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PERFORMANCE OF MALE BROILER CHICKENS FED CHELATED COPPER (MINTREX) AND INORGANIC SALTS EQUIVALENT OF COPPER AND METHIONINE

BY

BELLO OLUWATOBI MICHAEL

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OF THE

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CERTIFICATION

This is to certify that research work on "Performance of male broiler chickens fed chelated copper and inorganic salts equivalent of copper and methionine was carried out by BELLO OLUWATOBI MICHAEL with matriculation number, 2009/0300 of the Department Of Animal Nutrition, College Of Animal Science And Livestock Production, Federal University Of Agriculture, Abeokuta, Ogun State, Nigeria under my supervision.

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Dr O.M.O Idowu Date

Supervisor

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ABSTRACT

A feeding trial was conducted for eight weeks to evaluate the effect of two different sources of copper and methionine. Inorganic copper sulphate+DL- methionine and copper mintrex (chelate) on the performance response of male finisher broiler chickens. Four hundred and eighty day old Anak 2000 broiler chicks were randomly assigned to eight treatments and each treatment were replicated six times. Mintrex was included at 0, 73.53, 147.06 and 294.12g/100kg of diets. The inorganic equivalent in 100kg diet from copper sulphate ($CuS0_4$) and DL-methionine were 0g$CuS0_4$+0gDL-methionine, 49.12g$CuS0_4$+63.9gDL-methionine, 98.24g CuS04+196.00g DL methionine 196.4g$CuS0_4$+255.9gDL-methionine respectively. The mintrex and inorganic equivalent salt of $CuS0_4$ and DL- methionine supplied 0, 125, 250 and 500ppm of copper in combination with 0, 640, 1279, and 2559ppm of methionine. At starter phase the inclusion of mintrex and inorganic equivalents significantly ($P<0.05$) influenced the final weight, weight gain, feed intake, and feed conversion ratio. The final weight and weight gain in both mintrex and inorganic equivalents significantly increased as the level of supplementation increased ($p<0.05$). The value obtain in mintrex group were higher than those of the inorganic equivalents. The feed intake of group fed mintrex of 73.53g and 147.06g/00kg diet and inorganic equivalents of 49.12g$CuS0_4$+63.90gDL-methionine are statistically the same ($P>0.05$).The feed conversion ratio improved with increased level of supplementation with mintrex and inorganic equivalents. The best feed conversion ratio was obtained when mintrex was added at 294.12g/100kg of diet. At finisher phase the inclusion of mintrex and inorganic equivalents significantly ($P<0.05$) influenced the final weight, weight gain, feed intake and feed conversion ratio. The final weight and weight gain in both mintrex and inorganic equivalents significantly ($P<0.05$) increased as the levels increased. The value of final weight and weight gain in mintrex group were higher

than those of the inorganic equivalent. The feed intake increased as level of mintrex and inorganic equivalent increased, except in group fed diet that contained mintrex at 147.06g/100kg diet where there was depression in feed intake. The feed conversion ratio also improved with increased level of supplementation with mintrex and inorganic salt equivalents. The best feed conversion ratio was obtained when mintrex was added at 294.12/100kg diet. Livability was statistically the same (P>0.05). It was concluded from this study that mintrex at 294.12g/100kg supported better performance at starter and finisher than all other inorganic equivalents.

DEDICATION

This research work is dedicated to the one who was, who is and is to come, the mastermind behind this piece to my ever supportive treasures, Mr. and Mrs. Moses Bolatito Bello, I dedicate this report.

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CHAPTER ONE

1.0 INTRODUCTION

Broilers are chicken (Gallus gallus domesticus) bred and raised specifically for meat production. They are one of the most common and widespread domesticated animal with a population of 19billion in 2011(The Economist, July 27th 2011). The first week post hatch represents 20% of the productive life of many broilers, and is the period when the greatest relative growth occurs (Rocha *et al*., 2003). Most commercial broiler bred for meat reach slaughter weight at between 5-7weeks of age although slower growing strains reach slaughter weight at approximately 14weeks of age. Broiler feed consist of different feedstuff which belongs to different classes which are energy, protein, fat, water, and mineral. Minerals can be divided into two types the essential mineral which cannot be synthesized in the body of the birds, which has to be supplemented in the diet example of such are copper and sulphur, and the non-essential which are synthesized in the body of the animal.

Methionine the requisite amino acid for broiler production, amino acid is the building block of protein in the body. Methionine plays a significant role in energy production, regulation of cell division and protein synthesis in broiler and its deficiency in broiler will result to deficiency in sulphur containing amino acid which are critical for proper feathering of birds and also decrease in growth rate of bird. With lower level of methionine in broiler ration growth rate decreases.

Copper is an essential trace mineral for chicken development, growth and production. The common copper sources used in poultry diets are inorganic copper salts, primarily the sulfate form. With increasing concern of environmental pollution from minerals in the excreta, improving the biological availability by using organic trace minerals in broiler diet is one strategy to reduce their excretion (Ferket *et al*., 2002). Copper is an essential component of several enzyme systems which are important for cellular respirations.

The National Research Council (NRC, 1994) recommended between 8 and 10 ppm copper for broiler diets. Copper is normally fed to broiler chickens at levels above the nutritional requirement as a growth promoter and antimicrobial agent. However, there are conflicting reports about the growth stimulating effects of Cu on broiler chickens. Bakalli et al. (1995), Pesti and Bakalli (1996), Bakalli and Pesti (1996), Ewing et al. (1998), Luo et al. (2005), Arias and Koutsos (2006), Lu et al. (2010) and Kim et al.

(2011) have shown that feeding dietary Cu in excess of the basal level that satisfied the nutritional requirement (10 ppm) improved the growth performance and feed conversion efficiency of broilers.

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Dietary sources of copper affect the biological availability of copper to animal for absorption and utilization. Copper may exist as compounds of salt, such as, copper sulphate (CuSO4), copper oxide (CuO), copper citrate, copper acetate, and copper carbonate or as complexes such as copper-methionine chelate, copper lysine complex, and tribasic copper chloride

Copper is normally fed to broiler chickens at levels above the nutritional requirement as a growth promoter and antimicrobial agent. However, there are conflicting reports about the growth stimulating effects of Cu on broiler chickens others have also shown that supplemental copper has little or no effect on growth performance and feed utilization of boiler chickens (Chiou *et al.*, 1999; Nys, 2001).

MINTREX chelated trace minerals combine ALIMET® with an essential trace mineral in a two-to-one chelated molecule. This protects the mineral from antagonists, allowing it to be more efficiently absorbed once reaching the small intestine. The result is greater bioavailability, digestive tract stability and a residual methionine effect that can reduce the required level of supplemental methionine per ton of feed

1.1 Justification

Research has shown that methioine has the ability to increase nutrient intake in feed, act as anti-oxidant and also reduce anti- nutritional factor and Ruiz *et al*, (2000) reported that copper stimulated poultry growth and increased its performance and also vital in the body as a component of (or cofactor for) enzyme systems, also organic copper is unpopular to the the poultry and livestock farmer in Nigeria and this is due to the fact they do not have adequate information regarding its usefulness in poultry production. Animal digest organic mineral than inorganic mineral, Many nutritionists and feed manufacturers are concerned about the contradictory reports on the growth promoting effect of different sources of supplemental copper therefore there is need to study utilization of organic copper and organic methionine over inorganic copper and methionine

1.2 Objectives

1.2.1 Broad objective

To determine the performance of male broiler chickens fed graded level of mintrex and copper sulphate + methionine at both starter and finisher phase

1.2.2 Specific objectives

To investigate the effect of mintrex on performance of male broiler chickens fed experimental diet

To determine the effect of copper sulphate and methionine on performance of male broiler chickens fed experimental diet

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To make recommendation based on the experiment

CHAPTER TWO

2.0 Literature review

2.1 Nutrition of broiler chickens

Nutrition is one of the most important factors in poultry production, it is more than just giving any available feed to your birds. Feed has a major impact on broiler production, as it contributes to 60-70% of total production cost (coon, 2002). A growing broiler needs to be supplied sufficient nutrient to meet its requirement for maintenance and for the growth of all components.

Broiler require proper nutrition to grow and finish out in correct balance of five classes of nutrients (proteins, carbohydrates, fats and oils, vitamins, minerals, and water) for optimum growth, maintenance, finishing, work, reproduction, and production (Poultry Science Manual, 2013). For maximum performance, good health and digestibility, poultry need a steady supply of energy, protein, essential amino acid mineral, vitamins and most important water.

2.2 Nutrient requirement of broiler chickens

Feed is considered to be the most important factor in broiler production and about 70% of the total cost of production is spent on feed formulation. It is thereby necessary to formulate balance feed in term of energy, protein, amino acid minerals and vitamin. Nutrient requirement differs among types, breeds, age and strain of birds (NRC 1994). Feed intake is the difference between feed offered to broiler and feed left offer by broiler. Nutrient intake is a function of feed intake and the nutrient available in the feed. For successful broiler production, digestibility and nutrient intake the nutritional requirement must be in balance form.

2.2.1 Energy requirement of broiler chickens

Animal require energy for growth, maintenance, digestion and production. Dietary nutrients that yield energy are protein fat and carbohydrate. Carbohydrate is the chief source of energy in the diet of broiler. Carbohydrates represent the major energy component. About 70% of the bio-available energy comes from the carbohydrates, starch being the most important fraction for animal nutrition (Klein *et al*., 2001). Dietary energy level is the main factor influencing feed intake as broiler will under normal circumstances eat to satisfy their energy needs. The metabolazable energy requirement per day during hot season has been found to be lower the metabolazable energy per day in the cool season Olomu (1995).

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2.2.2 Protein requirement of broiler chickens

Proteins are fundamental components of all body cells and include many biochemical's (such as enzymes, hormones, and antibodies) necessary for proper body functions. They are essential in the broilers diet for growth and repair of tissue and can be obtained from many feedstuffs such as meat and fish meals, cereal grains and legume byproducts such as soybean meal. The protein content of an ingredient or complete diet is usually described as Crude Protein. Olomu, 1995 postulated three crude proteins require by broiler 24% (0-3weeks), 20% (3-6weeks) and 18% (6-9weeks). Olomu, 1995 also recommended a level of 23% for inclusion in the starter diet and 20% for inclusion in the diet of finisher in Nigeria.

2.2.3 Water requirement of broiler chickens

Water quality is an important consideration when planning to raise animals. Water must be regarded as an essential nutrient because it regulate body temperature, transports other nutrients, and takes part in numerous chemical reactions in the body although it is not possible to state precise requirements. Limiting water intake especially during hot weather conditions and after eating high protein ration will reduce feed intake and this will affect nutrient digestibility. According to National Research Council, NRC (1994), the estimated daily water consumption of broiler at the end of the first and eight weeks of age are 20 and 80litres respectively per 100lttres at an environmental temperature of 21^{o}C.

2.2.4 Vitamin requirement of broiler chickens

Vitamins are essential organic (carbon based) compounds needed in small poultry nutrition to assist physiological processes which include growth, development and maintenance. Vitamins do not directly build body tissue as do macro minerals like calcium and phosphorus. They assist many of the enzymes controlling the metabolic processes of life and are often referred to as co-enzymes (Poultry Science Manual, 2013). Dalloul *et al*, (2012) demonstrated that broilers fed vitamin A deficient diet have lower cellular immune responses resulting in reduced ability an E. acervulina infection. Deficiency of vitamin can cause nervous disorder, reduced growth in meat birds and improper development. Essential vitamins are supplemented in the diet using vitamin and premixes.

2.2.5 Fat and oil requirement of broiler chickens

They are very important nutrients in the diet performance, in terms of providing energy, fats and oils serve the same function as do digestible carbohydrates. Fats and oils are the densest forms of energy and derived from plants and animals. At room temperature, fats are solids and oils are liquids. They both provide 2.25 times more energy than do carbohydrates (9kilocalories per gram versus 4kilocalories per gram for digestible carbohydrates and protein). Poultry require only small amounts of fats and oils (Poultry Science Manual, 2013).

2.2.6 Mineral requirement of broiler chickens

Calcium and phosphorus are essential for good bone formation and bone quality in broilers; they are also the most important mineral in broiler diet. The balance between these nutrient is also important and the normal content of starter diet are about 10g calcium and 4.5 available phosphorus in the approximate kg of 2:1 Mineral are often classified as macro or trace minerals in reference to the concentration required. Calcium and phosphorus are required in larger quantities like trace mineral like iron, iodine, and copper. The trace mineral are associated with an improvement in immunity. Among minerals required by broiler for normal physiological function are calcium 1.0-0.8%, phosphorus available 0.45-0.35%, potassium 0.4-0.3% sodium 0.15% magnesium 600mg zinc 40mg copper 8mg iron 80mg (NRC, 1984). Essential mineral are supplied in the diet because the animal cannot synthesis them. Others help regulate many metabolic activities.

2.3 Factor affecting performance of broiler chickens

2.3.1 Temperature

Probably the most important non-dietary factor influencing feed conversion is the ambient temperature of the poultry house. Chickens are homeotherms (warm-blooded) meaning they maintain a relatively constant body temperature regardless of the environmental temperature. Broilers perform best when there is minimal variation in house temperature over a 24 hour period of time.

In a cool environment, broilers will eat more feed but many of the calories they obtain from this feed will be used to sustain normal body temperature. When the calories are used for warmth, they are not converted to meat. Optimum temperatures allow the broilers to convert nutrients into growth rather than using the calories for temperature regulation. The ideal environmental temperatures for promoting feed conversion must be provided by the service personnel. At high environmental temperatures, broilers consume less feed, and convert this feed less efficiently. The biological cooling mechanisms that birds use during hot weather (panting, etc.) require energy, just as the warming mechanisms do during cool weather.

2.3.2 **Litter quality**

Litter conditions significantly influence broiler performance and, ultimately, the profits of growers and integrators. Litter is defined as the combination of bedding material, excreta, feathers, wasted feed, and wasted water. See Chapter 14 for more information on the use of litter amendments

2.3.3 **Feed wastage and feed deprivation**

Placing too much feed in the chick feeders results in feed wastage and contributes to an inferior feed conversion. To prevent excessive loss of feed, add small quantities of feed to the feeder lids by running the automatic feeders frequently for short periods. This will stimulate the chicks to eat more often. **2.4 Effect of copper on male broiler performance**

Copper is normally fed to broiler chickens at levels above the nutritional requirement as a growth promoter and antimicrobial agent. However, there are conflicting reports about the growth stimulating effects of Cu on broiler chickens. Bakalli *et al.* (1995), Pesti and Bakalli (1996), Bakalli and Pesti (1996), Ewing *et al*. (1998), Luo *et al.* (2005), Arias and Koutsos (2006), Lu *et al*. (2010) and Kim *et al.* (2011) have shown that feeding dietary Cu in excess of the basal level that satisfied the nutritional requirement (10 ppm) improved the growth performance and feed conversion efficiency of broilers.

Others have also shown that supplemental copper has little or no effect on growth performance and feed utilization of boiler chickens (Chiou *et al.,* 1999; Nys, 2001; Skrivan *et al*., 2002; Sevcikova *et al.,* 2003; Waldroup et al., 2003; Blanks et al., 2004; Pang *et al*., 2009; Xiang-Qi *et al*., 2009; Karimi *et al*., 2011). Higher levels of supplementation (above 250 mg/kg) have even been reported to decrease weight gain and feed utilization (Xiang-Qi *et al*., 2009; Karimi *et al*., 2011).

2.5.0 Copper in broiler nutrition

Copper is classified as trace element and is an essential component of several enzymes. Copper has growth stimulating properties especially in broiler. Copper propionate is copper that is rich in protein and are more closely related to that of small peptide and amino acid which appear to be a more suitable form to use in formulating diet containing mineral level of trace mineral

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2.5.1 Uses of copper in broiler nutrition

It is vital in the body as a component of (or cofactor for) enzyme systems involved in iron transport and metabolism, red blood cell formation and immune function. Included in almost every trace mineral premix (blended to provide mineral supplementation to animal rations) is enough copper to satisfy the minimal nutritional requirements of broilers.

Ruiz *et al*. (2000) reported that copper stimulated poultry growth and increased its performance. Improved availability of copper from organic copper complexes compared with the commonly used copper salts recently has been suggested. Chelates, complexes or proteinates are the organic form of copper and are usually considered for use in animal diet as alternatives to inorganic copper source. More bioavailability of copper is probably due to better absorption, which enhances its efficiency (Downs *et al*., 2000; Yu *et al*., 2000; Guo *et al*., 2001).

2.5.2 Factor affecting utilization of copper

Copper is absorbed in the upper small intestine. Copper absorption is affected by the physiological stage of the animal, dietary level of copper and interactions with phytate, ascorbic acid, fibre, tannin etc. which appear to complex with copper and other trace elements. Copper absorption is higher in neonates than in adults. Interferences from high level of molybdenum and sulfur, iron, zinc, and other compounds cause copper deficiency by reducing its availability.

2.5.3 Copper toxicity in broiler nutrition

Numerous studies have reported toxic effects induced when animals and humans are exposed to certain metals (Valko *et al*.,2005,)animal exposed to copper acid composition have been observed in the erythrocyte and hepatocyte of the animal (Zang *et al*., 2000). Copper is capable of reacting with practically every biological molecule inhibiting oxidative damage by abstracting the hydrogen from a carbon centered protein radical and from an unsaturated fatty acid to form a lipid radical (Powell, 2000). Although copper is a major essential element, serious toxic effects of this metal have been reported when it is over loaded (Toplan *et al*., 2005, Zhang *et al*., 2000). The OH- radical generated during copper-induced oxidative stress may lead to lipid per oxidation and formation of reactive products which may be involved in severe damage of cell molecules and structures (Videla *et al*., 2003). In higher doses of more than 250 mg/kg feed, copper caused proventriculitis in broilers and at 1477ppm level it also produced oral ulcers as well as reduced feed intake and a drop in egg production in layers.

2.6.0 Methionine in broiler nutrition

Methionine is an essential amino acid and it is classified to be non-polar. Methionine is one of the two amino acid encoded by a single codon. The condon AUD is also the start message for ribosome that signals the initiation of protein translation from MRNA. Due to this methionine has been allowed as a supplement under the U.S certified organic pattern. Methioine has the ability to increase nutrient intake in feed, act as anti-oxidant and also reduce anti- nutritional factor like tannin this process helps in feed usage and digestibility.

2.6.1 Uses of methionine in broiler nutrition

Supplementation of methionine in diet improved performance in terms of feed consumption ratio but feed intake was similar between methionine supplemented and unsupplemented groups. Similarly in the present investigation, supplementation of DL methionine improved feed consumption ratio compared to control whereas supplementation of herbal methionine@1kg/tonne of feed showed better feed consumption ratio than DL methionine supplemented birds. The survivability of birds during the experimental period will not be differing significantly among treatments. It will indicate that dietary supplements have no detrimental effect on survivability (Rajurker *et al*., 2009).

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2.7 Interaction between copper methionine

Although selenium supplementation prevented the pathological conditions it is possible that an interference with normal sulfur amino acid metabolism by copper may have been involved in the appearance of muscular dystrophy since cystine is one nutrient capable of Preventing this myopathy in chick. Extra methionine counteracted the growth depression observed in chicks fed a diet supplemented with 500ppm copper.

CHAPTER THREE

3.0 Materials and Method

3.1 Experimental Site

The experiment was carried out at the livestock unit of the Directorate of University Farms (DUFARMS), while the digestibility test was done at the laboratory of the Department of Animal nutrition, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. Both sites are situated in Odeda local government area of Ogun State (Latitude $7^0 93^1$N and Longitude $3^0 20^1$E). Abeokuta, the Ogun State capital is in the south western part of Nigeria.

3.2 Experimental birds and management

A total of 480 male broiler chicks was purchased from CHI farm at Ibadan. The bird were brooded using wood shavings as bedding material and fed on a starter ration for the first four weeks of their age, the brooder temperature was regulated on the basis of the chicks' behaviour. Neat and toxin free feed and water was made available to the birds. Coccidiostat, probiotic, and anti-toxin were added as shown in the table. All recommended medication was strictly adhered to.

3.3 Dietary treatment

8 dietary treatments were formulated at starter and finisher phases. The major variation in the diets were. 4levels of mintrex and 4 varying levels of copper sulphate and methionine. The four levels of mintrex were 0g, 75.53g/100kg of diet which supplied 125ppm of copper and 640ppm of methionine, 147.06g/100kg of diet which supplied 250ppm of copper and 1279ppm of methionine, 294.12g/100kg of diet which supplied 500ppm of copper and 2559ppm of methionine.

Basal diet at starter and finisher stage

Table 1: Composition of the experimental broiler starter and finisher diets

Name	starter (%)	finisher (%)
Corn7.7%cp	50.92	59.34
Soya 45/6 Arg	20.95	12.48
Soybean oil	2.06	25.01
Herring meal (fish meal) 70%	1.00	1.00
Alimet	0.52	0.47
Di-calcium phosphate	0.04	0.00
Grits	0.01	0.01
Salt	0.15	0.13
Limestone	1.71	1.41
Coccidiostat 6.6%	0.05	0.05
Full fat soya	20.00	20.00
Anti aflatoxin	0.30	0.30
Probiotic	0.05	0.05
Broiler premix	2.25	2.25
Total	**100**	**100**

Chemical composition of the diet

Nutrients	**unit**	**Starter**	**Finisher**
ME protein	kcal/kg	3000.00	3140.00
Crude protein	g/kg	224.89	195.00
Crude fat	g/kg	75.35	81.20
Crude ash	g/kg	70.97	62.61
Crude fibre	g/kg	45.28	41.71
Calcium	g/kg	10.50	9.00
Phosphorus	g/kg	6.01	5.58
Av-phosph	g/kg	4.50	4.27
Methionine	g/kg	7.38	6.65
Dig methionine	g/kg	6.86	6.20
Methyl lysine	g/kg	10.87	9.73
Fe	mg/kg	46.13	46.13
Zn	mg/kg	56.25	56.25
Cu	g/kg	8.02	7.32

3.4 Experimental design

A complete randomized design was used and this was involve using of 3x4 factorial arrangement of the treatment in the study

Data collection

The growth performance data were determined from 1day to 56 days. During this period, weekly body weight and feed consumption were recorded. Feed conversion ratio was calculated from the body weight and feed consumption data

3.5.1 Weight gain

This was determined on weekly basis. The weight of broiler were determined by differences between the initial body weight and final body weight.

3.5.2 Feed intake

A known quantity of feed was given to each replicate at the beginning of each day and left over was deducted from the amount given after 24hours and the difference was taken to be the amount of feed consumed/day

3.5.3 Feed conversion ratio

This was calculated as the ratio of feed intake to weight gain.

$$FCR = \frac{\text{amount of feed consumed}}{\text{Weight gain}}$$

3.6 **Statistical analysis**

Data generated in this study was subjected to analysis of variance in a 3x4 factorial design using SAS statistical package (SAS,1999) while the significant means at $p < 0.05$ was separated using Duncan multiple range test using the same package.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1.0 Performance of broiler chickens fed chelated copper and inorganic salt equivalent of copper and methionine at starter phase

The effect of copper sulphate + DLmethionine and mintrex levels on performance of male broiler chickens at starter phase as shown in Table2: At starter phase the inclusion of mintrex and inorganic equivalents significantly ($P<0.05$) influenced the final weight, weight gain, feed intake, and feed conversion ratio. The final weight and weight gain in both mintrex and inorganic equivalents significantly increased as the level of supplementation increased ($p<0.05$). The value obtain in mintrex group were higher than those of the inorganic equivalents. The feed intake of group fed mintrex of 73.53g and 147.06g/00kg diet and inorganic equivalents of 49.12g$CuS0_4$+63.90gDL-methionine are statistically the same ($P>0.05$) . The feed conversion ratio improved with increased level of supplementation with mintrex and inorganic equivalents. The best feed conversion ratio was obtained when mintrex was added at 294.12g/100kg of diet.

Trace mineral complexed with organic molecule have been implied to be more bioavailable than inorganic trace mineral (Brown and Zerinque, 1994). At starter phase the inclusion of mintrex and inorganic equivalents significantly ($P<0.05$) influenced the final weight , weight gain feed intakean d feed conversion ratio which agrees bwith the result of (Hong *et al.*, 2002) which reported that supplementation of 100ppm of copper as Met-Cu improved performance in broilers.

The final weight and the weight gain was in both mintrex and inorganic equivalents significantly increased as the level increased. The highest final weight (912.9kg) and highest weight gain (871.16kg) was obtained at 294.12/100kg of dietary supplentation of mintrex this support the result of (Jegede et al., 2011) which says dietary Cu from an organic source was reported to improve body weight and feed efficiency level in broilers compared to the inorganic source and result of (Richard et al., 2005, Yi et al., 2007) which says mintrex organic trace mineral are absorbed as a source of methionine activity this into a greater availability of mintrex compared to $Cus0_4$+ DL methionine for feeding broiler, while the lowest final weight (416.90kg) and lowest weight gain (377.06kg) was obtained at 0g$Cus0_4$+0g DL-methionine. Reduction in weight gain of male broiler chickens fed $CuS0_4$+DL-methionine also support result of (Spears, 1996) which says utilization of organic trace mineral is dependent on the ability of the animal to convert them to organic biologically active forms.

The inclusion of mintrex and inorganic equivalent significantly influenced feed intake. The feed intake of mintrex at 73.53g and 147.06g/100kg diet and inorganic equivalent of 49.12$CuS0_4$+63.90g DL-methionine and 98.24g$CuS0_4$+196.40g DL-methionine are statistically the same. The feed conversion ratio improved with mintrex and inorganic equivalent and the best feed conversion ratio was obtained when mintrex was added at 294.12/100kg diet.

Livability was 100% across treatment and this support reports from various worker throughout the world confirms (Du *et al*., 1996 and Paik, 2001) that metal chelates of amino acids and peptides can enhance the bioavailability of the trace elements, thereby leading to the improvement of growth and general health status.

Table2: Performance of broiler chickens fed chelated copper and inorganic salt equivalent of copper and methionine at starter phase

	Mintrex				CuSo4+ methionine				
Initial weight (g/bird)	40.14	40.50	40.50	40.33	40.80	40.17	40	40.83	0.31
Final weight (g/bird)	671.00^{d}	817.70^{b}	892.10^{ab}	912.09^{a}	416.90e	689.20^{d}	688.10^{d}	733.60^{c}	21.5
Weight gain (g/bird)	630.20^{d}	776.92^{b}	847.32^{a}	871.16^{a}	377.06^{e}	648.40^{d}	647.31^{d}	692.77^{c}	21.4
Feed intake (g/bird)	1453.96^{a}	1487.58^{a}	1473.02^{a}	1407.58^{b}	1201.58^{c}	1495.33^{a}	1431.99^{a}	1363.75^{b}	16.4
FCR	2.34^{b}	1.91^{c}	1.76^{d}	1.61^{e}	3.23^{a}	2.3^{b}	2.2^{abc}	1.9^{c}	0.07
Livability	100	100	100	100	100	100	100	100	0.00

S.E.M means standard error of mean

abcde means across the row with different superscript are significantly diffrent

4.1.2 Performance of broiler chickens fed chelated copper and inorganic salt equivalent of copper and methionine at finisher phase.

The effect of copper sulphate + DLmethionine and mintrex levels on performance of male broiler chickens at finisher phase as shown in Table3: At finisher phase the inclusion of mintrex and inorganic equivalents significantly (P<0.05) influenced the final weight, weight gain, feed intake and feed conversion ratio. The final weight and weight gain in both mintrex and inorganic equivalents significantly (P<0.05) increased as the levels increased. The value of final weight and weight gain in mintrex group were higher than those of the inorganic equivalent. The feed intake increased as level of mintrex and inorganic equivalent increased, except in group fed diet that contained mintrex at 147.06g/100kg diet where there was depression in feed intake. The feed conversion ratio also improved with increased level of supplementation with mintrex and inorganic salt equivalents. The best feed conversion ratio was obtained when mintrex was added at 294.12/100kg diet. Livability was statistically the same (P>0.05). It was concluded from this study that mintrex at 294.12g/100kg supported better performance at starter and finisher than all other inorganic equivalents.

At finisher phase the inclusion of mintrex and inorganic equivalents significantly (P<0.05) influenced the final weight , weight gain feed intake and feed conversion ratio which agrees with the result of (Hong *et al*., 2002) which reported that supplementation of 100ppm of copper as Met-Cu improved performance in broilers.

The final weight and the weight gain was in both mintrex and inorganic equivalents significantly increased as the level increased. The highest final weight (2444.24kg) and highest weight gain (1711.24kg) was obtained at 294.12/100kg of dietary supplentation of mintrex this support the result of (Jegede et al., 2011) which says dietary Cu from an organic source was reported to improve body weight and feed efficiency level in broilers compared to the inorganic source and result of (Richard et al., 2005, Yi *et al.*, 2007) which says mintrex organic trace mineral are absorbed as a source of methionine activity this result to a greater availability of mintrex compared to $Cus0_4$+ DL methionine for feeding broiler, while the lowest final weight (1729.09kg) and lowest weight gain (995.79kg) was obtained at 0g$Cus0_4$+0g DL-methionine. Reduction in weight gain of male broiler chickens fed $Cus0_4$+DL-methionine also support result of (Spears, 1996) which says utilization of organic trace mineral is dependent on the ability of the animal to convert them to organic biologically active forms.

The inclusion of mintrex and inorganic equivalent significantly influenced feed intake. The highest feed intake (3935.85g) was obtained at 294.12g/100kg diet supplementation of mintrex, and lowest feed intake (2820.14g) was obtained at 0g/100kg of mintrex and the feed intake was statistically the same as inorganic equivalent of 0g$CuS0_4$+0gDL-methionine and 49.12$Cus0_4$+63.90g DL-methionine. The feed conversion ratio improved with mintrex and inorganic equivalent and the best feed conversion ratio was obtained when mintrex was added at 294.12/100kg diet.

Livability was 100% across treatment and this support reports from various worker throughout the world confirms (Du *et al.*, 1996 and Paik, 2001) that metal chelates of amino acids and peptides can enhance the bioavailability of the trace elements, thereby leading to the improvement of growth and general health status.

Table3: Performance of broiler chicken fed chelated copper and organic salt equivalent of copper and methionine

	Inclusion level of $Cuso_4$+DL methionine				Inclusion level of mintrex				
	I	II	III	IV	I	II	III	IV	SEM
Initial weight(g/bird)	733.30	733.28	733.38	733.67	733.47	733.17	733.40	733.47	
Final weight(g/bird)	1729.09^{d}	1763^{d}	1974.00^{c}	2084.00^{d}	1763.00^{d}	2121.00^{b}	2209.00^{b}	2444.24^{a}	47.50
Weight gain (g/bird)	995.79^{d}	1029.72^{d}	1240.62^{c}	1350.33^{b}	1030.13^{d}	1387.83^{b}	1475.60^{b}	1711.24^{a}	29.5
Feed intake	2987.37^{c}	3004.79^{c}	3101.55^{bc}	3240.79^{b}	2820.14^{c}	3608.35^{b}	3570.95^{b}	3935.85^{a}	18.2
FCR	3.00^{a}	2.91^{a}	2.50^{c}	2.40^{c}	2.77^{bc}	2.6^{b}	2.42^{c}	2.30^{d}	0.11
Livability	100	100	100	100	99.82	99.18	99.82	91.00	0.07

S.E.M means standard error of the mean
abcde means across the row with different superscript are diffrent

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CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION.

From the result of this study it can be deduced that, dietary copper supplementation can substantially influence the growth performance and feed utilization of broilers. Mintrex can be incorporated at 294.12g without any noticeable adverse effects on the performance of the birds. The birds appeared to perform better at 294.12g of mintrex level which supply 500ppmcopper and 2559ppm of methionine. One can therefore, recommend that copper from mintrex can be safely incorporated into broiler diet up to 500 ppm without any noticeable adverse effect on performance and the health of the animal.

5.2 RECOMMENDATION

From the result of this experiment, it can therefore be recommended that male broiler should be fed copper mintrex at the level 294.12g because at this point the highest weight is observed and the feed conversion ratio is also the best. It is noted that mintrex at 73.53g inclusion gave a similar performance at 196.40$CuS0_4$+255.8g at the starter phase

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