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PROTEIN UTILIZATION BY BROILER CHICKENS FED THREE COMMERCIAL PREMIXES

BY

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ABSTRACT

Three feeding trials, the first of nine weeks duration, the second and third of ten weeks duration each were carried out to investigate the protein utilization by broiler chicks fed three premixes.

In the first trial three diets with different premixes were fed to the broiler chickens. The premixes used were sanders broiler starter and finisher premix (premix S), Roche zoodry broiler premix (premix R) and Dizengoff vitadiz B.P (premix D). The starter rations contained 23% crude protein and energy level of 2970 Kcal ME/kg diet. The finisher rations contained 20% crude protein and energy level of 2940 Kcal ME/kg diet.

Records of average weekly live weight, feed intake and body weight gain; feed conversion ratio, body weight gain per gram protein intake were taken, while the dry matter digestibility, nitrogen digestibility and nitrogen retention trials were carried out at the fourth and eighth weeks. There were significant differences ($P < 0.05$) in all parameters tested except in the dry matter digestibility coefficient. Birds fed premix S and those fed premix R had the best performances.

In the second trial the premixes used were the same as in the first experiment. At the starter phase the birds were divided into three dietary treatments based on different premixes. All the diets had 23% crude protein and the energy level was 2970 Kcal ME/kg diet.

The birds fed the different premixes showed significant differences ($P < 0.05$) in their average weekly live weight, feed intake, and body weight gain; feed conversion ratio, dry matter digestibility coefficient, carcass trait, weights of wings, back, breast, total edible meat and total bone; crude protein content (dry matter basis) of organs, blood glucose, liver glutamate oxaloacetate transaminase (LGOT) and liver xanthine dehydrogenase. Birds fed premix S and those fed premix R had the best feed utilization and carcass characteristics.

For the finisher phase each of the three treatments of the starter phase was further divided into three, and the three treatments of a finisher phase obtained from a single treatment of the starter phase were allocated to three different premixes. Thus there was a total of nine treatments at the finisher phase. All the diets contained 20% crude protein and the energy level was 2940 Kcal ME/kg diet. The birds fed the different diets showed significant differences ($P < 0.05$) in all parameters except in their nitrogen retention, weights of spleen, lungs, breast, abdominal fat, and total bone, blood glucose, plasma albumin, plasma globulin, serum total protein, serum albumin, serum creatine and LGOT. Birds fed premix S at the starter and finisher phases had the best feed utilization and carcass characteristics.

In the third trial the premixes used were the same as in trials one and two. At the starter phase the experiment was designed so that the diets contained three different premixes with two levels of palm oil (1% and 2%). There was a total of six dietary treatments.

All the diets were isocaloric (about 3000 Kcal/kg diet) and isonitrogenous (23% crude protein). The birds fed the different premixes showed significant differences ($P < 0.05$) in all the parameters tested except in the average weekly body weight gain, dry matter digestibility coefficient, weights of feathers, viscera, liver, spleen, kidney, lungs, abdominal fat and total bone; blood urea nitrogen, plasma components, serum total protein, globulin, uric acid, creatine, and creatinine; and LGOT. Birds fed premix R with 1% or 2% oil and birds fed premix S with 2% oil had better feed utilization while birds fed premix R with 1% or 2% oil had the best nitrogen retention and carcass characteristics.

For the finisher phase each of the six treatments of the starter phase was divided into three, and the three treatments of the finisher phase obtained from a single treatment of the starter phase were allocated to the three premixes, thus making a total of eighteen treatments at the finisher phase. All the diets were Isocaloric and Isonitrogenous.

Birds fed the different premixes showed significant ($P < 0.05$) differences in all parameters measured except in their total nitrogen output, nitrogen retention (grams), plasma globulin, serum globulin and serum creatine. Birds fed premix R at the starter and finisher phases with 2% oil had the best feed utilization and carcass characteristics.

It was concluded that premix S and premix R gave satisfactory results in respect of broiler feed utilization, nitrogen retention and carcass characteristics, when fed throughout at the starter and finisher phases or interchangeably at the starter and finisher phase, with or without palm oil. However 2% palm oil can be added to improve the performance of the birds. The need for establishing appropriate combinations of premixes to be used for broiler production in Nigeria was highlighted, it was also suggested that standards be established for the premixes used in Nigeria.

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ADEDIRAN OLUFUNMILOLA SEGUN.

DEDICATION

To

Elshaddia

CERTIFICATION

I certify that this work was carried out by Mr. Olufunmilola Segun Adediran in the Department of Animal Science University of Ibadan, under my supervision.

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TABLE OF CONTENT

CHAPTER ONE

INTRODUCTION

In Nigeria the problem of malnutrition particularly protein malnutrition is very serious. An antidote to this problem is to develop our livestock industry particularly poultry and especially broilers. Although broiler strains meant for fast growth rate have been developed, but to be able to derive the maximum benefit out of the genetic potentials of the superior stock, optimum environment is the foremost pre-requisite which includes nutrition, climate, and management. It is often said that the genetic make-up of an animal certainly sets the ceiling, while the environment, mainly nutrition, dictates the pace at which the ceiling is reached. It means that an animal must be adequately provided with the right kind of nutrient for the maximum expression of its genetic combination.

Broiler production represents a very specialized application of the utilization of feed for growth. In raising broiler usually two different feeds are used: "starter" and "finisher". The starter is relatively high in protein but moderately high in energy, this is usually well fortified with vitamins and minerals. The finisher diet is of similar energy content, less protein, and similar vitamins and minerals content.

Feed is the major cost of production of broilers. In Nigeria, feed accounts for over 70 percent of the cost of broiler production.

The cost of feeds and ingredients have increased and they may continue to increase unless something is done to arrest the situation. The main cause of this increase in price is the inability of the local production to meet the demand for these feed ingredients, especially maize, fishmeal, and groundnut cake. Consequently they had been imported and the supply depends on uncertainty depending on our relation with the producer countries. The cost of importation is often prohibitive and it determines the quantity available.

The protein concentrates are the most expensive, but yet they are very important in the diet. This increase and perhaps unending competition between man and his livestock for limited food and feed, especially protein supplies, has worsened the already belaboured quest for supplementary protein source or better utilization of the protein available. If the protein can be better utilized by the birds this may lower the amount required in the diet, thereby reducing the feed cost.

Adequate nutrition of the birds requires a knowledge of the quantitative nutrient requirement at various stages of the life cycle. The domestic fowl requires the following classes of nutrients in their feed carbohydrates, protein, fat and oil, vitamins and minerals, they also require adequate water supply. The energy in the diets of broilers is derived from the cereals mostly maize while protein is supplied by both plant and animal sources.

Protein is the principal constituent of the organs structure of human and animal body, a liberal and continuous supply is needed in the food and feed throughout life for growth and repairs, and thus the transformation of food protein to body protein is a very important part of nutritional process. Proteins are made up of amino-acids of which there are twenty. Thirteen of these amino acids are essential for chickens (Arginine, histidine, Isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophane, valine, proline, glycine, and glutamic acid), while seven are non-essential (Tyrosine, serine, cysteine, Aspactic acid, Asperagine, Alanine, and glutamine). The chicken obtains amino acids from three major sources: from dietary protein which is hydrolysed to amino acids and absorbed through the portal circulation. This is the most important source of amino acids for chickens.

The second source is from the breakdown of tissue protein since the body tissue are in a state of dynamic equilibrium. The third source is from the synthesis of amino acids in the liver, the amino acids obtained from this source is mainly the non-essential amino acids.

The macro elements of the diet are supplied mainly by the feeding stuffs and by oyster shell, bone meal, and salt, while the vitamins and micro elements are supplied by vitamins - mineral premix.

Vitamins are organic compounds essential for growth and maintenance of animal life some are required for metabolic reactions, essentially for the metabolism of protein and energy. Poultry requires thirteen vitamins these are the fat soluble vitamin A (retinol), vitamin D_3 (chole calcipherol), vitamin E (Tocopheral) and vitamin K (Naphthoquinone), the water soluble vitamin B, VITAMIN B_1 (Thiamine), vitamin B_2 (riboflavin); vitamin B_3 (Niacin), vitamin B_6 (pyridoxine), folic acid, biotin, pantothenic acid, vitamin B_{12} (cobalamines), and choline. Some of the vitamins are required as organic catalysts or as an essential components of catalysts (coenzymes) that play important roles in biological oxidation. Vitamin A functions in the maintenance of the epidermal tissue of the body and in vision. Vitamin D is important for the metabolism of calcium and phosphorus. Vitamin E is a powerful anti-oxidants in the body in that it prevents lipid peroxidation, on the other hand vitamin K functions physiologically in the production of some factors that are needed for the coagulation of blood, these factors are proteins formed in the liver in the presence of vitamin K, studies suggest that vitamin K functions at the location were sugars are incorporated into protein at the post ribosomal stage.

Thiamine functions physiologically as thiamine pyrophosphate (TPP), the TPP is the coenzyme of two major enzymes: pyruvate dehydrogenase and α-keto-glutarate dehydrogenase. The two enzymes function in energy transformation. Riboflavin also functions

physiologically in two co enzyme forms: flavin mononucleotide (FMN) and flavine adenine dinucleotide (FAD). Both FMN and FAD are components of flavin enzymes that catalyse hydrogen transfer. Niacin is another vitamin that functions as co-enzyme in the body, the two physiologically active co-enzyme form of niacin are: niacinamide adenine dinucleotide (NAD) and niacinamide adenine dinucleotide phosphate (NADP), the two coenzymes functions in the transfer of hydrogen. Pyridoxine is a very important coenzyme in transamination of amino acids, co-decarboxylation of amino acids, deamination of amino acids and in the synthesis of compounds in which amino acids serve as precursor.

Structurally folic acid functions as 5, 6, 7, 8 tetrahydrofolic acid (THFA) which is important in the metabolism of single carbon units. The biochemical importance of biotin is due to the carboxylation reaction in which biotin participates, that is the activation of carbon dioxide. Pantothenic acid within the body functions as coenzyme A (CoA) which activates the weak acids to form energy rich thioesters, acetyl CoA functions in oxidative decarboxylation in the tricarboxylic acid cycle, it is needed for the synthesis of lipids, for the formation of acetyl choline, useful for the detoxification of sulphonamides and related compounds. Vitamin B_{12} functions in close relationship with folic acid, it is needed in the formation of coenzyme forms of folic acid, it is also needed for the formation of the methyl groups which are important in single carbon metabolism and it also keeps sulphurhydryl groups (SH group) of enzyme in the reduced state.

Inorganic minerals play important roles in the nutrition of poultry. The birds obtain these minerals from the diet. Some of the essential minerals are calcium, phosphorus, sodium, potassium, chlorine, magnesium, sulphur, iodine, manganese, copper, cobalt, iron, molybdenium, selenium and zinc. Practical rations contain most minerals at needed levels. An excess of a mineral can be detrimental to the birds, while the deficiency reduces performance to such a level that economic loss results.

In view of the problems of low protein supply in Nigeria several researches are being undertaken and several products are introduced into the market in order to revolutionize agriculture. The premixes are a set of these several products needed to improve poultry production. Premix is derived from the word premixing which mean prior mixing. That is in its simplest form it is a form of "mixing" before "mixing". In the poultry industry premixes are made up of micronutrients that have been mixed together and packaged. They can then be used as sources of the micronutrients when whole feed is being compounded. The micronutrients consist mainly of vitamins and micro-minerals (These are the minerals that are required in trace amounts), but recently other substances especially antioxidants, preservatives, antibiotics, drugs, amino acids, enzymes, pigments and flavour are added.

The idea of premixing micronutrients came about as individual quantities of the micronutrients present in the balanced feed is so small. Their thorough blending in a uniform manner in the feed should therefore be ensured. This uneven distribution of these micronutrients could lead to either of the two deleterious effects on the livestock namely a deficiency in some parts of the feed or, an overloading of some of these micronutrients over and above the required minimal quantities in the birds. This often leads to imbalance of some of the micronutrients which might be as harmful as a deficiency case. It has thus become the practice to premix these micronutrients in a basic material which increases the bulk. The premix is finally addede to the total feed mixture.

Premixes can thus be defined simply as mixtures of all essential micronutrients and other feed additives as dictated by the nutrient requirement of the particular class and type of stock. These nutrients are added to a basic material which could either be part of the major feed ingredient or a non-active substance in the feed mixture. This premix is then added to other main feed ingredients at specified levels, to make up a balanced ration for the specific livestock.

A premix consists of two basic ingredients: the micro-nutrients portion and the carrier. The micronutrients portion consists of the vitamins, minerals and some other feed additives.

From the basic need that a premix should serve, it is very necessary that a premixing base be made use of, which is termed a carrier base. A suitable or good carrier should not be dusty or have a high segregating power or a poor holding capacity. Normally the carriers used are some of the major feed ingredients.

There are various brands of the premixes in the Nigerian market. These various brands are said to perform the same functions, however going through the composition of these premixes it can be found that their contents are different. Thus the aim of this study is to find out whether these variations in quantity and quality of the different constituents would have any marked effect on the protein utilization and development of the birds.

CHAPTER TWO

LITERATURE REVIEW

2.1 PREMIXES

Premixes play a very important role in the nutrition of birds (Poultry) in that the microelements and vitamins required by the poultry birds are supplied by the premixes. Leerbeck and Hjarde (1975); Chumacheako and Khudoshchevskaya (1976) concluded that most of the ingredients that are used in the preparation of vitamin - mineral premixes are quite stable and give the correct amount of these vitamins and minerals in the premixes for about 4 - 5 months after production, after which the potency starts to decrease. Olson et al (1973) concluded that selenium was quite stable with a variety of premix carriers such as glucose monohydrate wheat bran, corn, linseed meal, soy bean or soy bean protein in premixes kept reasonably dry and stored at temperatures below 40°C.

2.2 REQUIREMENT OF CHICKENS FOR VARIOUS VITAMINS AND MINERALS.

2.2.1 VITAMIN A.

The National Research Council (N.R.C.) (1977) estimated the vitamin A requirement of broiler chickens (starter and finisher) to be 1500 I.U/kg diet. Scott et al (1976) recommended a level of 11000 I.U vitamin A/kg diet for broiler starter and 6600 I.U vitamin A/kg diet for broiler finisher. However Ogunmodede (1975a) observed that 100 I.U of vitamin A/100gm of diet was adequate for growth of broiler chickens in the tropics but that the minimum requirement is 90 I.U/100gm of diet. He also showed that under practical

condition at least 150 I.U of vitamin A/100gm of diet should be fed.

2.2.2 VITAMIN D

The vitamin D_3 requirement of the chicken depends upon the source of phophorus in the diet, the amount of, and ratio of calcium to phosphorus in the diet, and the extent of the exposure of the animal to direct sunlight. The N.R.C. (1977) estimated requirement is 200 I.U of vitamin D_3/kg diet for both broiler starter and finisher. While Scott et al (1976) recommended a level of 1100 I.U of vitamin D_3/kg of diet for broiler starter and 660 I.U of vitamin D_3/kg diet for broiler finisher.

Ogunmodede (1980a) studied the dietary level of phosphorus and sodium in estimating vitamin D_3 requirement of broiler chickens in the humid tropics and found 100 I.C.U per 100g of feed adequate. He also found that when the calorie: protein ratio was maintained at about 124 and the phosphorus level was increased from 0.66% to 1.20%, the vitamin D_3 requirement was not increased but body weight gain and feed utilization were increased when 1.20% and 0.5% sodium chloride were fed. The weight gain, feed efficiency, bone ash, and total blood phosphorus indicated the need for higher dietary phosphorus and sodium for broiler chicks in humid tropics.

2.2.3 VITAMIN E

The National Research Council (N.R.C) (1977) has estimated the vitamin E requirement of broiler starter and finisher to be 10 I.U per kg of diet, while Scott et al (1976) recommended a level

of 11 I.U per kg of diet for broiler starter and 8.8 I.U per kg of diet for broiler finisher. Ogunmodede (1980b) studied the requirement of broiler chickens in humid tropical environment for vitamin E and found that 12 p.p.m of vitamin E was adequate. Further increase in the level of vitamin E than 12 p.p.m did not produce better result.

2.2.4 VITAMIN K

Nelson and Norris (1960) studied vitamin K requirement of the chicks and found that at 2 weeks interval vitamin K requirement was 464, 541, 464, 631, 487 and 5.5 microgram per kg of diet. The National Research Council (N.R.C) (1977) put the estimated requirement of both broiler starter and finisher at 0.5mg per kg diet, while Scott et al (1976) put the recommended level for both broiler starter and finisher at 2.2mg per kg diet.

2.2.5 THIAMINE (VITAMIN B_1)

The N.R.C (1977) put the estimated requirement to be 1.8mg per kg diet for both broiler starter and finisher while Scott et al (1976) showed the recommended standard to be 2.2mg per kg diet for both broiler starter and finisher.

2.2.6 RIBOFLAVIN

Riboflavin requirement are highest in the very young chicks and they decrease rapidly with age. However the N.R.C (1977) showed the estimated requirement to be 3.6mg per kg diet for both broiler starter and finisher, while Scott et al (1976) put the recommended

standard at 4.4mg per kg of diet. Ogunmodede (1976) has also found that the riboflavin requirement of starting chicken is higher (5.1mg/kg feed) in the tropics than in the temperate zone.

2.2.7 NIACIN

Niacin requirement are complicated by the conversion of tryptophane into niacin. The N.R.C (1977) put the estimated requirement to be 27mg per kg of diet for both broiler starter and finisher while Scott et al (1976) put the recommended standard at 37.4mg per kg of feed for broiler starter and 33mg per kg of diet for broiler finisher.

2.2.8 PYRIDOXINE (VITAMIN B_6)

The National Research Council (N.R.C) (1977) showed that the estimated pyridoxine requirement for both broiler starter and finisher to be 3mg per kg diet, while Scott et al (1976) put the recommended requirement at 4.4mg per kg diet for broiler starter and 3.3mg per kg diet for broiler finisher. Ogunmodede (1981) studied the supplementation of groundnut based broiler chicks diet with pyridoxine and found that broiler chicks fed a semi-purified groundnut cake diet, the feed efficiency, carcass fat, and serum aspartate amino B transferase showed the need for supplementing the feed with at least 3mg pyridoxine or a total intake of 8.8mg of the vitamin per kg feed. Variable results were obtained with feeding corn-groundnut cake diet. Body weight gain, feed intake, and tissue aspartate amino transferase activities

suggested that supplementation of the ration was unnecessary, while feed efficiency showed the need for supplementation with 3mg or a total intake of 9mg pyridoxine per kg of feed. He went further to showed that the total intake of pyridoxine per kg feed when corn-groundnut cake diet was fed should be at least 7.2mg and 9mg for practical purpose.

2.2.9 PANTOTHENIC ACID

Panthothenic acid is required for normal growth and protection against dermatitis. N.R.C (1977) put the estimated requirement of both broiler starter and finisher at 10mg per kg diet, while Scott et al (1976) showed the recommended requirement to be 14.3mg per kg diet-for broiler starter and 13.2mg per kg diet for broiler finisher.

2.2.10 BIOTIN

Scott et al (1976) put the recommended amount of biotin for broiler starter at 0.15mg per kg diet while that for broiler finisher is 0.11mg per kg diet. The N.R.C (1977) showed the estimated requirement to be 0.15mg per kg diet for both the broiler starter and finisher. Ogunmodede (1978) found that while 120ug of biotin per kg ration was the minimum needed in the corn ration a level of 150ug per kg ration is recommended for areas where guinea corn are the grains in broiler chick ration. And that 180ug biotin per kg ration is recommended for areas where corn and guinea corn are the grains in broiler chick ration.

2.2.11 FOLIC ACID

Scott et al (1976) put the recommended amount of folic acid at 1.32mg per kg ration for broiler starter and 0.4mg per kg feed for broiler finisher. The N.R.C (1977) put the estimated requirement at 0.55mg per kg diet for both broiler starter and finisher.

2.2.12 VITAMIN B_{12}

Vitamin B_{12} is essential for normal chick growth and for normal hemoglobin formation. An estimated requirement of 0.009mg per kg diet for both broiler starter and finisher is stated by N.R.C (1977), while Scott et al (1976) put the recommended amount of vitamin B_{12} at 0.11mg per kg diet for broiler starter and 0.007mg per kg diet for broiler finisher.

2.2.13 CHOLINE

Choline is required for normal utilization of fat and for prevention of perosis, the requirement for choline are complicated by the interaction with methionine and other sources of methyl groups. The National Research Council (N.R.C) (1977) put the estimated choline requirement at 1300mg per kg diet for broiler starter and finisher. Scott et al (1976) found the recommended allowance to be 1320mg per kg diet for broiler starter and 990mg per kg feed for broiler finisher.

2.2.14 MANGANESE

Manganese is one of several factors needed to protect chicks against perosis. Scott et al (1976) recommended 55mg per kg diet

for both broiler starter and finisher, while the same amount is put as the estimated requirement for both broiler starter and finisher by N.R.C (1977).

2.2.15 ZINC

The National Research Council (N.R.C) (1977) put the estimated requirement for both broiler starter and finisher at 40mg of zinc per kg diet, while Scott et al (1976) showed the recommended allowance to be 44mg per kg diet for broiler starter and 33mg per kg feed for broiler finisher.

2.2.16 IRON

Davis (1962) recommended 80mg per kg of feed for optimal growth of chicken. Waddell (1964) found that dietary calcium and phosphorus affect the utilization of dietary iron by chicks and that approximately 56 p.p.m of iron is required in a ration containing 1.0% of calcium and 0.6% of phosphorus. The National Research Council put the estimated requirement for both broiler starter and finisher at 80mg per kg diet, while Scott et al (1976) showed the recommended allowance to be 88mg per kg diet for broiler starter and 55mg per kg feed for broiler finisher.

2.2.17 COPPER

Copper is required for satisfactory utilization of iron. Ogunmodede (1975b) showed that high dietary level of copper (300 p.p.m) depress growth, 100 p.p.m dietary copper seemed adequate for broiler starter and growers in the content of his

experiment. The N.R.C (1977) put the estimated requirement at 4mg per kg diet for both broiler starter and finisher, while Scott et al (1976) put the recommended amount at 11mg per kg diet for broiler starter and finisher.

2.2.18 IODINE

Scott et al (1976) put the recommended allowance at 0.37mg per kg diet for both broiler starter and finisher. While the N.R.C (1977) put the estimated requirement at 0.35mg per kg diet for both broiler starter and finisher.

2.2.19 MOLYBDENUM

Scott et al (1976) listed 0.2mg per kg diet of feed as the molybdenum requirement for growing chicks. He showed that the feeding of molybdenum deficient diet to chicks caused reduced growth.

2.2.20 SELENIUM

The National Research Council (1977) estimated the requirement for both broiler starter and finisher at 0.1mg per kg diet, while Scott et al (1976) recommended an allowance of 0.15mg per kg diet for both broiler starter and finisher.

2.3 RELATIONSHIP BETWEEN PROTEIN AND VITAMINS

Experiments have been conducted to determine the true relationship between protein and vitamins. There has been some attempts to study the effect of the deficiency of vitamin A on protein synthesis, thus De-Luca et al (1969) and De-Luca and

Wolf (1969) claimed that deficiency of vitamin A caused a decrease in the incorporation of (^{14}C) leucine into the protein synthesised by the intestinal mucosa, and De-Luca and Wolf (1969) were able to trace such defects in protein synthesis to the "pH 5 factor" which contains the aminoacyl-tRNA-synthetases and tRNAs. Subsequent work of De-Luca et al (1971) indicated that, while vitamin A deficiency does not affect the aminoacyl-tRNA-synthetases it leads to an actual decrease in the RNA content of the intestinal mucosa.

One of the most pronounced effects of deprivation of vitamin A is retardation and ultimate cessation of growth. When weanling rats are put on vitamin A - free diets they continue to grow until their initial reserves of vitamin A are exhausted, whereupon they cease to grow and attain the weight plateau stage of the deficiency, after this stage they rapidly loss weight and ultimately die (Bieri 1969). Thompson (1969) reported that when fertilized egg obtained from hens raised on a vitamin A deficient diet and supplemented with retinoic acid were incubated, the embryo grew only for 48 hours after which it died. But when methyl rectinoate or rectinol was injected into such eggs a good proportion of the embryo survived and hatched to baby chicks.

To account for the inability of vitamin A deficient chicks and rats to produce normal epithelial cells it was suggested that vitamin A might have a role in protein metabolism within epithelial tissues. It has however been found that vitamin A is essential

for tissue protein growth but not for its maintenance and that it is consumed in a liver process which transfers moieties from the ingested protein to other proteins and amino acids (Bieri 1969; De-Luca et al 1970).

It is known that vitamin D is very important for calcium and phosphorus metabolism. However it has been shown that a protein synthetic event was required for vitamin D action on calcium and phosphorus, it was noted that the administration of vitamin D to chick did not yield an immediate effect on calcium metabolism but that a certain lag period was required. This lag period is known to be comprised of several events. These include the translocation of vitamin D from source to liver and then to kidney with their concomitant hydroxylation reaction. The dihydroxy derivative is next transported to the target tissue. After the formation of the tissue active form (1, 25$(OH)_2$ D_3) localised in the target site, there is still a significant latent period before the begining of the physiological effect (Haussler et al 1971; Frolik and De-Luca 1972).

Specific proteins are synthesised in the presence of vitamin D at specific sites during this lag period. In the intestine, four intestinal proteins are synthesised these are the calcium-binding protein and three phosphatases-alkaline phosphatase, a calcium-sensitive adenosine triphosphatase and phytase.

In the kidney another calcium binding protein is synthesised and it has been found to be immunologically identical to, and of the same molecular size as intestinal calcium binding protein. In the skeleton it was found that vitamin D plays two important roles in which the non-functioning of these roles may lead to ricket and osteomalacia. These roles involve the metabolism of collagen, these are the hydroxylation of lysine residue of the collagen molecules (Toole et al 1972; Barnes et al 1973). The other role is the degree of cross linking between adjacent microfibrils in the collagen maturation process.

Vitamin K functions physiologically in the production of some factors that are needed for the coagulation of blood, these factors are proteins formed in the liver in the presence of vitamin K, studies suggest that vitamin K functions at the location where sugars are incorporated into proteins at the post ribosomal stage. The major proteins so synthesised are prothrombin, proconvertin, Christmas factor and stuart factor. (Lehninger 1977)

Riboflavin is a very important vitamin which functions in two coenzymes forms; these are flavin mononucleotide (FMN) or riboflavin 5' phosphate, and flavin adenine dinucleotide (FAD). The flavin nucleotides function as prosthetic groups of oxidation - reduction enzymes known as flavoenzymes or flavoproteins, they function in the oxidative degradation of amino acids. The oxidation of amino acid to keto acid via imino acid is brought

about by an enzyme containing FAD. It has been shown that a deficiency of riboflavin in the diet of chicks reduced the D-amino acid oxidase content of liver and kidney. Administration of the vitamin restoresthe enzyme activity to normal (Davis and Motzok 1972). Other flavoprotein enzymes are D-aspartic oxidase, glycine oxidase which occurs in liver and kidney, and oxidises glycine to glyoxylic acid and ammonia, L-amino acid oxidase, Diamino oxidase, quinine oxidase, fumaric dehydrogenase and pyruvic acid oxidase.

It has been established that a relationship exists between riboflavin, niacin and the amino acid tryptophane. It was shown that in niacin deficiency, tryptophane partly spared niacin but did not completely overcome the deficiency (Oh et al 1972). On weight basis the conversion of tryptophane to niacin was 45: 1 (27: 1 on molar basis) (Allen et al 1971). Czarnecki et al (1983) studied the interrelationship between tryptophane and niacin in growing chicks and found no growth response to dietary niacin were observed during severe tryptophane deficiency, with adequate amount of tryptophane present marked gain in weight and feed efficiency response to tryptophane occured regardless of niacin status in chicks.

Niacin occurs in two coenzymes form these are niacin amide adenine dinucleotide (NAD) and niacin amide adenine dinucleotide phosphate (NADP). These two coenzymes play

a very important role in amino acid metabolism. The two coenzymes function in the degradation of all amino acids and in the synthesis of all non-essential amino acids. One step in the degradation of amino acids in which the two coenzymes play an important role is the step of oxidative deamination (Martins et al 1981).

Vitamin B_6 (pyridoxine) participates in the synthesis and catabolism of all naturally occuring amino acids. The importance of vitamin B_6 as a co-enzyme in protein metabolism is well recognised (Christensen 1963). Quality as well as quantity of the protein in a ration seem to determine the need of the chick for vitamin B_6, the known functions of vitamin B_6 coenzyme in amino acid metabolism suggest that under certain conditions increasing the intake of vitamin B_6 might improve utilization of nitrogen, and growth with a diet containing only a limited amount of essential amino acid. The increased vitamin intake presumably would raise tissue vitamin B_6 coenzyme for the synthesis and conversion of amino acids. The effectiveness of this approach would depend upon the relative deficiency of an amino-acid, the amino acid balance of the diet, dietary nitrogen level, and the amino-acid need of the bird.

Sauberlich (1961) demonstrated that when an amino acid is limiting, added amount of vitamin B_6 in the diet may have a "sparing effect" by allowing more incorporation of the limiting amino acid into protein and growth instead of being channeled

into oxidative pathways. He concluded further that pyridoxine could increase the utilization of both L and D-amino acids by increasing intestinal absorption, reducing excretion and by increasing the activity of pyridoxal phosphate enzymes involved in the synthesis and interconversion of amino acids so that dietary and tissue amino acids could be modified more efficiently to a pattern favourable for protein synthesis. Kazemi and Kratzer (1980) showed that the type of protein significantly influenced the requirement of chicks for vitamin B_6 as the protein content of the diet increases the requirement of vitamin B_6 also increases.

Fuller and Hills (1964) confirmed that D-L methionine retards growth of chicks when added to a diet containing suboptimal pyridoxine level. They noted that the signs of pyridoxine deficiency were exercerbated by high levels of methionine, supplementation with increased amount of vitamin B_6 overcomes these effect. El-Husseiny et al (1980) confirmed the interrelationship between methionine and vitamin B_6. Daghir and Shah (1973) noted that when the vitamin B_6 level of the ration was raised from 3.1 to 6.1 p.p.m a significant increase in body weight gain, feed efficiency, and serum glutamate oxaloacetate transaminase (SGOT) resulted at high dietary protein level of 25% compared to low protein level of 15%.

Kratzer and Aboaysha (1978) established a relationship between pyridoxine and serine. They observed an increase in the requirement for vitamin B_6 with the addition of serine to a diet for chicks. Aboaysha and Kratzer (1980) later found that serine depressed growth and caused high mortality when given with pyridoxine hydrochloride (0.5mg/kg feed) but had no effect with 5mg/kg feed. When liver slices were incubated with ^{14}C serine there was a significant decrease in the incorporation of ^{14}C into protein when the chickens were deprived of pyridoxine. Chickens given pyridoxine 0.5mg/kg feed grew slowly and had less protein in the liver than other groups.

The evidence for the participation of vitamin B_6 in the cellular uptake of amino acids has been reviewed by Christensen (1963). This is based on the fact that the addition of pyridoxal increased the uptake of amino acid by cells, cells from vitamin B_6 deficient animals were less able to concentrate glycine, and glycine uptake increased after the addition of pyridoxal to the medium, uptake of α-amino isobutyric acid and phenylalanine into tissue decreased in vitamin B_6 deficient animal and return to normal after pyridoxine injection, intestinal absorption of L-methionine, L-histidine, and L-tyrosine decreased in vitamin B_6 deficient animals and increased following injection of different form of vitamin B_6 (Jacobs et al 1960).

The coenzyme form of pantothenic acid is known as coenzyme A (CoA). CoA is very important in amino acid degradation because it forms acetyl CoA which is the major point of entry into the tricarboxylic acid cycle for ten amino acids. Of these, five (Alanine, glycine, serine, threonine, and cysteine) are degraded to acetyl CoA via pyruvate and five (Phenylalanine, tyrosine, leucine, lysine and tryptophane) are degraded via acetoacetyl CoA and two (threonine and leucine) yield acetyl CoA directly. Leucine and tryptophane yield both acetyl CoA and acetoacetyl CoA.

Biotin is a component of the enzyme B-methyl crotonyl CoA carboxylase which is important in the metabolism (degradation) of leucine. The incorporation of radioactively labelled methionine (CH_3-(^{14}C)-L-methionine) into tissue protein invivo was reduced by 20-40% in biotin deficient chicks compared with chicks fed biotin containing feed. Studies on the incorporation of radioactively labelled alanine L-(^{14}C)-alanine into various liver fractions of paired-fed normal and biotin deficient chicks showed that the labelling of microsomal protein was reduced markedly in biotin deficient chicks (Dakshinamurti and Misty 1963).

Folic acid coenzyme 5, 6, 7, 8 tetrahydrofolic acid is very important in the metabolism of glycine and serine. Folic acid functions in the interconversion of glycine and serine. The conversion of serine to glycine is catalysed by serine hydroxymethyl-transferase which requires tetrahydrofolate and pyridoxal-5-phosphate

as co-factor. Serine is the source of one carbon unit while tetrahydrofolate acts as one carbon acceptor. This reaction is reversible and may account for the reported toxicity of glycine in chickens which is corrected by folic acid (Machlin et al 1961).

In studies on the interconversion of serine and glycine. Rabbani et al (1973) noted that when the diet was deficient in folic acid, L-serine was unable to replace glycine needed for improving chick growth. They noted that this was due to depression in the activity of the enzyme serine hydroxymethyl transferase in chick liver. Featherson (1979) indicated that a folic acid deficiency exerts a greater detrimental effect on chick growth than a deficiency of glycine or serine, and that the increased growth observed when a folic acid deficient diet containing normal level of amino acid was supplemented with glycine and serine suggested that these amino acids were exerting a folic acid sparing effect.

Vitamin B_{12} is essential for the normal maturation and development of erythrocytes. It has been shown that chicks fed adequate amount of Vitamin B_{12} had lower levels of non-protein nitrogen in the blood than had vitamin B_{12} deficient chick, and chicks given vitamin B_{12} grew more rapidly and utilized feeding stuff more efficiently than vitamin B_{12} deficient chicks. Vitamin B_{12} enhances the utilization of circulating amino

acids for building tissues. The addition of vitamin B_{12} to the diet of chicks also had a marked effect on the protein content of the liver (Norman et al 1970).

Vitamin B_{12} deficiency in the chick increased the blood level of non-protein nitrogen and amino-nitrogen and also the urea-nitrogen, creatinine, and glucose were decreased. The level of uric acid was consistently affected. Plasma protein was higher in vitamin B_{12} supplemented chicks than in deficient chicks and the albumin content was also different. It was found that vitamin B_{12} is necessary or enhance the utilization of circulating amino acid for building tissue (Weissbach et al 1960).

The relationship between, choline and protein was established by Ketola and Neshim (1974). They found that growth of chickens given 13% protein and 500mg choline per kg diet was not increased significantly by more choline, none had perosis. Those given 64% protein required about 1000mg choline per kg diet for maximum growth and about 1000 - 1500mg choline per kg diet to prevent perosis and on 13% protein diet addition of 0.84% methionine increased choline requirement from 300 to 800mg/kg diet. Czarnecki et al (1983) observed no growth response to dietary choline during severe methionine deficiency. With adequate amount of methionine marked gain in weight and feed response to choline occured. In contrast gain in weight and feed efficiency response to methionine occured regardless of choline status in the chick.

2.4 RELATIONSHIP BETWEEN PROTEIN AND MINERALS

The physiological interrelationship of minerals and nitrogenous components of the diet have been the subject of numerous investigation in man and animals. One of the enzymes involved in protein digestion is pancreatic carboxypeptidase which contains zinc as an integral part of the molecule and its total activity in the pancrease has been found to be reduced in zinc deficiency. This suggests that there may be impaired digestion of protein in zinc deficiency. Other evidence for a possible disturbance of protein metabolism in zinc deficiency arises from the observation of altered level of free amino-acids of plasma in zinc deficient chicks. When zinc deficient chicks are given zinc, the concentrations of some amino acids return to normal (i.e the same as in the control chick plasma) within an hour. Ogunmodede (1974) found that zinc supplementation of compounded feed increased the utilization of protein by growing chickens. The overall established fact is that zinc deficiency results in protein catabolism (Hsu and Anthony 1975).

Several reports have noted that high levels of copper in the range of 250 p.p.m or more may result in changes in the lining of the gizzard and appearance of ceca. Mabray and Waldroup (1979) found out that no significant interaction of copper and methionine was observed. They indicated that normal level of copper (11) sulphate ($CuSO_4$) does not interfere with the methionine

need of the growing chicks. However Robbin and Baker (1980) noted that increase in the copper content of the diet leads to increase in the requirement for sulphur amino acids by chicken. They found out that excess copper reduces the availability of sulphur compounds containing free sulphur hydryl groups (SH-groups) thus resulting in a growth depression. This is due to the fact that copper addition resulted in erosion of gizzard lining and copper deposition in the gizzard lining.

Ledoux et al (1986) showed that the depression caused by high dietary copper may not always be due to copper per se but may be due to nutrients deficiencies as a result of reduced intake. They showed that the decrease in body weight gain as the copper content of the feed increases could be overcome by increasing the presence of certain nutrients, such as methionine, lysine, vitamins and minerals in the diet. They showed that methionine alone overcome the depression in gain in weight for chicks fed 400mg copper per kg diet but not those fed 800mg per kg diet.

Bunk and Combs (1980) showed that selenium up to 5ug given to chicks increased their voluntary feed intake. However Bunk and Combs (1981) indicated that an impairment in the metabolic synthesis of cysteine in the selenium deficient chick is responsible for a major portion of the growth depression observed with severe uncomplicated selenium deficiency.

Early work on the *in vitro* culture of mammalian tissue first led to the suspicion that certain metallic ions might be involved in the transport of amino acids into cells, since this time many attempts have been made to define clearly those systems which are involved in this process of intracellular accumulation of amino acids against concentration gradients. With some amino acids there is good evidence from studies with intact rats and chicks (Ueda *et al* 1960). From work with intestinal preparation and from isolated ehrlich ascites tumor cells that the entry of amino acids may involve the formation of a schiff base between pyridoxal phosphate and amino acids.

Christensen (1960) investigated the possible role of pyridoxal phosphate-metal-amino acid complexes in amino acid transport. It was found that the accumulation of amino acid by preparation of isolated cells was accompanied by an uptake of manganese (but not copper, iron or zinc), and the rates of both amino acid and manganese absorption were increased by the addition of pyridoxal phosphate to the medium. The activation of an amino acid carrier system by the sodium ion is the postulate advanced by both Vidaver (1964) and Kipnis (1965) to account for the direct relationship which exists between the rate of cellular uptake of amino acids by a variety of tissue and the extracellular sodium ion concentration.

Attempts to achieve protein synthesis in cell-free system have repeatedly demonstrated that certain metals have pronounced stimulatory effect on the incorporation of labelled amino acids into protein (Korner 1961). It is now known that this effect is exerted at two levels in the chain of events leading to the synthesis of protein from individual amino acids. The first in this sequence is mediated by amino acid activating enzymes which with free amino acid and adenosine triphosphate (ATP) as substrate yield amino acid - adenylate complexes and pyrophosphate anions. The activity of this system is strongly dependent upon the magnesium ion concentration of the medium. Concentration of about 5mM magnesium ion being optimal (Korner 1961).

2.5 PROTEIN AND AMINO ACID UTILIZATION AND ADEQUACY OF BROILER CHICKENS

Proteins are complex compounds, macromolecules or polymers of amino acid joined together in peptide linkages. They contain approximately 16% nitrogen and sometimes sulphur, iron or phosphorus. Nearly half the weight of body cell is protein. The enzymes in cells, some hormones, and antibodies and membranes all have protein structure, protein is so important that no life can exist without it.

The protein in the feed of chicken passes through the digestive tract where it is broken down into free amino acids and

very few peptides and oligopeptides. The main site of protein digestion in chicken is the duodenum and the adjacent segment of jejunum. The librated substances are then absorbed through the small intestine into the body system. Absorption was greatest between duodenum and Meckel's diverticulum (Rymarz 1976).

Several factors are known to influence the ability of birds to digest protein. Sometimes the proteases are not able to penetrate through a non-digestible cell wall or to infiltrate a bulky inaccessible protein molecule, mainly native and non denatured proteins, or proteins whose structure is extremely distorted by technological manipulations, are resistant to the attack of the enzymes. Many peptidases show a high specificity depending on the structure of the binding site in the substrates. If these sites of contact are somehow changed, the action of the proteases is inhibited. Thus it is possible to inhibit the action of trypsin by blocking the E-amino group of lysine.

Sometimes the presence of protease inhibitor in some food protein is another factor which reduces their digestibility. A good example is raw soybean which contains a number of toxic stimulatory and inhibitory substances including allergenic, goitrogenic, and anticoagulant factors. MacDonald et al (1973), identified two of them as the kunitz antitrypsin factor and the Bowman Birk Chymotrypsin inhibitors. These inhibit the action of

proteases, leading to low digestibility of the protein.

Sometimes the digestion of the food proteins is possible, but the absorption of the amino-acid is inhibited. Several factors affect the accumulation of amino acid by chick: The rate of amino acid accumulation by intestinal segment decrease with the lapse of time and attain to an equilibrium in the first 10 minutes. The rate of lysine accumulation by the jejunum was the highest among various parts of the intestine and it is followed by the ileum duodenum, colon-rectum and ceca. From this it was confirmed that the small intestine plays a central role in amino acid absorption in chickens (Wakita et al 1970). Several peptides or peptide like compounds seem to inhibit the absorption of amino acids (Buraczewska et al 1967). Many amino acid derivatives can be absorbed, but they are not at all or are only partially utilizable. The principal reason for all these factors reducing the amino acid availability is an excessive heat treatment of the protein during the processing of the feedstuff.

The amino acids released from the breakdown of proteins undergo active transport and this is defined as against the concentration gradient. Neutral and basic amino acids appear to have separate transport system. The jejunum has the highest transport capacity. The criterion of active transport was the accumulation of amino acid in the sac and the amount of amino acid moved in relation to the total sac 100mg dry weight or 10cm length.

The list of L-amino acid: histidine, glycine, alanine, threonine, serine, phenylalanine, leucine, valine, methionine, isoleucine, lysine and proline is in the increasing order of amount transported in one hour incubation period in the ileum, the order in the jejunum was the same or similar (Scharrer 1971).

The cationic amino acids have been shown to represent a transport class in the small intestine of chicken on the basis of their competition for what seems to be a single transport site. This site does not appear to be the primary site of histidine entry. Leucine is a strong competitive inhibitor of arginine uptake while the influence of arginine on the influx of leucine is slight. Comparison of inhibition of lysine and methionine by different amino acids and analogue showed that the inhibition of lysine by neutral amino acid occurs by their attachment to a site other than the one involved in the uptake of methionine (Herzberg et al 1971).

It should be noted that factors which regulate amino acid utilization for protein synthesis are discussed on the basis of analysis of conversion of feed protein to tissue protein. These factors include, digestion and absorption of dietary protein, amino acid concentration in liver and blood, transfer of amino acid across cell wall, amino acid pool, synthesis and degradation of protein, and amino acid catabolism (Gazo 1980).

Rapid growth rate is the primary criterion of nutrient adequacy for the growing chick. In studies of the amino acid requirements of the growing chick, weight gain, efficiency of feed utilization, and nitrogen retention are the parameters commonly used. Recently serum total protein, creatinine, uric acid levels of blood, and enzyme activities in the blood have received attention as indices of protein utilization. The influence of dietary protein on serum protein have been demonstrated in chicks. Keyster et al (1968) observed a close relationship between dietary and serum protein concentration. Thomas and Combs (1967) more over using diets containing various concentration of protein observed a high correlation between serum protein concentration and body composition at a given age.

Eggum (1970) has reported that like serum total protein, urea and creatinine are also used as indirect measures of protein adequacy and quality. The serum urea indicates extent of protein catabolism through degradation of amino acid by the kreb-Henseleit pathway and serum creatinine indicating extent of muscle wastage and subsequent degradation of muscle phospho-creatine to form creatinine.

Uric acid metabolism in chicks according to Ward et al (1974) is influenced by the amount of protein in the diet, uric acid accounts for 55% to 82% of the total nitrogen excreted by the

chicks (Shoemaker, 1972). Hevia and Clifford (1977a) demonstrated that total uric acid excretion and uric acid concentration in excreta may represent very useful method of measuring dietary protein utilization in the chick. They also demonstrated that dietary protein level markedly affect uric acid production. Hevia and Clifford (1977b) also showed that poor quality proteins are deaminated and result in the induction of hepatic purine enzymes to convert nitrogen to uric acid thus suggesting that these enzymes xanthine dehydrogenase in particular (and others such as adenylosuccinate synthetase, purine nucleoside phosphorylase) may be useful in predicting quality of dietary protein in the chicken when small amount of test materials are available.

Several investigators have shown that there are correlations between the level of enzyme activity in the serum and dietary protein level and utilization. Positive correlation between the quality and utilization of dietary protein and glutamate oxaloacetate transaminase (GOT) activity was reported by Wirthgen et al (1967). While a negative correlation between the quality and utilization of protein and glutamate pyruvate transaminase activity was reported by Wirthgen and Bergner (1969). Ikeda et al (1970) showed that increase in protein given to broilers from 20% to 40% for 15 days caused an immediate increase in liver glutamate oxaloacetate transaminase to its highest value in 8 days, but the enzyme in heart muscle, glandular stomach, and pancrease did not

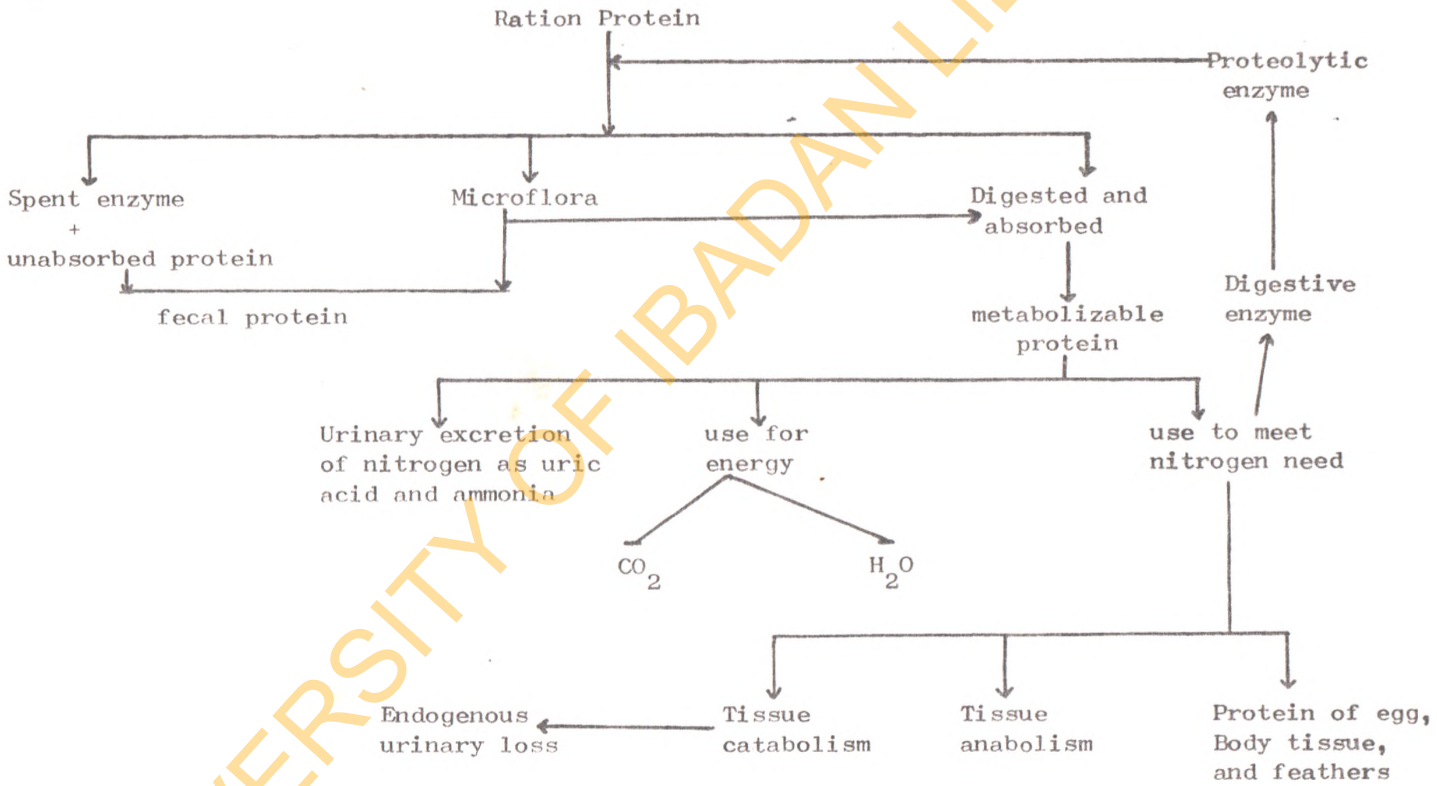
increase in 15 days and that in kidney it increased only slightly. Scholz and Featherson (1968) also reported a significantly higher xanthine dehydrogenase activity for birds on higher protein diet compared with birds fed the lower protein diet.

In animals with a high intake of balanced protein diet, many enzymatic adaptations occur. The amount of most amino acid degrading enzymes increases, as a result, capacity of the body for amino acid degradation also increases. In summary a change of protein or amino acid intake activates regulatory systems controlling amino acid degrading capacity. This is an effective homeostatic mechanism which would contribute towards conservation of amino acid for protein synthesis when degradative capacity falls in response to low amino acid intake. Conversely it would facilitate the removal of amino acids when degradative capacity rises in response to high amino acid intake.

Another criterion that has been used in measuring protein adequacy is the feathers of the birds. In an experiment by Yates and Schaible (1962), with Leghorn pullets it was observed that when birds were switched from 20% to a 16% unsupplemented protein diet at four or six weeks of age they consumed all the feathers which were molted as the pens containing these birds were free of feathers. However birds switched to the low protein diet at eight weeks of age or to a methionine supplemented diet did not consume fallen feathers to any appreciable extent. Kiker

and Sherwood (1974) recorded the incidence of bare back in broilers as influenced by strain, coccidiostat, environmental and management practices. Twining and Thomas (1974) developed a procedure where the number of unconsumed body feathers could be utilized as an additional criterion for determining the adequacy of various diets. Figure 2.1 gives a summary of the fate of dietary proteins and amino acids in the chicken.

Figure 2.1: SUMMARY OF THE FATE OF RATION PROTEIN AND AMINO ACID IN POULTRY



Source: Patrick and Schaible (1980).

2.6 UTILIZATION OF FAT AND OIL AS ANIMAL FEED

Fat contains the highest caloric density of any dietary component: 9 calories per gram compared to 4 calories per gram for carbohydrate and protein. Although they are the most concentrated form of energy, fats are generally less available and more expensive than carbohydrates.

True fat consists of glycerol and fatty acids. Linoleic and arachidonic acids are essential for the fowl since they can not be synthesised by the fowl. A deficiency of linoleic acid in the ration causes poor growth, liver fat accumulation and susceptibility to respiratory infection of the fowl. Seven percent of dietary fat is sufficient to provide two percent of essential fatty acid needed for growth. Fat is stored in the body and it is a medium for fat soluble vitamins (Oluyemi and Roberts 1979). Balton and Blair (1974) reported that fat and oil either from vegetable or animal origin can be incorporated in the diet for two purposes: To boost energy content of a diet in order to obtain an enhanced growth rate, to permit the use of a food which is cheaper but high in energy.

Palm oil is used in diet for poultry to supply energy, vitamin A and D and to reduce dustiness of feed. Supplementation of oils and fat in rations of broilers have been shown by many workers to have effect on growth, efficiency of feed conversion, feed intake, body weight gain, and carcass quality in terms of

deposited fat and moisture content, metabolisable energy of diet, protein utilization and mortality.

Carver (1960) reported that fat samples at levels ranging from 4 - 7%, when fed to broiler, had no adverse effect on feed conversion except for a sample of methyl esters of vegetable fat which impaired feed conversion. Daghir and Tannons (1964) comparing the nutritional value of corn oil and olive oil for growingh chickens observed that all fats added at 5% and 10% to the diet significantly improved feed efficiency. The most consistent result among the effect of oils on the performance of poultry chickens is the reduction in feed intake. Skotnicki et al (1970) included synthetic fatty acid, tallow and soybean oil in rations of fattening broilers and found that they all reduce feed intake per kilogram gain. Differences in feed conversion efficiency among different oils were reported by Lall and Slinger (1972). Vohra and Voln (1972) reported that there was progressive reduction in feed intake as the level of corn oil in chick ration increased from 5 - 25%. Toth et al (1977) also stated that with broilers an increase in fat content of the feed accompanied by improvement in the biological value of the protein resulted in reduction in total feed intake.

Bonomi et al (1972) indicated that when broilers recieved diets containing 2% fat given as beef tallow, palm oil, and coconut oil, intake were 2.69, 2.55, and 2.59kg per kg gained respectively.

All the fat reduced feed intake per kilogram gained. Sheppard et al (1977) showed that rape seed oil gave poorer feed conversion than maize when incorporated into the ration of chicks. When diets with added palm oil and rape seed oil at the rate of 2% and 11.4% were compared it was found that addition of palm oil up to 11.4% stimulated growth but rape seed oil had the reversed effect.

The studies of Babatunde et al (1974) on the case of palm oil as an energy source for pigs and poultry have shown superior response in rate of gain and feed efficiency compared to fat of animal origin. Lazor et al (1976) demonstrated that 1.5 - 6% of acidulated soap stock of sunflower in rations for fattening chicks improved weight gain. They also showed that at 5 weeks of age broilers raised on acidulated cotton seed oil soap stock had significantly higher body weight but at 10 weeks of age supplementation level did not have a significant effect on weight gains. It was reported by Reid and Weber (1975) that oil has effect on feed efficiency, growth rate, and weight gain for broilers and egg production, egg weight, and egg quality for layers. Babatunde and Fetuga (1976) observed improved performance when broilers were fed diets containing 2.5 - 5% palm oil. Several works with oils and fats has invariably improve growth, efficiency of feed conversion, feed intake, body weight gain and carcass quality in terms of deposited fat (Edward 1971; Menye 1971). Oluyemi et al (1979) reported that the inclusion of palm oil in the diet at 5% - 15% without

high salt resulted in significantly faster growth of chicks containing no oil. The effectiveness of the diets containing oil to improve the body weight of chickens can be attributed to an increase in the metabolizable energy of feed.

The calorie - protein ratio is very important in feeding poultry. The birds are able to adjust their energy requirements by the voluntary intake of feed, the feed intake of growing chicken will in general decrease as the energy content of the diet increase, and furnished with the correct protein content the birds can still perform well. Riomi and Pangi-Bini (1966) working on table birds showed that protein curtails the intake of lipids, protein appeared to be the controlling factor in fat deposition (Essary and Dawson 1963).

Carcass composition of broilers has become a major consideration in recent years because of the concern by many about the quantity of animal fat consumed by humans. Deposits of fat in the abdominal area of the broiler are considered a waste product in poultry, since some of the fat is freed from the carcass during processing and this is a loss when the cost of production is considered. The larger the quantity of fat the greater the cooking loss especially when frying. The amount of fat pad shows the degree of excess deposited after the adipose tissue have been saturated. The degree of fat deposition in broiler is influenced by both nutritional and non nutritional factors, one of the most

widely investigated is the calorie-protein ratio. Diets with more fat generally gave more abdominal fat.

Kubena et al (1974a), observed that the energy level of the starter diet at four weeks of age appeared to have an effect on abdominal fat present at 7 - 8 weeks of age. They indicated that abdominal fat was expressed as a percentage of dressed weight. Kubena et al (1974b) found that increasing dietary energy level with addition of fat increased the abdominal fat deposition even through calorie-protein ratio was held constant. Deaton et al (1981) stated that as the dietary animal fat increases the amount of abdominal fat also increases.

But the major disadvantage with use of oils and fats for feed is that, fats and oils tend to be rancid and in the process destroy some of the vitamins and minerals in the diet, thereby leading to vitamin and mineral deficiency symptoms (Bolton and Blair 1974). The rancidity of fats and oils may also poison the birds, leading to death and great economic loss.

OBJECTIVES OF THE STUDY

The utilization of protein by broiler chickens is one aspect of the nutrition of the birds which cannot be overlooked. This is because the lay down of protein constitute one of the important factors for the fast growth of the birds. Also protein sources in the feed of broilers are the most expensive and proper utilization

of these protein sources is very important otherwise the cost of production may increase astronomically. However one important factor which affect the utilization of these protein sources by birds is the amount of vitamins and minerals present in the feed. Although the amount required is small they play very important roles in protein utilization, thus this study was designed

(1) To find out to what extent the various premixes affect the protein utilization of broiler chickens, and which of the premixes allows best protein utilization.

(2) To find out the premix that best allows protein utilization at the starter phase, and that which best allows protein utilization at the finisher phase, and to find out to what extent a good finisher premix can compensate for the low growth and protein utilization of broilers fed a poor starter premix thereby allowing better growth and protein utilization.

(3) To find out what level of palm oil can be added to the feed of broilers without affecting the vitamins and trace minerals present in the premix and at the same time allow proper protein utilization.

(4) To provide a basis for further research into the effect of premixes on nutrient utilization of the various livestock.

CHAPTER THREE

PROTEIN UTILIZATION BY BROILER CHICKENS FED THREE PREMIXES AT THE STARTER AND FINISHER PHASES.

3.1 INTRODUCTION

The high cost of protein sources for broilers demands that the protein in the feed must be properly utilized so as to reduce the cost of production. The nutrients in chicken feed's that are seldom properly monitored are the vitamins and trace minerals. This practice leads to low productivity of the broiler chickens, high cost of production and the birds exhibit various vitamin and mineral deficiency symptoms. The vitamins and minerals are added to the feed as premixes. There are various brands of the premixes in the Nigerian market, but these various brands with varying composition are said to perform the same function.

It can be seen that some of the premixes contain some of the vitamins and minerals required by the chicken, while some are deficient in one or two. It was also observed that the level of the various vitamins and minerals in the premixes varied. Thus the aim of this study was to find out whether these variations in composition would have any marked effect on the protein utilization and growth of broiler chickens fed the same premix at the starter and finisher phases.

3.2 MATERIALS AND METHODS

3.2.1 BIRDS AND THEIR MANAGEMENT

The experiment was carried out in the poultry unit of the Teaching and Research Farm, University of Ibadan. One hundred and fifty cobb broiler chickens of mixed sexes were collected at day old. Prior to collection the floor of the cage and brooder units were cleaned and disinfected, heat was supplied to the brooder units, feed and water were placed in their proper positions. The chicks were divided into three groups of fifty birds per group, each of the three groups was further divided into two to form two replicates making a total of six replicates consisting of twenty five birds per replicate. The chicks were weighed before alloting them to the different treatment groups and replicates.

The birds were managed throughout on deep litter house with a short side wall which was about 1m high and topped with wire mesh to a height of about 2.0 meters from the floor. The pens were partitioned with wire mesh providing a uniform sized pen of about 2.8 meters by 1.1m in dimension with an area of $3.08m^2$ and provided floor space of $0.123m^2$ per bird. The pens were sealed with wire mesh to ensure complete exclusion of rodents. The roof of the house was made of corrugated iron sheets and full span with ridge ventilation. Ventilation was adequate as the deep litter was open sided and the density of the birds in the house was low. The floor was made of concrete and

the litter was wood shavings, about 5cm deep turned every other day to avoid accumulation of pathogens and maintained in a dry friable state.

Water was supplied twice daily in plastic water fountains of 4 litres each. The water troughs were placed on platforms to prevent spillage and they were designed in such a way that contamination with dropping was reduced to a minimum. Two feeders measuring about 0.8m in length each were used per replicate. Feed and water were provided ad libitum. The routine management carried out included inspection for mortality every morning and supply of feed and water. At weekly intervals the average live weight of the birds and average weight of feed intake were measured. On arrival, the birds were given intraoccular vaccine against New Castle disease. At two weeks they were vaccinated against gomborro (infectious bursal disease) at four weeks they were vaccinated again against gomborro, while the last vaccine was at five weeks which was Lasota against Newcastle disease.

3.2.2: COMPOSITION OF THE DIETS

Ingredients for the feed were obtained from the local Ingredient dealers. The experiment was divided into two phases, the starter and the finisher phases. There were three diets at both phases and the diets contained different premixes, but the premixes used at the starter was the same used at the finisher

TABLE 3.1

PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS STARTER PHASE

Ingredients (%)	PREMIX S	PREMIX R	PREMIX D
Maize	58.80	58.80	58.80
Groundnut Cake	19.63	19.63	19.63
Fish meal	4.91	4.91	4.91
Blood meal	4.91	4.91	4.91
Brewers grains	8.00	8.00	8.00
*Premix	0.50	0.25	0.20
Bone meal	2.00	2.15	2.20
Oyster shell	1.00	1.10	1.10
Salt	0.25	0.25	0.25
Total	100	100	100
CALCULATED ANALYSIS:			
Crude protein (%)	23.00	23.00	23.00
M.E Kcal/Kg	2970	2970	2970
DETERMINED COMPOSITION:			
Crude protein (%)	22.87	22.81	23.44
Dry matter (%)	87.25	89.10	88.42

* Table 3.9 and Table 3.10.

TABLE 3.2

PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS FINISHER PHASE

Ingredients (%)	PREMIX S	PREMIX R	PREMIX D
Maize	61.63	61.63	61.63
Groundnut Cake	15.08	15.08	15.08
Fish meal	3.77	3.77	3.77
Blood meal	3.77	3.77	3.77
Brewers grains	10.00	10.00	10.00
* Premix	0.50	0.25	0.20
Bone meal	3.00	3.15	3.20
Oyster Shell	2.00	2.10	2.10
Salt	0.25	0.25	0.25
Total	100	100	100
CALCULATED ANALYSIS			
Crude protein (%)	20.00	20.00	20.00
M.E Kcal/kg	2940	2940	2940
DETERMINED COMPOSITION			
Crude protein (%)	19.64	19.93	20.22
Dry matter (%)	87.53	89.60	87.88

* Table 3.9 and Table 3.10.

phase with the exception of premix S (Sander's premix) which had different premix for the starter and for the finisher phases. The diets were formulated to contain 23% crude protein at the starter phase and 20% crude protein at the finisher phase. The calculated energy for the starter phase was 2970 Kcal ME/kg diet (table 3.1). The energy for the finisher phase was 2940 Kcal ME/kg diet (table 3.2). Premix S was the Sander's broiler starter premix and Sander broiler finisher premix, premix R was the Roche Zoodry broiler premix, and premix D was the Dizengoff vitadiz B.P premix.

Yellow maize, brewer's grains, groundnut cake, fish meal and blood meal were the source of protein and energy. The premixes supplied the microelements and vitamins, while Salt, Oystershell and bone meal supplied the macroelements. The feed was compounded every two weeks so as to minimize the deterioration of the vitamins in the premixes.

3.2.3: PERFORMANCE CHARACTERISTICS

The average weekly live weight, and average weekly feed intake were recorded on the farm, while the average weekly body weight gain, feed conversion ratio, and body weight gain per gram protein intake were calculated from the data obtained on the farm.

3.2.4: DIGESTIBILITY TRAILS

When the birds were four weeks old two birds from each of the six replicates, making four birds from each treatment group

were randomly selected and weighed. They were then transferred to the metabolic cage, and the two birds from each replicate were provided the same feeder and drinker and trays for collection of droppings. The trays were each covered with polythene sheets so as to effect total collection of the droppings. The polythene sheet was first sprinkled with 1% boric acid in order to minimize the loss of ammonia. The amount of feed consumed by the birds in each replicate was measured. The birds were allowed to adjust for two days while collection of droppings and feed measurement were done for six days.

After collection the droppings were weighed and transferred to the laboratory where a small amount was left aside for dry matter determination and the rest was dried in the oven at 65°C for 72 hours. After drying the samples were allowed to cool in a dessicator and weighed, before chemical analysis was carried out on them. The same procedure was used when the birds were eight weeks (finisher phase diets).

3.2.5: DETERMINATION OF APPARENT DRY MATTER DIGESTIBILITY

This was carried out at the end of the starter and finisher phases and it was calculated by this formula.

$$\frac{\text{Drymatter intake} - \text{Dry matter output}}{\text{Dry matter intake}} \times 100$$

3.2.6: DETERMINATION OF FAECAL NITROGEN

The faeces nitrogen was determined by a direct chemical separation of the faeces from the urine, by oxidising the uric

acid with potassium permanganate. One gram of dried finely ground dropping was weighed into 250ml beaker and wetted with a few millilitres of ethanol to aid dispersion. To this was added 50ml of distilled water, 40ml of buffer solution with pH 8 (1 mole = 61.8g boric acid + 0.1 mole = 4.0g NaOH per litre i.e 4 milliequivalents of sodium per sample); 10mls of 0.1M potassium permanganate solution (15.8g per litre) was added to provide about 1ml for every 5mg total nitrogen in the sample. The beaker was then placed in water bath at a temperature of 50 + 1°C and stirred mechanically for 35 minutes. Then 25ml of a solution containing 4 millimoles of uranyl acetate (12.5ml of 0.16M solution or 68g per litre) was added. The sample was then left overnight to cool and precipitate. The mixture was then filtered through a rapid medium fast filter paper (Whatman No. 4). The residue was then washed with 1% uranyl acetate solution at room temperature. The precipitate was well flocculated and as such the process of filtering and washing were completed quickly. The filter paper with the residue was then transferred into a 300ml kjeldahl's flask and it was digested for nitrogen.

10ml of 0.1M potassium permanganate was added to 1g dropping to prevent oxidation of faecal nitrogen which could occur in the presence of excess potassium permanganate. The uranyl acetate was added to the solution to reduce the pH to about 5 which is the vicinity of the isoelectric point for most common proteins.

The uranyl acetate was able to dissolve uric acid in poultry excreta thereby correcting for the non-protein nitrogen in the dropping. The protein was precipitated mainly in combination with uranium and as a result of hydrolysis, a great deal of the excess uranium was precipitated in the flocculated state thereby enhancing filtration.

3.2.6: DETERMINATION OF TOTAL NITROGEN

Analysis for total nitrogen was done to determine the amount of nitrogen in feed, faeces and excreta. About 2g of the feed, 1g of faeces, and 2g of excreta were weighed into different kjeldahl flasks, three tablets of copper sulphate and a tablet of selenium, followed by 25ml of concentrated sulphuric acid were added to each flask. This was placed in the fume cupboard and heated gently for 5 to 10 minutes.

The contents were digested until they assumed a green colour. The samples were cooled and diluted with 50ml of distilled water, and then transferred to separate 250ml graduated flask and were made up to mark with distilled water. The micro kjeldahl distillation apparatus was used to determine the nitrogen content of the samples.

3.2.7: EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS

The feeding trial was based on the complete randomised block design, and data collected were subjected to analysis of variance (ANOVA) and the Duncans multiple range test according to the crips package using the computer.

3.3: RESULTS

3.3.1: LIVE WEIGHT

Table 3.3 presents the average weekly live weight per bird per treatment. At the end of the first and second weeks of study there was no significant difference ($P > 0.05$) between the different dietary treatments. At the end of the third week there were significant differences ($P < 0.05$) between the birds given the different premixes. Variation in liveweight also occurred at the fourth, seventh, eight and nineth week with birds fed premix S or premix R having better body weights than birds fed premix D at the nineth week.

3.3.2: FEED INTAKE

Table 3.4 shows the average weekly feed intake. There was no significant difference ($P > 0.05$) in the quantity of the experimental diets consumed by the birds within the first three weeks as well as in the fifth week. For weeks six and seven birds given premix S or premix R consumed more feed than those given premix D. The total average consumed over the nine week period did not show any significant difference ($P > 0.05$).

3.3.3: BODY WEIGHT GAIN

The average weekly body weight gain of the birds fed the various premixes is shown in table 3.5. There was no significant difference ($P > 0.05$) in the body weight gain of the birds in the three experimental treatments for the first two weeks.

TABLE 3.3

AVERAGE WEEKLY LIVE WEIGHT OF BROILER CHICKENS FED THREE PREMIXES (GRAMS)

AGE (weeks)	PREMIX S	PREMIX R	PREMIX D	SEX
0	29.32	32.11	29.38	0.42
1	39.87	38.81	38.69	0.30
2	87.07	87.07	85.15	0.52
3	203.33^{a}	178.57^{b}	154.50^{c}	11.52
4	311.67^{a}	296.43^{a}	271.67^{b}	9.53
5	401.51	405.00	394.64	2.49
6	521.50	520.00	496.65	6.57
7	671.38^{a}	665.10^{ab}	647.51^{b}	5.84
8	987.63^{b}	1014.70^{a}	981.91^{b}	8.27
9	1427.63^{a}	1439.52^{a}	1303.49^{b}	6.15

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 3.4

AVERAGE WEEKLY FEED INTAKE (GRAMS) OF BROILERS FED THREE PREMIXES

AGE (Weeks)	PREMIX S	PREMIX R	PREMIX D	SE$\bar{X}$
1	85.02	88.63	82.56	1.44
2	157.24	159.88	153.35	1.55
3	220.76	212.67	223.92	6.50
4	351.82^{a}	359.94^{a}	335.61^{b}	5.85
5	452.68	447.32	460.61	5.43
6	587.24^{b}	620.49^{a}	535.88^{c}	46.48
7	710.49^{a}	692.39^{a}	663.22^{b}	37.90
8	759.20^{a}	730.49^{b}	777.16^{c}	19.65
9	848.90^{b}	832.67^{b}	882.62^{a}	13.15
Total	4153.35	4144.48	4114.93	134.66

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 3.5

AVERAGE WEEKLY BODY WEIGHT GAIN (GRAMS) OF BROILERS FED THREE PREMIXES

AGE (Weeks)	PREMIX S	PREMIX R	PREMIX D	SEX
1	10.55	6.70	9.31	0.93
2	47.20	48.26	46.44	0.43
3	116.26^{a}	91.50^{b}	69.35^{c}	11.08
4	108.34	117.86	117.17	2.51
5	89.83^{b}	108.57^{ab}	122.97^{a}	7.84
6	120.00	115.00	102.01	4.38
7	149.88	145.10	153.70	2.11
8	316.25^{b}	349.60^{a}	334.50^{ab}	7.88
9	429.80^{a}	424.84^{a}	321.58^{b}	3.54

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

However in the third week birds fed premix S had the highest body weight gain. In weeks four, six, and seven there were no significant differences ($P > 0.05$) between the experimental treatments while in weeks five, eight and nine there were significant differences ($P < 0.05$) between the experimental treatments.

3.3.4: FEED CONVERSION RATIO

The feed conversion ratio of the birds for the duration of the experiment is shown in table 3.6. The feed conversion ratio indicates to what extent the birds have converted their feed to body gain, the lower the ratio the better the conversion. The first week showed a significantly lower conversion ($P < 0.05$) by birds given premix R although the conversion was generally poor for the three experimental treatments. During the other weeks there were no significant differences ($P > 0.05$) between the experimental treatments. However the feed conversion improved over time and very good values were obtained at the nineth week.

3.3.5: BODY WEIGHT GAIN PER PROTEIN INTAKE

Table 3.7 shows the body weight gain per gram protein intake for the duration of the experiment. The body weight gain per gram protein intake shows the relationship between the feed protein and the body weight gain of the birds, the higher the ratio the better the feed protein utilization. The ratio was very low for the three experimental treatments in

TABLE 3.6

AVERAGE WEEKLY FEED CONVERSION RATIO OF BROILERS FED THREE PREMIXES

AGE (Weeks)	PREMIX S	PREMIX R	PREMIX D	SEX
1	8.05[a]	13.61[b]	8.88[a]	1.41
2	3.34	3.32	3.31	0.01
3	1.90	2.33	3.22	0.22
4	3.44	3.06	2.89	0.13
5	5.05	4.14	3.75	0.36
6	4.90	5.45	5.25	0.25
7	4.74	4.82	4.32	0.29
8	2.40	2.09	2.32	0.10
9	1.98	1.96	2.74	0.08

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 3.7

AVERAGE WEEKLY BODY WEIGHT GAIN/GRAM PROTEIN INTAKE OF BROILERS FED THREE PREMIXES

AGE (Weeks)	PREMIX S	PREMIX R	PREMIX D	SEM
1	0.55	0.34	0.48	0.05
2	1.31	1.32	1.29	0.01
3	2.31^{a}	1.89^{b}	1.32^{c}	0.18
4	1.35	1.44	1.50	0.03
5	0.87^{c}	1.02^{b}	1.14^{a}	0.09
6	1.04	0.93	0.94	0.05
7	1.07	1.02	1.14	0.08
8	2.12^{b}	2.41^{a}	2.13^{b}	0.08
9	2.58^{a}	2.56^{a}	1.80^{b}	0.05

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 3.8

AVERAGE DAILY NITROGEN RETENTION AT WEEKS FOUR AND EIGHT

PARAMETERS	AGE (Weeks)	PREMIX S	PREMIX R	PREMIX D	SEX
Dry matter digestibility coefficient	4	67.57	67.92	66.12	0.45
	8	68.10	70.49	67.71	0.71
Nitrogen digestibility coefficient	4	74.18	71.80	71.54	0.69
	8	68.68^{b}	72.56^{a}	67.25^{b}	1.30
Nitrogen retention (%)	4	51.69^{a}	51.23^{ab}	46.97^{b}	1.26
	8	44.99^{b}	50.06^{a}	42.91^{b}	1.74

Values with the same superscripts on the same horizontal row were significantly different ($P < 0.05$).

the first week compared with the other weeks. Birds fed premix S or premix R had ratios that were higher than for those fed premix D in weeks three and nine. For week five birds fed premix D had the highest ratio.

3.3.6: NITROGEN RETENTION

The average daily nitrogen retention at weeks four and eight is shown in table 3.8. The dry matter digestibility coefficients were not significantly different ($P > 0.05$) between the dietary treatments in weeks four and eight. Also when both weeks were compared there was no significant difference ($P > 0.05$) between the two weeks. The nitrogen digestibility coefficient showed no significant difference ($P > 0.05$) between the dietary treatments in week four, but significant difference ($P < 0.05$) existed between the dietary treatments in week eight, with premix R having the highest digestibility coefficient of 72.56%. When both weeks were compared there was no significant difference ($P > 0.05$) between them.

The nitrogen retention (%) at week four showed the best for birds fed premix S. At the eighth week premix R produced significantly ($P < 0.05$) the highest nitrogen retention. When both weeks were compared it was found that no significant difference ($P > 0.05$) existed between them.

3.4: DISCUSSION

3.4.1: LIVE WEIGHT

Premixes are given to broilers as sources of the major vitamins and trace minerals that are needed by broiler chickens. It has been noticed that broilers are very sensitive to vitamins and trace mineral deficiencies and the non addition of the premixes to broiler rations tend to lead to complete loss. The composition of the premixes showed that premix R (Table 3.9 and Table 3.10) had the most balanced composition in that it contained more vitamins and minerals than the other premixes. However in terms of the quantity of the various vitamin and minerals premix S had the highest quantity of most of the vitamins and minerals than the other premixes. The values obtained for the live weight at the nineth week for the birds given the three premixes varied this may indicate the fact that variation in the quantity and quality of the premixes did affect feed utilization by the birds. Another reason may be due to the fact that the composition of the premixes for some of the vitamins and trace minerals did not met the requirements of N.R.C. (1977); Scott et al (1976); Ogunmodede (1975a, 1976, 1981). This is indicated by tables 3.9 and 3.10.

Values for live weight of nine weeks old broiler chicken obtained in this trial were lower than that obtained by Akpet (1987), the reason for this may be due to the supplemental vitamins which he gave to the birds, it may also be due to the difference

TABLE 3.9

AMOUNT OF THE VITAMINS, MINERALS, AND ADDITIVES IN THE VARIOUS PREMIXES CONTAINED IN 100g OF THE FEED.

	SANDER'S PREMIXES (Premix S)		ROCHE PREMIX (Premix R)	DIZENGOFF PREMIX (Premix D)
	STARTER	FINISHER	ZOODRY	VITADIZ.B.P.
Vitamin A	1800.i.u.	1500.i.u.	1250.i.u.	1000.i.u.
Vitamin D_3	250.i.u.	250.i.u.	275.i.u.	200.i.u.
Vitamin E	1.40.i.u.	1.10.i.u.	1.50.i.u.	0.30.i.u.
Vitamin K			0.20mg	0.20mg
Vitamin B_1			0.15mg	
Riboflavin	1.20mg	1.00mg	0.60mg	0.5mg
Pyridoxine	2.80mg	2.00mg	0.35mg	0.05mg
Niacin	4.40mg	4.00mg	3.50mg	2mg
Biotin			0.005mg	
Pantothenic acid				0.30mg
Calcium Pantothenate			1.0mg	
Choline Chloride	48mg	40mg	30mg	20mg
Folic acid			0.10mg	
Vitamin B_{12}			0.002mg	0.001mg
Vitamin C			2.5mg	
Manganese	12mg	12mg	10mg	8mg
Zinc			4.5mg	5mg
Cobalt			0.0225mg	0.02mg
Iodine	0.22mg	0.22mg	0.155mg	0.12mg
Selenium	0.02mg	0.02mg	0.01mg	0.01mg
Copper	1.00mg	1.00mg	0.20mg	0.20mg
Iron	7mg	7mg	5mg	2.50mg
Methionine	13mg	12mg	20mg	
Lysine	24mg	18mg		
Antioxidant	25mg	25mg		12.50mg
Zinc bacitracin			2mg	
Avatec (Lasalocid)			9mg	

TABLE 3.10

PERCENTAGE OF NATIONAL RESEARCH COUNCIL NUTRIENT REQUIREMENT OF BROILER CHICKENS SUPPLIED BY THE PREMIXES

	* N. R. C. Requirements (Per 100g Feed)	SANDERS PREMIX (Premix S) Starter (%)	Finisher (%)	ROCHE PREMIX (Premix R) Zoodry (%)	DIZENGOFF PREMIX (Premix D) Vitadiz B .P (%)
Vitamin A	150.i.u.	1200	1000	833	666
Vitamin D_3	20.i.u.	1250	1250	1375	1000
Vitamin E	1.i.u.	140	110	150	30
Vitamin K	0.05mg	-	-	400	400
Vitamin B_1	0.81mg	-	-	83	-
Riboflavin	0.36mg	333	277	166	139
Pyridoxine	0.30mg	933	666	116	16
Niacin	2.7mg	163	148	130	74
Biotin	0.015mg	-	-	33	-
Pantothenic acid	1.0mg	-	-		30
Calcium Pantothenate	1.0mg	-	-	100	
Cholin Chloride	130mg	37	31	23	15
Folic acid	0.055mg	-	-	181	-
Vitamin B_{12}	0.0009mg	-	-	222	111
Manganese	5.5mg	218	218	182	145
Zinc	4.0mg	-	-	112	125
Iodine	0.35mg	628	628	443	343
Selenium	0.01mg	200	200	100	100
Copper	0.4mg	250	250	50	50
Iron	8.0mg	87	87	62	31

* N. R. C. (1977).

in breed since it was observed that the live weight of birds not given supplemental vitamins were still higher than that obtained in this trial. The values were however similar to that obtained by Kiker (1976), and Benoff and Hudspeth (1981), although their experiment lasted for eight weeks.

3.4.2: BODY WEIGHT GAIN

The values of body weight gain obtained in this trial were at four weeks lower than that of Ogunmodede (1976), at five weeks lower than that of Al-Nasser et al (1986) and higher than that of Henry et al (1986) at nine weeks. The average weekly body weight gain of the birds fed the three premixes showed a sharp increase between week seven and week nine. Birds fed premix D had the lowest weight gain at week nine. From the view point of this trial in which the utilization of protein by birds as affected by different sources of vitamins and trace minerals is the main factor being considered, the increase or high weight gain observed among the birds given the premixes does not mean an increase in tissue protein, since body weight gain involves several other factors such as fat and water deposition. Carcass analysis would have given a more reliable result.

3.4.3: FEED CONVERSION RATIO.

The feed conversion ratio actually indicates to what extent the feed consumed by the birds is converted to body products. It is known that lower ratio indicates better feed conversion. The feed conversion ratio obtained in this study for the first

week to the seventh week were worse than that obtained by Temperton and Cassidy (1964) and Begin (1967). However for weeks eight and nine better conversion ratios were obtained than those reported by these authors.

From the data obtained on feed conversion ratio it can be seen that weeks eight and nine produced the best conversion in the three treatments. This may indicate that there was better conversion of the feed to body products during this period for the three premixes. But the feed conversion ratio does not tell us to what extent feed protein is being converted to body products. The feed conversion ratio only gives a broad outlook of the conversion of the whole feed nutrients to body products. Thus it may be that only energy given products are being utilized by the birds, thus causing the deposition of fat. This is usual at the broiler finisher phase.

A look at the table for feed conversion ratio showed that there was a similar trend for all treatments, this trend indicates that for all the treatments the rate and ability of the birds to convert the feed consumed into body product was very low in the first few weeks but later increased during the last few weeks. This may infact confirm that the birds were late starters or that more feed was wasted during the brooding stage.

3.4.4: BODY WEIGHT GAIN PER PROTEIN INTAKE

The body weight gain per protein intake is a step further in determining the extent to which the feed protein can be related

to the body product. Although it is not absolute, it gives a brief description of the relationship between protein intake and growth of the birds. The result obtained showed that the body weight gain per gram protein intake followed the same trend for all the treatments. A high ratio indicates a better utilization of the feed protein.

3.4.5: DAILY NITROGEN RETENTION

The values for the nitrogen digestibility coefficient were lower than that obtained by Kroydahl and Dalsgard (1981). The values for the nitrogen digestibility coefficient of the younger birds were slightly higher than their nitrogen digestibility coefficient at adult stage with the exception of premix R. One would generally expect the birds to have a higher nitrogen digestibility at the fourth than at the eighth week, because at that age more proteinaceous tissues are being laid down. Therefore protein utilization should be higher, this is supported by the work of Ogunmodede (1974), which showed that protein digestibility generally declined with age in growing birds, and this can be attributed to decline in requirement for growth. However a general view of the data indicated that birds fed premix S had the best performance in week four, while birds fed premix R had the best performance in week eight.

The result for the apparent nitrogen retention showed that values for the fourth week for the three treatments were slightly

higher than for the eighth week. The values obtained were similar to that of Payne et al (1977). The nitrogen retention actually indicates the proportion of feed nitrogen that is retained by the body for productive purposes. Birds fed premix S had the highest retention in week four although at that week birds fed this premix had body weight gain that was not significantly higher than that of birds fed other premixes. It could be that the nitrogen retained was used for other purposes especially feather formation. This however was not studied.

The nitrogen digestibility trial shown in appendix 1 indicated that nitrogen retained in grams between the two weeks (weeks four and eight) was slightly different but the weight gained between the weeks that the trials were carried out was very high. These high weight gains by the birds at the eight week compared to the fourth week may be due to the fact that during the adult stage not only protein is laid down but more fat is being laid down by the birds. This is confirmed by the fact that animals tend to lay down less protein and more fat during the adult stage than when young. The result showed that at eight weeks birds fed premix R significantly had the highest nitrogen retention in percentage. This may be responsible for birds fed premix R having high body weight gain in week eight.

Indications from the parameters considered especially the live weight showed that birds fed premix S or premix R had the best performance.

CHAPTER FOUR

PROTEIN UTILIZATION BY BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

4.1: INTRODUCTION

The improvement of broiler production in the tropics requires among other things, knowledge of the nutrient requirement of the chickens in the tropical environment. It has been observed that the growth rate of chicks in the tropical environment is usually lower than that obtained in the temperate zone, due partly to the fact that birds consume less feed in a hot environment. Feed intake regulates vitamins and mineral intake, and feed intake is closely moderated by environmental temperature and energy of the feed. There is evidence that vitamins and minerals are not required by animals in isolation, that the requirement of one vitamin or mineral may be influenced by the intake of others, and that it is impossible to fix a minimum requirement which will remain constant when other constituents of the diet are changed.

Gleeves et al (1961) suggested the need for more research work dealing with interaction between various vitamins and other feed nutrients. Since the main effect of one study alone may be entirely different when all nutrients are considered. Based on the previous experiment in which it was observed that the difference in the level of various vitamins and minerals found in the different premixes did affect protein utilization of the

birds, this experiment was designed to see if feeding the birds different premixes at the starter and finisher phases will have any effect on the protein utilization. This will show any interaction between the starter premix and finisher premix.

4.2: MATERIALS AND METHODS

4.2.1: BIRDS AND THEIR MANAGEMENT

The experiment was carried out in the poultry unit of the Teaching and Research Farm, University of Ibadan. Two hundred and seventy Hubbard broiler chicks of mixed sexes were collected at day old. At the starter phase the chicks were divided into three treatment groups of ninety birds per treatment group, each of the three treatment groups was further divided into two replicates, making the birds fortyfive per replicate. Each of the three treatment groups was randomly assigned to the three dietary treatments of the starter phase.

At the finisher phase each of the three treatment groups of the starter phase was divided again into three treatment groups making on the total nine treatment groups. Each treatment group was replicated twice making a total of eighteen replicates. The three treatment groups that were obtained from each of the treatment group of the starter phase were allocated to three dietary treatments containing different premixes. So that on the whole some particular treatment groups of the finisher phase were fed diets containing *the same premix as they were fed in starter phase (Figure 4.1).*

The other management practices were the same as obtained in experiment one.

FIGURE 4.1

EXPERIMENTAL DESIGN FOR EXPERIMENT TWO

Treatment No.	Premix fed at starter phase 90 birds/Premix/ Treatment	Premix fed at finisher phase 30 birds/Premix/ Treatment
1	S	S
		R
		D
2	R	S
		R
		D
3	D	S
		R
		D

4.2.2: COMPOSITION OF DIETS

The procedure was as described in experiment one, but the diets were formulated to contain 23% crude protein and 2970 KCal ME/Kg diet, for all the dietary treatments at the starter phase (Table 4.1). For the finisher phase all dietary treatments were formulated to contain 20% crude protein and 2940 KCal ME/Kg diet (Table 4.2). The premixes used in this experiment were the same as in experiment one.

4.2.3: PERFORMANCE CHARACTERISTICS AND DIGESTIBILITY TRIALS

The methods were the same as obtained in experiment one. However digestibility trials in this experiment were carried out when the birds were four weeks and nine weeks old respectively. The methods used in obtaining the dry matter of dropping, the faecal nitrogen, and total nitrogen excreted were the same as in experiment one.

4.2.4: CARCASS EVALUATION

Two birds from each replicate were selected at the end of the starter phase (five weeks) and at the end of the finisher phase (Ten weeks). They were selected using the method of Adams et al (1986). They were starved for twelve hours, weighed to obtain their liveweight and then slaughtered by servering their jugular vein just below the head. They were scalded in hot water, plucked and weighed before they were eviscerated and reweighed.

TABLE 4.1

PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS AT STARTER PHASE

INGREDIENTS:	Premix S	Premix R	Premix D
Maize	58.80	58.80	58.80
Groundnut cake	19.63	19.63	19.63
Fish meal	4.91	4.91	4.91
Blood meal	4.91	4.91	4.91
Brewers grains	8.00	8.00	8.00
*Premix	0.50	0.25	0.20
Bone meal	2.00	2.15	2.20
Oyster shell	1.00	1.10	1.10
Salt	0.25	0.25	0.25
CALCULATED ANALYSIS:			
Crude protein (%)	23.00	23.00	23.00
ME (Kcal/Kg)	2970	2970	2970
DETERMINED ANALYSIS:			
Dry matter (%)	38.94	89.39	89.12
Crude protein (%)	23.16	23.08	23.11

* See table 3.9 and table 3.10.

TABLE 4.2

PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS AT FINISHER PHASE

INGREDIENTS:	Premix S	Premix R	Premix D
Maize	61.63	61.63	61.63
Groundnut cake	15.08	15.08	15.08
Fish meal	3.77	3.77	3.77
Blood meal	3.77	3.77	3.77
Brewers grains	10.00	10.00	10.00
*Premix	0.50	0.25	0.20
Bone meal	3.00	3.15	3.20
Oyster shell	2.00	2.10	2.10
Salt	0.25	0.25	0.25
CALCULATED ANALYSIS			
Crude protein (%)	20.00	20.00	20.00
ME (Kcal/Kg)	2940	2940	2940
DETERMINED ANALYSIS			
Dry matter (%)	90.02	87.92	88.09
Crude protein (%)	20.12	20.17	20.21

* See table 3.9 and table 3.10.

The parameters measured were: Live weight; Dressed weight, this is the weight of the birds after the removal of feathers and blood; Eviscerated weight, this is the dressed weight less shank, head and offals, weight of feathers; weight of viscera; Total bone, the weight obtained after the removal of total edible meat from eviscerated weight; Total edible meat, the weight of all edible meat in an eviscerated weight after the removal of all the bone, were obtained; Other parameters measured were, weights of drumstick, thigh, neck, wing, back, breast abdominal fat, liver, heart, gizzard, spleen, kidney, and lungs.

4.2.5: BLOOD AND OTHER BODY FLUID PARAMETERS

Blood was collected when the birds were five weeks and ten weeks of age, blood collection was done in the morning around 0800 hours. Hypodermic needle with syringe was used to pierce the jugular vein of the birds from which the blood was drained and collected into bottles. One of the bottles contained heparin as an anticoagulant. The blood in this bottle was used to obtain the plasma while the other bottle contained no heparin and the blood was used to obtain the whole blood and the serum. Blood was collected from at least five chickens in each replicate in order to obtain a pool of blood for a particular replicate. Analysis was carried out on each pool of blood separately.

The blood so collected for plasma analysis was centrifuged for twenty minutes at 2,000 r.p.m. This separated the serum and

plasma which were collected in different bottles. Values for glucose and urea nitrogen were obtained in the whole blood, while values for total protein, albumin, globulin, uric acid, creatinine, creatine, serum glutamate pyruvate transaminase, serum glutamate oxaloacetate transaminase were obtained from the serum, while total protein, albumin, globulin and xanthine dehydrogenase were obtained from the plasma.

4.2.5.1: DETERMINATION OF BLOOD GLUCOSE

Glucose was determined by the O Toluidine method (Cooper and McDaniel 1970; Frings et al 1970). The reaction was carried out in screw-capped tube with Telfon lined caps. An aliquot of 3ml of Toluidine reagent was added to series of the tubes using accurate micro-pipettes, 0.05ml of glucose standard (1.0g of pure glucose in benzoic acid solution (2g/litre) and diluted to 100ml) and blood samples were added to separate tubes. One tube was reserved for the blank in which 0.05ml of water was added. The tubes were capped tightly and the content of each tube was mixed. A boiling water bath was used to heat the tubes and their content at 100°C for 12 minutes, and they were cooled under a running tap water. The standard and samples were read against the blank at 630nm.

Calculation: Concentration of sample =

$$\frac{\text{absorbance of sample}}{\text{absorbance of standard}} \times \text{concentration of standard}$$

4.2.5.2: UREA DETERMINATION

Urea was determined by the Diacetyl monoxine method. In this method equal volumes of colour reagent (Dissolved 1g of diacetyl monoxine 2, 3, butanedione monoxine, 0.2g of thiosemicarbazide and 9g sodium chloride in water and diluted to 1 litre), and acid solution (60ml of concentrated sulfuric acid and 10ml of 85% phosphoric acid to about 800ml of water: Dissolved 0.1g of ferric chloride ($FeCl_3.6H_2O$) in the solution and diluted to 1 litre) were mixed together, and 5ml of the mixed reagent was put in separate tubes using a pipette.

To these tubes, 0.5ml of sample and standard solution were added (Dissolved 1.5g of sodium benzoate and 0.7ml of concentrated sulphur acid in 1 litre of water. 0.644g of pure urea was added to the benzoic acid solution), in the tubes and one tube was used for the blank. All tubes were heated in boiling water bath at 100°C for 15 minutes and cooled. Standard and samples were read against blank at 520nm.

Calculation: Concentration of sample =

$$\frac{\text{absorbance of sample}}{\text{absorbance of standard}} \times \text{concentration of standard}$$

4.2.5.3: DETERMINATION OF SERUM CREATININE

This was determined by the Folin-Wu filtrate method. The serum samples were first filtered and 4ml aliquots from the blank and 4ml standard mixture (which was not filtered) (Dissolved 150mg of pure creatinine in water containing 0.5ml

of concentrated hydrochloric acid made up to 100ml) were transferred to separate tubes.

To each tube 0.2ml of 25M sodium hydroxide solution was added, this was mixed and the standard and sample were read against blank at 520nm at exactly 20 minutes after the addition of the sodium hydroxide solution.

Calculation: Concentration of sample =

$$\frac{\text{absorbance of sample}}{\text{absorbance of standard}} \times \text{concentration of standard.}$$

4.2.5.4: DETERMINATION OF SERUM CREATINE

The serum creatine was determined by Folin method. The preformed creatinine was first determined by the method using the Folin-Wu filtrate as presented earlier. In this section using the same filtrate and diluted standard, to separate 15ml graduated centrifuge tubes, 6ml of water as blank, 3ml of filtrate plus 3ml of water, 1ml of the diluted standard plus 5ml of water were added. To each tube 1ml of picric acid solution (Dissolved 10.5g of reagent grade picric acid in water to make 1 litre (0.04M)), was added and heated in a boiling water bath for about 2 hours until the volume was reduced below 4ml.

The tube was then removed from the bath, cooled and diluted to 4ml. To each tube was added 1ml of NaOH 0.75M, this was mixed and readings taken after 20 minutes at 520nm. The calculations are the same as for preformed creatinine, the standard used corresponds to 2mg/dl creatinine. This gives the total

creatinine in the sample.

Calculation: Total Creatinine - preformed creatinine x 1.16 = Creatine. The factor 1.16 converts creatinine concentration to creatine.

4.2.5.5: DETERMINATION OF SERUM AND PLASMA TOTAL PROTEINS.

The biuret method was used. To a series of appropriately labelled tubes 5ml of biuret reagent was added to the separate tubes, exactly 0.1ml of standard (commercially available lyophilised control serums or plasmas), samples and water (reagent bulk) were added. These were mixed and allowed to stand at 30^{o}C for 10 minutes. The standard and samples were read against blank at 550nm.

Serum blank was set up using the same procedure except that the tartrat iodine blank solution (Dissolved 9g of sodium iodide and 5g of potassium iodide in 0.2M sodium hydroxide solution and diluted to 1 litre) is used instead of the biuret solution. This was read against water blank at 550nm. The absorbance obtained from the blank was subtracted from that obtained from the respective serum samples to obtain correct readings.

Calculation: Concentration of sample g/dl =

$$\frac{\text{Correct absorbance of sample}}{\text{correct absorbance of standard}} \times \text{concentration of standard}$$

4.2.5.6: DETERMINATION OF SERUM AND PLASMA ALBUMIN

This was done by the Bromocresol green binding reagent. To 5ml of the working dye reagent (1 volume of stock bromocresol

green with 3 volumes of the stock buffer were mixed), 25ml of plasma or serum was added and mixed. The standard (commercially available lyophilized serum or plasma) was treated similarly. They were then mixed and allowed to stand for 10 minutes the standard and samples were read against a reagent blank at 628nm.

Calculation: Concentration of sample (g/dl)

$$\frac{\text{absorbance of sample}}{\text{absorbance of standard}} \times \text{concentration of standard}$$

4.2.5.7: DETERMINATION OF SERUM AND PLASMA GLOBULIN

Serum and plasma globulin are the difference between serum and plasma total protein and serum and plasma albumin respectively.

4.2.5.8: DETERMINATION OF SERUM URIC ACID

Uric acid was determined by the phosphotungstate method (Caraway 1963). A sample of 1ml of serum was added to 9ml of tungstic acid precipitating solution (To 800ml of water and 50ml each of the sodium tungstate and sulphuric acid solution used for the Folin Wu precipitation 0.5ml of 85% phosphoric acid was added and diluted to 1 litre). This was mixed well and allowed to stand for 10 minutes. This was later centrifuged to separate tubes, 5ml of the supernatant, 5ml of the working standard, (1g of lithium carbonate was dissolved in 500ml of water and 0.5g of uric acid was added, 5ml of 40% formaldehyde and about 400ml of water were later added and the pH adjusted to 5.5), and 5ml of water as blank were added to separate tubes.

To each tube 1ml of 0.95M sodium carbonate solution was added, mixed well and allowed to stand for 10 minutes. 1ml of the diluted phosphotungstic acid was added to each tube mixed well and allowed to stand for 10 minutes. The standard and sample were read against the blank at 660nm.

Calculation: Concentration of sample

$$\frac{\text{absorbance of sample}}{\text{absorbance of standard}} \times \text{concentration of standard}$$

4.2.5.9: DETERMINATION OF GLUTAMATE OXALOACETATE TRANSAMINASE

This was determined by the Sigma Chemical Company method. 1.0ml sigma prepared substrate stock No. 505-1 was added to a test tube and placed in 37^{o}C water bath to warm. 0.2ml of serum or liver extractant was added mixed together and left in the water bath. Exactly 1 hour after adding serum or liver extractant. 1.0ml sigma colour reagent stock No. 505-2 was added this was mixed thoroughly and left at room temperature (25 $\pm$ 5^{o}C), 20 minutes after adding colour reagent 10.0ml of 0.40N sodium hydroxide solution was added and mixed by inversion. This was allowed to wait for 5 minutes and the absorbance was recorded. The GOT activity was determined in *Sigma-frankel (SF) unit/ml.

4.2.5.10: DETERMINATION OF GLUTAMATE PYRUVATE TRANSAMINASE

This was determined by the Sigma Chemical Company method 1.0ml alanine and ketoglutarate substrate stock No. 505-51 was

added to a test tube and placed in 37°C water bath to warm. 0.2ml serum or liver extractant was added, mixed and left in the water bath. At exactly 30 minutes after adding serum or liver extractant, 1.0ml sigma colour reagent stock No. 505-2 was added, mixed and left at room temperaturer (25°C ± 5°C), 20 minutes after adding colour reagent 10.0ml 0.40N sodium hydroxide solution was added and mixed by inversion. This was allowed to wait for 5 minutes, and the absorbance was recorded, glutamate pyruvate transaminase (GPT) activity was determined in *Sigma-Frankel (SF) unit/ml.

*One Sigma Frankel (SF) unit of GOT or GPT will form 4.82 x 10^{-4} u moles glutamate per minute at pH 7.5 and 25°C.

4.2.5.11: PREPARATION OF LIVER SAMPLES FOR ENZYME ASSAY.

At each carcass analysis two birds per replicate were slaughtered, liver from each bird was removed separated from gall bladder and washed in ice cold 39nM sodium-potassium phosphate buffer pH 7.4. Each liver was then blotted on filter paper, 5 gram sample taken from the whole liver was homogenised with 20ml buffer in a Potter-Elvehjein glass homogeniser with teflon pestle driven at 920 revolutions per minute.

The homogenate was then centrifuged for 20 minutes at 24,000 x g in a refrigerated centrifuge (0°C) fitted with multispeed attachment and rotor No. 5060. At the end of the run care was taken to discard as much as possible of the "fatty fluvy"

layer at the top of the supernatant. The supernatant was decanted labelled and analysed.

4.2.5.12: DETERMINATION OF LIVER AND PLASMA XANTHINE DEHYDROGENASE

The oxidation of hypoxanthine to uric acid is catalysed by xanthine dehydrogenase and proceeds via xanthine. Either hypoxanthine or xanthine can act as substrate for this enzyme which utilizes niacin amide adenine dinucleotide (NAD) as hydrogen acceptor. The procedure used to measure xanthine dehydrogenase followed the colorimetric method of Stripe and Corte (1965). This method is based on the measurement of disappearance of the substrate.

One milliliter of the clear liver supernatant or 1ml of plasma were pre-incubated separately for 20 minutes at 37^{o}C in a shaker water bath inside a 25ml pyrex test-tube containing 4.0ml of 0.039M sodium-potassium phosphate buffer (pH 7.4) and 0.5ml of 0.02M methylene blue. After preincubation period, 0.6ml of 0.38M xanthine solution was added to the reaction mixture, 0.5ml of the aliquot was removed after 10 minutes and immediately placed into centrifuge tube containing 3.5ml of 40 percent sodium tungstate: 2N concentrated sulphuric acid: water (1: 1: 5 v/v). After 15 minutes the volume was adjusted to 6ml with distilled water and the tubes were centrifuged. Xanthine was determined in 1ml portion of the supernatant.

This 1ml was mixed with 1ml of Folin-Ciocaltea reagent, and 5ml of saturated sodium carbonate. The colour intensity was then determined at 660mM using Spectonic 20 spectrophotometer. The standard curve was set up over a range from 4.73 to 94.6u m mole of xanthine. The colour development was carried out in the same manner as for the sample. A plot was made up of the resulting data in which the ordinate was the xanthine remaining in the system (for 1ml of aliquot of the system multiplied by a dilution factor of 48 equivalent of 0.24g of liver) and the abscissa was the absorbance at the 10th minute. Methylene blue did not interfere in the colourimetric determination of xanthine because it was absorbed by the protein precipitate leaving colourless supernatant.

4.2.6: EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS

At the starter phase three dietary treatments were used based on the complete randomised block design, while for the finisher phase each of the three dietary treatments of the starter phase was again divided into three making a total of nine dietary treatments such that the design was a 3 x 3 factorial analysis at the finisher phase. The data collected in both cases were subjected to Analysis of Variance (ANOVA) and Duncan's multiple range test according to the crips and Genstat packages using the Computer.

4.3: RESULTS

4.3.1: FEED UTILIZATION

Table 4.3 presents the feed utilization by the broilers for the starter phase. The table showed that the average live weight of the birds given the three dietary treatments increased progressively as the age increased. At the first three weeks there was no significant difference ($P>0.05$) between the three experimental treatments. However there was significant difference ($P<0.05$) between birds fed premix S and birds fed premix D in weeks four and five but not between birds fed premix R and birds fed the other two premixes in week four. There was significant difference ($P<0.05$) between birds fed premix R and birds fed premix D in week five.

The average weekly feed intake increased progressively from the first week to the fifth week. The feed intake for week two and the total feed intake for the starter phase showed no significant difference ($P>0.05$) between the treatment groups.

Table 4.3 also presents the results for the average weekly body weight gain, feed conversion ratio and the body weight gain per gram protein intake at the starter phase. For the average weekly body weight gain, and feed conversion ratio, there were no significant differences ($P>0.05$) between the experimental treatments in the first four weeks, however significant differences ($P<0.05$) were observed between the experimental treatments in

TABLE 4.3: FEED UTILIZATION

AVERAGE WEEKLY LIVEWEIGHT (GRAMS) AT STARTER PHASE					AVERAGE WEEKLY FEED INTAKE (GRAMS) AT STARTER PHASE				AVERAGE WEEKLY BODY WEIGHT GAIN (GRAMS) AT STARTER PHASE				FEED CONVERSION RATIO AT STARTER PHASE				BODY WEIGHT GAIN PER GRAM PROTEIN INTAKE AT STARTER PHASE			
WEEKS	PREMIX S	PREMIX R	PREMIX D	SEX	PREMIX S	PREMIX R	PREMIX D	SEX	PREMIX S	PREMIX R	PREMIX D	SEX	PREMIX S	PREMIX R	PREMIX D	SEX	PREMIX S	PREMIX R	PREMIX D	SEX
0	39.25	37.80	37.00	0.54																
1	64.58	65.67	63.52	0.51	58.07^{b}	63.49^{ab}	71.04^{a}	3.07	25.33	27.87	26.52	0.60	2.29	2.28	2.68	0.11	1.88	1.90	1.61	0.08
2	132.14	129.60	124.00	1.97	135.71	137.02	134.92	0.50	67.56	63.93	60.48	1.67	2.03	2.14	2.23	0.03	2.15	2.02	1.94	0.06
3	231.93	223.48	207.36	5.89	205.41	200.96	220.53	4.84	99.79	93.88	83.36	3.93	2.06	2.14	2.65	0.14	2.10	2.02	1.64	0.15
4	391.90^{a}	381.66^{ab}	357.70^{b}	8.28	330.43	341.17	372.64	10.37	159.97	158.18	150.34	2.42	2.07	2.16	2.48	0.10	2.09	2.00	1.75	0.11
5	594.39^{a}	571.59^{a}	504.17^{b}	22.12	406.01	398.89	421.11	5.36	200.49^{a}	189.93^{a}	146.47^{b}	13.88	2.03^{a}	2.10^{a}	2.88^{b}	0.22	2.13	2.06	1.50	0.17
Total					1135.63	1141.53	1220.28	22.29												

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$)

week five. The average weekly body weight gain increased progressively from the first week to the fifth week. Week two showed the best feed conversion ratio for all the experimental treatments, while week one showed the least conversion ratio for all the experimental treatments. For the body weight gain per gram protein intake there were no significant differences ($P>0.05$) between the dietary treatments throughout the starter phase.

Table 4.4 presents the average weekly live weight for the birds at the finisher phase, that is after the birds have been redivided and reallocated to another dietary treatment. At week six there was no significant difference ($P>0.05$) between the dietary treatments. For week seven the values ranged from 840.06 grams for birds fed premix D at the starter and finisher phase to 1010. 83 grams for birds fed premix S at the starter and finisher there were significant differences ($P<0.05$) between the different dietary treatments. Values for weeks eight, nine and ten also followed similar trend as in week seven with birds fed premix S at starter and finisher having the highest value and birds fed premix D at starter and finisher phases having lowest value. Significant differences ($P<0.05$) were also observed between the different dietary treatments at the three weeks.

Table 4.5 shows the feed intake for the experimental birds at the finisher phase. There were significant difference ($P<0.05$) between the dietary treatments in all the weeks, and

TABLE 4.4

AVERAGE WEEKLY LIVE WEIGHT (GRAMS) AT FINISHER PHASE OF BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS)				
		6	7	8	9	10
S	S	758.88	1010.83^{a}	1217.69^{a}	1553.24^{a}	1917.86^{a}
	R	772.85	989.00^{ab}	1173.30^{bc}	1500.66^{bc}	1864.13^{bc}
	D	760.07	922.80^{cd}	1116.84^{d}	1456.53^{d}	1792.33^{e}
R	S	753.03	942.90^{bc}	1183.51^{ab}	1524.35^{ab}	1885.53^{b}
	R	745.72	899.88^{cde}	1141.64^{c}	1473.67^{c}	1828.14^{de}
	D	746.54	862.40^{ef}	1076.67^{e}	1370.30^{f}	1749.02^{f}
D	S	719.17	936.32^{c}	1164.91^{bcd}	1502.64^{bc}	1838.76^{cd}
	R	716.99	889.94^{de}	1125.53^{d}	1412.45^{e}	1754.92^{f}
	D	709.32	840.06^{f}	1060.00^{e}	1321.06^{g}	1678.55^{g}
	SEM	6.97	16.35	37.38	25.64	25.65

Values with different superscripts on the same vertical row were significantly different ($P < 0.05$).

TABLE 4.5

AVERAGE WEEKLY FEED INTAKE (GRAMS) AT FINISHER PHASE BY BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES.

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS)					
		6	7	8	9	10	TOTAL
S	S	461.73^{cd}	568.17^{f}	645.26^{f}	689.40^{d}	744.44^{ef}	3069.00^{f}
	R	416.49^{d}	581.50^{d}	658.94^{e}	699.00^{cd}	759.36^{cd}	3115.29^{d}
	D	400.33^{e}	633.11^{a}	709.07^{b}	708.49^{bc}	758.11^{cd}	3209.11^{b}
R	S	426.81^{c}	554.36^{g}	641.83^{f}	671.44^{e}	735.61^{f}	3030.05^{g}
	R	418.11^{d}	587.72^{cd}	662.14^{d}	666.40^{e}	772.00^{b}	3106.37^{e}
	D	399.04^{e}	620.66^{b}	717.83^{a}	723.32^{a}	767.91^{bc}	3228.76^{b}
D	S	438.19^{b}	572.10^{e}	629.37^{g}	700.00^{cd}	746.02^{e}	3085.68^{ef}
	R	462.12^{a}	591.48^{c}	642.10^{f}	711.84^{abc}	752.64^{de}	3160.18^{c}
	D	440.16^{b}	628.36^{a}	697.11^{c}	715.38^{ab}	783.63^{a}	3264.64^{a}
	SEM	6.29	10.15	10.24	12.69	4.72	28.48

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

TABLE 4.6

AVERAGE WEEKLY BODY WEIGHT GAIN (GRAMS) AT FINISHER PHASE BY BROILERS FED DIFFERENT PREMIXES AT STARTER AND FINISHER PHASES.

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS)				
		6	7	8	9	10
S	S	176.50	251.90^{a}	206.91	335.55^{a}	364.55
	R	172.22	216.15^{b}	184.30	327.36^{a}	363.47
	D	154.57	162.73^{cd}	194.04	339.69^{a}	335.80
R	S	181.70	189.87^{c}	240.61	340.84^{a}	361.18
	R	176.11	154.16^{d}	241.76	332.02^{a}	354.47
	D	171.23	115.86^{e}	214.27	293.63^{b}	378.72
D	S	215.97	217.15^{b}	228.59	337.73^{a}	336.12
	R	214.02	172.95^{cd}	235.59	286.92^{b}	342.47
	D	205.20	130.74^{e}	219.94	261.06^{c}	357.49
	SEM	6.26	13.83	6.42	9.14	4.52

Values with different superscripts on the same vertical row were significantly different ($P < 0.05$).

in the total feed intake for the finisher phase. The total feed intake ranged from 3030.05grams for birds fed premix R at starter and finished with premix S to 3264.64 grams for birds fed premix D at starter and finisher phases. The average weekly feed intake for the birds increased progressively from week six to week ten however similar feed intake were observed in weeks eight and nine in most cases. Treatments fed premix S at the finisher phase irrespective of the premix fed at the starter phase had lower total feed intake.

Table 4.6 shows the average weekly body weight gain for the finisher phase. There were no significant differences ($P>0.05$) between the values for the experimental treatments in weeks six, eight and ten, while in weeks seven and nine there were significant differences ($P<0.05$) between the experimental treatments. In week nine birds fed premix S at the starter phase irrespective of the premix fed at the finisher phase; birds fed premix R at the starter phase and finished with either premix S or premix R
and also birds fed premix D at the starter phase and finished with premix S all had better body weight gain.

The feed conversion ratio of the birds in the experimental treatments for the finisher phase is shown in table 4.7. In weeks six, eight and ten there were no significant differences ($P>0.05$) between the experimental treatments, while there were significant differences between the experimental treatments in

TABLE 4.7

FEED CONVERSION RATIO AT FINISHER PHASE OF BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS)				
		6	7	8	9	10
S	S	2.48	2.26^{a}	3.26	2.05^{ab}	2.04
	R	2.45	2.75^{b}	3.66	2.14^{ab}	2.10
	D	2.57	3.89^{e}	3.67	2.10^{ab}	2.26
R	S	2.35	2.98^{c}	2.67	1.97^{a}	2.04
	R	2.37	3.85^{e}	2.76	2.01^{a}	2.18
	D	2.28	5.48^{g}	3.35	2.20^{b}	2.03
D	S	2.03	2.64^{b}	2.76	2.12^{ab}	2.23
	R	2.16	3.43^{d}	2.73	2.50^{c}	2.20
	D	2.15	4.83^{f}	3.25	2.74^{d}	2.21
	SE$\bar{X}$	0.05	0.33	0.12	0.08	0.03

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

TABLE 4.8

BODY WEIGHT GAIN PER GRAM PROTEIN INTAKE AT FINISHER PHASE OF BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS)				
		6	7	8	9	10
S	S	2.07	2.19^{a}	1.59	2.41^{ab}	2.42
	R	2.05	1.85^{b}	1.39	2.44^{ab}	2.37
	D	2.02	1.28^{e}	1.36	2.41^{ab}	2.20
R	S	2.11	1.70^{c}	1.86	2.51^{a}	2.43
	R	2.09	1.31^{e}	1.81	2.47^{ab}	2.28
	D	2.21	0.93^{g}	1.49	2.02^{c}	2.45
D	S	2.45	1.88^{b}	1.80	2.34^{b}	2.23
	R	2.30	1.45^{d}	1.82	2.01^{c}	2.26
	D	2.32	1.04^{f}	1.57	1.81^{d}	2.30
	SE$\bar{X}$	0.04	0.12	0.06	0.07	0.03

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

weeks seven and nine. Results for the feed conversion ratio followed the same trend as the average weekly body weight gain shown in table 4.6.

The results for the body weight gain per gram protein intake at the finisher phase is shown in table 4.8. There were significant differences (P 0.05) only at weeks seven and nine. For week seven birds fed premix S at starter and finisher phase had the best expression of the conversion of feed protein to body protein. It was noted that the trend obtained at week seven is similar to that obtained at week seven of the body weight gain (Table 4.6) and feed conversion ratio (Table 4.7). In week nine there was no clear picture as to which premix produced the best conversion, but treatments fed premix S at the starter phase irrespective of the premix fed at the finisher phase; and treatments fed premix R at the starter phase and finished with either premix S or premix R all had better body weight gain per gram protein intake than birds fed premix D at starter and finished with any premix. Generally lower conversions were obtained at week seven for all experimental treatment except for birds fed premix S at starter and finisher phases, lower conversions were obtained in weeks seven and eight compared to the other weeks, while the best conversions were obtained mostly in weeks nine and ten.

The average weekly live weight and average weekly body weight gain per gram protein intake showed no significant (P 0.05) interaction between the starter premix and the finisher premix, while the average weekly feed intake, average weekly body weight gain and feed conversion ratio showed significant (P 0.05)

interaction between the starter and finisher premixes (appendix 4a).

4.3.2: AVERAGE DAILY NITROGEN RETENTION OF BROILER CHICKENS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASE

The average daily nitrogen retention of the broiler chicks at four weeks is shown in table 4.9. The dry matter intake and dry matter output showed the same trend. Birds fed premix D had values that were significantly higher than the values for birds fed the other premixes, while there was no significant difference (P 0.05) between birds fed premix S and birds fed premix R. In the other parameters measured there were no significant differences (P 0.05) between the dietary treatments.

Table 4.10 presents the result for the average daily nitrogen retention at week nine. There were no significant differences (P 0.05) between the experimental treatments in the nitrogen retention (grams) and nitrogen retention (percentage). Birds fed premix S at the finisher phase irrespective of the premix fed at the starter phase had lower dry matter intake, dry matter output, nitrogen intake, faecal nitrogen output and total nitrogen excreted but higher dry matter digestibility coefficient and nitrogen digestibility coefficient than those fed premix D at finisher phase irrespective of the premix fed at starter. The results also show that values for dry matter output, faecal nitrogen output increased progressively from

TABLE 4.9

AVERAGE DAILY NITROGEN RETENTION AT WEEK FOUR BY BROILER CHICKENS FED THREE PREMIXES.

	PREMIX S	PREMIX R	PREMIX D	SE$\bar{X}$
Dry matter intake (gm)	96.22^{b}	100.29^{b}	107.08^{a}	2.59
Dry matter output (gm)	25.64^{a}	29.56^{a}	33.54^{b}	1.86
Dry matter digestibility coefficient (%)	73.88^{a}	70.56^{a}	68.88^{b}	1.21
Nitrogen intake (gm)	3.56	3.70	3.97	0.10
Fecal Nitrogen output (gm)	0.77	0.91	1.02	0.06
Nitrogen digestibility coefficient (%)	78.41	75.44	74.80	1.28
Total Nitrogen excreted (gm)	1.59	1.74	1.90	0.07
Nitrogen retention (gm)	1.97	1.97	2.07	0.03
Nitrogen retention (%)	55.33	53.23	52.14	0.81

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 4.10

AVERAGE DAILY NITROGEN RETENTION AT WEEK NINE BY BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	D.M.I (gm)	D.M.O (gm)	D.M.D.C (%)	N.I (gm)	F.N.O (gm)	N.D.C (%)	T.N.E (gm)	N.R (gm)	N.R (%)
S	S	135.57^{e}	38.03^{f}	71.98^{a}	4.38^{e}	1.20^{g}	72.64^{a}	2.07^{d}	2.31	52.72
	R	140.85^{bc}	43.35^{b}	69.12^{def}	4.54^{b}	1.36^{c}	70.07^{bc}	2.39^{ab}	2.14	47.01
	D	143.15^{a}	45.24^{a}	68.58^{ef}	4.61^{a}	1.39^{b}	69.88^{bcd}	2.45^{ab}	2.16	46.86
R	S	136.72^{d}	40.33^{e}	70.55^{bc}	4.42^{de}	1.23^{f}	72.20^{a}	2.18^{c}	2.24	50.70
	R	139.83^{c}	41.61^{cd}	70.29^{bc}	4.50^{bc}	1.33^{d}	70.49^{b}	2.37^{b}	2.13	47.30
	D	141.88^{b}	44.02^{b}	68.99^{def}	4.57^{ab}	1.42^{a}	68.94^{d}	2.43^{ab}	2.14	46.85
D	S	137.40^{d}	41.07^{de}	70.20^{bc}	4.44^{cde}	1.26^{e}	71.63^{a}	2.20^{c}	2.24	50.46
	R	140.19^{c}	42.84^{c}	69.52^{cde}	4.51^{b}	1.35^{c}	70.09^{bc}	2.40^{ab}	2.11	46.77
	D	140.64^{c}	44.35^{ab}	68.48^{f}	4.53^{b}	1.40^{b}	69.11^{cd}	2.48^{a}	2.05	45.28
	SE$\bar{X}$	0.79	0.71	0.35	0.02	0.03	0.41	0.05	0.02	0.77

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

D.M.I - Dry matter intake; D.M.O - Dry matter output; D.M.D.C - Dry matter digestibility coefficient; N.I - Nitrogen intake; F.N.O - Faecal nitrogen output; N.D.C - Nitrogen digestibility coefficient; T.N.E - Total nitrogen excreted; N.R - Nitrogen retention (grams); N.R - Nitrogen retention (%).

birds fed the finisher premix S, to birds fed the finisher premix R and lastly birds fed the finisher premix D when any premix of the starter phase is considered. There was significant ($P < 0.05$) interaction between the [illegible] premixes as shown in appendix 4b.

4.3.3: CARCASS CHARACTERISTICS OF BROILER CHICKENS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

The carcass weights of the broiler chickens at week five are presented in table 4.11. The live weight, dressed weight, and eviscerated weight showed significant differences ($P < 0.05$) between the dietary treatments with premix S producing the highest value and premix D the least value. The weight of feathers and weight of viscera were not significantly different ($P > 0.05$) between the dietary treatments. When the values for the carcass traits were expressed as percentage of the live weight and then transformed into arc sine values (table 4.12) there were no significant differences ($P > 0.05$) between the birds given the different dietary treatments in all parameters considered. The premix fed did not produce significant difference ($P > 0.05$) in the weights of selected organs. When the weights of the organs were expressed as percentage of dressed weight and then transformed into arc sine values (table 4.12) there were still no significant difference ($P > 0.05$) between the experimental treatments.

The drum stick, thigh, neck and abdominal fat showed no significant differences ($P > 0.05$) between the experimental treatments.

TABLE 4.11

CARCASS WEIGHT (GRAMS) OF BROILER CHICKENS (AT WEEK FIVE) FED THREE PREMIXES (GRAMS)

	PREMIX S	PREMIX R	PREMIX D	SE$\bar{X}$
CARCASS TRAITS:				
Live weight	587.66^{a}	557.03^{b}	522.92^{c}	15.28
Dressed weight	505.75^{a}	467.49^{b}	436.62^{c}	16.34
Weight of feathers	34.46	31.09	25.79	2.07
Eviscerated weight	409.14^{a}	369.89^{b}	345.57^{c}	15.14
Weight of viscera	77.63	76.11	75.73	0.40
ORGANS:				
Liver	8.29	9.11	8.30	0.22
Heart	2.02	2.06	2.14	0.03
Gizzard	9.73	8.66	8.61	0.38
Spleen	0.51	0.54	0.52	0.01
Kidney	2.18	2.34	2.07	0.09
Lungs	2.55	2.25	2.27	0.08
CUT UP PARTS:				
Drum stick	75.66	74.27	74.21	0.38
Thigh	68.32	61.83	58.31	2.40
Neck	34.39	33.04	31.16	0.77
Wing	56.46^{a}	51.49^{ab}	45.21^{b}	2.66
Back	74.71^{a}	64.35^{ab}	58.67^{b}	3.84
Breast	85.13^{a}	81.62^{ab}	70.81^{b}	3.52
Abdominal fat	4.22	3.11	3.25	0.29
Total edible meat	290.70^{a}	275.73^{b}	250.80^{c}	9.39
Total bone	115.33^{a}	89.16^{b}	91.55^{b}	6.83

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 4.12

ARC SINE VALUES OF CARCASS CHARACTERISTICS OF BROILER CHICKENS (AT WEEK FIVE) FED THREE PREMIXES

	PREMIX S	PREMIX R	PREMIX D	SE$\bar{X}$
VALUES EXPRESSED AS % OF LIVE WEIGHT:				
Dressed weight	68.08	66.36	66.04	0.52
Weight of featherss	14.01	13.65	12.83	0.29
Eviscerated weight	56.55	54.59	54.08	0.62
Weight of viscera	20.97	21.66	22.37	0.33
VALUES EXPRESSED AS % OF DRESSED WEIGHT:				
Liver	7.35	8.01	7.92	0.17
Heart	3.63	3.80	4.01	0.09
Gizzard	7.98	7.82	8.07	0.06
Spleen	1.81	1.95	1.99	0.04
Kidney	3.76	4.05	3.95	0.08
Lungs	4.07	3.97	4.13	0.03
VALUES EXPRESSED AS % OF EVISCERATED WEIGHT:				
Drum stick	25.11^{b}	26.23^{b}	27.62^{a}	0.59
Thigh	23.75	23.73	24.25	0.14
Neck	16.34	16.84	17.32	0.23
Wing	21.40	21.45	21.20	0.06
Back	24.93	24.24	24.38	0.17
Breast	26.78	28.02	26.92	0.29
Abdominal fat	5.82	5.26	5.55	0.13
Total edible meat	56.82	59.70	58.40	0.68
Total bone	32.08	29.40	30.99	0.64

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

The weights of wing, back and the breast showed significant different ($P<0.05$) between birds fed premix D and birds fed premix S there were significantly higher values ($P<0.05$) for birds fed premix S compared with those fed premix D. More total edible meat and more total bone were produced by birds fed premix S than by birds fed other premixes. When the values for the weights for the cut-up parts were expressed as percentage of eviscerated weight and then transformed into the arc sine values (table 4.12), only the drum stick showed significant difference ($P<0.05$) between the experimental treatments. Birds fed premix D had higher drum stick arc sine value than others.

Table 4.13 shows the result for the carcass traits at week ten. Birds fed premix S at the finisher phase but given premix S or premix R at the starter phase had values that were not significantly different ($P>0.05$) for the live weight, weight of feathers and the weight of viscera. Also the live weight, dressed weight, weight of feathers, eviscerated weight and weight of viscera were not significantly different ($P>0.05$) for birds fed premix R at the finisher phase but fed either premix S or premix R at the starter phase. Feeding premix D at the finisher phase regardless of the type of premix fed at the starter phase resulted in the lowest values for the live weight, dressed weight and eviscerated weight. When the weights were expressed as percentage of the live weight and then transformed into the arc sine values (table 4.14) no significant differences ($P>0.05$) were observed

TABLE 4.13

CARCASS TRAITS (GRAMS) OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Live Weight	Dressed weight	Weight of feathers	Eviscerated weight	Weight of viscera
S	S	2040.37^{a}	1726.07^{a}	104.00^{ab}	1366.39^{a}	166.84^{bc}
	R	1987.61^{b}	1663.09^{cd}	98.70^{cd}	1321.18^{b}	164.21^{cde}
	D	1899.64^{c}	1593.68^{f}	92.85^{e}	1236.22^{cd}	154.88^{ef}
R	S	2015.80^{a}	1673.65^{bc}	106.45^{a}	1323.35^{b}	176.10^{ab}
	R	1974.55^{b}	1651.14^{d}	101.19^{bc}	1302.01^{b}	165.46^{cd}
	D	1913.51^{c}	1601.75^{ef}	96.56^{d}	1255.62^{c}	150.12^{f}
D	S	1984.30^{b}	1680.34^{b}	101.98^{bc}	1297.97^{b}	179.77^{a}
	R	1887.76^{c}	1611.51^{e}	98.39^{cd}	1208.93^{d}	159.14^{cdef}
	D	1795.28^{d}	1539.45^{g}	96.13^{d}	1159.16^{e}	156.37^{def}
	$SE\bar{X}$	24.10	17.62	1.34	20. 41	3.07

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

TABLE 4.14

ARC SINE VALUES OF CARCASS TRAITS EXPRESSED AS PERCENTAGE OF LIVE WEIGHT

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Dressed weight	Weight of Feathers	Eviscerated weight	Weight of viscera
S	S	66.89	13.04	54.92	16.62
	R	66.17	12.87	54.64	16.70
	D	66.34	12.57	53.77	16.59
R	S	65.67	13.28	54.12	17.19
	R	66.15	13.09	54.29	16.82
	D	66.19	12.98	54.10	16.26
D	S	66.96	13.10	53.98	17.52
	R	67.52	13.21	53.16	16.87
	D	67.77	13.37	53.47	17.15
	$SE\bar{X}$	0.22	0.10	0.17	0.15

TABLE 4.15

WEIGHT OF ORGANS (GRAMS) OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	LIVER	HEART	GIZZARD	SPLEEN	KIDNEY	LUNGS
S	S	43.65^{a}	12.69^{a}	45.15^{a}	3.71	12.09^{a}	10.62
	R	41.75^{b}	11.73^{b}	42.66^{bc}	3.58	11.01^{cd}	9.80
	D	38.81^{d}	11.24^{cd}	41.28^{cd}	2.87	10.76^{d}	9.48
R	S	41.26^{bc}	11.63^{bc}	43.35^{b}	3.43	11.75^{a}	10.46
	R	38.79^{de}	11.72^{b}	41.26^{d}	3.55	11.06^{cd}	10.41
	D	38.23^{de}	10.98^{d}	40.97^{de}	3.12	10.25^{e}	9.45
D	S	40.24^{c}	11.51^{bc}	43.44^{b}	3.11	11.24^{bc}	10.49
	R	38.27^{de}	10.88^{d}	41.34^{d}	2.98	11.00^{cd}	9.75
	D	37.71^{e}	10.78^{e}	39.87^{e}	3.00	10.13^{e}	9.47
	$SE\bar{X}$	0.63	0.20	0.51	0.11	0.20	0.15

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

TABLE 4.16

ARC SINE VALUES OF ORGANS EXPRESSED AS PERCENTAGE OF DRESSED WEIGHT

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	LIVER	HEART	GIZZARD	SPLEEN	KIDNEY	LUNGS
S	S	9.15[a]	4.93	9.32	2.69	4.80	4.50
	R	9.11[ab]	4.87	9.08	2.69	4.79	4.44
	D	8.98[ab]	4.80	9.28	2.43	4.76	4.52
R	S	9.03[ab]	4.80	9.29	2.63	4.87	4.55
	R	8.82[b]	4.83	9.10	2.69	4.70	4.55
	D	8.88[ab]	4.76	9.21	2.36	4.59	4.41
D	S	8.90[ab]	4.76	9.26	2.50	4.76	4.47
	R	8.87[ab]	4.73	9.23	2.50	4.76	4.66
	D	9.01[ab]	4.80	9.26	2.56	4.66	4.52
	SEX	0.04	0.02	0.03	0.11	0.03	0.01

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

between the experimental treatments in all the parameters considered.

Table 4.15 shows the result for the weight of organs, weights of the liver, heart and gizzard showed that birds fed premix S at the starter and finisher phases had the highest weight. Also the liver, heart, gizzard and kidney showed that birds fed premix S at the starter and finisher phases had significantly ($P < 0.05$) higher weights than birds fed premix D at the finisher phase but fed any of the premixes at the starter phase, when the weights of the organs were expressed as a percentage of the dressed weight and then transformed into arc sine values (table 4.16). Significant differences ($P < 0.05$) existed only between the livers of the experimental treatments. The difference was only between birds fed premix S at the starter and finisher phases, which showed higher values than birds fed premix R at the starter and finisher phases.

Results of the cut up parts at week ten is presented in table 4.17. Birds fed premix S at the starter and finisher phases had the highest weights for the drum stick, thigh and total edible meat. Also the weights of the thigh and neck showed that birds fed premix S at the finisher phase but fed any of the premixes at the starter phase had higher weights than birds fed premix D at the finisher

TABLE 4.17

CUT UP PARTS (GRAMS) OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	D.S	T.H	N.E	W.I	B.A	B.R	A.F	T.E.M.	T.B
S	S	206.85^{a}	204.74^{a}	81.33^{c}	160.53^{a}	278.85^{a}	402.35	29.45	1016.58^{a}	349.02
	R	196.95^{b}	191.89^{b}	80.84^{c}	156.41^{ab}	267.92^{bc}	408.11	32.40	971.34^{b}	349.05
	D	181.51^{d}	176.62^{de}	72.08^{f}	145.81^{cd}	258.90^{cd}	375.32	24.39	886.40^{d}	349.19
R	S	191.69^{bc}	191.10^{b}	91.38^{a}	151.52^{bc}	277.11^{ab}	395.06	24.10	963.34^{b}	358.90
	R	181.87^{c}	184.45^{bc}	85.56^{b}	144.67^{cd}	265.05^{c}	404.33	27.51	951.36^{bc}	349.30
	D	185.57^{cd}	178.91^{cd}	77.75^{d}	139.75^{d}	266.81^{c}	379.25	25.55	925.66^{c}	328.70
D	S	191.72^{bc}	186.85^{b}	81.66^{c}	144.28^{cd}	260.05^{c}	404.22	27.64	922.45^{c}	374.72
	R	172.88^{e}	175.09^{de}	75.38^{e}	134.62^{e}	249.90^{de}	373.36	26.41	863.95^{d}	343.79
	D	171.34^{e}	169.64^{e}	75.83^{de}	135.38^{e}	240.12^{e}	348.14	17.41	831.29^{e}	326.72
	$SE\bar{X}$	7.48	3.36	1.74	2.80	3.87	6.31	1.31	18.16	4.55

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

D.S - Drum stick; T.H - Thigh; NE - Neck; WI - Wing; BA - Back; BR - Breast; A.F - Abdominal fat; T.E.M - Total edible meat; T.B - Total bone.

TABLE 4.18

ARC SINE VALUES OF CUT UP PARTS EXPRESSED AS PERCENTAGE OF EVISCERATED WEIGHT

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	D.S	TH	NE	WI	BA	BR	A.F	T.E.M	T.B
S	S	22.90	22.75	14.13	20.05	26.86	32.86	8.45	59.61	30.40
	R	22.71	22.41	14.32	20.13	26.77	33.74	9.02	59.03	30.60
	D	22.53	22.21	13.97	20.09	27.23	33.44	8.09	57.85	32.15
R	S	22.25	22.33	15.24	19.78	27.23	33.10	7.80	58.56	31.44
	R	22.40	22.10	14.85	19.48	27.08	33.87	8.35	58.73	31.27
	D	22.63	22.18	14.41	19.49	27.08	33.34	8.72	59.16	30.84
D	S	22.19	22.30	14.52	19.48	27.09	33.93	8.39	57.44	32.56
	R	22.22	22.36	14.47	19.50	27.04	33.76	8.51	57.70	32.29
	D	22.21	22.50	14.84	19.98	27.15	33.22	7.03	58.21	32.11
	SE$\bar{X}$	0.08	0.06	0.13	0.09	0.12	0.12	0.18	0.23	0.29

D.S - Drum stick; TH - Thigh; NE - Neck; WI - Wing; BA - Back; BR - Breast

A.F - Abdominal fat; T.E.M - Total edible meat; T.B - Total bone.

phase but fed any of the premixes at the starter phase. When the weights of the cut-up parts were expressed as percentage of the eviscerated weights and then converted to the arc sine values (table 4.18) there were no significant differences between the experimental treatments in all parameters. Significant interactions ($P<0.05$) (appendix 4c) were observed between the starter premixes and finisher premixes in the carcass traits (table 4.13), organs (table 4.15), and cut-up parts (table 4.17).

4.3.4: PROTEIN CONTENT OF ORGANS OF BROILER CHICKENS FED DIFFERENT PREMIXES AT STARTER AND FINISHER PHASES

Table 4.19 presents the results of the percentage crude protein content of organs of broiler chicks at week five. The liver and spleen followed the same trend with birds fed premix S having the highest percentage crude protein. The heart and the gizzard of birds fed premix R had the highest crude protein. Values for the liver, heart and lungs of birds fed premix S had significantly higher crude protein than birds fed premix D, while birds fed premix D had the highest kidney crude protein.

The results for the percentage crude protein of the organs at week ten is shown in table 4.20. Birds fed premix S at the starter and finisher phases had the highest crude protein in the liver and kidney, The heart and lungs of birds fed premix S at the starter phase and finished with premix R had the highest crude protein. Protein in gizzard and lungs of birds fed premix R

TABLE 4.19

PERCENTAGE CRUDE PROTEIN (DRY MATTER BASIS) OF ORGANS OF FIVE WEEK OLD BROILERS FED DIFFERENT PREMIXES

	PREMIX S	PREMIX R	PREMIX D	$SE\bar{X}$
Liver	89.29^{a}	87.04^{b}	86.16^{c}	0.76
Heart	74.60^{b}	75.99^{a}	73.07^{c}	0.69
Gizzard	73.53^{b}	76.53^{a}	74.33^{b}	0.73
Spleen	56.83^{a}	53.07^{c}	55.19^{b}	0.89
Kidney	78.26^{b}	79.95^{b}	82.11^{a}	0.91
Lungs	75.75^{a}	74.67^{ab}	73.89^{b}	0.44

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 4.20

PERCENTAGE CRUDE PROTEIN (DRY MATTER BASIS) OF ORGANS OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	LIVER	HEART	GIZZARD	SPLEEN	KIDNEY	LUNGS
S	S	77.15^{a}	66.86^{b}	65.85^{cd}	43.27^{d}	70.94^{a}	69.01^{b}
	R	74.52^{c}	69.28^{a}	66.74^{bc}	40.21^{e}	67.80^{b}	71.35^{a}
	D	73.35^{d}	66.09^{b}	68.27^{a}	39.35^{f}	66.52^{c}	68.50^{bc}
R	S	73.57^{d}	64.75^{c}	66.84^{b}	46.81^{a}	67.67^{b}	67.96^{c}
	R	71.91^{e}	64.52^{cd}	64.47^{fg}	47.29^{a}	65.54^{cde}	66.03^{e}
	D	75.39^{b}	66.48^{b}	65.91^{bcd}	45.36^{bc}	64.92^{ef}	63.72^{f}
D	S	71.58^{e}	64.34^{cd}	65.58^{de}	45.48^{bc}	65.27^{de}	69.34^{b}
	R	73.26^{d}	63.24^{d}	64.76^{ef}	43.32^{d}	63.70^{f}	67.01^{d}
	D	73.65^{d}	64.35^{cd}	63.61^{g}	44.65^{c}	63.64^{f}	66.34^{e}
	SE$\bar{X}$	0.53	0.56	0.46	0.89	0.73	0.70

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

or premix D at the starter and finisher phases were not significantly different ($P > 0.05$). Protein in the spleen of birds fed premix R at the starter phase and finished with either premix S or premix R was not significantly different. However for most of the organs no particular trend was observed in their crude protein content. Significant interactions were observed between the starter premixes and finisher premixes as shown in appendix 4c.

4.3.5: INDICES OF PROTEIN UTILIZATION BY BROILER CHICKENS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES.

Table 4.21 presents the result for the indices of protein utilization for five weeks old broilers. The table presents the level of some whole blood, plasma, serum and liver fluid components. The results showed no significant difference ($P > 0.05$) in selected serum components, plasma components, blood urea nitrogen and liver glutamate pyruvate transaminase (LGPT) between the birds fed the various premixes. The blood glucose showed no significant difference ($P > 0.05$) between birds fed premix S and those fed premix D, but birds fed these two premixes had significantly higher blood glucose than birds fed premix R. Liver glutamate oxaloacetate transaminase (LGOT) showed no significant difference ($P > 0.05$) between birds fed premix S and those fed premix R, but birds fed these two premixes had significantly higher LGOT than birds fed premix D. Liver xanthine dehydrogenase showed significant difference ($P < 0.05$) between the birds fed the various

TABLE 4.21

INDICES OF PROTEIN UTILIZATION BY FIVE WEEKS OLD BROILER CHICKENS FED THREE PREMIXES.

	PREMIX S	PREMIX R	PREMIX D	SE$\bar{X}$
WHOLE BLOOD (Mg/dl):				
Blood glucose	347.95^{a}	323.90^{b}	338.89^{a}	5.73
Blood urea nitrogen	11.74	12.95	14.19	0.58
PLASMA:				
Total proteins (gm/dl)	9.73	9.33	8.06	0.41
Albumin (gm/dl)	6.65	6.66	5.55	0.30
Globulin (gm/dl)	3.09	2.68	2.51	0.14
Plasma xanthine dehydrogenase (i.u/10min/litre)	2.36	2.45	2.64	0.14
SERUM:				
Total proteins (gm/dl)	11.64	10.59	9.78	0.44
Albumin (gm/dl)	7.12	6.38	5.53	0.38
Globulin (gm/dl)	4.52	4.21	4.25	0.09
Uric acid (mg/dl)	1.65	1.85	2.01	0.09
Creatinine (mg/dl)	1.25	1.38	1.42	0.04
Creatine (mg/dl)	0.21	0.34	0.31	0.06
SGPT (SF unit/ml)	32.11	31.04	31.24	0.27
SGOT (SF unit/ml)	44.28	46.84	45.44	0.61
LIVER FLUID:				
LGPT (SF unit/ml)	92.07	89.22	84.53	1.80
LGOT (SF unit/ml)	113.53^{a}	110.25^{a}	105.22^{b}	1.98
Liver xanthine dehydrogenase (Umole/10 min/g fresh liver)	6.02^{c}	6.82^{b}	7.40^{a}	0.33

Values with different superscript on the same horizontal row were significantly different ($P<0.05$).

premixes with birds fed premix D having the highest value.

Table 4.22 presents the results for some whole blood and plasma components of ten weeks old broilers. The result showed no significant difference ($P > 0.05$) between the birds fed the various premixes in their blood glucose, plasma albumin and plasma globulin. Highest blood urea nitrogen was found in birds fed premix D at the starter and finisher phases, while birds fed premix S at the starter and finisher phases had the lowest blood urea concentration. The plasma total protein values showed that birds fed premix D at the starter phase and finished with any of the three premixes had the lowest values. While birds fed premix R at the starter phase and finished with either premix S or premix D and birds fed premix D at the starter phase and finished with premix R had the highest plasma xanthine dehydrogenase. However in most of the parameters no consistent trend was obtained.

Table 4.23 shows the result of some serum components of ten weeks old broilers. There were no significant differences ($P > 0.05$) in the total protein, albumin and creatine of the birds fed the various premixes. Birds fed premix S at the starter and finisher phases had the highest serum glutamate pyruvate transaminase (SGPT), while birds fed premix D at the starter and finisher phases had the lowest serum glutamate oxaloacetate transaminase (SGOT). Birds fed either premix R at the starter and premix D at the finisher phases or premix D at the starter and premix R at the finisher phases had serum creatinine values that were not significantly different. However the globulin and uric acid values

TABLE 4.22

AVERAGE VALUES OF SOME WHOLE BLOOD AND PLASMA COMPONENTS OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES.

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	WHOLE BLOOD COMPONENTS		PLASMA COMPONENTS			
		Blood glucose (Mg/dl)	Blood urea nitrogen (Mg/dl)	Total protein (gm/dl)	Albumin (gm/dl)	Globulin (gm/dl)	Xanthine dehydrogenase (i.u/10 min/ litre)
S	S	428.82	14.07^{f}	14.45^{a}	10.30	4.15	3.19^{e}
	R	422.89	17.00^{cd}	14.13^{ab}	9.87	4.26	3.43^{d}
	D	414.76	16.74^{c}	14.06^{abc}	9.86	4.21	3.52^{bc}
R	S	398.82	16.93^{cd}	14.00^{bc}	9.45	4.55	4.03^{a}
	R	401.69	15.90^{e}	13.96^{bc}	10.10	4.03	3.48^{cd}
	D	421.35	17.29^{de}	13.74^{c}	9.91	3.84	4.17^{a}
D	S	393.61	16.69^{c}	12.97^{d}	8.09	4.52	3.67^{b}
	R	404.30	17.78^{b}	12.91^{de}	8.63	4.16	4.14^{a}
	D	384.63	18.42^{a}	12.56^{e}	8.36	4.20	3.50^{bcd}
	$SE\bar{X}$	4.67	0.39	0.21	0.26	0.11	0.11

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

TABLE 4.23

AVERAGE VALUES OF SOME SERUM COMPONENTS OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES.

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	T.P (gm/dl)	AL (gm/dl)	GL (gm/dl)	U.A (mg/dl)	CRN (mg/dl)	CT (mg/dl)	SGPT (SF unit/ml)	SGOT (SF unit/ml)
S	S	15.45	8.75	6.80^{ab}	3.01^{f}	2.96^{e}	0.83	74.43^{a}	81.55^{a}
	R	15.02	8.67	6.36^{c}	3.61^{de}	3.29^{cde}	0.90	68.90^{c}	74.49^{b}
	D	15.12	8.21	6.91^{a}	3.95^{cd}	3.36^{cd}	0.90	67.97^{c}	72.23^{c}
R	S	16.41	10.51	5.81^{d}	3.51^{de}	3.19^{de}	0.86	67.71^{c}	73.84^{bc}
	R	15.52	9.03	6.49^{bc}	3.87^{cd}	3.48^{cd}	0.93	58.90^{e}	80.24^{a}
	D	14.85	9.54	5.32^{e}	4.45^{ab}	4.32^{ab}	0.95	64.38^{d}	75.40^{b}
D	S	15.37	8.82	6.55^{bc}	3.46^{ef}	3.56^{c}	0.99	59.45^{e}	69.33^{d}
	R	14.41	7.70	6.76^{ab}	4.10^{bc}	4.07^{b}	1.00	70.87^{b}	74.39^{b}
	D	14.27	7.79	6.44^{c}	4.74^{a}	4.59^{a}	0.98	59.58^{e}	67.13^{e}
	SE$\bar{X}$	0.20	0.26	0.16	0.17	0.18	0.02	1.75	1.45

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

T.P - Total protein; AL - Albumin; GL - Globulin; U.A - Uric acid; CRN - Creatinine; CT - Creatine; SGPT - Serum glutamate pyruvate transaminase; SGOT - Serum glutamate oxaloacetate transaminase.

TABLE 4.24

AVERAGE VALUES OF SOME LIVER FLUID COMPONENTS OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES.

PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Liver glutamate pyruvate transaminase (SF unit/ml)	Liver glutamate oxaloacetate transaminase (SF unit/ml)	Liver xanthine dehydrogenase (Umole/10 min/ g fresh liver)
S	S	184.23^{a}	278.08	12.21^{de}
	R	176.14^{a}	279.21	13.36^{bc}
	D	183.26^{a}	255.51	14.04^{ab}
R	S	186.82^{a}	249.13	11.40^{e}
	R	182.75^{a}	228.66	12.33^{d}
	D	176.70^{a}	254.24	12.85^{cd}
D	S	163.71^{b}	242.65	13.24^{bc}
	R	163.60^{b}	251.78	13.89^{b}
	D	163.33^{b}	234.64	14.82^{a}
	SEX	2.80	5.42	0.27

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

showed no consistent trend. Table 4.24 shows the result of some liver fluid components of ten weeks old broilers. There were no significant differences ($P>0.05$) in the liver glutamate oxaloacetate transaminase (LGOT) of the broilers. Birds fed premix S at the starter phase and finished with any of the three premixes, and birds fed premix R at the starter phase and finished with any of the three premixes had higher liver glutamate pyruvate transaminase (LGPT) than those fed premix D at the starter phase. The xanthine dehydrogenase was highest in birds fed premix D at the starter and finisher phases, although it was not significantly different ($P>0.05$) from the value for birds fed premix S at the starter phase and finished with premix D.

4.4: DISCUSSION

4.4.1: FEED UTILIZATION BY BROILER CHICKENS FED DIFFERENT PREMIXES AT THE STARTER AND FINISHER PHASES

Premixes are of fundamental importance in the diets of chickens, since they provide easy method of addition of important vitamins and trace minerals to the diets of chickens. Vitamins and trace minerals found in conventional feed ingredients may not be enough for broiler chickens and any attempt to exclude premixes from the diet may lead to severe damage to the birds. The composition of the premixes used in this trial (Table 3.9 and table 3.10) showed that they contained different number of vitamins and trace minerals but premix S had higher quantity of

these vitamins and trace minerals.

At the starter phase birds fed premix S had the highest live weight at week five. The values obtained for the live weight of the broilers at five weeks were similar to that obtained by Okon (1987), but higher than that obtained by Ofovbe (1987). The values obtained for the live weight at the tenth week for the birds in the nine dietary treatments were higher than that obtained by Wahid et al (1974) even though their own experiment lasted for twelve weeks, it was however similar to that obtained by Akpet (1987), although his experiment lasted for nine weeks. The result of the live weight at week ten showed great discrepances between birds fed premix S at the starter and finisher phases which had the highest body weight and birds fed premix D at the starter and finisher phases which had the lowest body weight, the high body weights of birds fed premix S at starter and finisher phases may be due to the high amount of the vitamins and trace minerals present in premix S, but at the same time premix S lacked some important vitamins and trace minerals (table 3.9 and table 3.10) as said earlier, and one would expect this to have an effect on the live weight of the birds. It appears that the feedingstuff supplied adequate quantities of the micronutrients not present in premix S.

The average feed intake figures obtained in this trial at the starter phase showed that birds fed premix D, had the

highest total feed intake. This high feed intake was not reflected in the body weight since the birds had the lowest body weight at week five. The high feed intake of birds fed premix D may be due to the unavailability of the vitamins and trace minerals present in premix D (table 3.9 and table 3.10) which may inturn lead to increased consumption of feed by the birds in order to meet their requirements for these vitamins and trace minerals, but the birds have a limit in the amount of feed they can consume. The whole exercise may then lead to the birds having satisfied the quantity of feed they can take, but at the same time not satisfying their requirements for these vitamins and trace minerals. But they can not take in more feed in order to meet their requirements for these vitamins and trace minerals, so that on the long run what happened was that the birds were satisfied in terms of the amount of feed they consumed, but their requirements for vitamins and trace minerals which are important in protein metabolism and growthh were not met. This inturn drastically affected the live weight.

The body weight gain values obtained in this experiment were at four weeks lower than that of Ogunmodede (1976), at five weeks lower than that of Al-Nasser et al (1986). The average weekly body weight gain at starter phase of the birds in the three dietary treatments increased progressively from week one to five, with birds fed premix S having the highest value.

At week ten there was no significant difference ($P > 0.05$) in the average weekly body weight gain of the birds fed the various dietary treatments. The values obtained at week ten were higher than that of Henry et al (1986). The average weekly body weight gain were little affected by the premixes that were fed but one would have expected birds fed premix D to have the highest body weight gain since they consumed the largest amount of feed.

The feed conversion ratios reported here were better than those reported by Temperton and Cassidy (1964), but they are comparable to the findings of Begin (1967). Birds fed premix S at the starter phase had the best feed conversion ratio at week five, while birds fed premix D had the least, this actually confirms that most of the feeds being consumed by the birds fed premix D were not properly utilized. For the finisher phase there was no significant difference ($P > 0.05$) in feed conversion ratio at week ten. The insignificant difference in the feed conversion ratio at that week is in agreement with the findings of Watts and Davis (1960), Edward et al (1963) who reported no significant difference in efficiency of utilization of feed at particular weeks due to the fact that broiler chickens in each experimental group made use of consumed feed almost equally.

The body weight gain per gram protein intake ratios of the birds fed the various premixes did not show much difference between the starter and finisher phases, this will be expected

since this relationship of body weight and protein intake is not absolute, many factors are needed to be taken into consideration when feed proteins are to be related to body protein or to growth. These factors include standardization of the feed protein, sex, age of the animal, and duration of the experiment.

4.4.2: AVERAGE DAILY NITROGEN RETENTION

At week four birds fed premix S had the lowest dry matter intake and dry matter output but they had the highest dry matter digestibility coefficient. While at week nine birds fed premix S at the starter and finisher phases also had the lowest dry matter intake and dry matter output, but showed the highest dry matter digestibility coefficient. The better dry matter digestibility coefficient of the birds fed premix S throughout the experiment (both starter and finisher phases) may be responsible for the better performance of these birds in terms of live weight and body weight gain of the birds.

The nitrogen intake, nitrogen output and nitrogen digestibility coefficient also followed the same trend like the dry matter digestibility trial. The nitrogen digestibility values obtained in this study were lower than those of Kroydahl and Dalsgard (1981). It was observed that the type of premix had a very significant effect on the dry matter intake, dry matter output and dry matter digestibility coefficient at both weeks four and nine, but it had no significant effect on the nitrogen intake,

nitrogen output, and nitrogen digestibility coefficient at week four, however significant effects were observed at week nine.

The total nitrogen output for week four showed that birds fed premix D had the highest nitrogen excreted. They also had the highest nitrogen retention in grams, while they had the lowest nitrogen retention in percentage. For week nine birds fed premix S at starter and finisher phases had the lowest total nitrogen excreted, highest nitrogen retention in grams and in percentage. However the type of premix fed at both the starter and finisher phases had significant effect on only the total nitrogen excreted. It was observed that birds fed a particular premix at the starter phase had higher percentage nitrogen retention at week four than at week nine when fed the same premix at the finisher phase. This will be expected since at week four most of the tissues being laid down by the birds are proteinaceous tissues compared to week nine when most of the tissues laid down are fat tissues. The high nitrogen retention of birds fed premix S at week four and high nitrogen retention of birds fed premix S at the starter and finisher phases in week nine may be responsible for the better performance of birds fed premix S at both the starter and finisher phases. Although birds fed premix D at the finisher phase had higher dry matter intake which resulted in their high nitrogen intake they still had lower dry matter digestibility coefficient and lower nitrogen

digestibility coefficient, due to their high dry matter output and high faecal nitrogen output.

One would have expected that the high dry matter intake of birds fed premix D at week four which produced a better or higher nitrogen retention, to also produce higher body weights but this was not the case. Rather they had the lowest body weight, this may be due to the improper balance and unavailability of vitamins and trace minerals in premix D and other nutrients in the diet. This imbalance may inturn lead to improper utilization of nutrients such that body growth is not enhanced. This thus indicates that high feed intake does not mean proper utilization of the nutrients contained in the feed.

4.4.3: CARCASS CHARACTERISTICS

The values for the live weight of broilers slaughtered at five weeks in this study ranged from 522.92g to 587.66g, the value obtained for the birds slaughtered at ten weeks ranged from 1795.28g to 2040.37g and were higher than that of Wahid et al (1974) who slaughtered at twelve weeks. There was significant effect of premixes fed at the starter and finisher phases on the live weight of the birds slaughtered at five and ten weeks respectively. The type of premix fed at the starter and finisher phases also had significant effect on the dressed weight values with the same trend being observed as in the live weight.

The dressed weight values obtained in this study were higher than that reported by Benoff and Hudspeth (1981), but were similar to that reported by Lesson and Summer (1983); and Ofovbe (1987). The values may be due to the live weight of the birds since Hayse and Marion (1973) confirmed that heavier birds produced a greater eviscerated yield.

The weights of feathers at week five and week ten showed that birds with higher body weights had higher feather weights. This may be due to their large surface area causing the need for more feathers to cover their body. This is not in support of Znanieaka and Frydrychenez (1976) who observed that feathers account for 6 - 8% of the body weight of birds and this tends to decrease with increasing body weight. The value for the eviscerated weight at week five ranged from 345.57g to 409.14g with the type of premix fed having a significant effect on the weights. The values obtained at week ten were significantly affected by the type of premix fed at the finisher phase and partially by the type of premix fed at the starter phase.

The weight of viscera showed no significant effect of the premixes fed at week five, while at week ten the weight showed that birds with higher live weight had the highest viscera weight. This may account for their high live weight, since most of the viscera consist of the digestive tract, thus the larger digestive tract may indicate better feed utilization.

The result obtained for the arc sine values for the carcass traits at week five showed no significant difference between the premixes. The same observation was made at week ten when the arc sine values for the carcass traits showed no significant effect of the premix fed at the starter and finisher phases. The arc sine values of the carcass traits were lower than that reported by Okon (1987). The difference in result observed in respect of the arc sine values of the carcass traits may be due to the type of experimental diets, age of the birds at slaughter, strain of birds, and the nature of the routine management techniques employed.

The drum stick, thigh, neck and abdominal fat showed no significant difference ($P>0.05$) between the dietary treatments at week five, however birds fed premix S had the highest cut-up parts value in all the parts considered. When the values for the cut up parts were expressed as percentage of the eviscerated weight and then transformed into the arc sine values only the drum stick showed significant difference. At week ten except for the breast, abdominal fat and total bone, there was significant effect of the dietary treatment fed on the weights obtained. The weights obtained for the different parameters in the cut up parts at ten weeks were slightly higher than those obtained by Wahid et al (1974) and Akpet (1987), the difference may be due to the age since Wahid et al (1974) slaughtered their

birds at twelve weeks, while Akpet (1987) slaughtered his birds at nine weeks. Znanieaka and Frydrychenez (1976) confirmed that edible meat increase with increasing body weight. This supports the higher edible meat that was observed in birds with higher live weight at both the starter and finisher phases.

4.4.4: PERCENTAGE CRUDE PROTEIN CONTENT OF ORGANS

The percentage crude protein content of organs gives a picture of the extent to which proteinaceous tissues or substances have been laid down in the organs. It was observed that the liver had the highest crude protein content (percentage) at both week five and week ten, with higher crude protein percentage generally being observed at week five than at week ten. This generally will be expected since the liver (and other organs) of the birds when young (week five) is very active in protein synthesis than when the birds are old (week ten), since less protein is laid down at older age when compared with younger age. At week five values obtained for the liver showed premix S having the highest value. However the values obtained for the other organs at week five were inconsistent.

At week ten values obtained for the liver showed bird fed premix S at the starter and finisher phases having the highest crude protein content and with consistent trend being observed for the liver value. Birds fed premix S at the starter and finisher phases also had the highest crude protein content for

the kidney. This may indicate better utilization of the vitamins and trace minerals present in premix S for the synthesis of protein in this two organs (Featherson 1979). For the other organs inconsistent trends were obtained. However birds fed premix S at starter and finished with premix R had the highest percentage crude protein for the heart and lungs. For the spleen it was the group of birds fed premix R at starter and finisher phases, while birds fed premix S at starter and finished with premix D had the highest percentage crude protein for gizzard.

4.4.5: INDICES OF PROTEIN UTILIZATION

Feeding broiler chickens rations containing different permixes at week five had significant effect on the blood glucose, liver glutamate oxaloacetate transaminase (LGOT), and liver xanthine dehydrogenase. At week five birds fed premix S had the highest blood glucose level. At week ten dietary treatment had no significant effect on the blood glucose level, plasma albumin, plasma globulin, serum total protein, serum albumin, creatine , and liver glutamate oxaloacetate transaminase (LGOT). The values obtained for the blood urea nitrogen at ten weeks showed that feeding premix D at starter and finisher phases gave the highest blood urea nitrogen. Kumta and Harper (1961) used blood urea nitrogen to demonstrate protein utilization by rats and they showed that rats with high blood urea nitrogen had lower

protein utilization. This supports the low nitrogen retention and body weights observed in birds fed premix D at starter and finisher phases.

The plasma total protein showed birds fed premix S at the starter and finisher phases at week ten having the highest value. Tao and Hurley (1971) have shown that zinc deficiency causes alteration in plasma protein pattern in rats, thus one would expect the zinc deficiency in premix S to have detrimental effect on the plasma protein perhaps adequate zinc was supplied by the feedingstuff.

The plasma xanthine dehydrogenase showed birds fed premix R at starter and finished with premix D at week ten had the highest level. However for the plasma xanthine dehydrogenase levels inconsistent results were obtained when compared to the results obtained for the nitrogen excretion. The serum globulin values obtained at week ten were inconsistent. However birds fed premix S at starter and finished with premix D had the highest value. Uric acid is the main end product of nitrogen metabolism in birds. The values obtained for the serum uric acid at week ten showed that birds fed premix D at the starter and finisher phases had the highest value. This is consistent with the high value of total nitrogen excretion obtained for birds fed the same combination of the premix. It has been observed that uric acid accounts for 55% - 82% of the total nitrogen excreted by the chicks (Shoemaker 1972).

Eggum (1970) reported that serum creatinine can be used as indirect measure of protein utilization as the values tend to be higher with low dietary protein levels. In this study however the higher values of serum creatinine observed in birds fed premix D may indicate low utilization of the vitamins and trace minerals in premix D which subsequently affected the proper utilization of the feed protein. Serum glutamate oxaloacetate transaminase (SGOT) and serum glutamate pyruvate transaminase (SGPT) mainly give information concerning the severity and state of liver and heart damage. However they have also been used extensively to study the state of protein metabolism in man and animals (Grigorev and Truznikova 1970; Ghazalah et al 1980; Saroka and Combs 1986). The premixes had no effect on the SGOT and SGPT at five weeks while at ten weeks the premixes had significant effects on the SGOT and SGPT with birds fed premix S at the starter and finisher phases having the highest level in both cases. Daghir and Balloun (1963) reported that the level of pyridoxine (vitamin B_6) present in the diet affects the level of SGOT and SGPT present in chicks blood, while Loza (1979) showed that in broilers, activity of the transaminating enzymes in serum correlated significantly with average daily body weight, body weight gain, and quick maturity. Putting these two findings together one may conclude that the high pyridoxine level of premix S and the higher levels of transaminating

enzymes in serum of birds fed premix S is responsible for the high live weight and better performance observed in birds fed this premix either at the starter phase or at the starter and finisher phases.

The level of liver glutamate oxaloacetate transaminase (LGOT) at week five showed that birds fed premix S had the highest level, but the diet had no significant effect on the liver glutamate pyruvate transaminase (LGPT). At week ten birds fed premix R at starter and finished with premix S had the highest LGPT level while the diets had no significant effect on the LGOT at week ten. It is known that both LGOT and LGPT play very important roles in protein metabolism since most of the amino acid degradation and synthesis takes place in the liver, where there is movement of amino group from one amino acid to another, or generally from one amino group donor to another amino group acceptor.

Xanthine dehydrogenase plays a very important role in protein and amino acid catabolism in chickens, since it functions in the pathway by which proteins and amino acids are catabolised to produce uric acid which is the main nitrogenous excretory product for chickens. Hevia and Clifford (1977b) have also shown that uric acid production and xanthine dehydrogenase level may be used as an index of protein utilization. The result of the

liver xanthine dehydrogenase at five weeks showed birds fed premix D having the highest value, the result for week ten also showed birds fed premix D at starter and finisher phases having the highest value. The high values being observed by birds fed this premix(es) may be responsible for the low live weight observed. This high xanthine dehydrogenase might have caused a high degradation of the nitrogen consumed by birds fed this premix(es). Nitrogen had then been excreted instead of being laid down as tissues. This was confirmed by the high total nitrogen excretion which was observed for the birds.

Indication from the parameters considered in this experiment at the starter phase especially the live weight and carcass traits showed that birds fed premix S or premix R had better performance than birds fed premix D. Parameters used for the finisher phase indicated that starting the birds on either premix S or premix R, and finishing them with either of the two premixes (premix S or premix R) gave satisfactory result.

CHAPTER FIVE

PROTEIN UTILIZATION BY BROILER CHICKENS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

5.1: INTRODUCTION

Considerable attention has been paid to the use of fat in broiler diets because of the beneficial effect observed when fat is added to broiler diets. Since chicks eat according to their energy requirement, they therefore obtain less total feed as the energy value of the diet increases. Thus the quantity of fat present in the diet may affect the requirement of the birds for various vitamins and trace minerals. This is because birds may not get enough vitamins and trace minerals if their energy requirement is satisfied before they consume the amount of diet containing their required amount of vitamins and trace minerals. It is important that the vitamins and trace minerals level of the diet must be such that the birds will receive enough vitamin and trace mineral from the feed consumption rate governed by the energy level of the diet.

Moreover it is possible that the need of one vitamin may be raised by increasing the intake of fat, while that for another vitamin or trace mineral may be lowered. It seems probable that a balanced intake of vitamin and trace minerals which is appropriate when the diet is low in fat may become imbalanced when the diet is high in fat or vice versa. Thus the purpose

of this experiment based on the results obtained from the last experiment in which it was observed that different premixes may be required for the starter and finisher phases when certain types of premixes are used, was to observe if there is any effect of adding two levels of palm oil to the diet. The experiment was also designed to show the premix that will give the best protein utilization at the starter and finisher phases when these two oil levels are added to the diet. Two low levels of oil were used in order to minimise the effect of rancidity of the oil on the vitamins and trace minerals present in the different premixes.

5.2: MATERIALS AND METHODS

5.2.1: BIRDS AND THEIR MANAGEMENT

The experiment was carried out at the Teaching and Research Farm, University of Ibadan. Five hundred and forty Hubbard broiler chickens of mixed sexes were collected at day old. At the starter phase the chicks were divided into six treatment groups of ninety birds per treatment group, each of the six groups was further divided into two making two replicates per treatment group, and there were forty five birds per replicate. Each of the six groups was randomly assigned to the six dietary treatments (of which three contained 1% oil and the other three contained 2% oil) at the starter phase.

At the finisher phase each of the six treatment groups of the starter phase was further divided into three treatment groups making on the total eighteen treatment groups and thirty six replicates. The three treatment groups that were obtained from each of the treatment groups of the starter phase were reallocated to three dietary treatments containing different premixes but the same oil levels as was fed in the starter phase (Figure 5.1). Hence one of the treatment groups was fed diet containing the same premix and level of oil as in the starter phase, while the other two were fed diets containing different premix from that which they were fed at the starter phase, but the same level of oil, as shown in figure 5.1. Other management practices were the same as obtained in experiments one and two.

5.2.2: COMPOSITION OF DIETS

The feed ingredients used in this experiment were the same as obtained in experiments one and two. At the starter phase six diets were formulated, (table 5.1) three of these diets contained 1% palm oil with 23% crude protein and 3000 Kcal ME/kg diet, while the other three diets contained 2% palm oil with 23% crude protein and 3040 Kcal ME/kg diet. These diets were fed to six treatment groups.

At the finisher phase six diets were formulated (table 5.2) three of these diets contained 1% palm oil with 20% crude protein

FIGURE 5.1

EXPERIMENTAL DESIGN FOR EXPERIMENT THREE

Dietary oil level	Premix fed at starter phase 90 birds/Premix	Premix fed at finisher phase 30 birds/Premix
1%	S	S
		R
		D
	R	S
		R
		D
	D	S
		R
		D
2%	S	S
		R
		D
	R	S
		R
		D
	D	S
		R
		D

TABLE 5.1

PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS FOR STARTER PHASE IN TRIAL THREE

PREMIXES:	Premix S	Premix R	Premix D	Premix S	Premix R	Premix D
LEVEL OF OIL:	1%	1%	1%	2%	2%	2%
Maize	56.22	56.22	56.22	57.00	57.00	57.00
Groundnut Cake	22.17	22.17	22.17	20.89	20.89	20.89
Fish meal	4.43	4.43	4.43	4.18	4.18	4.18
Blood meal	4.43	4.43	4.43	4.18	4.18	4.18
Brewer's grains	8.00	8.00	8.00	8.00	8.00	8.00
*Premix	0.50	0.25	0.20	0.50	0.25	0.20
Bone meal	2.00	2.15	2.20	2.00	2.15	2.20
Oyster shell	1.00	1.10	1.10	1.00	1.10	1.10
Palm oil	1.00	1.00	1.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25
CALCULATED ANALYSIS:						
Crude protein %	23.00	23.00	23.00	23.00	23.00	23.00
M.E (Kcal/kg)	3000	3000	3000	3040	3040	3040
DETERMINED ANALYSIS:						
Dry matter (%)	89.14	88.67	88.42	86.92	86.71	86.95
Crude protein (%)	22.96	23.07	23.09	23.30	23.38	23.24

* Table 3.9 and table 3.10

TABLE 5.2

PERCENTAGE COMPOSITION OF EXPERIMENTAL DIETS FOR FINISHER PHASE IN TRIAL THREE

PREMIXES:	Premix S	Premix R	Premix D	Premix S	Premix R	Premix D
LEVEL OF OIL:	1%	1%	1%	2%	2%	2%
Maize	58.78	58.78	58.78	59.72	59.72	59.72
Groundnut Cake	18.35	18.35	18.35	16.09	16.09	16.09
Fish meal	3.06	3.06	3.06	3.22	3.22	3.22
Blood meal	3.06	3.06	3.06	3.22	3.22	3.22
Brewer's grains	10.00	10.00	10.00	10.00	10.00	10.00
*Premix	0.50	0.25	0.20	0.50	0.25	0.20
Bone meal	3.00	3.15	3.20	3.00	3.15	3.20
Oyster Shell	2.00	2.10	2.10	2.00	2.10	2.10
Palm oil	1.00	1.00	1.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25
CALCULATED ANALYSIS:						
Crude protein (%)	2 .00	20.00	20.00	20.00	20.00	20.00
M.E (Kcal/kg)	2970	2970	2970	3000	3000	3000
DETERMINED ANALYSIS:						
Dry matter %	89.98	89.61	89.74	88.61	88.43	88.57
Crude protein %	20.49	20.32	20.58	20.12	20.26	20.14

* Table 3.9 and table 3.10.

and 2970 Kcal ME/kg diet, while the other three diets contained 2% palm oil with 20% crude protein and 3000 Kcal ME/kg diet. These diets were fed to eighteen treatment groups at the rate of three treatment group per diet. The premixes used in this experiment were the same as in experiment one. (table 3.9 and table 3.10)

5.2.3: PERFORMANCE CHARACTERISTICS AND DIGESTIBILITY TRIAL

The performance characteristics and digestibility trials were as obtained in experiments one and two. The methods used were the same. Digestibility trials in this experiment were carried out when the birds were four weeks and nine weeks old. The methods used in obtaining the dry matter of droppings, the faecal nitrogen, and total nitrogen excreted were the same as in experiment one.

5.2.4: CARCASS EVALUATION, BLOOD AND LIVER PARAMETERS

The carcass evaluation, whole blood, plasma, serum and liver fluid parameters and the methods used in both the chemical and physical assessments were the same as in experiment two.

5.2.5: EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS

At the starter phase six dietary treatments were used; three contained 1% palm oil and the other three contained 2% palm oil, such that the design was a 2 x 3 factorial analysis. For the finisher phase each of the dietary treatments of the starter phase was again divided into three to make a total of eighteen dietary

treatments such that the design was a 2 x 3 x 3 factorial analysis. The data collected in both the starter and finisher phases were subjected to Analysis of Variance (ANOVA) and Least Significant Difference (LSD) according to the Genstat package using the computer.

5.3: RESULTS

5.3.1: FEED UTILIZATION BY BROILER CHICKENS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

The results for the average weekly live weight at the starter phase are presented in table 5.3. At the beginning of the study and at week three, there was no significant difference ($P>0.05$) between the birds fed the different dietary treatments. In week one it was observed that there was no significant difference ($P>0.05$) between the birds fed 1% oil and those fed 2% oil with the same premix, but birds fed premix D had the lowest weight. In weeks two and four, for birds fed any of the premixes the live weight increased as the level of oil was increased from 1% to 2%. Birds fed premix D with 1% oil had the lowest weight in week five. Table 5.4 presents the result for the average weekly feed intake at the starter phase. There were no significant differences ($P>0.05$) in the feed intake of the birds at weeks one and two. The average weekly feed intake increased progressively with age. Birds fed premix D with 1% oil had the highest total feed intake, and generally birds fed 2% oil had lower total feed

TABLE 5.3

AVERAGE WEEKLY LIVE WEIGHT (GRAMS) OF BROILER CHICKS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE

LEVEL OF PALM OIL:	1% oil			2% oil			
AGE (Weeks)	PREMIX S	PREMIX R	PREMIX D	PREMIX S	PREMIX R	PREMIX D	SE$\bar{X}$
0	38.97	37.71	37.34	39.93	39.29	39.98	0.42
1	68.08^{a}	68.14^{a}	64.71^{b}	67.51^{a}	67.68^{a}	64.08^{b}	0.68
2	130.82^{c}	132.18^{bc}	127.45^{d}	133.78^{ab}	135.78^{a}	135.05^{bc}	0.98
3	224.66	231.22	198.74	236.59	247.48	211.44	6.57
4	386.87^{c}	399.56^{bc}	352.29^{d}	410.25^{ab}	423.37^{a}	399.21^{bc}	9.08
5	586.41^{b}	604.50^{ab}	511.95^{c}	613.43^{ab}	627.40^{a}	593.24^{b}	15.15

Values with different superscripts on the same horizontal row were significantly different ($P<0.05$).

TABLE 5.4

AVERAGE WEEKLY FEED INTAKE (GRAMS) OF BROILER CHICKS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM AT THE STARTER PHASE

LEVEL OF OIL:	1% oil			2% oil			
PREMIXES	S	R	D	S	R	D	$SE\bar{X}$
AGE (WEEKS)							
1	61.13	60.67	61.15	59.08	58.57	61.27	0.43
2	147.15	144.39	151.28	144.26	140.25	149.37	1.48
3	229.52^{b}	220.24^{c}	250.38^{a}	210.08^{d}	232.43^{b}	223.00^{c}	5.08
4	395.36^{b}	389.29^{bc}	404.24^{a}	368.08^{d}	360.11^{e}	388.25^{c}	6.26
5	479.09^{b}	464.05^{c}	492.49^{a}	434.50^{e}	412.37^{f}	448.00^{d}	10.95
Total	1312.25^{b}	1278.64^{c}	1359.54^{a}	1216.00^{d}	1203.73^{e}	1269.99^{c}	21.80

Values with different superscript on the same horizontal row were significantly different ($P < 0.50$).

intake than birds fed 1% oil with the same premix. The average weekly body weight gain of the birds at starter phase which is presented in table 5.5 showed no significant difference ($P>0.05$) between the experimental treatments in all the weeks.

Table 5.6 shows the feed conversion ratio for the birds at the starter phase. Only the first and fifth week showed significant differences ($P<0.05$) between the experimental treatments. In both weeks there were no significant difference ($P>0.05$) between birds fed premix S and those fed premix R within a particular oil level. In week one birds fed premix D with 2% oil had the poorest feed conversion while for week five birds fed premix D with 1% oil had the poorest feed conversion. However in both weeks birds fed premix S or premix R showed no significant differences ($P>0.05$) when the two oil levels were fed.

Table 5.7 shows the result for the body weight gain per gram protein intake at the starter phase. For the second week no significant differences ($P>0.05$) were observed between the experimental treatments within a particular oil level. There were also no significant difference between birds fed the same premix but different oil levels. In week five birds fed premix D with 1% oil had low conversion of fed protein to body protein. Also within a particular oil level there was no significant difference ($P>0.05$) between birds fed premix S and those fed premix R.

TABLE 5.5

AVERAGE WEEKLY BODY WEIGHT GAIN (GRAMS) OF BROILER CHICKS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE.

LEVEL OF OIL:	1% oil			2% oil			
PREMIXES	S	R	D	S	R	D	$\overline{SE}$
AGE (Weeks)							
1	29.12	30.43	27.37	27.58	28.39	24.10	0.80
2	62.74	64.04	62.74	66.27	67.37	67.48	0.82
3	93.84	98.89	71.30	102.82	112.43	79.89	5.64
4	162.21	168.50	153.55	173.66	175.89	187.77	4.40
5	199.55	204.94	159.67	203.18	204.03	194.03	6.48

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 5.6

FEED CONVERSION RATIO OF BROILER CHICKS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE.

LEVEL OF OIL:	1% oil			2% oil			
PREMIXES	S	R	D	S	R	D	SE$\bar{X}$
AGE (WEEKS)							
1	2.10^{ab}	1.99^{a}	2.24^{b}	2.14^{ab}	2.07^{ab}	2.55^{c}	0.07
2	2.35	2.25	2.41	2.18	2.08	2.21	0.04
3	2.45	2.23	3.51	2.04	2.07	2.79	0.18
4	2.43	2.31	2.63	2.21	2.05	2.07	0.09
5	2.40^{b}	2.26^{ab}	3.08^{c}	2.14^{ab}	2.02^{a}	2.31^{ab}	0.13

Values with different superscript on the same horizontal row were significantly different ($P < 0.05$).

TABLE 5.7

BODY WEIGHT GAIN/GRAM PROTEIN INTAKE OF BROILER CHICKS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE

LEVEL OF OIL:	1% oil			2% oil			
PREMIXES	S	R	D	S	R	D	$SE\bar{X}$
AGE (WEEKS)							
1	2.07	2.21	1.95	2.01	2.08	1.69	0.07
2	1.86^{b}	1.92^{ab}	1.80^{b}	1.97^{ab}	2.05^{a}	1.94^{ab}	0.05
3	1.78	1.95	1.38	2.10	2.07	1.54	0.20
4	1.79	1.88	1.43	2.02	2.08	2.08	0.11
5	1.81^{c}	1.91^{bc}	1.40^{d}	2.01^{ab}	2.12^{a}	1.86^{bc}	0.12

Values with different superscript on the same horizontal row were significantly different (P 0.05).

The average weekly live weight at the finisher phase is presented in table 5.8. In weeks six and seven increasing the oil from 1% to 2% led to better live weight for birds fed premix D at the starter phase and finished with any premix. In weeks nine and ten, it was observed that the live weight of the birds increased when the premix fed remained the same but the level of oil was increased from 1% to 2%. The result also showed that in both weeks nine and ten birds fed premix D at the starter and finisher phases with 1% oil had the lowest live weight.

The results for the average weekly feed intake at the finisher phase is shown in table 5.9. Significant differences ($P<0.05$) were observed between the experimental treatments in all the weeks. It was observed that increasing the level of dietary oil from 1% to 2% and maintaining the type of premix fed generally led to lower total feed intake by the birds. Birds fed premix D at the starter and finisher phases with 1% oil had the highest total feed intake while birds fed premix R at the starter and finisher phases with 2% oil had the lowest total feed intake. It was also observed that the feed intake increased progressively with increase in age.

Table 5.10 shows the result for the average weekly body weight gain of the birds at the finisher phase. At the sixth week birds fed 1% dietary oil level tended to gain significantly ($P<0.05$) more weight than those fed 2% oil level with the same

TABLE 5.8

AVERAGE WEEKLY LIVE WEIGHTS (GRAMS) AT FINISHER PHASE OF BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS) 6	7	8	9	10
1%	S	S	752.26^{cd}	998.08^{de}	1201.58^{g}	1521.33^{i}	1858.31^{f}
		R	767.03^{b}	1007.43^{c}	1210.06^{fg}	1573.38^{f}	1914.49^{d}
		D	756.45^{bcd}	935.62^{h}	1117.17^{i}	1437.92^{l}	1751.19^{j}
	R	S	750.15^{cd}	1004.24^{cd}	1219.04^{f}	1543.08^{h}	1882.03^{e}
		R	758.07^{bcd}	1029.23^{b}	1244.35^{de}	1590.73^{e}	1960.13^{b}
		D	747.36^{d}	982.06^{f}	1209.19^{fg}	1460.11^{k}	1766.34^{ij}
	D	S	724.36^{f}	932.38^{h}	1167.09^{h}	1508.27^{j}	1784.29^{i}
		R	711.12^{g}	987.25^{ef}	1200.13^{e}	1542.38^{h}	1833.27^{g}
		D	712.01^{g}	863.44^{j}	1054.46^{k}	1330.28^{n}	1639.11^{l}
2%	S	S	757.44^{bcd}	1008.06^{cd}	1265.58^{c}	1610.15^{d}	1954.35^{bc}
		R	764.13^{b}	1029.52^{b}	1281.09^{b}	1655.48^{b}	1957.23^{b}
		D	751.26^{cd}	960.05^{g}	1170.43^{h}	1521.92^{i}	1817.83^{h}
	R	S	763.16^{bc}	1017.09^{bc}	1287.29^{b}	1625.23^{c}	1935.28^{c}
		R	779.31^{a}	1043.31^{a}	1322.18^{a}	1682.39^{a}	1991.37^{a}
		D	758.31^{b}	997.22^{de}	1254.22^{cd}	1555.11^{g}	1862.35^{ef}
	D	S	736.27^{e}	951.70^{g}	1196.26^{g}	1550.47^{gh}	1804.49^{h}
		R	739.07^{e}	1004.12^{cd}	1238.27^{e}	1602.41^{de}	1870.10^{ef}
		D	728.35^{ef}	885.20^{i}	1083.48^{j}	1420.49^{m}	1675.53^{k}
		$SE\bar{X}$	4.23	11.37	16.03	19.95	22.53

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

TABLE 5.9

AVERAGE WEEKLY FEED INTAKE (GRAMS) AT FINISHER PHASE OF BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS)					
			6	7	8	9	10	TOTAL
1%	S	S	439.09^{ab}	659.76^{cd}	651.10^{de}	818.56^{de}	861.81^{b}	3430.31^{d}
		R	414.52^{de}	640.28^{f}	633.82^{gh}	802.61^{f}	823.70^{d}	3314.93^{h}
		D	411.40^{def}	708.60^{a}	731.18^{a}	841.08^{b}	883.66^{a}	3575.92^{b}
	R	S	420.44^{cd}	623.71^{g}	637.69^{g}	790.35^{f}	820.16^{de}	3292.35^{i}
		R	401.05^{efg}	604.20^{h}	622.95^{ij}	764.93^{gh}	789.95^{g}	3183.08^{k}
		D	386.44^{h}	691.36^{b}	678.41^{c}	832.14^{bc}	861.09^{b}	3449.44^{c}
	D	S	431.34^{bc}	667.40^{c}	654.70^{d}	840.76^{b}	836.83^{c}	3434.03^{d}
		R	441.22^{ab}	653.81^{de}	642.70^{efg}	824.44^{cd}	831.79^{c}	3393.96^{e}
		D	449.26^{a}	712.68^{a}	703.54^{b}	859.84^{a}	892.34^{a}	3617.66^{a}
2%	S	S	392.25^{gh}	602.33^{h}	616.72^{jk}	764.10^{gh}	812.95^{e}	3188.35^{j}
		R	357.37^{i}	597.16^{i}	597.53^{l}	760.24^{hi}	791.19^{f}	3103.49^{n}
		D	423.29^{c}	655.68^{d}	659.20^{d}	796.58^{f}	830.04^{c}	3364.79^{f}
	R	S	411.10^{def}	588.62^{i}	583.64^{m}	770.49^{g}	771.28^{h}	3125.13^{m}
		R	414.28^{j}	560.45^{j}	561.80^{n}	729.98^{j}	742.34^{i}	3008.85^{o}
		D	384.72^{h}	644.59^{ef}	612.67^{k}	817.51^{de}	813.04^{e}	3272.53^{i}
	D	S	398.11^{fg}	619.62^{g}	631.83^{hj}	810.09^{e}	819.08^{d}	3278.73^{i}
		R	393.70^{h}	607.56^{h}	595.18^{l}	750.18^{i}	801.73^{f}	3148.35^{l}
		D	403.64^{ef}	653.29^{de}	640.46^{fg}	814.50^{e}	828.67^{cd}	3340.56^{g}
		SE$\bar{X}$	6.15	7.86	9.48	8.24	8.58	38.99

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

TABLE 5.10

AVERAGE WEEKLY BODY WEIGHT GAIN (GRAMS) AT FINISHER PHASE OF BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS)				
			6	7	8	9	10
1%	S	S	164.88^{cd}	245.82^{ef}	203.50^{h}	319.50^{f}	336.99^{b}
		R	185.31^{b}	240.91^{fg}	202.63^{h}	363.33^{bc}	341.11^{b}
		D	164.55^{cd}	179.17^{j}	181.56^{k}	320.75^{f}	313.29^{cd}
	R	S	158.61^{de}	254.12^{d}	214.78^{g}	324.03^{ef}	338.72^{b}
		R	145.55^{ef}	271.16^{b}	214.63^{g}	346.88^{cde}	369.39^{a}
		D	145.58^{ef}	234.70^{g}	227.13^{f}	250.92^{i}	319.72^{c}
	D	S	219.57^{a}	208.02^{i}	234.71^{e}	341.19^{cdef}	276.02^{fg}
		R	192.49^{b}	278.13^{a}	210.88^{g}	342.25^{cdef}	290.85^{ef}
		D	195.09^{b}	151.43^{k}	191.02^{j}	275.83^{h}	308.83^{cde}
2%	S	S	135.84^{fg}	250.61^{de}	257.52^{c}	344.57^{cde}	344.20^{b}
		R	153.34^{de}	265.39^{c}	251.57^{cd}	374.39^{b}	301.76^{cde}
		D	140.11^{fg}	208.79^{hi}	210.38^{g}	351.49^{cd}	295.91^{def}
	R	S	131.24^{gh}	253.94^{d}	270.20^{b}	337.94^{def}	310.05^{cde}
		R	149.50^{e}	263.99^{c}	278.88^{a}	360.21^{bcd}	258.99^{gh}
		D	129.44^{gh}	238.81^{g}	257.01^{c}	300.88^{g}	307.24^{cde}
	D	S	145.58^{ef}	214.91^{h}	245.09^{d}	354.21^{bcd}	254.02^{gh}
		R	141.60^{fg}	251.56^{de}	234.15^{e}	364.14^{bc}	267.69^{fg}
		D	127.90^{h}	156.86^{k}	198.28^{i}	337.02^{def}	255.04^{gh}
		$SE\bar{X}$	5.90	8.64	6.48	7.76	8.43

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

premix, the exception being birds fed premix R at the starter and finisher phases. In week seven for any of the oil levels, when any of the starter premix is considered, birds fed premix D at the finisher phase had the lowest body weight gain. In week eight there was increased body weight gain when the premix was maintained but the level of oil was increased from 1% to 2%. For weeks nine and ten no particular trend was observed.

Table 5.11 shows the result for the feed conversion ratio of the birds at the finisher phase. In week seven for any of the oil level, and for any of the starter premix birds fed premix D at the finisher phase had the poorest conversion of feed to body weights when compared with the other two finisher premixes of that particular starter premix. Week eight showed that birds fed 2% oil level had better feed conversion than birds fed 1% oil with the same premix, for week nine in the 2% oil treatments birds fed premix R at the finisher phase but fed any premix at the starter phase had the best feed conversion ratio. Also for this week birds fed 2% oil had significantly ($P<0.05$) better feed conversion than birds fed 1% oil with the same premix with the exception of birds fed premix R at the starter phase and finished with premix S with 2% oil which were not significantly better than their counterpart fed 1% oil level. In week ten for the 2% oil treatments birds fed premix D at the starter phase and finished with any of the premixes had lower feed

TABLE 5.11

FEED CONVERSION RATIO AT FINISHER PHASE BY BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS) 6	7	8	9	10
1%	S	S	2.67	2.68^{f}	3.20^{h}	2.56^{efg}	2.56^{bc}
		R	2.26	2.66^{f}	3.13^{h}	2.21^{bc}	2.46^{b}
		D	2.51	3.95^{l}	4.03^{j}	2.62^{fg}	2.82^{de}
	R	S	2.66	2.45^{e}	2.97^{fg}	2.44^{de}	2.39^{b}
		R	2.77	2.23^{ab}	2.90^{ef}	2.21^{b}	2.14^{a}
		D	2.66	2.95^{g}	2.99^{g}	3.32^{i}	2.63^{cd}
	D	S	1.97	3.21^{h}	2.79^{e}	2.46^{ef}	3.09^{fg}
		R	2.35	2.35^{cde}	3.05^{e}	2.41^{cde}	2.86^{e}
		D	2.31	4.71^{k}	3.68^{i}	3.12^{h}	2.90^{ef}
2%	S	S	2.90	2.40^{de}	2.39^{c}	2.22^{bc}	2.40^{bc}
		R	2.34	2.25^{b}	2.38^{c}	2.03^{a}	2.63^{cd}
		D	3.03	3.14^{h}	3.13^{h}	2.27^{bcd}	2.44^{b}
	R	S	3.15	2.32^{bcd}	2.16^{b}	2.28^{bcd}	2.52^{bc}
		R	2.77	2.12^{a}	2.01^{a}	2.03^{a}	2.87^{e}
		D	2.98	2.70^{f}	2.38^{c}	2.72^{g}	2.70^{cde}
	D	S	2.80	2.88^{g}	2.58^{d}	2.29^{bcd}	3.48^{h}
		R	2.81	2.41^{d}	2.54^{d}	2.06^{a}	3.25^{g}
		D	3.19	4.16^{j}	3.23^{h}	2.42^{cde}	3.26^{gh}
		SE$\bar{X}$	0.11	0.12	0.19	0.08	0.08

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

conversion. Also birds fed premix R at the finisher phase but fed any of the premix at the starter phase with 1% oil had significantly (P 0.05) better feed conversion than their counterparts fed the 2% oil level.

The body weight gain per gram protein intake of the birds for the finisher phase is shown in table 5.12. In week six birds fed premix D at the starter phase and finished with any of the premixes with 1% oil had significantly (P 0.05) better conversion of feed protein to body protein than their counterparts fed 2% oil level. Also birds fed premix D at the finisher phase but fed any of the premix at the starter phase with 1% oil had better conversion of feed protein to body protein than their counterparts fed 2% oil with the same premix except for birds fed premix R at starter and finished with premix D. In week seven for any of the oil levels, and for any of the starter premix birds fed premix D at the finisher phase had the lowest conversion of feed protein to body protein when compared to the other two premixes in that particular starter premix. In weeks eight and nine birds fed 2% oil level had better conversion of feed protein to body protein than those fed 1% oil level with the same premix, however no particular trend was observed within the oil levels. Week ten showed that birds fed any of the premixes at the starter phase and finished with premix R with 1% oil had better conversion of feed protein to body protein

TABLE 5.12

BODY WEIGHT GAIN/GRAM PROTEIN INTAKE AT FINISHER PHASE OF BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	AGE (WEEKS) 6	7	8	9	10
1%	S	S	1.82^{def}	1.82^{g}	1.53^{h}	1.90^{g}	1.90^{cd}
		R	2.21^{b}	1.85^{f}	1.57^{fg}	2.23^{cd}	2.04^{b}
		D	1.96^{cd}	1.23^{k}	1.21^{j}	1.85^{g}	1.73^{efgh}
	R	S	1.84^{de}	1.99^{e}	1.64^{f}	2.00^{ef}	2.01^{bc}
		R	1.80^{def}	2.21^{b}	1.69^{e}	2.23^{cd}	2.31^{a}
		D	1.85^{de}	1.65^{h}	1.63^{f}	1.47^{h}	1.86^{de}
	D	S	2.48^{a}	1.52^{j}	1.74^{e}	1.98^{f}	1.60^{hi}
		R	2.16^{b}	2.09^{d}	1.61^{f}	2.04^{de}	1.72^{fgh}
		D	2.12^{bc}	1.03^{l}	1.32^{i}	1.56^{h}	1.69^{g}
2%	S	S	1.72^{efg}	2.07^{d}	2.08^{c}	2.24^{cd}	2.10^{b}
		R	2.12^{bc}	2.19^{bc}	2.07^{c}	2.43^{b}	1.86^{d}
		D	1.65^{fg}	1.58^{i}	1.58^{fg}	2.19^{bc}	1.78^{efg}
	R	S	1.59^{g}	2.14^{c}	2.30^{b}	2.18^{cd}	2.00^{bc}
		R	1.78^{e}	2.33^{a}	2.45^{a}	2.44^{b}	1.72^{fgh}
		D	1.67^{fg}	1.84^{f}	2.08^{c}	1.83^{g}	1.88^{c}
	D	S	1.82^{def}	1.72^{g}	1.93^{d}	2.17^{b}	1.45^{j}
		R	1.78^{e}	2.04^{d}	1.94^{d}	2.24^{a}	1.52^{ij}
		D	1.57^{g}	1.19^{k}	1.54^{gh}	2.05^{ef}	1.53^{ij}
		SE$\bar{X}$	0.06	0.08	0.08	0.09	0.05

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

than those fed 2% oil with the same premix. Also it was observed that for treatments in the 2% dietary oil level, birds fed premix D at the starter phase and finished with any of the premixes had the lowest conversion of feed protein to body protein.

5.3.7: AVERAGE DAILY NITROGEN RETENTION OF BROILER CHICKENS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES

Table 15.13 presents the result for the average daily nitrogen retention of the broilers at four weeks old. Birds fed premix D with 1% oil had the highest dry matter intake and dry matter output. Also for both the dry matter intake and dry matter output birds fed premix S or premix R with 1% oil showed no significant difference ($P>0.05$) to their counterparts fed the same premix but with 2% oil level. Within a particular oil level birds fed premix R had the lowest dry matter intake and dry matter output. Within a particular oil level birds fed premix D had the highest nitrogen intake and faecal nitrogen output, for the faecal nitrogen output and nitrogen digestibility coefficient there was no significant difference ($P>0.05$) between birds fed premix S or premix R with 1% oil and their counterparts fed the same premix but with 2% oil. The nitrogen digestibility coefficient within a particular oil level for birds fed premix R was not significantly different ($P>0.05$) for values from birds fed premix S. However birds fed either premix S or premix R had

TABLE 5.13

AVERAGE DAILY NITROGEN RETENTION AT WEEK FOUR OF BROILER FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL.

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	SE$\bar{X}$
Dry matter intake (gm)	98.69^{c}	92.43^{de}	109.82^{a}	96.15^{cd}	90.00^{e}	104.64^{b}	2.79
Dry matter output (gm)	27.42^{cd}	23.61^{ef}	34.89^{a}	25.44^{de}	20.39^{f}	30.83^{bc}	1.93
Dry matter digestibility coefficient (%)	72.26	74.42	68.24	73.78	77.31	70.50	1.18
Nitrogen intake (gm)	3.64^{b}	3.41^{c}	4.03^{a}	3.57^{b}	3.53^{b}	3.94^{a}	0.08
Fecal nitrogen output (gm)	0.85^{c}	0.73^{de}	1.08^{a}	0.79^{cd}	0.71^{e}	0.95^{b}	0.05
Nitrogen digestibility coefficient (%)	76.67^{bc}	78.58^{ab}	73.34^{d}	77.86^{ab}	78.91^{a}	75.68^{c}	0.78
Total nitrogen output (gm)	1.62^{b}	1.44^{c}	1.92^{a}	1.56^{b}	1.40^{c}	1.81^{a}	0.08
Nitrogen retention (gm)	2.02^{bc}	1.98^{c}	2.11^{ab}	2.01^{c}	1.97^{c}	2.14^{a}	0.03
Nitrogen retention (%)	55.44^{c}	57.96^{ab}	52.22^{d}	56.37^{bc}	58.67^{a}	53.52^{d}	0.93

Values with different superscripts on the same horizontal row were significantly different ($P<0.05$).

significantly higher nitrogen digestibility coefficient than birds fed premix D. The total nitrogen output, nitrogen retention (grams) and nitrogen retention (percentage) showed that birds fed any of the premixes with 2% oil were not significantly different ($P>0.05$) from birds fed the same premix but with 1% oil level. The highest total nitrogen output was obtained from birds fed premix D. The nitrogen retention (grams) within a particular oil level for birds fed premix S were not significantly different ($P>0.05$) from those of birds fed premix R. In the case of nitrogen retention (percentage) within a particular oil level birds fed premix R had the highest nitrogen retention (percentage).

Table 5.14 shows the results for the average daily nitrogen retention of the birds at week nine. Birds fed any of the premix at the starter or at the finisher phase with 1% oil had significantly ($P<0.05$) higher dry matter intake, dry matter output, nitrogen intake and faecal nitrogen output than birds fed the same premix but with 2% oil. In any of the oil levels when any particular starter premix is considered, birds fed premix D at the finisher phase had higher dry matter output than birds fed the other two finisher premixes in that particular starter premix. The dry matter digestibility coefficient showed no particular trend. The nitrogen digestibility coefficient for birds fed 2% oil were not significantly ($P>0.05$) different from those of birds fed 1% oil with the same premix with the exception of birds fed premix S at the starter and

TABLE 5.14

AVERAGE DAILY NITROGEN RETENTION AT NINE WEEKS BY BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	D.M.I (gm)	D.M.O (gm)	D.M.D.C (%)	N.I (gm)	F.N.O (gm)	N.D.C (%)	T.N.O (gm)	N.R (gm)	N.R (%)
1%	S	S	129.59^{ef}	44.62^{ef}	65.59^{ef}	4.26^{d}	1.30^{i}	69.48^{de}	2.09	2.17	50.96^{d}
		R	130.69^{de}	45.92^{de}	64.88^{fg}	4.25^{e}	1.32^{hi}	68.90^{defg}	2.15	2.10	49.33^{ef}
		D	135.29^{ab}	47.84^{bc}	64.63^{fg}	4.44^{b}	1.45^{de}	67.42^{g}	2.40	2.02	45.57^{ik}
	R	S	130.90^{de}	44.60^{ef}	65.91^{de}	4.31^{cde}	1.30^{i}	69.78^{cd}	2.14	2.17	50.29^{de}
		R	121.75^{g}	39.62^{hi}	67.45^{abc}	3.96^{h}	1.11^{k}	73.24^{a}	1.87	2.09	52.75^{b}
		D	131.77^{de}	47.08^{bcd}	64.30^{g}	4.32^{cd}	1.38^{fgh}	68.18^{f}	2.30	2.02	46.70^{hij}
	D	S	133.41^{bc}	48.25^{b}	63.84^{h}	4.39^{b}	1.54^{b}	65.02^{i}	2.26	2.13	48.56^{fgh}
		R	132.41^{cd}	47.71^{bc}	63.97^{gh}	4.31^{cde}	1.39^{ef}	67.74^{gh}	2.19	2.12	49.11^{f}
		D	137.50^{a}	50.79^{a}	63.06^{h}	4.51^{a}	1.65^{a}	63.63^{j}	2.48	2.04	45.08^{k}
2%	S	S	123.15^{g}	40.34^{ghi}	67.29^{bc}	3.97^{h}	1.15^{jk}	71.17^{b}	1.92	2.05	51.58^{bcd}
		R	122.37^{g}	40.94^{gh}	66.61^{cd}	3.98^{h}	1.20^{j}	69.93^{cd}	1.98	2.01	50.38^{de}
		D	131.16^{cd}	45.39^{ef}	65.39^{ef}	4.23^{f}	1.34^{ghi}	68.39^{fg}	2.28	1.95	46.20^{ijk}
	R	S	121.99^{g}	39.33^{i}	67.74^{ab}	3.94^{h}	1.15^{jk}	70.88^{bc}	1.92	2.02	51.12^{cd}
		R	113.64^{h}	36.03^{j}	68.34^{a}	3.70^{i}	0.98^{l}	73.49^{a}	1.71	1.99	53.90^{a}
		D	127.82^{f}	43.93^{f}	65.65^{def}	4.12^{g}	1.30	68.51^{efg}	2.16	1.96	47.60^{gh}
	D	S	130.33^{d}	46.55^{cd}	64.29^{gh}	4.20^{f}	1.47^{cd}	65.15^{i}	2.13	2.07	49.28^{ef}
		R	128.84^{f}	44.96^{ef}	65.11^{ef}	4.19^{f}	1.34^{ghi}	68.01^{fg}	2.08	2.11	50.28^{de}
		D	133.09^{bcd}	48.38^{h}	63.64^{h}	4.29^{cde}	1.52^{bc}	64.68^{ij}	2.31	1.98	46.18^{ijk}
		SEX	1.36	0.86	0.33	0.05	0.04	0.63	0.04	0.02	0.58

Values with different superscript on the same vertical row were significantly different (P 0.05).

D.M.I - Dry matter intake; D.M.O - Dry matter output; D.M.D.C - Dry matter digestibility coefficient;

N.I - Nitrogen intake; F.N.O - Faecal nitrogen output; N.D.C - Nitrogen digestibility coefficient;

T.N.O - Total nitrogen output; N.R - Nitrogen retention.

finisher phases. In this case 2% oil produced higher nitrogen digestibility coefficient than 1% oil level.

For birds fed the same premix but different level of oil there was no significant difference ($P > 0.05$) in their nitrogen retention percentage with the exception of birds fed premix R at the starter and finisher phases with 2% oil and birds fed premix D at the starter phase and finished with premix R with 2% oil both of which had better nitrogen retention (percentage) than their counterparts fed the same premix but with 1% oil. However in most of the parameters the birds fed the various premixes within a particular oil level did not show any particular trend with the exception of the dry matter output which showed that for any of the oil levels when any particular starter premix is considered birds fed premix D as the finisher premix had higher dry matter output than those fed the other finisher premixes under that particular starter premix.

5.3.3: CARCASS CHARACTERISTICS OF BROILER CHICKENS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

Table 5.15 shows the carcass traits for five weeks old broilers. There were no significant differences ($P > 0.05$) in the weights of feather and viscera of the birds. The live weight and the dressed weight showed that birds fed either premix S or premix D with 2% oil

TABLE 5.15

AVERAGE WEIGHT OF CARCASS TRAITS (GRAMS) OF FIVE WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	SE$\bar{X}$
Live weight	589.32^{c}	617.23^{ab}	528.51^{d}	608.53^{b}	622.36^{a}	584.20^{c}	12.83
Dressed weight	522.93^{c}	546.30^{ab}	455.90^{d}	538.51^{b}	554.61^{a}	521.72^{c}	13.21
Weight of feather	31.40	33.48	33.16	30.93	31.05	27.68	0.77
Eviscerated weight	444.83^{b}	470.26^{a}	386.47^{c}	452.71^{b}	475.25^{a}	440.59^{b}	11.85
Weight of viscera	75.48	71.48	66.78	81.40	74.68	76.86	1.92

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

had higher weights than birds fed the same premix but with 1% oil. Also for any particular level of oil birds fed premix R in that particular level of oil had the highest weights. The eviscerated weight showed no significant difference ($P<0.05$) between birds fed either premix S or premix R with 2% oil and their counterparts fed the same premix but with 1% oil. When these values were expressed as percentage of live weight and then converted to the arc sine values (table 5.16) there were no significant differences ($P>0.05$) between the experimental treatments in all parameters.

Table 5.17 shows the weight of the organs. Only the heart and gizzard showed significant difference ($P<0.05$) between the experimental treatments. Weights for the heart showed that birds fed premix S with 1% oil had higher weights than birds fed premix S with 2% oil while birds fed premix D with 1% had lower heart weight than birds fed premix D with 2% oil. Weights of the gizzard showed that birds fed premix S with 2% oil had the highest weight, with birds fed either premix S or premix R with 2% oil having significantly ($P<0.05$) higher gizzard weights than birds fed these premixes with 1% oil. However within a particular oil level, birds fed premix S within that oil level had the highest gizzard weight. When these values were expressed as percentage of dressed weight and then transformed into the

TABLE 5.16

ARC SINE VALUES OF CARCASS TRAITS EXPRESSED AS PERCENTAGE OF LIVE WEIGHT

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	SE$\bar{X}$
Dressed weight	70.42	70.19	68.33	70.19	70.75	70.92	0.34
Weight of feathers	13.33	13.47	14.47	13.03	12.88	12.57	0.24
Eviscerated weight	60.33	60.79	58.84	59.60	60.92	60.29	0.29
Weight of viscera	20.95	19.89	20.72	21.46	20.27	21.25	0.22

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 5.17

AVERAGE WEIGHT OF ORGANS (GRAMS) OF FIVE WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE

LEVEL OF OIL:	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	$\overline{SEX}$
Liver	9.02	8.72	8.94	9.06	9.32	8.88	0.08
Heart	2.46^{a}	2.58^{a}	2.13^{b}	2.07^{b}	2.49^{a}	2.54^{a}	0.08
Gizzard	9.24^{c}	9.01^{d}	8.53^{e}	9.63^{a}	9.33^{b}	8.20^{f}	0.20
Spleen	0.52	0.63	0.58	0.72	0.68	0.57	0.03
Kidney	2.32	2.49	2.22	2.47	2.53	2.33	0.04
Lungs	2.60	2.72	2.27	2.40	2.80	2.51	0.07

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

arc sine values (table 5.18), only the kidney and the lungs showed significant difference between the experimental treatments. For the kidney birds fed premix D with 1% oil had the highest value while the other experimental treatments showed no significant ($P>0.05$) difference between their values irrespective of the level of oil fed. For the lungs birds fed either premix S or premix R with 2% oil had higher values than their counterparts fed the same premix but with 1% oil.

The weights of cut up parts is shown in table 5.19. The experimental treatments had no significant effect on the abdominal fat and total bone. The drum stick, neck, wing and breast showed that in any particular oil level birds fed premix R in that particular oil level had the highest weights. There were no significant differences ($P>0.05$) between birds fed either premix S or premix R with 2% oil and their counterparts fed the same premix but with 1% oil. Birds fed premix D with 2% oil had higher weights than birds fed premix D with 1% oil. The weights of thigh and the back of birds fed premix S or premix R with 2% oil were not significantly ($P>0.05$) different from their counterparts fed the same premix but with 1% oil. However birds fed premix D with 2% oil had significantly ($P<0.05$) higher weights of cut up parts than birds fed premix D with 1% oil. Birds fed any of the premixes with 2% oil had significantly higher ($P<0.05$) weight of total edible meat than birds fed the

TABLE 5.18

ARC SINE VALUES OF ORGANS EXPRESSED AS PERCENTAGE OF DRESSED WEIGHT

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIX	S	R	D	S	R	D	$SE\bar{X}$
Liver	7.54	7.25	8.05	7.46	7.45	7.50	0.10
Heart	3.93	3.93	3.91	3.55	3.84	3.99	0.03
Gizzard	7.63	7.37	7.86	7.69	7.46	7.20	0.09
Spleen	1.82	1.95	2.07	2.11	2.02	1.91	0.04
Kidney	3.83^{b}	3.86^{b}	3.99^{a}	3.86^{b}	3.87^{b}	3.85^{b}	0.02
Lungs	3.04^{d}	3.04^{d}	4.05^{ab}	3.83^{c}	4.12^{a}	3.99^{b}	0.19

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 5.19

AVERAGE WEIGHTS OF CUT UP PARTS (GRAMS) OF FIVE WEEK OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	$SE\bar{X}$
Drum sticks	81.14^{b}	89.86^{a}	75.81^{c}	83.61^{b}	88.04^{a}	84.30^{b}	1.87
Thighs	75.48^{cd}	83.23^{a}	64.78^{e}	77.85^{bc}	80.11^{ab}	72.14^{d}	2.43
Neck	41.43^{b}	46.40^{a}	33.38^{c}	42.10^{b}	49.10^{a}	41.86^{b}	2.00
Wings	63.83^{b}	70.14^{a}	56.30^{c}	63.72^{b}	68.83^{a}	63.14^{b}	1.83
Back	81.83^{bc}	89.02^{a}	69.82^{d}	81.61^{bc}	86.30^{ab}	78.73^{c}	2.49
Breast	90.88^{b}	99.70^{a}	83.72^{c}	92.81^{b}	97.16^{a}	91.97^{b}	2.06
Abdominal Fat	3.12	3.39	3.84	4.30	4.09	4.81	0.23
Total edible meat	308.14^{d}	348.31^{b}	259.87^{e}	322.25^{c}	357.16^{a}	309.71^{d}	12.92
Total bone	133.95	120.36	122.97	127.32	117.24	127.76	2.23

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

same premix but with 1% oil. When these values were expressed as percentage of eviscerated weight and then converted to the arc sine values (table 5.20) all the parameters showed no significant difference ($P>0.05$) between the experimental treatments.

Table 5.21 shows the weights of the carcass traits for ten weeks old broilers. The live weight and the dressed weight showed that birds fed any of the premixes with 2% oil had higher weights than birds fed the same premix but with 1% oil with the exception of birds fed premix S at the starter and finished with premix D, and birds fed premix D at the starter and finished with either premix S or premix R. In both parameters birds fed premix R at the starter and finisher phases with 2% oil had the highest weights. Within a particular oil level when any of the starter premixes were considered birds fed premix R as the finisher premix had the highest weight when compared to the values for birds fed the other two premixes in that particular starter premix and with birds fed premix S as the finisher premix having higher values than birds fed premix D as the finisher premix when any particular starter premix was considered. The weight of feathers shows no consistent trend between and within the two oil levels fed to the birds. However birds fed premix R at the starter and finisher phases

TABLE 5.20

ARC SINE VALUES OF CUT UP PARTS EXPRESSED AS PERCENTAGE OF EVISCERATED WEIGHT

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	$SE\bar{X}$
Drum sticks	25.30	25.93	26.29	25.45	25.50	25.94	0.13
Thighs	24.32	24.88	24.17	24.49	24.24	23.87	0.09
Neck	17.76	18.30	17.09	17.75	18.73	17.96	0.21
Wings	22.59	22.72	22.44	22.55	22.36	22.25	0.09
Back	25.40	25.79	25.15	25.13	25.22	25.01	0.10
Breast	26.87	27.42	27.73	26.92	26.87	27.19	0.13
Abdominal fat	4.75	4.86	5.72	5.56	5.29	6.00	0.19
Total edible meat	56.34	59.39	55.08	57.53	60.11	56.98	0.70
Total bone	33.28	30.49	34.35	32.03	29.77	32.58	0.61

Values with different superscripts on the same horizontal row were significantly different ($P<0.05$).

TABLE 5.21

AVERAGE WEIGHT OF CARCASS TRAITS (GRAMS) OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Live weight	Dressed weight	Weight of feathers	Eviscerated weight	Weight of viscera
1%	S	S	2003.37^{h}	1757.29^{f}	96.78^{fg}	1439.57^{f}	170.00^{d}
		R	2047.68^{f}	1780.22^{e}	105.44^{bc}	1462.35^{e}	169.01^{d}
		D	1896.76^{n}	1644.44^{k}	95.07^{gh}	1331.79^{l}	157.87^{fgh}
	R	S	2028.35^{g}	1776.59^{e}	99.11^{fg}	1448.48^{f}	176.98^{c}
		R	2130.60^{b}	1860.32^{b}	114.55^{a}	1553.29^{c}	161.87^{efg}
		D	1914.82^{l}	1664.86^{j}	95.82^{gh}	1376.63^{j}	152.82^{hi}
	D	S	1925.29^{k}	1687.03^{h}	100.23^{ef}	1391.67^{hi}	155.41^{ghi}
		R	1973.78^{i}	1721.08^{g}	91.58^{h}	1413.14^{g}	155.40^{ghi}
		D	1791.77^{q}	1538.87^{n}	96.42^{fg}	1264.17^{m}	145.57^{i}
2%	S	S	2084.62^{d}	1825.58^{c}	102.89^{cdef}	1558.62^{c}	178.83^{bc}
		R	2119.07^{c}	1865.13^{d}	98.34^{fg}	1590.23^{b}	184.66^{ab}
		D	1883.04^{o}	1634.47^{l}	96.93^{fg}	1381.99^{ij}	163.64^{def}
	R	S	2073.31^{e}	1815.34^{d}	104.85^{bcd}	1537.83^{d}	188.42^{a}
		R	2187.55^{a}	1927.40^{a}	104.83^{bcd}	1663.92^{a}	179.12^{bc}
		D	1923.53^{k}	1676.63^{i}	101.99^{def}	1408.60^{g}	183.91^{ab}
	D	S	1904.61^{m}	1652.19^{k}	100.93^{def}	1404.72^{gh}	159.14^{ef}
		R	1939.07^{j}	1683.55^{hi}	106.28^{bc}	1444.53^{f}	160.21^{efg}
		D	1832.51^{p}	1580.04^{m}	97.13^{fg}	1348.12^{k}	152.45^{hi}
		SE±	25.08	24.14	1.23	23.12	3.56

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

with 1% oil had the highest feather weight.

Birds fed any of the premixes at the starter and finisher phases with 2% oil had significantly higher ($P<0.05$) eviscerated weight than birds fed the same premix but with 1% oil with the exception of birds fed premix D at the starter and finished with premix S with 2% oil. Generally birds fed premix R at the starter and finisher phases with 2% oil had the highest eviscerated weight. Within a particular oil level when a particular starter premix is considered birds fed premix R as the finisher premix had higher eviscerated weights than birds fed the other two finisher premixes within that particular starter premix. The weight of viscera showed that birds fed any of the premixes at the starter and finisher phases with 2% oil had higher viscera weight than birds fed the same premix but with 1% oil, with the exception of birds fed premix S at the starter and finished with premix D and also birds fed premix D at the starter and finished with either premix R or premix D all with 2% oil which were not significantly different from their counterparts fed the same premix but with 1% oil.

When these values were expressed as percentages of live weight and then transformed into the arc sine values (table 5.22) only the dressed weight and the eviscerated weight showed significant differences ($P<0.05$) between the experimental treatments. No significant difference ($P>0.05$) existed between the dressed weight of the birds fed any of the premixes

TABLE 5.22

ARC SINE VALUES OF CARCASS TRAITS EXPRESSED AS PERCENTAGE OF LIVE WEIGHT

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Dressed weight	Weight of feathers	Eviscerated weight	Weight of viscera
1%	S	S	69.49^{a}	12.70	57.96^{f}	16.93
		R	68.81^{ab}	13.12	57.68^{fg}	16.70
		D	68.61^{ab}	12.93	56.92^{h}	16.77
	R	S	69.37^{a}	12.77	57.68^{fg}	17.18
		R	69.14^{a}	13.40	58.63^{d}	16.00
		D	68.83^{ab}	12.93	57.99^{f}	16.41
	D	S	69.43^{a}	13.17	58.24^{e}	16.51
		R	69.03^{a}	12.44	57.79^{f}	16.30
		D	67.94^{b}	13.41	57.14^{gh}	16.55
2%	S	S	69.36^{a}	12.83	59.85^{b}	17.15
		R	69.74^{a}	12.45	60.03^{b}	17.16
		D	68.70^{ab}	13.11	58.94^{d}	17.14
	R	S	69.35^{a}	12.99	59.45^{bc}	17.27
		R	69.83^{a}	12.64	60.71^{a}	16.63
		D	69.01^{a}	13.31	58.77^{de}	18.00
	D	S	68.65^{ab}	13.31	59.18^{cd}	16.79
		R	68.71^{ab}	13.51	59.67^{bc}	16.70
		D	68.21^{b}	13.32	59.06^{cd}	16.76
		$SE\bar{X}$	0.12	0.07	0.24	0.10

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

at the starter and finisher phases with 2% oil and those fed the same premix with 1% oil, while for the eviscerated weights, birds fed any of the premixes at the starter and finisher phases with 2% oil had higher values than birds fed the same premix but with 1% oil.

The weight of organs of ten weeks old broilers is shown in table 5.23. Birds fed any of the premixes at the starter and finisher phases with 2% oil had higher liver weight than birds fed the same premix but with 1% oil with the exception of birds fed premix R at the starter and finished with either premix R or premix D and birds fed premix D at the starter phase and finished with premix R. Birds fed premix R at the starter phase and finished with any of the premixes with 2% oil showed no significantly better heart weight than birds fed the same premix with 1% oil. The gizzard weights of birds fed premix D at the starter phase and finished with premix R with 2% oil and birds fed premix S at the starter and finisher phases with 2% oil were not significantly ($P > 0.05$) different from those of birds fed the same premix with 1% oil, while birds fed premix R at the starter and finisher phases with 1% oil had the highest gizzard weight.

Weights of spleen of birds fed any of the premixes at the starter and finisher phases with 2% oil were higher than spleen of birds fed the same premix but with 1% oil with the exception of birds fed premix S at the starter and finisher phases and

TABLE 5.23

AVERAGE WEIGHT OF ORGANS (GRAMS) OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Liver	Heart	Gizzard	Spleen	Kidney	Lungs
1%	S	S	46.88^{c}	14.11^{c}	47.62^{c}	4.06^{def}	13.02^{e}	11.17^{de}
		R	43.40^{f}	13.89^{c}	46.61^{d}	4.27^{cd}	13.34^{d}	11.04^{efg}
		D	39.62^{l}	12.43^{de}	43.09^{h}	3.11^{j}	11.26^{i}	9.82^{j}
	R	S	44.93^{e}	14.10^{c}	44.39^{fg}	4.45^{bc}	13.64^{c}	11.56^{c}
		R	49.24^{a}	17.85^{a}	49.87^{a}	4.77^{a}	14.21^{b}	12.94^{a}
		D	41.38^{ij}	13.85^{c}	44.89^{ef}	3.64^{gi}	12.93^{e}	10.47^{i}
	D	S	41.56^{hi}	12.10^{e}	44.27^{g}	3.53^{i}	11.87^{h}	10.61^{hi}
		R	42.19^{g}	14.11^{c}	45.30^{e}	3.67^{g}	12.16^{f}	10.94^{fg}
		D	38.88^{m}	11.38^{f}	41.79^{i}	3.04^{j}	10.92^{j}	9.83^{j}
2%	S	S	49.02^{a}	14.79^{b}	47.24^{c}	4.21^{cde}	13.82^{c}	11.43^{cd}
		R	48.38^{b}	14.84^{b}	49.04^{b}	4.87^{a}	13.64^{c}	12.06^{b}
		D	40.73^{k}	12.12^{e}	47.53^{c}	3.81^{fg}	12.93^{e}	10.79^{gh}
	R	S	46.07^{d}	13.92^{c}	45.09^{e}	4.42^{c}	14.27^{b}	11.59^{c}
		R	49.52^{a}	17.61^{a}	49.11^{b}	4.69^{ab}	14.92^{a}	12.65^{a}
		D	41.39^{ij}	14.02^{c}	46.82^{d}	4.11^{de}	13.39^{cde}	11.34^{cde}
	D	S	42.64^{g}	13.74^{c}	45.07^{e}	3.84^{fg}	12.31^{i}	10.47^{i}
		R	42.13^{gh}	13.82^{c}	44.88^{ef}	4.02^{ef}	12.96^{gh}	10.82^{gh}
		D	40.81^{jk}	13.01^{d}	42.38^{i}	3.61^{gi}	11.44^{i}	10.46^{i}
		SE$\bar{X}$	2.75	0.38	0.53	0.12	0.25	0.19

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

birds fed premix R at the starter phase and finished with either premix S or premix R all with 2% oil. These had values that were not significantly ($P>0.05$) different from those for birds fed the same premix with 1% oil. Weights of the kidney of birds fed 2% oil with premix S at starter and finished with any of the premixes were higher than those of birds fed 1% oil with the same premix. Within a particular oil level birds fed premix R at the starter and finisher phases had the highest lungs weight. The lungs weight also showed that birds fed any of the premixes at the starter phase and finished with premix D with 2% oil had higher weights than birds fed the same premix with 1% oil, also birds fed premix S at starter and finished with premix R with 2% oil had higher lungs weight than their counterparts fed the same premix with 1% oil.

When these values were expressed as percentage of dressed weight and then converted to the arc sine values (table 5.24). Values for the spleen and the kidney were not significantly different ($P>0.05$) between the experimental treatments. For the liver birds fed premix S at the starter phase and finished with any of the premixes and birds fed premix R at starter and finished with premix S or premix R all with 1% oil had higher values than their counterparts fed the same premix but with 2% oil. Also birds fed premix D at starter and finished with premix S with 2% oil had higher values than birds fed the same

TABLE 5.24.

ARC SINE VALUES OF ORGANS EXPRESSED AS PERCENTAGE OF DRESSED WEIGHT.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Liver	Heart	Gizzard	Spleen	Kidney	Lungs
1%	S	S	9.39^{a}	5.15^{bc}	9.48^{bc}	2.78	4.93	4.59^{abc}
		R	8.99^{bc}	5.07^{bc}	9.32^{cd}	2.81	4.96	4.52^{bc}
		D	8.93^{bc}	4.98^{bc}	9.32^{cd}	2.50	4.74	4.43^{c}
	R	S	9.15^{ab}	5.12^{bc}	9.09^{de}	2.89	5.03	4.63^{abc}
		R	8.94^{bc}	5.62^{a}	9.62^{bc}	2.89	5.00	4.78^{a}
		D	8.46^{f}	5.22^{b}	9.05^{b}	2.69	5.05	4.56^{abc}
	D	S	8.44^{f}	4.87^{c}	9.33^{cd}	2.62	4.80	4.56^{abc}
		R	8.40^{f}	5.20^{bc}	9.33^{cd}	2.65	4.82	4.57^{abc}
		D	8.47^{ef}	4.94^{bc}	9.48^{bc}	2.53	4.85	4.59^{abc}
2%	S	S	8.80^{cd}	5.17^{bc}	9.26^{cde}	2.75	5.00	4.53^{bc}
		R	8.69^{d}	5.11^{bc}	9.34^{c}	2.92	4.90	4.61^{abc}
		D	8.45^{f}	4.94^{bc}	9.82^{a}	2.78	5.01	4.66^{abc}
	R	S	8.58^{df}	5.02^{bc}	9.06^{e}	2.84	5.01	4.59^{abc}
		R	8.66^{d}	4.49^{d}	9.18^{de}	2.83	5.00	4.66^{abc}
		D	8.44^{f}	5.24^{b}	9.63^{ab}	2.83	5.13	4.71^{ab}
	D	S	8.61^{de}	5.24^{b}	9.51^{b}	2.78	4.95	4.57^{abc}
		R	8.47^{ef}	5.18^{bc}	9.41^{b}	2.83	5.04	4.61^{abc}
		D	8.58^{de}	5.21^{bc}	9.42^{b}	2.56	4.88	4.66^{abc}
		SE$\bar{X}$	0.07	0.05	0.05	0.03	0.03	0.02

Values with different superscript on the same vertical row were significantly different ($P \leq 0.05$).

premix with 1% oil. Values for the heart showed that birds fed premix R at starter and finisher with 1% oil had higher values than birds fed the same premix with 2% oil, while birds fed premix D at starter and premix S at finisher with 2% oil had higher value than birds fed the same premix but with 1% oil. Values for the gizzard showed that birds fed premix S at starter and premix D at finisher with 2% oil had the highest arc sine value. Results for the lungs showed that birds fed any of the premixes at starter and finisher phases with 2% oil had values not significantly ($P>0.05$) different to that of birds fed the same premix but with 1% oil.

Table 5.25 shows the weight for the cut up parts of ten weeks old birds. Weights for drum sticks of birds fed any of the premixes at the starter and finisher phases with 2% oil were significantly ($P<0.05$) higher than drum sticks of birds fed the same premix but with 1% oil with the exception of birds fed premix R at starter and premix S at finisher with 2% oil. Generally birds fed premix R at the starter and finisher phases with 2% oil had the highest drum sticks weight. Lowest weight of thighs were obtained with birds fed 1% oil with any particular starter premix and premix D was the finisher premix. Generally birds fed premix R at starter and finisher phases with 1% oil had the highest thigh weight. The neck of birds fed 2% oil with any of the premixes at the starter and

TABLE 5.25

AVERAGE WEIGHT OF CUP UP PARTS (GRAMS) OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	D.S	TH	NE	WI	BA	BR	AF	T.E.M	T.B
1%	S	S	210.78^{ef}	200.83^{e}	89.92^{de}	164.02^{fg}	283.87^{fg}	433.63^{f}	32.16^{de}	1047.21^{e}	381.35^{de}
		R	213.56^{e}	213.13^{d}	97.11^{c}	157.44^{h}	289.54^{e}	417.95^{h}	32.10^{de}	1074.80^{d}	377.54^{e}
		D	192.57^{ij}	189.75^{g}	74.81^{h}	150.18^{i}	271.80^{i}	404.25^{k}	27.64^{fg}	974.53^{j}	347.26^{h}
	R	S	217.27^{d}	219.34^{bc}	90.93^{d}	165.39^{f}	278.90^{gh}	427.88^{g}	29.72^{ef}	1051.16^{de}	385.32^{cd}
		R	239.42^{b}	232.58^{a}	92.77^{cd}	179.66^{d}	304.98^{d}	471.34^{a}	25.83^{g}	1168.44^{b}	374.86^{e}
		D	192.26^{ij}	196.53^{ef}	81.49^{g}	162.49^{fg}	276.35^{h}	407.88^{j}	18.16^{h}	1011.72^{gh}	352.92^{g}
	D	S	198.34^{hi}	189.64^{g}	84.62^{fg}	159.50^{gh}	285.30^{ef}	408.36^{j}	31.92^{de}	1024.27^{fg}	356.39^{g}
		R	201.20^{gh}	199.15^{e}	86.38^{ef}	163.66^{fg}	279.47^{gh}	417.17^{h}	27.62^{fg}	1038.15^{ef}	365.99^{f}
		D	178.02^{k}	172.88^{h}	77.38^{h}	147.93^{i}	244.12^{j}	367.70^{n}	24.32^{g}	931.35^{k}	322.82^{j}
2%	S	S	221.27^{d}	210.20^{d}	109.99^{b}	186.43^{c}	311.71^{c}	460.52^{c}	36.54^{bc}	1159.71^{b}	381.07^{e}
		R	231.88^{c}	215.33^{cd}	116.10^{a}	196.93^{b}	318.25^{b}	456.63^{d}	41.55^{a}	1167.61^{b}	400.74^{b}
		D	206.26^{fg}	193.16^{fg}	86.98^{ef}	159.69^{gh}	274.91^{hi}	402.69^{k}	36.54^{bc}	984.20^{i}	378.83^{e}
	R	S	220.99^{d}	214.50^{cd}	105.91^{b}	187.83^{c}	303.89^{d}	443.92^{e}	34.84^{bcd}	1110.88^{c}	410.47^{a}
		R	247.33^{a}	221.33^{b}	116.92^{a}	215.03^{a}	339.62^{a}	465.59^{b}	35.37^{bcd}	1251.73^{a}	396.69^{b}
		D	210.27^{ef}	194.77^{fg}	94.59^{cd}	174.38^{e}	278.58^{gh}	399.73^{l}	35.00^{bcd}	1004.91^{h}	385.90^{c}
	D	S	205.59^{fj}	190.80^{g}	86.74^{ef}	174.52^{e}	286.88^{ef}	402.32^{k}	37.39^{b}	1019.09^{g}	368.83^{f}
		R	212.71^{e}	192.07^{fg}	97.13^{c}	183.18^{c}	284.48^{ef}	412.75^{i}	34.73^{bcd}	1062.59^{d}	364.62^{f}
		D	186.72^{j}	189.46^{g}	87.63^{ef}	160.24^{fg}	270.30^{i}	391.32^{m}	35.54^{bcd}	1003.21^{h}	336.75^{i}
		SE$\bar{X}$	4.12	3.49	2.80	3.97	4.90	6.49	2.20	18.83	5.13

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

D.S - Drum stick; TH - Thigh; NE - Neck; WI - Wing; BA - Back; BR - Breast; A.F - Abdominal fat; T.E.M - Total edible meat; T.B - Total bone.

finisher phases were higher than those of birds fed the same premix with 1% oil with the exception of birds fed premix D at starter and premix S at finisher with 2% oil. Weights of the wings of birds fed 2% oil with any of the premixes at starter and finisher phases were higher than those of birds fed the same premix with 1% oil, Birds fed premix R at starter and finisher with 2% oil had the highest wings weight.

Birds fed premix R at the starter and finisher phases with 2% oil had the highest back weight, however birds fed premix S at starter and finished with premix D, birds fed premix R at starter and finished with premix D and birds fed premix D at starter and finished with premix S all with 2% oil did not have higher back weights than birds fed the same premix but with 1% oil. Birds fed other premixes at the starter and finisher phases with 2% oil had higher back weights than birds fed the same set of premixes with 1% oil. For birds fed 2% oil when any of the starter premix is considered birds fed premix D as finisher premix had the lowest back weight for that particular starter premix. Breast weights showed that with the exception of birds fed premix R at starter and finished with premix R or premix D and birds fed premix D at the starter phase and finished with premix S or premix R all with 1% oil which had higher breast weights than birds fed the same premix with 2% oil. Also, birds fed premix S at starter and finished with premix D

with 2% oil had breast weights that were not higher than those for birds fed the same premix with 1% oil. However birds fed other premixes at starter and finisher phases with 2% oil had higher breast weights than birds fed the same premix with 1% oil.

Weights of the abdominal fat showed that for birds fed 2% oil there was no significant difference ($P>0.05$) between the birds fed the different premixes irrespective of the premix fed at the starter or finisher with the exception of birds fed premix S at starter and finished with premix R which had significant higher abdominal fat both for birds fed 2% oil and when all the experimental treatments are compared. Generally birds fed 2% oil level with any of the premixes at the starter and finisher phases had significantly ($P<0.05$) higher abdominal fat than their counterpart fed the same premix with 1% oil. For the total edible meat birds fed 2% oil level with any of the premix at the starter and finisher phases had higher total edible meat than birds fed 1% oil with the same premix, with the exception of birds fed premix R at starter and finished with premix D and birds fed premix D at starter and finished with premix S both with 2% oil. In these two cases the total edible meats were not higher than for their counterparts fed the same premix with 1% oil. For any particular oil level, when any of the starter premixes was considered, birds fed premix D as the finisher premix had the lowest total edible meat compared to birds fed

the other two finisher premixes.

Values for the total bone showed that birds fed premix R at starter and finished with premix S with 2% oil had the highest total bone, with birds fed 2% oil with any of the premixes at the starter and finisher phases having higher total bone than their counterparts fed the same premix with 1% oil, exceptions being birds fed premix S at the starter and finisher phases and birds fed premix D at starter and finished with premix R both 2% oil. These had total bone weights not significantly ($P > 0.05$) higher than their counterparts fed the same premix but with 1% oil. When the values were expressed as percentages of eviscerated weight and then transformed to the arc sine values (table 5.26). The drum stick, neck, back and breast did not show significant differences ($P > 0.05$) between the experimental treatments. The arc sine values for the thigh of birds fed premix R at starter with premix S or premix R at finisher with 1% oil were significantly higher than those for their counterpart fed the same premix with 2% oil. For birds fed 2% oil there was no significant difference ($P > 0.05$) between the experimental treatments irrespective of the premix fed at the starter and finisher phases.

Arc sine values for the wing of birds fed premix S at starter with premix R at finisher, and birds fed premix R at starter and finisher both with 2% oil were significantly higher than those

TABLE 5.26

ARC SINE VALUE OF CUT UP PARTS EXPRESSED AS PERCENTAGE OF EVISCERATED WEIGHT

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	D.S	TH	NE	WI	BA	BR	A.F	T.E.M	T.B
1%	S	S	22.50	21.93^{bcd}	14.47	19.72^{cde}	26.36	33.29	8.73^{bcd}	58.53^{de}	30.98^{abcd}
		R	22.46	22.44^{abc}	14.92	19.16^{e}	26.83	32.32	8.45^{cd}	59.02^{bcde}	30.53^{bcde}
		D	22.85	22.17^{abcd}	13.77	19.62^{de}	26.85	33.43	8.31^{d}	58.81^{cde}	30.61^{abcd}
	R	S	22.79	22.90^{a}	14.46	19.87^{cde}	26.02	32.92	8.16^{d}	58.42^{defg}	31.04^{abcd}
		R	23.11	22.77^{ab}	14.14	19.89^{bcde}	26.29	33.43	7.40^{de}	60.15^{a}	29.43^{ef}
		D	22.04	22.20^{abcd}	14.36	20.10^{abcde}	26.62	32.97	6.69^{e}	59.01^{bcde}	30.19^{def}
	D	S	22.18	21.67^{bcd}	14.28	20.11^{abcde}	26.92	32.78	8.69^{bcd}	59.08^{bcde}	30.40^{bcde}
		R	22.16	22.05^{abcd}	14.32	19.90^{bcde}	26.41	32.91	8.04^{de}	58.99^{bcde}	30.55^{bcde}
		D	22.03	21.70^{bcd}	14.32	19.94^{bcde}	26.06	32.64	8.00^{de}	59.13^{bcde}	30.36^{cdef}
2%	S	S	22.13	21.53^{cd}	15.29	20.24^{abcd}	26.57	32.93	9.95^{ab}	59.60^{abc}	29.64^{ef}
		R	22.45	21.59^{cd}	15.67	20.61^{abc}	26.27	32.40	9.30^{abc}	58.97^{cde}	30.45^{bcde}
		D	22.73	21.95^{bcd}	14.53	19.74^{cde}	26.49	32.76	10.58^{a}	57.55^{g}	31.57^{ab}
	R	S	22.28	21.93^{bcd}	15.22	20.45^{abcd}	26.39	32.50	9.83^{abc}	58.21^{efg}	31.11^{abc}
		R	22.68	21.37^{d}	15.37	21.07^{a}	26.86	31.94	9.50^{abc}	60.15^{a}	29.23^{f}
		D	22.73	21.83^{bcd}	15.01	20.60^{abc}	26.41	32.19	10.29^{a}	57.63^{fg}	31.56^{ab}
	D	S	22.49	21.63^{bcd}	14.39	20.63^{ab}	26.87	32.36	10.59^{a}	58.25^{efg}	31.33^{abc}
		R	22.56	21.38^{cd}	15.01	20.85^{ab}	26.34	32.31	10.31^{a}	58.56^{cdef}	30.16^{def}
		D	21.85	22.02^{bcd}	14.77	20.17^{abcde}	26.60	32.60	10.62^{a}	59.62^{abc}	29.99^{ef}
		SEX̄	0.08	0.10	0.11	0.11	0.06	0.10	0.23	0.17	0.15

Values with the different superscript on the same vertical row were significantly different ($P<0.05$).

D.S - Drum stick; TH - Thigh; NE - Neck; WI - Wing; BA - Back; BR - Breast; A.F - Abdominal fat; T.E.M - Total edible meat; T.B - Total bone.

of their counterparts fed the same premix but with 1% oil. For birds fed 1% oil there was no significant difference ($P > 0.05$) between the experimental treatments irrespective of the premix fed at the starter and finisher phases. When any of the starter premix is considered irrespective of the oil level it was observed, that in the arc sine values of the wing there were no significant differences ($P > 0.05$) between the birds fed the different finisher premixes under that particular starter premix, however no consistent trend was observed between the two oil levels. Birds fed 2% oil with premix D at starter and finished with any other premix and also birds fed premix S at starter and finished with premix D with 2% oil all had higher abdominal fat arc sine values than birds fed the same premix with 1% oil. For birds fed 2% oil there was no significant difference ($P > 0.05$) between the dietary treatments irrespective of the premix fed at the starter or finisher phases.

Arc sine values for total edible meat showed no particular trend both between and within oil levels. Arc sine values for total bone showed that only birds fed premix S at the starter and finisher phases with 1% oil and birds fed premix R at starter with premix D at finisher with 2% oil had significantly higher values than birds fed the same premix but different levels of oil.

5.3.4: PERCENTAGE CRUDE PROTEIN CONTENT (DRY MATTER BASIS) OF ORGANS OF EXPERIMENTAL BIRDS

Table 5.27 shows the result for the percentage crude protein of organs of five weeks old broilers. The liver crude protein of only birds fed premix R with 2% oil was higher than that of birds fed the same premix but with 1% oil. Within a particular oil level birds fed premix R had the highest liver crude protein. Crude protein values of the heart and gizzard of birds fed premix S with 2% oil were the highest. In case of the heart birds fed premix S with 2% oil had higher crude protein than birds fed the same premix with 1% oil. Crude protein values for the spleen, kidney and lungs did not show any particular trend. However for the kidney birds fed premix R with 2% oil had the highest kidney crude protein while for the lungs birds fed premix D with 1% oil and birds fed premix R with 2% oil had the highest lungs crude protein.

Values for the crude protein of organs of broilers at ten weeks old are shown in table 5.28. Birds fed premix R at starter and premix S at finisher with 2% oil had the highest liver crude protein. It was observed that for birds fed 2% oil with premix R or premix D at the starter phase, only birds fed premix R at finisher in both cases had lower liver crude protein than their counterparts fed the same premix with 1% oil. Heart crude protein values showed that birds fed 1% oil with any premix at

TABLE 5.27

PERCENTAGE CRUDE PROTEIN CONTENT (DRY MATTER BASIS) OF ORGANS OF FIVE WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE

LEVEL OF OIL:	1% oil inclusion			2% oil inclusion			
PREMIXES:	S	R	D	S	R	D	SE$\bar{X}$
Liver	88.62^{c}	90.34^{b}	86.65^{d}	88.97^{c}	91.35^{a}	87.02^{d}	0.68
Heart	76.81^{c}	77.52^{b}	73.41^{d}	79.02^{a}	77.24^{bc}	73.26^{d}	0.88
Gizzard	74.82^{c}	75.81^{c}	77.64^{b}	78.18^{a}	75.81^{c}	75.31^{c}	0.51
Spleen	57.50^{c}	58.93^{ab}	53.40^{d}	59.17^{a}	53.12^{d}	57.81^{bc}	1.01
Kidney	81.92^{b}	80.34^{c}	78.64^{d}	80.75^{c}	83.20^{a}	79.93^{cd}	0.59
Lungs	74.82^{b}	74.71^{b}	75.96^{a}	74.41^{b}	76.27^{a}	75.02^{b}	0.28

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 5.28

PERCENTAGE CRUDE PROTEIN CONTENT (DRY MATTER BASIS) OF ORGANS OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIX AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Liver	Heart	Gizzard	Spleen	Kidney	Lungs
1%	S	S	73.29^{hi}	69.62^{a}	62.15^{hi}	40.81^{jk}	65.01^{ij}	70.89^{c}
		R	75.21^{e}	68.38^{c}	67.43^{cd}	44.00^{fgh}	72.04^{b}	69.60^{de}
		D	71.95^{k}	65.91^{e}	67.22^{d}	44.64^{efg}	69.93^{d}	67.98^{hi}
	R	S	76.34^{d}	72.00^{a}	71.09^{a}	40.05^{k}	71.06^{c}	68.00^{gh}
		R	79.84^{b}	68.04^{c}	67.29^{cd}	42.66^{i}	70.34^{cd}	70.10^{de}
		D	74.45^{f}	64.28^{g}	63.76^{e}	43.77^{h}	67.29^{ef}	71.68^{b}
	D	S	72.09^{k}	65.81^{e}	64.17^{e}	45.69^{c}	63.69^{k}	67.02^{j}
		R	73.89^{gh}	64.17^{g}	61.72^{i}	49.02^{b}	65.63^{hi}	63.81^{k}
		D	70.92^{l}	62.00^{j}	63.69^{ef}	41.29^{j}	66.66^{fg}	68.43^{fgh}
2%	S	S	73.55^{g}	68.88^{b}	63.08^{g}	42.11^{i}	69.66^{d}	69.62^{de}
		R	75.64^{e}	68.24^{c}	67.46^{cd}	44.76^{ef}	75.53^{a}	68.71^{f}
		D	71.90^{k}	66.31^{d}	67.77^{c}	45.33^{cd}	66.39^{gh}	68.92^{f}
	R	S	80.93^{a}	68.00^{c}	68.04^{b}	50.73^{a}	72.63^{b}	72.88^{a}
		R	77.74^{c}	72.01^{a}	71.40^{a}	43.93^{gh}	67.67^{e}	72.41^{a}
		D	75.16^{e}	69.01^{h}	69.18^{fg}	40.57^{jk}	72.10^{b}	67.52^{ij}
	D	S	72.68^{j}	65.38^{f}	64.07^{e}	43.98^{fg}	65.54^{i}	68.99^{f}
		R	73.02^{ij}	64.04^{g}	60.05^{j}	44.82^{de}	66.47^{fgh}	68.91^{f}
		D	71.71^{k}	62.65^{i}	62.25^{h}	40.71^{jk}	64.25^{jk}	65.34^{ij}
		SEX	0.64	0.69	0.74	0.65	0.83	0.52

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

starter but finished with premix S had higher crude protein content than birds fed 2% oil with the same premix. For birds fed 1% oil if any of the starter premix is considered birds fed premix S as the finisher premix had the highest heart crude protein values compared to birds fed other finisher premix under that particular starter premix. Birds fed premix R at the starter and finisher phases with 2% oil and birds fed premix R at starter and premix S at finisher with 1% oil both had the highest gizzard crude protein values. For the spleen birds fed premix R at starter and premix S at finisher with 2% oil had highest crude protein. However in both the gizzard and spleen no particular trend was observed.

Crude protein values for the kidney showed that birds fed 2% oil with any premix at the starter and finished with premix S had higher values than their counterparts fed the same premix but 1% oil. However no particular trend was observed within the oil levels. Birds fed 2% oil with premix R at the starter phase and finished with premix S or premix R had the highest lungs crude protein value. It was observed that birds fed 2% oil with premix R or premix D at starter and finished with either premix S or premix R had lungs crude protein values which were higher than values for their counterparts fed the same premix but with 1% oil.

5.3.5: INDICES OF PROTEIN UTILIZATION BY BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES

Table 5.29 shows the results for some whole blood and plasma component of five weeks old broilers. Only the blood glucose showed any significant difference ($P<0.05$) between the experimental treatments. Birds fed premix S with 2% oil had the highest blood glucose concentration. Table 5.30 shows the average values of some serum components with the albumin, serum glutamate pyruvate transaminase (SGPT) and serum glutamate oxaloacetate transaminase (SGOT) showing significant differences ($P<0.05$) between the experimental treatments. Birds fed premix R with 2% oil had the highest albumin concentration. For SGPT birds fed premix D with 1% oil had the highest concentration, with no significant difference ($P>0.05$) between birds fed premix S with 1% or 2% oil. Birds fed premix D with 2% oil had the highest SGOT concentration.

Average values for liver fluid components are shown in table 5.31. Birds fed premix R and birds fed premix D both with 1% oil had higher liver glutamate pyruvate transaminase (LGPT) concentrations than their counterparts fed the same premix but with 2% oil. Birds fed premix D irrespective of the level of oil had the highest liver xanthine dehydrogenase concentration.

Table 5.32 shows the average values for some whole blood and plasma components of ten weeks old broilers. The blood glucose

TABLE 5.29

AVERAGE VALUES OF SOME WHOLE BLOOD AND PLASMA COMPONENTS OF FIVE WEEKS OLD BROILER FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT STARTER PHASE

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	SE$\bar{X}$
WHOLE BLOOD COMPONENTS (Mg/dl)							
Blood glucose	328.84^{c}	361.34^{b}	273.12^{d}	384.94^{a}	324.87^{c}	331.93^{c}	14.51
Blood urea nitrogen	11.98	11.70	11.72	12.12	10.93	13.46	0.51
PLASMA COMPONENTS							
Total protein (gm/dl)	9.12	9.41	8.88	9.60	11.04	9.91	0.29
Albumin (gm/dl)	6.31	6.74	5.63	6.84	7.21	6.72	0.20
Globulin (gm/dl)	2.81	2.67	3.25	3.17	3.83	3.19	0.15
Plasma xanthine dehydrogenase (i.u/10 mm/litre)	2.52	2.20	2.77	2.39	2.08	2.54	0.09

Values with different superscripts on the same horizontal row were significantly different ($P<0.05$).

TABLE 5.30

AVERAGE VALUES OF SOME SERUM COMPONENTS OF FIVE WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT STARTER PHASE

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	$SE\bar{X}$
Total protein (gm/dl)	11.19	12.21	9.95	11.78	11.63	10.40	0.34
Albumin (gm/dl)	6.87^{b}	6.93^{b}	5.34^{e}	6.32^{c}	7.41^{a}	6.00^{d}	0.28
Globulin (gm/dl)	4.32	5.28	4.61	5.45	4.22	4.40	0.19
Uric acid (Mg/dl)	1.78	1.35	1.91	2.08	1.71	1.24	0.12
Creatinine (Mg/dl)	1.39	1.14	1.49	1.43	1.10	1.36	0.05
Creatine (Mg/dl)	0.24	0.21	0.30	0.23	0.21	0.32	0.02
SGPT (SF unit/ml)	35.68^{b}	32.95^{c}	40.72^{a}	34.88^{b}	32.38^{c}	35.36^{b}	1.10
SGOT (SF unit/ml)	66.83^{cd}	65.33^{d}	68.19^{bc}	61.46^{e}	69.73^{b}	72.51^{a}	1.41

Values with different superscripts on the same horizontal row were significantly different ($P<0.05$).

TABLE 5.31

AVERAGE VALUES OF SOME LIVER FLUID COMPONENTS OF FIVE WEEKS OLD BROILER FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER PHASE.

LEVEL OF OIL	1% oil inclusion			2% oil inclusion			
PREMIXES	S	R	D	S	R	D	SE$\bar{X}$
LGOT (SF unit/ml)	124.61	111.54	127.22	127.49	128.37	119.36	2.44
LGPT (SF unit/ml)	106.13^{d}	128.68^{a}	127.74^{a}	121.86^{b}	123.44^{b}	111.38^{c}	3.40
Liver xanthine dehydrogenase (U mol/10 min/g fresh liver)	6.81^{b}	6.33^{cd}	8.12^{a}	6.76^{bc}	6.18^{d}	7.90^{a}	3.00

Values with different superscripts on the same horizontal row were significantly different ($P < 0.05$).

TABLE 5.32

AVERAGE VALUES OF SOME WHOLE BLOOD AND PLASMA COMPONENTS OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	WHOLE BLOOD COMPONENTS		PLASMA COMPONENTS			
			Blood glucose (Mg/dl)	Blood urea nitrogen (Mg/dl)	Total protein (gm/dl)	Albumin (gm/dl)	Globulin (gm/dl)	Xanthine dehydrogenase I.U/10 min/litre
1%	S	S	406.92^{fgh}	14.33^{hi}	13.86^{k}	8.63^{cde}	5.24	3.58^{g}
		R	394.70^{i}	14.21^{hi}	14.34^{h}	9.03^{bcd}	5.33	3.77^{efg}
		D	410.17^{fgh}	17.04^{cd}	14.01^{ij}	9.49^{abc}	4.52	4.13^{abc}
	R	S	425.11^{de}	15.51^{g}	14.83^{e}	9.24^{abcd}	5.59	3.71^{f}
		R	441.30^{c}	14.72^{h}	15.02^{d}	10.09^{a}	4.93	3.37^{h}
		D	409.12^{fgh}	16.54^{de}	13.96^{j}	7.14^{g}	6.82	4.00^{bcd}
	D	S	391.41^{i}	16.78^{cde}	12.72^{o}	6.13^{h}	6.59	4.21^{ab}
		R	400.00^{hi}	16.21^{ef}	13.10^{n}	7.10^{g}	6.00	3.66^{g}
		D	372.12^{j}	18.76^{a}	12.14^{q}	6.88^{gh}	5.26	3.89^{def}
2%	S	S	458.36^{b}	17.38^{c}	16.83^{a}	9.10^{bc}	7.73	3.42^{h}
		R	483.12^{a}	14.08^{i}	14.42^{g}	8.91^{cd}	5.51	3.72^{fg}
		D	450.16^{b}	13.66^{i}	14.71^{f}	9.25^{abcd}	5.38	4.13^{abc}
	R	S	455.93^{b}	13.86^{i}	15.95^{c}	9.80^{ab}	5.93	3.97^{cde}
		R	451.99^{b}	12.03^{j}	16.33^{b}	9.50^{ab}	5.83	3.24^{h}
		D	489.46^{a}	15.98^{efg}	13.70^{l}	7.36^{fg}	6.34	3.42^{h}
	D	S	415.34^{efg}	15.70^{fg}	14.03^{j}	8.55^{de}	5.48	4.02^{bcd}
		R	430.88^{d}	16.82^{cde}	13.62^{m}	8.00^{ef}	5.62	3.58^{g}
		D	421.88^{de}	18.10^{b}	12.39^{p}	6.65^{gh}	5.74	4.30^{a}
		SEX	7.34	0.41	0.29	0.24	0.17	0.07

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

values showed that birds fed 2% oil with any premix at the starter and finisher phases had higher concentration than their counterparts fed the same premix but with 1% oil. Also when 2% oil was fed, birds fed premix S and birds fed premix R at the starter phase and finished with any of the premixes had higher blood glucose concentration than birds fed premix D at starter and finished with any of the premixes. Blood urea nitrogen values showed that at dietary 1% oil when any of the starter premix was considered birds fed premix D at finisher stage had higher blood urea nitrogen than birds fed the other finisher premixes. For plasma components the total protein values of birds fed 2% oil with any premix at the starter and finisher phases were higher than those for birds fed the same premix but with 1% oil. Birds fed premix S at starter and finisher phase with 2% oil had the highest total plasma protein concentration. Plasma albumin values showed that birds fed 2% oil with either premix S or premix R at starter and finished with any of the premixes had values not significantly ($P>0.05$) higher than for birds fed the same premix but with 1% oil. Birds fed 1% oil with any of the premixes at the starter phase and finished with premix R had plasma xanthine dehydrogenase concentrations that were not significantly higher than that for birds fed the same premix with 2% oil.

Table 5.33 shows the average values of some serum components of ten weeks old broilers. Total protein values showed that only birds fed premix R at starter and premix D at finisher with 1% oil had concentrations that were higher than that of their counterparts fed the same premix but with 2% oil, the values

TABLE 5.33

AVERAGE VALUES OF SOME SERUM COMPONENTS OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES.

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	T. P (gm/dl)	AL (gm/dl)	GL (gm/dl)	U .A (mg/dl)	CRN (mg/dl)	CT (mg/dl)	SGOT (SF unit/ml)	SGPT (SF unit/ml)
1%	S	S	16.11^{cd}	10.28^{de}	5.83	3.20^{b}	3.33^{fgh}	0.88	76.82^{kl}	61.75^{ij}
		R	17.36^{b}	10.75^{cd}	6.61	3.19^{b}	3.52^{f}	0.96	87.20^{fg}	60.32^{jk}
		D	14.30^{fg}	9.11^{ghi}	5.19	4.24^{a}	3.18^{hi}	0.92	94.10^{bc}	74.24^{b}
	R	S	16.01^{cd}	11.09^{bc}	4.93	3.61^{c}	4.08^{cd}	1.07	80.42^{j}	73.92^{b}
		R	18.73^{a}	12.02^{a}	6.71	2.98^{b}	3.22^{hi}	0.97	75.91^{l}	61.16^{ij}
		D	15.64^{de}	8.93^{ghij}	6.71	3.16^{b}	3.14^{hi}	0.81	94.78^{b}	62.96^{h}
	D	S	15.52^{de}	8.59^{hijk}	6.93	3.70^{c}	4.51^{a}	1.01	87.40^{f}	60.86^{ij}
		R	15.91^{bcd}	8.02^{kl}	7.89	3.55^{c}	3.97^{de}	0.94	82.85^{i}	64.92^{gh}
		D	14.55^{fg}	7.26^{l}	7.29	4.14^{ab}	3.81^{e}	1.11	92.33^{cd}	74.81^{b}
2%	S	S	15.92^{bc}	10.03^{ef}	5.89	3.96^{bc}	3.47^{fg}	0.82	78.51^{jk}	58.22^{k}
		R	17.42^{b}	10.09^{cd}	6.52	3.08^{b}	3.29^{gh}	0.83	85.36^{gh}	65.20^{g}
		D	14.90^{ef}	8.42^{ijk}	6.48	3.28^{bc}	3.78^{e}	0.91	91.39^{de}	77.60^{a}
	R	S	16.73^{bc}	10.48^{de}	6.25	3.14^{b}	3.32^{g}	0.91	70.53^{m}	69.95^{de}
		R	18.66^{a}	11.87^{ab}	6.79	2.96^{b}	3.04^{i}	0.79	83.51^{hi}	61.63^{ij}
		D	13.89^{g}	9.20^{fghi}	4.69	4.10^{a}	4.24^{bc}	1.00	92.22^{cd}	67.00^{fg}
	D	S	15.00^{ef}	9.71^{efg}	5.29	3.73^{c}	4.36^{c}	1.05	89.72^{e}	72.95^{bc}
		R	16.43^{bc}	8.18^{jk}	8.25	3.50^{c}	4.07^{cd}	0.89	80.00^{j}	68.70^{ef}
		D	14.80^{ef}	9.34^{fghi}	5.46	4.13^{a}	4.13^{cd}	1.13	98.75^{a}	71.01^{cd}
		SE±	0.30	0.31	0.22	0.10	0.11	0.02	1.75	1.33

Values with different superscript on the same vertical row were significantly different ($P<0.05$).

T.P - Total protein; AL - Albumin; GL - Globulin; U.A - Uric Acid CRN - Creatinine; CT - Creatine SGOT - Serum glutamate oxaloacetate transaminase; SGPT - Serum glutamate pyruvate transaminase.

also showed that birds fed premix R at starter and finisher phases irrespective of the oil level had the highest total serum protein concentration. Birds fed premix R at starter and premix S at finisher with 1% oil had higher serum albumin concentration than birds fed the same premix but with 2% oil. Also birds fed 2% oil with premix D at starter and finished with either premix S or premix D had albumin concentration higher than that of birds fed the same premix with 1% oil, serum Uric acid values showed that birds fed premix R or premix D at starter and finished with premix D with 2% oil, birds fed premix S at starter and premix D at finisher with 1% oil, and birds fed premix D at starter and finisher with 1% oil had the highest serum uric acid concentration.

Creatinine values obtained in this experiment showed no particular trend. There was no significant difference ($P \quad 0.05$) between the birds fed the different premixes in their serum creatine concentration. However for the serum glutamate oxaloacetate transaminase (SGOT) values, irrespective of the oil level when any particular starter premix is considered it was observed that birds fed premix D as the finisher premix had the highest concentration of SGOT compared to birds fed other finisher premixes at that particular starter premix. There was no particular trend in the serum glutamate pyruvate transaminase (SGPT) values, however birds fed premix S at starter and premix D at finisher with 2% oil had the highest concentration.

TABLE 5.34

AVERAGE VALUES OF SOME LIVER FLUID COMPONENTS OF TEN WEEKS OLD BROILERS FED DIFFERENT PREMIXES AND TWO LEVELS OF PALM OIL AT THE STARTER AND FINISHER PHASES

LEVEL OF PALM OIL	PREMIX FED AT STARTER	PREMIX FED AT FINISHER	Liver glutamate oxaloacetate transaminase (SF unit/ml)	Liver glutamate pyruvate transaminase (SF unit/ml)	Liver xanthine dehydrogenase (U mole/10 min/g fresh liver)
1%	S	S	287.54^{ef}	169.13^{gh}	11.82^{d}
		R	251.82^{l}	182.71^{c}	12.10^{d}
		D	275.46^{ij}	169.15^{gh}	13.09^{b}
	R	S	268.81^{k}	175.83^{de}	12.71^{c}
		R	296.11^{c}	179.55^{cd}	11.31^{f}
		D	279.36^{hi}	164.52^{h}	13.24^{b}
	D	S	293.78^{cd}	188.35^{b}	14.02^{a}
		R	281.37^{gh}	188.03^{b}	13.21^{b}
		D	267.35^{k}	174.19^{ef}	14.16^{a}
2%	S	S	263.88^{k}	166.72^{gh}	11.59^{ef}
		R	281.65^{gh}	189.36^{ab}	12.02^{d}
		D	301.92^{b}	169.77^{fg}	12.94^{bc}
	R	S	274.56^{ij}	164.38^{h}	12.00^{d}
		R	293.45^{cd}	188.13^{b}	11.28^{f}
		D	272.64^{j}	178.44^{cde}	11.79^{de}
	D	S	308.60^{a}	180.01^{cd}	13.07^{b}
		R	289.60^{de}	190.64^{a}	13.04^{b}
		D	284.14^{fg}	180.29^{cd}	13.81^{a}
		SE$\bar{X}$	3.30	2.16	0.22

Values with different superscript on the same vertical row were significantly different ($P < 0.05$).

Average values of some liver fluid components of ten weeks old broilers are shown in table 5.34. Birds fed premix D at starter and premix S at finisher with 2% oil had the highest liver glutamate oxaloacetate transaminase (LGOT) concentration. Birds fed 2% oil with premix D at starter and finished with any of the premixes had higher LGOT concentrations than birds fed the same premix but with 1% oil. Birds fed 2% oil with any of the premixes at the starter phase and finished with premix R had higher liver glutamate pyruvate transaminase (LGPT) concentrations than birds fed the same premix but with 1% oil, for birds fed 2% oil if a particular starter premix is considered birds fed premix R as the finisher premix had LGPT concentrations higher than that of birds fed other finisher premixes under that particular starter premix. Birds fed 1% oil with any of the premixes at starter and finished with premix S had liver xanthine dehydrogenase concentrations higher than birds fed the same premix but with 2% oil, while for birds fed 1% oil with any of the premixes at starter and finished with premix R had liver xanthine dehydrogenase concentrations that were not significantly ($P > 0.05$) higher than that of birds fed the same premix but with 2% oil.

5.4: DISCUSSION

5.4.1: FEED UTILIZATION

The superior live weight of birds fed the 2% oil compared with birds fed 1% oil with the same premix is in concurrence with

previous observations (Essary et al., 1965; and Coon et al., 1971). These workers noted that broilers fed supplemental oil or fat grew faster. It is possible that the increase in weight of birds in treatments containing 2% oil was due to the improvement in the efficiency of utilization of dietary metabolisable energy for body gain. Studies with chickens and turkeys (Touchburn and Naber 1966; Jesen et al., 1970) have shown that adding fat to ration improved the utilization of metabolisable energy and protein. This explanation applies to this study especially where the birds were fed the same premix but different dietary oil levels. Another reason that may be given is that the higher oil content might have enhanced the proper utilization of the vitamins and trace minerals.

The premixes used in this study (Table 3.9 and Table 3.10) contained different vitamins and trace minerals in different quantities. Roche zoodry broiler premix (premix R) contained the highest number of vitamins and trace minerals, followed by Dizengoff Vitadiz B.P. (premix D) and Sander broiler starter and broiler finisher premixes (premix S). However Sanders broiler starter and finisher premixes contained the largest quantity of the vitamins and trace minerals. This large amount may be one of the reasons for the better performance of birds fed premix S when compared to birds fed premix D. Another reason may be that the vitamins and trace minerals may be made more available in the case

of premix S than in premix D. However availability test was not carried out, because of the problems involved.

Two reasons may be given for the better performance of birds fed premix R over birds fed premix S. The first is that vitamins and trace minerals do not function in isolation and that the deficiency of some vitamins and trace minerals in premix S may have an effect on the proper utilization of the other vitamins and trace minerals. Another way in which this first reason can be viewed is that the high amount of vitamins and trace minerals present in premix S may have antagonistic effects on the proper utilization of other nutrients present in the feed, such as the antagonistic effect of copper on methionine (Robbin and Baker 1980). The second reason for the better performance of birds fed premix R over birds fed premix S may be due to the easy availability of the vitamins and trace minerals in premix R compared to premix S.

The significantly high live weight at ten weeks of birds fed premix R at starter and finisher phases with 2% oil may be due to the added advantage of thiamine which premix R had over the other premixes. Thiamine is a very important vitamin needed in fat utilization, thus the 2% oil content combined with the thiamine may thus have a positive effect on the growth of the birds. This can be confirmed by the fact that birds that were fed premix S or premix D at both the 1% and 2% oil level at the starter phase and then fed premix R at the finisher phase with either 1% or 2%

oil gave higher live weights than their counterparts fed the other premixes at the finisher phase with either 1% or 2% oil. The improvement in the performance of the broilers when fed premix R may be due to the well balanced nature of the vitamins and trace minerals present in premix R in addition to the other reasons given earlier.

The observation in this study that increasing dietary oil level from 1% to 2% had effect on the feed intake of the birds is at variance with the work of Akpet (1987) who reported no significant difference ($P > 0.05$) in feed intake of birds fed 2% and 4% oil level. The results showed that birds consuming 2% oil had lower feed intake when compared with their counterparts fed the same premix but 1% oil. This is supported by the work of Salmon and O'Neil (1971) and Owen et al (1981) who showed that supplementation of diets with fat reduced feed intake in chickens and turkey. Oluyemi and Oyenuga (1974) kept chicks for six weeks on diets containing 0, 2, 5, 6, 7 and 10% palm oil and they observed that feed intake decreased as the fat level in the diet increased but that the effect was inconsistent.

The result showed that for a particular starter premix irrespective of the level of oil, birds fed premix R as the finisher premix consumed less feed when compared to the feed intake of birds fed the other two finisher premixes under that particular starter premix. One would have expected birds fed

premix R as the finisher premix to consume more feed than birds fed the other two finisher premixes because of their higher body weight than birds fed the other two finisher premixes. Also one would expect the birds fed premix R as finisher premix to consume more feed because of the balanced vitamins and trace minerals present in premix R which one will expect should stimulate appetite (Ferguson et al 1961). Farrell et al (1973) selected broilers for increased growth and found that growth rate was positively correlated with feed intake.

The body weight gains reported in this trial were lower than the reported values by Al-Nasser et al (1986) for five weeks old broilers, but higher than that reported by Henry et al (1986). Adding 2% oil improved the body weight gain of the birds. This is consistent with the report of Combs (1960); and Coon et al (1981) who showed that increasing dietary fat levels improved body weight gain. One would have expected that the lower feed intake of birds fed premix R as the finisher premix compared to the two other finisher premixes at a particular starter premix will result in lowered nutrient intake, so that this lowered amount of vitamins and trace minerals will affect macro-nutrient utilization which will result in low body weight gain and finally low live weight, but the contrary was observed, which does not support the work of Nelson and Norris (1960); Yoshida et al (1966); Al-Nasser et al (1986); and Akpet (1987), who stated that increasing

the level of some vitamins and trace minerals up to a certain point leads to increased feed intake and better body weight gain.

The feed conversion and body weight gain per gram protein intake both show the relationship between body weight and feed intake. The feed conversion ratios reported in this trial were worse than that reported by Kazemi and Daghir (1986) at four weeks, but they were better than those reported by Temperton and Cassidy (1964). Dietary palm oil appeared to improve feed efficiency according to the finding of Quarles et al (1968); Vermeersch and Vanschoubroek (1968). However in this trial the improvement in feed efficiency was not related to the level of oil used. This is possibly due to the level of other feed ingredients in the ration which may have interfered with the utilization of the ration, and also due to the low levels of oil used. However when the type of premix fed is taken into consideration birds fed premix R had only a slight edge over birds fed the other premixes in terms of their feed conversion. The body weight gain per gram protein intake ratios were little affected by the level of oil both at the starter and finisher phases. The birds generally had better relationship between protein intake and body weight gain at starter phase than at the finisher phase. This should be expected since at the younger stage more protein was deposited than at the older stage, when more fat was laid down.

5.4.2: AVERAGE DAILY NITROGEN RETENTION

The dry matter intake and dry matter output for the fourth week were lower than that observed at the nineth week. This is expected since as birds grow their feed intake will also increase. The dry matter intake and output observed at the fourth week for birds fed premix R with 1% or 2% oil was lower than for birds fed the other premixes within that oil level. The result for the dry matter digestibility coefficient showed that the birds had better digestibility at the fourth than at the nineth week.

The nitrogen intake, nitrogen output and nitrogen digestibility coefficient also followed the same trend like the dry matter intake, dry matter output and dry matter digestibility coefficient. The values for nitrogen digestibility coefficient obtained in this study were lower than that of Kroydahl and Dalsgard (1981). It was observed that dietary oil level did not have much effect on the dry matter and nitrogen digestibility coefficients, although it led to better digestion in some cases. This is supported by the work of Okon (1987) who showed that dietary palm kernel oil when added to broiler feed, led to improved apparent nutrient retention, but that the retention was not related to the level of palm kernel oil included in the ration.

The total nitrogen output for week four showed that birds fed premix D had the highest nitrogen excreted. They also had the highest nitrogen retention (grams), and the lowest nitrogen retention (percentage).

One would expect that the high nitrogen retention (grams) by birds fed premix D with 1% or 2% oil at week four would lead to higher body weight but this was not reflected in their body weight. Rather they had lower live weights when compared to birds fed the other premixes. This may be due to the improper balance and availability of the vitamins and trace minerals present in premix D which may lead to improper or non synthesis of protein leading to high nitrogen excretion. It was also observed that lower nitrogen digestibility coefficient and nitrogen retention (percentage) were observed at week nine than at week four. This will be expected since less nitrogen is needed at nine weeks than at four weeks.

5.4.3: CARCASS CHARACTERISTICS

The live weight of birds slaughtered at ten weeks (1791.77g - 2187.55g) were higher than that of Wahid et al (1974) who slaughtered at twelve weeks with live weight of 998 - 1696.60g. The difference may be due to the breed of the birds. There was a significant effect of oil level on live weight. This is supported by the work of Essary et al (1965) who reported that different levels of added fat significantly influence live weight. Significant effect of the various premixes fed were also observed on the live weight with birds fed premix R with 2% oil having the highest live weight at week five and birds fed premix R at starter and finisher phases with 2% oil having the highest weight at week ten. Palm oil levels and the type of premix fed had significant effect on the dressed

weight. The dressed weight values obtained in this study at week ten were higher than that obtained by Wahid et al (1974) at twelve weeks. The result showed that high live weights also lead to high dressed weights. Feather weights obtained at week ten were inconsistent with dietary treatments.

The eviscerated weight values obtained at week five showed that oil levels had no effect on the eviscerated weights of birds fed premix S and premix R. The eviscerated weight values obtained at week ten were significantly affected by oil levels; with birds fed premix R at the starter and finisher phases with 2% oil having the highest eviscerated weight. This is supported by the work of Hayse and Marion (1973), who confirmed that heavier birds produced a greater eviscerated yield. The eviscerated yield obtained in this study was similar to that of Akpet (1987). The level of oil and premix fed had no effect on the viscera weight obtained at five weeks but the opposite was obtained at week ten.

The arc sine values of carcass traits at week five showed that the level of oil and premix fed had no effect on the treatments. This is supported by the work of Ogunmodede et al (1978) who did not observe any significant difference in percentage plucked weight of three strains of chickens used in their experiment. They also reported that the relative proportion of feathers and the entrails were the same in the birds studied. The arc sine values for the carcass traits at week ten showed that there was no significant

difference in the weight of feathers and viscera, but significant differences were observed in the dressed weight and eviscerated weight, with the level of oil having significant effect only on the eviscerated weight. The weight of the organs with the exception of the heart and the gizzard showed no significant difference at week five. The lack of effect of oil level on liver weight is supported by the work of Essary et al (1972) who reported that different levels of oil in the diet of broiler chicks had no significantly different effect on the weight of liver. At week ten oil level had significant effect on the weight of all the organs with treatments fed 2% oil in some cases having higher organ weight than those fed 1% oil with the same premix. The effect of trace minerals on organ development is shown by Kozakova and Volkova (1977) who concluded that increasing copper level to 50mg/kg diet stimulates growth of internal organs and that doses greater than that were inhibitory.

Except for the abdominal fat and total bone, there were significant difference between the weights of cut part parameters measured, at week five. The results showed that in most of the cut part parameters measured the birds with the highest eviscerated weight at week five (birds fed premix R with 1% or 2% oil) had the highest cut parts weight. This is in agreement with the report of Walters et al (1963) that weights, volumes and dimensions of broiler parts were directly related to the carcass weight.

When the weights obtained were expressed as arc sine values, the result showed no significant difference. The values obtained for the different parameters of the cut up parts at week ten were higher than those obtained by Wahid et al (1974) and Bouwkamp et al (1973). This may be due to the diet, age, and improvement in the broiler strains now available in the 80's. Also the cut-up parts values obtained at week ten were not in agreement of the report by Walters et al (1963). Dietary oil levels also had effect on the weights obtained thus contradicting Marion and Woodroff (1965) who showed that carcass composition, particularly total bone, is not affected by level of dietary protein or fat, and that this is significantly affected by age. The reason for this may be due to the difference in the sex, diet, and strain of broilers used. This is supported by the work of Kondral et al (1962) who compared the effect of sex, diet and strain on meat yield in broilers and found that high dietary protein levels produced less abdominal fat. Also Kubena et al (1974b) found that female broilers had a larger percentage of abdominal fat than male broilers.

5.4.4: PERCENTAGE CRUDE PROTEIN CONTENT OF ORGANS

The percentage crude protein content of organs expressed the extent to which the feed protein has been used in organ protein synthesis. The liver showed the highest crude protein content of all the organs analysed. This will be expected because of the naturally high blood and other protein components or compounds

which are normally found in the liver. The liver was followed by the kidney, this also will be expected because of the nature of the work of the kidney in having to do with excretion of nitrogen containing compounds, while the heart, lungs and gizzard had almost the same values, and the spleen having the lowest value. At week five values obtained for the liver showed birds fed premix R with 2% oil having the highest. However values obtained for the spleen, kidney and lungs at week five were inconsistent.

Week ten values obtained for the liver crude protein showed birds fed premix R at starter and finished with premix S with 2% oil having the highest crude protein content with most of the values showing consistent trend in that birds fed 2% oil had higher liver crude protein than birds fed 1% oil with the same premix. The observation that for the liver crude protein values at week ten, irrespective of the level of oil, when a particular starter premix is considered, birds fed premix D as the finisher premix had the lowest crude protein values when compared to birds fed the other premixes under that particular starter premix. This may indicate the importance of vitamins and trace minerals in tissue protein synthesis (Sauberlich 1961; Dakshimurti and Misty 1963; De Luca et al 1969; Ogunmodede 1974; Featherson 1979), and since premix D had the lowest content of some of the vitamins and trace minerals of all the premixes used, it will thus be expected to have lower tissue protein content.

5.4.5: INDICES OF PROTEIN UTILIZATION

Feeding broiler chickens rations containing different premixes and levels of oil at the [illegible] week significantly affected the blood glucose, serum albumin, serum glutamate pyruvate transaminase (SGPT), serum glutamate oxaloacetate transaminase (SGOT), liver glutamate pyruvate transaminase (LGPT) and liver xanthine dehydrogenase. These indicate that the quality of the experimental diets were not the same in these respect. The high values of blood glucose recorded in the case of birds fed premix S and birds fed premix D both with 2% oil when compared with birds fed the same premix but with 1% oil at week [illegible] may be due to the conversion of the extra lipids to glucose which can be readily used as a source of energy in the body. Such high values for birds fed 2% oil over their counterparts fed the same premix but with 1% oil were also obtained at week ten. This may infact confirm this conversion. However Twiest and Smith (1970) concluded that in experiment where blood glucose level is to be used as a physiological indicator appropriate consideration must be given to condition of feeding, lighting and sampling time, and that there is indeed a very significant daily pattern in the blood glucose level of chickens.

At ten weeks of age dietary treatments had no effect on the plasma globulin, serum globulin and creatine. The values obtained for blood urea nitrogen at ten weeks showed that feeding birds premix D at starter and finisher with 1% [illegible] oil gave high blood

urea nitrogen values. Blood urea nitrogen has been used successfully by Münchow and Bergner (1968) to determine the quality and quantity of protein present in a diet, while Kumta and Harper (1961) in experiment with rats used it to demonstrate protein utilization. Thus from the works of these two authors one may conclude that the high blood urea nitrogen of birds fed premix D at starter and finisher was due to improper utilization of the feed protein for body protein synthesis so that the absorbed amino acids are deaminated to urea and then excreted via the blood.

The plasma total protein values obtained at week ten showed that in most cases birds fed 2% oil had higher values than birds fed the same premix but with 1% oil, and birds fed premix D at the starter and finisher phases with 1% oil or 2% oil having low total protein values. The albumin values obtained at week ten showed that for birds fed premix S or premix R at the starter phase oil levels had no significant effect on the values. Birds fed premix D at the starter and finisher phases with 2% oil had the highest plasma xanthine dehydrogenase values. Xanthine dehydrogenase is known to function in the synthesis of uric acid, thus one would expect that when premix D was fed at starter and finisher phases with 2% oil there would be higher total nitrogen output and lower body weight than when birds were fed the same premix but with 1% oil (which had lower plasma xanthine dehydrogenase than birds fed 2% oil with premix D at starter and finisher). This expectation

is due to the fact that normally the plasma xanthine dehydrogenase would be expected to convert most of the absorbed feed nitrogen (amino acids) to uric acid which is excreted from the body. But this was not the case as birds fed premix D at starter and finisher with 2% oil had higher body weight than birds fed the same premix with 1% oil.

The serum albumin values obtained in week five showed that dietary treatments had significant effect on the serum albumin content. At week ten the values obtained for the serum total protein and serum albumin were little affected by dietary oil levels. This is supported by the report of Leveille et al (1960) who showed that dietary fat and cholesterol exert little influence on serum protein of chicks. From the work of Chatterjee (1973) who concluded that riboflavin deficiency or low level leads to decrease in serum total protein with decrease in all functions except B-globulin, one would expect the low riboflavin level of premix D to cause a decrease in serum total protein of all the birds fed this premix. This decrease was only observed in few birds fed this premix. The conclusion by Aftar et al (1967) that vitamin B_6 (pyridoxine) deficiency had no effect on serum globulin level may be a reason for the non significant difference in serum globulin values obtained in week ten inspite of the very low levels of pyridoxine present in premix R and premix D compared to that in premix S. However Leveille and Sauberlich (1961) and Keyser et al (1968) observed

close relationship between dietary protein and serum protein concentration.

Uric acid is the main end product of nitrogen metabolism in birds. Thus the blood uric acid is a true index of the rate and amount of dietary protein converted to uric acid and excreted. Dietary oil level had little effect on the serum uric acid at week ten. However feeding different premixes had a significant effect on the serum uric acid with birds fed premix S at starter and premix D at finisher with 2% oil having the highest serum uric acid level. Several investigators have reported levels of uric acid in the range of 4 - 6mg/100ml in plasma of chicks and that uric acid concentration in the serum is influenced by age, sex, reproductive state and nutritional status (Featherson 1979). Investigation has shown that the removal of uric acid from blood is normally efficient such that uric acid level in the blood rarely exceeds 5 - 10mg/100ml of chicken blood (Scott et al 1976) thus it is difficult to know the actual amount of uric acid excreted into the blood. Ward et al (1974) showed that uric acid metabolism in chicks is influenced by the amount of protein in the diet. While Shoemaker (1972) showed that uric acid account for 55% - 82% of the total nitrogen excreted by the chicks.

Creatinine is obtained from creatine, the amount of creatine and creatinine present in the blood has been used as an index of muscle wastage. Creatine is synthesised mainly from arginine and

glycine. Austic and Nesheim (1972) found that only 5% of the arginine on molar basis consumed by birds is excreted as creatine and creatinine. In this study creatinine and creatine content of the serum of five weeks old birds were lower than that of ten weeks old birds. This is to be expected since at the younger age more muscles were being laid down than being wasted unlike for the adult age. Both dietary oil levels and premixes had no effect on the creatine and creatinine levels of birds serum at five weeks. While at ten weeks dietary oil levels and premixes exert their influences only on the serum creatinine but the results obtained were inconsistent.

Serum glutamate oxaloacetate transaminase (SGOT) and serum glutamate pyruvate transaminase (SGPT) mainly give information regarding severity and state of damage to the liver and heart, although they may to some extent, give the state of protein metabolism. Dietary oil level had little effect on the SGPT level at the five weeks old birds while the premixes had significant effect on the SGPT level at five weeks. Birds fed premix D with 1% oil had the highest level of SGPT. This may indicate high protein metabolism. Dietary oil level and premix fed had significant effects on the SGOT level at five weeks with birds fed premix D and 2% oil having highest level. At week ten although both dietary oil level and premixes had significant effect on the level of SGOT and SGPT, the results obtained for the SGPT were inconsistent.

Daghir and Balloun (1963) reported that the level of pyridoxine (Vitamin B_6) present in the diet affects the level of SGOT and SGPT present in chicks blood, and that lower levels of pyridoxine in feed resulted in lower SGOT and SGPT levels of chicks serum. Thus variation in the SGOT and SGPT values of the chicks serum at five and ten weeks of age may be due to the variation in the pyridoxine level of the premixes fed to them, however the variation observed in this experiment did not follow the pattern of variation observed by Daghir and Balloun (1963).

Sova et al (1972) noted that iodine supplementation of chicks diet leads to increase in SGPT level and decrease in SGOT level. However the variation in the iodine level of the premixes was not reflected in the SGOT and SGPT levels of birds serum. Loza (1979) showed that in broilers, activities of transaminating enzymes in serum correlated significantly with average daily body weight gain, quick maturity, feed cost per unit of gain as well as amount of muscle, and adipose tissues deposited. However results obtained in this trial for most of the parameters did not support this conclusion.

The level of liver glutamate oxaloacetate transaminase (LGOT) and liver glutamate pyruvate transaminase (LGPT) actually indicates the rate or extent at which amino acids in the body are being metabolised, since most of the transamination reaction of amino acids takes place in the liver. There was no significant difference

between the levels of the LGOT at five weeks, while at five weeks both the dietary oil level and premixes had significant effects on the level of the LGPT. Birds fed premix R and 1% oil had the highest level. This may indicate high level of transamination between glutamate and alanine in these birds. At week ten both the dietary level of oil and the premix fed had significant effects on the LGOT and LGPT levels. In most cases birds fed 2% oil had higher values than those fed the same premix but 1% oil. Both LGOT and LGPT play a very important role in protein metabolism. It is known that transamination is one of the major pathways by which all amino acids are degraded and at the same time some especially the none essential amino acids are synthesised. However a true picture or method of relating amino acid metabolism to enzyme level has not been found.

Xanthine dehydrogenase is a very important enzyme in the production of uric acid. Hevia and Clifford (1977a, 1977b, 1978) showed that poor proteins are deaminated and they result in increase production of xanthine dehydrogenase. They also show that uric acid production and xanthine dehydrogenase production may be used as an index of protein utilization. The result showed that the premix fed had significant effect on the liver xanthine dehydrogenase level at week five and that birds fed premix D with 1% or 2% oil had the highest value. This may be responsible for the low body weights of birds fed this premix because most of their feed proteins

were not laid down as body tissues but were deaminated and excreted, the situation is reflected in their high total nitrogen output at week five. The results obtained at week ten is similar to that obtained at week five but in this case there is minimal effect of dietary oil with the premix having a significant effect on the level of liver xanthine dehydrogenase at week ten.

It was observed that birds fed premix R at the starter and finisher phases along with 1% or 2% oil had low liver xanthine dehydrogenase at week ten. This may be responsible for their high body weight at week ten, since most of the feed nitrogen (amino acids) absorbed, instead of being catabolised and excreted as uric acid were converted to tissue protein. It can thus be concluded that liver xanthine dehydrogenase level is correlated to the body weights, and that high liver xanthine dehydrogenase level leads to poor growth and body development, while low levels of liver xanthine dehydrogenase leads to increase growth and proper body development. However there is not much work in the literature to back up this claim, this may thus be an area for further research in order to ascertain the true picture of the relationship.

Indication from the parameters considered in this experiment at the starter phase especially the live weight, feed intake, feed conversion, carcass traits, and cut-up parts showed that birds fed premix R had better performance than birds fed the other premixes,

and that birds fed premix S had better performance than birds fed premix D. Generally for the three premixes it was observed that feeding the birds 2% oil along with the premix gave better performance, than feeding the birds 1% oil along with the premix. Parameters for the finisher phase especially the live weight, feed intake, feed conversion, carcass traits, weight of organs and cut-up parts indicated that birds fed premix R with 2% oil at starter and finisher phases had better performance than others and that starting the birds with either premix S or premix R and finishing with any of the two premixes showed satisfactory result. However in most cases feeding 2% oil along with the premix gave better result than feeding 1% oil along with the premix.

CHAPTER SIX

6.1: GENERAL DISCUSSION

The vitamins and trace minerals present in the premixes play a very important role. Table 3.9 and table 3.10 give the composition of the premixes, and the percentage nutrients which they supply in relation to the N.R.C. (1977) requirements of broiler chickens for these nutrients. The difference in the composition and quality of the premixes may be responsible for the variation in the feed utilization, nitrogen retention, carcass characteristics and body fluid analysis, that were observed at the starter and finisher phases, particularly at weeks four and eight for experiment one and weeks five and ten for experiments two and three.

Variation in the composition of the premixes to a considerable extent affected the feed utilization of the birds fed these premixes. The difference in feed utilization was pronounced at the finisher phase than at the starter phase for the three experiments. It was observed that in the three experiments birds fed premix S or premix R at the starter phase or at the starter and finisher phases had better feed utilization than birds fed premix D at the starter phase or at the starter and finisher phases.

Generally for nitrogen retention variation in the composition of the different premixes was not so pronounced in that significant effect of the premixes on the nitrogen retention of the birds were

only observed in week eight of experiment one and weeks four and nine of experiment three. It was observed that in weeks four and nine of experiment three birds fed premix D at the starter phase or birds fed premix D at the starter and finisher phases had lower nitrogen retention (percentage).

The effects of the variation in the composition of the premixes on carcass characteristics were observed in both weeks five and ten in experiments two and three. In both experiments birds fed premix S or premix R had better carcass characteristics than birds fed premix D. In the case of the organ crude protein content and body fluid analysis, although in most cases there were differences in the values obtained for the birds fed the different premixes. Variation in the composition of the premixes in most cases did not cause a consistent trend in the values obtained.

In experiments two and three it was observed that when birds fed premix D at the starter phase were finished with premix S or premix R these premixes were capable, to some extent, of improving the growth of these birds fed premix D at the starter phase.

The low performance in terms of feed utilization, nitrogen retention and carcass characteristics, of birds fed premix D at at the starter phase or at the starter and finisher phases when compared to birds fed premix S or premix R at the starter phase or at the starter and finisher phases can not be attributed solely to the composition of the premix, since premix S like premix D

lacked some vitamins and trace minerals. Infact premix D had higher number of vitamins and trace minerals than premix S. Also both premixes have in most cases amount of vitamins and trace minerals that were above that of the N.R.C. (1977) requirements. Perhaps the performance of birds fed premix D can be attributed to the quality of the premix in which case there is low availability and low utilization by the birds of the vitamins and trace minerals present in the premix.

The vitamins and trace minerals absent in premix S and premix D are known to play important roles in protein utilization. Biotin which is absent in both premixes is known to play a very important role in protein metabolism. One of the two most limiting amino acid in conventional broiler ration, methionine (the other is lysine) requires biotin for its proper utilization and incorporation into tissue protein. Another amino acid which requires biotin for its utilization is alanine (Dakshinamurti and Misty, 1963). Absence of these vitamins and trace minerals from premix S was not manifestly reflected in the performances of the birds.

The lack of vitamin K in premix S may impair, protein utilization in broilers, since vitamin K is important in the synthesis of certain proteins in the liver. Pantothenic acid which is also lacking in this premix plays an important role in protein metabolism. Folic acid lacking in premix D and premix S plays an important role in the interconversion and utilization of glycine and serine.

Thus its deficiency will impair glycine and serine utilization. Vitamin B_{12} which plays an important role in development of blood cells is lacking in premix S. Its deficiency leads to protein wastage. Zinc which is important in protein digestion and in the incorporation of amino acid into tissue protein is lacking in premix S, that also lacks cobalt. The role of cobalt in protein utilization is not clear, except for its function in vitamin B_{12}.

The absence of some of these vitamins and trace minerals in premix S and premix D will be expected to affect the growth of the chickens and for the chickens to exhibit deficiency symptoms of these vitamins and trace minerals. However since the diets used were not purified diets, it is possible that the chickens obtained some amount of these lacking vitamins and trace minerals from other ingredients in the feed.

Vitamins and trace minerals are known to be interrelated and interdependent. A vitamin or trace mineral is not solely responsible for the metabolism of a particular amino acid. Generally vitamins and trace minerals have an interwoven relationship with the other nutrients. In some cases the lack of one of these nutrients can be compensated for by another nutrient like the sparing action of tryptophane on niacin and that of selenium on vitamin E. The high amount of vitamins and trace minerals in premix S could cause sparing action for the absent ones.

It was observed that absence of these vitamins and trace minerals in premix S did not to a large extent affect the growth of the birds fed this premix. However the absence of these vitamins and trace minerals in premix D had a detrimental effect on the growth of the birds. Generally it can be deduced that birds fed premix S were more able than birds fed premix D to mobilise some amount of the absent vitamins and trace minerals from the other feed ingredients, so as to balance up with the other vitamins and trace minerals supplied by the premix to give a better performance.

From the feed utilization and nitrogen retention values obtained in experiments one (with the exception of nitrogen retention at week eight), and starter phase of experiment two, it was observed that there was not much difference between birds fed premix S and those fed premix R even though a greater number of vitamins and trace minerals were present in premix R than that of premix S. The main reason may be that birds fed premix S were able to mobilize as much vitamins and trace minerals from the premix and other feed ingredients, and utilize them properly than birds fed premix R which had enough and may tend to waste it.

However the feed utilization, nitrogen retention and carcass characteristics values obtained in the finisher phase of experiment two showed that birds fed premix S at the starter and finisher phases had better values in most cases than birds fed premix R at the starter and finisher phases. This may be due to the fact

that for birds fed premix S, as the birds grew older their ability to mobilise vitamins and trace minerals from the premix and other feed ingredients improved over that of birds fed premix R. Or as birds fed premix R grew older their ability to mobilise vitamins and trace minerals from the premix and other feed ingredient decreased compared to the ability of birds fed premix S. There was no clear distinction in most cases between birds fed premix S at the starter and finished with premix R and those fed premix R at the starter phase and finished with premix S. This showed that both premixes were quite capable of complementing each other in what ever way they were used. Thus it can be concluded that although some vitamins and trace minerals were lacking in premix S the birds fed the premix still had good performance.

In the third trial it was observed that birds fed 2% oil level performed better in most cases than those given 1% oil when the same premix was fed. It may be that the better performance in terms of feed utilization, nitrogen retention and carcass characteristics observed in these birds were due to the extra amount of nutrients such as vitamin A, vitamin D, calories, saturated and unsaturated fatty acids received from the extra oil or it may be that the extra oil led to better availability of the fat soluble vitamins and proteins (Patrick and Schiable 1980) and better feed digestion (Mateos and Sell 1982).

A comparison of experiments two and three showed a sharp contrast in the effect of the premixes on the relative performance of the broiler chickens. The better live weight observed in experiment three over that of experiment two, for birds fed the same premix in the two experiments, may be due to the addition of palm oil or to genetic make up of the birds. However the most contrasting difference between experiments two and three, was that in experiment two, birds fed premix S at finisher phase had higher live weight than birds fed premix R, but in experiment three birds fed premix R at finisher phase had higher live weight than birds fed premix S. This however may suggest that the addition of palm oil may have made the vitamins and trace minerals in premix R more available or it may have had a negative effect on the vitamins and trace minerals in premix S. This last suggestion can be discarded because of the better live weight of birds fed this premix S in experiment three over the live weight of the birds fed the same premix in experiment two. Another reason may be that the added oil may have improved the utilization of the vitamins and trace minerals present in premix R. The oil might not have had any effect, either negative or positive, on the utilization of the vitamins and trace minerals present in premix S.

However to fully understand the effect of the premixes on the broiler chickens and also the effect of the deficient vitamins and trace minerals in the premixes on the broiler chickens, there

may be the need to test the effect of each vitamin and trace mineral present in the premix on the utilization of other nutrients by broiler chickens using purified diets. This will however be an herculean task which will not give proper result since, as said earlier, vitamins and trace minerals do not function in isolation. On the other hand it may be necessary to use purified diets when the effect of the various premixes are to be tested.

CHAPTER SEVEN

7.1: SUMMARY CONCLUSION AND RECOMMENDATIONS

7.1.1: SUMMARY

A total of three feeding trials were carried out aimed at:

1. Determining protein utilization by broiler chicks fed three different premixes at the starter and finisher phases.
2. Investigating the protein utilization of broiler chicks fed three different premixes such that premix fed at starter was different from the one fed at the finisher phase.
3. Assessing the protein utilization of broilers fed three different premixes such that the premix fed at the starter was different from the premix fed at the finisher phase, with two levels of palm oil being fed at the two phases (starter phase and finisher phase).

In the first trial three premixes: Dizengoff vitadiz B.P. (premix D), Roche zoodry broiler premix (premix R), and Sanders broiler starter and broiler finisher premixes (premix S) were used. The results indicated that the broilers fed these different premixes in their diet, showed significant difference ($P < 0.05$) in their average weekly live weight, average weekly feed intake, average weekly body weight gain, feed conversion ratio, body weight gain per gram protein intake, nitrogen digestibility coefficient, and nitrogen retention, while there was no significant difference ($P > 0.05$) in the dry matter digestibility coefficient.

The overall result showed that broilers fed premix S or premix R had higher body weights, while birds fed premix R had the best nitrogen retention at week eight.

The second trial was designed to examine if proper utilization of protein by broilers chicks could be achieved by giving them different premixes at the starter and finisher phases and the effect the starter premix will have on the finisher premix. The trial was also designed to find out if deficiencies in the starter premix can be made up for, by the finisher premix. The premixes used in this experiment were the same as in experiment one.

For the starter phase the results indicated that broilers fed the different premixes showed significant difference ($P < 0.05$) in their average weekly live weight, average weekly feed intake, average weekly body weight gain, feed conversion ratio, dry matter digestibility coefficient, wing, back, breast, total edible meat, total bone, carcass trait, percentage crude protein of organs, blood glucose, liver glutamate oxaloacetate transaminase, and liver xanthine dehydrogenase. Birds fed premix S and those fed premix R had the best live weight while birds fed premix S had the best carcass characteristics.

For the finisher phase each treatment of the starter phase was divided into three and allocated to the three premixes, thus making a total of nine treatments and eighteen replicates (Figure 4.1). The results indicated that broilers fed the

different premixes showed significant difference ($P < 0.05$) in all the parameters tested except in the nitrogen retention, actual weights of spleen, lungs, breast, abdominal fat, and total bone others are blood glucose, plasma albumin, plasma globulin, serum total protein, serum albumin, creatine, and liver glutamate oxaloacetate transaminase. Birds fed premix S at the starter and finisher phases had the best feed utilization and carcass characteristics at week ten.

The third trial was designed to examine effects of 1% and 2% oil levels. In this trial the premixes used were the same as in the first two experiments.

At the starter phase the birds were divided into six treatment group. The six treatments were divided into two consisting of three treatment per oil level, the three treatments in a particular oil level were allocated to the three different premixes. The result at the starter phase showed that the birds exhibited significant difference ($P < 0.05$) in all the parameters tested except in the average weekly body weight gain, dry matter digestibility coefficient, weights of feather, viscera, liver spleen, kidney, lungs, abdominal fat, and total bone others are blood urea nitrogen, plasma components, serum components (except serum albumin, serum glutamate oxaloacetate transaminase and serum glutamate pyruvate transaminase) and liver glutamate oxaloacetate transaminase. Birds fed premix R with 1% or 2% oil and birds fed premix S with 2% oil had better feed utili-

zation, but only birds fed premix R with 1% or 2% oil had the best nitrogen retention percentage and carcass characteristics.

At the finisher phase each treatment of the starter phase was divided into three and allocated to the three different premixes, thus making a total of eighteen treatments and thirty six replicates (Figure 5.1). The result showed that the birds fed the different levels of oil and different premixes had significant difference ($P < 0.05$) in all the parameters considered except in their total nitrogen output, nitrogen retention (grams), plasma globulin, serum globulin and serum creatine. Birds fed premix R at the starter and finisher phases with 2% oil produced the best feed utilization, nitrogen retention, and carcass characteristics. There were significant effects of dietary palm oil on the feed utilization, nitrogen retention and carcass characteristics. In most cases birds fed 2% oil had better performance than those fed the same premix but with 1% oil inclusion.

From the results of these three trials it was observed that the different premixes that are available in the Nigerian poultry input market do affect the ability of the birds to utilize protein.

7.1.2: CONCLUSION

From the results of the three experiments it can be concluded that there is the need for proper selection of a premix which will

allow optimal utilization of protein by the broilers in other to minimise cost of production and to increase gain. Also it was found that if a poor premix is used at the starter phase, the finisher premix to a limited extent can augment the deficiencies of the starter premix but the results obtained were not as good compared to when a good starter premix is used. The results obtained revealed that:

- When a single premix was used throughout for the production of the broiler chickens premix S and premix R gave satisfactory results.
- For the starter phase only premix S and premix R gave satisfactory results. For the finisher phase, Feeding the birds either premix S or premix R at the starter phase and finishing them with either premix S or premix R or alternating them gave satisfactory results.
- When palm oil was included in the ration the result showed that feeding premix R with 2% oil and premix S with 2% oil gave satisfactory result for the starter phase. For the finisher phase, feeding the birds either premix R with 2% oil or premix S with 2% oil at the starter phase and finishing them with either premix R with 2% oil or premix S with 2% oil or alternating them gave satisfactory result.

7.1.3: RECOMMENDATION

The following recommendations are being made:

- That premix R, and premix S are recommended for good broiler production, but further researches are needed to actually determine the level, availability, and the utilization of the vitamins and trace minerals that are present in these premixes, so as to allow for proper monitoring of these vitamins and trace minerals.
- That the addition of oil to a level which is 2% of the diet had no detrimental effect on the utilization of the vitamins and trace minerals present in the premixes, and that this level of oil improved the growth and nitrogen retention of the birds. However there is the need to further research into the actual level of oil and the type of oil that will give satisfactory growth without affecting the vitamins and trace minerals that are present in the premixes.
- That a single premix is satisfactory for broiler production at both the starter and finisher phases. However two premixes can be used if it is noticed that the premix used at the starter phase is not satisfactory. A better premix can then be used at the finisher phase to augment the deficiency of the starter premix. This will however not completely repair the damage done by the deficiencies of the starter premix.
- That a further research into how the various premixes affect the utilization of the other nutrients is necessary in order to

fully establish the effect of these premixes on nutrient utilization.

- That the various premixes which are available in the Nigerian poultry input market need to be streamlined to meet a particular standard so that many poultry farmers who are not aware of the importance of premixes in the broiler ration will not be thrown into complete loss.

- That future establishment and review of the requirements of broiler chickens in the tropics for various vitamins and trace minerals should not be done individually but in conjuction with other vitamins, trace minerals, and other nutrients.

REFERENCES

Aboaysha A.M., and F.H. Kratzer (1980). Serine utilization in the chick as influenced by dietary pyridoxine. Proc. of the society for experimental biology and medicine 163(4): 490 - 495.

Adams R.L., J.E. Larsen, M.E. Einstein and W.J. Stadelman (1986). Selecting birds for yield studies. Poult Sci 65(1): 152 - 156.

Aftar M.W., N.J. Daghir and J. Asmar (1967). Influence of vitamin B_6 deficiency on certain serum components in mature female chicken. Poult Sci 46(4): 838 - 843.

Agricultural Research Council (A.R.C) (1975). The nutrient requirement of farm livestock poultry No. 3 London.

Akpet S.O. (1987). Performance of broiler chicks fed two cakes, two oils and two levels of thiamine and riboflavin. Ph.D thesis, University of Ibadan, Nigeria.

Allen N.K., D.H. Baker and G. Graber (1971). Interrelationships among leucine, tryptophane and niacin in the chick. Poult Sci 50(5): 1544, (abstract).

Al-Nasser A.Y., A.A. Al-Awadi, M.R. Diabi, M.D. Husseini, M.A. Ilian and A.J. Salman (1986). The effect of adding essential amino acid and vitamins to the rations of broilers Poult Sci 65(4): 742 - 748.

Austic R.E. and M.C. Nesheim (1972). Arginine and Creatine interrelationship in chicks Poult Sci 51: 1098 - 1105.

Babatunde G.M. and B.L. Fetuga (1976). Determination of minimum crude protein requirement of broiler starter and finisher in the tropics Nig. J. Ani Prod 3: 126 - 128.

Babatunde G.M., B.L. Fetuga and V.O. Oyenuga (1974). Palm oil as energy source for monogastics. Nig J Ani Prod 1: 92 - 98.

Balton C, and M. Blair (1974). Poultry Nutrition Ministry of Agric. Fisheries and Food HMSO London Bulletin 174 11th edition.

Barnes M.J., B.J. Constable, L.F. Morton, and E. Kodicek (1973). Bone collagen metabolism in vitamin D deficiency. Biochem J 132: 113 - 117.

Begin J.I. (1967). The effect of breed and sex of chickens on the metabolic efficiency of nitrogen. Poult Sci 46: 48 - 54.

Benoff F.H., and J.P. Hudspeth (1981) Deboning yields from the breast, drumstick and thighs of male and female broilers. Poult Sci 60 (7): 1594, (abstract).

Bieri J.G. (1969). Vitamin A in development of the embryo. Am J Clin Nutr 22: 1083 - 1092.

Bonomi A., N. Bianchi and D. Dimou (1972). Fat supplementation of different origin of mixed feed for broilers, Nutr and Review 42 (4): 1678 - 1683.

Bonwkamp E.L., D.E. Bigbee, and C.J. Wabeck (1973). Strain influence on broiler parts yield. Poult Sci 52: 1517 - 1523.

Bunk M.J. and G.F. Combs Jr. (1980). Effect of selenium on appetite in the selenium deficient chick. J. of Nutr 110 (4): 743 - 749.

Bunk M.J. and G.F. Combs Jr. (1981). Evidence of an impairment in the conversion of methionine to cysteine in selenium deficient chicks. Proc of the society for exp Biology and medicine 167(1): 87 - 93.

Buraczewski S, L. Buraczewski and J. Ford (1967). Acta biochim pol 14: 121 - 128.

Caraway W.T. (1963). Standard method. Clin chem 4: 239 - 245.

Carver D.S. (1960). Variation in the effect of fat supplement on broiler pigmentation, growth and feed conversion. Poult Sci 38(1): 71 - 76.

Chatherjee A.K. (1973). Effect of protein depletion and repletion on serum protein in riboflavin deficiency. J Nutr Sci and Vitaminology 19(4): 289 - 294.

Christensen H.N. (1960). Adv Protein Chemistry 15: 239 - 245.

Christensen H.N. (1963). In chemical and biological aspect of pyridoxal catalysis (Snell E.E., P.M. Fasella, A.E. Braunstein and A. Rossi Fanelli eds): 533 - 542. Pergamon press N.Y.

Chumachenko V.E. and V.D. Khudoshchevskaya (1976). Khimiya v selskon khozyaistve. 14(10): 28 - 29.

Comb G. (1960). Practical broiler ration studies. Proc. univ Md Nutr Conf Feed Mfrs: 71 - 80.

Coon C.N., W.A. Becker and J.V. Spencer (1981). Effect of feeding high energy diets containing supplemental fat on broiler weight gain, feed efficiency and carcass composition. Poult Sci 60: 1264 - 1271.

Cooper G.R. and V. McDaniel (1970). Standard Methods. Clin Chem. 6: 159 - 166.

Czarnecki G.L., K.M. Hapin and D.H. Baker (1983). Poult Sci 62(2): 371 - 374.

Daghir N.J. and S.L. Balloun (1963). Evaluation of the effect of breed on vitamin B_6 requirement of Chicks. J Nutr 79: 279 -,287.

Daghir N.J. and M.A. Shah (1973). The effect of dietary protein level on vitamin B_6 requirement of chicks. Poult Sci 52(4): 1247 - 1252.

Daghir N.J. and R.I. Tannons (1964). Comparative nutritional value of corn oil and olive oil for growing chickens. Poult Sci 44(3): 697 - 701.

Dakshinamurti K. and S.P. Misty (1963). Amino acid incorporation and biotin deficiency. J Biol Chem 238: 297 - 301.

Davis P.N. (1962). Iron deficiency studies in chicks using treated isolated soy bean protein diet J Nutr 78: 445 - 453.

Davis M.I. and T. Motzok (1972). Isolation of a protein responsible for aggregation of avian embryonic cells. Nature London 226: 970 - 971.

Deaton J.W., J.L. McMaughton, F.N. Reece and B.O. Lott (1981). Abdominal fat of broilers as influenced by dietary level of animal fat. Poult Sci 60: 1250 - 1253.

De-Luca L., H.K. Klemman, E.P. Little and G. Wolf (1971). RNA metabolism in rat intestinal mucosa of normal and vitamin A deficient rats. Arch Biochem Biophys 145: 332 - 337.

De-Luca L., E.P. Little, and G. Wolf (1969). Vitamin A and protein synthesis by rats intestinal mucosa. J Biol Chem 244: 701 - 708.

De-Luca L., M.G.C. Rosso and G. Wolf (1970). The biosynthesis of a mannolipid that contains a polar metabolite of 15 - 14C - retinol. Biochem Biophys Res Commun 41: 199 - 203.

De-Luca L. and G. Wolf (1969). Vitamin A and protein synthesis in mucos membranes. Am J Clin Nutr 22: 1059 - 1062.

Edward H.M. Jr. (1971). Effect of type of fat supplementation on body composition of broilers. Feedstuff 43(16): 66 - 70.

Edward H.M. Jr., J.E. Marion, H.L. Fuller and J.C. Diggers (1963). Studies on Calcium requirement of broilers. Poult Sci 42: 699 - 703.

Eggum B.O. (1970). Blood urea measurement as a technique for accessing protein quality. Br. J. Nutr 24: 983 - 988.

El-Husseiny O, M.R. El-Abbady, A.A. Ghazalah (1980). Sulfur amino acid and vitamin B_6 requirements and their interactions in broilers. Poult Sci 59(7): 1603, (abstract).

Essary E.O. and L.E. Dawson (1963). Quality of fryer carcasses as related to protein and fat levels in the diet. Poult Sci 44(1) 7 - 15.

Essary E.O., L.E. Dawson, E.L. Wisman and C.E. Holmes (1965). Influence of dietary level of fat and protein in broiler rations on live weight, dressing percentage and specific gravity of carcass. Poult Sci 44: 304 - 305.

Essary E.O., L.E. Dawson, E.L. Wiseman and C.E. Holmes (1972). Influence of added fat with different level of protein in ration on ten weeks old broiler: Weight, dressing percentages and percent moisture, protein and fat of fryers. Poult Sci 51: 1248 - 1249.

Farrell D.J., R.B. Cumming and J.B. Hardaker (1973). The effect of dietary energy concentration on growth rate and conversion of energy to weight gain in broiler chickens. Brit Poult Sci 14: 329 - 340.

Featherson W.R. (1969). Nitrogenous metabolites in the plasma of chicks on high protein diet Poult Sci 48: 645 - 652.

Featherson W.R. (1979). Effect of dietary amino acid level, folic acid glycine and serine on chick performance and blood parameters. Poult Sci 58(7): 906 - 912.

Ferguson T.M., C.H. Whiteside, C.R. Creger, M.L. Jones, R.C. Atkinson and J.R. Couch (1961). B-Vitamins deficiency in the mature turkey hen. Poult Sci 40: 1151 - 1159.

Food and Agricultural Organisation (F.A.O) (1969). Poultry Feeding in the tropical and subtropical countries. F.A.O. year book Rome.

Frings C.S., C.R. Ratliff and R.T. Dunn (1970). Automated determination of glucose in serum or plasma by a driect O - toluidine procedure. Clin Chem 16: 282 - 284.

Frolik C.A. and H.R. De-Luca (1972). Metabolism of 1, 25 dihydroxy Cholecalciferol in the rats. J Clin invest 51: 2900 - 2906.

Fuller H.L. and R.C. Hill (1964). The relationship of vitamin B_6 and the utilization of the various forms of methionine in the chick. Poult Sci 43: 1320, (abstract).

Gazo M. (1980). Metabolism of amino acids in relation to their utilization. Biologizace a chemizace Zivocisne Vyroby veterinaria 16(6) 489 - 495.

Ghazalah A.A., O.E. Husseiny and M.I. El-Rotoury (1980). Effect of methionine and Vitamin B_6 level on body composition and blood constituents of broilers. Poult Sci 59(7): 1613, (abstract).

Gleeves E.W., L.V. Tonkinson, T.J. Mills, K.E. Dunkelgod, C.A. Roberts, R.H. Thayer, R.J. Sirny and R.D. Morrison (1961). Interrelationship of riboflavin and niacin in laying hen diets Poult Sci 40: 1098 - 1105.

Grigor'ev N.G. and T.M. Truzinkova (1970). Amino acid in the diet and protein metabolism in broilers. Vesta sel'skohoz Nauki 7: 91 - 95.

Haussler M.R., D.W. Boyce, E.T. Littledike and H. Rasmussen (1971). Proc Nat Acad Sci US 68: 177 - 179.

Hayse P.L. AND W.W. Marion (1973). Eviscerated yield, component part and meat, skin and bone ratios in the chicken broiler. Poult Sci 52: 718 - 722.

Henry P.R., C.B. Ammerman and R.D. Miles (1986). Influence of virginiamycin and dietary manganese on performance, manganese utilization and intestinal tract weight of broilers. Poult Sci 65: 321 - 324.

Herzberg G.R., H. Sheerm, J. Lerner (1971). Cationic amino acid transport in chicken small intestine. Comparative biochem and physiol 140 A(1): 229 - 247.

Hevia P. and A.J. Clifford (1977a). Protein intake, uric acid metabolism and protein efficiency ratio in growing chicks. J of nutr 107(6): 959 - 964.

Hevia P. and A.J. Clifford (1977b). Chicken hepatic purine enzyme activities in relation to the quality of dietary protein. Nutrition reports International 16(6): 825 - 830.

Hevia P. and A.J. Clifford (1978). Protein intake, hepatic purine enzyme levels and uric acid production in growing chicks J Nutr 108(1): 46 - 54.

Hsu J.M. and W.E. Anthony (1975). Effect of zinc deficiency on urinary excretion of nitrogenous compounds and liver amino-acid catabolizing enzyme in rats J of Nutr 105(1): 26 - 31.

Ikeda K, T. Takado and T. Sugihashi (1970). Studies on glutamic-oxalacetic transaminase (GOT) in the chicken: effect of dietary protein on the activity of GOT in various chicken organ. Jap J Zootech Sci 41: 233 - 232.

Jacobs F.A., L.J. Coen and R.S.L. Hillman (1960). Influence of pyridoxine, pyridoxal phosphate, Deoxypyridoxine and 2, 4, Dinitrophenol on methionine absorption. J Biol Chem 235: 1372 - 1375.

Jensen L.S., G.W. Schumaier and J.D. Latshaw (1970). Extra caloric effect of dietary fat for developing turkeys as influenced by C:P ratio. Poult Sci 49: 1697 - 1704.

Kazakova M.V. and O.I. Volkova (1977). Effect of Copper on development of internal organs in chickens. Referativnyi Zhurnal 58 (1): 80 - 84.

Kazemi R. and N.J. Daghir (1986). Interrelationship between methionine and Vitamin B_6 in chick diet. Poult Sci 65 (4): 432 - 437.

Kazemi R. and F.H. Kratzer (1980). Source of protein affecting the vitamin B_6 requirement of chicks. Poult Sci 59 (1): 95 - 99.

Ketola H.G., and M.C. Nesheim (1974). Influence of dietary protein and methionine levels on the requirement for Choline. J of Nutr 104(11) 1484 - 1489.

Keyser E.G., W.W. Waldroup and G.C. Harris (1968). The effect of dietary protein level on serum protein. Poult Sci 47: 1678 - 1680.

Kiker J.T. (1976). The relationship between percentage yield of the total carcass and percentage yield of the shell (less neck and Giblets). Poult Sci 55: 2052, (abstract).

Kiker J.T. and D.H. Sherwood (1974). Bearback in broiler type chickens Poult Sci 53 : 1639, (abstract).

Kipnis D.M. (1965). In: Control of energy metabolism (Ed by Chance B., R.W. Estabrook and J.R. Williamson) New York Academic press.

Korner A. (1961). Studies on incorporation of amino acids into protein in Isolated rat liver ribosomes. Biochem J 81: 168 - 178.

Kratzer F.H. and A.M. Aboaysha (1978). Effect of pyridoxine on serine utilization in the chick. Fed proc 37: 588, (abstract).

Kroydahl A. and B. Dalsgard (1981). Estimation of nitrogen digestibility in poultry content and distribution of major urinary nitrogen compounds in Excreta. Poult Sci 60(11): 2480-2485.

Kubena L.F., T.C. Chen, S.W. Deaton and F.N. Reece (1974a). Factors influencing the quality of abdominal fat in broilers. Poult Sci 53(1): 211 - 214.

Kubena L.F., T.C. Chen, S.W. Deaton and F.N. Reece (1974b). Factors influencing the quality of abdominal fat in broilers: 3 dietary energy level Poult Sci 53: 974 - 978.

Kumta H.S. and A.E. Harper (1961). Problems in the prediction of protein values of diets. Br J Nutr 15: 11 - 19.

Lall S.P. and S.J. Slinger (1972). The metabolizable energy content of rape seed oil foods and the effect on blending with other fats Poult Sci 52(1): 143 - 151.

Lazor A., S. Slojanovic, T. Juhas, B. Lipstein and Z. Bornsteinuv-curevic (1976). Acidulated soap stock of sunflower oil in rations for fattening chickens. Nutr Abstr and Revs 41: 729, abstr.

Ledoux D.R., C.B. Ammerman, R.D. Milles and R.H. Harms (1986). The influence of methionine and selected nutrient supplementation on the performance of broiler chicks fed higher copper levels. Poult Sci PSA and SPSS Abstr 65(1): 133, (abstract).

Leerbeck E. and W. Hjarde (1975). Acta Agriculturae Scandinavia 25(4): 313 - 319.

Lehninger A.L. (1977). Biochemistry 2nd Ed. Worth Publ inc New York.

Lesson S. and J.D. Summers (1983). Growth and carcass characteristics of broiler fed salinomy in diets containing graded levels of methionine and energy. Canadian J Anim Sci 63: 409 - 419.

Leveille G.A., A.S. feigenbaum and H. Fisher (1960). The effect of dietary protein, fat and cholesterol on plasma cholesterol and serum protein component of the growing chick. Arch Biochem Biophys 86: 67 - 69.

Leveille G.A., and H.E. Sauberlich (1961). Influence of dietary protein level on serum protein component and cholesterol in growing chick. J Nutr 74: 500 - 504.

Loza A.R. (1979). Relation between transaminase activity of blood serum and economic salient features of broilers. Referativnyi Zhurnal 58 (5): 172 - 177.

Mabray C.J. and P.W. Waldroup (1979). Interrelationship between copper and methionine in broiler diets. Poult Sci 58(4): 1018, (abstract).

Marion J.E. and J.G. Woodroff (1965). Diet and carcass composition. Poult Sci 45: 241 - 244.

Martin D.W., P.A. Mayes and V.W. Rodwell (1981). Harper's Review of Biochemistry 18th edition. Lange Medical publications Drawer L. Los Altos Califonia.

Mateos G.G. and J.L. Sell (1982). Rate of food passage (transit time) as influenced by level of supplemental fat. Poult Sci 61: 94 - 100.

McDonald P, R.A. Edward and J.F.D. Greenhalgh (1973). Animal nutrition 2nd Ed Edinbury, Oliver and Boyd Press: 412 - 413.

Menya H. (1971). The influence of dietary oil in chick growth rate. Poult Sci 50(1): 219 - 222.

Munchow H. and H. Bergner (1968). Arch Tierernahr 18: 222 - 225.

Musharaf N.A. and J.D. Latshaw (1982). Effect of protein levels in broiler finisher diet on body composition. Poult Sci 61 (7): 1517, (abstract).

National Research Council (N.R.C) - National Academy of Science (NAS) (1977). Nutrient requirement of domestic animals. No. 1 nutrient requirement of poultry. Seventh revised edition Washington D.C.

Nelson M.M. (1960). Commercial broiler production. Agric Res Hand-book: 320 - 322.

Norman F.W., A.K. Mircheff, T.H. Adams and A. Spielvogel (1970). Studies on the mechanism of action of Calciferol Vitamin D - mediated increase of intestinal brush border alkaline phosphatase activity. Biochim Biophys Acta 215: 348 - 359.

Ofovbe V.N. (1987). Metabolism of some divalent minerals by broilers fed palm kernel products and varying calcium to phosphorus ratio. Ph. D thesis, University of Ibadan, Nigeria.

Ogunmodede B.K. (1974). Dietary zinc and protein utilization by growing chickens. Niq. J Anim prod 1(2): 198 - 203.

Ogunmodede B.K. (1975a). Vitamin A requirement of broiler chicks in Nigeria. Accepted in Poult Sci (1977) 56(1): 231 - 233.

Ogunmodede B.K. (1975b). Comparative effect of copper and tetramycin on performance of broiler chicks and growers. Niq J Anim Prod 22: 199 - 203.

Ogunmodede B.K. (1976). Riboflavin requirement of Starting Chicks in a tropical environment. Poult Sci 56: 231 - 234.

Ogunmodede B.K. (1978). Biotin requirement of broiler chick fed maize-groundnut cake or guinea corn-groundnut cake ration. Afri J of Agric Sci 5(1): 47 - 53.

Ogunmodede B.K. (1980a). Dietary level of phosphorus and Sodium in estimating vitamin D_3 requirement of broiler chicken in humid tropics. World Poult Sci Ass German Branch (Feb 1980) 111: 340 - 346.

Ogunmodede B.K. (1980b). The requirement of broiler chickens in humid tropical environment for Vitamin E. Ife J of Agric 2 (1): 77 - 83.

Ogunmodede B.K. (1981). The Supplementation of groundnut based broiler chick diets with pyridoxine. Brit Poult Sci J 22(3): 153 - 164.

Ogunmodede B.K., J.A. Oluyemi and G.N. Egbunike (1978). Characteristics of meat from local and exotic strains of chicken in Nigeria. Nig Nutr J 1: 20 - 25.

Oh S.Y., J.D. Summer, A.S. Wood (1972). Performance of chicks fed graded levels of niacin and tryptophane. Canadian J of Anim Sci 52(4) 745 - 750.

Okon B.I. (1987). Utilization of periwinkle flesh by broilers fed palm kernel based ration. Ph.D thesis, University of Ibadan, Nigeria.

Olson O.E., C.E. Holinquist and C.W. Carlson (1973). The stability of inorganic selenium in premixes. Poult Sci 52(1): 403 - 406.

Oluyemi J.A., A.O. Okubanjo and O.B. Abdallah (1979). The effect of high dietary levels of palm oil and salt on the performance and meat quality of chickens. Poult Sci 56: 432 - 436.

Oluyemi J.A. and V.A. Oyenuga (1974). The effect on chicks of varying by supplementation with palm oil, the dietary energy levels in starter diets. West Afri J Biol Appl Chem 17(2): 12 - 19.

Oluyemi J.A. and F.A. Roberts (1979). Poultry production in warm wet climates. The Macmillian press Ltd.

Ovchmnikov A.V. (1981). Activity of some enzymes in blood serum in relation to meat yield of broilers. Referativnyi Zhurnal 58 (3): 170 - 174.

Owen J.A., P.W. Waldroup, C.J. Mabray and P.J. Slagter (1981). Response of growing turkeys to dietary energy level. Poult Sci 60: 418 - 424.

Patrick H. and P.J. Schaible (1980). Poultry feed and nutrition (Second edition). Avi publishing company inc Westport Connecticut.

Payne W.L., R.R. Kifer, D.G. Symder and G.F. Combs (1977). Studies of protein digestion in the chicken. Poult Sci 56: 131 - 136.

Quarles C.L., T.W. Burr, J.H. MacNell and G.O. Bressler (1968). The effect of varying levels of hydrolysed Animal and Vegetable fat upon growth and carcass characteristics of broilers. Poult Sci 47: 1764 - 1767.

Rabbani A, S.S. Akrabawi, N.J. Daghir (1973). Effect of dietary folic acid deficiency on serine-glycine interconversion and the activity of liver serine hydroxymethyl transferase in the chicks. Poult Sci 52(5): 1962 - 1967.

Reid B.L. and C.W. Weber (1975). Supplemental dietary fat and laying hen performance. Poult Sci 54: 422 - 428.

Riomi N. and R. Pangi-Bini (1966). Vegetable diets with different fat contents for feeding poultry. Alimentazione Animale 10: 77 - 86.

Robbin K.R. and D.H. Baker (1980). Effect of Sulfure amino acid level and source on the performance of chicks fed high levels of copper. Poult Sci 59(6): 1246 - 1253.

Rymarz A. (1976). Digestion of protein in the digestive tract of chickens. Roczniki Nauk Rolniczych B97(4) 55 - 67.

Salmon R.E. and J.B. O'Neil (1971). The effect of the level and source of dietary fat on the growth, feed efficiency grade and carcass composition of turkeys. Poult Sci 50: 1450 - 1467.

Saroka J.M. and G.R. Combs Jr. (1986). The lack of effect of a pyridoxine deficiency on the utilization of the hydroxyl analogue of methionine by the chick. Poult Sci 65(4): 764 - 768.

Sauberlich H.E. (1961). Effect of vitamin B_6 on the growth of rats fed diet limiting in an essential amino acid and on the utilization of isomers of tryptophane, methionine and valine. J Nutr 74: 289 - 297.

Scharrer E. (1971). Active intestinal transport of amino acid in chickens. Archiv fur Greflugelkinde 35(1): 21 - 25.

Scholz R.W. and W.R. Featherson (1968). Effect of alteration in protein intake on liver xanthine dehydrogenase in chicks. J. Nutr 95: 271 - 277.

Scott M.L., M.C. Nesheim and R.J. Young (1976). Nutrition of chickens 2nd edition. M.L. Scott and Associates Ithaca New York.

Sheppard A.J., J.J. Fritz, W.H. Hooper, T. Robberts, W.D. Hubbard, A.R. Prosser and W. Boehne (1977). Cramble and rape seed oil as energy source for rats and chicks and some data in organ weight and body cavity fat composition. Poult Sci 50(1): 79 - 84.

Shoemaker V.M. (1972). Osmoregulation and excretion in birds In: Avian Biology by Farner D.S., J.R. King and D.S. Parker ed II: 527 - 574 Academic Press New York.

Skotnicki J, Z. Stawinska and S. Lukaszak (1970). Soybean oil for fattening broilers. Nutr Abst and Revs 41: 729, (abstract).

Sova Z., T. Kalous, D. Pichova, A. Urbenska, D. Trefny, A. Hrdinova, Z. Nemec and M. Stradal (1972). Effect of different amount of iodine for fattening broilers: serum glutamic pyrivic transaminase, blood protein, uric acid and cholesterol. Biologizace a Chemizace vyzivy zvirat 8(4): 299 - 306.

Steel R.D. and J.H. Torrie (1980). Principles and procedures of statistics. A biometrical Approach international student edition. McRaw and Hill international book company London.

Tao S.H. and L.S. Hurley (1971). Changes in plasma protein in zinc deficient rats. Proc Soc Exp Biol Med 136: 165 - 167.

Temperton H. and J. Cassidy (1964). Phosphorus requirement of Poultry 1: The utilization of phytin phosphorus by the chick as indicated by balance experiment. Br Poult Sci 5: 75 - 80.

Thomas O.P. and G.F. Comb (1967). Relationship between serum protein levels and body composition in the chick. J. Nutr 91: 468 - 472.

Thompson J.N. (1969). Vitamin A in development of the embryo. Am J Clin Nutr 22: 1063 - 1069.

Toole B.P., A.H. Kang, R.L. Treslad and J. Gross (1972). Biochem J 127: 715 - 718.

Toth M., T. Valter, H. Lakitsa, J. Matyas and J.A. Somogyi (1977). The effect of fat supplement in fattening chickens. Al tenyeztes Ib 241 - 253.

Touchburn S.P. and E.C. Naber (1966). The energy value of fats for growing turkeys: 190 - 195 in Proc 13th World Poultry Congr kiev U.S.S.R.

Twiest G. and C.J. Smith (1970). Circadian rhythm in blood glucose level of chickens. Comp Biochem physiol 32: 371 - 375.

Twining P.V. Jr. and O.P. Thomas (1974). Consumption of floor feathers as a method of evaluating diet for broiler chicken Proc XV World Poultry Congress: 488 - 489.

Ueda K, H. Adeko and M. Suda (1960) J Biochem Tokyo 48: 584 - 589.

Vermeersch G. and R. Vanschoubroek (1968). The quantification of the effect of increasing levels of various fats on body weight gain, efficiency of feed conversion and feed intake of growing chicks. Brit Poult Sci 9: 13 - 30.

Vidaver G.A. (1964). Transport of glycine by pigeon red cells. Biochemistry. N.Y. 3: 662 - 667.

Vohra P. and B. Voln (1972). Evaluation of metabolisable energy for poultry. World poult sci J 29: 204 - 214.

Waddell H. (1964). Effect of dietary calcium and phosphorus on the utilization of dietary iron by chicks. Poult Sci 43: 1249 - 1257.

Wahid A., T.K. Mukherjee and S. Jalaludin (1974). The influence of breed and sex on live performance, dressing and yield of meat from 12 weeks old broilers. Poult Sci 53 (4): 1511 - 1519.

Wakita M., S. Hoshmo, K. Morimoto (1970). Factors Affecting the accumulation of amino acid by the chick intestine. Poult Sci 49(4): 1046 - 49.

Walters R.E., K.N. May and P.D. Rogers (1963). Relations of weight and sizes of broiler parts to carcass weights. U.S.D.A. Marketing Res Report 604: 30 - 33.

Ward T.M., R.A. McNabb and A.F.M. McNabb (1974). The effect of change in dietary protein and water availability on urinary nitrogen compounds in the rooster gallus domesticus: 1 urinary flow and the excretion of uric acid and ammonia. Comp Biochem physical 51A: 166 - 169.

Watts A.B. and B.H. Davis (1960). The effect of level of Calcium and source of phosphorus on growth of broilers. Poult Sci 39: 1304, (abstract).

Weissbach H., J. Tooley and H.A. Baker (1960). Proc Nat Acad Sci 45: 521 - 523.

Wirthgen B., and H. Bergner (1969). Time course of adaptation of GOT, GPT, CAP, OCT and Arginase in rat liver during quantitatively varied protein nutrition. Nahgrung 13: 385 - 392.

Wirthgen B., H. Bergner and H. Muchow (1967). Arch Tieremhr 17: 281 "Nutrition" Eur Ass Animal Proc Pub 16: 252 - 254.

Yates J.D. and P.J. Schaible (1962). Protein levels and amino acid supplementation for the early rearing leghorn type pullets. Poult Sci 41: 1969 - 1973.

Yoshida M, H. Hoshii and H. Morimoto (1966). Studies on the vitamin requirement of poultry. Poult Sci 1966 45 (4): 736 - 744.

Znaniecka G. and J. Frydrychenez (1976). Yield of edible meat: Protein and energy for fattening broilers. Poult Abst 3(9): 300, (abstract).

APPENDIX 1

AVERAGE DAILY NITROGEN RETENTION OF FOUR AND EIGHT WEEKS OLD BROILERS IN EXPERIMENT ONE

	FOUR WEEKS			EIGHT WEEKS		
PREMIX:	S	R	D	S	R	D
Dry matter intake	111.36	113.45	109.21	145.78	143.81	140.61
Dry matter output	36.13	36.64	37.01	46.52	42.44	45.39
Nitrogen intake	4.11	4.13	4.10	4.58	4.56	4.58
Faecal nitrogen output	1.05	1.17	1.17	1.44	1.25	1.50
Total nitrogen output	2.05	2.02	2.17	2.52	2.28	2.62
Nitrogen retention	2.06	2.12	1.93	2.06	2.28	2.00

APPENDIX 2

F-VALUES OF COMPARED PARAMETERS IN EXPERIMENT ONE

PARAMETERS	F-VALUES
Live weight	13.46
Feed intake	146.00
Body weight gain	0.29
Feed conversion ratio	5.23
Body weight gain/gram protein intake	2.18
Nitrogen retention	0.79

APPENDIX 3

F-VALUES OF COMPARED PARAMETERS AT STARTER PHASE OF EXPERIMENT TWO

PARAMETERS	F-VALUES
Live weight	14.73
Feed intake	60.94
Body weight gain	13.76
Feed conversion ratio	8.59
Body weight gain/gram protein intake	5.29 n.s
Nitrogen retention (WEEK 4)	11.43
Carcass characteristics (WEEK 5)	101.87
Crude protein of organs (WEEK 5)	12.10
Blood indices (WEEK 5)	12.75

n.s = not significant ($P > 0.05$)

APPENDIX 4a

F-VALUES OF COMPARED PARAMETERS AT FINISHER PHASE OF EXPERIMENT TWO.

Age (weeks)	Live weight	Feed Intake	Body weight gain	Feed conversion ratio	Weight gain/ protein intake
6	1.52n.s	19.29	2.33 n.s	1.00 n.s	1.00 n.s
7	3.80	56.03	6.25	6.50	13.00
8	4.28	33.43	1.57 n.s	2.17 n.s	2.14 n.s
9	12.06	5.98	5.50	4.90	16.56
10	20.12	3.57	0.88 n.s	9.03 n.s	6.67 n.s
Total	-	34.06	-	-	-
INTERACTION Starter x finisher premix	0.34n.s	1.40	1.52	7.55	0.57 n.s

n.s - not significant ($P > 0.05$)

APPENDIX 4b

F-VALUES OF COMPARED PARAMETERS FOR NINE WEEKS OLD BROILERS IN EXPERIMENT TWO

PARAMETERS	F-VALUES
Dry matter intake	13.12
Dry matter output	10.54
Dry matter digestibility coefficient	3.59
Nitrogen intake	4.63
Nitrogen output	78.57
Nitrogen digestibility coefficient	3.88
Total nitrogen output	5.29
Nitrogen retention (grams)	1.42 n.s
Nitrogen retention (%)	2.98 n.s
INTERACTION (Starter x finisher premixes)	0.08

n.s - not significant ($P > 0.05$)

APPENDIX 4c

F-VALUES OF COMPARED PARAMETERS FOR TEN WEEKS OLD BROILERS IN EXPERIMENT TWO

PARAMETERS	ACTUAL WEIGHTS	ARC SINE
Live weight	21.42	-
Dressed weight	46.33	1.69 n.s
Feather weight	3.56	1.71 n.s
Eviscerated weight	8.35	0.62 n.s
Weight of viscera	3.54	1.69 n.s
Liver	9.54	3.50
Heart	6.27	1.44 n.s
Gizzard	3.62	0.42 n.s
Spleen	1.99 n.s	2.50 n.s
Kidney	7.20	1.62 n.s
Lungs	3.13 n.s	1.00 n.s
Drum stick	8.47	0.61 n.s
Thigh	5.44	2.00 n.s
Neck	27.85	1.33 n.s
Wing	4.06	0.88 n.s
Back	4.04	0.96 n.s
Breast	3.12 n.s	0.35 n.s
Abdominal fat	2.85 n.s	1.46 n.s
Total edible meat	7.93	3.37 n.s
Total bone	1.93 n.s	2.47 n.s
INTERACTION (Starter x finisher premix)	6.08 n.s	0.00 n.s

n.s - not significant ($P > 0.05$).

APPENDIX 4d

F-VALUES OF COMPARED PARAMETERS FOR TEN WEEKS OLD BROILERS IN EXPERIMENT TWO

PARAMETERS (CRUDE PROTEIN CONTENT)	F-VALUES
Liver	20.91
Heart	4.91
Gizzard	6.37
Spleen	32.45
Kidney	13.50
Lungs	17.75
INTERACTION (Starter x finisher premixes)	1.35

APPENDIX 4e

F-VALUES OF COMPARED PARAMETERS FOR TEN WEEKSOLD BROILERS IN EXPERIMENT TWO

PARAMETERS	F-VALUES
WHOLE BLOOD	
Blood glucose	3.28 n.s
Blood urea nitrogen	17.23
PLASMA	
Total protein	8.53
Albumin	2.31 n.s
Globulin	0.39 n.s
Xanthine dehydrogenase	10.87
SERUM	
Total proteins	2.62 n.s
Albumin	2.43 n.s
Globulin	6.18
Uric acid	3.98
Creatinine	7.07
Creatine	3.13 n.s
SGOT	35.08
SGPT	32.38
LIVER FLUID	
LGPT	6.52
LGOT	1.22 n.s
Xanthine dehydrogenase	4.54
INTERACTION (Starter x finisher premixes)	1.79

n.s - not significant ($P > 0.05$)

APPENDIX 5a

F-VALUES OF COMPARED PARAMETERS AT STARTER PHASE OF EXPERIMENT THREE

Age (weeks)	Live weight	Feed intake	Body weight gain	Feed conversion ratio	Weight gain/ protein intake
0	0.69 n.s	-	-	-	-
1	10.96	1.93 n.s	4.56 n.s	5.57	4.43 n.s
2	5.84	1.60 n.s	3.45 n.s	2.40 n.s	8.30
3	2.98 n.s	29.26	2.15 n.s	2.88 n.s	4.73 n.s
4	13.45	33.42	0.88 n.s	1.75 n.s	2.33 n.s
5	12.44	85.10	3.46 n.s	6.10	7.36
Total	-	163.62	-	-	-
INTERACTION					
Premix x oil	98	1.81	1.13	0.84	0.06 n.s

n.s - not significant ($P > 0.05$).

APPENDIX 5b

F-VALUES OF COMPARED PARAMETERS AT FINISHER PHASE OF EXPERIMENT THREE

Age (weeks)	Live weight	Feed intake	Body weight gain	Feed conversion ratio	Weight gain/ protein intake
6	3.89	4.55	5.01	2.28 n.s	2.41
7	15.34	25.78	43.44	41.38	57.28
8	23.97	24.81	22.25	25.59	36.29
9	51.74	16.77	3.42	4.44	7.17
10	27.54	13.82	3.44	3.53	3.58
Total	-	96.60	-	-	-
INTERACTIONS					
Finisher premix x oil	1.69	1.68	0.57	0.78	0.06 n.s
Starter x finisher premix premix	16.96	2.42	1.52	3.50	0.06 n.s
Starter finisher x x oil premix premix	0.76	2.32	0.65	0.25 n.s	0.21 n.s

n.s - not significant ($P > 0.05$).

APPENDIX 5c

F-VALUES OF COMPARED PARAMETERS FOR FOUR AND NINE WEEKS OLD BROILERS IN EXPERIMENT THREE

	WEEK FOUR F-VALUES	WEEK NINE F-VALUES
Dry matter intake	11.84	8.14
Dry matter output	9.97	8.24
Dry matter digestibility coefficient	2.74 n.s	3.00
Nitrogen intake	27.14	10.47
Nitrogen output	20.39	6.91
Nitrogen digestibility coefficient	5.03	7.08
Total nitrogen output	13.04	0.57 n.s
Nitrogen retention (grams)	20.50	1.76 n.s
Nitrogen retention (%)	6.81	6.61
INTERACTIONS		
Starter premix x oil	0.07 n.s	-
Finisher premix x oil	-	0.00 n.s
Starter premix x finisher premix	-	1.06
Starter premix x finisher premix x oil	-	0.62 n.s

n.s - not significant ($P > 0.05$).

APPENDIX 5d

F-VALUES OF COMPARED PARAMETERS FOR FIVE AND TEN WEEKSOLD BROILERS IN EXPERIMENT THREE

	WEEK FIVE		WEEK TEN	
	ACTUAL WEIGHTS	ARC SINE VALUES	ACTUAL WEIGHTS	ARC SINE VALUES
Live weight	41.35	-	368.97	-
Dressed weight	69.13	1.61 n.s	221.67	2.43
Feather weight	1.76 n.s	1.44 n.s	3.13	2.00 n.s
Eviscerated weight	32.60	1.96 n.s	71.86	31.56
Weight of viscera	1.43 n.s	2.21 n.s	3.90	1.67 n.s
Liver	0.88 n.s	1.29 n.s	47.95	16.00
Heart	9.40	2.00 n.s	8.55	3.53
Gizzard	5.00	1.40 n.s	25.34	7.00
Spleen	1.00 n.s	4.00 n.s	7.04	0.03 n.s
Kidney	2.54 n.s	11.00	28.65	2.00 n.s
Lungs	0.00 n.s	10.00	10.23	3.00
Drum sticks	12.86	2.33 n.s	10.99	1.71 n.s
Thighs	14.82	1.66 n.s	10.42	2.76
Neck	11.54	4.17 n.s	8.32	1.71 n.s
Wings	5.95	0.40 n.s	14.35	3.06
Back	8.74	2.29 n.s	26.47	0.82 n.s
Breast	9.66	3.51 n.s	160.99	1.94 n.s
Abdominal fat	0.59 n.s	0.83 n.s	9.31	8.00
Total edible meat	17.33	8.17	43.53	6.64
Total bone	2.42 n.s	1.13 n.s	29.65	3.92
INTERACTIONS				
Starter premix x oil	0.25 n.s	0.11 n.s	-	-
Finisher premix x oil	-	-	0.00 n.s	0.76
Starter premix x Finisher premix	-	-	30.89	0.05 n.s
Starter premix x Finisher premix x oil	-	-	16.50	0.12 n.s

n.s - not significant ($P > 0.05$).

APPENDIX 5e

F-VALUES OF COMPARED PARAMETERS FOR FIVE AND TEN WEEKS OLD BROILERS IN EXPERIMENT THREE

PARAMETERS (CRUDE PROTEIN CONTENT)	WEEK FIVE F-VALUES	WEEK TEN F-VALUES
Liver	44.64	39.46
Heart	69.18	69.69
Gizzard	8.15	44.52
Spleen	26.61	16.89
Kidney	14.84	19.06
Lungs	7.33	15.74
INTERACTIONS		
Starter premix x oil	0.11 n.s	-
Finisher premix x oil	-	0.00 n.s
Starter premix x finisher premix	-	3.78
Starter premix x finisher premix x oil	-	0.00 n.s

n.s - not significant ($P > 0.05$)

APPENDIX 5f

F-VALUES OF COMPARED PARAMETERS FOR FIVE AND TEN WEEK OLD BROILERS IN EXPERIMENT THREE

	WEEK FIVE	WEEK TEN
WHOLE BLOOD		
Blood glucose	37.27	8.71
Blood urea nitrogen	2.50 n.s	8.28
PLASMA		
Total protein	1.78 n.s	3.39
Albumin	0.94 n.s	2.70
Globulin	0.32 n.s	0.64 n.s
Xanthine dehydrogenase	2.48 n.s	2.73
SERUM		
Total proteins	1.05 n.s	2.81
Albumin	35.97	3.49
Globulin	0.40 n.s	2.07 n.s
Uric acid	1.77 n.s	2.71
Creatinine	0.63 n.s	6.90
Creatine	2.00 n.s	1.67 n.s
SGOT	14.48	19.24
SGPT	5.36	9.11
LIVER FLUID		
LGPT	25.85	4.77
LGOT	1.42 n.s	24.68
Xanthine dehydrogenase	14.68	12.63
INTERACTIONS		
Starter premix x oil	0.17 n.s	-
Finisher premix x oil	-	0.00 n.s
Starter premix x finisher premix	-	4.41
Starter premix x finisher premix x oil	-	0.00 n.s

n.s - not significant ($P > 0.05$).