AKENTEN APPIAH-MENKAH
UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

EFFECTS OF REGULAR MAIZE AND DIFFERENT VARIETIES OF MAIZE ON THE GROWTH PERFORMANCE AND CARCASS TRAITS OF BROILER CHICKENS

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A thesis in the Department of Animal Science Education, Faculty of Agriculture Education, submitted to the School of Graduate Studies in partial fulfillment
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DECLARATION

STUDENT'S DECLARATION

I, Vera Owusu declare that this thesis, except for quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work and it has not been submitted, either in part or whole for another degree elsewhere.

SIGNATURE: ……………………

DATE: …………………………….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work were supervised in accordance with the guidelines for supervision of the thesis as laid down by the Akenten Appiah – Menkah University of Skills Training and Entrepreneurial Development.

DR. HOLY KWABLA ZANU (Supervisor)

SIGNATURE: …………........................

DATE: ………………………………..

DEDICATION

This piece of work is dedicated to God, my children Kwabena Agyei Appau and Nana Achiaa Appau.

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Without God's guidance and grace, nothing could have been possible. Therefore, I thank Jehovah God for seeing me through this journey of my study.

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ABSTRACT

This study was conducted to investigate the effect of different varieties of certified maize and silo maize on the growth performance and carcass characteristics of broiler chickens. One hundred and eighty (180) broiler chicks aged day old were used for the experiment. The experimental diets were Regular maize, (T1), Obatanpa Maize (T2), Abontem Maize (T3), Honampa Maize (T4), and a combination of certified maize varieties (T5). A Complete Randomized Design (CRD) was used for the experiment. Data collection was subjected to the Analysis of Variance (ANOVA) model using Minitab Statistics (Version 20.3) and treatment means were compared using Tukey's Pairwise Comparisons at a 5% significant level. Results of the study showed that birds fed with different varieties of certified maize and silo maize had no significant (P>0.05) effect on feed intake throughout the experiment. It was observed that feed conversion was high in birds fed with a T4 (Honampa) maize diet with T1 (regular maize) recording the least feed conversion in weeks 1 and 2. Breast weight, thigh weight, heart weight, duodenum weight, liver weight, gizzard weight, jejunum weight, ileum weight, and caeca weight observed in this study were not significantly (P>0.05) influenced by the different varieties of certified maize and silo maize inclusion in the diets of broilers. It can therefore be deduced that the various dietary treatments did not influence growth performance and carcass characteristics, except for live weight and weight of proventriculus. It is recommended to farmers that, feeding broilers with different varieties of maize has no significant effect on growth characteristics and so farmers can include any maize variety in the diets of broilers provided it is certified.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The success of poultry production depends primarily on three factors; the quality of the bird, the environment, and the provision of a balanced feed (Heise *et al*., 2015). Feed is the most expensive input in poultry and accounts for 65-70% of broiler and 75-80% of layer production costs (Gulli, 2017). Cereal grains are the main source of dietary energy and maize is the most preferred energy source in poultry production because of the high energy, low fiber, better palatability, and the fact that it contains pigments and essential fatty acids (Ahiwe *et al*., 2018). Carbohydrates and proteins are mostly the important nutrients in poultry diets as, they represent approximately 90% of the total cost of the ingredients in the ration (Ravindran, 2013). They are mainly dietary sources of energy but can vary widely between grain types and animal species (Ravindran, 2013). The most common feed grains for poultry are maize, wheat, barley, and sorghum.

Maize, (*Zea mays)*, is the most abundantly produced cereal in the world and it is grown on every continent except Antarctica (Wilkes, 2014). About 50 species exist and consist of different colors, textures, and grain shapes and sizes. White, yellow, and red are the most common cultivated maize types. The white and yellow varieties are preferred by most people and have been used extensively as animal feed (Prasanna, 2012). Maize grain has a digestible energy content of 3,931– 4,180 kcal/kg. For chickens and pigs, the metabolizable energy values recorded when maize was fed were 3.6 and 3.8 kcal/g, respectively, and the corresponding gross energy digestibility was 86% in chickens and 92% in pigs (Dei, 2017). Maize, is popular for feeding monogastric animals, particularly poultry and it is used in the formulation of high-energy poultry rations that are recognized throughout the world (Yadav and Kumar, 2016).

In feeding poultry, maize grains are either fed directly or are milled and compounded with other ingredients and thoroughly mixed. The mixture is then fed or converted into forms most desired by specific animals (Dei, 2017). Maize is the major feed grain grown and preferred for feeding poultry. Maize constitutes about 50 – 60% of most poultry diets (Kumaravel & Natarajan, 2014) and has a greater acceptance in poultry feeds but its production is not sufficient to meet the ever, increasing demand of the poultry industry. Also, its price is increasing continuously due to intensive competition for its usage by man or other livestock species and Starch and allied industries (Mwambo *et al*., 2020). Although maize is preferred by the poultry industries, its nutritional content is considered to be low in protein content, hence the search for nutritionally improved maize varieties to help improve the performance of poultry birds.

1.2 Problem Statement

A lot of breeding work have been done in maize across the world to improve nutritional quality. In Ghana, several varieties and hybrids have been developed by the Crop Research Institute of the Council for Scientific and Industrial Research. Nonetheless, in the market where poultry producers purchase maize for feed mixing, the maize available is rather an adulteration of several other varieties. It is not known whether maize varieties when used individually or in a mixture with other varieties would give similar results in the growth performance of chickens. Though diets could be formulated with different varieties and meet the nutrient requirement of chickens, it was hypothesized in this study that factors such as texture, fiber (especially non-starch polysaccharides), carotene, etc. levels of the varieties could make a difference in the performance of broiler chickens.

1.3 Objectives to the Study

1.3.1 Main objectives

The main objective of the study was to investigate the effects of the different varieties of maize (Obatanpa, Abontem, Honampa, or their mixture) and regular maize on the growth performance of broiler chickens.

1.3.2 Specific objectives

The specific objectives of this study were:

1. To determine the proximate composition of Obatanpa, Honampa, and Abontem maize or their mixture and regular maize.
2. To determine the effects of Obatanpa, Honampa, and Abontem maize or their mixture and regular maize on the growth performance of broiler chickens.
3. To investigate the influence of the inclusion of Obatanpa, Honampa, and Abontem maize or their mixture and regular maize on the carcass qualities of broiler chicken.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Maize is Ghana's most important cereal crop and is grown by the vast majority of rural households. It is widely consumed throughout the country and is the second most important staple food in Ghana, next to cassava (Andam *et al.,* 2017). Maize is the main input in feed production for poultry. Production in Ghana averaged 1.8 million metric tons per year harvested from about 1.02 million hectares over the last five years (Andam *et al.,* 2017). Maize is the predominant feed grain used in poultry feeds worldwide. This is mainly because its energy source which is starch is highly digestible by poultry (FAO, 2013). Maize is also highly palatable with a high-density source of readily available energy which is free of anti-nutritional factors (FAO, 2013).

The metabolizable energy value or nutritional value of maize is higher (3,365 Kcal/kg) than other possible source of feed for poultry, rice (3,320 Kcal/kg), rice bran (2,620 Kcal/kg), peanut (2,915 Kcal/kg) and oilcake (2,350Kcal/kg)) and is considered as the standard with which other energy feed sources are measured (FICCI and NCDEX, 2015; FAO, 2013). It is the most commonly used energy source for poultry feed which is the largest component of the poultry diet (FAO, 2013). The feed and poultry industry standard for energy requirements in chickens is 3,200 Kcal/ kg for broilers and 2,300 Kcal/ kg for layer feed of which maize provides approximately 3,400 kcal/ kg making it the most preferred due to its easy availability and higher energy content (FICCI and NCDEX, 2015). Maize is the largest segment in animal feed with around 70% of total volumes used by the feed industry (Hellin *et al.,* 2013).

2.2 The Role of Maize in the Poultry Industry

Maize is preferred in poultry feed because of its easy availability (Murdia *et al*., 2016). Maize is a critical raw material that constitutes about 60% of poultry feed production and has greater calorific value, is rich in amino acids, and has fewer toxins compared to grains like millet and broken rice (FICCI and NCDEX, 2015; Prandini *et al.,* 2016). Maize has long been used as a human staple for generations. However, over the last few decades, its direct food usage has been on the decline in certain jurisdictions across the world due to rising income levels and changes in food habits among others (Kaul *et al.,* 2019). The use of maize in poultry feed and industrial applications has also gone up within the same period. Yellow kernelled cultivars of the crop are preferred as poultry feed because they are a rich source of β-carotenes and xanthophylls providing yellow colour for coloration of egg yolk, poultry fat, and skin when it is used at 30% and above in the diet (Kaul *et al.,* 2019).

Animal feed production is the largest end-user of all cultivated maize (Afolayan *et al.,* 2012). The demand for as well as the cultivation of maize is expected to go up due to the growing population and increasing taste towards higher protein consumption in the form of meat and eggs. Maize is more readily accepted as poultry feed than rice and wheat both in terms of price and nutrition (FICCI and NCDEX, 2015). Improving domestic poultry production has the potential of increasing farmer incomes and generating jobs within the sector and could serve the purpose of increasing demand for maize and other ingredients used in poultry feed, thereby benefiting smallholder farmers producing maize (Andam *et al.,* 2017). Feed for poultry forms a large chunk of the overall production cost; for both meat and egg production. Poultry feed constitutes about 70% - 75 % of production costs (Andam *et al*., 2017).

2.3 Maize as Feed Ingredient

As livestock feed, it is the grain that is most important. The stalks, leaves, and immature ears are used as forage for ruminants (Jain and Chanana, 2016). Maize grain is recognized as giving the highest conversion of dry matter into meat, milk, and eggs of other cereal grains (Oladejo and Adetunji, 2012). It is used extensively as the main source of calories in the feeding of poultry, pigs, and cattle (Schedle, 2016). Maize contributes approximately 65% of the metabolizable energy and 20% of the protein in a broiler starter diet and is by far the most commonly used cereal grain in the diets of intensively reared poultry (Aardsma *et al*. 2017). One reason for the wide spread use of maize in the diets of farmed livestock is that there is a perception that maize is of a consistent and high nutritional value. However, studies by Abdollahi, (2013) revealed that the chemical composition and nutritional value of maize are variable, making generic matrix values for maize inaccurate. The nutritional value of maize for poultry is a function of the content of starch, oil protein, and antinutrient (Erdaw *et al*., 2016).

Maize constitutes the predominant ingredient in most swine and poultry diets and is described as an indispensable cereal grain in the diets of monogastric farm animals in Ghana and several other countries where it forms about 50-60% of such diets (Manu *et al*., 2015). Maize is high in energy, low in fiber, palatable, and easily digested. The normal maize varieties used in Ghana and elsewhere have two major limitations, namely: low protein content (9-10%) and low levels of some essential amino acids, particularly lysine (0.23%) and tryptophan (0.06%) (Badu-Apraku and Fakorede, 2017). It is, therefore, not an adequate protein source for mono gastric. Even though normal maize has approximately 10% protein, this is not available to monogastric animals including humans because the protein is low in two essential amino acids, lysine and tryptophan (Humer and Schedle, 2015).

2.4 Energy Requirement of Broilers

One of the factors affecting the performance of broiler chicks is the levels of nutrients in the diets mainly the energy and protein contents. Diets of high energy levels tend to promote more rapid growth and better feed conversion in chicks than diets of lower energy contents (Ahiwe *et al.*, 2018). Feed formulation involves a prudent usage of various available feed ingredients to supply sufficient amounts and proportions of several nutrients required by poultry. Poultry feed is made up of many ingredients, and these ingredients are grouped into those that provide energy (fats, oils, and carbohydrates), protein (amino acids), vitamins, and minerals (Choct, 2015). Among the feed nutrients, dietary energy is one of the most important feed nutrients because it influences the utilization of other nutrients through its ability to regulate feed intake to a high degree (Choct, 2015).

Formulation of poultry diets should be done to achieve optimum energy levels based on the composition of the feed ingredient to lower feed cost per unit of poultry product and produce quality end-products. In animal feeds, energy supply represents a major part of the cost of the formula. Since feed ingredients that supply energy in a standard broiler diet are in the highest amount (40–70%) in terms of inclusion level, it is important to improve the knowledge of energy utilization and energy requirement by the animal to better meet its energy needs (Musigwa *et al.*, 2021). The energy requirement for broilers at different phases of growth and breeds are 3000 kcal ME/kg or 12.55 MJ/kg (starter); 3100 kcal ME/kg or 12.97 MJ/kg (growers) and 3200 kcal ME/kg or 13.39 MJ/kg (finisher) (Hamungalu, 2019). Adequate knowledge of broiler nutritional requirements based on breed, the energy composition of a feed ingredient, and availability, and cost of these ingredients is fundamental in the least cost formulation and achieving improved broiler performance (Oghenerume, 2016). Manipulating dietary energy has been reported to influence feed intake with a resultant effect on performance and carcass quality. Poultry adjusts their feed intake to accommodate a wide range of diets with differing energy contents at different ages and in response to various factors, including dietary energy (Gous *et al*., 2018). The energy which a bird uses for maintenance and productive functions is obtained mainly from starches (carbohydrates), lipids, and protein. Energy feed ingredients could be classified into cereal grains, roots, tubers, plant protein sources, animal protein sources, fats, and oil. These feed ingredients provide high to moderate dietary energy (Gous *et al*., 2018). Hall *et al*. (2019) found that as the metabolizable energy content of a diet increased, the birds would grow faster and the ME energy required per unit of body weight gain decreases significantly as dietary ME content is increased. On the other hand, the efficiency of feed conversion improved with the energy intake of finishing diets.

2.5 Nutrient Composition of Maize Grain

2.5.1 *Protein content of maize grain*

The maize grain is deficient in protein, but its variability is low with a standard error of the order 7 g/kg of crude protein (Barros *et al*., 2017). The protein content of maize grain ranges from 8 to 11 g/100 g grain of dry matter. The various fractions of grain vary considerably in protein content. Even though the majority of protein in the grain occurs in the endosperm, the germ (184 g/kg DM) is considerably higher in protein content than the endosperm (80 g/kg DM) (Dei, 2017). Generally, the low protein content of the grain limits its nutritive value as the only source of food for both humans and livestock (Barros *et al*., 2017). The amino acid composition of whole maize grain is determined by both the relative proportions of the various protein fractions and the amino acid composition of each fraction (Gebru *et al*., 2019). Maize grain endosperm proteins are usually referred to as albumins, globulins, prolamins, and glutelins, depending on their solubility in different solvent systems. Prolamins and glutelin also referred to as storage proteins are confined to the endosperm, whereas albumins and globulins also referred to as water-soluble proteins are also found in the aleurone layer and the germ (Ortiz-Martinez *et al*., 2017). In normal maize grain, the prolamin content exceeds that of glutelin and represents about 50–60% of the total protein (Chen *et al*., 2018). Each protein fraction tends to have a characteristic amino acid composition, and the relative proportion of each fraction strongly affects the level of individual amino acids in the total grain protein. Prolamins are most deficient in lysine, thereby rendering maize protein poor in terms of nutritional quality (Chen *et al*., 2018). The general deficiency of lysine in maize grain is essentially the consequence of its low content of albumin and globulin, which besides having high lysine content exhibits a well-balanced amino acid composition similar to that of animal proteins of superior nutritional value (Kato *et al*., 2019). Moreover, maize prolamins are characterized by larger quantities of leucine than isoleucine, thus causing the typical amino acid imbalance that further reduces the protein quality of maize (Chen *et al*., 2018).

2.5.2 Vitamin content of maize grain

Vitamins in maize grain are concentrated mainly in the aleurone layer and the germ (Ndolo and Beta, 2013). Analysis of the vitamin content of maize indicates that the grain furnishes significant quantities of riboflavin, pantothenic acid, choline, and pyridoxine which are sufficient to satisfy the requirements of most livestock (Baker and Stein, 2012).

However, the most significant feature of the vitamin pattern in maize is the low niacin content. Besides, much of the niacin that occurs in the grain is in a bound form (niacytin), which is not available to monogastric animals (Baker and Stein, 2012). Furthermore, the high level of the essential amino acid, leucine, in the maize grain increases the niacin requirement in humans (Prabhu and Mponda, 2021). Thus, people who live only on a diet of maize suffer from the disease pellagra, associated with niacin deficiency. Nevertheless, niacin shortage alone would not cause pellagra if normal maize were rich in tryptophan or heat-treated with alkali (Prabhu and Mponda, 2021). Yellow maize shows vitamin A activity, whereas white maize does not. The vitamin A potency of yellow maize results primarily from the presence of carotenes in the grain. The carotene content of yellow maize is 0.46 mg/100 g of grain (Hossain, 2019). The occurrence of vitamins mainly in the aleurone layer and the germ implies that food preparations that do not retain these parts of the grain further decrease vitamins in the diet (Hossain, 2019). The vitamin content of maize grain is presented in Table 2.1

Table 2.1: Vitamin content of maize grain

Vitamin	Concentration (g/kg)
Carotene	4.6
Vitamin E	0.46
Thiamine (B_1)	4.83
Riboflavin (B_2)	1.61
Nicotinic acid	25.29
Pantothenic acid	6.44
Pyridoxine (B_6)	8.74
Choline	655.17

(Source: Zhang *et al*., 2012)

2.5.3 Mineral content of maize grain

The inorganic or mineral component (ash) of maize grain constitutes less than 2% (Reza *et al*., 2015) and of this, about 75% is found in the germ. The grain is most abundant in phosphorus and potassium, but deficient in calcium and trace minerals except iron (Fryer *et al*., 2019). Much of the phosphorus, however, is present in the form of phytic phosphorus which is not digested by monogastric animals (Fryer *et al*., 2019). The little calcium that is normally present also has low bioavailability because it forms complexes with phytic phosphorus (Gupta and Singh, 2015). The mineral content of maize grain is presented in Table 2.2

Table 2.2 Mineral content of maize grain

Mineral	Concentration (mg/100 g)
Calcium	6.0
Phosphorus	300.0
Magnesium	160.0
Sodium	50.0
Potassium	400.0
Chlorine	70.0
Sulphur	140.0
Iron	2.5
Manganese	6.8
Copper	4.5

(Source: Badau *et al*., 2013)

2.5.4 Fiber content in maize

All feed ingredients from plant sources contain fiber and it is mainly polysaccharides from non-starch sources in the cell wall of plants (Sinha *et al*., 2011). Dietary fibers are also called non-starch polysaccharides. They are indigestible in the non-ruminant gastrointestinal tract and they comprise; non-cellulose, cellulose, gums, pectin, hemicellulose, lignin, and mucilages. According to Dhingra *et al*. (2012) cereals, fruits, nuts, and vegetables are rich in fiber and contribute positively to the health of the animal. Eswaran (2013) stated that the consumption of these fibers decreases the incidence of many digestive problems. Dietary fiber is obtainable in marketable quantities. Despite the obtainability of this agricultural-industrial by-product at moderately lower prices, their addition to poultry feeds is restricted because of their adverse effects on growth, gut viscosity, and the overall performance of birds (Sinha *et al*., 2011). It is now well-acknowledged that enzyme addition in poultry diets decouples their linkages to reduce gut viscosity and improve the nutritive value of feedstuffs that contain them in large amounts (Hussein *et al.,* 2020). The length of caecum may increase with a corresponding increase in fiber as a result of a physiological adjustment to delay digesta in the gut (Wang *et al*., 2019). A higher weight of crop, gizzard, and intestines was observed by Martinez *et al*. (2015) when different fiber (ranging from 3 to 5%) sources were included in poultry diets. A study conducted by Martinez *et al.* (2015) observed relatively lighter weights in the gizzard, crop, intestines, and oviduct of laying pullets when fed a diet with 3.5% crude fiber compared to the birds on 3.0% crude fiber diet but there were no differences in serum total protein, urea and creatinine levels between the two levels of the crude fiber used.

2.5.5 Carotene content in maize

Cereals, vegetables, and fruits contain several phenolic compounds including carotenoids, carotene, β-cryptoxanthin, lycopene, lutein, and zeaxanthin), flavonoids (anthocyanin), and other phenolic compounds (Palermo, 2014). These compounds usually impose bright colours on leaves, fruits, grains, and other plant parts. β-carotene usually confers yellow colour whilst anthocyanin usually confers red and purple colours on plant parts (Singh *et al.,* 2020). Phenolic compounds have been found to have high free radical scavenging activity thereby reducing the deleterious effect of free radicals on the human body (Nag Moti *et al*., 2012). During the past few decades research findings have shown that polyphenols have effects on the human body and that they are anti-carcinogenic, anti-mutagenic, anti-inflammatory, antioxidant, anti-viral, anti-microbial, anti-proliferative, anti-allergic and these enable the prevention of certain chronic diseases including cardiovascular disorders (Ghosh and Konishi, 2014). Carotene and cryptoxanthin are pro-vitamin A. The chemical structure of the vitamin A (retinol) molecule is essentially one-half of the carotene molecule which is the most potent pro-vitamin A and also the most widespread (Yahia, 2010). Carotenoids have been found to enhance the immune system and prevent regenerative diseases and prevent irreversible blindness and cataract in the elderly (Aversa *et al*., 2016). In the maize kernel, carotenoids are formed in the endosperm whilst flavonoids are formed in the aleurone layer. The colour of the aleurone layer usually dominates and covers that of the endosperm therefore yellow and white maize has colorless aleurone layers and the colour of the endosperm can be seen (Ghosh and Konishi, 2014). Red and purple-coloured maize have the red or purple pigment accumulated in vacuoles of aleurone cells and therefore the colour of the endosperm cannot be seen. The carotene content of cereals and other crops is affected by several environmental, mechanical, and physiological factors such as soil type, light, and temperature, stage of development, processing, and storage. Zeaxanthin and lutein are the major carotenoids with carotene and cryptoxanthin being present in much smaller amounts (Aversa *et al*., 2016).

2.6 Nutritionally Improved Maize Grain

A study by Kaur *et al*. (2020), revealed that the proteins in maize are poor because they are deficient in the essential amino acids, lysine, and tryptophan. These deficiencies were attributed to the high zein fraction of maize protein in the maize grain of most varieties (Kaur *et al*., 2020). Results obtained from extensive studies of zein by Zhang *et al*. (2018) indicated that it contains very low levels of lysine and tryptophan. Several researchers including Oliviero *et al*. (2017) and Berta (2019), studied the factors that affected the protein quality of maize and reported that both the variety of maize and the environment had in several cases, a significant effect on lysine content. It has been shown that the opaque-2 gene in maize caused a genetic increase in the: lysine concentration of maize protein (Oliviero *et al*., 2017). These researchers further reported that the lysine increment in opaque-2 maize was the result of a change in the distribution of endosperm protein fractions, of which the opaque-2 maize contained approximately 22% zein compared with 50% zein in normal maize. Chemical analysis of maize protein for amino acids showed that opaque-2 maize contained 60–130% more lysine than normal maize, plus a 12–40% reduction in leucine as well as elevated levels of tryptophan (Li and Song, 2020). Since these findings, several other mutant genes of maize have been identified. Collectively designated “high-lysine” genes, all of them control the level of zein accumulation during endosperm development (Tripathy *et al*., 2017). These “high-lysine” genes include most importantly floury-2; opaque-7; opaque-6 and floury-3. Of these genes, opaque-2 has proven superior in zein reduction (Tripathy *et al*., 2017). The development of these nutritionally improved maize varieties is of particular significance to those who rely on maize as basic food and animal feed, and can thereby improve such diets nutritionally at no added cost.

2.7 Improved Maize Variety

2.7.1 Obatanpa Maize

Obatanpa maize is a medium maturity white dent and flint endosperm Quality Protein Maize (QPM) with elevated levels of lysine and tryptophan and was first released by CRI, Ghana in 1992 as Obatanpa to help improve the protein nutritional status and the health of a large population of low-income groups in sub-Saharan Africa who depend on maize as a major component of their dietary protein intake (Boateng, 2015). Maize has such a critical nutritional role to play because it is the most important staple food crop across sub-Saharan Africa (Ekpa *et al*., 2018). Traditionally, maize is consumed as a starchy base in a variety of forms such as gruels, porridge, pastes, etc. It is also widely fed as porridge to weaning children 2 to 3 years until the children are completely weaned at the age of 15 to 24 months) and preschool children (3 to 5 yrs.) without protein supplements (Reynolds *et al*., 2015). Normal maize has a major nutritional constraint as a human food because even though it has about 10% protein, the protein is deficient in two essential amino acids, lysine and tryptophan (Humer and Schedle, 2015). The result is that infants fed on normal maize without any balanced protein supplements suffer from malnutrition and develop diseases such as kwashiorkor, a fatal syndrome characterized by initial growth failure, irritability, skin lesions, edema, and fatty liver (Humer and Schedle, 2015). The high lysine content of QPM improves the absorption of Zn and Fe in the human digestive system and may thus contribute to improved micronutrient status (Gupta *et al*., 2015). Obatanpa has been widely adopted by farmers and consumers in Ghana. Presently, it covers more than 50% of the maize hectarage (650 000 ha) in Ghana (Mensah *et al*., 2021). It has also been released formally or informally in several other African countries including Benin (as Faaba), Togo, Mali (as Debunyuman), Guinea, Burkina Faso, Cote d'Ivoire, Senegal, Cameroon, Nigeria (as 8AMMAZ 14), Mozambique (Susuma), Uganda, Ethiopia, Zimbabwe, Swaziland, Malawi, and South Africa (Badu-Apraku *et al*., 2016). The cultivar is also serving as a source of inbred lines for the development of QPM hybrids and synthetic varieties in several maize breeding programs in Africa (Williams *et al*., 2014). Obatanpa has good levels of resistance to the Maize streak virus (MSV), lowland rust incited by Puccinia polysora Under, and moderate levels of resistance to blight caused by Bipolaris maydis (Blankson *et al*., 2018). A picture of Obatanpa maize grain is shown in the plate below;

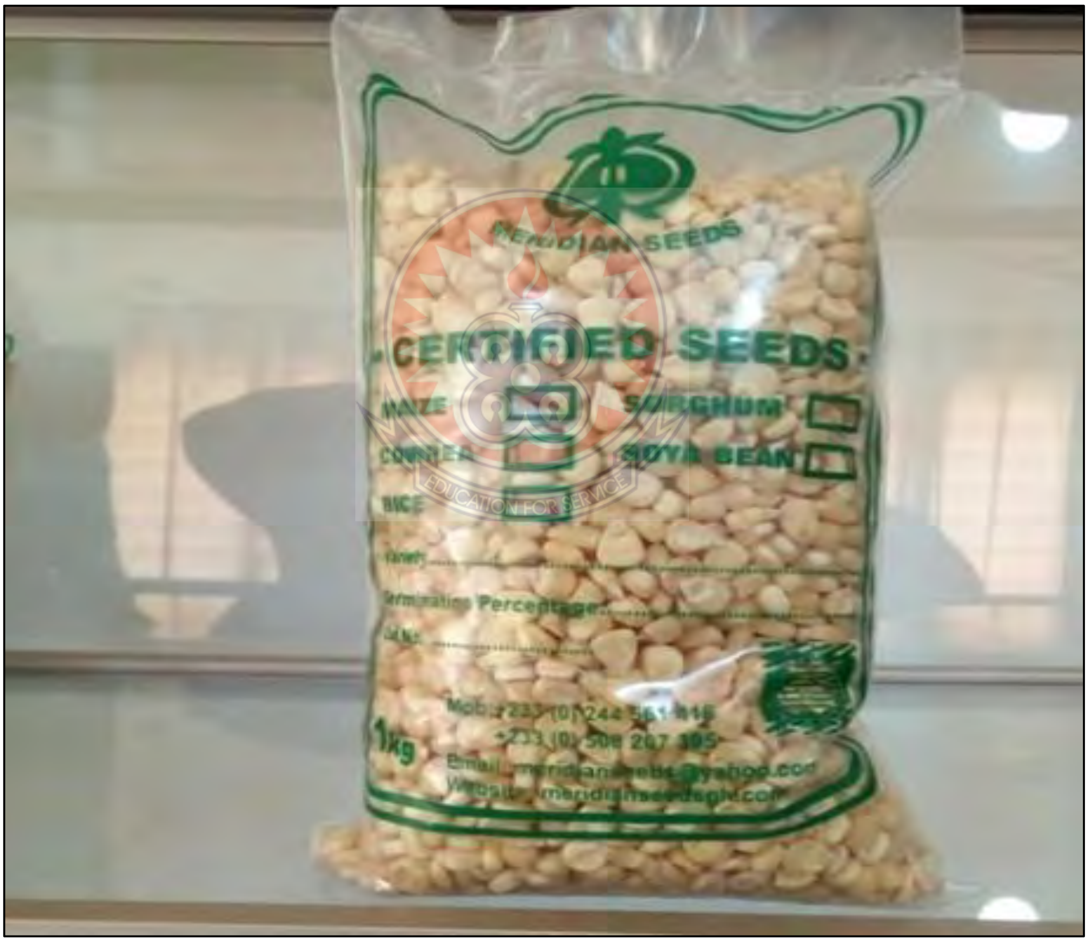

Plate 2.1: A plate showing Obatanpa maize seeds

2.7.2 Honampa Maize

Honampa maize is an orange-colored pro-vitamin A maize variety that was produced and released to farmers in the year 2012 by CSIR-CRI (Yeboah *et al*., 2019). It is an Open

Pollinated Variety (OPV), flint seed, and streak tolerant. Honampa maize variety is adapted to growing conditions in Ghana with pro-vitamin A levels of between 7-15 micrograms per gram and mature in 110 days with yield potentials of between 5-6 tons/ha (Afriyie-Debrah *et al*., 2018). It is suitable for human, poultry, and livestock consumption. Regarding the level of pro-vitamin, A, it is capable of boosting the immune system of consumers and further enhancing the decline in vitamin A deficiency in the country (Afriyie-Debrah *et al*., 2018).

Plate 2.2: A plate showing Honampa maize seeds

2.7.3 Abontem Maize

Abontem is a Quality Protein Productive yellow maize (vitamin A <3ug/g) produced by CSRI in 2010 (Owusu, 2016). Abontem is an OPV flint seed maize with drought and Striga tolerance. It has a 75-80 days maturity period of 4.7 tons/ha potential yield (Nartey and Odoi, 2018). Abontem maize is suitable for human, poultry, and livestock consumption and it is suitable for all Agroecologicall zone in Ghana (Nartey and Odoi, 2018).

Plate 2.3: A plate showing Abontem maize seeds

2.8 Effects of Obatanpa, Honampa and Abontem maize or their mixture and regular maize on carcass characteristics of broilers.

A study conducted by Onimisi *et al* |(2009). The result of the carcass study showed that all the carcass parameters measured were not significantly different for all the treatments.

Thus, the QPM did not stimulate the development of organs and the section of the body beyond that of normal maize. They further conclude that QPM in poultry diets improves the growth performance of broilers. Generally, feed formulated with Obatampa resulted in higher weight gains than normal maize.

2.9 Effect of maize on growth performance of broilers.

From the stand point of poultry production, we are partially interested in the influence of the growth rate and body weight of the birds on the final production. Growth as described by the Reverso dictionary is an increase in size and number. Growth can also be described as an increase in height, length, and weight that occurs when a healthy meat animal is given adequate, food, water, and shelter.

Aviagen (2009), stated that successful broiler production depends upon supplying the birds with feed of the highest achievable quality, in terms of ingredients used, processing procedures applied, and finally the form in which the feed is presented to the birds. A study has shown that the feeding of QPM diets improved growth in poultry. Result from Lui et al (1993). showed that feeding chicken with QPM-based diets improved the growth rate by 20% compared to feeding normal maize.

According to Osei et al. (1998). QPM feed-fed birds consumed 14% more feed and gained weight at 1.7 times that of a normal maize group. Feed conversion efficiency was 20% better in the QPM group than in the normal maize group. A similar study was conducted by Nyanamba et al,2003. The study also revealed that broilers raised with a mixture of QPM and normal maize had feed intake, mortality, and growth rate comparable to that of the QPM diets.

Recently, Mbuya et al. (2011), reported that dietary inclusion of QPM for poultry increased body weight by 50% compared to those fed with normal maize. A study by Onimis et al (2009), reported shows that birds fed with QPM performed better than birds fed with normal maize due to the lower ratio of leucine and isoleucine in QPM. The higher levels of leucine and isoleucine in regular maize are known to interfere with protein synthesis.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Location and Duration of the Experiment

The experiment was conducted at the poultry section of the Department of Animal Science Farm, under the Faculty of Agriculture Education of Akenten Appiah Menkah University of Skills Training and Entrepreneurial Development (Mampong campus) from March 2021 to April 2021. From Meteorological Service Department (MSD, Mampong Agency), Ashanti Mampong is located in the forest transitional zone of Ghana between latitude 07º 04°N and longitude 01º 24°W with an altitude (Green Which Meridian) of 457.1m above sea level.

The Municipality has an average annual rainfall of 1,270 mm and two rainy seasons. The major rainy season starts in March and ends in August whiles the minor is between September and November. The remaining months span the harmattan dry season. The average annual temperature is 27 ^{0}C with variations in mean monthly temperature ranging from 22 ^{0}C – 30 ^{0}C (Ghana Statistical Service, 2019). The Mampong Municipal lies within the wet semi – equatorial forest zone. The land is fairly low – lying in the South and steadily undulates towards the North. The highest point is about 2400meters above the mean sea level whilst the lowest point is 135 meters above the mean sea level (Ghana Statistical Service, 2019).

3.2 Experimental Birds

One hundred and eighty (180) experimental birds aged day old were used for the study. The birds were obtained from chicks and chickens at Kumasi. The birds were managed under the same housing and management practices.

3.3 Experimental Design

A completely Randomized Design (CRD) was used for the experiment. There were five treatments with four (4) replicates under each treatment. Each replicate had nine (9) birds. The various experimental coops were labeled following their experimental treatment and replicated to avoid biases of experimental birds selected into a particular treatment.

3.4 Experimental Diet (treatments)

The diets employed in this experiment consisted of two types, starter, and finisher diets. They were formulated from the local feed ingredients and imported once which were used together to complete the formulation of the diets. The experimental diets were formulated such that the first diet consist of maize from the silo (Regular maize), Obatanpa Maize, Abontem Maize, Honampa Maize, and a mixture of Obatanpa, Honampa, and Abontem maize respectively. Starter and finisher diets ware prepared using the feed ingredients. The diet was fed to the birds for 6 weeks. An equal amount of feed was fed to the experimental birds throughout the study.

Table 3.1: Ingredients and percentage composition of the starter and finisher diets.

	STARTER DIET					FINISHER DIET				
INGREDIENTS	RM	OB	ABM	HO	O+A+H	RM	OB	AB	HM	OB+AM+HM
Regular. maize	58	-	-	-	-	60	-	-	-	-
Obatanpa maize	-	58	-	-	20	-	60	-	-	20
Abontem maize	-	-	58	-	20	-	-	60	-	20
Honampa maize	-	-	-	58	19.5	-	-	-	60	20
Wheat bran	12.5	13	14	12.5	13	18	16	17	16	16
Soya bean meal	16	15.5	15	16	14	11	13	12	13	12
Fish meal	11	11	11	11	11	9	9	9	9	10
Premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Oyster shell	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DCP	1	1	1	1	1	0.5	0.5	0.5	0.5	0.5
Calculated nutrient compositions										
Protein, %	23	23	23	23	23	18	18	18	18	18
Energy, Kcal /kg	3000	3000	3000	3000	3000	3200	3200	3200	3200	3200
Calcium	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.9
Av Phosphorus	0.45	0.45	0.45	0.45	0.45	0.35	0.35	0.35	0.35	0.35

RM=Regular Maize, OBM=Obatanpa Maize, ABM=Abontem Maize, HM=Honampa Maize, DCP=Dicalcium phosphate, Regular maize: the maize normally sold out in the market and used for feeding chickens. Vitamin mineral premix provided the following per kg of diet: vitamin A, 10,000IU: D, 400,000IU, E, 3,000IU: K, 2,000IU: B1 200mg B2, 900mg: B12, 2400mg: niacin, 5,000mg: Fe, 9,000mg: Cu, 500mg: Mn, 12,000mg: Co, 1000mg: Zn, 10,000mg: Se, 4.

3.4.1 *Proximate Composition of Obatanpa, Honampa and Abotem or Their Mixture and Regular Maize*

The feed ingredient used for the ration includes certified maize, fishmeal, premix, oyster shell, vitamin, soya bean meal, common salt, and wheat brain. The diet was formulated according to (NRC, 1994) specification. Proximate analysis of diet was carried out at the Nutrition Laboratory of Animal Science department of the Faculty of Agriculture, Kwame Nkrumah University of Science and Technology, Kumasi. The experimental ration and their composition are presented in Table 3

3.4.2 *Sources and Processing of Experimental Diets*

The dietary ingredients (maize varieties) was purchased from the CSIR-Crop Research Institute Kumasi and Mampong market and the other feed ingredient was purchased from an agrochemical shop at Mampong market. The preparation (compounding) of the research diet was done at E and A Agro Company Limited situated in Mampong, close to the Ministry of Food and Agriculture (Mampong Municipal Office). The feed ingredients were thoroughly mixed, using the NRC 1994 guide line requirement for feed formulation for broiler chickens.

3.5 Housing of Experimental Birds

A total of twenty (20) experimental cages were used for housing the experimental birds. Each cage had a 4.5-liter plastic watering trough and plastic feeding trough. The floor was concreted and wood shavings were used as litter for the birds. In the middle, of the experimental house were electric bulbs hanged one meter from the ceiling to the floor level. Lighting was supplied continuously. The lighting was used as a source of heat during the brooding period. The heat provision was adjusted periodically according to the prevailing house temperature. Before the arrival of the chicks, the pens were cleaned and disinfected, wood shavings litter was spread in each pen., the feeders and water troughs were also made available. Water was provided ad-libitum.

Plate 3.1 shows experimental birds eating and drinking water containing antibiotics in their pens.

3.6 Medication

Drugs and medications used during the experimental period include Glucose, pen – strep powder (w. s. p) 100g, (Globivac IBD SUPRIM) against Gumboro, vitaminolite to enhance growth, vaccination against Newcastle, Ampolin 300Ws mixed with Oxy 200 Wsp against cocci/ kidney infection and a mixture of Amprolin 300 and Ciprosav -10%. The broiler chicks were given glucose as an anti-stress at age 1-2 days, dewormed later and appropriate medication given thereafter throughout the experimental period. Birds were observed for signs of ill-health and the right steps taken to restore health. The birds were vaccinated with the first and second Newcastle disease vaccines when the birds attained seven (7) and twenty-one (21) days of age, the birds were also vaccinated against Gumboro at 14 and 28 days of age.

3.7 Growth performance

The growth performance of the birds was checked by recording some parameters at the start of age 0 to 42 days.

3.7.1 *Parameters Measured*

Parameters measured include: body weight (g/bird), final body weight (g/bird), body weight gain, (g/bird), daily weight gain (g/bird, daily feed intake (g/bird) and feed conversion ratio

3.7.2 *Mean weekly feed intake*

The weekly leftover feed was measured and feed intake was determined by subtracting the leftover feeds from the quantity of feed given and the product divided by the number of birds. This can be expressed mathematically as:

$$FeedIntake = Weightgain \times FeedConversion\ ratio\ \{\text{FCR}\}$$

$$Per\ bird\ Intake = \frac{Weekly\ Intake}{Numberofbirds\ per\ pen}$$

3.7.3 *Body weight*

Birds were weighed every week to determine the weekly weight gain. Weekly weight gained was determined by subtracting the initial weight from the final weight. This can be expressed mathematically as:

Weekly weight gain = final weight – initial weight.

3.7.4 *Feed conversion ratio corrected (FCR_C)*

The feed conversion ratio is the ratio of the total weight gain in grams (g) throughout the experimental period to total feed intake in g. It was expressed as gain to feed ratio.

That is,

$$\text{FCR} = \frac{\text{Feed Intake}}{\text{Average weight gained}}$$

$$\text{FCRc} = \frac{\text{Feed Consumed}}{\text{PW} - \text{PWO} + \text{DBW}}$$

$$\text{DBW} = \text{Dead Body Weight}, \qquad \text{PW} = \text{Pen Weight}$$

3.7.5 *Mean Weekly Body Weight*

The body weights of the birds were taken weekly per pen. Body weight is used to calculate growth rates. It was calculated with the formula below;

$$\text{Bodyweight} = \frac{\text{Pen weight}}{\text{Number of birds}}$$

3.7.6 *Livability (LIV)*

Livability is the number of birds alive. A weekly pen count was done after pen weight is done to know the survival expectancy. Livability is an important indicator which is characterized by the ratio of the final number of birds to the initial.

The livability of the birds was calculated as;

$$\text{LV} = \frac{\text{Number of birds alive}}{\text{Initial number of birds}} \times 100$$

3.8 Sample Collection

3.8.1 *Carcass and Organs Feature Evaluation*

At the end of the experiment, two (2) birds were selected from each pen on a random base without any bias. A total of forty (40) birds were euthanized. Before rapid head surgical dislocation was done, their live weights were taken. Breast, liver and gall bladder, thigh, empty gizzard, heart, empty proventriculus, duodenum, jejunum, ileum, and caeca weights were recorded.

3.9 Statistical Analysis

Data collected on growth performance and carcass traits were subjected to Analysis using the General Linear Modules (GLM) procedure of Minitab version 17.0 statistical software the means of different treatments were compared with Tukey Pairwise Comparison tests. Significance was considered at $P < 0.05$ level.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1. Proximate composition of Regular, Obatanpa, Abontem, Honampa, or their mixture.

Table 4.1: Proximate composition (%) of the four maize varieties used in the experiment (as-fed basis).

PARAMETERS	RM	OBM	ABM	HM
Moisture	11.1	9.3	10.5	9.4
Ash	0.9	1.1	0.7	0.78
Crude protein	11.38	12.92	13.13	12.04
Crude fat	1.15	1.0	2.05	1.5
Crude fiber	1.95	1.91	1.75	1.45
Nitrogen free Extract	73.52	74.07	71.87	74.84
[1]M/E Kcal/kg	3088.33	3160.47	3168.95	3187.23

[1]Predicted

The determination of the proximate composition of different varieties of maize is important to detect the varieties that are good sources of basic nutrients required for the proper growth and development of animals (Adeniyi & Ariwoola, 2019). The moisture content of food is of higher economic importance to both the processor and the consumer. This is because; the amount of moisture in food is inversely related to the amount of dry matter it contains. Grains that have high moisture content are subjected to mold growth, and insect damage(Adeniyi & Ariwoola, 2019)

Table 4.1 shows the Nutritional Composition of the various maize varieties used (Regular, Obatanpa, Abontem, Honampa). The percentage moisture content for the maize variety ranged from 9.3 to 11.1 with Regular maize recording the highest and

OBM recording the least. This is higher than the result recorded by (Ape et al., 2016) who recorded a moisture content of 7.16% for maize.

The result of the proximate composition indicates that Regular maize, which is the normal maize recorded the higher moisture content followed by Abontem. The ash content in maize gives a rough idea of the mineral content. The ash content ranged from 0.7 to 1.1%.this was lower than the result reported by (Enyisi et al., 2014). Protein provides minerals that aid in body building and maintenance of the body. The results indicated that the protein content was highest for ABM (13.13) and lowest for RM (11.38). Crude fat is an important component of maize grains as they aid in the transmission of fat-soluble vitamins (Adeniyi & Ariwoola, 2019). According to table 4.1, the crude fat content of the maize varieties ranged from 1.0 to 2.05 with ABM giving the highest and OBM giving the least. Crude fiber, a diet rich in fiber helps in the good digestibility of food. It is therefore considered as a healthy diet. As the nutritional composition falls within the recommended composition of healthy feed for birds. Eswaran (2013) recorded similar nutritional composition for maize and also stated that, the consumption of these fibers decreases the incidence of many digestive problems. The percentage result of crude fiber record for the analyzed maize variety ranges from 1.45 to 1.95. the metabolizable energy results recorded shows HM recording the high followed by ABM and RM recording the least. Nitrogen free extract results recorded indicate high for HM followed by OBM.

4.2.0 Effect of maize variety, (Regular maize, Obatanpa, Abontem, and Honampa) maize on the growth performance of broilers.

4.2.1 Growth Performance of experimental broilers on variety of maize from day 0 to 7 day.

Table 4.2 indicates the results of the analysis of variance for the effect of Regular maize, Obatanpa, Abontem, and Honampa and maize on the growth performance of broilers between 0 to 7 days.

Table 4.2 The effect of Regular maize, Obatanpa, Abontem, and Honampa maize on the growth performance of broilers from day 0 to 7 day.

Parameters	RM	OBM	ABM	HM	(OB+AB+H)	P-VALUE	SEM
Liv, %	97.22^a	91.67^a	91.67^a	100.0^a	97.22^a	0.455	1.69
BW, g	117.701^a	125.26^a	127.13^a	125.72^a	117.24^a	0.312	1.91
Gain, g	76.67^a	84.71^a	87.57^a	86.89^a	76.00^a	0.247	1.82
FCRc	0.8309^a	1.195^a	0.8021^a	1.077^a	0.9240^a	0.437	0.0784
Intake, g	66.32^a	101.1a	71.0^a	93.3^a	70.82^a	0.436	6.96

SEM: Standard Error of Means; a, b, c: Means with different superscripts on the same row are Significant differences (p<0.05). Mean values with the same superscript in the same row are not significantly different (P>0.05). RM=Regular Maize, OBM=Obatanpa maize, ABM=Abontem maize, HM=Honampa maize. Liv=Liveability, BW= Body Weight, FCRc= Feed Conversion Ratio corrected and it was corrected for mortalit

Table 4.3 indicates the results of the analysis of variance for the effect of Regular maize, Obatanpa, Abontem, and Honampa and maize on the growth performance of broilers between 0 to 14 days.

Table 4:3 Performance of experimental broilers from day 0 to day 14

Parameters	RM	OBM	ABM	HM	(O+A+H)	P - VALUE	SEM
Liv, %	91.67^a	91.67^a	86.89^a	97.22^a	97.22^a	0.723	2.19
BW, g	236.37^a	256.8^a	264.6^a	264.01^a	243.2^a	0.322	5.16
Gain, g	198.35^a	216.2^a	225.1^a	225.18^a	202.6^a	0.292	4.97
FCRc	1.4730^a	1.5818^a	1.3884^a	1.474^a	1.5051^a	0.456	0.031
Intake, g	291.92^a	341.3^a	313.6^a	333.2^a	304.5^a	0.559	10.1

SEM: Standard Error of Means; a, b, c: Means with different superscripts on the same row are Significant differences (p<0.05). Mean values with the same superscript in the same row are not significantly different (P>0.05). RM=Regular Maize, OBM=Obatanpa maize, ABM=Abontem maize, HM=Honampa maize. Liv=Liveability, BW= Body Weight, FCRc= Feed Conversion Ratio corrected and it was corrected for mortality.

Table 4.4 indicates the results of the analysis of variance for the effect of Regular maize, Obatanpa, Abontem, and Honampa and maize on the growth performance of broilers between 0 to 21 days.

Table 4:4 Performance of experimental broilers from day 0 to day 21

PARAMETER	RM	OBM	ABM	HM	O+A+H	P-VALUE	SEM
Liv, g	91.67[a]	88.89[a]	86.11[a]	97.22[a]	94.44[a]	0.525	2.11
BW, g	403.90[a]	437.3[a]	469.30[a]	448.20[a]	431.80[a]	0.207	8.83
Gain, g	365.8[a]	396.8a	429.80[a]	409.40[a]	391.20[a]	0.210	8.72
FCR	1.700[a]	1.640a	1.5825[a]	1.5486[a]	1.525[a]	0.836	0.049
Intake, g	616.5[a]	645.4[a]	679.8[a]	632.5[a]	586.6[a]	0.405	15.0

SEM: Standard Error of Means; a, b, c: Means with different superscripts on the same row are Significant differences ($p<0.05$). Mean values with the same superscript in the same row are not significantly different ($P>0.05$). RM=Rgular Maize, OBM=Obatanpa maize, ABM=Abontem maize, HM=Honampa maize. Liv=Liveability, BW= Body Weight, FCRc= Feed Conversion Ratio corrected and it was corrected for mortality.

Table 4.5 indicates the results of the analysis of variance for the effect of Regular maize, Obatanpa, Abontem, and Honampa and maize on the growth performance of broilers between 0 to 28days.

Table 4:5 Performance of experimental broilers from day 0 to day 28

PARAMETER	RM	OBM	ABM	HM	O+A+H	P-VALUE	SEM
Liv, %	86.11[ab]	77.8[ab]	58.33[b]	94.44[a]	88.89[a]	0.022	4.04
BW, g	585.1[b]	706.3[ab]	779.2[a]	686.8[ab]	667.5[ab]	0.068	22.1
Gain, g	547.0[b]	665.7[ab]	739.6[a]	648.0[ab]	626.9[ab]	0.069	22.00
FCRc	1.869[a]	1.6599[a]	1.603[a]	1.6736[a]	1.6885[a]	0.358	0.042
Intake, g	1014.8[a]	1099.3[a]	1165.3[a]	1080.6[a]	1056.1[a]	0.305	22.4

SEM: Standard Error of Means; a, b, c: Means with different superscripts on the same row are Significant differences ($p<0.05$). Mean values with the same superscript in the same row are not significantly different ($P>0.05$). RM=Regular Maize, OBM=Obatanpa maize, ABM=Abontem maize, HM=Honampa maize. Liv=Liveability, BW= Body Weight, FCRc= Feed Conversion Ratio corrected and it was corrected for mortality.

Table 4.6 indicates the results of the analysis of variance for the effect of Regular maize, Obatanpa, Abontem, and Honampa and maize on the growth performance of broilers between 0 to 35 days.

Table 4:6 Performance of experimental broilers from day 0 to day 35

PARAMETER	RM	OBM	ABM	HM	OB+AB+H	P-VALUE	SEM
Liv, %	72.22^{ab}	72.2^{ab}	52.78^{b}	91.67^{a}	86.11^{ab}	0.029	4.41
BW, g	689.4^{a}	780.2^{a}	900.8^{a}	845.8^{a}	812.8^{a}	0.092	25.8
Gain, g	651.3^{a}	739.7^{a}	861.3^{a}	807.0^{a}	772.2^{a}	0.092	25.7
FCRc	2.369^{a}	1.939^{a}	1.7738^{a}	1.9298^{a}	1.950^{a}	0.100	0.073
Intake, g	1490.9^{a}	1423.6^{a}	1523.2^{a}	1555.6^{a}	1490.4^{a}	0.547	24.0

SEM: Standard Error of Means; a, b, c: Means with different superscripts on the same row are Significant differences (p<0.05). Mean values with the same superscript in the same row are not significantly different (P>0.05). RM=Regular Maize, OBM=Obatanpa maize, ABM=Abontem maize, HM=Honampa maize. Liv=Liveability, BW= Body Weight, FCR= Feed Conversion Ratio corrected and it was corrected for mortality.

Table 4.7 indicates the results of the analysis of variance for the effect of Regular maize, Obatanpa, Abontem, and Honampa and maize on the growth performance of broilers between 0 to 42 days.

Table 4:7 Performance of experimental broilers from day 0 to day 42

Parameters	RM	OM	ABM	HM	OB+AB+H	P - VALUE	SEM
Liv, %	58.3^{a}	61.1^{a}	52.78^{a}	80.56^{a}	80.56^{a}	0.183	4.70
BW, g	804.4^{b}	947.1^{ab}	1130^{a}	1002.6^{ab}	1054^{ab}	0.050	37.5
Gain, g	776.3^{b}	906.5^{ab}	1090.4^{a}	963.7^{ab}	1014^{ab}	0.050	37.3
FCRc	3.497^{a}	2.680^{ab}	2.4006^{b}	2.6672^{ab}	2.436^{ab}	0.046	0.135
Intake, g	2625^{a}	2415^{a}	2605^{a}	2569^{a}	2410.5^{a}	0.787	67.0

SEM: Standard Error of Means; a, b, c: Means with different superscripts on the same row are Significant differences (p<0.05). Mean values with the same superscript in the same row are not significantly different (P>0.05). RM=Silo Maize, OBM=Obatanpa maize, ABM=Abontem maize, HM=Honampa maize. Liv=Liveability, BW= Body Weight, FCR= Feed Conversion Ratio corrected and it was corrected for mortality.

4.3 The effect of Regular maize, Obatanpa, Abontem, and Honampa maize on Carcass Characteristics of experimental broiler chickens on the varieties of maize

Table 4.8 indicates the results of the carcass characteristics of experimental broiler chicken on the maize varieties at the end of the experimental period, day 42. Parameters taken on carcass were mean live weight, breast weight, thigh weight, heart weight, duodenum weight, liver weight, proventriculus weight, gizzard weight, jejunum weight, ileum weight, and caeca weight.

Table 4.8. The effect of Regular maize, Obatanpa, Abontem, and Honampa maize on Carcass Characteristics of broiler chickens.

PARAMETERS (% per liveweight)	RM	OBM	ABM	HM	OAH	P-VALUE	SEM
Mean live wgt	875[b]	1104[b]	1750[a]	1572[ab]	1653[a]	0.006	101.00
Breast wgt (BW)	5.232[a]	5.731[a]	6.838[a]	6.938[a]	6.875[a]	0140	0.273
Thigh wgt (TW)	9.5605[a]	9.451[a]	10.244[a]	9.993[a]	9.795[a]	0.374	0.137
Heart wgt (HW)	0.5926[a]	0.5689[a]	0.4595[a]	0.5286[a]	0.4305[a]	0.052	0.021
Duodenum wgt	1.359[a]	1.258[a]	0.9523[a]	0.9959[a]	0.908[a]	0.262	0.077
Liver wgt (LW)	2.880[a]	2.759[a]	2.309[a]	2.2178[a]	2.400[a]	0.075	0.092
Proventriculus wgt	0.6587[a]	0.6666[a]	0.4513[b]	0.5039[ab]	0.4601[b]	0.002	0.027
Gizzard wgt (GW)	2.481[a]	2.313[a]	2.167[a]	2.1238[a]	2.257[a]	0.367	0.059
Jejunum wgt (JW)	2.072[a]	1.805[a]	1.561[a]	1.632[a]	1.740[a]	0.256	0.076
Ileum wgt (IW)	1.4365[a]	1.267[a]	1.0691[a]	1.191[a]	1.117[a]	0.191	0.052
Caeca (CW)	0.632[a]	0.666[a]	0.3858[a]	0.4632[a]	0.4340[a]	0.057	0.038

SEM: Standard Error of Means; a, b, c: Means with different superscripts on the same row are Significant differences ($p<0.05$). Mean values with the same superscript in the same row are not significantly different ($P>0.05$). RM=Regular Maize, OBM=Obatanpa maize, ABM=Abontem maize, HM=Honampa maize

4.2 Discussion

4.2.1 Feed intake

The results of the growth performance of broilers fed with a variety of maize are presented in table 4.1 to table 4.7.

The result obtained from the study showed that the different varieties of certified maize and regular maize had no significant (P> 0.05) effect on feed intake throughout the experiment (weeks 1-6) even though differences exist in the treatment means recorded for the various treatments. Higher feed intake was recorded for birds fed with (Abontem) maize variety diet in weeks 3 and 4, higher feed intake was recorded for birds fed with (Regular maize) diet in week 6, and also higher feed intake was seen in birds fed with (Obaatanpa) maize diet in week 1 and 2, whereas (Honampa) maize diet giving the best feed intake in the week due to the high protein content in HM gave the high life weight. This is in agreement with the study by (Amevor, 2017) who had similarities in his study of moringa leaf meal for broiler chicken. The result of the study revealed that feed intake increased significantly as the birds grew from weeks 1-6. The difference in the nutritional content in the various maize varieties did not have much influence on the feed intake of the birds throughout the study. The difference in the feed intake values could be due to the appetizing effect of some of the maize varieties. The similarities recorded in feed intake were following what was earlier reported when four different varieties, two Quality Protein Maize and two normal maize, were fed to pigs (Oliveira *et al*., 2011). The results of this study agree with the study by Okai *et al*. (2015), who studied the nutritional evaluation of some new maize varieties and the effects on growth performance and carcass traits of albino rats and found no significant difference in the feed intake throughout the experiment, though comparable values were recorded for (RM) and

(OBM). This is in agreement with the finding by (Bello & Muhammad, 2021) who had no significant difference in feed intake for broilers fed on dietary level of maize residue.

4.2.2 Body weight

The birds fed with the (Abontem) diet recorded the highest (127.72g) body weight in week 1 with the combination of the three varieties of maize recording the least body weight (117.24g). A similar pattern was recorded in week 2 and week 3. Although differences exist among the treatment means, analysis of variance showed no significant difference (P> 0.05) in body weight in weeks 1, 2, 3, and 5. (Regular maize) recorded the least body weight from week 2 to week 6. Analysis of variance showed a significant difference (P <0.05) for body weight in weeks 4 and 6. Treatment comparisons showed a significant difference between (Regular maize) and (Abontem) maize diets in week 4. A similar trend was recorded in week 6. The difference in body weight recorded for the various treatment could be attributed to the different nutrients present in the maize varieties. This present study agrees with Khan *et al*. (2020) who reported that the supplementation of different varieties of maize in broilers' diet had no significant impact on the body weight of broilers. Dela *et al.* (2014), evaluated that supplementation of certified maize varieties in the diets of broilers significantly increases the body weight compared to the control group. The increase in body weight of the broilers fed with maize varieties(Honampa, Abontem, Obatanpa) could be attributed to the extra nutrient and metabolizable energy properties of the compounds found in the certified maize varieties.

The results obtained from the study revealed that birds fed with the (Abontem) maize variety recorded the highest body weight gain throughout the experimental period (weeks 1-6). Body weight gain was low in (combination) maize varieties in week one.

However, birds fed with (Regular maize) diet recorded the least body weight gain from weeks 2-6. Although differences exist between the treatment means, analysis of variance showed no significant difference ($P > 0.05$) between the treatment means in weeks 1, 2, 3, and 5. However, analysis of variance showed a significant difference ($p < 0.05$) for feed intake in weeks 4 and 6. The difference in body weight gain could be attributed to the nutrient and metabolizable energy properties found in the maize varieties.

This agrees with the work of Oliveira *et al*. (2011), who concluded from their work that there were no effects of dietary treatment on body weight gain of the broilers fed on different maize varieties. The insignificance difference observed across the treatment groups, showed that the inculcation of different maize diets does not have any effect on the body weight gain of broilers. This could be accorded to the similar nutrients available in the maize varieties. The result of this study is in correspondence to Yesilbag *et al.* (2013), who reported that average weight gain increases with increasing feed supplied to the broiler. Singh *et al.* (2014), also reported a nonsignificant difference in feed consumption and body weight when they research into the positive effects of using different varieties of maize on pigs at 42 days of age. Gholipour *et al*. (2016), reported that the use of different varieties of maize in the diets for guinea fowls resulted in a nonsignificant difference ($P > 0.05$) in the body weight gain.

4.2.3 Feed Conversion Ratio

The results obtained showed that the feed conversion ratio at all levels of growth was not significant ($P > 0.05$) influenced by different varieties of maize in the diets of birds from (week 1 to week 5) of the study. The variations that were not observed in the feed conversion ratio are an indication that birds fed with the different varieties of maize were not efficient in converting the feed mass they consumed into body mass (Table 4.5). However, analysis of variance showed a significant difference ($P < 0.05$) in the feed conversion ratio for birds fed with different varieties of maize diets in week 6. Although differences exist in the treatment means, treatment comparisons showed no significant difference between treatments 2, 3, and 4. According to (Bello & Muhammad, 2021) there was no significant difference in FCR for birds fed with dietary maize residue but the values for FCR do not conform to the result of the present study. Improvement in the FCR has also been realized in pigs-fed diets containing Obatanpa (Carman *et al*., 2013). This is in line with Oliveira *et al.* (2011), who reported that broiler diets supplemented with different varieties of maize have no significant effect on the feed conversion ratio. This again is in correlation with the work by Walsh *et al.* (2012), who reported in the inculcation of different varieties statically did not influence the feed conversion ratio of pigs. This also agrees with the work of Okai et al. (2015), whose work supported this present study by stating from his work that, broiler birds fed with different varieties of certified maize showed no significant differences ($P> 0.05$) in performance and their control diet as well.

4.2.4 Livability

The results obtained from the study revealed that livability weight was high in birds fed with (Honampa) maize diet with (Abontem) having the least livability weight in week 1 A similar pattern was observed from weeks 2-3. Although differences exist in the treatment means, analysis of variance showed no significant effect ($P>0.05$) on livability in weeks 1, 2, 3, and 6. However, analysis of variance showed a significant effect ($P<0.05$) on livability in weeks 4 and 5. The insignificant difference obtained in the birds on livability for the first three weeks was due to the starter diet provided which has sufficient protein for use by the birds. The results of this study agree with the study by Oliveira *et al.* (2011), who reported that broiler diets supplemented with different varieties of maize have no significant effect on the livability of the birds.

4.3 Carcass traits

The summary of the result revealed a significantly different ($P<0.05$) among treatments for live weight and proventriculus weight. However, no significant difference($P>0.05$) was recorded among treatments for breast weight, thigh weight, heart weight, duodenum weight, liver weight, gizzard weight, jejunum weight, and ileum weight. ABM recorded high numerical values for the mean live weight (1750g) whilst RM has the least values (875g), there were similarities for carcass thigh weight, heart weight, and liver weight among treatments. Results for proventriculus showed a significant difference among treatments, RM recorded the high value of 0.6587g whilst ABM has the lower value, 0.4513g. Birds on RM had a higher value for gizzard compared to the other birds fed on the other treatment. Jejunum, ileum, and caeca had no significant difference among treatments. This can relate to the finding by(Ayssiwede *et al.*, 2020) who recorded no significant difference among treatments except for dressed weight, gizzard weight, and breast weight when the birds were fed with moringa leaf meal.

Also, different varieties of certified maize and regular maize inclusion in the diet of broilers had a significant ($P<0.05$) effect on the live weight and weight of proventriculus. The component of carcass traits that were significantly influenced by different varieties of certified maize and control maize according to Yesilbag *et al.* (2013), was a result of the different nutrients supplied to the birds which influenced the body weight of the broiler birds. This is in line with Melo-Durán *et al.* (2021) who reported that the live weight of birds was affected by the inclusion of maize in their diets.

The non-differences among all treatment groups for breast weight, thigh weight, heart weight, duodenum weight, liver weight, gizzard weight, jejunum weight, ileum weight, and caeca weight are supported by the work of Panda (2010), who did not observe any significant effect of feeding broilers with different varieties of certified maize. This present study agrees with Singh (2020) who reported that internal organ weights and carcass characteristics were not influenced by feeding different varieties of maize except proventriculus weight. A similar observation was observed in the study by Khan *et al.* (2020), who did not report any significant influence of different maize varieties on relative weights of liver, heart, and carcass at slaughter age in broilers. This again is in line with the work of Okai *et al.* (2015), who in their work found no significant differences in liver weight and heart weights of broiler chickens fed with wheat soybean meal diets supplemented with different varieties of maize.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion;

From the result of the experiment, it could be concluded that;

1. The Proximate analysis of the variety of maize had similarities in percentage values for all the chemical compositions
2. The growth performance of the experimental birds was not negatively influenced by the various maize (Regular maize, Obatanpa, Abontem, and Honampa maize) though there were some differences in values for the growth parameters.
3. Carcass characteristics of the broiler birds were not negatively influenced by the dietary treatment (Regular maize, Obatanpa, Abontem, and Honampa maize). Even though significant difference between Livabity and proventriculus was recorded.

5.2 Recommendation;

Considering the results of the study, farmers can feed broilers with different varieties of maize (Regular maize, Obatanpa, Abontem, and Honampa maize) since it has no significant difference in growth performance and carcass characteristics. Also, further research should be done to determine the growth performance and carcass characteristics of poultry apart from broiler chickens.

I, therefore, recommend that Obatanpa being a quality protein maize is the most appropriate maize variety for diet composition since it increased the weight of the birds as compared to the other maize varieties

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APPENDICES

Growth performance ANOVA

ANALYSIS OF VARIANCE LIVEABILITY DAY 0-7

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	222.2	55.56	0.96	0.455
Error	15	864.2	57.61		
Total	19	1086.4			

ANALYSIS OF VARIANCE FOR INITIAL BODY WEIGHT DAY 0-7

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	360.1	90.03	1.31	0.312
Error	15	1032.7	68.85		
Total	19	1392.8			

ANALYSIS OF VARIANCE WEIGHT GAIN DAY 0-7

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	363.5	90.87	1.52	0.247
Error	15	897.9	59.86		
Total	19	1261.4			

ANALYSIS OF VARIANCE FOR CONSUMPTION DAY 0-7

Source	DF	Adj SS	Adj MS	F-Value	P Value
TRMT	4	258826	64706	1.00	0.437
Error	15	967672	64511		
Total	19	1226498			

ANALYSIS OF VARIANCE FCR DAY 0-7

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	0.4468	0.1117	0.89	0.495
Error	15	1.8870	0.1258		
Total	19	2.3338			

ANALYSIS OF VARIANCE FOR INTAKE DAY 0-7

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	3887	971.7	1.00	0.436
Error	15	14522	968.2		
Total	19	18409			

ANALYSIS OF VARIANCE FOR LIVEABILITY DAY 7-14

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	222.2	55.56	0.52	0.723
Error	15	1604.9	107.00		
Total	19	1827.2			

ANALYSIS OF VARIANCE FOR BODY WEIGHT DAY 7-14

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	2568	642.1	1.28	0.322
Error	15	7539	502.6		
Total	19	10107			

ANALYSIS OF VARIANCE FOR WEIGHT GAIN DAY 7-14

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	2503	625.8	1.37	0.292
Error	15	6869	457.9		
Total	19	9372			

ANALYSIS OF VARIANCE FOR CONSUMPTION DAY 7-14

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	63719	15930	0.19	0.939
Error	15	1241122	82741		
Total	19	1304841			

ANALYSIS OF VARIANCE FOR FCR DAY 7-14

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	0.07746	0.01936	0.96	0.456
Error	15	0.30148	0.02010		
Total	19	0.37894			

ANALYSIS OF VARIANCE FOR INTAKE DAY 7-14

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	6614	1653	0.77	0.559
Error	15	32023	2135		
Total	19	38637			

ANALYSIS OF VARIANCE FOR LIVEABILITY DAY 14-21

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	308.6	77.16	0.83	0.525
Error	15	1388.9	92.59		
Total	19	1697.5			

ANALYSIS OF VARIANCE FOR BODY WEIGHT DAY 14-21

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	9167	2292	1.68	0.207
Error	15	20479	1365		
Total	19	29646			

ANALYSIS OF VARIANCE FOR WEIGHT GAIN DAY 14-21

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	8888	2222	1.67	0.210
Error	15	20001	1333		
Total	19	28889			

ANALYSIS OF VARIANCE FOR CONSUMPTION DAY 14-21

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	625039	156260	0.73	0.583
Error	15	3191742	212783		
Total	19	3816781			

ANALYSIS OF VARIANCE FOR FCR DAY 14-21

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	0.08064	0.02016	0.36	0.836
Error	15	0.84841	0.05656		
Total	19	0.92906			

ANALYSIS OF VARIANCE FOR INTAKE DAY 14-21

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	19062	4765	1.07	0.405
Error	15	66670	4445		
Total	19	85732			

ANALYSIS OF VARIANCE FOR LIVEABILITY DAY 21-28

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	3173	793.2	3.93	0.022
Error	15	3025	201.6		
Total	19	6198			

ANALYSIS OF VARIANCE FOR BODY WEIGHT DAY 21-28

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	78457	19614	2.75	0.068
Error	15	107145	7143		
Total	19	185602			

ANALYSIS OF VARIANCE FOR WEIGHT GAIN DAY 21-28

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	77248	19312	2.73	0.069
Error	15	106012	7067		
Total	19	183260			

ANALYSIS OF VARIANCE FOR CONSUMPTION DAY 21-28

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	3295999	824000	3.18	0.044
Error	15	3882075	258805		
Total	19	7178074			

ANALYSIS OF VARIANCE FOR FCR DAY 21-28

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	0.1607	0.04017	1.18	0.358
Error	15	0.5095	0.03397		
Total	19	0.6702			

ANALYSIS OF VARIANCE FOR INTAKE DAY 21-28

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	49679	12420	1.33	0.305
Error	15	140402	9360		
Total	19	190081			

ANALYSIS OF VARIANCE FOR LIVEABILITY DAY 28-35

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	3642	910.5	3.66	0.029
Error	15	3735	249.0		
Total	19	7377			

ANALYSIS OF VARIANCE FOR BODY WEIGHT DAY 28-35

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	99574	24893	2.44	0.092
Error	15	152829	10189		
Total	19	252402			

ANALYSIS OF VARIANCE FOR WEIGHT GAIN DAY 28-35

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	98546	24636	2.44	0.092
Error	15	151505	10100		
Total	19	250051			

ANALYSIS OF VARIANCE FOR CONSUMPTION DAY 28-35

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	10235494	2558873	2.87	0.060
Error	15	13353175	890212		
Total	19	23588669			

ANALYSIS OF VARIANCE FOR FCR DAY 28-35

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	0.7922	0.19805	2.36	0.100
Error	15	1.2600	0.08400		
Total	19	2.0523			

ANALYSIS OF VARIANCE FOR INTAKE DAY 28-35

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	38340	9585	0.79	0.547
Error	15	181036	12069		
Total	19	219377			

ANALYSIS OF VARIANCE FOR LIVEABILITY DAY 35-42

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	2716	679.0	1.79	0.183
Error	15	5679	378.6		
Total	19	8395			

ANALYSIS OF VARIANCE FOR BODY WEIGHT DAY 35-42

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	240585	60146	3.06	0.050
Error	15	295036	19669		
Total	19	535621			

ANALYSIS OF VARIANCE FOR WEIGHT GAIN DAY 35-42

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	238199	59550	3.06	0.050
Error	15	291438	19429		
Total	19	529637			

ANALYSIS OF VARIANCE FOR CONSUMPTION DAY 35-42

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	8289209	2072302	4.35	0.016
Error	15	7152623	476842		
Total	19	15441833			

ANALYSIS OF VARIANCE FOR FCR DAY 35-42

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	3.154	0.7885	3.15	0.046
Error	15	3.756	0.2504		
Total	19	6.910			

ANALYSIS OF VARIANCE FOR INTAKE DAY 35-42

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMT	4	174454	43614	0.43	0.787
Error	15	1531576	102105		
Total	19	1706030			

CARCASS ANOVA

ANALYSIS OF VARIANCE FOR % BODY LIVE WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	2317834	579459	5.63	0.006
Error	15	1543486	102899		
Total	19	3861320			

ANALYSIS OF VARIANCE FOR % BREAST WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	9.954	2.488	2.04	0.140
Error	15	18.306	1.220		
Total	19	28.260			

ANALYSIS OF VARIANCE FOR % THIGH WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	1.654	0.4134	1.14	0.374
Error	15	5.427	0.3618		
Total	19	7.081			

ANALYSIS OF VARIANCE FOR % HEART WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	0.07728	0.019321	3.02	0.052
Error	15	0.09590	0.006394		
Total	19	0.17319			

ANALYSIS OF VARIANCE FOR % DUODENUM WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	0.6454	0.1613	1.47	0.262
Error	15	1.6511	0.1101		
Total	19	2.2965			

ANALYSIS OF VARIANCE FOR % LIVER WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	1.348	0.3370	2.64	0.075
Error	15	1.914	0.1276		
Total	19	3.262			

ANALYSIS OF VARIANCE FOR % PROVENTRICULUS WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	0.18142	0.045355	6.86	0.002
Error	15	0.09916	0.006611		
Total	19	0.28058			

ANALYSIS OF VARIANCE FOR % GIZZARD WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	0.3131	0.07828	1.16	0.367
Error	15	1.0128	0.06752		
Total	19	1.3259			

ANALYSIS OF VARIANCE FOR % JEJENUM WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	0.6227	0.1557	1.49	0.256
Error	15	1.5713	0.1048		
Total	19	2.1940			

ANALYSIS OF VARIANCE FOR % ILEUM WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	0.3330	0.08326	1.75	0.191
Error	15	0.7125	0.04750		
Total	19	1.0455			

ANALYSIS OF VARIANCE FOR % CAECA WEIGHT

Source	DF	Adj SS	Adj MS	F-Value	P-Value
TRMTS	4	0.2499	0.06247	2.92	0.057
Error	15	0.3210	0.02140		
Total	19	0.5709			