**A**

**RESEARCH PROJECT**

**ON THE TOPIC:**

**EFFECT OF GINGER (*Zingiber officinale*) RHIZOME ON THE HAEMATOLOGY, SERUM AND LIPID PROFILE OF BROILER CHICKEN**

**PRESENTED BY:**

**COX, IDONGESIT FRIDAY**

**AK17/AGR/ANS/004**

**SUPERVISED BY:**

**DR. UKPANNAH**

**DEPARTMENT OF ANIMAL SCIENCE**

**FACULTY OF AGRICULTURE**

**AKWA IBOM STATE UNIVERSITY**

**OBIO AKPA CAMPUS.**

**FEBRUARY, 2024**

**CHAPTER ONE**

**INTRODUCTION**

* 1. **Background of the Study**

The need for poultry meat is on the increase both locally and internationally, and to meet the increasing demand, most commercial poultry enterprise operates using an intensive system of production (Oso *et al*., 2021). The intensive system which ensures and sustains high feed efficiency of poultry, however, is highly challenged with various infections and high feed cost which may be devastating, and huge losses may be incurred (Carrasco *et al*., 2019). Conventionally used feed additives usually called antibiotic growth promoters (AGPs) are used for combating various infections experienced in poultry production. Doses of these growth promoters also improved feed utilization efficiency with resultant improved growth and increased economic returns (Suresh *et al*., 2018). However, consequent harmful residual effects on consumers involving transmission of antibiotic resistant bacteria and transfer of zoonotic infections are issues of concern discouraging its use in poultry production (Durairajan *et al*., 2021).

To confront these threats, alternatives to antibiotics collectively called phytogenics are being explored which include medicinal plants and their products, plant extracts and essential oils of plants/parts of plants and plant extracts which are capable of positively influencing performance and immune status of birds without adverse effect on the animal and the final consumers (Karangiya *et al*., 2016; Alloui *et al*., 2014).

Phytobiotics, also called phytogenic feed additives (PFA) are plant derived products added to feed in order to enhance the performance of livestock through the improvement of digestibility, nutrient absorption and elimination of pathogens residents in the animal gut (Borgohain *et al*., 2019). There is an increase in the use of phytogenics in recent times as feed supplements in poultry production and this has attracted much attention due to the inherent beneficial properties of the plants (Abou-Elkhair *et al*., 2014; Paraskeuas *et al*., 2017). Recent consumers' expectations in relation to food quality, have led to increasing use of plant feed additives by poultry producers.

Ginger belong to this class of phytogenic plants which are natural growth promoters that are suitable alternatives to feed antibiotics. In addition, these herbal plants are locally accessible and available in adequate quantity (Gbenga *et al*., 2009). Gingerols, gingerdiol and gingerdione as a constituent of ginger has the ability to exhibit digestive enzyme stimulation and antimicrobial activity (Dieumou *et al*., 2009). The positive effects of these feed supplements on broiler performance, carcass characteristics and meat quality have been demonstrated (Schleicher *et al*., 1998). Evidence also showed that gram positive and gram negative food-borne bacteria, yeast and mould could be inhibited by garlic, onion, cinnamon, cloves, thyme and other spices (Smith-Palmer *et al*., 1998). PFA, such as ginger (*Zingiber officinale Roscoe*) has been reported to prevent accumulation of lipids including neutral fats and cholesterol (Bamidele and Adejumo, 2012). The rhizome of *Zingiber officinale* is consumed as a delicacy, medicine, or spice (David, 2009).

Ginger contains several bioactive components that has antioxidant, anti-inflammatory, anticarcinogenic and antibacterial properties (Sudrashan *et al*., 2010; Minghetti *et al*., 2007). Zhao *et al*. (2011) reported that feed intake and feed conversion ratio did not differ among laying hens fed dried ginger at 5, 10, 15 and 20g/kg inclusion levels, Onu (2010) found that 0.25% inclusion of ginger in broiler diets improved feed conversion ratio although feed intake did not change. Broilers fed diets containing ginger produced higher carcass weights, higher dressing percentages and improved carcass quality (Zhang *et al*., 2009).

Total cholesterol, low density lipoprotein (LDL) cholesterol and very low density lipoprotein (VLDL) cholesterol decreased significantly (P<0.05) in broilers fed aqueous ginger extract, while, high density lipoprotein (HDL) cholesterol concentration increased (Saeid *et al.*, 2010). Reduction of total fat and cholesterol contents and alteration of the lipid profile to a more unsaturated kind were methods for improving the quality of meat health-wise (WHO and FAO, 2003). Achieving this through dietary inclusion of naturally occurring herbs would be a cheap and safe strategy, and amenable to adoption by poultry farmers, hence, the need to evaluate the efficacy of ginger leaf on broilers hematology, serum and lipid profile.

* 1. **Problem Statement**

Antibiotic growth promoters (AGPs) are used for combating various infections experienced in poultry production (Murugesan *et al*., 2015). Doses of these growth promoters also improved feed utilization efficiency with resultant improved growth and increased economic returns (Suresh *et al*., 2018). However, consequent harmful residual effects on consumers involving transmission of antibiotic resistant bacteria and transfer of zoonotic infections are issues of concern discouraging its use in poultry production (Durairajan *et al*., 2021).

**1.3 Justification of the Study**

Ginger (*Zingiber officinale*), a widely used herb and food spice is a major constituent of most Nigerian cuisine. Ginger is a natural growth promoter and a suitable alternative to feed antibiotics. It is locally accessible and available in adequate quantity (Gbenga *et al*., 2009). The medicinal value of ginger has been linked to its antioxidant potential that arises from the oleoresins which are present in it. The oleoresins in ginger have been credited for various pharmacological effects such as antimicrobial, anti-inflammatory, antioxidant, anti-hypercholesterolemic, anti-hyperglycemic, and antispasmodic. The positive effects of these feed supplements on broiler performance, carcass characteristics and meat quality have been demonstrated (Schleicher *et al*., 1998; Abou-Elkhair *et al*., 2014; Paraskeuas *et al*., 2017). Hence, there is need to evaluate the efficacy of ginger rhizomes on the haematology, serum and lipid profile of broilers for increased production and safe consumption.

**1.4 Objectives of the Study**

The objectives of this study was to;

1. evaluate the hematological parameters of broilers fed diets containing varying levels of ginger (*Zingiber officinale*) rhizome.

2. evaluate the serum and lipid profile of broilers fed diets containing varying levels of ginger (*Zingiber officinale*) rhizome.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1 Poultry Production in Nigeria**

There are diverse definition regarding the term 'poultry' but does not deviate from the domestication of economic birds (Banerjee*,* 2007). These domesticated birds include: chicken, pigeons, turkey, goose and duck. Globally, chicken birds are the most domesticated class amongst the numerous classes of birds. Chicken birds are categorized into: broilers (meat producers) and the layers (egg producers) birds (Marlo*,* 2008). The Poultry industry is one of the sub-sector of agriculture that have emerged drastically over the decades with over 100million birds in Nigeria and it has grown steadily despite the challenges faces (NABC, 2020). According to NABC (2020), report 'A time for Africa', Ivory Coast and Benin shows the most potential for poultry sector development in terms of increasing local demand and the incentives available, both fiscal and non-fiscal. Since 2008, the Nigerian Government have invested in the poultry sector by launching the commercial Agriculture credit scheme (CACS) to encourage farmers focus more on commercial farming than subsistence farming in order to produce more and boost the economic growth: noting that the poultry sub-sector contribute to the Gross Domestic Product (GDP), hence the poultry industry is significant for economic growth and development (NABC, 2020).

**2.2 Economic Importance of Broilers Production**

The benefits of poultry production are 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 Broilers Production**

Poultry production industry is faced with numerous challenges which cannot be over-looked. The challenges encountered in the poultry production industry includes;

* High cost of feeding (Adeyoma and Onikoyi, 2012).
* Inadequate poultry extension services (Adeyoma and Onikoyi, 2012).
* Lack of technical knowledge in the management and production of poultry as majority ventures into the sector because of the huge profit regardless of the ethics (Aromalaran *et al.,* 2013).
* High rate of disease and pest attack (Ajala *et al.,* 2007).
* Lack of access to loans and credits procurement (Aromalaran *et al.,* 2013).
* High rate of mortality which is due to supply and use of poor quality materials (Anosike *et al.,* 2005; Ajala *et al.,* 2007).

Amongst the endless list of challenges faced by poultry production industry, high cost of feeding is the major challenge that impedes the growth of the production which has been reported by Agro-Ind (2002) to be anchored by the competitive nature of the feed ingredients with man and unavailability. Where the total cost of feeding covers about 60-70% of the production cost thereby endangering profit maximization by the producer (Anosike *et al.,* 2015).

**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 contain 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 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 arginine 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; 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).

**2.5 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). Hematological parameters are those parameters that are related to the blood and blood forming organs (Waugh *et al.,* 2001; Bamishaiye *et al.,* 2009). Hematological 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 Hematological studies are of ecological and physiological interest in helping to understand the relationship of blood characteristics to the environment (Isaac *et al.,* 2013). Hematological 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 hematological 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, breeds 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 hemoglobin. Hemoglobin reacts with oxygen carried in the blood to form oxyhaemoglobin during respiration. 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 (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 (Isaac *et al,* 2013). 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. 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; 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 (Isaac *et al.,* 2013).

**2.6 Serum and Lipid Parameters of Broilers**

Serum parameters refer to various substances present in the liquid portion of blood after clotting. These parameters provide crucial information about organ function, metabolic processes, and nutritional status. Some key serum parameters and their importance include:

**a. Total Protein (TP):** TP measurement helps evaluate the overall protein status of an animal, including albumin and globulin levels. Abnormal TP levels may indicate malnutrition, liver disease, kidney disease, or other disorders. (Feldman *et al.,* 2020).

**b. Blood Urea Nitrogen (BUN):** BUN indicates the level of nitrogenous waste products (urea) in the blood, reflecting renal function. Elevated BUN levels are associated with kidney disease or dehydration. (Feldman *et al.,* 2020).

**c. Creatinine:** Creatinine is another marker used to assess renal function. Increased levels of creatinine are indicative of impaired kidney function. (Harvey and Tasker, 2012).

**d. Liver Enzymes:** Serum levels of enzymes, such as Alanine Aminotransferase (ALT) and Alkaline Phosphatase (ALP), help assess liver health. Abnormal enzyme levels may indicate liver dysfunction, hepatotoxicity, or bile duct obstruction. (Harvey and Tasker, 2012).

Lipid parameters are measures of various fats and lipids present in the blood, providing insights into lipid metabolism and cardiovascular health. Some important lipid parameters include:

**a. Total Cholesterol:** Cholesterol is an essential lipid required for various physiological processes. Elevated cholesterol levels may indicate hyperlipidemia, hypothyroidism, or liver disease. (Feldman *et al.,* 2020).

**b. Triglycerides:** Triglycerides are a type of fat utilized for energy storage. Increased triglyceride levels are associated with obesity, diabetes, pancreatitis, or certain endocrine disorders. (Harvey and Tasker, 2012).

**c. High-Density Lipoprotein (HDL) and Low-Density Lipoprotein (LDL) Cholesterol:** HDL and LDL cholesterol levels help evaluate the ratio of "good" and "bad" cholesterol in animals. Abnormal levels may indicate lipid metabolism disorders or cardiovascular disease risk. (Feldman *et al.,* 2020).

Notably, serum and lipid parameters may vary depending on the animal species, breed, age, and other factors.

**2.7 Roles of Spices in Broilers Production**

Spices are non-leaf parts of plants, including seeds, fruits, bark or root with intensive taste or smell (Applegate *et al.,* 2010). Spices hold great potential in improving broiler production by enhancing growth performance, promoting nutrient utilization, improving gut health, and providing antioxidative and antimicrobial effects. The incorporation of spices in broiler diets has gained significant attention due to their numerous benefits. Spices encompass a wide range of aromatic plant parts, including seeds, leaves, barks, roots, and fruits, that have been used for centuries in human diets for their flavor, aroma, and medicinal properties. In general, the need to meet chicken demand for the increasing populace, it is paramount to lower cost of animal feed taking into considerations of consumers’ safety. The use of plant extracts has been examined for this reason. Several studies suggest that plants rich in antioxidants, for example, play a protective role in health and against diseases, and their consumption lowers health risks, hence enhance feed efficiency. The potential of these medicinal plants may be related to the concentration of phenolic substances (flavonoids, hydrolyzable tannins, proanthocyanidins, phenolic acids, phenolic terpenes) and some vitamins (E, C, and A). The advent of phytogenic feed additives such as herbs and spices particularly in poultry production improved flavor and palatability, thereby enhancing productive performance. Today herbs and spices are extensively studied because of their potent properties and used as alternative non-antibiotic growth promoters.

**2.7.1 Improved Growth Performance**

Numerous studies have reported that the inclusion of various spices in broiler diets leads to improved growth performance. Spices such as black pepper, turmeric, cinnamon, and ginger have been shown to enhance body weight gain and feed conversion ratio (FCR) in broilers (Windisch *et al.,* 2008; Ali *et al.,* 2015; Sawosz *et al.,* 2017).

**2.7.2 Enhanced Nutrient Utilization**

Spices possess bioactive compounds that can improve the utilization of nutrients in broilers. For instance, garlic and its extracts have been demonstrated to enhance nutrient digestibility, absorption, and retention, leading to better overall nutrient utilization (Mohiti-Asli and Ghanaatparast-Rashti, 2018). Other spices, such as cumin, coriander, and fenugreek, have also shown similar effects (Padhi *et al.,* 2017).

**2.7.3 Gut Health Improvement**

Spices have been recognized for their positive impacts on gut health in broilers. The inclusion of spices in broiler diets can modulate gut microbiota composition, improve intestinal morphology, enhance gut barrier function, and reduce pathogenic bacterial colonization (Windisch *et al.,* 2008; Khan *et al.,* 2011; Pandya *et al.,* 2019). Some common spices used include oregano, thyme, turmeric, and cinnamon.

**2.7.4 Antioxidative and Antimicrobial Effects**

Several spices possess antioxidative and antimicrobial properties, which play a vital role in broiler production. The inclusion of spices rich in antioxidants, such as turmeric, rosemary, and clove, can help reduce oxidative stress and enhance meat quality (Botsoglou *et al.,* 2002; Han *et al.,* 2011). Furthermore, spices like oregano, thyme, and garlic exhibit antimicrobial effects against harmful bacteria, thereby reducing the need for antibiotics (Abd El-Hack *et al.,* 2018; Mehmood *et al.,* 2019).

The use of spices in broiler production has gained significance due to their remarkable properties. Spices can improve growth performance, enhance nutrient utilization, promote gut health, and provide antioxidative and antimicrobial effects

**2.8 Nutritive and Chemical Composition of Ginger (*Zingiber officinale*)**

Ginger, (*Zingiber officinale),* belongs to the family Zingiberaceae. It is a flowering plant that originated in Southeast Asia and is now cultivated in tropical regions worldwide. The ginger plant is characterized by its thick, aromatic rhizome, which is the part commonly used for culinary and medicinal purposes (Rasouli, 2017).

Ginger is not only renowned for its distinct flavor and aroma but also for its rich nutritional content. While the exact nutrient composition may vary slightly depending on the variety and growing conditions, ginger generally contains the following essential nutrients per 100 grams of raw ginger:

|  |  |
| --- | --- |
| **Nutrients** | **Composition** |
| Calories | 80 kcal |
| Carbohydrates | 18 grams |
| Dietary fiber | 2 grams |
| Protein | 1.8 grams |
| Fat | 0.8 grams |
| Vitamin C | 5 milligrams |
| Vitamin B6 | 0.2 milligrams |
| Iron | 0.6 milligrams |
| Potassium | 415 milligrams |
| Phosphorus | 34 milligrams |
| Magnesium | 43 milligrams |
| Calcium | 16 milligrams |
| Zinc | 0.3 milligrams |

**(**Rasouli, 2017**)**

Ginger owes its medicinal properties to its diverse array of bioactive compounds, particularly gingerols, shogaols, paradols, and zingerone. These compounds contribute to ginger's characteristic pungent taste and aroma. Ginger also contains essential oils, phenolic compounds, and flavonoids. The chemical composition of ginger may vary depending on various factors, including the variety, stage of maturity, and processing methods (Rahmani *et al.,* 2012**)**

Gingerols and shogaols, in particular, have been extensively studied for their pharmacological activities, such as anti-inflammatory, antioxidant, analgesic, and anti-nausea effects. These bioactive compounds have also shown potential benefits for gastrointestinal health, cardiovascular health, and immune modulation **(**Rahmani *et al.,* 2012**)**

**2.9 Feeding Trials of Ginger in Broiler Nutrition**

Feeding trials conducted on the inclusion of ginger in broiler nutrition have shown promising results in terms of growth performance, gut health, and immune function. Ginger, scientifically known as *Zingiber officinale*, is a popular spice and medicinal plant known for its bioactive compounds and health benefits.

A study by Hosseini-Vashan *et al.,* (2016) evaluated the impact of ginger root powder on broiler growth performance. The results demonstrated that dietary inclusion of ginger up to 10 g/kg improved body weight gain, feed intake, and feed conversion ratio compared to the control group.

Ginger has been reported to have positive effects on gut health in broilers. A study conducted by Hajati and Rezaei (2010) investigated the influence of ginger powder on broiler gut morphology. The researchers found that ginger supplementation improved villus height and crypt depth, indicating enhanced nutrient absorption and intestinal health.

Moreover, ginger has been associated with antimicrobial properties against pathogenic bacteria in the gut. A study by Rasouli *et al.,* (2017) demonstrated that ginger supplementation promoted a favorable gut microbiota balance by suppressing harmful bacteria like Escherichia coli and increasing beneficial bacteria like lactobacilli in broilers.

Several studies have explored the immunomodulatory effects of ginger in broilers. A research conducted by Jang *et al.,* (2007) investigated the impact of dietary ginger extract on broiler immune responses. The findings revealed that ginger supplementation improved antibody production and enhanced the immune response against Newcastle disease virus.

Furthermore, ginger has been shown to possess antioxidant properties that can protect broilers from oxidative stress. Al-Kassie *et al.,* (2013) demonstrated that adding ginger powder to the diet reduced oxidative damage, enhanced antioxidant enzyme activities, and improved liver function in broilers.

Overall, the feeding trials on ginger in broiler nutrition have consistently suggested its beneficial effects on growth performance, gut health, and immune function. However, it is important to note that optimal inclusion levels and duration of ginger supplementation may vary depending on factors such as bird age, ginger form (powder, extract, etc.), and study design. The results of haematology and serum analysis are usually used to assess the health status of an animal. Haematological and serum biochemistry parameters are good indicators of the physiological status of animals and their changes are important in assessing the response of such animals to various physiological situations. Furthermore, changes in haematological parameters are often used to assess stress in animals due to environmental, nutritional and/or pathological factors. One of the health-promoting effects of phytochemicals from plants is thought to arise from their protective effects of counteracting reactive oxygen species, as well as their antimicrobial action. Therefore, further research is warranted to establish precise guidelines for ginger supplementation in broiler diets.

**CHAPTER THREE**

**MATERIALS 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 is 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 Experimental Materials**

Rhizomes of ginger (*Zingiber officinale*) were purchased from the Abak market. The rhizomes were chopped into smaller sizes and oven dried for 24 hours before being grinded and mixed as supplement in the diet at varied levels.

**3.3 Purchase and Management of Experimental Birds**

A total of ninety-six (96) day-old broiler chicken were purchased for the experiment. The birds were purchased from a local dealer 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 was provided *ad-libitum.* The birds were vaccinated against the most common diseases such as; Newcastle Disease and Infectious Bursal Disease (Gomboro).

**3.4 Experimental Design**

On day fourteen, the birds were weighed to obtain their initial weights and divided into four (4) treatment groups. Each treatment group was further replicated thrice, with each replicate having eight (8) birds. Completely randomized design (CRD) was employed for this experiment. Treatment one (T1) received 0% of the Ginger Rhizome Powder and served as the control while T2, T3 and T4 received Ginger Rhizome Powder at an inclusion level of 10%, 20% and 30% in their feed. The birds were administered these treatments for six weeks (42 days) and data were collected during the course of the feeding trial.

**Table 3.1: Experimental Diet Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ingredients** | **T1 (0%)** | **T2 (10%)** | **T3 (20%)** | **T4 (30%)** |
| Maize | 52.00 | 52.00 | 52.00 | 52.00 |
| Soyabean meal | 20.00 | 20.00 | 20.00 | 20.00 |
| Groundnut cake | 10.00 | 10.00 | 10.00 | 10.00 |
| Fishmeal | 3.00 | 3.00 | 3.00 | 3.00 |
| Wheatoffals | 11.20 | 11.20 | 11.20 | 11.20 |
| Bonemeal | 3.00 | 3.00 | 3.00 | 3.00 |
| Starter premix | 0.25 | 0.25 | 0.25 | 0.25 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | 0.20 | 0.20 | 0.20 | 0.20 |
| Methionine | 0.10 | 0.10 | 0.10 | 0.10 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** |

**3.5 Proximate Analysis of Test Materials**

Sample of the Ginger Powder was taken to the laboratory for proximate analysis according to methods described by AOAC (2003).

**3.6 Data Collection**

2 mls of blood samples was collected from each bird into ethylene diamine-tetra acetic acid (EDTA) treated bottles for the estimation of haematological parameters and another 3mls of blood samples was collected into bottle without anticoagulant for determination of serum lipid profile.

Haematological parameters included; packed cell volume (PCV), red blood cell count (RBC), white blood cell (WBC), haemoglobin, mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC) and platelets while serum and lipid profile parameters included; Albumin (g/dl), Total protein (g/dl), Glucose (g/dl), AST (g/dl), ALT (g/dl), Triglyceride (g/dl), cholesterol (g/dl), HDL (g/dl), LDL (g/dl), Globulin (g/dl).

**3.7 Data Analysis**

All data collected was subjected to Analysis of Variance (ANOVA) procedure of Statistical Package for Social Sciences (SPSS 2007). Significant differences were separated using Duncan’s Multiple Range test at p>0.05 (Duncan 1955).

**CHAPTER FOUR**

**RESULTS AND DISCUSSION**

**Table 4.1: Haematological indices of broiler chickens fed diets supplemented with varying levels of *Ginger rhizome meal***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameters** | **T1** | **T2** | **T3** | **T4** | **SEM** |
| RBC(×106/μl) | 3.24c | 3.36c | 3.79a | 3.58b | 0.07 |
| PCV(%) | 24.67c | 25.33c | 29.33a | 26.67b | 0.56 |
| Haemoglobin(g/dl) | 10.57c | 10.73c | 12.57a | 11.47b | 0.25 |
| WBC(×103/μl) | 23.57 | 24.30 | 22.60 | 23.83 | 0.33 |
| PLT(×103/μl) | 249.67 | 245.00 | 246.33 | 251.00 | 1.56 |
| MCV(fl) | 76.20ab | 75.39b | 76.35a | 74.48b | 0.40 |
| MCH(pg) | 32.65ab | 31.94c | 33.13a | 32.02bc | 0.17 |
| MCHC(g/dL) | 42.83 | 42.37 | 42.73 | 42.93 | 0.13 |
| Neutrophil (%) | 34.67 | 34.33 | 34.67 | 32.00 | 0.71 |
| Lymphocytes(%) | 59.33 | 59.33 | 59.00 | 62.67 | 0.84 |
| Monocytes(%) | 3.67 | 4.00 | 3.67 | 3.33 | 0.19 |
| Eosinophil(%) | 2.33 | 2.33 | 2.67 | 2.00 | 0.14 |
| Basophil(%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

abcd: Means across treatments bearing different superscripts are significant (P<0.05). MCV = Mean corpuscular volume, MCH = Mean corpuscular haemoglobin, MCHC = Mean corpuscular haemoglobin concentration, SEM = Standard error of mean, T1 = Control, T2 = Birds that received 10% Ginger Rhizome Meal (GRM), T3 = Birds that received 20% Ginger Rhizome Meal (GRM), T4 = Birds that received 30% Ginger Rhizome Meal (GRM).

Table 4.1 shows the hematological characteristics of the birds. From the results, Red Blood Cell Count (RBC), Packed Cell Volume (PCV), Hemoglobin Concentration (Hb), MCV and MCH were significantly different (P<0.05) among the treatments groups across the hematological indices.

From the results, the RBC mean values (3.79 ×106/μl) of the Birds that received 20% Ginger Rhizome Meal (GRM) inclusion in their diet (T3) were significantly different (P<0.05) compared to T4 (3.58 ×106/μl) and the control (T1) (3.24 x 106/μl). Red blood cells serve as a carrier of haemoglobin, it is also involved in the transport of oxygen and CO2 in the body. A reduced RBC will mean a reduction in the level of oxygen that would be carried to the tissues as well as a reduction in the amount carbon dioxide that would be returned to the lungs (Isaac *et al.,* 2013; Doneley and Doneley, 2010). Since RBC values were within normal range it implies that oxygen circulation within the body, and removal of carbon dioxide was not impaired as a result of the presence of GRM up to 30% level in the diets of the experimental birds.

Additionally, the mean values for Packed Cell Volume recorded from this study showed significant difference (P<0.05) as T3 (29.33%) was significantly different compared to T4 (26.67%) and the control (T1) (24.67%). The PCV is involved in the transport of oxygen and absorbed nutrient, if an animal is anaemic, it will usually be indicated by a decrease in the PCV value which will be usually lower than the normal range. This was not the case in this study showing that the birds were not anaemic.

From the study, Hemoglobin Concentration (Hb) also showed significance different (P<0.05) among the treatment groups as the mean values Hb of T3 (12.59g/dl) was significantly different compared to T4 (11.47g/dl) and the control (T1) (10.57g/dl).

Mean Corpuscular Hemoglobin (MCH) also showed significance difference among the treatment groups. The mean values of Mean corpuscular Hemoglobin of T3 (33.13%) was significantly different compared to the control (T1) (32.65%) and T2 (31.94%).

Mean Corpuscular Volume (MCV)also showed significance difference among the treatment groups. The mean values of Mean corpuscular volume of T3 (76.35%) was significantly different compared to the control (T1) (76.20%) and T4 (74.48%).

MCH and MCHC were all within normal reference range of 40-60 (fl), 11-17 (pg) and 30-36 (g/dl) reported for healthy Animals (Al-Kassie *et al.,* 2012). This further shows that the experimental Birds were not anaemic by any means.

These findings are in-line with reports by Ihekwumere, (2004) and Okagbare *et al*., (2011), who indicated that blood variables are affected by dietary influences.

It is obvious that ginger had a significant effect on the Blood parameters which may be related to the many active compounds present in ginger such as; atsiri oil, bornoeol, kamfen, limonene, humulen, gingibrol, gingiberen and gingerdiol; all these compounds improves the hematological parameters of the animals. The hypolipidemic action of ginger supplementation can also lower risk factor of the cardiovascular diseases and cancer either in animals or human (Ademola *et al*., 2009).

**Table 4.2: Serum biochemical indices of broiler chickens fed diets supplemented with varying levels of *Ginger rhizome meal***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameters** | **T1** | **T2** | **T3** | **T4** | **SEM** |
| Total protein (g/ dl) | 3.42b | 3.53b | 3.53b | 3.87a | 0.05 |
| Albumin  (g/dl) | 1.85b | 2.05a | 2.09a | 2.20a | 0.05 |
| Glucose  (mg/dl) | 135.67 | 144.67 | 145.00 | 144.33 | 2.01 |
| ALP  (u/l) | 70.00 | 66.00 | 67.00 | 65.67 | 0.89 |
| Cholesterol (mg/dl) | 170.61a | 149.47b | 132.96c | 131.58c | 4.81 |
| Triglyceride (mg/dl) | 123.27 | 126.60 | 125.93 | 125.67 | 1.12 |
| HDL-C (mg/dl) | 62.27c | 66.27c | 76.13b | 81.73a | 2.41 |
| LDL-C (mg/dl) | 63.74a | 48.15b | 44.66b | 41.38b | 2.80 |
| VLDL-C (mg/dl) | 24.65 | 25.32 | 25.19 | 24.13 | 0.23 |

abcd: Means across treatments bearing different superscripts are significant (P<0.05), ALP: Alkaline Phosphatase, LDL-C: Low Density Lipoprotein, HDL-C: High Density Lipoprotein, VLDL-C: Very Low Density Lipoprotein

Results of the serum biochemical characteristics of the birds are shown in Table 4.2. Significant (P<0.05) differences were recorded among dietary treatments in all parameters except Glucose, ALP, Triglyceride and VLDL-C.

Total protein content of birds fed T4 (3.87 g/ dl) were significantly (P<0.05) higher compared to those fed T1 (3.42 g/dl), T2 (3.53 g/dl) and T3 (3.53 g/dl). Birds of the control group (T1) exhibited the least mean value (3.42g/dl) of total protein content.

Albumin content of birds fed T2 (2.05 g/ dl), T3 (2.09 g/ dl) and T4 (2.20 g/ dl) were significantly (P<0.05) higher compared to those fed the control Diet T1 (1.85 g/dl). Birds of the control group (T1) exhibited the least mean value (1.85g/dl) of Albumin content.

Cholesterol content of birds fed T1 (170.61mg/ dl) were significantly (P<0.05) higher compared to those fed the T2 (149.47mg/ dl), T3 (132.96mg/ dl) and T4 (131.58mg/ dl). Birds fed 30% of Ginger Rhizome Meal (T4) exhibited the least mean value (131.58mg/dl) of Cholesterol content.

HDL-C of birds fed T4 (81.73mg/ dl) and T3 (81.73mg/dl) were significantly (P<0.05) higher compared to those fed the T2 (66.27mg/ dl) and the control Diet T1 (62.27mg/ dl). Birds of the control group (T1) exhibited the least mean value (62.27mg/ dl) of HDL-C.

LDL-C of birds fed T1 (63.74mg/ dl) were significantly (P<0.05) higher compared to those fed the T2 (48.15mg/ dl), T3 (44.66mg/ dl) and T4 (41.38mg/ dl). Birds fed 30% of Ginger Rhizome Meal (T4) exhibited the least mean value (41.38mg/dl) of LDL-C. These findings are in-line with Daniel *et al.,* (2016) but not tandem to the report of Ayo-enwerem *et al.,* (2017).

The very minute amounts of ginger had a very strong impact as antilipdemic effect on serum cholesterol and triglycerides. Ginger had many active compounds such as atsiri oil, bornoeol, kamfen, limonene, humulen, gingibrol, gingiberen and gingerdiol; all these compounds improves feed digestion and stimulate its enzymes and thus enhancing the serum biochemical parameters as we noticed in this study (Alizadeh *et al.,* 2008). The hypolipidemic action of ginger supplementation can be used to lower risk factor of the cardiovascular diseases and cancer either in animals or human (Ademola *et al*., 2009). The supplementation of ginger reduced cholesterol levels in blood serum because of its antioxidative action which also a mechanism could be used as anti-stress approach (Jang *et al*., 2007). The hypocholesterol action may be performance and lowering effect on blood serum cholesterol, triglycerides and glucose, which can refer to strong anti-oxidative action and potential anti stress action. The higher value of Total protein and albumin shows the ability of Ginger to stimulate high feed efficiency in the birds (Ademola *et al*., 2009).

**CHAPTER FIVE**

**CONCLUSION AND RECOMMENDATION**

**5.1 Conclusion**

Exploring the benefit of broiler production and the need to boost production due to increased demand and in a quest to resolve high cost of broilers feed, spices, such as; Ginger *(Zingiber officinale)* have been exploit. Additionally, regarding the detrimental effect of antibiotics on human consumer, spices have comparatively improved performance and safer than antibiotics. Spices such as Ginger *(Zingiber officinale)* from this study has improved hematological and serum parameters which is essential for broilers growth and productivity.

**5.2 Recommendation**

Reference to the medicinal and nutritive value of Ginger *(Zingiber officinale)*, it is a better substitute for Ginger as it has been proven from this study, to improve hematological and serum parameters which is essential to maintain proper health of broilers. Hence, Ginger *(Zingiber officinale)* is recommended at 30% in broilers diet in order to invariably provide safe chicken meat for the human consumers and increase poultry production.

**REFERENCES**

Abou-Elkhair, R., Ahmed, H.A. and Selim, S. (2014). Effects of black pepper (*Piper nigrum*), turmeric powder (*Curcuma longa*) and coriander seeds (*Coriandrum sativum*) and their combinations as feed additives on growth performance, carcass traits, some blood parameters and humoral immune response of broiler chickens. *Asian Australasian Journal of Animal Sciences*. 27: 847-854.

Ademola SG, Farinu GO and Babatunde GM. (2009). Serum lipid, growth and haematological parameters of broilers fed garlic, ginger and their mixtures. *World Journal of Agricultural Science,* 5, 99–104.

Adeyemo, A. and Onikoyi, M.P. (2012). Prospects and Challenges of Large Scale Commercial Poultry Production in Nigeria; *Agricultural Journal,* (7); 388-393.

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-Ind (2002). European Union- West African Agro-Business sector meeting; strategic evaluationof 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. K. Nwagu, B. L and Otchere, E.O (2007). Socioeconomic of free range poultry production among Agro-pastoral women in Giwa Local Government Area of Kaduna State. *Nigeria 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.

Ali BH, Blunden G, Tanira MO, Nemmar A. (2008). Some phytochemical, pharmacological and toxicological properties of ginger (*Zingiber officinale Roscoe)*: a review of recent research. *Food Chem. Toxicol.;* 46(2):409-420.

Ali, M. A. (2015). Black cumin seeds improve growth performance, carcass yield, antioxidant status and immune response in broilers. *Livestock Science,* 170, 115-121.

Alizadeh-Navaei R, Roozbeh F, Saravi M, Pouramir M, Jalali F and Moghadamnia A. (2008). An investigation of the effect of ginger on the lipid levels. A double blind controlled clinical trial. *Saudi Medical Journal,* 29(9), 1280–1284.

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.

Al-Kassie GAM. (2013). Effects of ginger (*Zingiber officinale*) on hematological and immunological parameters and liver function in broiler chicks. *Jundishapur J. Nat. Pharm. Prod.,* 8(4), 175-179.

Al-Kassie, G.A.M., Butris, G.Y. and Ajeena, S.J. (2012). The potency of feed supplemented mixture of hot red pepper and black pepper on the performance and some hematological blood traits in broiler diet. *International Journal of Advanced Biological Research 2: 53-57*.

Alloui, M.N., Agabou, A. and Alloui, N. (2014). Application of herbs and phytogenic feed additives in poultry production – A Review. *Global Journal of Animal Scientific Research*. 2: 234-243

Anosike, F. U., Naanpose, C. D., Rekwot, G. Z. Sani, A., Owoshagba, O. B and Madziga, I.I (2005). 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, University of Ibadan, Oyo State. pp. 302-306

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.

Aromolaran, A. K; Ademiluyi, I. O and Hebu, O. J (2013) Challenges of small poultry farmers in Layers production in Ibadan, Oyo state, Nigeria. *Global journal of Science Frontier Research,* **13**:2:1.

Ayo-Enwerem, M. C., Ahaotu, E. O., Nwogu, C. and Esukhpa, M. (2017). Haematology and serum biochemistry indices of broiler birds fed diets containing redSandalwood leaf meal. *International Standard Journal,* 2(4):110-114.

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.

Banerjee G. C (2007). A text book of Animal Husbandry 8th ed. Oxford and IBH Pub. Co. Pvt Limited, New Delhi, India 450-467.

Borgohain, B., Mahanta, J.D., Sapcota, D., Handique, B. and Islam, R. (2019). Effect of feeding garlic (*Allium sativum*) on haematological, serum biochemical profile and carcass characteristics in broiler chicken. *International Journal Current Microbiology and Applied Sciences*. 8(10): 492-500.

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.

Carrasco, J.M.D., Casanova, N.A. and Fern, M.E. 2019. Microbiota, gut health and chicken productivity/: What is the Connection? *Microorganisms*. 7(374): 1-15.

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.

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

Daniel, L.N., Boniface, N.D., Helen, D., Charity, N., Ajuku, A., Deborah, A., Peterside, R.K. and Mary, S. (2016). Establishment of Reference Values for Some Biochemical and Haematological Parameters for Broilers and Layers in Plateau State Nigeria. *Vom Journal of Veterinary Science.* 11:30–35.

David, A. B. (Eds) (2009). A Dictionary of Food and Nutrition. David, A.B. (editor). Oxford University Press, 2009

Dieumou, F.E., Teguia, J.R., Kuiate, J.R., Tamokou, J.D., Fonge, N.B. and Dongmo, M.C. (2009). Effects of ginger (*Zingiber officinale*) and garlic (*Allium sativum*) essential oils on growth performance and gut microbial population of broiler chickens. *Livestock Research for Rural Development*. 21:25-34

Doneley, B. and Doneley, R. (2010). Avian Medicine and Surgery in Practice: Companion and Aviary Birds. Manson Publishing Ltd., London, UK.

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

Durairajan, R., Murugan, M., Karthik, K. and Porteen, K. (2021). Farmer's stance on antibiotic resistance to E. coli and extended spectrum -â-lactamase producing (esbl) *E. coli* isolated from poultry droppings. *Asian Journal of Dairy and Food Research*. 40: 88-93.

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

Feldman, E. C., Nelson, R. W., & Reusch, C. E. (2020). Canine and feline endocrinology and reproduction. *Elsevier Health Sciences*.

Gbenga, O. E., Adebisi, O. E., Fajemisin, A. N. and Adetunji, A. V. (2009). Response of broiler chickens in terms of performance and meat quality to garlic (*Allium sativum*) supplementation*. African Journal of* *Agricultural Research*. 4: 511-517.

Grzanna R, Lindmark L, Frondoza CG. (2005). Ginger--an herbal medicinal product with broad anti-inflammatory actions. *J. Med. Food*.; 8(2):125-132.

Hajati H, Rezaei M. (2010). The application of prebiotics in poultry production. *Int. J. Poult. Sci.,* 9(3), 298-304.

Harvey, J. W., & Tasker, J. B. (2012). Veterinary hematology: a diagnostic guide and color atlas. *Elsevier Health Sciences.*

Heinrich M, Bremner P, Gibbons S. (2013). *Handbook of African Medicinal Plants*. 2nd ed. CRC Press.

Hosseini-Vashan S. (2016). Effect of dietary ginger (*Zingiber officinale*) on growth performance, carcass traits and humoral immune responses in broiler chickens. *Animal Production Science*, 56(1), 123-130.

Ihekwumere, F. C. (2004). Effect of Human Gonadotrophin on Haematological and Serum Biochemical Parameters of Nigeria Indigenous Chickens. *International Journal of Poultry Science*. 5 (7): 632-634.

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

Jang SI. (2007). Studies on the antioxidant activity of ginger (*Zingiber officinale*). *J. Food Sci*., 72(3), S138-S143.

Jang, I.S., Y.H. Ko, S.Y. Kang and C.Y. Lee, (2007). Effect of a commercial essential oil on growth performance, digestive enzyme activity and intestinal microflora population in broiler chickens. *Anim. Feed Sci. Technol*., 134: 304- 315.

Karangiya, V.K., Savsani, H.H., Shrikant, S.P., Garg, D.D., Murthy, K.S., Ribadiya, N.K. and Vekariya, S.J. (2016). Effect of dietary supplementation of garlic, ginger and their combination on feed intake, growth performance and economics in commercial broilers. *Veterinary World*. 9: 245–250.

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

Khan, S. (2011). Effects of dietary essential oils on the growth, ileal nutrient digestibility, blood parameters, intestinal morphology and carcass characteristics of broilers. *Journal of Animal Physiology and Animal Nutrition,* 89-101.

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

Marco Q. (2008). Water quality and broiler performance. Broiler Supervisor’s Short Course. Bulletin, New Carolina, USA. 11 – 13

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

Minghetti, P., Sosa, S. and Cilurzo, F. (2007). Evaluation of the topical anti-inflammatory activity of ginger dry extracts from solutions and plasters. *Planta Medica,* 73(15):1525–1530.

Mohiti-Asli, M., & Ghanaatparast-Rashti, M. (2018). Effects of garlic powder on productive performance and immune response of broiler chickens challenged with E. coli lipopolysaccharide. *Poultry Science Journal,* 6(1), 50-59.

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

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.

NseAbasi N., Glory E., Mary E., MetiAbasi D. and Edem E. (2013). Haematological Parameters: Indicators of the Physiological Status of Farm Animals. *British Journals,* 10 (1) 2047-3745

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

Okagbare, N. G., Llodigwe, E. E., Ajaghaku, D. L. and Esimone, C.O. (2011). Acute and Sub Chronic Toxicities of Ethanol Leaf Extract of Pterocarpus Santalinoides In Experimental Animals. *Journal of Pharmaceutical and Biomedical Sciences*. 12 (18):239-292.

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.

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.

Onu, P. N. (2010). Evaluation of two herbal spices as feed additives for finisher broilers. *Biotechnology in Animal Husbandry*, 26: 383-392.

Oso, A.O., Suganthi, R.U., Malik, P.K., Thirumalaisamy, G. and Awachat, V.B. (2021). Effect of dietary supplementation of a phyto-supplement on carcass characteristics of broiler chickens. *Asian Journal of Dairy and Food Research*, 18805.

Padhi, M. K. (2017). Influence of cumin (*Cuminum cyminum L.)* seed on growth performance, nutrient utilization, immunity and caecal microflora in broiler chicks. *Animal Nutrition,* 3(4), 344-350.

Paraskeuas, V., Fegeros, K., Palamidi, I., Hunger, C. and Mountzouris, K.C. (2017). Growth performance, nutrient digestibility, antioxidant capacity, blood biochemical biomarkers and cytokines expression in broiler chickens fed different phytogenic levels. *Animal Nutrition*. 3: 114-120.

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.

Rahmani AH, Alsahli M and Aly SM. (2012). Therapeutics role of ginger and its active constituents in the prevention and treatment of gastrointestinal cancer: current knowledge and future perspectives. *J. Nutr. Metab*. 142-516.

Rasouli B. (2017). Effects of ginger (*Zingiber officinale*) extract on broiler performance and microbial population in the digestive tract. *Livestock Sci*., 202, 12-16.

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

Saeid, J. M., Arkan, B. M. and Al- Baddy, M. A. (2010). Effect of aqueous extract of ginger (*Zingiber officinale*) on blood biochemistry parameters of broiler. *International Journal of Poultry Science*, 9: 944-947.

Sawosz, F. (2017). Effect of dietary ginger (*Zingiber officinale Rosc*.) supplementation on growth performance, antioxidant capacity, and immune response in broiler chickens. *Poultry Science,* 96(6), 1783-1790.

Schleicher, A., Fritz, Z. and Kinal, S. (1998). Zastosowanie wybranych ziów mieszankach tre\_ciwych dlakurcz\_t rze\_nych [The use of some herbs in concentrates for broiler chickens. *Rocz. Nauk. Zootech*., 25(3): 213-244 (in Polish).

Shahidi, F., Janitha, P. K. and Wanasundara, P. (1992). Phenolic antioxidants. *Critical Reviews in Food Science and Nutrition*, 32: 67-102.

Shukla Y, Singh M. (2007) Cancer preventive properties of ginger: a brief review. *Food Chem. Toxicol.*;45(5):683-690.

SLUS-AK (1989). *Soils and land use studies, Goverment print office, Uyo, Akwa Ibom State Soil Survey Staff* 1994. Key to soil Taxonomy Soil Management Support Serviec (SMSS). Technology. No.19.pp306

Smith-Palmer, A., Stewart, J. and Fyfe, L. (1998). Antimicrobial properties of plant essential oils and essences against five important food-borne pathogens. *Letters in Applied Microbiology,* 26: 118–122.

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

Suresh, G., Das, R.K., Brar, S.K., Rouissi, T., Ramirez, A.A., Chorfi, Y. and Godbout, S. (2018). Alternatives to antibiotics in poultry feed: molecular perspectives. *Critical Reviews in Microbiology*. 44(3): 318-335

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.

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.

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.

WHO and FAO (2003). Diet, nutrition, and the prevention of chronic diseases: Report of a Joint WHO/FAO Expert Consultation. Report 916. Geneva: WHO.

Windisch, W. (2008). Influence of phytogenic products on digestibility in piglets and poultry. *Journal of Animal Science,* 86(14 Suppl), E140-E148.

Zhang, G. F., Yang, Z. B., Wang, Y., Yang, W. R., Jiang, S. Z. and Gai, G. S. (2009). Effects of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poultry Science*, 88: 2159- 2166.

Zhao, X., Yang, Z. B., Yang, W. R., Wang, Y., Jiang, S. Z. and Zhang, G. G. (2011). Effects of ginger root (*Zingiber officinale*) on laying performance and antioxidant status of laying hens and on dietary oxidation stability. *Poultry Science*, 90: 1720-1727.

**APPENDIX**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | |
|  | N | Minimum | Maximum | Mean | | Std. Deviation |
| Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| RBC | 12 | 3.20 | 3.94 | 3.4925 | .06688 | .23168 |
| PCV | 12 | 24.00 | 30.00 | 26.5000 | .55732 | 1.93061 |
| Hb | 12 | 10.30 | 12.90 | 11.3333 | .24659 | .85422 |
| WBC | 12 | 20.90 | 24.90 | 23.5750 | .33192 | 1.14980 |
| PLT | 12 | 238.00 | 256.00 | 248.0000 | 1.55700 | 5.39360 |
| MCV | 12 | 73.90 | 78.60 | 75.8583 | .39895 | 1.38200 |
| MCH | 12 | 31.60 | 33.30 | 32.4167 | .16644 | .57656 |
| MCHC | 12 | 42.00 | 43.30 | 42.7583 | .11900 | .41222 |
| Valid N (listwise) | 12 |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | |
|  | N | Minimum | Maximum | Mean | | Std. Deviation |
| Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| NEUTROPHILS | 12 | 30 | 39 | 33.92 | .712 | 2.466 |
| LYMPHOCYTES | 12 | 55.00 | 65.00 | 60.0833 | .83900 | 2.90637 |
| MONOCYTES | 12 | 3.00 | 5.00 | 3.6667 | .18803 | .65134 |
| EOSINOPHILS | 12 | 2.00 | 3.00 | 2.3333 | .14213 | .49237 |
| Valid N (listwise) | 12 |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | |
|  | N | Minimum | Maximum | Mean | | Std. Deviation |
| Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| TOTAL PROTEIN | 12 | 3.36 | 3.92 | 3.5875 | .05344 | .18514 |
| ALBUMIN | 12 | 1.77 | 2.25 | 2.0458 | .04518 | .15652 |
| GLUCOSE | 12 | 129 | 153 | 142.42 | 2.006 | 6.947 |
| ALP | 12 | 62 | 73 | 67.17 | .886 | 3.070 |
| CHOLEST | 12 | 129.57 | 172.70 | 146.1558 | 4.81089 | 16.66540 |
| TRIGLYC | 12 | 119.9 | 130.2 | 125.367 | 1.1240 | 3.8937 |
| HDL-C | 12 | 59.9 | 84.6 | 71.600 | 2.4129 | 8.3584 |
| LDL-C | 12 | 23.98 | 26.04 | 24.9067 | .22277 | .77170 |
| VLDL-C | 12 | 39.30 | 69.32 | 49.6492 | 2.82093 | 9.77200 |
| Valid N (listwise) | 12 |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Descriptive Statistics** | | | | | | |
|  | N | Minimum | Maximum | Mean | | Std. Deviation |
| Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic |
| INITIAL WEIGHT | 12 | 238 | 263 | 250.17 | 2.177 | 7.542 |
| FINAL WEIGHT | 12 | 2125 | 2763 | 2400.08 | 53.620 | 185.745 |
| DAILY WEIGHT GAIN | 12 | 52.08 | 69.81 | 59.7183 | 1.47660 | 5.11509 |
| DAILY FEED INTAKE | 12 | 79.24 | 82.21 | 80.0642 | .22847 | .79145 |
| FEED CONVERSION RATIO | 12 | 1.15 | 1.53 | 1.3450 | .03044 | .10544 |
| Valid N (listwise) | 12 |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: RBC | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | .566a | 5 | .113 | 27.446 | .000 |
| Intercept | 146.371 | 1 | 146.371 | 35507.711 | .000 |
| TREATMENT | .543 | 3 | .181 | 43.948 | .000 |
| REPLICATE | .022 | 2 | .011 | 2.693 | .146 |
| Error | .025 | 6 | .004 |  |  |
| Total | 146.961 | 12 |  |  |  |
| Corrected Total | .590 | 11 |  |  |  |
| a. R Squared = .958 (Adjusted R Squared = .923) | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Duncana,b | | | | |
| TREATMENT | N | Subset | | |
| 1 | 2 | 3 |
| T1 | 3 | 3.2367 |  |  |
| T2 | 3 | 3.3600 |  |  |
| T4 | 3 |  | 3.5800 |  |
| T3 | 3 |  |  | 3.7933 |
| Sig. |  | .057 | 1.000 | 1.000 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .004. | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | |
| b. Alpha = 0.05. | | | | |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | | | |
| Dependent Variable: PCV | | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | | | F | Sig. |
| Corrected Model | | 38.833a | | 5 | | 7.767 | | | 21.508 | .001 |
| Intercept | | 8427.000 | | 1 | | 8427.000 | | | 23336.308 | .000 |
| TREATMENT | | 38.333 | | 3 | | 12.778 | | | 35.385 | .000 |
| REPLICATE | | .500 | | 2 | | .250 | | | .692 | .536 |
| Error | | 2.167 | | 6 | | .361 | | |  |  |
| Total | | 8468.000 | | 12 | |  | | |  |  |
| Corrected Total | | 41.000 | | 11 | |  | | |  |  |
| a. R Squared = .947 (Adjusted R Squared = .903) | | | | | | | | | | |
| **PCV** | | | | | | | |
| Duncana,b | | | | | | | |
| TREATMENT | N | | Subset | | | | |
| 1 | | 2 | | 3 |
| T1 | 3 | | 24.6667 | |  | |  |
| T2 | 3 | | 25.3333 | |  | |  |
| T4 | 3 | |  | | 26.6667 | |  |
| T3 | 3 | |  | |  | | 29.3333 |
| Sig. |  | | .223 | | 1.000 | | 1.000 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .361. | | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | | |
| b. Alpha = 0.05. | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | | | |
| Dependent Variable: Hb | | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | | | F | Sig. |
| Corrected Model | | 7.742a | | 5 | | 1.548 | | | 32.596 | .000 |
| Intercept | | 1541.333 | | 1 | | 1541.333 | | | 32449.123 | .000 |
| TREATMENT | | 7.460 | | 3 | | 2.487 | | | 52.351 | .000 |
| REPLICATE | | .282 | | 2 | | .141 | | | 2.965 | .127 |
| Error | | .285 | | 6 | | .047 | | |  |  |
| Total | | 1549.360 | | 12 | |  | | |  |  |
| Corrected Total | | 8.027 | | 11 | |  | | |  |  |
| a. R Squared = .964 (Adjusted R Squared = .935) | | | | | | | | | | |
| Hb | | | | | | | | | | |
| Duncana,b | | | | | | | | | | |
|  |  | | 1 | | 2 | | 3 |
| T1 | 3 | | 10.5667 | |  | |  |
| T2 | 3 | | 10.7333 | |  | |  |
| T4 | 3 | |  | | 11.4667 | |  |
| T3 | 3 | |  | |  | | 12.5667 |
| Sig. |  | | .385 | | 1.000 | | 1.000 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .047. | | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | | |
| b. Alpha = 0.05. | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: WBC | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 7.794a | 5 | 1.559 | 1.386 | .348 |
| Intercept | 6669.367 | 1 | 6669.367 | 5929.791 | .000 |
| TREATMENT | 4.629 | 3 | 1.543 | 1.372 | .338 |
| REPLICATE | 3.165 | 2 | 1.583 | 1.407 | .315 |
| Error | 6.748 | 6 | 1.125 |  |  |
| Total | 6683.910 | 12 |  |  |  |
| Corrected Total | 14.543 | 11 |  |  |  |
| a. R Squared = .536 (Adjusted R Squared = .149) | | | | | |

|  |  |  |
| --- | --- | --- |
| **WBC** | | |
| Duncana,b | | |
| TREATMENT | N | Subset |
| 1 |
| T3 | 3 | 22.6000 |
| T1 | 3 | 23.5667 |
| T4 | 3 | 23.8333 |
| T2 | 3 | 24.3000 |
| Sig. |  | .111 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 1.125. | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | |
| b. Alpha = 0.05. | | |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | | | |
| Dependent Variable: PLT | | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | | Mean Square | | F | Sig. |
| Corrected Model | | 96.667a | | 5 | | | 19.333 | | .519 | .755 |
| Intercept | | 738048.000 | | 1 | | | 738048.000 | | 19828.155 | .000 |
| TREATMENT | | 70.667 | | 3 | | | 23.556 | | .633 | .620 |
| REPLICATE | | 26.000 | | 2 | | | 13.000 | | .349 | .719 |
| Error | | 223.333 | | 6 | | | 37.222 | |  |  |
| Total | | 738368.000 | | 12 | | |  | |  |  |
| Corrected Total | | 320.000 | | 11 | | |  | |  |  |
| a. R Squared = .302 (Adjusted R Squared = -.280) | | | | | | | | | | |
| **PLT** | | | | | |
| Duncana,b | | | | | |
| TREATMENT | N | | Subset | | |
| 1 | | |
| T2 | 3 | | 245.0000 | | |
| T3 | 3 | | 246.3333 | | |
| T1 | 3 | | 249.6667 | | |
| T4 | 3 | | 251.0000 | | |
| Sig. |  | | .293 | | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 37.222. | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | |
| b. Alpha = 0.05. | | | | | |
| **Tests of Between-Subjects Effects** | | | | | | | | | | |
| Dependent Variable: MCV | | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | | Mean Square | | F | Sig. |
| Corrected Model | | 14.681a | | 5 | | | 2.936 | | 2.784 | .122 |
| Intercept | | 69053.841 | | 1 | | | 69053.841 | | 65471.116 | .000 |
| TREATMENT | | 13.209 | | 3 | | | 4.403 | | 4.175 | .065 |
| REPLICATE | | 1.472 | | 2 | | | .736 | | .698 | .534 |
| Error | | 6.328 | | 6 | | | 1.055 | |  |  |
| Total | | 69074.850 | | 12 | | |  | |  |  |
| Corrected Total | | 21.009 | | 11 | | |  | |  |  |
| a. R Squared = .699 (Adjusted R Squared = .448) | | | | | | | | | | |
| **MCV** | | | | | | | |
| Duncana,b | | | | | | | |
| TREATMENT | N | | Subset | | | | |
| 1 | | 2 | | |
| T4 | 3 | | 74.5000 | |  | | |
| T2 | 3 | | 75.3667 | | 75.3667 | | |
| T1 | 3 | | 76.2333 | | 76.2333 | | |
| T3 | 3 | |  | | 77.3333 | | |
| Sig. |  | | .093 | | .064 | | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 1.055. | | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | | |
| b. Alpha = 0.05. | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | | |
| Dependent Variable: MCH | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | | F | Sig. |
| Corrected Model | | 2.790a | | 5 | | .558 | | 3.863 | .065 |
| Intercept | | 12610.083 | | 1 | | 12610.083 | | 87300.577 | .000 |
| TREATMENT | | 2.763 | | 3 | | .921 | | 6.377 | .027 |
| REPLICATE | | .027 | | 2 | | .013 | | .092 | .913 |
| Error | | .867 | | 6 | | .144 | |  |  |
| Total | | 12613.740 | | 12 | |  | |  |  |
| Corrected Total | | 3.657 | | 11 | |  | |  |  |
| a. R Squared = .763 (Adjusted R Squared = .565) | | | | | | | | | |
| **MCH** | | | | | | |
| Duncana,b | | | | | | |
| TREATMENT | N | | Subset | | | |
| 1 | | 2 | |
| T2 | 3 | | 31.9333 | |  | |
| T4 | 3 | | 32.0000 | |  | |
| T1 | 3 | | 32.6333 | | 32.6333 | |
| T3 | 3 | |  | | 33.1000 | |
| Sig. |  | | .072 | | .183 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .144. | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | |
| b. Alpha = 0.05. | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | | |
| Dependent Variable: MCHC | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | | F | Sig. |
| Corrected Model | | 1.396a | | 5 | | .279 | | 3.539 | .078 |
| Intercept | | 21939.301 | | 1 | | 21939.301 | | 278103.813 | .000 |
| TREATMENT | | .669 | | 3 | | .223 | | 2.827 | .129 |
| REPLICATE | | .727 | | 2 | | .363 | | 4.606 | .061 |
| Error | | .473 | | 6 | | .079 | |  |  |
| Total | | 21941.170 | | 12 | |  | |  |  |
| Corrected Total | | 1.869 | | 11 | |  | |  |  |
| a. R Squared = .747 (Adjusted R Squared = .536) | | | | | | | | | |
| **CHC** | | | | | | |
| Duncana,b | | | | | | |
| TREATMENT | N | | Subset | | | |
| 1 | | 2 | |
| T2 | 3 | | 42.3667 | |  | |
| T1 | 3 | | 42.8333 | | 42.8333 | |
| T3 | 3 | | 42.8333 | | 42.8333 | |
| T4 | 3 | |  | | 43.0000 | |
| Sig. |  | | .097 | | .508 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .079. | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | |
| b. Alpha = 0.05. | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | |
| Dependent Variable: WBC\_DIFFERENTIAL | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | F | Sig. |
| Corrected Model | | 28.083a | | 5 | | 5.617 | .868 | .552 |
| Intercept | | 13804.083 | | 1 | | 13804.083 | 2132.820 | .000 |
| TREATMENT | | 14.917 | | 3 | | 4.972 | .768 | .552 |
| REPLICATE | | 13.167 | | 2 | | 6.583 | 1.017 | .416 |
| Error | | 38.833 | | 6 | | 6.472 |  |  |
| Total | | 13871.000 | | 12 | |  |  |  |
| Corrected Total | | 66.917 | | 11 | |  |  |  |
| a. R Squared = .420 (Adjusted R Squared = -.064) | | | | | | | | |
| **WBC\_DIFFERENTIAL** | | | | |
| Duncana,b | | | | |
| TREATMENT | N | | Subset | |
| 1 | |
| T4 | 3 | | 32.00 | |
| T2 | 3 | | 34.33 | |
| T1 | 3 | | 34.67 | |
| T3 | 3 | | 34.67 | |
| Sig. |  | | .265 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 6.472. | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | |
| b. Alpha = 0.05. | | | | |
| **Tests of Between-Subjects Effects** | | | | | | | | |
| Dependent Variable: LYMPHOCYTES | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | F | Sig. |
| Corrected Model | | 50.083a | | 5 | | 10.017 | 1.403 | .343 |
| Intercept | | 43320.083 | | 1 | | 43320.083 | 6068.183 | .000 |
| TREATMENT | | 26.917 | | 3 | | 8.972 | 1.257 | .370 |
| REPLICATE | | 23.167 | | 2 | | 11.583 | 1.623 | .273 |
| Error | | 42.833 | | 6 | | 7.139 |  |  |
| Total | | 43413.000 | | 12 | |  |  |  |
| Corrected Total | | 92.917 | | 11 | |  |  |  |
| a. R Squared = .539 (Adjusted R Squared = .155) | | | | | | | | |
| **LYMPHOCYTES** | | | | |
| Duncana,b | | | | |
| TREATMENT | N | | Subset | |
| 1 | |
| T3 | 3 | | 59.0000 | |
| T1 | 3 | | 59.3333 | |
| T2 | 3 | | 59.3333 | |
| T4 | 3 | | 62.6667 | |
| Sig. |  | | .160 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 7.139. | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | |
| b. Alpha = 0.05. | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | |
| Dependent Variable: MONOCYTES | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | F | Sig. |
| Corrected Model | | 1.833a | | 5 | | .367 | .776 | .600 |
| Intercept | | 161.333 | | 1 | | 161.333 | 341.647 | .000 |
| TREATMENT | | .667 | | 3 | | .222 | .471 | .714 |
| REPLICATE | | 1.167 | | 2 | | .583 | 1.235 | .355 |
| Error | | 2.833 | | 6 | | .472 |  |  |
| Total | | 166.000 | | 12 | |  |  |  |
| Corrected Total | | 4.667 | | 11 | |  |  |  |
| a. R Squared = .393 (Adjusted R Squared = -.113) | | | | | | | | |
| **MONOCYTES** | | | | |
| Duncana,b | | | | |
| TREATMENT | N | | Subset | |
| 1 | |
| T4 | 3 | | 3.3333 | |
| T1 | 3 | | 3.6667 | |
| T3 | 3 | | 3.6667 | |
| T2 | 3 | | 4.0000 | |
| Sig. |  | | .299 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .472. | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | |
| b. Alpha = 0.05. | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: EOSINOPHILS | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | .833a | 5 | .167 | .545 | .739 |
| Intercept | 65.333 | 1 | 65.333 | 213.818 | .000 |
| TREATMENT | .667 | 3 | .222 | .727 | .572 |
| REPLICATE | .167 | 2 | .083 | .273 | .770 |
| Error | 1.833 | 6 | .306 |  |  |
| Total | 68.000 | 12 |  |  |  |
| Corrected Total | 2.667 | 11 |  |  |  |
| a. R Squared = .313 (Adjusted R Squared = -.260) | | | | | |

|  |  |  |
| --- | --- | --- |
| **EOSINOPHILS** | | |
| Duncana,b | | |
| TREATMENT | N | Subset |
| 1 |
| T4 | 3 | 2.0000 |
| T1 | 3 | 2.3333 |
| T2 | 3 | 2.3333 |
| T3 | 3 | 2.6667 |
| Sig. |  | .208 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .306. | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | |
| b. Alpha = 0.05. | | |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | | | | |
| Dependent Variable: TOTAL PROTEIN | | | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | | F | | Sig. | |
| Corrected Model | | .346a | | 5 | | .069 | | 13.402 | | .003 | |
| Intercept | | 154.442 | | 1 | | 154.442 | | 29908.055 | | .000 | |
| TREATMENT | | .346 | | 3 | | .115 | | 22.315 | | .001 | |
| REPLICATE | | .000 | | 2 | | .000 | | .034 | | .967 | |
| Error | | .031 | | 6 | | .005 | |  | |  | |
| Total | | 154.819 | | 12 | |  | |  | |  | |
| Corrected Total | | .377 | | 11 | |  | |  | |  | |
| a. R Squared = .918 (Adjusted R Squared = .849) | | | | | | | | | | | |
| **TOTAL PROTEIN** | | | | | | |
| Duncana,b | | | | | | |
| TREATMENT | N | | Subset | | | |
| 1 | | 2 | |
| T1 | 3 | | 3.4167 | |  | |
| T2 | 3 | | 3.5300 | |  | |
| T3 | 3 | | 3.5333 | |  | |
| T4 | 3 | |  | | 3.8700 | |
| Sig. |  | | .103 | | 1.000 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .005. | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | |
| b. Alpha = 0.05. | | | | | | |
| **Tests of Between-Subjects Effects** | | | | | | | | | | |
| Dependent Variable: ALBUMIN | | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | | F | Sig. | |
| Corrected Model | | .214a | | 5 | | .043 | | 4.580 | .046 | |
| Intercept | | 50.225 | | 1 | | 50.225 | | 5386.081 | .000 | |
| TREATMENT | | .198 | | 3 | | .066 | | 7.093 | .021 | |
| REPLICATE | | .015 | | 2 | | .008 | | .811 | .488 | |
| Error | | .056 | | 6 | | .009 | |  |  | |
| Total | | 50.495 | | 12 | |  | |  |  | |
| Corrected Total | | .269 | | 11 | |  | |  |  | |
| a. R Squared = .792 (Adjusted R Squared = .619) | | | | | | | | | | |
| **ALBUMIN** | | | | | | |
| Duncana,b | | | | | | |
| TREATMENT | N | | Subset | | | |
| 1 | | 2 | |
| T1 | 3 | | 1.8467 | |  | |
| T2 | 3 | |  | | 2.0467 | |
| T3 | 3 | |  | | 2.0867 | |
| T4 | 3 | |  | | 2.2033 | |
| Sig. |  | | 1.000 | | .103 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .009. | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | |
| b. Alpha = 0.05. | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | |
| Dependent Variable: GLUCOSE | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | F | Sig. |
| Corrected Model | | 185.083a | | 5 | | 37.017 | .642 | .678 |
| Intercept | | 243390.083 | | 1 | | 243390.083 | 4222.671 | .000 |
| TREATMENT | | 182.917 | | 3 | | 60.972 | 1.058 | .434 |
| REPLICATE | | 2.167 | | 2 | | 1.083 | .019 | .981 |
| Error | | 345.833 | | 6 | | 57.639 |  |  |
| Total | | 243921.000 | | 12 | |  |  |  |
| Corrected Total | | 530.917 | | 11 | |  |  |  |
| a. R Squared = .349 (Adjusted R Squared = -.194) | | | | | | | | |
| **GLUCOSE** | | | | |
| Duncana,b | | | | |
| TREATMENT | N | | Subset | |
| 1 | |
| T1 | 3 | | 135.67 | |
| T4 | 3 | | 144.33 | |
| T2 | 3 | | 144.67 | |
| T3 | 3 | | 145.00 | |
| Sig. |  | | .201 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 57.639. | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | |
| b. Alpha = 0.05. | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | |
| Dependent Variable: ALP | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | F | Sig. |
| Corrected Model | | 36.167a | | 5 | | 7.233 | .643 | .678 |
| Intercept | | 54136.333 | | 1 | | 54136.333 | 4812.119 | .000 |
| TREATMENT | | 35.000 | | 3 | | 11.667 | 1.037 | .441 |
| REPLICATE | | 1.167 | | 2 | | .583 | .052 | .950 |
| Error | | 67.500 | | 6 | | 11.250 |  |  |
| Total | | 54240.000 | | 12 | |  |  |  |
| Corrected Total | | 103.667 | | 11 | |  |  |  |
| a. R Squared = .349 (Adjusted R Squared = -.194) | | | | | | | | |
| **ALP** | | | | |
| Duncana,b | | | | |
| TREATMENT | N | | Subset | |
| 1 | |
| T4 | 3 | | 65.67 | |
| T2 | 3 | | 66.00 | |
| T3 | 3 | | 67.00 | |
| T1 | 3 | | 70.00 | |
| Sig. |  | | .182 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 11.250. | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | |
| b. Alpha = 0.05. | | | | |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | | | |
| Dependent Variable: CHOLEST | | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | | F | | Sig. |
| Corrected Model | | 3019.245a | | 5 | | 603.849 | | 101.070 | | .000 |
| Intercept | | 256338.331 | | 1 | | 256338.331 | | 42905.164 | | .000 |
| TREATMENT | | 2986.461 | | 3 | | 995.487 | | 166.622 | | .000 |
| REPLICATE | | 32.784 | | 2 | | 16.392 | | 2.744 | | .142 |
| Error | | 35.847 | | 6 | | 5.975 | |  | |  |
| Total | | 259393.424 | | 12 | |  | |  | |  |
| Corrected Total | | 3055.092 | | 11 | |  | |  | |  |
| a. R Squared = .988 (Adjusted R Squared = .978) | | | | | | | | | | |
| **CHOLEST** | | | | | | | | |
| Duncana,b | | | | | | | | |
| TREATMENT | N | | Subset | | | | | |
| 1 | | 2 | | 3 | |
| T1 | 3 | | 131.5800 | |  | |  | |
| T2 | 3 | | 132.9633 | |  | |  | |
| T3 | 3 | |  | | 149.4700 | |  | |
| T4 | 3 | |  | |  | | 170.6100 | |
| Sig. |  | | .514 | | 1.000 | | 1.000 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 5.975. | | | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | | | |
| b. Alpha = 0.05. | | | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | |
| Dependent Variable: TRIGLYC | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | F | Sig. |
| Corrected Model | | 88.878a | | 5 | | 17.776 | 1.369 | .353 |
| Intercept | | 188601.613 | | 1 | | 188601.613 | 14528.616 | .000 |
| TREATMENT | | 19.027 | | 3 | | 6.342 | .489 | .703 |
| REPLICATE | | 69.852 | | 2 | | 34.926 | 2.690 | .147 |
| Error | | 77.888 | | 6 | | 12.981 |  |  |
| Total | | 188768.380 | | 12 | |  |  |  |
| Corrected Total | | 166.767 | | 11 | |  |  |  |
| a. R Squared = .533 (Adjusted R Squared = .144) | | | | | | | | |
| **TRIGLYC** | | | | |
| Duncana,b | | | | |
| TREATMENT | N | | Subset | |
| 1 | |
| T1 | 3 | | 123.267 | |
| T4 | 3 | | 125.667 | |
| T3 | 3 | | 125.933 | |
| T2 | 3 | | 126.600 | |
| Sig. |  | | .319 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 12.981. | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | |
| b. Alpha = 0.05. | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | | | | | |
| Dependent Variable: HDL-C | | | | | | | | | |
| Source | | Type III Sum of Squares | | df | | Mean Square | | F | Sig. |
| Corrected Model | | 720.033a | | 5 | | 144.007 | | 17.828 | .002 |
| Intercept | | 61518.720 | | 1 | | 61518.720 | | 7615.798 | .000 |
| TREATMENT | | 716.373 | | 3 | | 238.791 | | 29.561 | .001 |
| REPLICATE | | 3.660 | | 2 | | 1.830 | | .227 | .804 |
| Error | | 48.467 | | 6 | | 8.078 | |  |  |
| Total | | 62287.220 | | 12 | |  | |  |  |
| Corrected Total | | 768.500 | | 11 | |  | |  |  |
| a. R Squared = .937 (Adjusted R Squared = .884) | | | | | | | | | |
| **HDL-C** | | | | | | |
| Duncana,b | | | | | | |
| TREATMENT | N | | Subset | | | |
| 1 | | 2 | |
| T1 | 3 | | 62.267 | |  | |
| T2 | 3 | | 66.267 | |  | |
| T3 | 3 | |  | | 76.133 | |
| T4 | 3 | |  | | 81.733 | |
| Sig. |  | | .136 | | .052 | |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 8.078. | | | | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | | | | |
| b. Alpha = 0.05. | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: LDL-C | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 2.042a | 5 | .408 | .543 | .740 |
| Intercept | 7444.105 | 1 | 7444.105 | 9905.954 | .000 |
| TREATMENT | 1.308 | 3 | .436 | .580 | .649 |
| REPLICATE | .734 | 2 | .367 | .488 | .636 |
| Error | 4.509 | 6 | .751 |  |  |
| Total | 7450.655 | 12 |  |  |  |
| Corrected Total | 6.551 | 11 |  |  |  |
| a. R Squared = .312 (Adjusted R Squared = -.262) | | | | | |

|  |  |  |
| --- | --- | --- |
| **LDL-C** | | |
| Duncana,b | | |
| TREATMENT | N | Subset |
| 1 |
| T3 | 3 | 24.5200 |
| T1 | 3 | 24.6533 |
| T4 | 3 | 25.1333 |
| T2 | 3 | 25.3200 |
| Sig. |  | .321 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = .751. | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | |
| b. Alpha = 0.05. | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tests of Between-Subjects Effects** | | | | | |
| Dependent Variable: VLDL-C | | | | | |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 887.939a | 5 | 177.588 | 6.558 | .020 |
| Intercept | 29580.477 | 1 | 29580.477 | 1092.387 | .000 |
| TREATMENT | 877.994 | 3 | 292.665 | 10.808 | .008 |
| REPLICATE | 9.945 | 2 | 4.973 | .184 | .837 |
| Error | 162.473 | 6 | 27.079 |  |  |
| Total | 30630.889 | 12 |  |  |  |
| Corrected Total | 1050.412 | 11 |  |  |  |
| a. R Squared = .845 (Adjusted R Squared = .716) | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **VLDL-C** | | | |
| Duncana,b | | | |
| TREATMENT | N | Subset | |
| 1 | 2 |
| T2 | 3 | 41.3767 |  |
| T1 | 3 | 44.6600 |  |
| T3 | 3 | 48.8167 |  |
| T4 | 3 |  | 63.7433 |
| Sig. |  | .142 | 1.000 |
| Means for groups in homogeneous subsets are displayed.  Based on observed means.  The error term is Mean Square(Error) = 27.079. | | | |
| a. Uses Harmonic Mean Sample Size = 3.000. | | | |
| b. Alpha = 0.05. | | | |