EVALUATION OF HERBOMETHIONINE (METHIOREP®) AS A SUBSTITUTE FOR SYNTHETIC DL- METHIONINE IN THE DIETS OF EGG-TYPE CHICKENS

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Declaration

I declare that the work in the thesis entitled Evaluation of Herbomethionine (methiorep®) as a Substitute for Synthetic DL- Methionine in the diets of Egg-Type Chickens has been performed by me in the Department of Animal science under the supervision of Professor S.O. Ogundipe and Professor G.S. Bawa. The information derived from the literature has been duly acknowledged in the text. No part of this Research work has previously been presented for another degree at any university.

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Certification

This thesis entitled "EVALUATION OF HERBOMETHIONINE (METHIOREP®) AS A SUBSTITUTE FOR SYNTHETIC DL- METHIONINE IN THE DIETS OF EGG-TYPE CHICKENS" by Dauda Ahmed Ndah meets the regulations governing the award of the degree of Masters in Animal Science, Ahmadu Bello University, Zaria and is approved for its contribution to knowledge the literary presentation.

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TABLE OF CONTENTS

Title page ……i

Declaration ……ii

Certification ……iii

Acknowledgements……iv

Dedication ……vi

Table of contents……vii

List of tables ……xi

Abstract……xii

CHAPTER ONE 1

1.0 INTRODUCTION 1

1.1 Justification 3

1.2 Objectives of the study 4

1.3 Research Hypothesis 4

CHAPTER TWO 5

2.0 LITERATURE REVIEW 5

2.1 Roles of methionine in the nutrition of laying hens 5

2.2 Metabolism and pathway of methionine 5

2.2 Egg Production and formation 6

2.4.0 Effects of DL-Methionine on Poultry Performance 8

2.4.1 Effects of DL-Methionine supplementation on feed intake 8

2.4.2 Effect of Methionine Supplementation on Egg Weight and Egg Mass 9

2.4.3 Effect of Methionine and Lysine Supplementations on Body Weight of Laying Hens. 9

2.5.0 Nutrient Requirement of Laying Birds 10

2.5.1 Energy requirement 10

2.5.2 Vitamin requirement 11

2.5.3 Mineral requirement 11

2.6 Deficiency of methionine in layer's diets 12
2.7 Criticisms on the use of methionine for laying birds 12
2.8.0 Herbomethionine (methiorep®) 13
2.8.1 Ingredient composition of methiorep® 13
2.8.2 Source of Herbomethionine (methiorep®) 13
2.8.3 Application of methiorep® 14
2.9.0 Effect of Herbomethionine (methiorep®) Supplementation on Poultry 15
2.9.1 Effects of Herbomethionine (methiorep®) supplementation on feed Intake 15
2.9.2 Effects of Herbomethionine (methiorep®) supplementation on weight gain 16
2.9.3 Effect of Herbomethionine (methiorep®) supplementation on feed conversion ratio 16
2.9.4 Effect of Herbomethionine (methiorep®) supplementation on mortality 16

CHAPTER THREE 18
3.0 **MATERIALS AND METHODS** 18
3.1 Experimental Site 18
3.2 Source of experimental birds 18
3.2.1 Feeding Trials 18
3.2.2 Experiment 1: Evaluation of growth performance of pullets fed varying levels and combinations of herbomethionine (methiorep®) and in their diets (9-20weeks). 18
3.2.2.1 Experimental diets: 18
3.2.2.2 Experimental Design and Management of Birds 21
3.2.2.3 Parameters measured 21
3.2.2.4 Data analysis 21
3.2.3 Experiment 2: Evaluation of early egg laying performance of birds fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their diets (22-34weeks) 22
3.2.3.1 Experimental diets: 22
3.2.3.2 Experimental Design and Management of Birds 22
3.2.3.3 Parameters measured 23
3.2.3.4 Data analysis 23
3.2.4.1 Experimental design 25
3.2.4.2 Experimental diets 25
3.2.4.3 Hematological study 26
3.2.4.4 Parameters measured 26

3.2.4.5 Egg quality determinations 26
3.2.4.6 Data analysis and statistical model 29

CHAPTER FOUR 30
4.0 RESULTS 30
4.1 Proximate Composition of Grower Diet 30
4.2 Proximate Composition of Layer Diet 30

4.3.1 Experiment 1: Effect of Supplementation of Herbomethionine (methiorep®) and DL-Methionine in the Diet of Growers (9-20weeks) 30
4.3.2 Experiment 2: Early Laying Performance of hens fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their diets (22 – 34 weeks) 33
4.3.3 Experiment 3: Laying Performance of hens fed varying levels and combinations of Herbomethionine (methiorep®) and DL- Methionine in their Diets (35 –50 weeks). 37
4.3.4: Effect of Herbomethionine (methiorep®) and DL-Methionine supplementations on hematological parameters of egg-type chickens (50weeks). 38
4.3.6: Internal Egg Quality Characteristics of Birds fed Herbomethionine (methiorep®) and DL–Methionine in their Diets. 40

CHAPTER FIVE 44

5.0 DISCUSSIONS 44

5.1 Experiment 1: Effect of Supplementation of Herbomethionine (methiorep®) and DL-Methionine in the Diet of Growers (9-20weeks). 44
5.2 Experiment 2: Early Laying Performance of Hens fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their diets (22-34weeks). 45
5.3 Experiment 3: Laying Performance of Hens fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their Diets (35-50weeks). 47
5.4 Effect of Supplementation of Herbomethionine (methiorep®) and 50
DL-Methionine hematological parameters of egg–type chickens (50weeks). 50

5.5 External Egg Quality Characteristics of Birds fed Herbomethionine (methiorep®) and DL-Methionine in their Diets. 51

5.6 Internal Egg Quality Characteristics of Birds fed Herbomethionine (methiorep®) and DL-Methionine in their Diets. 52

CHAPTER SIX 53
6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 53
6.1 Summary 53
6.2 Conclusion 53
6.3 Recommendation 53
REFERENCES 54

LIST OF TABLES

3.1 Composition of pullet grower diets……...20

3.2 Composition of early layer diets……..…24

3.3 Composition of layer diets……...28

4.1 Proximate composition of grower diets……31

4.2 Proximate composition of layer diet……32

4.3 Effects of supplementation of herbomethionine (methiorep®) and DL-Methionine in the diet of growers (9-20weeks)……35

4.4 Early laying performance of hens fed varying levels and combinations of herbomethionine (methiorep®) and DL-Methionine in their diets (22-34 weeks)...36

4.5 Laying performance of birds fed varying levels and combinations of herbomethionine (methiorep®) and DL-Methionine in their diets (35-50weeks)....39

4.6 Effect of varying levels and combinations herbomethionine (methiorep®) and DL-Methionine supplemented diets on hematological parameters of egg-type chickens (50 weeks)……...……..…….……...….41

4.7 Effect of herbomethionine (methiorep®) and DL-Methionine supplemented diet on external egg quality indices of egg- type chickens……...42

4.8 Effect of herbomethionine (methiorep®) and DL-Methionine supplementation on internal egg quality indices of egg-type chickens……..…43

ABSTRACT

Three experiments were conducted to evaluate the growth performance and egg production parameters of ISA-BROWN (ISA-B) growing pullets and laying birds fed Herbomethionine and DL-Methionine in their diets. In the first experiment, 234 nine weeks old growing pullets with an average initial weight of 625g were allotted to six dietary treatment groups. There were 39 birds per treatment made up of three replicates of thirteen birds each. In the second and third experiments, 216 laying birds selected from birds used in experiment 1 with an average initial weight of 1500g and 1610g respectively were allotted to six dietary treatment groups of 36 birds replicated three times with 12 birds each. Treatment 1 had 0.10% DL-Methionine, no Herbomethionine, Treatment 2 had 0.10% Herbomethionine, no DL-Methionine, Treatment 3 had 0.10% each of DL-Methionine and Herbomethionine, Treatment 4 had 0.30% DL-Methionine, no Herbomethionine, Treatment 5 had 0.30% Herbomethionine, no DL-Methionine, Treatment 6 had 0.15% of DL-Methionine and 0.15% Herbomethionine. The results of experiment one showed that birds fed DL-Methionine and Herbomethionine at 0.30% performed significantly ($P<0.05$) better than all other treatments in weight gain (790g and 779g), feed intake (7.34kg and 7.26kg) and feed conversion ratio (8.61 and 9.92) respectively. No significant ($P>0.05$) difference was observed in mortality. Results of experiments 2 and 3 showed that treatment 6 (birds fed diet with 0.15% of DL-Methionine and 0.15% Herbomethionine methiorep®) supplementations performed significantly ($P<0.05$) better in egg number (82) compared with treatment 2 (birds fed diet with 0.10% Herbomethionine) supplementations. Highest percent hen-day egg production was recorded in T6 (80) than T1 (69) and T2 (65). Dietary treatments had significant ($P<0.05$) effects on egg shell weight, egg shell thickness, albumen weight and yolk diameter. The Haugh unit was not significantly ($P>0.05$) affected by dietary treatments. There were significant ($P<0.05$) differences in hematological parameters such as packed cell volume, hemoglobin count and total proteins. It was concluded that herbomethionine supplemented at 0.30% was found to be as effective as 0.30% DL-methionine in the grower study whereas in the layer study, herbomethionine supplemented at 0.15% plus DL-methionine supplemented at 0.15% gave the best performance in egg production and egg quality.

CHAPTER ONE

1.0 INTRODUCTION

Poultry production in Nigeria is faced with so many challenges and only the farmers who embrace new measures to improve on their production efficiency while lowering their production costs can really have a profitable poultry venture. The frequent collapse of many commercial poultry farms in Nigeria have been attributed to high cost of poultry feeds (Ogundipe, 2002).

The challenge of poultry nutritionists is to formulate economically viable diets, which provide as closely as possible the nutrient requirements of chickens. Methionine is required at higher level to comply with the increased tissue and egg demands when bird is predisposed to fast growth along with high production performance (Halder and Roy, 2007). Methionine is usually limiting in the diets of layers and therefore need to be supplemented (Fancher and Jensen, 1989).

Methionine deficiency is associated with poor quality eggs, thin shells or shelless eggs (Bishnol, 2008). It is economical to add methionine to poultry diets than soybean meal or other natural protein to meet the requirement (Halder and Roy, 2007).

An oversupply of amino acids cannot be converted to body proteins and it may depress performance leading to inefficient and uneconomical egg production (Reinhart, 1996). Methionine serves as an integral portion of body protein, a precursor for cysteine and an important source of dietary sulfur as well act as a lipotropic agent in balancing protein requirements (Young *et al*., 1995). Sulpur-Adenosyl Methionine (SAM) is a potent donor

of methyl groups that contributes to the synthesis of other substances including epinephrine, choline and creatinine (Bender, 1975).

Applying DL-Methionine supplements in feeding layers resulted in changes in physio-chemical traits in the egg in terms of size and internal quality. Proteins from animal sources contain adequate amounts of methionine but are often too expensive for use in practical rations *(*Dafwang *et al*., 1980*;* Dafwang, 2006). The authors concluded that methionine requirements for poultry can be met by supplementing with DL– Methionine.

Recently, the safety of such practices has been questioned and their use is becoming restricted in many regions of the world (Chattopadhyay *et al*., 2006). The arguments against the use of synthetic methionine is that dietary adjustments aiming to maximize production performance without special concern for nutrient over supply, especially proteins and amino acids, creates more environmental problems due to increased production of nitrogen from poultry droppings (Bishnol, 2008).

The use of synthetic Methionine is controversial in organic poultry production and nutritionists have been challenged to find suitable alternatives to synthetic methionine.

A new product is just being introduced into the Nigerian animal feed industry market to take care of some of the problems. This product is known as Herbomethionine (methiorep®). Methiorep® is prepared from specially selected methionine-rich plant materials that harmoniously meet the requirements for methionine in poultry diets. This product supplies methionine via a sustained-release of peptides and oligopeptides forms along with enzymes required for the conversion of methionine into SAM s-adenosyl methionine (Animal Care Service Konsults, 2008).

Supplementation of methionine with this phyto-additive made from herbs have been scientifically proven to ensure efficient nutrient and energy utilization, reduction in feather pecking and better performance of breeder flocks (Bishnol, 2008).

Ayurvet Limited (2007), An Indian company that manufactures methiorep® also claims the following benefits for supplementing poultry diets with methiorep:

a. Provision of optimum activity of methionine.
b. Optimum protein synthesis and energy utilization in layer birds.
c. Increased efficiency of production and optimum egg size in laying birds.
d. Better performance of breeder birds.
e. Improved growth, performance, feed conversion ratio and livability of flocks.

There is need to investigate the use of Herbomethionine (methiorep®) as a substitute for synthetic methionine in layer diets since little or no study has been conducted in this part of the country to determine the efficacy of this product as a substitute for synthetic DL – Methionine in poultry diets. This study is designed to compare the efficiency of herbomethionine (methiorep®) against synthetic DL –methionine in grower and layer diets.

1.1 Justification

The use of synthetic DL-methionine in poultry feed is becoming more expensive, consumers worldwide prefer eggs produced by birds fed on natural materials rather than synthetic materials.

The study is undertaken to determine the comparative efficacy of combination of synthetic methionine plus herbomethionine (methiorep®) incorporation on egg production and egg quality traits of layers.

1.2 Objectives of the study

1. To evaluate the effect of feeding Herbomethionine (methiorep®) and DL-Methionine in the diets of growing Pullets (9-20weeks).
2. To evaluate the effects of Herbomethionine (methiorep®) and DL-Methionine supplemental diets on the laying performance of egg-type chicken.
3. To assess the effects of Herbomethionine (methiorep®) and DL- Methionine supplemental diets on egg quality characteristics of egg-type chickens.

1.3 Research Hypothesis

Null hypothesis

1. Feeding varying levels of Herbomethionine (methiorep®) and DL-Methionine has no effect on performance of growing pullets.
2. Feeding varying levels Herbomethionine (methiorep®) and DL-Methionine has no effect on egg laying performance of egg-type chickens.
3. Feeding varying levels of Herbomethionine (methiorep®) and DL-Methionine has no effect on egg quality characteristics of egg-type chickens.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Roles of methionine in the nutrition of laying hens

The major concern today with feeding and managing laying hens is achieving the desired weights for age in the pullet during the early growing period. Methionine, an indispensable amino acid is needed for good health and high productivity in poultry. Methionine has played a major role in energy production, protein synthesis and in maintaining optimum egg size (Binder, 2003). Pullets that are on target weight at maturity will inevitably be the best producing birds for the shell egg market (Lesson, 1988).

The key to a successful nutritional management today is through maximizing body weight of the pullet (Leeson and Summers, 2005). Amino acids are important building blocks of life and therefore very critical in the diet of layers (Summers *et al*., 1991). Methionine is a major amino acid that can be limiting in practical feeds for laying hens (Olomu, 1995).

2.2 Metabolism and pathway of methionine

Methionine, an indispensible Amino acid must be supplied in the diet of laying hens, as the birds are unable to synthesize it in the amount necessary to sustain life and growth (Halder and Roy, 2007). Methionine is the limiting amino acid in poultry diets and very essential for all vital biological functions of birds (Swick *et al*., 1990). Methionine is manufactured as pure amino acid. Common forms are DL-Methionine and liquid DL-Methionine hydroxyl analogue free acid (Binder, 2003).

Methionine is a white crystalline powder that is soluble in water, it usually occurs as a racemic mixture of DL (Lesson and Summers, 2001). It serves as a methyl donor for transmethylation reactions in the biosynthesis of lipids and lipid transport in the blood (Patterson and Kung, 1998).

It can donate sulphur groups and serve as a building block for proteins (Pesti *et al.,* 1998). It aids protein synthesis, improves growth performance and egg production with optimum egg size as well as feed conversion ratio in birds (Binder, 2003). Methionine is classified as an essential amino acid and regulated as an animal feed supplement by the Food and Drug Administration (NOSB, 2003).

Methionine from the liver can be recovered by transferring activated methyl groups from tetrahydrofolate donor to s-adenosyl methionine in the presence of ATP to form s-adenosyl-methionine, releasing both inorganic phosphate and pyro-phosphate (Bertram *et al*, 1991) and the catalyst for this reaction is adenosyl-transferase (Lubert, 1981). Methionine can function in the absence of nutrients ranging from choline, sulphate, selenium and counters the deleterious influence of copper sulphate exposure (Summers, *et al*., 1991).

2.2 Egg Production and formation

Egg production is the major index of performance of commercial laying flocks. The physiological basis of egg production indicated that the maximum a fowl is capable of producing is about 300 eggs in the first year.

In the tropics, production has remained at 180-200 eggs or below, although higher levels have been reported (Oluyemi and Roberts, 1990). Egg consists of three main parts namely yolk, albumen and shell. On the average, egg of domestic fowl contains 54% albumen, 34% yolk and 13.5% shell. The yolk contains fat, having seven times more energy per unit weight than the albumen.

Larger eggs have more albumen in relation to their yolk content and therefore as the weight of egg increases, its energy content per unit weight decreases. The parts that are mostly concerned in the process of egg formation are the ovary and oviduct. The process of egg formation is a complex hormone controlled reaction. The total time interval between the release of the yolk from the ovary and laying of the egg is usually around 24-26 hours. However, it may vary between 23-30 hours.

The albumen secreted from the magnum is homogenous and gel-like in structure due to its mucin content which is secreted as mucin fibres. Since the protein of gel adjacent to the egg yolk undergoes liquefaction by the time it leaves the magnum, the mucin fibres get down together as the egg passes making spiral movement during the process of its development and it leads to the formation of chaziferous layer known as chalazae. Shell formation takes the longest time in the uterus portion of the oviduct.

Calcium deposition during the first four hours is hardly at the rate of 2.2 percent which increases to 5.6 percent per hour during the next 16 hours or more. The hen utilizes both dietary and skeletal calcium available for the formation of shell, around 45 percent of skeletal calcium is directed to shell formation.

When the egg is laid, normally it has no air cell. As blunt end of the egg comes out first, where pores are comparatively more, an air cell is formed between the two shell membranes, parallel with the cooling of the egg contents (Oluyemi and Roberts, 1990).
The air cell at the large (blunt) end of the egg is a product of the rate of contraction between the shell and its contents.

2.4.0 Effects of DL-Methionine on Poultry Performance

2.4.1 Effects of DL-Methionine supplementation on feed intake

Methionine is a non-polar sulfur containing amino acid, a precursor of lecithin and a potent lipotropic and chelating agent and its deficiency may lead to fatty liver and other metabolic disturbances (Kershavarz, 2003). The levels and balance of amino acids in poultry diets are important nutritional variables that affect the economic efficiency of an egg laying enterprise (Al-saffar and Rose 2002).

Chen *et al.,* (1999) reported better egg production with 0.62% methionine + cysteine and 0.53% methionine when fed to layers. Murakami *et al.,* (1994) concluded that methionine and sulphur amino acid levels in the diet had no effect on the feed intake of quails during the laying period. Imbalance in amino acids composition in layer diet which is needed for egg protein synthesis will result in lowered egg output along with poor plumage condition, feather pecking, cannibalism and increased mortality (Ambrosen and Paterson, 1997). Amaefule *et al*., (2004) reported that there were significant effects of methionine supplementation on egg production and egg quality characteristics of old layers.

2.4.2 Effect of Methionine Supplementation on Egg Weight and Egg Mass

Pinto (1998) reported that egg weight and egg mass were improved with increasing protein and methionine in the diets of birds. Egg weight was greater with increasing methionine (Vidal *et al*., 2000).

There was significant interaction between protein, methionine + cysteine levels on egg weight as birds fed on 18% and 20% CP and 0.875% methionine plus cysteine diet had greater egg weight than those birds fed on 0.700% methionine + cysteine diet.

Amaefule *et al.,* (2004) reported that for maximal egg production and egg weight, diets containing 19% CP, 1.0% lysine and 0.62% methionine fulfilled the nutritional requirement of the amino acid.

Denner and Bessi (2003) demonstrated that essential amino acids had a significant influence on egg weight and that inadequate supplementation of indispensable amino acid in the diets of birds resulted in reduced egg weight within two weeks. Murakami *et al*, (1994) reported that 18% CP in the diet of laying quails were adequate for improved egg weight and egg mass.

2.4.3 Effect of Methionine and Lysine Supplementations on Body Weight of Laying Hens.

Ojano-Dirain and Waldroup, (2002) in their study on the effect of dietary lysine on meat quality reported that supplemental lysine from 0.83-0.93% improved feed conversion and body weight gain of laying hens. Yamane and Tanaka (1979) reported that low protein intake significantly decreased body weight gain of laying birds.

Dozier *et al.,* (2005) reported a total of 0.93% dietary lysine as the requirement for female broilers. Murakami, *et al.,* (1994) found that laying quail fed higher protein diets (20% and 22% CP) showed significantly higher body weights than those fed the lower protein levels of 16% and 18% CP.

Souza (2003) indicated that hens fed protein on a free-choice basis had higher levels of protein intake than conventionally fed ones and were able to significantly increase egg size in hot environment. Summers *et al.,* (1991) showed that the supplementation of a low protein diet with 0.30% DL-methionine led to a 10% increase in egg mass. Lysine and methionine supplemented diet of 10% CP further increased egg mass output by 26%.

2.5.0 Nutrient Requirement of Laying Birds

2.5.1 Energy requirement

Fancher and Jensen (1989) reported that 2950 Kcal per kg of the diet could meet the requirement for metabolisable energy in layer diets. Birds require about 25g of feed per head per day at chick phase and will do well on a ration containing 22-25% crude protein with 2800Kcal per kg diet (Harms *et al*., 2000). Each protein level was tested at two dietary energy levels of 2700 and 3000 ME/Kg of the diets.

Egg production was improved significantly on increasing the protein levels of the diet from 12-15%. Feed efficiency was poor with protein levels of 12 and 15% when compared with those at 18 and 20% levels.

2.5.2 Vitamin requirement

Vitamins are only needed in small quantities for normal growth of chickens (Harms *et al.*, 1991). Vitamin requirement of laying chickens may not be sufficient for normal growth of chicks and maximum egg production (Elliot, 1988).

A requirement for some vitamins is not yet known, but it appears that for most vitamins, the quantity needed for maximum hatchability are greater than those for egg production alone. According to Mississippi State University (1997) vitamins are always added to feed in amounts that meet minimum dietary requirement. During period of stress, it is recommended that supplementary vitamins can be provided in the drinking water for layers.

2.5.3 Mineral requirement

In order to maintain adequate daily consumption of minerals when feed intake decreases, the percentage of minerals in the diet should be increased. According to NRC (1994), calcium requirement for laying hens was 3.25% for 100g intake.

Research indicated that feeding optimum calcium levels and the correct limestone solubility to young layers will support stronger bones and egg shells at the end of the laying cycle (Civitelli *et al*., 1992).

Phosphorus requirement are difficult to determine because of uncertainties regarding the availability of phytate phosphorus, however according to Francis *et al.,* (2012), addition of phytase to a corn-soya layer diet eliminated the need for inorganic phosphate supplementation without affecting performance.

To maximize egg shell quality and maintain strong bones, older layers towards the end of their laying cycle may need a lower soluble limestone (8-10%) and a higher calcium intake of 5g for egg shells and 6g for bones.

2.6 Deficiency of methionine in layer's diets

Methionine deficiency could lead to decrease in egg production, poor quality eggs, small sized egg and thin shelled eggs (Bishnol, 2008). In severe cases, it could impair immune response and increase susceptibility to disease infection thereby affecting layer growth and performance.

Methionine deficiency could reduce feed intake and weight gain in pullet chicken (Lesson and Summers, 2001). The non polar sulphur containing amino acid, precursor of lecithin and potent lipotropic and chelating agent and diet inadequate in this amino acid may lead to fatty liver syndrome (Kershavarz, 2003). Methionine deficiency lead to poor feed conversion, retarded growth and reduced egg production in layers (Binder, 2003).

2.7 Criticisms on the use of methionine for laying birds

Synthetic methionine is listed among the prohibited synthetic substances and its usage has been questioned in organic farming practices (Anonymous, 1999).

Synthetic methionine is metabolized into highly toxic compounds such as methyl propionate which may adversely affect bird's performance (Bender, 1975). Synthetic methionine is listed among the prohibited synthetic substances and its usage has been questioned in organic farming practices (Waskar *et al*., 2009).

An argument against the use of synthetic methionine is that dietary adjustments aimed at maximizing production performance without special concern for nutrient oversupply, especially protein and amino acids, creates more environmental problems due to increased production of nitrogen from poultry droppings (Bishnol, 2008). The use of synthetic methionine is controversial in organic poultry production and nutritionists have been challenged to find suitable alternatives. It has been reported that methionine content of feed when supplemented with methiorep® a phytoadditive made from herbs like kidney beans, wheat bran onion and velvet beans were scientifically proven to ensure efficient nutrient utilization (Bishnol, 2008).

2.8.0 Herbomethionine (methiorep®)

2.8.1 Ingredient composition of methiorep®

Rajurker *et al.,* (2009) reported that methiorep® is composed of Phaseolus *mungo* (mung beans), Triticum *sativum* (wheat) and Allium *sativum* (Garlic). Methiorep® also contains Cicer *arientirum* (Chick pea) and Phaseolus *vulgaris* (kidney beans) with highly available methionine.

2.8.2 Source of Herbomethionine (methiorep®)

Methiorep® is said to have originated from India and it is manufactured and marketed by Ayurvet Limited Baddi, the leading producers of herbal products in Asia. Methiorep® is a scientifically developed combination of herbs that contains herbal ingredients rich in methionine in free form and as conjugated form (Itoe, 2010).

Methiorep® is reported to be preferred to methionine in a number of ways because it is seen as natural analogue to replace synthetic methionine. There is economic and better

performance of birds fed methiorep® supplemented diet compared to methionine (Animal Care Konsults, 2008). Its activity remains unaltered during pelleting and the powder form ensures equivalent distribution of the product in the feed.

2.8.3 Application of methiorep®

A feeding trial was carried out using male and female rats. Methiorep® doses of 500-5000mg per kilogramme body weight was administered, no visible signs of convulsions, tremor, depression and mortality were recorded (Rajurker *et al.*, 2009).

They therefore inferred that it was safe at a higher limit dose, belonging to the class 5 or unclassified substances as per Globally Harmonized classified System (GHC) for chemical substances and mixtures indicative of very high LD_{50} value and therefore recommended it as a very safe product to replace synthetic methionine in layer rations and for supplementation in basal diets for normal use.

Methiorep® was introduced into the Nigerian market and serve as the best substitutes to effectively replace synthetic methionine in poultry production as well as reduce the cost of poultry production in Nigeria.

Methiorep® is said to contain herbal ingredients rich in methionine. The use of synthetic methionine in organic feed had been criticized for increasing bird growth rather than health and it create more environmental problems due to increased production of nitrogen from poultry droppings (Bishnol, 2008). The author concluded that this was not a problem when the methionine content of the feed was supplemented with methiorep® that was

scientifically proven to ensure efficient nutrient and energy utilization and better performance in birds.

Herbal formulations of methionine proved better than DL-methionine in lowering total serum cholesterol due to the hypo-cholesterolemic activity of certain constituent in the herbs of methiorep® such as Allium *sativum,* Allium *sepa,* Phaseolus *mungo* and Mucuna *pruriens* (Itoe, 2010).

Herbomethionine (methiorep®) serve as a natural analogue to replace synthetic methionine, for economic and better performance of laying flocks. Its activity remains unaltered during pelleting and the powder form ensures equivalent distribution of the product in feed. (Animal Care Konsults, 2008).

2.9.0 Effect of Herbomethionine (methiorep®) Supplementation on Poultry

2.9.1 Effects of Herbomethionine (methiorep®) supplementation on feed Intake

Garlich (1985) reported variation in synthetic DL-methionine supplemented groups compared to the methiorep® group during the finisher phase. Chattopadhyay *et al.*, (2006) reported effect of dietary supplementation of herbomethionie (methiorep®) on feed intake.

Halder and Roy (2007) reported variations among treatments in the feed intake of the control group over the methiorep® treatment group. Ibrahim (2014) reported no significant effect on supplementation of methiorep® in feed intake.

2.9.2 Effects of Herbomethionine (methiorep®) supplementation on weight gain

Chattopadhyay *et al.,* (2006) reported a higher weight gain as a result of 15g herbal methionine supplementation (P<0.01) as compared to 10g synthetic methionine supplementation per hundred kilogramme diet.

Halder and Roy (2007) reported significantly (P<0.01) higher live weight during starter and finisher phases with herbal methionine groups as against the DL-Methionine supplemented groups.

Kalbande *et al*., (2009) reported a significantly (P<0.01) higher final body weight during finisher phase with methiorep® supplemented groups compared to DL-Methionine supplemented groups.

2.9.3 Effect of Herbomethionine (methiorep®) supplementation on feed conversion ratio

Chattopadhyay *et al.,* (2006) reported better feed conversion ratio with 15g herbal methionine supplemented diet per hundred kilogram diet. Halder and Roy (2007) reported non-significant differences in feed conversion ratio between methionine supplemented and the herbal methionine supplemented groups.

Kalbande *et al.,* (2009) reported better feed conversion ratio of herbomethionine diet over the synthetic methionine supplemented diet.

2.9.4 Effect of Herbomethionine (methiorep®) supplementation on mortality

Halder and Roy (2007) reported non-significant difference among methionine supplemented and herbomethionine supplemented groups, indicating that dietary treatments

have no effect on mortality. Kalbande *et al*., (2009) indicated that supplementation of methiorep® had no significant effect on mortality and that it was safe for use in poultry rations. Francis *et al.,* (2010) reported significant effect of supplementation of Herbomethionine on mortality when fed to layers.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental Site

The experiments were carried out at the poultry unit of the Animal Science Department Teaching and Research farm, Ahmadu Bello University, Zaria, Kaduna State in the northern Guinea Savannah zone, located on longitude 11^0 09'01.78"N and latitude $7^0$39'14.79"E, 671m above sea level (Google Earth, 2010). Average annual rainfall of 70-1400mm occurring between the months of April and October.

3.2 Source of experimental birds

All birds used in the experiment were Isa- brown layers.

3.2.1 Feeding Trials

The feeding trial consists of three studies viz;

3.2.2 Experiment 1: Evaluation of growth performance of pullets fed varying levels and combinations of herbomethionine (methiorep®) and in their diets (9-20weeks).

3.2.2.1 Experimental diets:

Six grower diets were formulated such that control (diet 1) had no herbomethionine (methiorep®) but had 0.10 % DL-Methionine, Diet 2 contained no DL-Methionine but had 0.1% herbomethionine (methiorep®) while diet 3 contains 0.10% herbomethionine (methiorep®) and 0.10% DL-Methionine. Diet 4 contained 0.30% DL-Methionine, but no

herbomethionine (methiorep®), Diet 5 contained 0.30% herbomethionine (methiorep®) but no DL-Methionine and diet 6 contains 0.15% of DL-Methionine and 0.15% herbomethionine (methiorep®). The diets were designed to be isocaloric and isonitrogenous and were formulated to meet the requirement for energy, protein, calcium and phosphorus (NRC, 1994). The proximate composition of the diet was carried out according to the A.O.A.C (1990) method. The grower diets were fed for eleven weeks. The ingredient compositions and the calculated analyses of the experimental diets were as shown in Table 3.1.

Table 3.1: Composition of grower diets –Experiment 1

	Treatment					
Ingredients	**1**	**2**	**3**	**4**	**5**	**6**
Maize	35.00	35.00	35.00	35.00	35.00	35.00
Maize offal	27.10	27.10	27.00	27.00	27.10	27.10
GNC	14.10	14.10	14.10	14.10	14.10	14.10
BDG	11.80	11.80	11.80	11.70	11.60	11.6
Soya bean meal	8.00	8.00	8.00	8.00	8.00	8.00
Bone meal	2.75	2.75	2.75	2.75	2.75	2.75
Limestone	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.30	0.30	0.30	0.30	0.30	0.30
VIT/Mineral Premix*	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.10	0.10	0.10	0.10	0.10	0.10
DL-Methionine	0.10	0.00	0.10	0.30	0.00	0.15
HM (Methiorep®)	0.00	0.10	0.10	0.00	0.30	0.15
TOTAL	100	100	100	100	100	100
Calculated Analysis						
ME: Kcal/kg	2537	2536	2537	2536	2536	2534
Crude Protein (%)	15.50	15.50	15.50	15.50	15.50	15.50
Calcium (%)	1.61	1.61	1.61	1.61	1.61	1.61
Avail phosphorus (%)	0.55	0.52	0.55	0.51	0.51	0.52
Ether extract (%)	4.07	4.07	4.07	4.06	4.06	4.06
Lysine (%)	0.83	0.82	0.83	0.83	0.83	0.82
Meth + cystine (in situ)	0.51	0.50	0.50	0.49	0.49	0.50
Methionine (in situ)	0.20	0.20	0.20	0.20	0.20	0.20

* Biomix per kg of diet: Vit A =8,000 I.U, Vit D_3 = 1500 I.U, Vit E = 7.00mg,Vit K_3 = 1.50mg,Vit B_1 = 2.00mg,Vit B_2 = 2.50mg,Vit B_6 = 2.00mg,Vit B_{12} = 0.01mg, Folic acid = 0.50mg, Niacin = 15.00mg, Pantothenic acid = 5.50mg ,Biotin H_2 = 0.25mg; Chlorine Chloride = 175mg; Cobalt = 0.20mg, Iodine = 1.00mg; Copper = 3.00mg; Iron = 21.00mg; Manganese = 40.0mg, Selenium = 0.20mg; Zinc = 31.0mg, Antioxidant = 1.25mg.

3.2.2.2 Experimental Design and Management of Birds

Two hundred and thirty four (234) ISA-BROWN (ISA-B) growers were used for this experiment. The birds were randomly allocated to six dietary treatments such that average weights of birds per pen were approximately equal. There were 3 replicates of 13 birds each per treatment in a completely randomized design in pens under the deep litter system.

The pullets were housed and managed in accordance with the standard procedures (Summers *et al.,* 1991). The birds were vaccinated against Newcastle (Lasota and Kamorov), Gumboro and fowl pox diseases during the rearing period. They were dewormed regularly. Feed and water were provided *ad-libitum*. The experiment lasted for 11 weeks.

3.2.2.3 Parameters measured

The following data were collected during the experiment; feed intake, weight gain, feed conversion ratio, feed cost per kilogramme weight gain and mortality rate.

3.2.2.4 Data analysis

All data obtained were to analysis of variance using the linear model procedure. Treatment means were separated using Duncan's multiple range test (SAS, 2008). The experiment was a completely randomized design.

3.2.3 Experiment 2: Evaluation of early egg laying performance of birds fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their diets (22-34weeks).

3.2.3.1 Experimental diets:

The treatmental diets were formulated as follows; control (diet 1) had no herbomethionine (methiorep®) but had 0.10% DL-Methionine, Diet 2 contained no DL-Methionine but had 0.1% herbomethionine (methiorep®) while diet 3 contains 0.10% each of herbomethionine (methiorep®) and DL-Methionine. Diet 4 contained 0.30% DL-Methionine but no herbomethionine (methiorep®), Diet 5 contained 0.30% herbomethionine (methiorep®) and no DL-Methionine and Diet 6 contained 0.15% of DL-Methionine and 0.15% herbomethionine (methiorep®). The diets were designed to be isocaloric and isonitrogenous and were formulated to meet the requirement for energy, protein, calcium and phosphorus (NRC, 1994). The trial lasted for 12 weeks. The proximate composition of the diet was carried out according to the A.O.A.C (1990) method. The composition of the experimental diets and the calculated analyses were as shown in Table 3.2.

3.2.3.2 Experimental Design and Management of Birds

Two hundred and sixteen (216) ISA-BROWN (ISA-B) laying birds obtained from experiment one were used for this experiment. The birds were randomly allocated to eighteen pen groups such that average weights of birds per pen were approximately equal. There were 12 birds per replicate in a completely randomized design and birds were housed under the deep litter system.

The layers were housed and managed in accordance with the standard procedures (Summers *et al*., 1991).The birds were vaccinated against Newcastle (Lasota and Kamorov) diseases. They were dewormed regularly and were given Vitalyte® in water to reduce stress. Feed and water were provided *ad-libitum*. The experiment lasted for 12 weeks.

3.2.3.3 Parameters measured

Parameters measured and calculated included feed consumption, weight gain, average age of birds at 1st egg and age of birds at 10% and 50% lay. Percent hen-day egg production was calculated as the ratio of the total number of eggs laid a day to the total number of hens present on that day multiply by 100.

Percent hen housed egg production was calculated as the ratio of the total number of eggs laid in a period to the total number of hens housed at the beginning of laying period multiplied by 100, Average egg weight and total egg number were also computed.

3.2.3.4 Data analysis

All data obtained were subjected to the analysis of variance using the linear model procedure. Treatment means were separated using Duncan's multiple range test (SAS, 2008). The experimental design was a completely randomized design

Table 3.2: Composition of early laying diets for experiments 2

	Treatments					
Ingredients	**1**	**2**	**3**	**4**	**5**	**6**
Maize	34.30	34.30	34.30	34.30	34.30	34.30
Maize offal	28.45	28.45	28.35	28.25	28.25	28.25
G\cake	15.80	15.80	15.80	15.80	15.80	15.80
Soya cake	10.00	10.00	10.00	10.00	10.00	10.00
Lime stone	7.50	7.50	7.50	7.50	7.50	7.50
Bone meal	3.20	3.20	3.20	3.20	3.20	3.20
Salt	0.30	0.30	0.30	0.30	0.30	0.30
VIT/Mineral Premix*	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.10	0.10	0.10	0.10	0.10	0.10
DL-Methionine	0.10	0.00	0.10	0.30	0.00	0.15
HM (Methiorep®)	0.00	0.10	0.10	0.00	0.30	0.15
TOTAL	100	100	100	100	100	100
Calculated Analysis						
ME: Kcal/kg	2643	2640	2641	2644	2632	2636
Crude protein %	17.00	17.00	17.00	17.00	17.00	17.00
Ether extract %	4.27	4.37	4.27	4.26	4.26	4.36
Crude fibre %	5.52	5.53	5.53	5.48	5.58	5.51
Calcium %	3.56	3.56	3.56	3.55	3.56	3.56
Available P %	0.52	0.52	0.52	0.52	0.52	0.52
Lysine (%)	0.83	0.82	0.83	0.83	0.83	0.82
Methionine (in situ)	0.20	0.20	0.20	0.20	0.20	0.20
Meth+ cysteine (in situ)	0.52	0.52	0.52	0.52	0.52	0.52

* Biomix provide per kg of diet: Vit A = 8500 I.U; Vit D_3 = 1500 I.U; Vit E = 10.00 I.U, Vit K_3 = 1.00mg; Pantothenic acid = 4.50mg;Vit B_1 = 1.50mg; Vit.B_2 = 4.50mg; Vit B_6 =3.00mg; Vit.B_{12} = 0.015mg; Niacin = 15.00mg; Folic acid = 0.60mg; Choline chloride = 175mg; Manganese = 40.0mg; Iron = 20mg; Zinc = 30.00mg; Copper = 3.00mg; Iodine = 1.00mg; Cobalt = 0.20mg; Selenium = 0.20mg; Biotin = 0.50mg; Antioxidant = 1.25mg.

3.2.4 Experiment 3: Evaluation of laying performance and egg quality characteristics of layers fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their Diets (35-50weeks).

3.2.4.1 Experimental design

Two hundred and sixteen (216) ISA-BROWN (ISA-B) layer birds were used for this experiment. The birds were randomly allocated to eighteen pen groups such that the average weights of birds in all the pens were approximately equal. There were 12 birds per pen and three pens per treatment. The design was a completely randomize design (CRD) with birds housed under the deep litter system. The experiment lasted for 15 weeks.

3.2.4.2 Experimental diets

The treatmental diets were as follows; control (diet 1) has no herbomethionine (methiorep®) but had 0.1% DL-Methionine, Diet 2 contained no DL-Methionine but had 0.1% herbomethionine (methiorep®) while diet 3 contained 0.1% of herbomethionine (methiorep®) and 0.1% DL-Methionine. Diet 4 contains 0.3% DL-Methionine but no herbomethionine (methiorep®), Diet 5 contained 0.3% herbomethionine (methiorep®) but no DL-Methionine and Diet 6 contained 0.15% of DL-Methionine and 0.15% herbomethionine (methiorep®).

The diets were formulated to be isocaloric and isonitrogenous and met the requirements for energy, protein, calcium and phosphorus (NRC, 1994). The composition of the diets and the calculated analyses were shown in Table 3.3.

3.2.4.3 Hematological study

At the end of the Layer Study, 2mls blood samples were taken from three birds per replicate via the wing vein into sample bottles treated with Ethylene Diamine Tetra Acetic Acid (EDTA) and taken to the laboratory for hematological study.

The samples were analyzed for packed cell volume (PCV), hemoglobin (Hb) count and total proteins (Tp). Samples were analyzed at the Clinical Pathology Laboratory; Department of Veterinary Science, Ahmadu Bello University, Zaria.

3.2.4.4 Parameters measured

Egg laying performance parameters measured included; egg weight, hen-housed egg production, Hen housed egg production, Hen day egg production, egg number, feed consumed and cost of feed per dozen eggs produced were computed.

3.2.4.5 Egg quality determinations

Egg collection was done daily and recorded. At the last three consecutive days of the 28-day period, eggs gathered were used for external and internal egg quality determinations Egg quality parameters were determined.

The external egg quality characteristics measured included egg weight, egg length, egg diameter, egg shell weight and egg shell thickness.

The internal egg quality characteristics considered include albumen width, albumen weight, yolk width and yolk height and yolk weight. Egg length and diameter were measured with a pair of vernier caliper, egg shape index was calculated as egg diameter divided by the length.

Eggs were broken into a flat plate to measure yolk height and albumen height using the vernier calipers, Albumen of the egg was carefully separated from the yolk using a separator and the albumen and yolk weight were measured with a sensitive weighing scale. Egg shell thickness was measured with a micrometer screw gauge.

The egg shell were carefully washed with water to remove adhering albumen, dried at room temperature for about 72 hours and weighed to obtain egg shell weight. Yolk index was calculated as yolk diameter/yolk weight.

The Haugh unit which is the most significant measure of egg quality was calculated using data on egg weight and albumen height as expressed in the following formulae proposed by Haugh (1937).

$Hu = 100\log_{10}(h - 1.7W^{0.37} + 7.6)$

Where; Hu= Haugh unit

H = observed height of albumen

W = weight of egg

The higher the value the better the egg quality.

Table 3.3: Composition of layer diets for experiment 3

	Treatment					
Ingredients	**1**	**2**	**3**	**4**	**5**	**6**
Maize	34.30	34.30	34.30	34.30	34.30	34.30
Maize offal	28.45	28.45	28.35	28.25	28.25	28.25
G/cake	15.80	15.80	15.80	15.80	15.80	15.80
Soya cake	10.00	10.00	10.00	10.00	10.00	10.00
Lime stone	7.50	7.50	7.50	7.50	7.50	7.50
Bone meal	3.20	3.20	3.20	3.20	3.20	3.20
Salt	0.30	0.30	0.30	0.30	0.30	0.30
VIT /Mineral Premix*	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.10	0.10	0.10	0.10	0.10	0.10
DL-Methionine	0.10	0.00	0.10	0.30	0.00	0.15
HM (Methiorep®)	0.00	0.10	0.10	0.00	0.30	0.15
TOTAL	100	100	100	100	100	100
Calculated Analysis						
ME: Kcal/kg	2643	2640	2641	2644	2632	2636
Crude protein %	17.00	17.00	17.00	17.00	17.00	17.00
Ether extract %	4.27	4.37	4.27	4.26	4.26	4.36
Crude fibre %	5.52	5.53	5.53	5.48	5.58	5.51
Calcium %	3.56	3.56	3.56	3.55	3.56	3.56
Available P %	0.52	0.52	0.52	0.52	0.52	0.52
Lysine (%)	0.83	0.82	0.83	0.83	0.83	0.82
Methionine (in situ)	0.20	0.20	0.20	0.20	0.20	0.20
Meth+ cysteine (in situ)	0.52	0.52	0.52	0.52	0.52	0.52

* Biomix provide per kg of diet: Vit A = 8500 I.U; Vit D_3 = 1500 I.U; Vit E = 10.00 I.U, Vit K_3 = 1.00mg; Pantothenic acid = 4.50mg;Vit B_1 = 1.50mg; Vit.B_2 = 4.50mg; Vit B_6 =3.00mg; Vit.B_{12} = 0.015mg; Niacin = 15.00mg; Folic acid = 0.60mg; Choline chloride = 175mg; Manganese = 40.0mg; Iron = 20mg; Zinc = 30.00mg; Copper = 3.00mg; Iodine = 1.00mg; Cobalt = 0.20mg; Selenium = 0.20mg; Biotin = 0.50mg; Antioxidant = 1.25mg.

3.2.4.6 Data analysis and statistical model

Data generated were subjected to statistical analyses using the general linear model and significant means were separated using Duncan's multiple range test (SAS, 2008).

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + E_{ijk}$$

Y_{ijk} = Observation of K in level i^{th} of Factor A and level j^{th} of Factor B

μ = overall means

A_i = effect of level of i^{th} of Factor A (level of M_e)

B_i = effect of level of j^{th} of Factor B (level of Hm)

$(AB)_{ij}$ = effect of level of i^{th} of Factor A with level j^{th} of factor B

E_{ijk} = random error

M_e = Methionine

Hm = herbomethionine(methiorep®)

CHAPTER FOUR

4.0 RESULTS

4.1 Proximate Composition of Grower Diet

The proximate composition of the grower diets was carried out and results were presented in Table 4.1. The DM % for Treatment 6 was 93.90 and Treatment 1 has 94.30. The CP % obtained was 15.70 in Treatment 1 and 15.60 in Treatment 2. The CF % obtained in Treatment 6 was 6.15 and Treatment 1 has 7.60 % CF. Ether extract % value obtained ranges from 7.78-9.72. The % Ash value obtained in T_6 was 8.49 and T_1 value obtained was 8.60.

4.2 Proximate Composition of Layer Diet

The proximate analysis of the layer diet was carried out and the results shown in table 4.2. The DM % obtained in T_6 was 95.46 and T_1 (96.41). The CP % obtained was 17.03 in T_1 while T_6 has CP% of 17.60.The % CF obtained in T_6 was 5.13 while that of T_1 was 6.5. The % E.E value obtained in T_6 was 9.94 while T_4 has 8.85. The % Ash value obtained T_6 was 9.89 while T_1 was 8.96.

4.3.1 Experiment 1: Effect of Supplementation of Herbomethionine (methiorep®)and DL-Methionine in the Diet of Growers (9-20weeks).

The growth performance of pullet grower birds fed herbomethionine (methiorep®) and DL-Methionine at varying levels and combinations are shown in Table 4.3. Final weights, weight change, feed intake, feed conversion ratio and feed cost per kg gain were significantly ($P < 0.05$) affected by dietary treatments.

Table 4.1: Proximate composition of grower diets (Experiment 1)

Treatments Parameters	1 0.1%ME 0.0%HM	2 0.0%ME 0.1%HM	3 0.1%ME 0.1%HM	4 0.3%ME 0.0%HM	5 0.0%ME 0.3%HM	6 0.15%ME 0.15%HM
Dry matter (%)	94.30	94.20	94.35	9470	93.5	93.90
Crude protein (%)	15.70	15.60	15.50	15.70	15.5	15.60
Crude fibre (%)	7.60	6.81	6.51	6.28	6.10	6.15
Ether extract (%)	8.80	9.72	8.10	8.25	7.78	8.49
Ash (%)	8.60	7.30	8.10	8.25	7.78	8.49

Me =DL-Methionine
HM =Herbomethionine

T**able 4.2: Proximate composition of layer diets (Experiment 2 and 3)**

Treatments Parameters	1 0.1%ME 0.0%HM	2 0.0%ME 0.1%HM	3 0.1%ME 0.1%HM	4 0.3%ME 0.0%HM	5 0.0%ME 0.3%HM	6 0.15%ME 0.15%HM
Dry Matter (%)	96.41	96.73	96.02	93.32	95.83	95.46
Crude Protein (%)	17.03	17.35	17.04	17.25	17.02	17.60
Crude Fibre (%)	6.58	6.47	5.47	6.43	5.78	5.13
Ether extract (%)	9.74	8.73	8.05	8.85	9.10	9.94
Ash (%)	8.96	7.08	8.29	9.91	7.98	9.89

ME = DL- Methionine
HM = Herbomethionine

The birds fed DL-Methionine level of 0.3% had the best result in final weight gains, feed intake and feed conversion ratio. Diet supplemented with Herbomethionine at 0.30% performed as better as diet supplemented with 0.30% DL-methionine in weight gain, total feed consumption, and feed cost per kilogramme weight gain.

There were no significant differences ($P > 0.05$) between T_1 T_2 and T_3 which contained 0.10% DL-methionine; 0.10% methiorep and 0.1% of both DL-Methionine and herbomethionine respectively. Supplementation of DL–Methionine and herbomethionine do not have effect on mortality.

4.3.2 Experiment 2: Early Laying Performance of hens fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their diets (22 – 34 weeks).

Table 4.4 shows the early laying performance of birds fed various levels and combinations of herbomethionine and DL- Methionine in their diets for the period of 12 weeks. Diet supplemented with herbomethionine at 0.15% each gave significantly higher weight gain compared to diet supplemented with 0.10% DL-Methionine had the least final body weight. Treatments 3, 4 and 5 (0.10% DL-Methionine, 0.10% herbomethionine; 0.30% DL-Methionine, and 0.30% herbomethionine) respectively were similar to the control diet in final body weight.

Body weight changes were however significantly higher for T_3 (0.1% each of DL-methionine and herbomethionine) and T_6 (0.15% of DL-Methionine and 0.15% herbomethionine) compared to T_1 and T_4. Values for feed consumption were statistically

similar ($P > 0.05$) across treatments, although T_6 had numerically higher feed consumption than all other treatments.

Weight of birds at first egg were not significantly ($P > 0.05$) affected by dietary treatments. Although weight of first egg were significantly ($P < 0.05$) affected by dietary treatments. It was however noticed that Diets 1, 4 and 6 had higher weight of first egg compared to Diets 2, 3 and 5. Age at first egg, age at 50% lay, % hen housed egg production, % egg mass and % mortality were not significantly ($P > 0.05$) affected by dietary treatments. Age at 10% lay were statistically ($P < 0.05$) different across treatment groups.

Birds fed T_6 (0.15% each of DL-Methionine and herbomethionine) attained 10% lay earlier than birds on T_1, T_3, T_4 and T_5. Age at which 50% lay achieved were not significantly ($P < 0.05$) different across treatments. Hen-day egg production was significantly ($P < 0.05$) affected by dietary treatments, T_6 gave a higher hen day egg production of 72% as compared to the control that had 67% hen day egg production. Hen-housed egg production, egg mass as well as percent mortality were not significantly ($P > 0.05$) affected by dietary treatments.

Table 4.3 Effect of Supplementation of Herbomethionine (methiorep®) and DL-Methionine in the Diet of Growers (9-20weeks).

TREATMENT	1	2	3	4	5	6	
	0.1%ME	0.0%ME	0.1%ME	0.3%ME	0.0%ME	0.15%ME	SEM
PARAMETERS	0.0%HM	0.1%HM	0.1%HM	0.0%HM	0.3%HM	0.15%HM	
Initial weight (g/bird)	625	627	622	628	625	627	2.720
Final weight (g/bird)	1229^{d}	1287^{cd}	1332^{c}	1418^{a}	1404^{b}	1361^{bc}	9.580
Weight gain (g)	604^{d}	658^{cd}	709^{c}	790^{a}	779^{ab}	732^{b}	6.402
AWG (g/b/d)	7.84^{d}	8.55^{cd}	9.90^{b}	10.26^{a}	10.12^{ab}	9.28^{c}	0.139
TFC (kg/bird)	6.80^{b}	6.35^{c}	6.70^{bc}	7.34^{a}	6.28^{c}	7.26^{ab}	0.062
ADFC (g/b)	88.31^{b}	82.43^{cd}	86.97^{c}	95.28^{a}	81.89^{d}	94.24^{ab}	0.520
Feed Conversion Ratio	12.10^{d}	9.20^{b}	9.40^{bc}	8.61^{a}	10.63^{cd}	9.92^{c}	0.830
Feed cost/kg gain (₦)	172^{bc}	175^{c}	172^{bc}	165^{a}	165^{a}	171^{b}	0.620
Mortality (%)	0.33	0.67	0	0.33	0	0.66	0.111

a,b,c = means with different superscripts on the same row are significantly different

TFC = Total feed consumed

ADFC= Average daily feed consumed

AWG = Average weight gain

SEM = Standard error of means

ME = DL-Methionine

HM = Herbomethionine

Table 4.4: Early laying performance of hens fed varying levels and combinations of herbomethionine (methiorep®) and DL-Methionine in their diets (22 – 34 weeks).

Treatment Parameters	1 0.1%ME 0.0%HM	2 0.0%ME 0.1%HM	3 0.1%ME 0.1%HM	4 0.3%ME 0.0%HM	5 0.0%ME 0.3%HM	6 0.15%ME 0.15%HM	SEM	LOS
Initial weight (kg)	1.54	1.54	1.53	1.56	1.54	1.56	0.005	NS
Final weight (kg)	1.62^{bc}	1.61^{c}	1.63^{b}	1.62^{bc}	1.63^{b}	1.66^{a}	0.005	*
Body weight gain (g)	76.67^{b}	73.33^{bc}	93.33^{a}	56.67^{c}	90^{ab}	100^{a}	5.560	*
TFC (kg)	8.13	8.60	8.28	8.85	8.43	9.00	0.132	NS
ADFC (g)	96^{c}	102^{b}	99^{bc}	105^{a}	101^{b}	107^{a}	1.500	*
Average daily wt. (g/b)	1.30^{ab}	1.13^{b}	1.23^{ab}	1.13^{b}	1.45^{a}	1.47^{a}	0.034	*
Wt. at 1^{st} egg (kg/b)	1.40	1.42	1.48	1.42	1.40	1.43	0.006	NS
Wt. of 1^{st}egg (g)	55^{a}	49^{b}	49^{b}	55^{a}	51^{b}	56^{a}	1.010	*
Age at 1^{st} egg (days)	150	152	157	151	153	154	0.006	NS
Age at 10% lay (days)	171^{bc}	169^{cd}	170^{c}	172^{b}	175^{a}	167^{d}	0.620	*
Age at 50% lay (days)	200	204	201	200	203	202	0.666	NS
HDEP (%)	67^{d}	68^{cd}	67^{d}	69^{c}	70^{b}	72^{a}	1.379	*
HHEP (%)	66	63	67	63	70	70	1.295	NS
Egg mass (kg/b)	1.93	1.32	1.35	1.37	1.42	1.49	0.045	NS
Mortality (%)	0.01	0.01	0.01	0.01	0.00	0.01	0.004	NS

a,b,c, = means with different superscripts on the same row are significantly different ($P < 0.05$)
SEM = Standard Error of Means,
NS = Non-significant difference ($P > 0.05$)
* = Significant difference ($P < 0.05$)
TFC =Total Feed Consumption,
ADFC =Average Daily Feed Consumption,
ME = DL-Methionine
HM = Herbomethionine (methiorep®)
HDEP = Hen-Day Egg Production,
HHEP = Hen-Housed Egg Production.

4.3.3 Experiment 3: Laying Performance of hens fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their Diets (35 –50 weeks).

Table 4.5 shows the laying performance of hens fed varying levels and combinations of herbomethionine (methiorep®) and DL- Methionine in their diets. The final weights, egg weights, hen-housed egg production and mortality rates were not significantly ($P > 0.05$) affected across dietary treatments. However, significant ($P < 0.05$) differences existed for weight change, egg number, egg mass, total feed consumed, average daily feed consumed, feed cost per dozen eggs and percent hen-day egg production.

For weight change, T_4 (0.3% methionine supplemented diet) had the highest value (126g) followed by T_5 (0.3% herbomethionine diet) which had a value of 116g. Diet 1(0.1% DL-methionine only), Diet 2 (0.1% herbomethionine only), Diet 3 (0.1% each of DL-methionine and herbomethionine) and Diet 6 (0.15% each of DL-Methionine and herbomethionine) had significantly lower weight gains values of 106g, 93g, 83g and 86g respectively.

The highest egg number of 82 was observed in Diet 6 (0.15% each of DL-Methionine and herbomethionine) as compared to T_1, T_2, T_3, T_4 and T_5 all having values of egg number falling within the range of 65 to 70. The highest egg mass (4.98) was observed in T_6 (0.15 each of DL-methionine and herbomethionine). Other treatments had their egg mass values falling within 3.85kg and 4.40kg. Treatment 1 (0.1% methionine diet) had the lowest egg mass value of 3.85kg.

Treatments 6 (1.5% each of DL-Methionine and herbomethionine) had significantly the highest total feed consumption value of 13.10kg ($P < 0.05$). This was followed by Treatment 5 (0.3% herbomethionine diet) with feed consumed value of 12.95kg. Treatments 3 and 4 had similar feed intake while T_1 (0.1% DL-Methionine diet) that had the lowest feed consumption value of 11.83kg. The feed conversion ratio was highest in T_6 (2.15) and T_2 (2.15) followed by T_5 (2.05). T_4 and T_1 had the lowest feed conversion ratio 2.03 and 2.00 respectively.

T_6 (0.15% DL-Methionine and 0.15% herbomethionine) and T_4 (0.30% DL-Methionine) had significantly lower feed cost per dozen eggs ($P < 0.05$) when compared to T_1, T_2 and T_5 that had much higher feed costs per dozen eggs.

The diet supplemented with (0.15% DL-Methionine and 0.15% herbomethionine) had the highest hen-day egg production than the rest of the treatments. The values observed in other treatments were significantly lower ($P < 0.05$) and they all fell within the range of 57 and 63%.

4.3.4: Effect of Herbomethionine (methiorep®) and DL-Methionine supplementations on hematological parameters of egg-type chickens (50weeks).

Table 4.6 shows the results of the hematological parameters determined on the blood of laying birds fed diets supplemented with various levels and combinations of DL-Methionine and herbomethionine. All the parameters measured were significantly ($P < 0.05$) affected by dietary treatments.

Table 4.5: Laying performance of birds fed varying levels and combinations of herbomethionine (methiorep®) and DL-Methionine in their diets (35–50 weeks).

Treatment Parameters	1 0.1%ME 0.0%HM	2 0.0%ME 0.1%HM	3 0.1%ME 0.1%HM	4 0.3%ME 0.0%HM	5 0.0%ME 0.3%HM	6 0.15%ME 0.15%HM	SEM	LOS
Initial weight (kg)	1.61	1.61	1.61	1.59	1.61	1.59	0.01	NS
Final weight (kg)	1.72	1.71	1.69	1.72	1.73	1.74	0.01	NS
Weight gain (g)	106^{bc}	93.0^{c}	83.0^{d}	126^{a}	116^{b}	86^{cd}	45.12	*
Egg number	68.0^{b}	65.0^{c}	65.0^{c}	70.0^{b}	67.0^{bc}	82.0^{a}	2.12	*
Egg weight (g)	59.0	57.0	62.0	63.0	63.0	61.0	0.51	NS
Egg mass (kg/b)	4.01^{cd}	3.71^{d}	4.00^{cd}	4.40^{b}	4.22^{ab}	7.03^{a}	0.13	*
TFC (kg/b)	11.83^{d}	12.26^{c}	12.56^{bc}	12.80^{b}	12.95^{ab}	13.10^{a}	0.23	*
DFC (g/b)	112^{d}	117^{cd}	120^{c}	120^{c}	123^{b}	125^{a}	0.52	*
FC₦/Dozen eggs	101^{ab}	102^{a}	97^{b}	92^{bc}	102^{a}	89^{c}	0.56	*
FCR (kg feed/kg egg)	2.00^{c}	2.15^{a}	2.03^{bc}	2.03^{bc}	2.05^{b}	2.15^{a}	0.05	*
Hen Day Egg Prod. (%)	69.0	65.0	68.0	65.0	68.0	80.0	2.43	NS
Hen Housed Egg Prod. (%)	59.0^{bc}	60.0^{b}	57.0^{b}	62.0^{b}	63.0^{b}	82.0^{a}	2.02	*
Mortality (%)	1.02	0.05	1.00	0.03	0.02	0.01	0.16	NS

a,b,c, means with different superscripts on the same row are significantly different ($P < 0.05$)
LOS = Level of Significance
NS = Non-significant difference ($P > 0.05$)
* = Significant difference ($P < 0.05$)
SEM = Standard Error of Means
ME = DL- Methionine
HM = Herbomethionine
TFC = Total feed consumption
DFC = Daily feed consumption
FC = Feed cost
FCR = Feed conversion ratio

Birds fed 0.15% DL-Methionine and 0.15% herbomethionine had the highest packed cell volume, hemoglobin count and total proteins of 27%, 9.10% and 5.87g/dl respectively when compared to treatment supplemented with 0.10% DL-Methionine that had packed cell volume value of 24.30%, hemoglobin count of 8.67% and 5.03g/dl total proteins.

4.3.6: Internal Egg Quality Characteristics of Birds fed Herbomethionine (methiorep®) and DL–Methionine in their Diets.

Table 4.8 shows the internal egg quality characteristics of birds fed varying levels and combinations of herbomethionine (methiorep®) and DL- Methionine in their diets. The result indicated no significant ($P > 0.05$) differences in the albumen height, albumen length and albumen weight. Also yolk height, yolk index and haugh unit values were not significantly affected by dietary treatments.

Yolk diameter in T_4 was significantly higher than yolk diameter in all other treatments. Also yolk weights were significantly higher for T_4 and T_6 than the values observed in treatments T_1, T_2 and T_3. having the lowest value of yolk weight.

Table 4.6: Effects of varying levels and combinations of herbomethionine (methiorep®) and DL-Methionine supplemented diets on hematological parameters of egg-type chickens (50weeks)

Treatment Parameters	1 0.1%ME 0.0%HM	2 0.0%ME 0.1%HM	3 0.1%ME 0.1%HM	4 0.3%ME 0.0%HM	5 0.0%ME 0.3%HM	6 0.15%ME 0.15%HM	SEM	LOS
Packed cell Volume (%)	24.30^{c}	24.67^{bc}	25.33^{b}	25.33^{b}	26.33^{b}	27.00^{a}	0.487	*
Hemoglobin Count (%)	8.67^{b}	8.10^{d}	8.30^{c}	8.40^{bc}	8.10^{d}	9.10^{a}	0.157	*
Total Proteins (g/dl)	5.03^{bc}	5.07^{b}	5.60^{ab}	5.60^{ab}	4.30^{c}	5.87^{a}	0.326	*

LOS = Level of Significance
SEM = Standard Error of Means
* = Significant difference ($P < 0.05$)
ME = DL-Methionine
HM = Herbomethionine (methiorep®)

Table 4.7: Effect of herbomethionine (methiorep®) and DL-Methionine supplemented diet on external egg quality indices of egg-type chickens.

Treatment Parameters	1 0.1%ME 0.0%HM	2 0.0%ME 0.1%HM	3 0.1%ME 0.1%HM	4 0.3%ME 0.0%HM	5 0.0%ME 0.3%HM	6 0.15%ME 0.15%HM	SEM	LOS
Egg weight (g)	58	58	59	58	59	59	0.532	NS
Egg length (cm)	5.53	5.72	5.70	5.69	5.68	5.74	0.310	NS
Egg shape index	1.34^{bc}	1.31^{bc}	1.32^{b}	1.34^{a}	1.30^{c}	1.29^{c}	0.180	*
Shell weight (g)	5.72^{d}	5.84^{cd}	5.74^{cd}	6.03^{b}	5.88^{c}	6.32^{a}	0.065	*
Shell thickness (mm)	0.31	0.29	0.30	0.32	0.30	0.30	0.177	NS
Egg Diameter (cm)	4.22^{d}	4.35^{bc}	4.32^{c}	4.24^{d}	4.37^{b}	4.48^{a}	0.020	*

a,b,c: means with different superscripts on the same row are significantly different ($P < 0.05$)
LOS = Level of Significance
SEM = Standard Error of Means
ME = DL-Methionine
HM = Herbomethionine (methiorep®)
* = Significant difference ($P < 0.05$)
NS = Non-significant difference ($P > 0.05$)

Table 4.8: Effects of herbomethionine (methiorep®) and DL-Methionine supplementation on internal egg quality indices of egg-type chickens.

Treatment Parameters	1 0.1%ME 0.0%HM	2 0.0%ME 0.1%HM	3 0.1%ME 0.1%HM	4 0.3%ME 0.0%HM	5 0.0.%ME 0.3%HM	6 0.15%ME 0.15%HM	SEM	LOS
Albumen height (cm)	0.64	0.65	0.66	0.69	0.68	0.69	0.015	NS
Albumen length (cm)	6.38	6.53	6.67	6.88	6.80	6.87	0.151	NS
Albumen weight (g)	35.50	35.11	35.83	34.03	34.14	36.53	0.643	NS
Yolk height (cm)	1.62	1.74	1.65	1.62	1.61	1.64	0.022	NS
Yolk diameter (cm)	4.21^{b}	4.20^{bc}	4.20^{bc}	4.25^{a}	4.13^{c}	4.22^{b}	0.014	*
Yolk weight (g)	15.80^{b}	15.38^{c}	14.90^{d}	16.21^{a}	15.82^{ab}	16.10^{a}	0.200	*
Yolk Index	0.38	0.41	0.38	0.39	0.38	0.39	0.006	NS
Haugh unit	79	80	80	82	82	81	1.012	NS

a,b,c = means with different superscripts on the same row are significantly different ($P < 0.05$)
LOS = Level of Significance
SEM = Standard Error of Means
ME = DL-Methionine
HM = Herbomethionine (methiorep®)
* = Significant difference ($P < 0.05$)
NS = Non-significant difference ($P > 0.05$)

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 Experiment 1: Effect of Supplementation of Herbomethionine (methiorep®)and DL-Methionine in the Diet of Growers (9-20weeks).

Diet supplemented with DL-Methionine at 0.30% and herbomethionine at 0.30% gave the highest weight gains of 790g and 779g respectively as compared to diet supplemented at 0.10% DL-Methionine and herbomethionine having 604g and 658g respectively.

The higher weight gains of birds fed DL-Methionine observed in diet 4 and 5 could be attributed to the fact that methionine plays a vital role in growth and performance. This study agrees with previous studies by Chattopadhyay *et al.,* (2006), Halder and Roy (2007) and Kalbande *et al.,* (2009) where they stated that birds fed herbomethionine had similar performance in terms of body weight gains as those birds fed DL-Methionine. The improvement in weight gain is due to the action of allicin which inhibit the growth of aflotoxins in the herbomethionine.

Diet supplemented with DL-Methionine at 0.30% and herbomethionine at 0.15% gave the highest feed consumption of 7.34kg and 7.26kg respectively compare to the diet supplemented with 0.10% of DL-Methionine and herbomethionine having 6.70kg.This higher feed intake recorded in this findings disagrees with report by Francis *et al.,* (2010) who reported no significant effects on feed intake when herbomethionine was fed to pullets compared to DL-Methionine.

DL-Methionine supplementation at 0.30% had the better feed conversion ratio of 8.61 compared to the diet supplemented with 0.10% DL- Methionine that had 12.10. This finding disagrees with the study by Ozturkan *et al.,* (1993) who reported that

supplementation of DL-Methionine in the diet of birds led to improved performance in feed conversion ratio.

The feed cost per kg weight gain was better for birds fed 0.30% DL-Methionine and 0.30% herbomethionine. This result agrees with reports by Simone *et al.,* (1995) who stated that supplementing synthetic methionine and herbal methionine led to improved lower cost of obtaining 1 kg weight gain in growers.

The diets containing DL-Methionine and herbomethionine had no significant effects on mortality. This agreed with results by Kalbande *et al.,* (2009) who reported that herbomethionine supplementation in the diet of birds have no significant effect on mortality. These indicate the safety in the use of herbomethionine in grower diets. However, Francis *et al.,* 2012 reported effect of herbomethionine supplementation on mortality when fed to layers.

5.2 Experiment 2: Early Laying Performance of Hens fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their diets (22-34weeks).

Diets supplemented with DL-Methionine and herbomethionine at 0.15% each and diet supplemented with 0.30% herbomethionine have the highest weight gain of 100g and 90g respectively compare to diet supplemented with DL-Methionine at 0.10% and herbomethionine at 0.10% each having weight gains of 76.67g and 73.33g.

The higher weight gain observed in diet supplemented with herbomethionine and DL-Methionine was due to the fact that herbomethionine facilitated efficient lipid metabolism and its transportation to body tissues and subsequently it increased growth. This result was

in agreement with reports by Kalbande *et al.,* (2009) and Francis *et al.,* (2012) where they reported increased weight gain when birds were fed herbomethionine.

The higher feed intake recorded in diet supplemented with herbomethionine and DL-methionine at 0.15% each was attributed to the supply of essential amino acids in the diet. These findings were similar to the findings by Wang *et al.,* (2004) who reported significant effect on feed intake when herbomethionine and DL-Methionine were fed to layers. Bertram *et al.,* (1991) also reported that the inclusion of DL-Methionine supplementation of 0.15% and herbomethionine at 0.15% led to improved feed intake.

Weight of bird at first egg results indicated that dietary treatments had no significant effect. These results was contrary to the report by Summers *et al.,* (1991) who reported that increasing level of supplementation of DL-Methionine in the diet of layers has a significant effect on weight of bird at first egg.

Weight of first egg was significantly affected by dietary treatments. Herbomethionine and DL-Methionine supplemented at 0.15% and 0.30% respectively gave similar weight at first egg as compared to 0.10% herbomethionine.

This can be attributed to the fact that incorporation of herbomethionine and DL-Methionine in the diet of layers resulted in increased egg weight because of the presence of Mucuna *pruriens* and Phaseolus *mungo* herbs in the herbomethionine that are rich in methionine in the diet. The result was similar to the report by Shafer *et al*., (1998) who reported that egg weight increases with increasing levels of amino acid intake in laying birds.

The supplementation of herbomethionine and DL-Methionine at 0.15% each had the lowest days at 10% lay of 167 days compared to herbomethionine supplemented at 0.30% having 175 days. This result is contrary to the report by Summers *et al*., (1988) who reported a lower day at 10% lay of 150 days.

Age at 50% lay was significantly affected by dietary treatments. This result was contrary to the report by Amaefule *et al*., (2004) who reported a significant effect of methionine on age at 50% lay.

The percent hen day egg production was significantly affected by dietary treatments with diet supplemented with herbomethionine and DL-Methionine at 0.15% each having the highest hen day egg production of 72% compared with treatment 1 that has 67%.

The percent hen housed egg production was not significantly affected by dietary treatments. This results was similar to the reports by Amaefule *et al.*, (2004) who reported no significant effect of methionine on hen housed egg production.

Dietary treatments had no significant effects on mortality. These results was contrary to the reports by Ambrosen and Peterson (1997) who stated that lowered DL-Methionine and herbomethionine resulted in increased mortality.

5.3 Experiment 3: Laying Performance of Hens fed varying levels and combinations of Herbomethionine (methiorep®) and DL-Methionine in their Diets (35- 50weeks).

Diet supplemented with herbomethionine and DL-Methionine at 0.15% each gave the highest weight gain of 126g compared with diet supplemented with herbomethionine at 0.10% having weight gain of 93g. The weight gain value obtained was contrary to the

report by Chattopadhyay *et al.*, (2006) and Halder and Roy (2007) who reported that diet supplemented with herbomethionine and DL-Methionine resulted in increased weight gain.

Egg number was significantly affected by dietary treatments. Diet with herbomethionine and DL-Methionine supplementation of 0.15% each had the highest egg number of 82 as compared to diet supplemented with 0.10% herbomethionine having egg number of 65.The higher egg number reported was attributed to the fact that high intake of amino acid led to higher metabolism in egg production. This result was similar to the report by Pourreza and Smith (1988) who reported that high protein synthesis leads to increased egg production.

Egg weight was not significantly affected by dietary treatments. This result was contrary to the result obtained by Liu *et al*., (2005) who reported that egg weight increased with increasing level of amino acid intake in laying hens.

The egg mass value obtained in diet supplemented with herbomethionine and DL-Methionine at 0.15% each was 7.03kg compared to diet supplemented with 0.10% herbomethionine having egg mass of 3.92kg. This was due to the amino acid content in the herbomethionine. These results was contrary to the report by Francis *et al*., (2012) who indicated that layers fed diets supplemented with herbomethionine had lower egg mass of 2.39kg.

The feed intake recorded in diet supplemented with DL-Methionine and herbomethionine at 0.15% each was 13.10kg which was highest compared to diet supplemented with herbomethionine having feed intake of 12.95kg. This higher feed intake value recorded was as a result of the presence of anti microbial and antioxidant activity in the herbs of

methiorep® which improved feed intake. This result agreed with Halder and Roy (2007) who reported higher feed intake when herbomethionine was fed to layers.

Feed cost per dozen eggs was significantly affected dietary treatments. Diets supplemented with 0.10% of DL-Methionine had the highest value of ₦92 as compared with diet supplemented with 0.15% herbomethionine and DL-Methionine each that had the lowest value of ₦89 per dozen eggs. These results can be attributed to the fact that herbomethionine was cheaper than synthetic methionine.

Feed conversion ratio obtained was significantly affected by dietary treatments. Treatment supplemented with 0.10% DL-Methionine and 0.30% DL-Methionine had the best feed conversion ratio of 2.00 and 2.03 respectively. The feed conversion ratio value obtained was similar to reports by Francis *et al*., (2012) who recorded a feed conversion ratio of 2.04 when DL-Methionine was fed to layers.

The percent hen day egg production was significantly affected by dietary treatments with diet supplemented with herbomethionine and DL-Methionine at 0.15% each having the highest value of 80 compared with diet supplemented with 0.10% hebomethionine with 60.

The percent hen housed egg production was not significantly affected by dietary treatments. This result was similar to reports by Amaefule *et al.*, (2004) who reported no significant effect on hen housed egg production.

Dietary treatments had no significant effect on mortality. This indicated safety in the use of herbomethionine for layers. This result agreed with the reports by Chattopadyay *et al*.,

(2006) and Kalbande *et al.,* (2009) that reported no significant effect of herbomethionine on mortality.

5.4 Effect of Supplementation of Herbomethionine (methiorep®) and DL-Methionine hematological parameters of egg–type chickens (50weeks).

Diets containing DL-Methionine and herbomethionine (methiorep®) supplementations at 0.15% each had highest packed cell volume of 27.00% compared with treatment supplemented with 0.10% DL-Methionine having packed cell volume of 24.30%.

This was in agreement with the results by Francis *et al*., (2012) who reported a packed cell volume of 27.38% when herbomethionine was fed on layers. Rekhatel *et al.,* (2010) reported higher packed cell volume of 33.55 ± 2.88.

Diets supplemented with herbomethionine and DL-Methionine at 0.15% each has the highest hemoglobin count 9.10% as compared with diet supplemented on 0.30% herbomethionine having the lowest hemoglobin count of 8.10%. These values were similar to 9.10 ± 0.96 reported by Francis *et al.,* (2012) but lower than that reported by Rekhatel *et al.,* (2010) who reported 9.33 ± 0.53 hemoglobin count.

Diets supplemented with 0.15% herbomethionine and 0.15% DL-Methionine has the highest total proteins of 5.87g/dl compared with diets supplemented with 0.10% DL-Methionine having lower total proteins of 5.03g/dl. This could be as a result of the fact that herbomethionine tend to reduce the total cholesterol and triglyceride concentrations due to the hypocholesterolemic activity of certain constituent herbs in the herbomethionine.

The higher total proteins reported was contrary to those reported by Halder and Roy (2007) and Rekhatel *et al*., (2010) who reported no significant effect of herbomethionine supplementation on total proteins.

The recommended total protein for healthy birds according to Probhakaran et al., (1996) was 4.45 ± 0.92. The values obtained were within the recommended values for healthy birds.

5.5 External Egg Quality Characteristics of Birds fed Herbomethionine (methiorep®) and DL-Methionine in their Diets.

Shell weight was significantly affected by dietary treatments. Diet supplemented with herbomethionine and DL-Methionine at 0.30% each has the highest shell weight of 6.32g compared to diet supplemented with 0.10% DL-Methionine which had the lowest shell weight of 5.72g.

This result indicated that herbomethionine supplementation can lead to increase shell strength and egg quality. This result was similar to the report by Pourreza and Smith (1988) who stated that high intake of herbomethionine led to increased shell weight.

Dietary treatments have no significant effect on egg length. This result was similar to the report by Kershavarz (2003) who reported no significant effect of DL-Methionine supplementation on egg length.

Egg shape index was significantly affected by dietary treatments. Diet supplemented with DL-Methionine at 0.30% had the highest value of 1.34 compared with diet on 0.30% herbomethionine that had 1.30. This result was contrary to reports by Francis *et al.*, (2012) who reported no significant effects when DL-Methionine was fed to layers.

Dietary treatments had no significant effect on shell thickness. This result was similar to the report by Francis *et al*., (2012) who reported that egg weight and shell thickness decreases with herbomethionine supplementation.

Egg diameter was significantly affected by dietary treatments. Diet supplemented with 0.15% herbomethionine and DL-Methionine each had the highest egg diameter of 4.48 compared with diet on 0.10% DL-Methionine which had the lowest egg diameter of 4.22. This result was similar to report by Amaefule *et al*., (2004) who reported egg diameter of 4.46.

5.6 Internal Egg Quality Characteristics of Birds fed Herbomethionine (methiorep®) and DL-Methionine in their Diets.

Albumen height had no significant effect on dietary treatments. These results disagreed with the report by Francis *et al*., (2012) who reported significant effect when herbomethionine was fed to layers. This can be attributed to the effect of allicin present in the herbomethionine.

Albumen weight, albumen length, yolk height and yolk index were not significantly affected by dietary treatments. These findings were in line with reports by Francis *et al*., (2012) who reported that supplementation of herbomethionine in the diet of layers had no significant effect on egg width, albumen weight and yolk height.

Haugh unit value calculated was not significantly affected by dietary treatments. This result was contrary to reports by Kiran *et al*., (2013) who reported significant increase in Haugh unit in the herbomethionine group. The differences were due to the increased weight of eggs.

CHAPTER SIX

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

Three experiment were conducted to evaluate herbomethionine (methiorep®) as a substitute for DL-Methionine in grower and layer diets. In experiment 1, birds fed 0.30% herbomethionine performed better as birds fed 0.30% DL-Methionine in final weight, weight gain, feed intake and feed to gain ratio. Experiments 2 and 3 showed that 0.15% herbomethionine (methiorep®) plus 0.15% DL-Methionine supplemented diets performed best in final weight, feed consumption, egg number, egg weight and hen-day egg production.

6.2 Conclusion

Herbomethionine supplementation at 0.30% was found to be as effective as 0.30% DL-Methionine in the grower study. The diet containing 0.15% DL-Methionine and 0.15% herbomethionine (methiorep®) gave the best results in the layer study. Based on the results obtained in this study, it was concluded that herbomethionine (methiorep®) can be fed in layer diets without adverse effects on their performance.

6.3 Recommendation

It was recommended that 0.30% herbomethionine was effective as 0.30% DL-Methionine and should be fed to growers for better performance.

0.15% herbomethionine in combination with 0.15% of DL-Methionine should be fed to layers for better performances in growth, egg number, egg quality and for least cost per dozen eggs.

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