**CHAPTER ONE**

**INTRODUCTION**

* 1. **Background of the Study**

Poultry is a term use to describe any kind of domesticated birds. It can literally be defined as domestic fowls, including; chickens, turkeys, goose and ducks, raised primarily for the production of meat and eggs (The American Heritage, 2009). Firstly, domesticated birds was only limited to chickens, turkeys, goose and ducks, but it has recently expanded to include; quail, pigeon and guinea fowl (The American Heritage, 2009).

Globally, the poultry industry benefit the farmer (producer) and by extension contributes to the national economy. It provides a means of livelihood or employment to the populace, source of income to the farmer, source of food (as meat and egg) for the population, source of raw materials for industrial activities, source of foreign exchange via export of products and contributes to the Gross Domestic Product (GDP) of the National economy (Nwafor *et al.,* 2011). The poultry industry is one of the emerging agri-business enterprise that has established its position as the fastest growing segment in the agricultural sector in Nigeria (David, 2002). Globally, chicken birds are the most reared type of birds compared to other poultry species; with over 50 million birds being reared annually as a source of meat and eggs (Gene, 2014). Chickens kept for the purpose of meat are termed ‘broiler chickens’, while those kept for eggs are “the layer chicken” (Adene and Oguntade 2006; USDA, 2013; Gene, 2014). The popularity of poultry production is attributed to the fact that poultry has many advantages over other livestock. Poultry birds are good converters of feed into useable protein in meat; its production cost per unit investment is relatively low and the return on investment is high (Adene and Oguntade, 2006; Heinke *et al.,* 2015). In Nigeria, in the last two decades, poultry production has gone from 1.8 to 3.8 million tons (CBN, 2010; Navjot *et al.,* 2017). The contribution of broiler production to Gross Domestic Product (GDP) have decreased from 5.61% in 1960 to about 2.64% in 2010 (CBN, 2010). This decrease may be attributed to the challenge or constraints faced by the poultry industry which include; high rate of disease and pest attack, lack of loan and credit procurement, lack of technical knowledge, high rate of mortality, high cost of poultry feed, supply of poor quality chicks, inadequate poultry extension services, inadequate access and high cost of veterinary services (Anosike *et al.,* 2018; Ajala *et al.,* 2007; Aromolaran *et al.,* 2013; Adebajo and Adeola, 2005). The challenges of broiler production in Nigeria are multifaceted but rising cost of feed is a major constraint faced by majority of broiler producers. Soniya and Swan (2004) reported that the cost of feed covers about 70% of the total cost of production. We can therefore conclude that the high cost of feeding of broiler chickens is attributed to the high cost of feed. Olaniyi *et al.* (2008) identified the high cost of feed ingredients, especially; protein and energy feed sources as a major contributory factor to feed cost. This, they concluded may result from the high competition of these feed ingredients with humans as a source of food.

Over the past 50 years, several studies focusing on strategies to reduce feeding cost in broiler chickens have been conducted, including; strategies to reduce cost of feed through the use of non-conventional feedstuff; the use of least cost in feed formulation; feed restriction methods and increased feed ultilization in birds (Igbal *et al*., 2011; Dhama *et al.,* 2007; Safa *et al.,* 2014; Navjot *et al.,* 2017; Mahady *et al.,* 2008). Studies targeted on increasing feed efficiency have mainly been on the use of feed additives on broiler nutrition (Menten, 2001; Jose *et al.,* 2008; Jones *et al.,* 2010; Han *et al.,* 2010). Feed additives are substances that are added to a diet to provoke response towards the exploitation of maximum genetic potential of the animal, improve nutritional value and as well improve growth and feed conversion efficiency (Dhama *et al.,* 2014). There are different feed additives that are used in the poultry industry and these include; minerals, enzymes, antibiotics, vitamins, hormones, etc. (Dhama *et al.,* 2007, 2011; Mahady *et al.,* 2008).

Since the 1950’s, antimicrobial feed additives (antibiotics and chemotherapeutic drugs) have been used as growth promoters in broiler production. This has contributed to increased productivity via improved growth rate of birds raised under intensive conditions (Menten, 2001; Jose *et al.,* 2008). The use of antibiotic-based growth promoting agents in broiler nutrition have correlated strongly with decreased feed consumption resulting from increased feed conversion rate in birds. This has contributed to a decrease in feeding cost and increased profit maximization (Jose *et al.,* 2008). Despite the observed improvement in broiler performance, reduction in comparative cost of feed and maximization of profit, the use of antibiotic growth promoters has been increasingly criticized due to it incriminating role in the development of antimicrobial resistance in humans, thought to result from modification of the micro biota in the gut of humans (Jose *et al.,* 2008; Jones *et al.,* 2010; Han and Thacker, 2010; Thacker, 2013). This may have contributed to the ban on the use of all antibiotics and chemotherapeutic drugs as growth promoters in poultry and livestock production in several countries, especially the European Union countries and North America (Dhama *et al.,* 2014). This increasing restriction of antibiotic growth promoters in poultry nutrition has redirected research attention to shift significantly to experimental trials on the use of non-antibiotic based or alternative growth promoting compounds that combines the positive growth promoting effect of antibiotics with increase food safety in human nutrition (Hassan *et al.,* 2004; Kamel, 2000).

Black pepper (*Piper nigrum L.*) is a known spice due to it pungent quality (Hassan *et al.,* 2007). It plays an important role in improving the taste, aroma and the general nutritional properties of the food in human nutrition (Abd El-Hack and Alagawany, 2015; Alireza *et al.,* 2021). It is a common medicinal herb usually processed by drying it fruit (Moorthy *et al.,* 2009). Turner and Jack (2014) reviewed that this spice have been employed for various treatment of health issues; stomach disorders, bronchitis and cancer. It works to help fight germs (microbes) and causes the stomach to increase the flow of digestive juice, hence improving digestibility (Moorthy *et al.,* 2009; Al-kassie *et al.,* 2011). Black pepper (*Piper nigrum L.*) is also reported to have numerous health benefits which may be attributed to its antioxidant properties (Al-kassie *et al.,* 2011; Hassan *et al.,* 2007). Additionally, the active compound *“piperine”* in black pepper has anti-ache effect (Mahady *et al.,* 2008) and has major pharmacological impact on the nervous and neuromuscular system (Great, 2003; Safa *et al.,* 2014). Its mechanism of action may be attributed to the active ingredients present, including; piperine, cupsacsin, cupsisin, supsantine, carotene and some vitamin B complexes (Khalaf, 2008; Mahady *et al*., 2008; Safa *et al.,* 2014; Turner and Jack, 2004). In broiler nutritional studies, many researchers have reported contrasting results using black pepper as additive (Great, 2003; Iqbal *et al.,* 2011; Safa *et al.,* 2014; Hassan *et al.,* 2007).

**1.2. Problem Statement**

In poultry production, feeding constitutes the highest variable cost, accounting for at least 70% of the total production cost in intensive rearing system. This high cost of feeding is attributed to competition of feed ingredients (especially; maize and soybean) by the human population for consumption and production. Broiler birds requires proper and balanced nutrients (energy, protein, vitamins, minerals and water) to produce quality meat. The feeding of broiler chickens, therefore is a major challenge and a major contributory factor limiting profitability in the broiler industry. Numerous studies have attempted measures to mitigate this production constraints in broiler production (Hassan *et al.,* 2007; Moorthy *et al.,* 2009; Turner and Jack, 2004; Safa *et al.,* 2014; Navjot *et al.,* 2017). In the last fifty years, increased usage of in-feed antibiotic based compounds broiler production have resulted in significantly increased growth rate, decreased age to market weight and general productivity. These benefits however, have been met with increasing criticism. Some studies have reported correlation between antibiotic prolonged antibiotic usage in chickens with the development of resistant strains of microbes in chicken and human gut (Jose *et al.,* 2008; Jones *et al.,* 2010; Han and Thacker, 2010; Thacker, 2013). This public health and food safety concern has therefore led to restriction and in some countries an outright ban of the use of antibiotic growth promoters in broiler chicken production. There is therefore, need to search for alternative feed additives that will boost production, increase farmers profit and reduce feed cost.

**1.3. Justification of the Study**

Broiler production is an important enterprise, a major employer of labour, source of income to producers, means of foreign exchange, etc. To boost it production, several strategies has been employed, including; the use of antibiotics, whose effect has been observed by modification of the microbiota of the gastrointestinal tract in human consumers of chickens. Black pepper (*Piper nigrum*) is a flowering vine in the family *Piperaceae,* genus *Piper* and species *Piper nigrum*. The outer fruit layer contains important odor-contributing terpenes, including, piperine, sabinene and limonene gives a tasty properties. This herb is a known spice which improves digestibility via stimulation of digestive enzyme activity (Moorthy *et al.,* 2009). Growth promoters as digestion and absorption enhancer are important feed additives for improving growth rate, feed efficiency and prevention of intestinal infections (Mohan *et al.,* 1996). Several authors carried out a number of experiments to investigate the efficiency of adding herbs to the broiler diets (Afifi, 2001; Al-Harthi *et al.,* 2002; Tolba and Hassan, 2003; El-Deek *et al.* 2003; Hassan *et al.* 2004). Pepper Species, commonly used in diet and traditional medicine, were assessed for their antioxidant potential. Catalase activity predominated in *Piper longum L.,* followed by *Piper cubeba* L. (Karthikeyan and Rani, 2003). Black pepper (*P. nigrum L.*) was found to be rich in glutathione peroxidase and glucose-6-phosphate dehydrogenase. It has also been shown that *piperine* can dramatically increase absorption of selenium, vitamin B complex, beta carotene and curcumin as well as other nutrients (Khalaf, 2008). *Piperine* enhances the thermogenesis of lipid and accelerates energy metabolism in the body and also increases the serotonin and beta–endorphin production in the brain (Malini *et al.,* 1999). In poultry nutrition, as it is known that feeding cost is considered the most expensive item in the whole production process. Therefore, attempts are usually made to reduce feed cost without adversely affecting performance or products safety (Gill, 1999; Dickens *et al.,* 2001; Abaza, 2001; AL-Harthi, 2002 et al., Hassan *et al.,* 2004; Hassan et al., 2007). Hence, there is need to evaluate the effect of Black pepper *(Piper nigrum)* on broiler chickens growth, serum and hematological parameters raised in the tropics.

**1.4 Objectives of the Study**

The specific objective of the study were:

1. To determine the growth performance of broiler chickens fed diet supplemented with Black pepper and Zinc Bacitracin.
2. To determine the hematological parameter of broiler chickens fed diet supplemented with Black pepper and Zinc Bacitracin.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1. Poultry Industry in Nigeria**

The domestication of birds such as, chickens, quails goose, turkeys, pigeons and ducks is refers to "poultry". Poultry is one of the lucrative sub-sector of the livestock sector in agriculture (FAOSTAT, 2002). Chickens birds are the most domesticated class of poultry worldwide and in Nigeria. According to NABC (2020) the Nigerian Poultry sub-sector is increasing drastically in terms of production and employment capacity. Poultry production is also recorded by Manyong *et al.,* (2005), to be a means of foreign exchange contributing to 25% of the total agricultural contribution to Nigerian GDP. Despite the tonnes of constraints faces by the poultry industry in Nigeria, lack of governmental support, high cost of feed, high cost of investment, lack of quality chick, high cost of veterinary services, etc., poultry production in Nigerian is recorded to be among the top list of countries in West Africa for high production capacity (FAO, 2010; Anosike *et al.,* 2015).

The average production capacity of broilers in Nigeria is 1 million tonnes per annum (FAO, 2010) and the future production capacity is postulated to be 10 million tonnes per annum before 2050 (NABC, 2020, FAO, 2010). Anosike *et al.,* (2015), reported that the Nigerian poultry industry production capacity is limited due to myriads of challenges facing the sector especially; high cost of feed which is affecting poultry producers in developing countries: Nigeria inclusive. He further postulated possible solutions to mitigate the constraints facing the industry with emphasize on various agencies to adopt especially the use of non-conventional feedstuff and feed additive to ameliorate high cost of feed.

**2.2 Economic Importance of Poultry**

The benefits of poultry production is innumerable and aside from provision of protein (as meat and eggs), poultry production benefits the population and the national economy in terms of; Provision of employment to the producers; NABC (2020) reported that the poultry sub-sector slave employs about 14 million Nigeria directly and indirectly. Aside from a means of employment, poultry production is a major source of income to keepers through sales of animal product, droppings and feather (FAO, 2010). Poultry production is a major source of raw materials for industrial production activities. Poultry production is also a means of foreign exchange as it is recorded to contribute about 25% of total agricultural to the nation's GDP (NABC, 2020).

**2.3 Challenges of Poultry Production**

Excluding the benefits of poultry production, the industry is faced with numerous challenges that have thwarted the progress and production rate of poultry especially in developing countries such as Nigeria. Anosike *et al.,* (2015) reported that most poultry investment fails due to lack of knowledge and expertise on poultry management and practices as majority of farmer venture into the industry without proper skill, knowledge and study all because of high profitability which in turns leads to failure. High feed cost and by extension, feeding have been reported by several authors as a major problem in poultry, accounting to over 70% of the total cost of production. This in part may be attributed to high demand and competition of conventional feed stuff (maize and soybean) by humans for food and production (Agro-lnd, 2002; Sonaiya and Swan, 2004; Anosike *et al.,* 2015; Alavi *et al.,* 2012; *Dhama et al.,* 2011).

**2.4 Nutrient Requirement of Broiler Chickens**

Broiler chickens are poultry birds that produces tender meat with soft, palatable, smooth textured skin and flexible breastbone cartilage. There is need to obtain rapid growth in broilers. Ultimately nutrient requirements are also higher than the chickens raised for egg production. In case of layer rate of growth is not important as they obtain a body weight of 1.5 kg in 20 weeks. The same weight is obtained in just 5-6 weeks in case of broiler (Cheeke, 2005). Broiler chickens requires; energy, protein, vitamins, minerals and water for growth, development and maintenance.

**2.4.1 Protein**

The growth of the broilers depends up on the level of a balanced protein along with other nutrients. The need of the body for proteins is actually a need for the amino acid especially the essential amino acids (Ravindran, 2013). The protein requirement of growing chicken includes the amount of protein needed for maintenance plus the amount needed for tissue growth with an allowance for the losses in the digestion and metabolism. For broiler chickens, 61% of the total protein consumed is retained by the body of a growing chicken. Protein for maintenance requirement is 1.6gm protein per kg body weight,i.e., 250 mg/kg body weight of broiler birds. Broiler chickens requires a protein level of about 19-24% for growth and development (Ravindran, 2013). A major constraint to the use of most protein sources is the presence of anti-nutritional factors in the diet. Some of the anti-nutritinal factors found in protein feed stuff include; Protease inhibitors, phytate, lectins, polyphenolic compounds, glucosinolates, saponins, etc. These anti-nutritional factors depress nutrient digestion and utilization (Bryden, 2009). Sources of dietary protein also tend to contain the highest concentrations of anti-nutritional factors. For example, soybeans contains a range of anti-nutritional factors, many of which are heat-labile and are destroyed during processing (Dale, 1996). Unless destroyed or inactivated by heat or some other suitable treatment, these substances can exert adverse physiological effects when fed to animals (Bryden *et al.,* 2009). However, heat treatment may reduce protein quality through protein denaturation and development of Maillard-type reaction products (Bryden *et al.,* 2009). Dietary trypsin inhibitors are often responsible for the poor digestibility of dietary protein by interference with the proper function of endogenous proteases, leading to growth retardation and pancreatic hypertrophy (Bryden *et al.,* 2009). Trypsin inhibitors are rich in sulphur-containing amino acids, and thus can create stress and cause a deﬁciency of methionine, which is basically the ﬁrst limiting amino acid in soybeans and many of the alternative feed ingredients (Aljubori *et al.,* 2017).

**2.4.2 Amino Acids**

Amino acids that are critical in the diet of poultry are arginine, threonine, lysine, methionine and tryptophan (Aljuobori *et al.,* 2017). Threonine and tryptophan are only marginally deficient and careful selection of ingredient can avoid there deficiency. Argenine deficiency is not a problem if groundnut cake is used as ingredients. Lysine and methionine are the limiting amino acid in practical poultry diets, it is reported that methionine and lysine are first and second limiting amino acid in poultry ration (Amad *et al.,* 2005). The limiting amino acid concept may also be explained as follow the ratio between the amount of amino acid and its requirement gives an idea, the lowest ratio give the first limiting amino acid, the next lowest ratio give the second most amino acid it has been reported that for poultry methionine is the only limiting amino acid in soya bean meal diets and if the diet contains sesame cake lysine is first limiting amino acid (Akhter *et al.,* 2008). In general all the amino acid must be present in the diet at the same time for their efficient utilization, the needed amino acid can be supplemented in the practical diet (Aljuobori *et al.,* 2017). Methionine is the most growth repressing when add at 40 gm per kg diet , excess methionine depress the growth of chicks, excess of amino acid are also harmful because on excess amino acid may create an increased demand for another one for example toxicity of dietary lysine is overcome by increasing the level of argenine or glycine ,threonine eliminate the toxic effect of tryptophan, glycine reduce the toxic effect of methionine ,similarly the toxic effect of an excess leucine or valine are removed by isoleucine these are established interaction between amino acid and must be remembered when formulation the ration (Akhter *et al.,* 2008). The maximum crude fibre and salt (NaCl) concentration in broiler diet should be 5% and 0.5%, respectively. Acid insoluble ash should not be more than 2.5% in broiler feeds. Higher intake of these components reduces feed utilization efficiency. Calcium (Ca) and total phosphorus (P) levels should be minimum 1% and 0.7%, respectively while available phosphorus is necessary to be minimum 0.45% in all types of broiler ration (Kirk, 2015).

**2.4.3 Energy**

Energy is required for maintenance, metabolism and growth. Energy is derived from carbohydrates, fat and oils (Ndams *et al.,* 2009). Energy feedstuff are high in energy and low in fiber (under18%), and generally contain less than 20% crude protein (FAO, 2011). Common energy sources in poultry feeds include: cereals, roots and tuber product, and fats and oils. From studies and results, broilers required an energy level of 3000-3200kcal ME/kg for efficient production (FAO, 2011). Energy level for starter broilers ranges from 2800 to 3000 kcal ME/kg (Ndams *et al.,* 2009; Chang *et al.,* 2011, Alu *et al.,* 2012). Energy level for finisher broiler ranges from 3000 to 3200 kcal ME/kg (Obun and Anyanwale, 2007; Ndams *et al.,* 2009). Although the starch in corn is highly digestible, most of the other grains contain anti-nutritional factors that interfere with digestion and/or the absorption of nutrients. These Anti-nutritional factors include the non-starch polysaccharides, making nutrient utilization inefficient. The metabolisable energy content of frequently used grains for poultry ranges from 2734 kcal/kg in rye to 3300 kcal/kg in corn. The nutritional profiles of energy vary according to type of feed stuff, location, season, cultivation, harvesting and handling conditions (Sogunle *et al.,* 2010).

**2.4.4 Feed intake in broiler chickens**

Feed intake is an extremely complex area involving a number of factors. According to Salah (2013) dietary factors such as nutrient composition; level of anti-nutritional factors in feed; feed formulation and feedstuff inclusion levels; feed pellet quality and managerial factors including feed and water availability to the birds, environmental management, stocking density, and disease control affect feed intake in birds. There are theories which are based on both physiological via controlling mechanisms within the bird which limit and encourage consumption of a particular nutrient or energy yielding components and physical, the bird eats the maximum gut fill (Kirk, 2015). Both mechanisms require the presence of sensors within the bird by which it is informed of intake. The amount of feed consumed is closely associated with growth performance in meat-type poultry. Modern commercial broilers and turkeys will not grow to their full genetic potential unless they consume their full nutritional requirement each and every day. Aside from adequate diet formulation, maintaining maximum feed intake is the single-most important factor that will determine the rate of growth and efficiency of nutrient utilization (Salah, 2013). Some feed ingredients such as raw soybeans contain a number of unknown factors which inhibit pancreatic trypsin activity and inhibit digestion of the dietary proteins (Aljubori *et al.,* 2017). Therefore, chickens fed raw soybeans often exhibit low intake and reduced feed efficiency.

**2.5 Hematological Parameters of broiler chickens**

Haematology refers to the study of the numbers and morphology of the cellular elements of the blood (Merck Manual, 2012). Blood cellular components include red cells (erythrocytes), white cells (leucocytes), and the platelets (thrombocytes). Haematological parameters are those parameters that are related to the blood and blood forming organs (Waugh *et al.,* 2001; Bamishaiye *et al.,* 2009). Haemtological studies are useful in the diagnosis of many diseases as well as investigation of the extent of damage to blood (Togun *et al.,* 2007). They Haematological studies are of ecological and physiological interest in helping to understand the relationship of blood characteristics to the environment (Ovuru and Ekweozor, 2004; Mmereole, 2008; Isaac *et al.,* 2013). Haematological parameters are good indicators of the physiological status of animals (Khan and Zafar, 2005). Blood act as a pathological reflector of the status of exposed animals to toxicant and other conditions (Olafedehan *et al.,* 2010). As reported by Isaac *et al.* (2013) animals with good blood composition are likely to show good performance. Afolabi (2010) posited that haematological values of farm animals are influenced by age, sex, breed, climate, geographical location, season, day length, time of day, nutritional status, life habit of species, present status of individual and other factors. Besides physiological and environmental factor that might affect blood values factors such as oestrus cycle, genetics, method of breeding, braeeds of animal, housing, feeding, fasting, extreme climatic conditions, stress, exercises, transport, castration and diseases have been identified (Aster, 2004).

**2.5.1 Red Blood Cells (Erythrocytes)**

Red blood cells (erythrocytes) serve as a carrier of haemoglobin. Haemoglobin reacts with oxygen carried in the blood to form oxyhaemoglobin during respiration (Chineke *et al.,* 2006). According to Isaac *et al.* (2013) red blood cell is involved in the transport of oxygen and carbon dioxide in the body. Thus, a reduced red blood cell count implies a reduction in the level of oxygen that would be carried to the tissues as well as the level of carbon dioxide returned to the lungs (Ugwuene, 2011; Soetan *et al.,* 2013; Isaac *et al,* 2013).

**2.5.2 Packed Cell Volume (PCV)**

The Packed Cell Volume (PCV) which is also known as haematocrit (Hct) or erythrocyte volume fraction (EVF), is the percentage (%) of red blood cells in blood (Purves *et al.,* 2003). According to Isaac *et al.* (2013), Packed Cell Volume is involved in the transport of oxygen and absorbed nutrients. Chineke *et al.* (2006) posited that high Packed Cell Volume (PCV) reading indicated either an increase in number of Red Blood Cells (RBCs) or reduction in circulating plasma volume. Mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration indicate blood level conditions. A low level is an indication of anaemia (Aster, 2004).

**2.5.3 Haemoglobin (Hb)**

Haemoglobin is the iron-containing oxygen-transport metalloprotein in the red blood cells of all vertebrates with the exception of the fish family, channichthyldae as well as tissues of invertebrates (Sidell and O’ Brien, 2006). Haemoglobin has the physiological function of transporting oxygen to tissues of the animal for oxidation of ingested food so as to release energy for the other body functions as well as transport carbon dioxide out of the body of animals (Ugwuene, 2011). Peters *et al.,* (2011) reported that the Packed Cell Volume, haemoglobin and mean corpuscular haemoglobin are major indices for evaluating circulatory erythrocytes, and are significant in the diagnosis of anaemia. They are also indicative of the bone marrow capacity to produce red blood cells (Chineke *et al.,* 2006).

**2.5.4 White Blood Cells (Leucocytes)**

The major functions of the white blood cell and its differentials are to fight infections, defend the body by phagocytocis against invasion by foreign organisms and to produce or at least transport and distribute antibodies in immune response (Isaac *et al.,* 2013). Thus, animals with low white blood cells are exposed to high risk of disease infection, while those with high counts are capable of producing antibodies in the process of phagocytocis and have high degree of resistance to diseases and enhance adaptability to local environmental and disease prevalent conditions (Okunlola *et al.,* 2012; Iwuji and Herbert, 2012; Isaac *et al.,* 2013).

**2.5.5 Platelets**

Blood platelets are implicated in blood clotting. Low platelet concentration suggests that the process of clot-formation (blood clotting) will be prolonged resulting in excessive loss of blood in the case of injury (Iwuji and Herbert, 2012; Isaac *et al.,* 2013).

**2.6 Feed Additives in Poultry Nutrition**

Feed additives are the substances that are added to a nutritionally balanced diet which provoke to maximum genetic potential of the host, in terms of growth as well as improvement in feed Conversion efficiency (Dhama *et al.,* 2014). During the last 2-3 decades, a substantial growth in poultry industry has been observed, largely in both large and small-scale organized poultry farming (Dhama *et al.,* 2013, Mahima *et al.,* 2012). This is mainly due to exploitation of various modern growth promoting strategies and appropriate disease preventive and control measures. Many antibiotics are used in poultry feeds as growth promoters and for improving health of animals. Other growth promoting agents and feed additives comprises of probiotics, prebiotics, organic acids, essential oils, enzymes, vitamins and minerals (Angelakis *et al.,* 2013). Herbs is also a novel growth promoter used in poultry industry to enhance growth and promote health/production (Dhama *et al.,* 2016; Mahima *et al.,* 2012).

**2.6.1. Antibiotic Growth Promoters (AGP)**

Antibiotic growth promoters are the antibiotics that are used in poultry feed continuously at a lower level to improve growth and feed conversion and not for the purpose of any therapeutic reasons (Dhama *et al.,* 2014, Hassan *et al.,* 2010). Antibiotic Compounds commonly used as growth promoters include; Bacitracin, Penicillin, Virginiamycin, Flavomycin, Chlortetracycline, Oxytetracycline, Colistin Sulphate, Enrofloxacin, Tramulin, Neocycin, Doxycycline, Erythromycin and Aureomycin (Chowdhury *et al.,* 2009). Antibiotics are gives at sub therapeutic dosage for stabilization of the microflora of intestine; for improving overall growth performance and prevention of colonization of the gut with pathogenic strains of microbes (Dibner and Richards, 2005; Hassan *et al.,* 2010). Antibiotic growth promoters have inhibitory effect on enzymes released by micro-organisms and also on enzymes involved in microbial metabolism (Dhama *et al.,* 2014). It also reduces the growth-depressing metabolites produced by micro-organisms (Feighner and Dashkeviez, 1987; Knarreborg *et al.,* 2004; Huyghebaert *et al.,* 2011). Addition of antibiotics to feed results in increased amino acid levels in the gut and improved nitrogen balance (Dhama *et al.,* 2014). It also improves absorption of feed nutrient because of thinning of intestinal wall, feed conversion ratio, weight gain, performance and productivity (Dhama *et al.,* 2011, 2014). Generally, the use of antibiotics have significantly increased poultry production across the globe.

**2.6.2 Challenges of Antibiotics Growth Promoters**

Despite the significant increase in poultry production due to the use of antibiotic growth promoter, the World Health Organization (WHO) along with block organization for Animal Health (WOAH) have encourage the health, agriculture veterinary sector to reduce the injudicious use of antibiotics as growth promoter in animal nutrition and production (Aidara-Kane, 2012). This is due to health threat of antibiotic use as growth promoter. The use of antibiotics through feed or drinking water when the birds are not infected can be dis advantageous, in certain aspects. However, it can lead to the development of antibiotic resistant strains of pathogenic micro-organisms including staphylococcus aureus and streptococcus spp. of bacteria in the gut of birds (Kocher, 2006; Nieworld, 2007). Devirgilis *et al.* (2013) in his review concluded that the continued use of antibiotics as routine feed additives may also contribute to the increased presence antibiotic residues in poultry products (Dhama *et al.,* 2014). Certain antibiotics even as residues can cause allergic hypersensitive reactions in consumers (Niewold, 2007). The continuous application of antibiotics can suppress sensitive natured microflora in the gut like: Saprophytes, commensals, non-pathogenic bacteria, fungi and yeasts or can show a compensatory growth and few can even increase their virulence (Huyghebaert *et al.,* 2011; Devirgilis *et al.,* 2013). Those activated micro-organisms invade the host causing complications as generally seen in infections caused by proteus, pseudomonas, Aspergillus, and Candida albinos (Pedroso *et al.,* 2013). Moreso, the elimination of micro-organisms in gastrointestinal tract by the continuous use of antibiotics may result in losses of Vitamin B complexes and K (Huyghebaert *et al.,* 2011; Devirgilis *et al.,* 2013, Dhama *et al.,* 2014). Due to the above mentioned disadvantages, its continued use as a growth promoter has been restricted or even banned some countries and the use of alternative growth promoters such as prebiotics and probiotics, enzymes, phytobiotics, are being encouraged (Pedroso *et al.,* 2013; Niewold, 2007; Kocher, 2006).

**2.6.3 Non-antimicrobial Based Feed Additives**

**2.6.3.1 *Prebiotics***

The use of small fragments of carbohydrates (such as oligosaccharides) in the feed of poultry birds is another method used to manipulate the gut ecosystem. Prebiotics was introduced by Gibson and Roberfroid (1995). Prebiotics mainly include, oligosaccharides of galactose, fructose or mannose (Gibson and Roberfroid, 1995). Prebiotics selectively fermented by beneficial microflora into short chain fatty Acids (SCTA) which effectively excludes the pathogenic microbes due to a lowered pH in gut through lactic acid production and thus inhibiting colonization of pathogenic bacteria (Roberfroid, 2007). The non-digestible oligosaccharides have been found to stimulate absorption of several minerals like: calcium, magnesium, zinc and Iron (Fallah and Rezaeí, 2013). Simultaneously, prebiotics have systemic effect on utilization of feed ingredient, stimulation of immunity and neutralization of toxins, promoting growth and health maintenance generally (Dhama *et al.,* 2014).

**2.6.3.2 *Probiotics***

Probiotics are the live microbial feed supplements which are used for balancing the microbial population in the intestine through the production of various compounds, competitive exclusion and displacement of pathogens from enterocytes, as well as maintenance of gut pH and thereby improving the health and immune status of the birds (Dhama *et al.,* 2014). Probiotics functions in improving feed intake, and food Conversion efficiency, increases growth rate, body weight gain and -productivity of birds (Hassan *et al.,* 2010). Probiotics regulate lipid metabolism, reduce the body cholesterol content, stimulate immunity by augmenting the effects of drugs, no residue in poultry product and it is also cost effective (Dhama *et al.,* 2011; Mookiah *et al.,* 2014).

**2.6.3.3 *Organic acids***

The utilization of organic acids has been increasingly used as growth promoters due to the development and emergence of antibiotic resistant microbes which helps in providing protection from adverse human health implications (Tiwari *et al.,* 2013). The use of organic acids such as formic, lactic, propionic citric, ascorbic and phosphoric acids have been used as acidifiers to optimize the balance of the micro flora of the gastrointestinal tract (Nave *et al.,* 2001: Griggs and Jacob, 2005). Organic acid functions in lowering the pit, at which the activity of protease and beneficial bacteria is minimized by a direct antibacterial effect destroying their cell membranes (Chowdhury *et al.,* 2009 Nava *et al.,* 2009). In order to inhibit growth of bacteria of intestine (those which compete with host for the nutrients that are available), dietary acidification is necessary thereby causing -reduced possibility of availability of bacterial metabolites which are toxic in nature and significantly increase the growth of birds (Wang *et al.,* 2010, Cengiz *et al.,* 2012).

**2.6.3.4 *Exogeneus enzymes***

The exogenous enzymes through the feeds include non-starch polysaccharides degrading enzymes, proteases and phytase that would help in better utilization and reduction in environmental pollution. In poultry feeding, fibre in the feed is usually considered as waste as these compounds are often called Non-Starch polysaccharides as an anti-nutritive factor Barley, wheat and rye contains glucans, are binoxylans or pentosans as non-starch polysaccharide. These substances have a negative effect or broiler performance and depress growth rate by encapsulating the nutrients, increasing the intestinal viscosity, increase endogenous nitrogen flow and bacterial fermentation in the gastrointestinal tract, reduces feed passage rate, resulting in overall reduced feed intake to depress production in broilers and cause sticky droppings, vent posting (Yin *et al.,* 2004). Hence, these Non-starch polysaccharides are degraded using enzymes such as, xylanases and beta-glucanases, play an important role in reducing the pathogenic bacteria such as; Clostridium perfringens (Jackson *et al.,* 2003). These enzymes also reduce the harmful effect of non-starch polysaccharide; such as; hemi-celluloses, pectins and oligosaccharides, arabianoxylans and glucans. (Hedemann *et al.,* 2009). The supplementation of protease enzyme resulted in improved crude protein and fat digestibility.

**2.6.3.5 *Phytobiotics***

This is the addition of herbs, botanical extract and spices as feed additives to increase and improve health, nutrient digestibility feed conversion efficiency and general performance of the broiler birds (Botlhoko, 2009; Tollba, 2010, Peric*et al.,* 2009). In recent years, phytobiotics feed additives have attracted an increasing attention as natural alternative to antibiotic promoters in broilers production which can be included in feeds as; dried, solid, ground form or as extracts (crude, concentrated and purified) (Gadde *et al.,* 2017). A wide variety of herbs and spices (thyme, garlic, ginger, green tea, black cumin, turmeric among others) have been used in poultry, individually for their potential application as antibiotics growth promoter’s alternatives (Gadde *et al.,* 2017). Several studies have been carried out using herbs, spices and showed inconsistent results on chicken performance, Although, Some studies shaved that photobiotic feed additives have positive effect on body weight gain and feed "Conversion ratio in chicken (Zhang *et al.,* 2009; Khattak *et al.,* 2014). Others reported either improved chicken body weight gain without affecting feed conversion ratio (OCak *et al.,*2008; Bozkurt *et al.,* 2009) or an enhanced feed conversion rate associated to a lack of effects on by weight or feed intake (Jamroz *et al.,* 2005; Amad *et al.,* 2005). This inconsistency may be explained by several factors such as; the botanical Source, the concentration and duration of supply of the active compounds, the feed composition, and the experimental challenging conditions, animal age and health status (Vander *et al.,* 2017; Nedra, 2021). Generally, examining the results of several researchers, it is deducted that the use of photobiotics have improved chicken performances. Additionally, evaluating digestibility is important as it directly contributes to the animal feed efficiency. However, improving the digestibility is crucial not only for better feed efficiency but also to reduce the amount of undigested feed in the gut, which may favour the occurrence of intestinal imbalances that may lead to inflammatory processes and accelerated turnover of intestinal tissue which result in poor performance (Nedra *et al.,* 2021). Numerous Studies have been carried out to study the effects of photobiotic feed additive on nutrient digestibility and majority have been reported of increased digestibility (Leskovec *et al.,* 2018; Ding *et al.,* 2017, Abdel-Wareth *et al.,* 2020, Hafeez *et al.,* 2016; Nedra *et al.,* 2021).

**2.6.3.6 *Spices and herbs***

Medicinal herbs, spices, and aromatic plants play important roles in improving the taste, aroma, and color of humans’ food and animals’ feed in addition to their positive effects on human and animal health (Abd El-Hack and Alagawany 2015; Abd El-Hack *et al.,* 2018). Thyme *(Thymus vulgaris)* is a medicinal plant of the mint family *Lamiaceae* and has anti-cough, anti-bloating, antimicrobial, antifungal, and anti-spasmodic properties. Thyme has colorful and fatty substances, bitter compounds, and a high level of manganese. Thyme essence contains pinne, deptante, carvacrol, and thymol, but its disinfecting property contains thymol and timic acid (Miraj and Kiani 2016). Dietary chicory powder supports positive growth performance and improves gut microbiota in broiler chickens (Khoobani *et al.,* 2020). Chicory leaves contain phosphorus, magnesium, and potassium and a bitter glucoside called *shikurin*, while the roots contain *inulin* (Nandagopal and Kumari 2007). Coriander *(Coriandrum sativum L)* is a medicinal and spice plant that significantly improves health. Different parts of the plant, such as leaves, seeds, and fruits, are antioxidants, diuretics, anti-diabetic, sedatives, antimicrobial, and anti-cancerous substances. Coriander seed extract or its powder can be used as an alternative to antibiotics against Newcastle and infectious bronchitis in the chicken feed (Hossein *et al.,* 2014). Aloe vera has many therapeutic purposes; it can act as antimicrobial, antitumor, anti-inflammatory, immunomodulator, wound healing, antioxidant, and antiprotozoal agents (Jalal *et al.,* 2019). The aqueous *Allium sativum* and Aloe vera extract can be used to treat coccidiosis control in poultry (Elbanna *et al.,* 2013). Turmeric *(Curcuma longa),* a perennial herb of the ginger family, contains rhizomes and underground roots that were originally used as a feed additive to enhance storage, appearance, flavor, taste, and food preservation (Jayaprakasha *et al.*, 2005). Turmeric is known as a phytobiotic that can improve intestinal health, gastrointestinal stimulation, and growth rate of chicken, and therefore, it is recommended as a feed additive in poultry diets (Patil *et al.,* 2019).

**2.7 Black Pepper**

**2.7.1 Description**

Black pepper (*piper nigrum*) is a flowering vine in the family. "*piperaceae*", genus "piper" and species "*piper nigrum*" (Alkassie *et al.,*2011). It is one of the commonest medicinal herb used in human diet. Black pepper (*piper nigrum*) is cultivated for its fruit; which is usually tried and used as a spice and seasoning (Moorthy *et al.,* 2007) Medicinally, it is used to treat stomach upset, cough, bronchitis and cancer (Turner, 2004). Black pepper (*piper nigrum*) also functions in fighting germs (microbes) and causes the stomach to increase the flow of digestive juices (Al-Kassie *et al.,* 2011) Black pepper (*piper nigrum*) been known as a spice due to it pungent quality constitute variety of activecompound which includes; cupsaresin, cupsisin, cupsentine and piperine which has antiache effect (Mahady *et al.,* 2008). In addition, the bioactivemolecule "piperine" present in pepper has major pharmacological impact on the nervous and neuro-muscular system (Safa *et al.,* 2014; Great, 2003). Piperine has been shown to dramatically increase absorption of selenium, Vitamin B Complex, beta Carotene and Curcumin (Khalaf, 2008). Piperine also enhances the thermogenesis of lipid and accelerates energy metabolism in the body and also increases the serafonin and beta-endorphin production in the brain; these are the chemical composition and reaction of black pepper (*Piper nigrum*) (Malini *et al.,* 1997; Safa *et al.,* 2014). Black pepper (*piper nigrum*) is also found to contain glutathione peroxidase and glucose-6-phosphate dehydrogenase, an enzyme necessary for energy metabolism (Safa *et al.,* 2014). Black pepper (*piper nigrum*) has been found to have antioxidant properties and anti-carcino genic effect (Alalini *et al.,* 2006). Black pepper. (*piper nigrum*) as a spices have numerous therapeutic potentials in human medicine health) and in a quest to promote broiler productor using phytobiotics, the use of black pepper (*piper nigrum*) is explore to enhance growth rate, feed efficiency, animal health and nutrient digestibility.

**2.7.2 Botanical Classification of Black Pepper (*piper nigrum)***

Kingdom: *Plantae*

Order: *Piperales*

Family: *Piperaceae*.

Genus: *Piper*

Species: *Piper nigrum* L.

(Safa *et al.,* 2014)

**2.7.3 Feeding trials**

Exploring the beneficial effect of black pepper in animal nutrition,Ghazalah *et al.,* (2007) and Tollba *et al.,* (2007) reported that the performance of animals to black pepper is attributed to the level of black pepper used that reflects the high activity of piperazine citrate included in the diet as they observed that the mean body weight of broilers at 2, 4 and 6 weeks of age showed that inclusion of feed with different levels of dried black pepper were different. Abou-Elkhair *et al.,* (2014) reported in their research that the use of black pepper powder solely in chicken nutrition did not have positive influence on feed conversion ratio when added at 1.8 kg/10kg of feed. Ademola *et al.,* (2009) and Doley *et al.,* (2009) observed no difference in feed intake in broiler fed black pepper which may be due to isocaloric and isonitrogenous diet fed throughout the experiment. Abou-Elkhair *et al.,* (2014) showed that the mixture of black pepper and turmeric powder to broiler chicken diet led to a higher final body weight of chickens during the fattening period of 35 days. Valiollahi *et al.,* 2013 also observed an improvement of body weight gain as a result of supplementation of black pepper powder in monogastric. Dhama *et al.,* 2007; 2014 reported that the addition of black pepper *(Piper nigrum)* has been shown to havepositive influence on feed utilization and efficiency of animals. The positive response of animals to black pepper is attributed to the bioactive ingredient present in the spice “*piperine*”, which active in digestion. The reports regarding the addition of black pepper and other spices on animals’ on blood and serum biochemical parameters is also contradictory. Valiollahi *et al.,* 2013 reported that the addition of black pepper in the amount of 1.0 g/100g of small ruminant feed significantly decreased the concentration of triglycerides (14.4 mg/dl) in blood serum. This effect can be explained by the possible inhibition of the Acetyl CoA syntheses enzyme that is necessary for the biosynthesis of fatty acids. In the investigation of Ghaedi *et al.,* (2014), the addition of black pepper decreased triglycerides and the total cholesterol while the concentration of HDL was increased. Sayrafi *et al.,* (2017) investigated the effects of adding turmeric and vitamin E to the diet on histopathological lesions from bursae of Fabricius cells concerning salinomycin in broiler chicks. The results of this study showed that turmeric protected the bursa of Fabricius against the toxicity of salinomycin in chickens. Sethy *et al.,* (2016) also examined the effects of a supplement of turmeric powder on broiler chicks’ growth and biochemical parameters. The supplement did not significantly affect blood biochemical parameters. However, the results showed the beneficial effects of Curcuma longa powder on weight and Hb concentration in broiler chicks. Malini *et al.,* (1999) and Alkassie *et al.,* (2011) further showed that treatment groups fed black pepper had significantly lowered cholesterol, H/L ratio, RBC, PCV and Hb as compared with the control group, but had no significant effect on WBC among treatments. The reduction of H/L ratio may be due to the fact that active compounds in black pepper have receptors on adrenal gland may affect the nervous system and decrease ACTH secretion that causes stress which may lead to increase blood glucose concentration as H/L ratio is regarded as a good indicator to examine the stress level of birds. The reduction of the parameters (PCV, Hb and RBC) may be due to the activity of black pepper which may act on oestrogen hormone. Hence, the performance of black pepper on blood and serum parameters is attributed to the level of the spice in the diets of the animal. Furthermore, action of spice herbs such as black pepper *(Piper nigrum)* in animals’ blood parameters can be facilitated by the activity of enzymes which are involved in the conversion of cholesterol to bilious acids and subsequently may result in lower cholesterol concentration in the carcass.

**CHAPTER THREE**

**MATERIAL AND METHODS**

**3.1 Experimental Site**

The experiment was conducted at the Poultry Research unit of the Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus, Oruk Anam Local Government Area, Akwa Ibom State. The area lies between latitude 4030’N and 50 00’N and longitudes 700 30’E and 800 00’E. The climate of the experimental site was a tropical rain forest characterized with high temperature (average of 300C), high rainfall (about 1500mm) and relative humidity of 70% on average (SLUS-AK, 1989).

**3.2 Sources and Processing of Experimental Materials**

The Black Pepper used in the experiment was purchased from the Abak market in dry form, ground into powder and stored in an air-tight plastic container free of moisture. The commercial grade Zinc Bacitracin antibiotics was purchased from a veterinary shop at No.226 Abak road, Uyo, and stored in a polythene bag. Full fat soybean was used for the experiment which was processed by roosting it for about 25 minutes and ground to eliminate anti-nutritional factors. The maize was purchased and also ground to a texture suitable for animal utilization. All other feed ingredients was purchased and processed properly, thereafter used as basal diet for the research.

**3.3 Experimental Diet**

For the experiment, the basal starter and finisher broilers diets were formulated as shown in Table 3.1 and 3.2.

**Table 3.1; Ingredient and Nutrient Composition of the Experimental Starter Broiler Chicks Diet**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Ingredient** | **Treatments** | | | |  |
|  | **T1**  **(control)** | **T2 (0.2%ZB)** | **T3**  **(0.5%ZB)** | **T4 (0.2%BP)** | **T5**  **(0.5% BP)** | |
|  |  |  |  |  |  |
| Maize | 52.10 | 52.10 | 52.10 | 52.10 | 52.10 |
| Soybean meal | 29.40 | 29.40 | 29.40 | 29.40 | 29.40 |
| Fish meal | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Wheat offal | 8.00 | 8.00 | 8.00 | 8.00 | 8.99 |
| Palm Oil | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Bone meal | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Limestone | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Salt | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Premix | 0.20 | 0.20 | 0.20 | 0.20 | 0.10 |
| Methionine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** |

**\*ZB – Zinc Bacitracin \*BP – Black Pepper**

**Calculated Composition:**

Crude Protein – 22%

Metabolizable Energy – 3000kcalME/kg

Crude fiber – 4%

Ether Extract – 5%

Calcium – 0.90%

Phosphorus – 0.50%

Lysine – 0.15%

Methionine – 0.20%

**Table 3.2: Ingredient and Nutrient Composition of the Experimental Finisher Broiler Diet**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Ingredient** | **Treatments** | | | |  |
|  | **T1**  **(control)** | **T2 (0.2%ZB)** | **T3**  **(0.5%ZB)** | **T4 (0.2%BP)** | **T5**  **(0.5% BP)** | |
|  |  |  |  |  |  |
| Maize | 56.36 | 56.36 | 56.36 | 56.36 | 56.36 |
| Soybean meal | 19.14 | 19.14 | 19.14 | 19.14 | 19.14 |
| Fish meal | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 |
| Wheat offal | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Palm Oil | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Bone meal | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Limestone | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Salt | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Premix | 0.20 | 0.20 | 0.20 | 0.20 | 0.10 |
| Methionine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** |

**\*ZB – Zinc Bacitracin \*BP – Black Pepper**

**Calculated Composition:**

Crude Protein – 20%

Metabolizable Energy – 3200kcal/MEkg

Crude fiber – 5%

Ether Extract – 4%

Calcium – 0.85%

Phosphorus – 0.50%

Lysine – 0.25%

Methionine – 0.30%

**Table 3.3: Analyzed Proximate Composition and Gross Energy Content of Formulated Basal Finisher Diet**

|  |
| --- |
| **Parameters Values** |
| Dry matter (%) 88.72  Crude protein (%) 21.74  Crude fibre (%) 3.60  Ether extract (%) 3.77  Ash (%) 5.84  Nitrogen-free extract (%) 53.77  Gross energy (MJ/Kg) 4.126 |

**\*%NFE = 100-(%Cp+%Cfat+Cfibre+%Ash) \*%DM = 100-%Moisture**

**3.4 Purchase and Management of Experimental Birds**

A total of one hundred (100) Arbor Acre plus strain of day-old broiler chicks were used for the experiment. The chicks were purchased from a hatchery agent; Brilliance Livestock Enterprise in Abak Local Government Area, Akwa Ibom State. The brooding of the birds at the first two weeks was done at a temperature of 32-35oC to enable feather development by providing adequate heat source. The birds were managed intensively using deep litter system. Wood shavings was used as litter material. Feed and water were provided ad-libitum. The chicks were vaccinated against the most common diseases such as; Newcastle Disease and Infectious Bursal Disease (Gomboro). They were acclimatized for one (1) week before the commencement of the experiment.

**3.5 Experimental Design**

On day seven (7), the birds were weighed to obtain their initial weights and randomly divided into five (5) treatment groups. Each treatment group was further replicated twice and each replicate had ten (10) birds each. A completely randomized design (CRD) was used for this experiment. Each group was supplied one of the five experimental starter broiler diets for first twenty one (21) days and experimental finisher broiler diet for the next 21 days to day 42. The treatments were as followed:

Group one: Basal diet only

Group two: Basal diet + ZnB at 0.2% inclusion level in-feed

Group three: Basal diet + ZnB at 0.5% inclusion level in-feed

Group four: Basal diet + BP at 0.2% inclusion level in-feed

Group five: Basal diet + BP at 0.5% inclusion level in-feed

The birds were administered these treatments for five (5) weeks and data was collected during the course of the feeding trial.

**3.6 Data Collection**

**3.6.1. Growth Performance**

The weekly weight of each bird was collected and recorded using a digital weighing scale. The amount of feed and water consumed (feed intake) was obtained by subtracting the weight of the amount of feed left over in each replicated group from the total amount of feed given. This was done thrice a day at 8am, 12pm and 5pm. Feed conversion ratio was also determined by dividing the total feed intake by body weight gain. Body weight gain was determined by subtracting the initial body weight from the final body weight of the birds.

**3.6.2. Blood Collection for Hematological Analysis**

At the end of the experimental period, 2ml of blood samples were collected from two (2) birds per replicate (4 birds per treatment group) from the wing vein using a 2ml syringe and 23G hypodermic needles. The blood was transferred into a sample bottle containing EDTA (ethylene Diamine tetra-acetate) for haematological analysis respectively. Haematological parameters analyzed included packed cell volume (PCV), haemoglobin concentration (Hb), red blood cell count (RBC), platelet count (PLT) and total white blood cell count (tWBC). The mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and Mean corpuscular Haemaglobin concentration (MCHC) and differential white blood cell count were calculated. These was done using an auto analyzer machine (BAYER®, 2005).

**3.7. Data Analysis**

All the data obtain was expressed as mean ± standard error and analyzed using One Way Analysis of Variance (ANOVA). Significant means was separated by applying Duncan multiple range post hoc test as outlined by Duncan (1955).

**CHAPTER FOUR**

**RESULTS AND DISCUSSIONS**

**4.1 Effect of Zinc Bacitracin (ZnB) and Black Pepper (BP) on Growth performance of broiler chickens**

There was a significant difference (P<0.05) in the final body weight of the birds across the treatment group as shown in Table 4.1. Birds in the control group had the least final body weight, while birds that received 0.5% Black pepper (BP) inclusion in their diet (T5) had the highest final body weight. The final weight of birds in the control group was also significantly lower (P<0.05) compared to birds that received BP at 0.2% and ZnB at 0.5% inclusion in their diet respectively. This findings is similar to that of Al-Kassie *et al.* (2011), Ghazalah *et al.* (2007) and Tollba *et al.* (2007). The higher final body weight of birds fed Black pepper diet inclusion could be attributed to the high activity of the bioactive ingredient in black pepper “*piperine*” which affect the flow of digestive juices and enzymes across the stomach, leading to improved feed utilization.

A significant difference (P<0.05) in weight gain of the birds was also observed across the treatment groups. The weight gain of birds in the control group was significantly lower (P<0.05) compared to birds that received ZnB and BP at their respective inclusion level. In addition there was no significant difference (P<0.05) between birds in the ZnB group and those of the BP treatment group. This result coincides with the findings of Al-Kassie *et al.* (2011). The higher weight gain of birds fed BP in their diet may be attributed to *piperine,* a bioactive ingredient of the spice that functions in digestion by stimulating the activity of digestive enzymes (Al-Kassie *et al.,* 2011)

The significantly increased total feed intake and feed conversion ratio (P<0.05) in birds that received BP in their diet compared to the control group may be suggestive of the appetite stimulatory, carminative and improved digestibility effect of piperine present in black pepper. This result is similar to the findings of Ghazallah e*t al.,* (2007). The high total feed intake may have contributed to the increased weight gain of birds in this treatment groups. There was however, no difference in feed intake and feed conversion rate between birds that received ZnB and those that received BP in their diet.

**Table 4.1: Effect of ZnB and BP on Growth performance of broiler chickens**

|  |
| --- |
| **T1 T2 T3 T4 T5 SEM**  **Parameters (control) (0.2% ZnB) (0.5% ZnB) (0.2% BP) (0.5% BP)** |
| Initial weight 177.5 165.1 172.3 159.1 169.5 0.85  (g)  Final weight 662.2b 894.9a 813.8ab 882.8a 932.6a 7.03  (g)  Weight gain 484.7b 739.2a 641.5a 723.7a 763.2a 25.7  (g)  Feed intake 3434.7d 3421.2e 3448.4c 3656.8b 3666.5a 12.0  (g)  FCR 7.91a 4.18c 6.01b 5.44bc 5.42bc 0.25 |

a-e =Means with different superscripts in a row are significantly different at p<0.05.

FCR= Feed conversion ratio

**4.2 Effect of Zinc Bacitracin (ZnB) and Black Pepper (BP) on haematological parameters of broiler chickens**

There was significantly lower (P<0.05) packed cell volume (PCV), red blood cell count (RBC) and hemoglobin concentration (Hb) in the birds that received 0.5% BP inclusion in their diet compared to those in the control group as shown in table 4.3. However, all other red blood cell indices and white blood cell parameters was unchanged across the treatment groups. Malini *et al.,* (1999) and Alkassie *et al.,* (2011) also reported a decreased red cell parameters with black pepper in broilers. The reason may be related to the level of inclusion in the diet of broilers since these parameters improved comparatively with decreased level of BP at 0.2% in the diet of the birds. The total white blood cell count and heterophil/lymphocyte ratio which may be indicative of the level of environmental stress in animals was not significantly different (P>0.05) in the BP treatment group compared to control further suggesting that the decreased red cell parameters may be unrelated to physiological or pathological stress.

**Table 4.2: Haematological Parameters of Chickens Birds Fed Diets Containing Zinc Bacitracin and Black Pepper *(Piper nigrum L.)***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PCV**  **(%)** | **RBC** | **Hb**  **(g/dl)** | **Twbc**  **X103/ul** | **H**  **(%)** | **LYM**  **(%)** | **H/L** | **PLT** | **EOS** | **BAS** | **MCV** | **MCH** | **MCHC** |
| **T1** | 29.7a | 3.4ab | 13.2a | 20.1 | 34.7 | 57 | 0.61 | 5.7 | 2.7 | 0 | 89.1 | 42.7 | 40.5 |
| **T2** | 32.7a | 3.7a | 13.8a | 21.5 | 30.0 | 61 | 0.49 | 5.0 | 3.3 | 0.7 | 89.4 | 40.8 | 38.6 |
| **T3** | 28.7ab | 3.3bc | 13.13a | 19.6 | 33.0 | 56.7 | 0.59 | 6.3 | 3.3 | 0.3 | 89.7 | 43.99 | 42.1 |
| **T4** | 29.0ab | 3.3ab | 12.93a | 20.1 | 33.0 | 58.7 | 0.56 | 5.7 | 2.3 | 0.3 | 90.4 | 43.44 | 41.0 |
| **T5** | 25.0b | 2.9c | 11.8b | 19.4 | 36.0 | 56.3 | 0.64 | 5.3 | 2.3 | 0 | 89.8 | 44.57 | 42.6 |
| **SEM** | 0.77 | 0.09 | 0.21 | 0.31 | 0.77 | 0.69 | 0.02 | 0.19 | 0.17 | 0.12 | 0.29 | 0.91 | 0.73 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

a-c =Means with different superscripts in a row are significantly different at p<0.05.

WBC = White Blood Cells; RBC = Red Blood Cells; HB = Haemoglobin; PCV = Packed Cell Volume; MCV = Mean corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration; PLT = Platelet; LYM = Lymphocytes; HET = Heterophils; EOS = Eosinophils; BAS = Basophils; MON = Monocytes

**CHAPTER FIVE**

**CONCLUSION AND RECOMMENDATION**

**5.1 CONCLUSION**

The study revealed that black pepper at 0.5% inclusion in broiler diet significantly improved growth performance and had no negative effect on haematological parameters in broilers.

**5.2 RECOMMENDATIONS**

I therefore recommended that black pepper at an inclusion rate of 0.5% be used to supplement broiler chickens. It should also be considered as an alternative to the use of growth promoting antibiotics in broiler feed.

**REFERENCES**

Abaza, I. (2001). The Use of Some Medical Plants as Feed Additives in Broiler Diets. Ph.D. Thesis, Faculty of Agriculture, Alexandria University, Egypt.

Abd El-Hack M. and Alagawany M. (2015). Performance, Egg Quality, Blood Profile, Immune Function, and Antioxidant Enzyme Activities in Laying Hens Fed Diets with Thyme Powder. *Journal of Animal Feed Science,* 24(2): 127– 133

Abd El-Hack M., Ashour E., Elaraby G., Osman A. and Arif M. (2018). Influences of Dietary Supplementation Of Peanut Skin Powder *(Arachis hypogaea)* On Growth Performance, Carcass Traits, Blood Chemistry, Antioxidant Activity And Meat Quality Of Broilers. *Animal Production Science*, 58(5): 965–972

Abel-Warcth, A. and Lohakare, J. (2020). Productive Performance, Egg Quality, Nutrients Digestibility and Psychological Response of Bovans Hens Fed Various Dietary Inclusion Levels of Peppermints Oil. *Animal Feed Science Technology*, 145: 1-31.

Abou-Elkhair R., Ahmed, H. and Selim, S. (2014). Phytogenicsford additives. *Asian Australian Journal Animal Science,* 27: 847-850

Adebayo, O. and Adeola, R. (2005). Socio-economic Factors Affecting Poultry Farmers in Ejibo Local Government Area of Osun State, Nigeria. *Journal of Human Ecology,* 18 (1): 39-41

Ademola S.G., Farinu, G. O., Ajayi, A. O. and Babutunde, G. M. (2004). Growth, Haematological and Biochemical Studies on Garlic and Ginger-Fed Broiler Chicken. *Journal of agricultural research*, 5(2): 122-128.

Adebayo, O. O. and Adeola, R. G. (2005). Socio-economic factors affecting poultry farmers in Ejibo Local Government Area of Osun State, Nigeria. *Journal of Human Ecology,* 18 (1): 39-41

Aidara-Kane L. (2012). Elimination of Antimicrobial Growth Promoters by Using Medical Herbs and Spices. *Journal of Poultry Science,* 14: 56-62.

Afifi, O.S. (2001). Effect of Different Levels of Freshly Crushed Nigella Sativa Seeds on Performance, Organ Weights and Blood Constituents of Broiler Chicks Reared Under Hot Climatic Conditions. *Egyptian Poultry Science*, 21: 567-583.

Afolabi, K. D., Akinsoyinu, A. O., Olajide, R. and Akinleye, S. B. (2010). *Haematological Parameters of the Nigerian Local Grower Chickens fed Varying Dietary Levels of Palm Kernel Cake.* Proceedings of 35th Annual Conference of Nigerian Society for Animal Production, Enugu, pp.247.

Agro-Industries (2002). European Union West Africa Agro-Business Sector meeting: Strategic evaluation of the Agro-Industrial sector, Dakar, Senegal.

Ahmad, T., M. Sarwar, Mahr-un-Nisa, Ahsan-ul-Haq and Zia-ul-Hasan (2005). Influence of Varying Sources of Dietary Electrolytes on the Performance of Broilers Reared in A High Temperature Environment. *Animal Feed Science* *Technology*, 120: 277-298

Ajala, M., Nwagu, B. and Otchere, E. (2007). Socio-economic of Free-Range poultry production Among Agro pastoral Women in Giwa Local Government Area of Kaduna State. *Nigerian Veterinary Journal,* 28 (3): 11-18

Akhtar M.S., Afzal H. and Chaudry F. (2008): Preliminary *in vitro* antibacterial screening of Bakain, and Zarisk against Salmonella. *Medicose*, 9: 6-7.

Alavi, S. A. N., A. Zakeri, B. Kamrani and Y. Pourakbari (2012). Effect of prebiotics, Probiotics, acidfire, growth promoter antibiotic and synbiotic on humural immunity of broiler chickens. *Global Veterinary*, 8: 612-617.

Alalini G, Aster J. and Fullah J. (2006). Probiotics in the Diets of Starter Broilers. *Journal of Poultry Science*, 15: 56-60.

Alireza S., Rakwot D. and Uktor N. (2021). Hematological determination of broilers fed Diet containing Allium sativa. *Poultry science,* 5: 67-70.

Al-Harthi, M. (2002). Efficacy of Vegetable Diets with Antibiotics and Different Type of Spices or Their Mixtures on Performance Economic Efficiency and Carcass Traits of Broilers. *Journal of Agriculture Science, Mansoura University*, 27: 3531-3545.

Al-Kassie, G., Mobseen, A. and Abd-Al-Jaleel, R. (2011). Modification of Productive Performance and Physiological Aspects of Broiler on the Addition of A Mixture Of Cumin and Turmeric to the Diet. *Resource* *Opinion* *Animal Veterinary Science*, 1: 31-34.

Al-Kassie, G., Mobseen, A. and Abd-Al-Jaleel, R. (2011). Use of Black Pepper (*Piper* *nigrum*) as feed Additive in Broilers Diet. *Resource* *Opinion* *Animal Veterinary Science*, 1: 40-50.

Aljuobori, A., Idrus, Z., Abdoreza, Soleimani, F., Norhani, A. and Liang, J*.* (2017)Extrusion Enhances Metabolizable Energy and Ileal Amino Acids Digestibility of Canola Meal for Broiler Chickens. *Italian Journal of Animal Science,* 13 (1): 44-47

Alu, T., Menten, G. and Jotku, L. (2012). Growth Performance of Broilers fed Diets containing Different Medicinal Herbs and Spices. *Journal of Pharmacology*, 14: 67-74

Angelakis, E., Merhej V. and Raoult D. (2013). Related Actions Of Probiotics And Antibiotics On Gut Microbiota And Weight Modification. *Lancet Infectious Disease*, 13: 889-899.

Anosike, F., Rekwot, G. and Owoshagba, B. (2011). Use of Red Pepper in Broilers Production. *Nigerian Journal of Animal Production,* 45 (1): 265-270.

Anosike, F., Naanpose, C., Rekwot, G., Sani, A., Owoshagha, O. and Malziga, I. (2015). *Challenges of Small-holder poultry farmers in Chikun, Kaduna State.* Proceedings of the 20th Annual conference of the Animal Science Association of Nigeria, 6-10th September, 2015, Kaduna, pp. 302-306.

Anosike, F., Rekwot, Z., Owoshagba, B., Ahmed, S and Atiku, J. (2018). Challenges of Poultry Production in Nigeria; A review. *Nigerian Journal of Animal Production,* 45 (1): 252-258

Aromolaran, A., Ademiluyi, I. and Hebu, O. (2013).Challenges of small poultry farmers in layers production in Ibadan, OyoState, Nigeria. *Global journal of Science frontier Research,* 13: 1-2

Aster, J., Kumar, V., Abbas, K., Fausto, N., Robbins, H. and Cotran, R. (2004). *Robbins and Cotran Pathologic Basis of Disease: Anaemia of diminished erythropoiesis* (7th ed.). Philadelphia, Saunders Co. (p.638-649).

Batiha, E., Beshbishy, M., Wasef, G., Elewa, Y., Al-Sagan, A., Abd El-Hack, M., Taha, A., Abd-Elhakim, M. and Prasad, D. (2020). Chemical Constituents and Pharmacological Activities of Garlic *(Allium sativum l.)-A* review. *Nutrients,* 12(3):872-875.

Bamishaiye, E., Muhammad, N. and Bamishaiye, M. (2009). Haematological Parameters of Albino Rats Fed on Tiger Nuts *(Cyperus esculentus)* Tuber Oil Meal-Based Diet. *The International Journal of Nutrition and Wellness,* 10(1): 92-93.

Bothoko, D. (2009). Performance of *Cloristrdium perfringes* Challenged Broiler Inoculated with Effective Microorganisms. M.sc Assertion, University of Pretoria, South Africa. Science, Texas A. and M. University.

Bozkurt, M., Kucukyilmaz, L, Cath, A. and Cinar, M. (2009). Effect of Dietary Manman Oligosaccharide with or Without Oregano Essential Oil and Hop Extract Supplementation on the Performance and Slaughter Characteristics of Broilers. *South African Journal of. Animal Science,* 39: 223-32

Branckaet, J. (1999). “Constraints in Poultry Production Among Smallholder”. *Journal of Agricultural Science,* 38: 387-399.

Bryden, W., Li X., Ravindran, G., Hew, L. and Ravindran, V. (2009), Ileal Digestible Amino Acid Values in Feedstuffs for Poultry. *Rural Industries Research and Development Corporation Publication,* 9: 71-76.

Cengiz, O., Koksal, H., Tatli, D., Sevim, O. and Avci H. (2012). Influence of Dietary Organic Acid Blend Supplementation and Interaction Loin Delayed Feed Access After Batch on Broiler Intestinal Health. *Veterinary Medicine,* 57: 515-523.

Central Bank of Nigeria 2010. Central Bank of Nigeria. Annual Report Statement of Account Statistical Bulletin.

Chang, L., Ferri, N., Terig, M., (2011). Energy level and requirement. Journal of Animal Nutrition, 24(2): 13-17.

Chang, L., Carré B, Mignon-Grasteau S, Juin H. (2008). Breeding For Feed Efficiency And Adaptation To Feed In Poultry. *World's Poultry Science Journal*, 64: 337-390

Cheeke, P. (Ed.) (2005). *Livestock feeds and feeding* (3rd ed.). Upper Saddle River, New Jersey: Pearson Prentice Hall.

Chineke, C. A., Ologun, A. G., and Ikeobi, C. O. N. (2006). Haematological Parameters In Rabbit Breeds And Crosses In Humid Tropics. *Pakistan Journal of Biological Sciences,* 9(11): 2102-2106.

Chowdhury, R., Islam, K., Khan, M., Karim, M., Hague, M., Khatun M. and Pesti G. (2009). Effect of Citric Acid Avilamy and Their Combination on the Performance, Tibia Ash And Immune Status of Broilers. *Poultry Sci*ence, 88: 1616-1622

Dale, N. (1996). Variation in Feed Ingredient Quality: Oilseed Meals. *Animal Feed Science Technology,* 59: 129–135.

David R. (2002). Poultry Production in the Tropics. *Poultryworld.Com*

Devirgilis, C., Zinno P. and Perozzi G. (2013). Update on antibiotic resistance in foodborne *Lactobaccilus* amd *Lactococcus species*. *Food Microbiology,* 4(10): 2289-2293.

Dhama, K., Latheef S., Mani S., Samad H., Karthik K., Tiwari R. and Laudadio V. (2015). Multiple Beneficial Applications And Modes Of Action Of Herbs In Poultry Health And Production-A Review. *International Journal of Pharmacology,* 11(3):152–176

Dhama, K., Tiwari, B., Rifat, U., Sandip, C., Marappan, G., Karthik, K. and Mani S. (2014). Growth promoters and Noval Feed Additives Improving Poultry Production And Heath Broactive principles and Beneficial Applications: The trends and Advances-A review. *International Journal pharmacology*, 10(3):129-159.

Dhama, K., Mahendran, M., Tomar, S. and Chauhan, R. (2016). Beneficial Effects Of Probiotics And Prebiotics In Livestock And Poultry. *The current perspectives,* 9: 1-12

Dhama, K., Chakraborty, S., Kapoor, S., Tiwari R. and Kumar A. (2013). One world, One Health-Veterinary Perspectives. *Advances of Animal Veterinary Sciences,* 1: 5-13.

Dhama, K and Singh S. (2010). Probiotics Improving Poultry Health And Production. An overview. *Poultry punch*, 26: 41-41

Dhama, K., Mahendran M. and Tomar S. (2007). Prebiotics and prebiotics: A safer way towards improving health and productivity in poultry. *Poultry world*, 2: 28-32

Dhama, K., Verma P., Sawant, R., Tiwari, B., Vaid, V. and Chauban R. (2011). Applications of Prebiotics In Poultry: Enhancing Immunity And Beneficial Effects In Production Performances And Health- A Review. *Journal of* *Immunopathology,* 13: 1-19.

Dibner, J. and Richards, J. (2005). Antibiotic Growth Promoters In Agriculture: The History And Mode Of Action. *Poultry Science*, 84: 634-643.

Dickens, J. and Ingram, K. (2001). Efficacy of Herbal Extract At Various Concentration On The Microbiological Quality Of Broiler Carcasses After Stimulated Chilling. *Journal of Applied Poultry Research*, 10: 194-198.

Ding, X., Yu, Y., Su, Z. and Zhang, K. (2017). Effect of Essential Oils On Performance, Egg Quality, Nutrient Digestibility And Yolk Fatty Acid Profile In Laying Hens. *Animal Nutrition,* 3: 127-131.

Dogan, S., Baylan, M., Erdoğan, Z., Küçükgül, A. and Bulancak, A. (2015). The Effects Of Licorice *(Glycyrrhriza glabra*) Root On Performance, Some Serum Parameters And Antioxidant Capacity Of Laying Hens. *Brazilian Journal of Poultry Science,* 20: 699–706

Doley, P., Singh, A. and Gogoi, S. (2009). Effect of Dietary Aloe Vera And Yeast Powder Onmuscle Growth Of Broiler Chicks. *Journal Veterinary Science,* 7(1): 93–95

Duncan, B., (1955). Multiple Range and F-Tests. *Biometrics,* 11: 1-42.

Elbanna H., El Latif A. and Soliman M. (2013) Anticoccidial Activity Of Allium Sativum And Aloe Vera In Broiler Chickens*. International Journal of Agro-Veterinary Medical Sciences,* 7(4): 117–125

El-Deek, A., Al-Harthi, A., Attia, Y. and Hannfy-Maysa, M. (2003). Effect Of Anise (*Pimpinella anisum*), Fennel *(Foeniculum vulgare)* And Ginger *(Zingiber roscoe* ) And Their Mixture On Growth Performance Of Broilers. *Archive Fur Geflugelkunde*, 67: 92-96.

Fallah, R., and Rezeci, T. (2013). Effect Of Dietary Prebiotic And Acidifier Supplementation On The Growth Performance, Carcass Characteristics And Serum Biochemical Properties Of Broilers. *Journal of Cell Animal Biology*, 7: 21-24

FAO. (2010). *Agribusiness Handbook: poultry meat and Eggs.* FAO Rome, Italy: Investment Centre Division.

FAO. (2011). Food and Agricultural Organization Corporate Document Repository in 2010

FAOSTAT. (2002). *World Food Production Trends*. Food and Agriculture Organization Statistics, Rome, Italy

Federal Department of Livestock and Pest Control (2004). Unpublished Report: Livestock Population, Production, Consumption and Diseases Control. FMARD, Gariki, Abuja. 2004

Feighner, S. and Dashkhevicz, M. (1987). Sub-Therapeutic Levels Of Antibiotics In Poultry Feeds And Their Effects On Weight Gain, Feed Efficiency And Bacterial Cholyltaurine Hydrolase Activity. *Applied Environment Microbiology,* 53: 331-536.

Gadde, U., Kim, W., Oh, T. and Lillehoj, H. (2017). Alternatives To Antibiotics For Maximizing Growth Performance And Feed Efficiency In Poultry: A Review. *Animal Health Research Review*, 18: 26–45.

Gene, T. (2014). Poultry Nutrition and Production. Wikipedia/poultry.

Ghazalah, A., El-Hakim, A. and Refaie, M. (2007). Response Of Broiler Chicks To Some Dietary Growth Promoters Throughout Different Growth Period. *Egyptian Poultry Science*, 27: 53-57.

Ghaedi, H., Nasr, J., Kheir, F., Miri, Y. and Rahimian, Y. (2013). Effect of Use Virginiamycin As Probiotic, Black Pepper Extract As Phytogenic Feed Additive On Performance Of Broiler Chicks. *Journal of Agricultural Science,* 3(12): 521-525.

Gibson, G. and Roberfreid, B. (1995). Retory Modulation Of The Hurro Colonic Microbiota: Intro Laing The Concept. *Journal of Nutrition*, 125: 1401-1412.

Gill, C. (1999). Herbs and plant extracts as growth enhancers. *Feed international,* 4: 20-23.

Great, H. (2003). Plants and Plant Extracts For Improving Animal Productivity. *Nutrition Societies,* 62: 279-290.

Griggs, J. and Jacob, P. (2005) Alternatives to Antibiotics For Organic Poultry Production. *Journal of Applied Poultry Research,* 14(4): 750–756

Hafeez, A., Manner, K., Schieder, C. and Zentck, J. (2016). Effect of Supplementation Of Phytogenic Feed Additives (Powered Vs Encapsulated On Performance And Nutrients Digestibility In Broiler Chickens. *Poultry Science,* 95: 622-629.

Han, Y. and P. Thacker (2010). Effects of Antibiotics, Zinc Oxide Or A Rare Earth Mineral-Yeast Product On Performance, Nutrient Digestibility And Serum Parameters In Weaning Pigs. *Asian-Australian Journal of Animal Science,* 23: 1057-1065.

Hassan, H., Mohamed, A., Youssef W. and Hass R. (2010). Effect of Using Organic Acids To Substitute Antibiotic Growth Promoters On Performance And Intestinal Microflora Of Broilers. *Asian-Australian* *Journal of Animal Science;* 23: 1348-1353

Hassan, I., Askar, A. and El-Shourbagy, G. (2004). Influence of Some Medical Plants Performance Physiological And Meat Quality Traits Of Broiler Chicks. *Egyptian Poultry Science Journal,* 24(1): 247-266.

Hassan, H., Abo Taleb, M, Wakwak, M. and Yousef, A. (2007). Productive, Physiological And Immunological Effects Of Using Some Natural Feed Additives In Japanese Quail Diets. *Egyptian Poultry Science* *Journal*, 27(11): 557-588.

Hedemann, P., Moss, K. Theil K. and Bach K. (2009). The Thickness Of The Intestinal Mucous Layer In The Colon Of Rats Fed Various Sources Of Non-Digestible Carbohydrates Is Positively Correlated With The Pool Of SCFA But Negatively Correlated With The Proportion Of Butyric Acidin Digesta. *Britain Journal of Nutrition*, 102: 117-125.

Heinke, H., Alexandra, C. and Ludwig, T. (2015). The Poultry Market in Nigeria: Market Structures And Potential For Investment In The Market. *International food and Agribusiness management Review*, 18(1): 23-32.

Hernandez, F., Madrid, J., Garcia, V., Orengo, J. and Megias, M. (2004) Influence of Two Plant Extracts On Broilers Performance, Digestibility, And Digestive Organ Size. *Poultry Science,* 83(2): 169–174

Hossein, H., Alaw, A., Seidavi, A., Norris, D. and Brown, D. (2014). Effects of Different Levels Of Coriander *(Coriandrum sativum*) Seed Powder And Extract On Serum Biochemical Parameters, Microbiota, And Immunity In Broiler Chicks. *The Scientific World Journal,* 6: 28-79.

Huyghebaert, G., Ducatelle, R. and Vanimmerseel, F. (2011). An Update On Alternatives To Antimicrobial Growth Promoters For Broilers. *Veterinary Journal,* 18(7): 182-188.

Idahor, K., Yakubu, A., Gwaza, D., Ayden, J., Adebayo, K. and Adagyo, L. (2011). *Physiologic response of broiler finishers fed sundried cassava peels*. Proceedings of the 3rd African International poultry summit, Abeokuta, Nigeria, pp. 13-17.

Isaac, L., Abah, G., Akpan, B., and Ekaette, I. (2013). *Haematological properties of different breeds and sexes of rabbits.* Proceedings of the 18th Annual Conference of Animal Science Association of Nigeria, Enugu, pp 24-27.

Iqbal, Z., Nadeem, Q., Khan, M., Akhtar, M. and Waraich, F. (2011). In vitro anthelmintic activity of *Allium sativum, Zingiber officinale, Curcurbita mexicana and Ficus religiosa.* *International Journal Agricultural Biology,* 3: 454-457.

Iwuji, T. and Herbert, U. (2012). *Haematological and Serum Biochemical Characteristics Of Rabbit Bucks Fed Diets Containing Garcimiola Kola Seed Meal.* Proceedings of 37th Annual Conference of Nigerian Society for Animal Production, Ogun, pp 87-89.

Jackson, M., Anderson, D., Mathis, G. and Fodge, D. (2003). Beneficial Effect Of B-Mannanase Feed Enzyme On Performance Of Chicks Challenged With *Eimeria Sp* And *Clostridium Perfringens.* *Avian Diseases*, 47: 759-763.

Jalal H., Akram M., Doğan S., Fırıncıoğlu S., Irshad N. and Khan M. (2019). Role of Aloe Vera as a Natural Feed Additive In Broiler Production. *Turkish Journal of Agricultural Sciences,* 1: 163–166

Jamroz D., Wiliczkiewicz, A. Wertelecki, T., Orda, J. and Skorupinska. J. (2005). Use of active substances of plant origin in Chicken diets based on maize and locally grown cereals. *British poultry Science,* 46: 485-493

Jones, F., Dave, R. and Hans, T. (2010). Animal production and Nutrition. *Journal of Poultry Science,* 8(6): 67-79

Jose, F., Pricila, R. and Aline, M. (2008). Plant extracts used as growth promoters in broilers. *Brazilian* *Journal of Poultry Science,* 109-115

Jayaprakasha, G., Rao, J. and Sakariah, K. (2005) Chemistry and Biological Activities Of C. longa. *Trends Food Science Technology,* 16(12): 533–548

Kamel (2000). Animal Growth, nutrition and Maintenance. *Poultry Science.*

Karthikeyan, J. and Rani, P. (2003). Enzymatic and non-enzymatic antioxidants in selected Piper species. *Indian Journal of Experimental Biology*, 41: 135-140.

Kataria, I., Mohan, C., Dey, S., Dash, B. and Dhama, K. (2005). Diagnosis and immunoprophylaxis of economically important poultry diseases. A Review. Indian *Journal Animal Science*, 75: 555-567.

Khalaf, A., Shakya, A., Al-Othman, A., El-Agbar, Z. and Farah, H. (2008). Antioxidant Activity of Some Common Plants. *Turkish Journal of* *Biology*, 32: 51-55.

Khan, T. and Zafar, F. (2005). Haematological Study in Response to Varying Doses of Estrogen in Broiler Chicken. *International Journal of Poultry Science,* 4(10): 748-751.

Khattak, F, Ronchi, A, Castelli, P. and Sparks, N. (2014). Effects of natural blend of essential oil on growth performance, blood bio Chemistry, fecal morphology, and Carcass quality of broiler Chickens. *Poultry Science,* 93: 132-137

Khoobani, M., Hasheminezhad, S., Javandel, F., Nosrati, M., Seidavi, A. and Kadim, I. (2020) Effects of Dietary Chicory (*Chicorium intybus L.)* and Probiotic Blend As Natural Feed Additives On Performance Traits, Blood Biochemistry, And Gut Microbiota Of Broiler Chickens. *Antibiotics* 9(1): 5-11.

Kirk O. (2015). Broilers in the Tropics. *Poultryworld*.*com*

Knarreborg, A., Lauridsen, C., Engberg R. and Jensen S. (2004). Dietary Antibiotic Growth Promoters Enhance The Bioavailability Of Atocopheryl Acetate In Broilers By Altering Lipid Absorption. *Journal of Nutrition,* 134: 1457-1492.

Kocher, A. (2006)*. Interfacing gut health and nutrition: The use of dietary prebiotics and probiotics to maximize growth performance pigs and poultry.* The Netherland, : Wageningen Academy Publications. pp.269-310.

Leskovec J., Levart A., Zgur S., Jordan D., Pirman T., Salobir J. and Rezar J. (2018). Effect of Olive Leaf And Marigold Extracts On The Utilization Of Nutrients And On Bone Mineralization Using Two Different Oil Sources On Broilers. *Journal Poultry Science,* 55; 17-27.

Mabima, A., Rabal, R., Latheef, K. and Samad, H. (2012). Immunomodulatory and Therapeutic Potentials Of Herbal, Traditional/Indigenous And Ethno Veterinary Medicines. *Pakistan Journal Biological Sc*ience, 23(5): 754-774

Mahady G., Pendl S., Yun G., Lu Z. and Stoia A. (2008). Ginger (*Zingiber officinale*) and The Gingerols Inhibit The Growth Of Cag A + Sstrains Of Helicobacter Pylori. *Anticancer Research,* 23: 3699-3702.

Malini, T., Arunakaran, J., Aruldhas, M. and Govindarajulu, P. (1999). Effects of Piperine On The Lipid Composition And Enzymes Of The Pyruvate –Malate Cycle In The Testis Of The Rat In Vivo. *Biochemistry and Molecular Biology International*, 47: 537-45.

Manyong, V., Ikpi, J., Olayemi, S., Yusuf, B., Omorona, V., Okoruwa, H. and Idachaba F. (2005). Agriculture in Nigeria: Identifying opportunities for increased commercialization and investment, ITA.

Merck Manual (2012). Haematologic reference ranges*. Mareck Veterinary Manual*; *Retrieved* from <http://www.merckmanuals.com/>.

Menten J. (2001). Aditivos alternativos na produção de aves: probióticos e prebióticos. Anais da Reunião Anual da Sociedade Brasileira de Zootecnia; Piracicaba, São Paulo. Brasil: Piracicaba, pp 141-157.

Miraj S. (2016). A systematic review on the *Heracleum persicum* effect and efficacy profiles. *Der Pharmaceutical Chemistry,* 8(14): 140–142

Miraj S. and Kiani S. (2016) Study of pharmacological effect of *Thymus vulgaris:* a Review. *Pharmaceutical Literature*, 8(9): 315–320

Mohan, B., Kardirvel, R., Natarjan, A. and Bhaskaran,M. (1996). Effect of Probiotic Supplementation on Growth, Nitrogen Utilization and Serum Cholesterol in Broilers. *British Poultry Science*, 37: 395-401.

Mmereole, F. (2008). The Effects of Replacing Groundnut Cake with Rubber Seed Meal on the Haematological and Serological Indices of Broilers. *International Journal of Poultry Science,* 7(6): 622-624.

Mookiah, S., Sico, C., Ramasamy, K., Abdullah, N. and Ho, Y. (2014). Effects Of Dietary Prebiotics, Probiotic And Symbiotics On Performance, Caecal Bacterial Populations And Caecal Fermentation Concentrations Of Broiler Chickens. *Journal Science of food Agriculture,* 94**:** 341-348.

Moorthy, M., Ravikumars, S., Viswanathan, K. and Edwin, S. (2009). Ginger Pepper and Curry Leaf Powder as Feed Additives in Broiler Diet. *International* *Journal of poultry science*, 8: 779-782.

Muhammad, N., Maigandi, S., Hassan, W. and Daneji, I. (2007). Quantification and Chemical Evaluation Of Rice Milling Waste Obtained From Sokoto Metropolis And Its Environment. *Tropical Journal of animal science,* 10(12): 445-450.

Ndams, S., Tegbe, S. and Ogundipe, S. (2009). Effects of feeding graded levels of re-fermented brewers’ dried grains on performance and carcass characteristics of broiler chickens. *Journal of applied Agricultural research,* 1: 37-45.

NABC (2020). Poultry Sector Study in Nigeria, Netherland Enterprise Agency

Nalini N., Manju Y. and Menon V. (2006). Effect of Spices To Lipid Metabolism In 1, 2-Dimethylhydrazine-Induced Rat Colon Carcinogenesis. *Journal of medicinal food*, 9: 237-245.

Nandagopal S. and Kumari B. (2007) Phytochemical and antibacterial studies of Chicory (*Cichoriumintybus L.)-*a multipurpose medicinal plant. *Advance Biology Research,* 1(1-2): 17–21

National Bureau of Statistic, (2010). Gross Domestic Product for Nigeria (Expenditure & Income) NBS, Plot 762, Independence Avenue, Central Business District, Abuja.

Navjot S., Udeybir S., Sethi A., Hundal J., Lamba J. and Amit S. (2017). Effect of Black Pepper and Jaggery Supplementation with or without Feed Restriction on Broilers Performance. *Journal of Animal Research*, 7, (5): 903-912.

Nave G., Bielke L., Callawat T. and Castaneda (2001). Probiotics alternatives to reduce gastrointestinal infections: The poultry experience. *Animal Health Research Review*, 6: 105-118.

Nava, G., Attene-Ramos, M., Gaskins R. and Richards J. (2009). Molecular Analysis Of Microbial Community Structure In The Thicken Ileum Following Organic Acid Supple Mentation. *Veterinary Microbiology,* 137: 345-353.

Nedra, A., David S. and Jose F. (2021). Phytogenic Feed Additive in Poultry: Achievements, Prospective and Challenges. *Animals*, 11: 34-71.

Nieworld, T. (2007). The Non-Antibiotic Anti-Inflammatory Effect of Antimicrobial Growth Promoters, the Real Mode of Action. A hypothesis. *Poultry Science*, 86: 605-609.

Nikolu, P., Stanaćev, V., Beuković, M., Ljubojević, D., Kostadinović L. and Džinić, N. (2014) *Animal Feeding and Nutrition for Increased Productivity.* In: Proceedings of International Scientific Conference, Vukovar, Croatia, pp75.

Nseabasi, N., Mary, E., Uduak, A. and Edem, E. (2014). Haematological Parameters and Factors Affecting Their Values. *Agricultural Science,* 2(1): 37-47.

NRC, National Research Council (1994). Nutrient requirement of poultry, 9th Ed., National Acad. Press, Washington) D.C., NAS, P: 155.

Nwafor M. (2011). Literature Review of Development Target in Nigeria. Ibadan: International Institute Tropical Agriculture.

Obun T. and Anyanwale M. (2007). Broilers Performance in the Tropics. *Journal of Tropical Agriculture,* 8: 7-12

Obun T. Ayanwale M. and Sunter G. (2014). Uses of Medicinal Spices in Poultry Production. *Journal of Tropical Agriculture,* 8: 30-40.

Ocak, N., Erner, G., Burak, A., Sugu, F., Attop, M. and Ozmen, A. (2008). Performance of Broilers Fed Diets Supplemented with Dry Peppermint *(mentha piperita l.)* or Thyme *(Thymus Vulgaris L.*) leaves as growth promoter Source. *Czech Journal of Animal Science,* 53: 169-175.

Olafedehan, O., Obun, A., Yusuf, M., Adewumi, O., Oladefedehan, A., Awofolaji, A. and Adeniji, A. (2010). *Effects of residual cyanide in processed cassava peal meals on haematological and biochemical indices of growing rabbits.* Proceedings of 35th Annual Conference of Nigerian Society for Animal Production, Ogun, pp212.

Olanyi, A., Adesiyan, O. and Ayoade, R. (2008). Constaints to Utilization of Poultry Production Technology among Farmers in Oyo State, Nigeria. *Journal of Human Ecology,* 24(4): 305-309

Okunlola, D., Olorunisomo, A., Aderinola, A., Agboola, A. and Omole, O. (2012). *Haematology and serum quality of red Sokoto goats fed Baobab (Adansonia digitata) fruit meal as supplement to guinea grass (Panicum maximum).* Proceedings of the 17th Annual Conference of Animal Science Association of Nigeria, Ogun, 27-433.

Ovuru, S. and Ekweozor, E. (2004). Haematological changes associated with crude oil ingestion in experimental rabbits. *African Journal of Biotechnology,* 3(6): 346-348.

Oyawoye, M. and Ogunkunle, H. (2004). *Biochemical and haematological reference values in normal experimental animals.* New York: Masson, 212-218.

Patil V., Surwase S., Belure A. and Govindrao A. (2019). Phytochemical Analysis and Antibacterial Evaluation of Curcuma Longa and Curcuma Aromatica Against Enteric Poultry Pathogens. *International Journal of Pharmaceutical Science Research,* 10(4): 2000–2003

Pedroso, A., Hurley-Bacon, A., Zedek, A., Kwan T. and Jordan, A. (2013). Probiotics Improve the Environmental Microbiome and Resistome of Commercial Poultry Production. *International Journal of Environmental Research for* *Public Health*, 10: 4534-4559.

Peters, S., Gunn, H., Imumorin, I., Agaviezor, O. and Ikeobi, O. (2011). Haematological studies on frizzled and naked neck genotypes of Nigerian native chickens. *Tropical Animal Health Production,* 43(3): 631-638.

Peric, L., D. Zikic and M. Lukic (2009). Application of alternative growth promoters in broiler production. *Biotechnology of* *Animal Husbandry*, 25: 387-397

Purves, W., Sadava, D., Orians, G. and Heller, H. (2003). *Life: The science of Biology*. Sinauer Associates and W. H. Freeman, 7: 954.

Rakesh, L. and Sushil, K. (2003). Bronchial asthxma In Scientific Basis For Ayurvedic Therapies Edited by Lakshmi Chandra Mishra, Published by CRC Press.

Ravindran V. (2013) Feed enzymes: The Science, Practice, And Metabolic Realities*. The Journal of Applied Poultry Research,* 22: 628-636

Roberfreid, M. (2007). Prebiotics. The Concept revisited. *Nutrition*, 137: 8305-8375

Safamehr A., Fallah F. and Nobakht A. (2012). Growth Performance And Biochemical Parameters Of Broiler Chickens On Diets Consist Of Chicory *(Cichoriuminty bus)* And *Nettle (Urticadioica)* With Or Without Multienzyme. *Iran Journal of Applied Animal Science,* 3(1): 131–137

Safamehr A., Mirahmadi M. and Nobakht A. (2014). Effect of nettle *(Urticadioica*) medicinal plant on Growth Performance, Immune Responses, and Serum Biochemical Parameters of Broiler Chickens. *Iran Journal of Applied Animal Science,* 3(4): 721–728

Salah W., Saleh E., Watkins, S., Waldroup, A. and Waldroup, P. (2013). Effects Of Early Quantitative Feed Restriction On Live Performance And Carcass Composition Of Male Broilers Grown For Further Processing. *Journal of Applied Poultry Research,* 14(1): 87-93.

Sayrafi R., Mirzakhani N. and Mobaseri R. (2017). Effects of Turmeric *(Curcuma longa)* and Vitamin E on Histopathological Lesions Induced in Bursa of Fabricius of Broiler Chicks by Salinomycin. *Veterinary Research Forum*, 8(3): 231–236

Sethy K., Swain P., Behera K., Nayak S., Barik S., Patro P. and Meher P. (2016) Effect of turmeric *(Curcuma longa)* Supplementation On Growth And Blood Chemistry Of Broilers. *Exploration of Animal Medicinal Research,* 6(1): 75–79

Sidell, B. and O’ Brien, K. (2006). When Bad Things Happen To Good Fish: The Loss Of Haemoglobin And Myoglobin Expression In Antarctic Icefishes. *The Journal of Experimental Biology,* 209: 1791-1802.

Sogunle F., Tallu J., Rawju T. and Fullah G. (2010). Poultry Management Systems, Nutrition and Reproduction. *Journal of poultry,* 23: 45-50

Sonaiya, E. and Swan, E. (2004). Small-scale poultry production. Technical Guide. FAO Animal production and Health Manual, Rome, Italy.

Soetan, K., Akinrinde, A. and Ajibade, T. (2013). *Preliminary studies on the haematological parameters of cockerels fed raw and processed guinea corn (Sorghum bicolor).* Proceedings of 38th Annual Conference of Nigerian Society for Animal Production, Ogun, pp. 49-52

SLUS-AK (1989). Soils and land use studies, Government print office, Uyo, Akwa Ibom State Soil Survey Staff 1994. Key to soil Taxonomy Soil Management Support Service (SMSS). *Technology*, 19: 306

Thacker, P.A. (2013). Alternatives to antibiotics as growth promoters for use in swine production. *Journal of Animal Science and Biotechnology,* 10(4): 321-327.

The American Heritage (2009). Definition of Poultry. *Wikipedia.com/poultry*

Tiwari, R., Chakraborty, S., Saminathan M., Dhama K. and Singh S. (2013).Antibiotic resistance- an emerging health problem: Gaver, worries, Challenges and solutions- A Review*. International Journal of Curriculum Research*, 5: 1850-1892

Tollba A. and Hassan A. (2003). Broilers Phytobiotics and Antibiotics Nutritional Evaluation. *Egyptian Poultry Science Journal,* 27: 750-760

Tollba, A., Azouz, H. and Abd-Samad, M. (2010). Antioxidants supplementation to diet of Egyptian chicken under different environmental condition: 2-The growth during cold winter stress. *Egyptian Poultry Science Journal*, 27: 727-748.

Togun, V., Oseni, B., Ogundipe, J., Arewa, T., Hammed, A., Ajonijebu, D. and Mustapha, F. (2007). *Effects of chronic lead administration on the haematological parameters of rabbits – a preliminary study*. Proceedings of the 41st Conferences of the Agricultural Society of Nigeria, p. 341.

Turner, and Jack. 2004. Black pepper and white pepper. http://en,wikipedia;org/wiki/Black\_pepper.

Ugwuene, M. (2011). Effect of Dietary Palm Kernel Meal for Maize on the Haematological and Serum Chemistry of Broiler Turkey. *Nigerian Journal of Animal Science, 13*: 93-103.

USDA (2013). United States Department of Agriculture, International Egg and Poultry Report.

Valiollahi, M., Rahimian, Y., Miri Y. and Rafiee, A. (2013). Use of Spices in Animal Nutrition. *Scholars Journal of Agricultural Science,* 3: 535-540.

Vander Aar, P., Molist, F. and Van derklis, J. (2017). The Central Role In Intestinal Health On The Effect Of Feed Additives On Feed Intake In Swine And Poultry. *Animal Feed Science Technology,* 233: 64-75.

Wang, J., Lee, J., Yoo, J., Cho, H., Ho, J., Kim J. and Kim H. (2010). Effects of Phenyllactic Acid On Growth Performance, Intestinal Microbiota, Relative Organ Weight Blood Characteristics And Meat Quality Of Broiler Chicks. *Poultry Science,* 89: 1549-1555.

Waugh, A., Grant, A., and Ross, J. (2001). Ross and Wilson Anatomy and Physiology in Health and Illness. *Churchill Livingston, an imprint of Elsevier Science Limited*, 9: 59-71.

Yin, Y., Lu, Z., Deng, H., Huang, H., Zhong, Z., How I. and Liu P. (2004). Nutritional And Health Functions Of Carbohydrate For Pigs. *Journal Animal Feed Sciences*, 13: 523-538

Zhang, G., Yang, Z., Wang, Y., Yang W., Jiang, S. and Gai, G. (2009). Effect of Ginger That *(Zingiber officinale)* Processed To Different Particle Sizes On Growth Performance, Antioxidant Status And Serum Metabolites Of Broiler Chickens. *Poultry Sciences,* 88: 2159-2166.