addition. Birds fed 8.0g and 10.0g stone grit did not differ significantly ($P>0.05$) from each other in values obtained for both FCR and feed cost per kg gain. Similarly birds fed 4.0g and 6.0g stone grit were comparable ($P>0.05$) to each other in both FCR and feed to gain ratio. It was observed that birds on the control diet (0.0g) stone grit gave the poorest result in FCR and feed cost per kg gain of 4.81 and 317.71 respectively as shown in Table 4.1. .

**Table 4.1: Effect of Graded Levels of Stone Grit on the Performance of Broiler Chickens Fed Rice Offal Based Diets (starter)**

| | Stone grit(g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Initial weight (g/b) | 79.16 | 79.20 | 79.16 | 79.20 | 79.23 | 79.16 | 0.04 |
| Final weight (g/b) | $331.79^{b}$ | $438.53^{a}$ | $468.13^{a}$ | $470.87^{a}$ | $472.20^{a}$ | $476.80^{a}$ | 11.30 |
| Weight gain (g/b/d) | $9.02^{c}$ | $12.73^{b}$ | $13.89^{a}$ | $13.99^{a}$ | $14.03^{a}$ | $14.20^{a}$ | 0.39 |
| Feed intake (g/b/d) | $43.41^{a}$ | $41.28^{a}$ | $40.38^{a}$ | $39.84^{b}$ | $35.80^{c}$ | $34.28^{c}$ | 1.62 |
| FCR | $4.81^{d}$ | $3.24^{c}$ | $2.90^{b}$ | $2.84^{ab}$ | $2.55^{a}$ | $2.41^{a}$ | 0.15 |
| Feed cost/bird(N) | $95.58^{c}$ | $90.90^{b}$ | $88.90^{b}$ | $87.71^{b}$ | $77.80^{a}$ | $75.47^{a}$ | 3.58 |
| Feed cost/kg gain(N) | $317.71^{d}$ | $254.81^{c}$ | $228.17^{b}$ | $223.80^{b}$ | $196.14^{a}$ | $189.75^{a}$ | 8.59 |
| Total cost/bird(N) | $483.87^{b}$ | $478.89^{a}$ | $480.90^{a}$ | $476.71^{a}$ | $476.19^{a}$ | $475.14^{a}$ | 3.37 |
| Mortality (%) | $8.77^{a}$ | $12.28^{b}$ | $12.28^{b}$ | $14.04^{c}$ | $8.77^{a}$ | $8.77^{a}$ | 1.62 |

Means with different superscript on the same row differ significantly ($P<0.05$)
SEM= Standard error of means, FCR= Feed Conversion Ratio, g/b/d= gram/bird/day, g.b/m=gram/bird/month

## 4.2 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit (finisher)

Performance of finishing broiler birds fed rice offal based diets with graded levels of stone grit is presented in Table 4.2. Feed intake significantly ($P<0.05$) decreased with increasing levels of stone grit. Birds fed 8.0g and 10.0g stone grit showed the least values of 70.25g per bird per day and 71.46g per bird per day respectively. Birds fed 6.0g stone grit ate less feed compared to birds fed 4.0g stone grit. Feed intake for birds fed 2.0g stone grit was also lower than the control. Results of body weight gain showed that a significant difference ($P<0.05$) existed across the graded levels of stone grit. Birds fed 8.0g and 10.0g stone grit had the highest weight gain, though they did not differ significantly ($P>0.05$) from each other. Birds fed 6.0g stone grit showed higher weight gain ($P<0.05$) compared to birds fed 4.0g and 2.0g stone grit. Birds on the control diet had the least result in weight gain.

FCR and feed cost per kg gain improved significantly ($P<0.05$) with increasing stone grit levels in the diet. Birds fed 8.0g and 10.0g stone grit showed comparable results ($P>0.05$) in both FCR and feed cost per kg gain followed by birds fed 6.0g stone grit. Birds fed 4.0g stone grit showed better performance in FCR and feed cost per kg gain compared to those fed 2.0g grit level. It was observed that birds without grit supply showed the poorest performance. Mortality records showed that the least mortality was observed for birds fed 6.0g and 8.0g stone grit. However all other levels of dietary grit supply showed comparable ($P>0.05$) results in mortality.

**Table 4.2: Effect of Graded Levels of Stone Grit on the Performance of Broiler Chickens Fed Rice Offal based Diets (finisher)**

| | Stone grit(g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Initial weight (g/b) | 620.20 | 620.23 | 620.20 | 620.16 | 620.20 | 620.20 | 0.04 |
| Final weight (g/b) | $1552.37^{d}$ | $1966.75^{c}$ | $2026.68^{c}$ | $2233.50^{b}$ | $2383.47^{a}$ | $2400.00^{a}$ | 22.33 |
| Weight gain (g/b/d) | $33.29^{d}$ | $48.09^{c}$ | $50.23^{c}$ | $57.62^{b}$ | $62.97^{a}$ | $63.56^{a}$ | 0.79 |
| Feed intake (g/b/d) | $126.63^{a}$ | $106.80^{b}$ | $98.42^{c}$ | $85.47^{d}$ | $70.25^{e}$ | $71.46^{e}$ | 1.38 |
| FCR | $3.80^{e}$ | $2.22^{d}$ | $1.96^{c}$ | $1.49^{b}$ | $1.12^{a}$ | $1.12^{a}$ | 0.04 |
| Feed cost/bird(N) | $289.85^{e}$ | $244.47^{d}$ | $225.28^{c}$ | $195.64^{b}$ | $160.80^{a}$ | $163.57^{a}$ | 3.17 |
| Feed cost/kg gain(N | $310.99^{e}$ | $181.65^{d}$ | $160.45^{c}$ | $121.45^{b}$ | $91.19^{a}$ | $91.90^{a}$ | 2.98 |
| Total Cost/bird(N) | 595.44 | 593.18 | 592.49 | 575.54 | 574.29 | 570.10 | 8.85 |
| Mortality (%) | $2.22^{b}$ | $2.22^{b}$ | $4.45^{b}$ | $0.00^{a}$ | $0.00^{a}$ | $2.22^{b}$ | 1.28 |

Means with different superscript on the same row differ significantly ($P<0.05$)
SEM= Standard error of means, FCR= Feed Conversion Ratio, g/b/d=gram/bird/day, g/b/m=gram/bird/month

## 4.3 Haematological Parameters of Finishing Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit

Table 4.3 shows the haematological parameters of broiler birds fed rice offal based diets. Packed cell volume (PCV) and haemoglobin level (Hb) did not show any significant difference ($P>0.05$) across the graded levels of stone grit. Result obtained for total protein showed that it was significantly ($P<0.05$) affected by dietary grit addition. It was observed that birds without stone grit and those fed 2.0g and 4.0g stone grit showed similar results in total protein and were significantly ($P<0.05$) lower than values obtained for birds fed 6.0g, 8.0g and 10.0g dietary stone grit. Birds fed 6.0g, 8.0g and 10.0g stone grit showed similar ($P>0.05$) result in total protein.

**Table 4.3: Haematological Parameters for Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit**

| | Stone grit(g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Packed cell volume (%) | 30.69 | 30.66 | 30.68 | 30.70 | 32.00 | 32.33 | 1.52 |
| Haemoglobin level (g/dl) | 9.50 | 9.73 | 9.97 | 9.97 | 9.80 | 9.98 | 0.41 |
| Total protein (g/dl) | $3.73^{b}$ | $3.87^{b}$ | $3.93^{b}$ | $4.20^{a}$ | $4.33^{a}$ | $4.40^{a}$ | 0.15 |

Means with different superscript on the same row differ significantly ($P<0.05$) SEM= Standard error of mean

## 4.4 Nutrient Digestibility of Broiler Birds fed Rice Offal Based Diets with Graded Levels of Stone Grit

Nutrient retention of broiler birds fed rice offal based diets with graded levels of stone grit is presented in Table 4.4. Results obtained showed that no significant difference (P>0.05) was observed in ether extract across the graded levels of stone grit. A significant difference was observed in crude fibre retention. Birds fed 8.0g and 10.0g stone grit showed the best result in crude fibre retention. Similarly, birds fed 2.0g, 4.0g and 6.0g stone grit showed comparable (P>0.05) results which was better than the control diet (0.0g) stone grit. Birds without stone grit and those fed 2.0g and 4.0g stone grit showed comparable results in nitrogen free extract and crude protein retention. Birds fed 6.0g, 8.0g and 10.0g stone grit did not differ significantly (P>0.05) from each other in nitrogen free extract and crude protein retention. It was observed that birds fed 6.0g, 8.0g and 10.0g stone grit gave the best result in dry matter, crude protein and nitrogen free extract retention.

**Table 4.4**: **Nutrient Digestibility of Broiler Birds fed Rice Offal Based Diets with Graded Levels of Stone Grit**

| | Stone grit (g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Dry matter | 57.11[c] | 56.84[c] | 60.54[b] | 61.31[a] | 64.50[a] | 64.94[a] | 2.20 |
| Crude protein | 76.66[b] | 76.32[b] | 76.67[b] | 78.04[a] | 79.02[a] | 80.11[a] | 1.27 |
| Crude fibre | 63.90[c] | 64.20[b] | 66.20[b] | 66.91[b] | 68.40[a] | 68.90[a] | 2.00 |
| Ether extract | 79.47 | 80.99 | 79.42 | 81.32 | 80.01 | 78.41 | 2.74 |
| Nitrogen free extract | 65.33[b] | 65.56[b] | 64.40[b] | 70.91[a] | 71.82[a] | 72.90[a] | 1.80 |

Means with different superscript on the same row differ significantly ($P<0.05$) SEM= Standard error of means

## 4.5 Carcass Characteristics of Finishing Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit

Table 4.5 shows the result of carcass characteristics of finishing broiler birds fed graded levels of stone grit. All parameters measured were expressed as percentages of the live weight. The live weight, dressed weight and dressing percentage were significantly ($P<0.05$) affected by graded levels of stone grit. Also stone grit significantly ($P<0.05$) increased eviscerated body parts such as breast, thigh and back. A significant difference ($P<0.05$) was observed in gizzard measurement across all levels of stone grit addition. Birds fed 10.0g stone grit had the highest gizzard weight followed closely by birds fed 6.0g and 8.0g stone grit. Birds fed 2.0g and 4.0g stone grit showed similar results ($P>0.05$) while the control diet was the least. Internal organs such as liver and heart were not significantly ($P>0.05$) affected by stone grit addition. Birds fed 2.0g-10.0g stone grit did not show any significant difference ($P>0.05$) in dressing percentage, however they performed better than the control. Other parameters measured such as neck, head, wing and intestine were not significantly ($P>0.05$) affected by the graded levels of stone grit.

**Table 4.5: Carcass Characteristics of Finishing Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit**

| | Stone grit(g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Live weight (g) | 1350.00$^{d}$ | 1366.70$^{d}$ | 1483.30$^{b}$ | 1433.30$^{c}$ | 1466.70$^{b}$ | 1516.70$^{a}$ | 10.02 |
| Slaughter wt.(g) | 1190.30$^{c}$ | 1300.00$^{b}$ | 1393.30$^{b}$ | 1309.30$^{b}$ | 1423.30$^{a}$ | 1420.00$^{a}$ | 0.21 |
| Defeathered wt. | 1150.00$^{d}$ | 1150.00$^{d}$ | 1333.30$^{b}$ | 1256.70$^{c}$ | 1316.70$^{b}$ | 1366.70$^{a}$ | 0.03 |
| Dressed wt. (g) | 750.30$^{e}$ | 865.70$^{d}$ | 930.40$^{b}$ | 916.42$^{c}$ | 916.70$^{c}$ | 965.00$^{a}$ | 0.22 |
| Dressing (%) | 60.02$^{b}$ | 63.34$^{a}$ | 62.73$^{a}$ | 63.93$^{a}$ | 62.50$^{a}$ | 63.62$^{a}$ | 1.79 |
| Breast (%) | 14.03$^{b}$ | 14.07$^{b}$ | 16.75$^{a}$ | 16.83$^{a}$ | 16.61$^{a}$ | 16.85$^{a}$ | 1.07 |
| Thigh (%) | 17.03$^{b}$ | 17.02$^{b}$ | 17.03$^{b}$ | 18.05$^{b}$ | 18.84$^{a}$ | 20.23$^{a}$ | 0.87 |
| Back (%) | 15.79$^{c}$ | 16.25$^{b}$ | 17.36$^{a}$ | 16.78$^{a}$ | 17.87$^{a}$ | 17.35$^{a}$ | 0.59 |
| Wing (%) | 7.75 | 7.84 | 8.42 | 8.08 | 7.79 | 8.03 | 0.17 |
| Shank (%) | 3.42$^{b}$ | 3.63$^{b}$ | 4.23$^{a}$ | 4.63$^{a}$ | 4.60$^{a}$ | 4.62$^{a}$ | 0.21 |
| Neck (%) | 4.60 | 4.11 | 4.12 | 4.81 | 5.00 | 5.44 | 0.40 |
| Head (%) | 2.89 | 3.15 | 2.89 | 2.67 | 2.78 | 2.75 | 0.15 |
| Gizzard (%) | 2.35$^{d}$ | 3.50$^{c}$ | 3.10$^{c}$ | 4.69$^{b}$ | 4.85$^{b}$ | 5.57$^{a}$ | 0.24 |
| Heart (%) | 0.67 | 0.66 | 0.69 | 0.68 | 0.65 | 0.66 | 0.03 |
| Liver (%) | 2.49 | 2.28 | 2.64 | 2.92 | 2.42 | 2.54 | 0.13 |
| Intestine full(%) | 7.60 | 6.75 | 6.69 | 6.86 | 7.18 | 6.66 | 0.34 |
| Intestine empty | 5.32 | 4.42 | 4.39 | 4.74 | 4.52 | 4.84 | 0.32 |
| Intestine lt.(cm) | 13.55 | 13.00 | 13.80 | 13.56 | 13.78 | 13.70 | 0.91 |

Means with different superscript on the same row differ significantly ($P<0.05$) SEM= Standard error of means, Wt= weight, Lt= Length

## 4.6 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation (starter)

Performance of broiler chicks fed rice offal based diets with graded levels of stone grit and enzyme supplementation is presented in Table 4.6. There was a significant decrease ($P<0.05$) in feed intake across the graded levels of stone grit. Birds without stone grit had the highest feed intake of 66.88g per bird per day followed by birds fed 2.0g stone grit with feed intake of 58.22g per bird per day. Birds fed 4.0g and 6.0g stone grit showed similar results ($P>0.05$) in feed intake while feed intake was least for birds fed 8.0g and 10.0g stone grit. Weight gain significantly increased ($P<0.05$) with increasing stone grit levels. Birds fed 6.0g, 8.0g and 10.0g stone grit showed comparable ($P>0.05$) results in weight gain. Also birds on 2.0g and 4.0g stone grit had higher weight gain compared to birds on the control diet. However birds without grit supply had the least weight gain.

Feed conversion ratio FCR and feed cost per kg gain improved with increasing stone grit levels. Birds fed 10.0g stone grit gave the best result in FCR followed by birds fed 8.0g grit. It was observed that birds on the 6.0g stone grit showed a better result in FCR compared to birds fed 4.0g and 2.0g stone grit. The least performance in FCR was observed for birds without dietary stone grit. It was observed that birds fed 10.0g stone grit showed the best result in feed cost per kg gain followed by birds fed 6.0g and 8.0g stone grit which showed comparable ($P>0.05$) results to each other. Similarly birds fed 4.0g stone grit showed a better result compared to birds fed 2.0g dietary stone grit. The control diet showed the poorest result in feed cost per kg gain.

**Table 4.6: Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation (starter)**

| | Stone grit(g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Initial weight (g/b) | 75.01 | 75.02 | 75.02 | 75.01 | 75.02 | 75.01 | 0.01 |
| Final weight (g/b) | $623.54^{c}$ | $676.89^{b}$ | $690.62^{b}$ | $723.76^{a}$ | $727.48^{a}$ | $740.11^{a}$ | 8.29 |
| Weight gain (g/b/d) | $26.12^{c}$ | $28.66^{b}$ | $29.13^{b}$ | $30.89^{a}$ | $31.07^{a}$ | $32.96^{a}$ | 1.04 |
| Feed intake (g/b/d) | $66.88^{a}$ | $58.22^{b}$ | $50.86^{c}$ | $48.58^{c}$ | $45.61^{dc}$ | $40.47^{d}$ | 1.99 |
| FCR | $2.56^{f}$ | $2.03^{e}$ | $1.74^{d}$ | $1.57^{c}$ | $1.47^{b}$ | $1.23^{a}$ | 0.06 |
| Feed cost/bird(N) | $110.45^{e}$ | $96.15^{d}$ | $84.00^{c}$ | $80.23^{c}$ | $75.32^{b}$ | $66.48^{a}$ | 3.30 |
| Feed cost/kg gain( | $201.06^{e}$ | $159.60^{d}$ | $136.48^{c}$ | $123.71^{b}$ | $115.68^{b}$ | $96.63^{a}$ | 4.56 |
| Total Cost/bird(N) | $484.56^{b}$ | $482.32^{b}$ | $481.81^{a}$ | $470.80^{a}$ | $455.80^{a}$ | $452.15^{a}$ | 9.84 |
| Mortality (%) | $3.51^{b}$ | $5.26^{c}$ | $5.26^{c}$ | $8.77^{c}$ | $0.00^{a}$ | $3.51^{b}$ | 2.32 |

Means with different superscript on the same row differ significantly ($P<0.05$) SEM= Standard error of means, FCR= Feed Conversion Ratio, g/b/d=gram/bird/day, g/b/m=gram/bird/month

## 4.7 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation (finisher)

Table 4.7 shows the performance of finishing broiler birds fed rice offal based diets with graded levels of stone grit and enzyme supplementation. Feed intake decreased significantly ($P<0.05$) with increasing levels of stone grit. Birds fed 2.0g stone grit had the highest feed intake of 121.29g per bird per day followed closely by those on the control diet 115.39g per bird per day. Birds fed 4.0g and 6.0g stone grit showed similar results in feed intake with values of 105.06g per bird per day and 103.52g per bird per day respectively. It was observed that birds fed 8.0g and 10.0g stone grit showed the least values of feed intake and were comparable ($P>0.05$) to each other.

It was observed that weight gain increased across the graded levels of stone grit. Birds fed 6.0g, 8.0g and 10.0g stone grit showed comparable ($P>0.05$) results of 59.69g per bird per day, 62.26g per bird per day and 63.88g per bird per day respectively. Birds fed 2.0g stone grit and birds on the control diet showed similar results in weight gain. It was observed that birds fed 4.0g stone grit showed a significantly ($P<0.05$) higher weight gain compared to birds fed 2.0g grit. A significant ($P<0.05$) improvement was observed in feed conversion ratio (FCR) with increasing stone grit levels. No significant difference was observed in FCR between birds fed 8.0g and 10.0g stone grit, however they gave the best result. Birds fed 6.0g stone grit showed a better result in FCR compared to birds fed 4.0g. Birds on the control diet and 2.0g stone grit showed the poorest result. Mortality records showed that birds fed 2.0g dietary stone grit had the highest mortality while birds on the control diet, birds fed 6.0g and 10.0g stone grit showed comparable ($P>0.05$) results. The least mortality was recorded for birds fed 4.0g and 8.0g stone grit.

**Table 4.7: Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation (finisher)**

| | Stone grit(g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Initial weight (g/b) | 900.03 | 900.01 | 900.02 | 900.02 | 900.02 | 900.02 | 0.01 |
| Final weight (g/b) | 1966.90$^{b}$ | 1980.40$^{b}$ | 2126.80$^{b}$ | 2487.20$^{a}$ | 2643.40$^{a}$ | 2688.70$^{a}$ | 59.32 |
| Weight gain (g/b/d) | 37.11$^{c}$ | 38.59$^{c}$ | 43.81$^{b}$ | 59.69$^{a}$ | 62.26$^{a}$ | 63.88$^{a}$ | 2.12 |
| Feed intake (g/b/d) | 115.39$^{ab}$ | 121.29$^{a}$ | 105.06$^{b}$ | 103.52$^{b}$ | 89.07$^{c}$ | 88.51$^{c}$ | 2.56 |
| FCR | 3.03$^{d}$ | 3.15$^{d}$ | 2.39$^{c}$ | 1.86$^{b}$ | 1.43$^{a}$ | 1.39$^{a}$ | 0.08 |
| Feed cost/bird(N) | 264.14$^{c}$ | 277.62$^{c}$ | 240.47$^{b}$ | 236.96$^{b}$ | 203.89$^{a}$ | 202.59$^{a}$ | 5.86 |
| Feed cost/kg gain(N | 247.50$^{d}$ | 257.20$^{d}$ | 196.02$^{c}$ | 151.66$^{b}$ | 117.21$^{a}$ | 122.71$^{a}$ | 6.68 |
| Total Cost/bird(N) | 585.11 | 589.82 | 583.05 | 590.15 | 589.82 | 578.92 | 3.95 |
| Mortality (%) | 2.38$^{b}$ | 9.89$^{c}$ | 0.00$^{a}$ | 2.38$^{b}$ | 0.00$^{a}$ | 5.13$^{b}$ | 1.94 |

a,b,c,d,e= Means with different superscript on the same row differ significantly (P<0.05) SEM= Standard error of means, FCR= Feed Conversion Ratio, g/b/d=gram/bird/day, g/b/m=gram/bird/month

## 4.8 Haematological Parameters of Finishing Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation

Table 4.8 shows the effect of graded levels of stone grit and enzyme supplementation on the haematological parameters of broiler birds fed rice offal based diets. No significant difference ($P>0.05$) was observed in packed cell volume (PCV), haemoglobin count (Hb) and total protein (TP) across the graded levels of stone grit.

**Table 4.8: Haematological Parameters of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation**

| | Stone grit(g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Packed cell volume (%) | 30.66 | 30.65 | 30.67 | 30.65 | 30.67 | 30.68 | 0.49 |
| Haemoglobin level (g/dl) | 9.48 | 9.79 | 9.49 | 9.58 | 9.59 | 9.55 | 0.41 |
| Total protein (g/dl) | 4.20 | 4.22 | 4.21 | 4.25 | 4.27 | 4.30 | 0.19 |

Means with different superscript on the same row differ significantly ($P<0.05$) SEM= Standard error of mean

## 4.9 Digestibility of Nutrients by Broiler Birds fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation

Table 4.9 shows the nutrient retention of broiler birds fed rice offal based diets with graded levels of stone grit and enzyme supplementation. Dietary stone grit did not significantly affect ($P>0.05$) nitrogen free extract and crude fibre retention. Crude protein retention did not differ significantly ($P>0.05$) for birds fed 2.0g and 4.0g stone grit, however they showed a better nutrient retention compared to birds on the control diet (0.0g grit). Similarly, birds fed 6.0g, 8.0g and 10.0g stone grit showed the best result in crude protein retention with values that were comparable ($P>0.05$) to each other. Results obtained for ether extract showed that birds fed 8.0g and 10.0g stone grit had the best result and they were comparable ($P>0.05$) to each other.

This was followed closely by birds fed 2.0g, 4.0g and 6.0g stone grit which showed values that were comparable ($P>0.05$) to each other. It was observed that birds on the control diet gave the poorest result in ether extract retention.

**Table 4.9: Nutrient Digestibility of Broiler Birds fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation**

| | Stone Grit(g/b/m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Dry matter | 73.23$^{b}$ | 75.07$^{b}$ | 74.09$^{b}$ | 74.39$^{b}$ | 77.59$^{a}$ | 77.22$^{a}$ | 0.98 |
| Crude protein | 62.96$^{c}$ | 65.91$^{b}$ | 66.35$^{b}$ | 69.17$^{a}$ | 72.10$^{a}$ | 73.12$^{a}$ | 2.57 |
| Crude fibre | 72.51 | 72.54 | 72.96 | 73.94 | 74.99 | 73.97 | 2.11 |
| Ether extract | 89.22$^{c}$ | 91.13$^{b}$ | 91.65$^{b}$ | 91.75$^{b}$ | 93.27$^{a}$ | 94.72$^{a}$ | 0.99 |
| Nitrogen free extract | 71.33 | 70.56 | 70.40 | 70.91 | 71.82 | 72.90 | 1.80 |

Means with different superscript on the same row differ significantly ($P<0.05$) SEM= Standard error of means

## 4.10 Carcass Characteristics of Finishing Broilers Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation

Table 4.10 shows the carcass characteristics of finishing broiler birds fed rice offal based diets with graded levels of stone grit and enzyme supplementation. Parameters measured were expressed as percentages of the live weight. The live weight, dressed weight, dressing percentage, gizzard, back, wing and thigh measurements were significantly ($P<0.05$) affected by dietary stone grit. Dressing percentage gradually increased across the graded levels of stone grit with birds fed 6.0g, 8.0g and 10.0g stone grit showing the best result. No significant difference was observed in dressing percentage between birds fed the control diet, birds fed 2.0g and 4.0g stone grit. Also no significant difference ($P>0.05$) was observed in measurement of internal organs such as liver and heart across all the graded levels of stone grit thus giving an indication that stone grit and enzyme supplementation is not of adverse effect to the health of broiler birds. Gizzard measurement increased significantly ($P<0.05$) with increasing stone grit level. Birds fed 10.0g dietary grit had the highest gizzard weight while birds fed 4.0g, 6.0g and 8.0g stone grit showed comparable ($P>0.05$) results. Birds fed diets without stone grit showed the least value in gizzard weight. Other measurements such as shank, neck, head and intestine were not significantly ($P>0.05$) affected by dietary stone grit.

**Table 4.10: Carcass Characteristics of Finishing Broilers Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation**

| | Stone grit(g/b/m | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | SEM |
| Live wt. (g) | 1816.70$^{b}$ | 1950.00$^{a}$ | 1850.00$^{b}$ | 1983.30$^{a}$ | 2050.00$^{a}$ | 2083.30$^{a}$ | 78.19 |
| Slaughter wt.(g) | 1733.30$^{b}$ | 1850.00$^{a}$ | 1766.70$^{b}$ | 1916.70$^{a}$ | 1983.30$^{a}$ | 1983.30$^{a}$ | 73.93 |
| Defeathered wt. | 1666.70$^{c}$ | 1783.30$^{b}$ | 1646.70$^{c}$ | 1833.30$^{a}$ | 1867.30$^{a}$ | 1920.30$^{a}$ | 64.02 |
| Dressed wt.(g) | 1466.70$^{d}$ | 1581.30$^{c}$ | 1442.80$^{d}$ | 1627.00$^{b}$ | 1762.15$^{a}$ | 1791.10$^{a}$ | 56.53 |
| Dressing (%) | 80.73$^{b}$ | 81.09$^{b}$ | 77.99$^{b}$ | 82.66$^{a}$ | 85.96$^{a}$ | 85.97$^{a}$ | 1.66 |
| Breast (%) | 15.83 | 15.94 | 15.99 | 16.72 | 18.31 | 18.95 | 0.80 |
| Thigh (%) | 17.00$^{c}$ | 18.84$^{b}$ | 18.05$^{b}$ | 20.84$^{a}$ | 20.23$^{a}$ | 21.84$^{a}$ | 0.87 |
| Back (%) | 16.26$^{b}$ | 17.36$^{a}$ | 14.70$^{c}$ | 16.78$^{a}$ | 17.35$^{a}$ | 17.87$^{a}$ | 0.59 |
| Wing (%) | 8.14$^{b}$ | 7.79$^{b}$ | 8.08$^{b}$ | 9.58$^{a}$ | 8.42$^{b}$ | 9.94$^{a}$ | 0.18 |
| Shank (%) | 3.33 | 3.69 | 3.54 | 3.55 | 3.49 | 3.73 | 0.22 |
| Neck (%) | 4.60 | 5.00 | 4.92 | 5.01 | 4.12 | 4.29 | 0.45 |
| Head (%) | 2.53 | 2.48 | 2.31 | 2.34 | 2.42 | 2.43 | 0.08 |
| Gizzard (%) | 1.87$^{d}$ | 2.29$^{c}$ | 2.54$^{b}$ | 2.52$^{b}$ | 2.67$^{b}$ | 3.29$^{a}$ | 0.19 |
| Heart (%) | 0.66 | 0.65 | 0.68 | 0.66 | 0.69 | 0.67 | 0.03 |
| Liver (%) | 2.51 | 1.72 | 1.98 | 2.19 | 2.54 | 2.06 | 0.23 |
| Intestine full(%) | 4.12 | 4.29 | 4.28 | 4.33 | 4.60 | 4.78 | 0.29 |
| Int. empty (%) | 3.00$^{b}$ | 2.56$^{b}$ | 4.54$^{b}$ | 2.49$^{b}$ | 2.77$^{b}$ | 4.60$^{a}$ | 0.14 |
| Intestine lt. (cm) | 9.86 | 10.29 | 10.83 | 10.23 | 10.18 | 10.96 | 0.37 |

a,b,c= Means with different superscript on the same row differ significantly ($P<0.05$) SEM= Standard error of means, Wt= weight, Lt= Length,

# CHAPTER FIVE

## 5.0 DISCUSSION

### 5.1 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit (starter)

The gradual decrease in feed consumption with increasing stone grit levels as observed in the starter phase of this experiment implied that, addition of stone grit to the diet of broiler birds significantly ($P<0.05$) improved feed utilization with consequent reduction in feed intake. This is in consonance with the report of Adeniji (2009) who observed a decrease in feed consumption as dietary grit level increased. Similarly, Waugh *et al*. (2006) reported that young ostriches that had no access to grit had higher feed intake than those that had access to grit. However, this negates the report of Abeke *et al.* (2010) who observed an increase in feed intake when stone grit was fed to pullet birds.

A possible reason for the higher weight gain observed for birds fed stone grit (2.0g-10.0g) could be as a result of improved feed utilization as more nutrients were extracted from the feed due to the grinding effect of stone grit in the gizzard. This agrees with the report of Atteh (2003) who observed that feed utilization improves when poultry birds are fed with diets containing granite grit. Feed to gain ratio FCR and feed cost per kg gain improved with increasing stone grit levels thus indicating that stone grit was influential in nutrient extraction from the feed vis a vis the improvement in both parameters. Birds fed 10.0g grit showed the best result in FCR thus implying that better feed utilization was achieved at this level of inclusion compared to other levels. This agrees with the report of Adeniji and Oyeleke (2008) who observed significant ($P<0.05$) improvement in both FCR and feed cost per kg gain when granite grit was fed to pullet

birds. Though a few mortalities were recorded in the experiment, it was not attributed to the effect of stone grit as it does not contain any toxic substance. This is consistent with the report of Ali *et al.* (2006) who reported that grit addition to the diet of broiler birds is not detrimental to their health.

## 5.2 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit (finisher)

The gradual decrease in feed intake with increasing stone grit levels showed that digestion was thorough hence more nutrients were extracted from the feed, consequently they ate less. However, birds on the control diet had the highest feed intake indicating that feed utilization was poor, and so they had to eat more feed to compensate for nutrients required. Gionfriddo and Best (1995) reported that grit addition to the diet of birds help to stimulate the secretion of digestive enzymes which aid to facilitate digestion. According to Ryan (2002) this means that ingested feed will be efficiently digested and body nutrient requirements will be met.

Result of weight gain showed that a significant ($P<0.05$) increase was observed for grit fed birds up to 10.0g per bird per month thus indicating efficient feed utilization as the birds were able meet their nutrient requirements, hence the increase in weight gain. This is consistent with the findings of Heuser (1958), Balloun (1959), Kennard and Chamberlain (1959) and Oluyemi *et al*. (1978) who reported that weight gain improved significantly with increasing grit levels. More recently were the reports of Jones and Tailor (1999), Waugh *et al*. (2006), Teresa *et al.* (2009) and Abeke *et al*. (2010) who observed a significant increase ($P<0.05$) in weight gain when poultry birds were fed diets containing granite grit. FCR and feed cost per kg gain improved significantly ($P<0.05$) with increasing stone grit levels in the diet. Result obtained for feed cost per kg gain showed that with increasing levels of stone grit in the diet of broiler birds the

quantity of feed consumed vis a vis the cost of feed required to put on the desired weight gain decreased. Result of feed cost per kg gain also showed that there was savings in cost of feed as the amount of stone grit increased in the diets. Mortality records obtained in this study was not attributed to the effect of stone grit as stone grit does not contain any toxic substance.

## 5.3 Haematological Parameters of Finishing Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit

Dietary treatments showed no significant difference ($P>0.05$) in the packed cell volume (PCV) and haemoglobin level (Hb). Indicating that stone grit had no direct influence on the amount of packed cell volume or haemoglobin count in the blood. However the values obtained for PCV were within the range of 33.55±2.90% for healthy chickens as reported by Abeke *et al.* (2008). Similarly, values obtained for haemoglobin level were within the range for healthy birds 11.30±1.82g/dl as reported by Oladele and Ayo (1999).

Values of total protein obtained for birds fed 6.0g, 8.0g and 10.0g stone grit were 4.20g/dl, 4.33g/dl and 4.40g/dl respectively. These values are within the range of 4.68-5.27g/dl±0.48 for healthy birds as reported by Oladele and Ayo (1999). Birds fed diets without stone grit, birds fed 2.0g stone grit and birds fed 4.0g stone grit had values of total protein as 3.73g/dl, 3.87g/dl and 3.93g/dl respectively. However, these values did not fall within the range for healthy birds.

## 5.4 Digestibility of Nutrients by Broiler Birds fed Rice Offal Based Diets with Graded Levels of Stone Grit

From the results obtained, ether extract was not affected by dietary stone grit however crude protein, crude fibre and nitrogen free extract were significantly ($P<0.05$) affected. The higher values obtained in crude protein, dry matter and nitrogen free extract for birds fed 6.0g, 8.0g and

10.0g stone grit could be an indication that the presence of stone grit in the diet of the birds was responsible for the improved digestibility vis a vis the higher weight gain recorded. This agrees with the report of Moore (1998) who reported that grit facilitates the physical breakdown of feed materials in the gizzard, thus influencing digestibility. Result obtained for nutrient retention showed that the simple addition of stone grit at little or no extra cost will result in an improved performance as evident in the crude protein, crude fibre, dry matter and nitrogen free extract retention by birds fed 6.0g, 8.0g and 10.0g stone grit. This supports the report of Rowland *et al.* (1980) who observed that nutrient retention improved with the incorporation of stone grit in diet of broiler birds. Similarly Adeniji (2009) reported similar observation when pullet birds were fed palm kernel cake with addition of stone grit.

## 5.5 Carcass Characteristics of Finishing Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit

Dressing percentage and eviscerated body parts such as breast, thigh and back improved significantly ($P<0.05$) with increasing stone grit levels thus indicating that stone grit was influential in improving prime cut characteristics. The observed increase in vital body parts such as the breast, thigh and back is contrary to the report of Ali *et al.* (2006) who observed no significant improvement ($P>0.05$) in eviscerated body parts of grit fed birds. Internal organs such as liver and heart were not affected ($P>0.05$) by dietary stone grit because, stone grit does not contain any toxic substance and as such it did not pose any adverse effect to the health of the birds. Other measurements such as neck, head, wing and intestine were not significantly ($P>0.05$) affected by graded levels of stone grit. It was observed that the gizzard size increased significantly ($P<0.05$) across all graded levels of stone grit. The gradual increase in gizzard size

with increasing levels of stone grit was due to increased grinding activity induced by the grit. This agrees with the reports of Moore (1998), Yildiz *et al*. (2001) and Ali *et al.* (2006).

### 5.6 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation (starter)

It was observed that feed intake significantly ($P<0.05$) decreased with increasing levels of stone grit. This implied that digestion improved and more nutrients were extracted from the feed to meet the birds requirement, consequently they ate less feed. This is similar to the report of Waugh *et al*. (2006) who observed that young ostriches that had no access to grit had higher feed intake than those that had access to grit. However, this negates the report of Abeke *et al.* (2010) who observed an increase in feed intake when stone grit was fed to pullet birds.

Results of weight gain showed that birds fed graded levels of stone grit had a significantly ($P<0.05$) higher weight gain compared to birds on the control diet. This implied that the abrasive effect of stone grit in the gizzard improved digestion and nutrient assimilation, hence the increase in weight gain. Atteh and Dare (2000) reported that increasing grit level allowed for efficient utilization of feed by broiler birds. This also agrees with the observation of Jones and Taylor (1999) who reported that the synergy between stone grit and enzyme supplementation resulted in higher weight gain. FCR and feed cost per kg gain improved with increasing stone grit levels.

### 5.7 Performance of Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation (finisher)

Result of finishing broiler birds fed rice offal based diets with graded levels of stone grit and enzyme supplementation showed that feed intake decreased significantly ($P<0.05$) with

increasing levels of stone grit in the diet. The decline in quantity of feed consumed with increasing stone grit levels gave an indication that the gizzard was able to grind and extract nutrients from the feed to meet their nutrient requirement, consequently they ate less feed. Ryan (2002) reported that when broiler birds are supplied feed without stone grit, they tend to have rapid feed intake with a rapid rate of digestion that results in poor feed utilization. Result of weight gain showed that birds fed 6.0g, 8.0g and 10.0g stone grit showed the best results with values that were comparable ($P>0.05$) with each other. However birds fed 10.0g stone grit showed a non-significantly higher ($P>0.05$) weight gain compared to birds fed 8.0g and 6.0g stone grit.

The increasing trend in weight gain across the graded levels of stone grit showed that better feed utilization was achieved. This was so because, as the amount of stone grit increased in the diet feed intake decreased significantly ($P<0.05$) while weight gain increased thus indicating that stone grit helped in improving feed utilization. This is in consonance with the report of Atteh and Dare (2000) who reported that increasing grit levels allowed for efficient utilization of feed by broiler birds. Similarly, Jones and Taylor (1999) reported that the synergy between stone grit and enzyme supplementation in diets fed to broiler birds resulted in higher weight gain. However, the higher weight gain with increasing stone grit levels observed in this study negates the report of Ali *et al*. (2006) who observed that birds fed stone grit did not gain more weight than those not given grit. Results of feed conversion ratio showed that there was an improvement across the graded levels of stone grit. This however, was related to the improved feed utilization that was observed as the stone grit increased in the diets. Mortality records obtained were not as a result of stone grit addition to the diet of the birds as it did not pose any detrimental effect to their

health. This is in consonance with the report of Ali *et al.* (2006) who reported that feeding stone grit to poultry birds has no adverse effect on their health.

## 5.8 Haematological Parameters of Finishing Broiler Birds Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation

No significant difference (P>0.05) was observed in the packed cell volume (PCV), haemoglobin count (Hb) and total protein (TP). However the values obtained for (PVC) ranged from 30.65-30.68% and were within the range for healthy birds 33.55±2.90% as reported by Abeke *et al.* (2008). Also values obtained for total protein ranged from 4.20-4.30g/dl and are within the range for healthy birds 4.68-5.27g/dl±0.48 as reported by Oladele and Ayo (1999).

Values of haemoglobin count ranged from 9.48-9.79g/dl and are within the range for healthy birds 11.30±1.82g/dl as reported by Oladele and Ayo (1999). The values obtained for packed cell volume PCV and haemoglobin count Hb showed that the synergy between stone grit and enzyme supplementation was beneficial to the birds as the result indicated that they were in a healthy state. Similarly, values obtained for total protein TP indicated that consequent upon digestion sufficient nutrients were absorbed through the small intestine and all six treatments were within the acceptable range of 4.68-5.27g/dl±0.48 as reported by Oladele and Ayo (1999).

## 5.9 Digestibility of Nutrients by Broiler Birds fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation

Dietary stone grit did not show any significant effect (P>0.05) in nitrogen free extract and crude fibre retention. No significant difference (P>0.05) was observed in crude protein retention for birds fed 2.0g and 4.0g stone grit however, they had a better nutrient retention than birds on the control diet. Similarly, birds fed 6.0g, 8.0g and 10.0g stone grit showed the best result in crude

protein retention with values that were comparable (P>0.05) to each other. This supports the report of Rowland *et al.* (1980) who reported that nutrient retention was improved with the incorporation of grit in diet of broiler birds.

### 5.10 Carcass Characteristics of Finishing Broilers Fed Rice Offal Based Diets with Graded Levels of Stone Grit and Enzyme Supplementation

The live weight, dressed weight, dressing percentage, gizzard, back, wing and thigh measurements were significantly (P<0.05) affected by graded levels of stone grit. Dressing percentage gradually increased across all levels of grit addition with birds fed 6.0g, 8.0g and 10.0g stone grit showing the best result. Results obtained for dressing percentage and vital body parts such as breast, thigh and back showed that 10.0g per bird per month of stone grit gave the best result compared to other grit levels thus indicating that at this level, stone grit was beneficial to the performance of the birds.

No significant difference (P>0.05) was observed in measurement of internal organs such as liver and heart thus indicating that stone grit and enzyme supplementation is not of adverse effect to the health of broiler birds. Gizzard measurement increased significantly (P<0.05) with increasing stone grit levels with birds fed 10.0g stone grit having the highest gizzard weight. Birds fed 4.0g, 6.0g and 8.0g stone grit showed comparable (P>0.05) results while birds fed the control diet had the least gizzard weight . This agrees with the report of Ali *et al.* (2006) who reported that granite grit fed to broiler birds significantly increased gizzard weight. Yildiz *et al*. (2001) further reported that feeding insoluble grit to broiler birds will lead to increased thickness of gizzard muscle.

# CHAPTER SIX

## 6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

### 6.1 SUMMARY

Two phased research was conducted to determine the effect of graded levels of stone grit with or without enzyme supplementation on the utilization of rice offal based diets by broiler chickens.

### 6.2 CONCLUSION

Results obtained from both experiments showed that stone grit significantly ($P<0.05$) reduced feed consumption with consequent improvement in weight gain, nutrient retention, carcass characteristics, feed conversion ratio, feed cost per kg gain and haematological evaluation (total protein). These parameters improved up to the highest level of stone grit addition (10.0g per bird per month) thus indicating efficient feed utilization. It was observed that birds fed diets without stone grit showed the poorest feed utilization which resulted in their rapid rate of feed intake to compensate for nutrients required. From the result obtained in both experiments, it was observed that birds fed diets containing stone grit and enzyme supplementation had higher final weight compared to birds fed diets containing stone grit alone. It was therefore concluded that feeding stone grit with enzyme supplementation is more beneficial than feeding stone grit alone

### 6.3 RECOMMENDATION

Further study to determine the optimum level of stone grit addition in the diet of broiler birds is encouraged since results obtained in this study showed that the optimum level was not attained. A similar experiment can be replicated with broiler birds raised in battery cage housing system to ascertain if the performance of the birds would yield similar or even better results compared to what was obtained in this study.

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