# RESPONSE OF GROWING AND LAYING JAPANESE QUAILS (*Coturnix coturnix japonica)* FED DIETARY GRADED LEVELS OF FERMENTED CASSAVA(*Manihot esculenta*) PEEL MEAL

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**THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY IN ANIMAL PRODUCTION.**

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## ABSTRACT

A two phase research work was conducted in a period of 12 weeks to determine the effect of feeding varying levels of fermented cassava (*Manihot esculenta*) peel meal on the growth performance and egg production of Japanese quails using 300 two week old growing quails with an initial mean body weight of 27.67 g of both sexes. The birds were randomly allotted to 4 dietary treatments with 75 birds per treatment. Each replicated thrice; designated $T_1$, $T_2$, $T_3$ and $T_4$ containing 0, 25, 50 and 75 % of fermented cassava peel meal (FCPM) as a replacement for dietary maize respectively. The parameters measured in the first 6 weeks (growing phase) were feed intake, weight gain, feed conversion ratio, nutrient digestibility and carcass characteristics. The results showed significant (P<0.05) difference in daily feed intake, while daily weight gain and feed conversion ratio showed no significant (P>0.05) difference among the treatment means. There were significant (P<0.05) differences in the nutrient digestibility among the treatment groups. A total of 120 female quails were allotted to 4 dietary treatment with 30 birds per treatment, replicated thrice and were fed with layers diet with same level of replacement ( laying phase). The parameters measured at the laying phase were daily feed intake, hen- day production, hen- house production and egg quality traits (Egg weight, egg length, egg width, egg shape index, yolk weight, yolk width, shell thickness, yolk index, Haugh unit, yolk height, albumen height and albumen weight). The results showed that there were no significant (P>0.05) differences in the daily feed intake, hen-day production, hen-housed production and in all the egg quality traits. It was concluded that dietary maize could be replaced with FCPM up to 50 % without any deleterious effect on growth performance while FCPM up to 75 % can be used to replace maize in the feed of laying Japanese quails without any deleterious effect on egg production and egg quality trait of quails.

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Male and Female quail (showing the bulbous gland which differentiate the male from the female.

# CHAPTER ONE

## 1.0 INTRODUCTION

Poultry production is a major sector of livestock production dealing with different kinds of birds. Years back, chickens were the most recognized and acceptable poultry birds reared by farmers; however recently, other birds came into limelight of which the Japanese quail (*Coturnix coturnix japonica*) is one of them. Quails with chickens, pheasants and partridges belong to the family *Phasanoidea* of order *Galliformes* of class *Aves* of the animal kingdom (Shim, 2005).There are about 44 known species but research has shown that only 22 have been domesticated.

Quails were brought to Nigeria with the sole aim of bridging the protein gap due to its fast multiplication rate and low investment cost. It has proven to be the quickest and cheapest substitute to the expensive sources of protein (Ayanwale and Arziki, 2005). The importance of animal protein in both human and animal nutrition cannot be over emphasized. Over the years, there has been a significant gap between the production and supply of animal protein to feed the over growing population. To halt this negative trend, efforts are being directed towards boosting the livestock industry with micro livestock having prolific tendency, short gestation, short generation interval and rapid growth (Owen and Amakiri, 2010). Introduction of Japanese quails to Nigeria in 1992 (Haruna, Musa, Okemole, Shemaki, Lombin, Molekwu and Karsin, 1997) has widened the scope for the availability of high rich proteinous food and of research (National Veterinary Research Institute, 1996; Olubamiwa, Haruna, Musa, Akinwale, Cambin and Longe, 1999;  Edache, Musa, Karsin, Esilonu and Jibrin, 2005).

Japanese quail is a fairly recently domesticated economic avian specie that is ideally suited for commercial rearing, eggs and meat production under intensive conditions

(Oladunjoye, Ojedapo and Ojebiyi, 2005). Japanese quails are hardy birds that thrive in small cages and cheap to produce (Odunsi, Rotimi and Amao, 2007). They have less feed requirements of about 20-25 g of feed per bird/day compared to chicken that requires 120-130 g of feed per bird/ day (Ani, Okeke and Emeh, 2009). Japanese quail meat and egg are very tasty and the meat is tender and low in cholesterol. Research findings had it that consumption of quail meat reduces the chances of hypertension and diabetes (Agwunobi and Ina-Ibor, 2007). Successful quail rearing depends on many factors like availability of feed ingredients at a reasonable cost, quality chicks and proper management. Among these factors, management factor seems not a problem as quails are resistant to diseases requiring less vaccination. (Maurice and Gerry, 2006).

The recent economic recession and difficulties with poultry production inputs in the last few years in Africa has now forced poultry farmers to look inward for cheaper raw materials (Yusuf, 2004). In order to maximize profit of poultry products there is the need to develop and incorporate alternative feed-stuffs which when used in compounding poultry diets will at least lower the cost of feed ingredients for Japanese quails and which will encourage farmers to go into quail farming.

One of the major constraints of the development of poultry industry in Nigeria is the high cost of feeds. Maize constitutes about 60 % of feed which also serves as food for many households in Nigeria. Competition between man and livestock for maize, soya beans among others is often responsible for high cost of these ingredients (Oladunjoye *et al.,* 2005). Several studies have been carried out on many energy supplying agricultural products as substitute for maize in poultry feed. Among such products that have been tried are sweet potatoes, cocoyam, yam, rice by- products, peels of tubers, molasses, sorghum and wheat. One of such agro-industrial by- product is cassava peels which are cheaper and unconventional alternative feed resources for livestock animals.

Cassava (*Manihot esculenta*) belongs to the genus *Manihot* of the order *Euphabiaceae.* It is said to have been introduced into West Africa from Brazil by the early Portuguese explorers. Cassava is the most productive tuber crop in terms of energy yield per unit land area (Garcia and Dale, 1999). Cassava peels are the back cover of the cassava tuber which is manually removed using sharp knives with little or no pulp in the peel. These peels are often two layers; the outer brownish and relatively thin rind and grayish, whitish or light brown inner and comparatively large rind. When processed for inclusion in diet, it is referred to as cassava peel meal. Cassava peel is one of the agro-industrial by-product that is readily available in countries where cassava is cultivated and processed into food for man. The peels account for about 10-15 % of the tuber by weight. It contains about 5.00 - 5.98 % crude protein (ldowu, Sogunle, Idowu, Jegede, Alabi, Adenugba and Bamgbose, 2006). There are limitations on the use of cassava products in poultry diet because of its dustiness, milling difficulty, reduction in feed intake and an appreciable content of anti-nutritional factor which is Hydrocyanic acid (HCN) (Essec and Nout, I989; and Salami, 1999). However, Oladunjoye, Ojebiyi and Odunsi (2008) reported several processing methods to enhance the feeding value of cassava products; like parboiling, soaking in water and sun drying (fermentation). Omoikhoje, Bamgbose and Aruna (2008) have reported on the extensive use of cassava peel meal as cheaper substitutes for maize in the diet of monogastrics.

## 1.1 General Objective

This work is aimed at investigating the response of Japanese quails (*Coturnix coturnix japonica*) fed diets containing graded levels of fermented cassava peel meal as a replacement for maize in the diets of growing and laying Japanese quails.

**Specific objectives are to:-**

1. evaluate the growth performance pattern (Body weight/ Body weight gain, feed conversion ratio) of the Japanese quail fed diets containing graded levels of fermented cassava peel meal.
2. determine the cost effectiveness of fermented cassava peel meal in quail diets.
3. determine the nutrients digestibility of Japanese quails fed diets containing graded levels of fermented cassava peel meal.
4. determine the carcass proportions of the Japanese quails fed diets containing graded levels of fermented cassava peel meal.
5. estimate the hen-day and hen-house production of the Japanese quails fed diets containing graded levels of fermented cassava peel meal.
6. investigate the effect of the different levels of fermented cassava peel meal on egg quality parameters such as (albumen height, Haugh units, shell thickness, egg shape index, egg weight, yolk weight, egg length, egg width, yolk height and albumen weight.

## 1.2 Justification for the study

1. The need to provide cheap source of animal protein which is of importance to public health.

2. The need to source for a non conventional feed ingredient to augment conventional feed ingredients.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Description of Japanese quails

#### 2.1.1 Quails (*Coturnix coturnix*)

Quails along with pheasant, partridges and swan belong to the order *Galliformes* and family *Phaseonidae* (Shim, 2005). *Coturnix* is considered as migratory species in Africa, Asia and Europe where they are generally found in breed sub-species including African quail (*Coturnix coturnix Africana*), European quail (*Coturnix coturnix*), Eussine quaiI (*Coturnix coturnix useriensis*) and Japanese quail. (*Coturnix coturnix japonica*) (Shim, 2005). Japanese quail was first discovered and recorded in the eight century in Japan (Nasrollah, 2008).This bird which was used as a pet song bird in the eleventh century has suddenly become a valuable food animal (Kayang, Vignal, Inone-Murayama, Miwa, Monvoisin, Ito and Minville, 2004).

The subspecie *Coturnix coturnix japonica* has become important as laboratory animals. They are known to be useful for studies on embryology, genetics, nutrition, endocrinology, physiology and toxicology. They are hardy birds that thrive in small cages and perform excellently in egg production; laying up to 300 eggs/ year. Incubation period is 17 days and they attain maturity in 5 to 6 weeks after hatching. They are inexpensive to maintain and are regarded as valuable for investigation purposes based on the above advantages. *Coturnix* is known in the world for its low cholesterol meat and egg. This is a unique advantage that makes it a special poultry bird. It is also known as a luxury food in human recipe (Shim, 2005).

### 2.1.2 *Coturnix* chicks

Young *coturnix* chicks are yellowish in appearance with stripes of brown and somewhat resembling turkey poult except for size (Shim, 2005). The newly hatched chicks weigh about 6 to 7 grams, but grow rapidly during the first few days. After three days flight feathers begin to appear and birds are fully feathered in about four weeks of age. Sexing can be done as early as three weeks of age based on feather colour which is distinct for male and female species (Odunsi, Oladunjoye and Ojebiyi, 2008).

### 2.1.3 Adult male quails

The adult male *coturnix* weighs about 100 to 140 grams in about 10 weeks of age. The male birds can be identified readily by the rusty brown coloured feathers on the upper throat and lower breast region (Mizutani, 2003). Males also have cloaca gland which is a bulbous structure located at the upper edge of the vent which secretes a white foamy secretion. This unique gland can be used to assess the reproductive fitness of the males. Males crow through the night during the height of the normal breeding season (Shim, 2005). Males sound has been described as "Ko-turn-neex" (Odunsi *et al*., 2008). Males generally live longer than females.

### 2.1.4 Adult female quails

The adult female *coturnix* is slightly heavier than the male; weighing between 120 to 160 g in about 10 weeks of age (Shim, 2005). The body coloration of the female bird is similar to the male except that the feathers on the throat and upper breast are long, pointed and much lighter plumage. Also, the light tan breast feathers are characteristically black-stippled (Shim, 2005).

The female under proper conditions, may start laying eggs as early as 35 days of age and may lay approximately 200-300 eggs a year (Odunsi *et al*., 2008).

### 2.1.5 Laying quails

Laying quails are two types: the commercial layers and breeding stock. Commercial layers are kept alone without males because they are meant to lay infertile eggs. They are purposely reared for their eggs. Breeders on the other hand are kept with males mainly to produce fertile eggs for hatching at the hatchery; therefore both males and females are housed together in a specified mating ratio of 1:3 (Oladunjoye *et al*., 2005). Water and feed must be provided *ad-libitum* to ensure maximum production. Feed and photoperiod are two factors that are of utmost importance in egg production as birds approach sexual maturity and become photo stimulatory. The ultraviolet rays cause the hypothalamus to release gonadotropin releasing factor (GRF) and luteinizing hormone releasing factor bringing about a change in the pattern of gonadotropin output. These effects result in rapid development of the ovarian follicle and increased steroidogenesis by the ovarian steroid producing cells. The estrogen that is produced in the interstitial tissue helps to increase the uptake of calcium from the gut and also acts on liver to produce the specific yolk lipoproteins. Also it causes changes of the vascular system, increases deposition of body fat, stimulate growth of the oviduct and play a role in the deposition of extra calcium in the bones.

### 2.1.6 Egg and egg production of Japanese quails

*Coturnix* eggs are characterized by a variety of colour patterns. They range from snow white to completely brown. More commonly they are tan and dark brown speckled or molted brown with a chalky blue covering. The average egg from mature female weighs about 10 grams and about 8 % of the body weight of the quail hen as compared to 3 %

for chicken egg (Shim, 2005). The eggs have first class protein. They contain amino acids, which are the building blocks for body growth such as hormones, enzymes and antibodies. The egg has 4.30 % less fat and 5.00 % more protein than the hen egg (Wentworth, Cigan and Schaaf, 2009). Shim ( 2005) reported that care must be taken in collecting and handling quail eggs because they are thin shelled and more fragile than chicken eggs.

The maturity of Japanese quail is within 6 weeks and in full egg production in 50 days of age. Under proper conditions hens can lay 200 eggs in their first year of lay and their life expectancy is between 2- 2½ years (Maurice and Gerry, 2006). Quails convert more feed to egg than chicken. Their small size and early onset of egg production enables quail enterprise to be established with a low capital outlay and early generation of income (Nwokedi, Sekoni, Omage and Alphonsus, 2010). According to Parvu, Andronie, Simon, Berghes and Amfim (2010) Japanese quail can produce egg mass about 20 times its own weight while a good layer hen can produce about 12 times its own weight in egg mass.

### 2.1.7 Eggs and egg quality traits

One of the animal protein requirements for man is provided by eggs (Dudusola, 2009). Egg has various uses and it contains nutrient that support life during essential embryonic growth and this has been reported as a complete food for man (Scolt and Silversides, 2001). Egg quality characteristics such as cleanliness, freshness and egg weight are important in consumers acceptability (Song, Chois and Oh, 2000; Adeogun and Amole, 2004). With time and depending on the shell, the internal content of the egg deteriorates (Adeogun and Amole, 2004; Kul and Seker, 2004).

Egg weight is a highly heritable trait which can be improved by selection. Birds which mature early tend to lay smaller eggs than those that mature later (Reddy, Praharaj, Reddy and Ray, 2004). Also as reported by (Cedro, Calixto, Gaspa, Curvello and Hora, 2009), egg weight is the main quantitative factor. Egg weight varies immensely among species (Campbell, Kenealy and Campbell, 2001). Yakubu, Ogah and Barde (2008) observed that egg weight was largely affected by environmental factors, feed restriction, parental average body weight and genetic constituents.

Haugh unit is a measure of egg protein quality based on the height of its egg white (Monira, Salahuddin and Miah, 2003; Kluger, 2010). According to Chang and Chen (2000) haugh unit and yolk indices are generally considered as good indicators to evaluate egg quality. The higher the yolk index and the haugh unit, the more desirable the egg quality (Dudusola, 2009). Table 2.1 shows the chemical composition of quail egg as reported by Shim (2005).

**Table 2.1: Chemical composition of quail egg**

| | |
|---|---|
| Energy | 158 Cal |
| Water | 74.60 % |
| Protein | 13.10 % |
| Fat | 11.20 % |
| Total ash | 1.10 % |
| Calcium | 0.59 mg |
| Iron | 3.80 mg |
| Vitamin A | 300iu |
| Phosphorus | 220 mg |
| Vitamin $B_1$ | 0.12 mg |
| Vitamin $B_2$ | 0.85 mg |
| Nicotinic acid | 0.10 mg |

**Source:** Shim (2005).

## 2.2 Feeding quails

Quail feed is designed to contain all the protein, energy, vitamins, minerals and other nutrients necessary for their proper and normal growth, egg production and health (NVRI, 1996). Diets must contain nutrient levels that meet the dietary needs of the type of birds being produced. Meat type Bob white quails have large bodies and gain weight quicker than birds grown for ‘’flight’’ purposes. Meat type bird feed is more expensive to produce than the flight bird feed; they are larger than necessary and not considered as good fliers. In contrast, smaller strain of Bob white quails are usually considered as good flight birds but not recommended as good meat producers. They do not convert feed to meat as well and produce less desirable carcasses when slaughtered (Tom, 2005). Quails do well on ration containing 27-28 % crude protein. They also do well on ration containing 24-25 % and broiler starter. However, they produce optimally on 18-20 % crude protein and 2800 kcal/kg ME.

## 2.3 Nutritional requirements of quails

### 2.3.1 Protein requirement for quails

Protein is the principal constituent of soft tissues and organs of the body. It is needed for the proliferation of tissues, growth and replacement of old and damaged tissue. It contains mainly carbon, hydrogen, oxygen, nitrogen and sulphur. Nitrogen takes 16 % of protein. The quality of protein is determined by its biological value (Carmen and George, 2004).The synthesis of protein in the body tissues of quails require an adequate supply of 19 different amino acids; thirteen of which are termed ‘’essential’’ amino acids because they cannot be synthesized by the birds and must be provided in the diet. Examples of these are lysine, leusine, isoleusine, histidine, methionine, phenylalanine, valine, arginine, tryptophan and threonine. Deficiencies, excess or imbalance of some amino acid can cause embryonic abnormalities which include abnormal beak, exposed viscera, twisted spine, short body and degeneration of the eye (Wilson, 1991). Protein of high quality with adequate amino acid balance is one of the most important nutrients for quails. It is also one of the most expensive nutrient (Soare, Fonseca, Santos and Mercandante, 2003). Japanese quails in the wild feed on insects and various seeds (Odunsi *et al*., 2007).The dietary protein requirement of quail is influenced by metabolizable energy content and ingredient used to formulate the diet (Maurice and Gerry, 2006). Protein can be obtained from either plant or animal origin. Animal protein is considered as of higher quality than plant protein because they are richer in sulphur - containing amino acids, minerals and vitamins.

Sources of animal protein include fish meal, blood meal, maggot meal, meat meal and hatchery by product meal (Odunsi, 2006). A combination of different protein sources (plant and animal protein) supplies a more adequate amino acid balance than one alone (Carmen and George, 2004). Vegetable protein sources are soya bean cake, palm kernel cake, groundnut cake and cotton seed cake. Soya bean is the widely used oil seed and it is deficient in methionine. Groundnut has an average content of crude protein of 45 % and a very high metabolizable energy due to its high oil content of 35 %. It is generally low in lysine and methionine which aids egg production. Murakami, Morases, Anki, Jungueria and Kronka (1993a) evaluated four crude protein levels (20, 22, 24 and 26 %) for Japanese quails and it was concluded that after lysine and methionine + cystine requirements were met, 20 % crude protein level resulted in best performance from 1 to 42 days of age. During the laying period, 18 % of crude protein was recommended. Hyankova, Devkova, Knizetva and Klecher (1997) reported that Japanese quails fed 26 and 21.60 % crude protein had good performance, 1 to 21 and from 22 to 32 days of age respectively; thus, requirements decrease with age similar to other animal species. Pinto *et al*.(1998) recommended 22.40 % crude protein level for laying Japanese quail which is lower than that of Murakami, Morases, Anki, jungueria and Kronka (1993b) and National Research Council (1994) recommended inclusion level of 24 and 20 % crude protein for quails in the rearing and egg production periods respectively.

### 2.3.2 Energy requirement for quails

The energy in feed stuff fed to poultry is usually expressed per unit weight. Energy in the diets is largely in form of carbohydrates and fats (vegetable oil and lards). Energy is mainly found in grains and cereals which are the main ingredients in most feed. Energy requirement for growing quails in the temperate region has been reported to be about 2600 to 3000 kcal/kg ME, while for the tropical region, it is about 2800 kcal/ kg ME (Shim and Lee, 1998). Layers (5-6 weeks) require 2900 kcal/kg ME while breeders require 2500 kcal/kg ME. NVRI, (1996). Deficiency of linoleic acid results in slow development, embryonic mal-positioning and increased embryonic mortality (Wilson, 1991).

### 2.3.3 Vitamins requirement for quails

Vitamins are complex organic structures required in minute form for growth, reproduction and health of poultry. The amount required depends on diet, rate of growth, production (egg), size of bird and possibly climate (Carmen and George, 2004). Vitamins are classified into fat soluble (A, D, E, K) and water soluble (B and C) vitamins and are important for hatchability and survival of newly hatched chicks. About 3200 iu vitamin A per/kg diet ensures adequate growth and assists birds in resistance to disease (Parish and Al Hassani, 1983). It is also essential for fertility in female, egg production and vision. Vitamin $D_3$ is essential for quails and aids in the absorption of calcium and phosphorus from the intestinal tract and also the deposition of calcium on egg shell. Deficiency of vitamin $D_3$ causes late embroyonic mortality, poor skeletal growth, stunting and rickets (Wilson, 1991). A deficiency of vitamin B in chicks causes a nervous system disease known as crazy chick disease. B vitamins are well distributed in grains and cereals. Thiamine (Vitamin $B_1$) is needed for metabolism of carbohydrates. Shim and Vohra (1983) showed that egg production and body weight can be affected by vitamin E deficiency, muscular weakness after hatching and haemorrhages. Circulatory disorders are also as a result of vitamin E deficiency (Wilson, 1991). Table 2.2 shows the vitamin requirements for quails as reported by (Tom, 2005).

**Table 2.2: Minimum vitamin requirements for quails**

| Vitamin (Units) | Amount of Vitamin per ton |
|---|---|
| Vitamins A (iu) | 4 million |
| Vitamins E (iu) | 30,000.00 |
| Vitamins $D_3$ (iu ) | 2 million |
| Vitamin K (iu) | 600.00 |
| Riboflavin (mg) | 4,000.00 |
| Pantotherate (mg) | 16,000.00 |
| Niacin (mg) | 40,000.00 |
| Pyridoxine (mg) | 4,000.00 |
| Vitamin $B_{12}$ (mg) | 10.00 |
| Choline (g) | 1,400.00 |

iu = International unit, mg = milligram, g = gram

**Source**: (Tom, 2005)

### 2.3.4 Mineral requirements for quails

Adequate levels of minerals must be provided to all birds. Laying quails require higher level of minerals for egg shell formation. Chicks require high levels of minerals for proper bone formation and development. Breeder feed is fed only to laying birds. When a breeder feed is fed to chicks, it reduces growth and unnecessary stress occurs. There are 2 major minerals required by the birds viz: Calcium and Phosphorus as shown in Table 2.4. The main functions of these two minerals are in the make-up of the bones of the body. Calcium is also essential for the deposition of egg shell. It is not only that calcium and phosphorus are required in sufficient quantity but also in correct proportion. The young quail needs a minimum of 0.8 percent of calcium in the diet and 0.45 percent as phosphorus while the laying quail needs 2.5 percent to 3 percent of calcium since this is the main constitute of egg shell (Shim, 2005). Oyster Shell, limestone, tricalcium phosphate or calcium carbonates are usually added to the feed to supplement these elements (Maurice and Gerry, 2005). Although not always required for survival, a trace mineral premix added to diets will give better performance. Trace minerals are the minerals required at very low levels for good growth, performance and production. Most feed ingredients contain these minerals but sometimes not enough of them. An excellent trace mineral premix is shown in Table 2.3. The premix provides enough trace minerals when added at the rate of 0.9kg per tonne of feed. *Coturnix* needs trace elements like zinc, selenium, magnesium, potassium and sodium (Odunsi *et al*., 2008).

**Table 2.3: Trace mineral premix for quails**

| Ingredient | Amount of Premix (kg) |
|---|---|
| Manganous sulphate | 0.57 |
| Zinc Oxide | 0.57 |
| Ferrous sulphate | 1.42 |
| Lime stone or oyster shell | 3.23 |
| Inclusion rate | 0.91kg |

**Source**: (Tom, 2005)

**Table 2.4 Recommended nutritional requirements for quails**

| Diet | Protein | Calcium | Phosphorus | Methionine |
|---|---|---|---|---|
| **Bobwhite Quail Meat type** | | | | |
| Starter (0 - 6 wk) | 23.0 | 1.00 | 0.50 | 0.50 |
| Finisher (6wk - market) | 19.0 | 0.90 | 0.50 | 0.50 |
| **Flight** | | | | |
| Starter (0 - 6wk) | 24.0 | 1.00 | 0.50 | 0.55 |
| Developer (6 - 16wk) | 20.0 | 0.90 | 0.50 | 0.42 |
| **Breeders** | | | | |
| Starter (0 - 6wk) | 23.0 | 1.00 | 0.50 | 0.50 |
| Developer (6 - 20wk) | 18.0 | 1.00 | 0.50 | 0.40 |
| Layer (20wk +) | 19.0 | 2.75 | 0.65 | 0.50 |
| ***Coturnix* (pharaol Quail)** | | | | |
| Starter (0 - 6wk) | 24.0 | 00.8 | 0.60 | 0.50 |
| Finisher (6wk - market) | 18.0 | 0.65 | 0.50 | 0.45 |

(OIubamiwa *et al.*, 1999)

## 2.4 Housing and equipment for quails

There are about three types of housing patterns for quails; floor housing which requires about 145 $cm^2$ of floor space and a wired floor which measures 125 $cm^2$ of floor space all for adult birds. Then a 7mm sq welded wire for cages or pen construction to secure footing, preventing leg injuries and escape of chicks through wall (Maurice and Gerry, 2005). Housing should be such that permits effective sanitization, well ventilated, insulated and free from draught and vermin's like rats, predatory birds and cats. Accessibility of water and feed should be ensured. Drinking troughs used for quails should be narrow lipped to prevent chicks from getting into them and drowning. Flat paper can be used as feeders for the first few days. Larger *coturnix* can be fed with feeders that are about 2 inches high by 2 inches wide. A grill of welded wire laced in the feeder on top of the feed helps to reduce waste.

## 2.5 Light requirement for quails

Japanese quails require 14-18 hours of light per day to maintain maximum egg production and fertility. This means that supplementary lighting must be provided in the autumn, winter and spring months to maintain production. Males not required for breeding or any quail being grown for meat production can be given only 8 hours of low-intensity light per day. This is not enough to initiate sexual maturity and the birds do not expend energy on fighting, mating and will tend to fatten more quickly (Maurice and Gerry, 2006). Long photoperiods stimulate sexual maturation whereas short photoperiods inhibit or delay sexual maturation (Boon, Visser and Daan, 2000). Growth in juvenile animals is always affected by day length through the effect of day length on daily energy intake and energy expenditure (Boon Watt, Smith and Visser, 2001). The interaction between light and dark period determines overall body weight gain (Boon *et al*. 2000).

## 2.6 Health management of quails

Sanitary management practices are best guaranteed against diseases. Equipment such as cages, feeders, drinkers and tools should be cleaned and sanitized frequently (Maurice and Gerry, 2005). Rodents and wild birds must be kept away with a good health management that depends on a continuous application of basic principles of sanitation. However, several diseases are transmitted congenitally even though they are relatively healthy and hardy birds compared to chickens. This include: Newcastle disease, *Salmonella spp*, *Mycoplasma spp*, *Bronchitis*, *Avian encephalomyelitis*, *Lymphoid leucosis* and *Adenoviruses* (Carmen and George, 2004)

## 2.7 Cassava (*Manihot esculenta)*

Cassava (*Manihot esculenta*) belongs to the genus *Manihot* of the natural order *Euphabiaceae*. It is said to have been introduced into West Africa from Brazil by the early Portuguese explorers. The plant possesses tall, thin straight stems attaining a height varying between 90 and 180 centimetres (cm) (Asaolu, 2007). Cassava is the most productive tuber crop in terms of energy yield per unit land area (Garcia and Dale, 1999). It is mainly grown in the tropics due to suitable weather and soil. It is consumed by both animals for example ruminants and monogastrics. Nigeria, being the largest producer of cassava in the world, produces about 34,000- 45,000 tonnes of tuberous root in a year as reported by Federal Ministry of Agriculture and Natural Resources Nigeria (FMANR, 1997).

### 2.7.1 Uses of cassava

Cassava is processed into finished products like *garri*, *fufu*, cassava chips and cassava flour for human consumption (Asaolu, 2007).The crop and its by- products can also be used to feed livestock (Garcia, 1999). Cassava and its by-products that are used in feeding livestock have to undergo some processing to make it acceptable to livestock (Salami and Odunsi, 2003).The animal fed successfully with this by- product include goat, rabbit, pig, cattle, sheep and poultry.

## 2.8 Anti-nutritional factors in cassava

Cassava cultivars contain varying amount of cyanogenic glucosides and are classified as "Bitter" or "sweet" based on the level of this compound (Asaolu, 2007). The cyanogenic content in the fresh peel is between 364.2 part per million to 814.7 part per million or more depending on the variety, plant age, soil condition, fertilizer application, weather and other factors. There is need to reduce it by processing methods such as sun-drying, soaking in water and ensiling (Gomez and Valdivieso, 1999). However the use of new varieties with low cyanogenetic glycoside content is increasing (Garcia and Dale, 1999). The respiratory process in animal tissues is obstructed by Hydrocyanic acid (HCN) through de-activation of the cytochrome-oxidase enzyme system (Garcia and Dale, 1999).The HCN is transformed in the liver by the enzyme rhodanese to thiocynate (SCN) which is excreted in the urine and this detoxification process utilizes sulphur from methionine, increasing the requirement for amino acids (Garcia and Dale, 1999). The amount of methionine required for this detoxification depends on the amount of HCN ingested by the animal (Oke, 1994). Chronic cassava toxicity in chicken has been reported to lower egg production, egg quality in layers, shell thickness and hatchability of eggs. Omole (1997) reported that cassava root meal produced a growth depression when included in the diet of poultry at 486 g/kg. Stevenson and Jackson (1995) observed that weight was unaffected by diet containing 50 % cassava root meal. Several studies by Tewe (1994) revealed that performance of poultry with cassava diet was satisfactory if the HCN content in the final ration did not exceed 100 part per million. Such ration must however be nutritionally balanced especially in terms of energy and essential amino acids.

## 2.9 Nutritional value of cassava

The most common types of feed stuffs produced from cassava roots are chips and pellets. Chips are the dried shredded root and are of variable sizes, shape and quality depending on rate of drying and contamination with sand during the processing (Garcia and Dale, 1999). The chips can be directly grinded and used in mixed feeds or pelleted. Pelleting of this feed produces a more compact product and reduces dustiness thus facilitating storage and transportation. Pellets have a lower nutritional value than chips because they include part of the shoot, which increases fiber and ash content from 1.5 to 2.0% (Institute National de la Recherече Agronomique 1990, Central veervvederbureau, 1998). Cassava root meal is mainly a source of energy with high starch content (about 60-70 %). However, the level of protein is very low being approximately 2.5% of dry matter (Garcia, 1999). The inclusion of cassava in diets depends on cost and availability of other energy and protein sources. When a balanced poultry ration is formulated, the cassava must be supplemented with protein, amino acids, fat, minerals and vitamins at higher levels than are needed in cereal based diets.

## 2.10 Cassava peel

Cassava peel is the covering of cassava tuber which is removed manually with knife (International Institute of Tropical Agriculture, 1990). Asaolu (2007) defined cassava peel as the product of processing cassava for human consumption. Cassava peel is abundant in most cassava processing sites but its potential is however beclouded by its low protein, high fibre and high cyanide content (Eruvbetine, Tajudeen, Adeosun and Olejede, 2003).

## 2.11 Processing methods of cassava

Cassava peel has to be processed to reduce the toxicity caused by some of its content and this content includes hydrocyanic acid (HCN) which is harmful to animals. Cassava is processed by various methods to increase acceptability and palatability by animals. Several processing methods have been applied over the years. Cassava peel can be processed using any of the following methods: grating and sun-drying, boiling, parboiling and sun-drying (Salami and Odunsi, 2003). Drying is the most popular practice to reduce cyanide in many tropical countries because the time of linamarase contact with the glucosides is higher with sun-drying and this method eliminates the cyanide more effectively than oven drying. Soaking and fermentation are inter-related processing steps practiced commonly in Africa.

The most important traditional staple food in West Africa is called *garri* made from cassava and it is produced by grating cassava roots, dewatering, fermenting and roasting the fermented product. Approximately 80 to 95 % cyanide reduction can be achieved through the various stages of garri production (Padmaja, 1995). Levels of cassava usage lower than 50 % inclusion (Wood, 1992) or less than 50 mg HCN equivalent per kg (Tewe, 1994) are used in compound feeds produced in the European Union.

## 2.12 Fermentation

Fermentation is one of the oldest applied biotechnologies being used in food processing, preservation as well as beverages production for over 6,000 years (Motarjemi, 2002).

Fermentation enhances the nutrient content of food through the biosynthesis of vitamins, essential amino acid and protein by improving protein quality and fibre digestibility. It also enhances micro nutrient bio availability and aids in degrading anti nutritional factors (Achinewhu, Barber and Ijeoma, 1998).

### 2.12.1 Fermentation of cassava peels

Cassava peel wastes are generated in the production of *farihna*, *garri* and *chikwangue*. One of the major problems faced with the storage of cassava peel is the inappropriate storage of the peels for long period during raining season. Utilization of the peels is limited by its low digestibility and toxicity from extremely high levels of hydrocyanic acid. Fermentation not only reduces toxicity but the enzymes –resistant lingo- cellulose material is converted into a more digestible substrate. Following fermentation, cassava peel can be fermented into pig and poultry feed (Ofuya and Obilor, 1993).

## 2.13 Non- conventional feed ingredients in monogastric ration

Agwunobi and Ina-Ibor (2007) evaluated the performance of broiler chicken fed sun dried trifoliate yam tuber meal (*D. dumetorum*) as replacement for maize grain. Five diets were prepared using sun dried trifoliate yam tuber meal as energy source to replace maize grain at 0, 30, 60, 90 and 100 % levels in more or less iso- nitrogenous and iso-caloric diet. Sixty day old broiler chicks were separated into five groups of 12 birds per treatment and randomly allotted to one of the diet. Results showed that feed intake, body weight gain, final body weight and feed efficiency differed significantly ($P<0.05$) among the treatments. Feed intake and body weight gain were higher at substitution with trifoliate yam. Similarly, feed efficiency improved with increase in trifoliate yam in the diet. Also cost of producing a kilogram flesh from the feed reduced significantly ($P<0.05$) with increase in the level of substitution with trifoliate yam. It was therefore concluded that sun dried trifoliate yam could serve as alternative source of energy in place of maize for broiler chicken production.

Etuk, Ude Gbunam, Emenalom and Esome (2011) studied the effect of partial replacement of maize with 2:1:1 combination of plantain peels (PP), yam peels (YP) and palm kernel cake (PKC) in broiler starter diet in a 28 day feeding trial using ninety-nine (99) day old marshal broiler chicks. Three experimental diets were formulated such that $T_1$ (control) contained 0.00 %, YP and PKM. Diets $T_2$ and $T_3$ respectively had maize replacement at 25.00 and 50.00 % level with PP, YP and PKC combined in the ratio 2:1:1. The birds were randomly allotted to three (3) replicates in a complete randomized design (CRD). The results showed a decreasing body weight gain with increasing dietary level of the test material. Feed intake increase with increasing dietary level of the test material though no significant (P>0.05) difference were observed. They concluded that PP, YP and PKC combined in the ratio 2:1:1 could replace up to 25.00 % of maize in broiler starter diet.

Igbebuike, Mohammed, Asheikh, Ubosi and Mohammed (2009) conducted a five (5) week feeding trial to assess the biological and economic performance of broilers fed graded levels of yam peel meal (YPM). YPM which contained 13.20 % crude protein and 7.00 % crude fibre were included at 20, 25, and 30 % respectively to partially replace maize in five (5) broiler finisher diets. One hundred and twenty broilers of four weeks of age were allocated to five dietary treatments in group of thirty birds each. The treatment were replicated two times with 15 birds per replicate and allowed unlimited asses to feed and drinking water throughout the experimental period. No significant (P>0.05) differences were observe in the daily intake, body weight gain and feed conversion ratio. The cost per kilogram of feed and cost of feed per kilogram gain decrease steadily as the level of YPM increase in the diet. Therefore it was concluded that 30 % of YPM could be incorporated into broiler finisher diet without adverse effect on performance.

Inaku, Bawa, Olugbemi and Buba (2011) conducted a 56 days trial to evaluate the nutritive value of yam peel meal (YPM) in broiler diet. Two hundred and twenty five day old broiler chicks with average initial live weight of 80 grams were randomly allocated to five dietary treatments with three replicate of 15 birds in a complete randomized design. The experimental diet consisted of five treatments with varied levels (0, 10, 20, 30, and 40 %) of YPM represented as 1, 2, 3, 4, and 5 respectively. Average daily gain and feed conversion showed significant ($P<0.05$) differences as the level of yam peel meal increased in the diet. Feed intake and crude fibre intake increase significantly with increasing level of YPM. The conclusion shows that 20 % YPM is adequate for better performance of broilers.

### 2.14 Response of monogastric animals to cassava peel and fermented cassava peel meal based diets

Olafadehan, Olafadehan, Adewumi, Omotugba and Daniel (2008) investigated on the use of ensiled cassava peel meal (ECPM), sun dried cassava peel meal (SCPM) and fermented cassava peel meal (FCPM) as a replacement for maize in weaned rabbit diets. Twenty four (24), 6-8weeks old rabbit balanced for their sex and weight, were randomly allotted to four (4) dietary treatments in which 20 % of maize in the control diet was replaced by ECPM, SCPM and FCPM respectively in a 9 week experiment using complete randomized design (CRD). Weight gain, intake of crude protein (CP), organic matter (OM), feed conversion efficiency, digestibility coefficient for dry matter, digestible energy (DE) and metabolizable energy (ME) were not significantly ($P>0.05$) influenced by the treatment. Intake of feed and crude fibre (CF) were significantly ($P<0.05$) reduced in the control diet compared to the cassava peel based (CPB) diets.

Feed intake expressed as the live weight of the rabbits were higher (P.0.05) for ECPM and SCPM than the control diet which had similar value as the FCPM, CP and CF were better digested in the control diet than the CPM diet. Among the CPM diets CP digestibility was better in ECFM and FCPM than SCPM. The result of the experiment was concluded that ECPM, FCPM and SCPM hold a promise as replacement for maize in weaned rabbit diets.

Ojebiyi, Eso, Olabanji, Farinu and Babatunde (2009) investigated the effect of feeding diets containing cassava peel/ leaf meal with or without methionine supplementation using 24 growing rabbits weighing between 629.3-630.75 grams. Three experimental diets were formulated such that diet 1 had no cassava peel/leaf meal mixture and thus serve as control. Diet 2 had 50 % maize of the control diet replaced with cassava peel meal /leaf meal mixtures with methionine supplementation while diet 3 had 50 % maize of the control diet replaced with cassava peel/ leaf meal without methionine supplementation. The result showed that the final weight was significantly ($P<0.05$) higher for the rabbit on the control and diet 2 than diet 3. The packed cell volume (PCV) lymphocytes, neutrophils as well as the eosinophil were significantly ($P<0.05$) influenced by the dietary treatment. It was concluded that methionine supplementation in cassava peel /leaf meal mixture diet will enhance growth performance. Ijaiya, Fasanya and Ayanwale (2002) recorded higher intake of feed with increasing levels of the fermented cassava peel meal in rabbit diets.

Onyimanui and Okeke (2008) carried out an experiment with four iso- caloric and iso-nitrogenous weaner diet for pigs in which maize was progressively replaced with 0, 5, 10, 15 % fermented and sun dried cassava peel meal (CPM). The four treatment diets 1, 2, 3 and 4 were fed to twenty four weaner pigs averaging $5.64\pm0.09$ kilograms at 8 weeks of age for 56 days. Results showed that there was a progressive decline in average daily weight gain (kg) and protein efficiency ratio as the level of CPM in the diets increased. Pigs performance in terms of these parameters was the same for the control, 5 or 10 % CPM diet ($P>0.05$). Significant ($P<0.05$) difference only showed up when CPM was fed at 15 % level. Pigs on 10 % CPM diets had significantly ($P<0.05$) better feed conversion ratio and feed cost per kilogram gain. Haematological examination reveal that the effects of treatment on packed cell volume, red blood cell, white blood cell, neutrophils and monocytes levels were significant ($P<0.05$). The results reveal that CPM could replace 10 % of maize in the diet of weaner pigs.

Idahor, Yakubu and Aya (2010) examine the effects of replacing maize up to 30 % with sun dried cassava peel in manufacturing broiler diet. The cassava peels were processed and fed to broilers for 4 weeks. Proximate compositions of the diets were determined and some haematological indices, viscera organ weight as well as weight gain were carefully monitored. Results showed that the diet contained up to 21.73 % CP, 4.27 kcal/g gross energy and as low as 3.96 mg/kg hydrocyanic acid. Haematological indices reveal that the treated birds were probably not malnourished or suffered any form of anaemic condition. All viscera organ weight was within normal range and were appreciable weight gain across the treatments. Therefore, cassava peels could suitably replace maize in broiler finisher diet up to a reasonable level. Onyimonyi and Ugwu (2007) observed that feeding starter broiler cassava peel/bovine blood meal at the various ration supported effective growth of the broilers. lkurior and Onuh (1996) observed that the weight gain of the birds decreased as the level of cassava peel increased. Layers could tolerate 50 % and 75 % replacement for maize without adverse effect on hen day production as observed by Salami (2000).

Salami and Odunsi (2003) reported on the performance in terms of hen-day production and egg quality of laying birds. They observed that rettling cassava peel meal (RCPM) could satisfactorily replace 75 % of maize while meals produced via other processing methods could not replace maize beyond 50 %. The terminal body weight of layers fed 100 % RCPM and parboiled cassava (PCM) at the expense of maize was not affected.

Salami (l999 and 2000) also observed that the birds showed aversion to cassava peel meal especially at the higher inclusion levels in their diet. Eruvbetine (1996) reported that birds could not tolerate cassava peel at levels beyond 50 % replacement at the expense of dietary maize. Esonu and Udedibe (l993) and Salami (2000) also observed that layers can be fed 50 % to 70 % replacement of maize without any adverse effect on hen-day production.

Pido, Adeyanju and Adegbola (1979) replaced fermented cassava meal for maize at the rate of 0, 25, 35 and 50 % of broiler rations. Body weight of birds at 9 weeks was similar for all treatments whereas feed conversion ratio slightly increases as the FCM levels increased. Adeyanju and Pido (1978) fed the fermented cassava peel to broiler chicks and recorded significant level from increased level of fermented cassava peel in the diet.

Akpodiete (2007) worked on the performance response and egg quality of laying birds fed enzyme supplemented palm kernel cake based diets. Three based diets were formulated to contained 0 %, 20 % and 40 % PKC as replacement for maize in layer diet. The 0 % PKC diet served as control. Three enzyme levels: 50 grams, 60 grams and 70 grams per 100 kilograms of feed were supplemented to the 20 % and the 40 % PKC diets respectively. Thus, the 20 % and the 40 % PKC based diets now have 3 diets; each diets respectively differing only by their enzyme concentrations giving a total dietary unit of 7. Each of the dietary unit was assigned to feed the 7 groups of birds. The diets were formulated to supply 2600k cal/kg ME and 17 % crude protein. The results of the performance characteristics showed that the initial live weight, final live weight and weight gains of the birds fed the different dietary treatment means. Feed intake, hen-day production, egg weight, feed efficiency per kilogram eggs were all significantly (P<0.05) affected by the dietary treatment. The results of the egg quality characteristics showed that all the external and internal egg qualities considered were not significantly (P>0.05) affected by the dietary treatments with the exception of the haugh unit.

Agbede, Abatan, Asaniyan, Adebayo and Aletor (2010) worked on effects of marginal increase in dietary fibre on egg quality and production of caecetomized laying hens. Three different layer's diets tagged $D_1$, $D_2$, and $D_3$ were formulated as experimental diets for the study. Twelve caecetomized bovine nera black breed laying hens, aged 43 weeks were used for the trial. The birds were randomly assigned to the treatments of 4 hens / treatment. The result showed that all the egg quality parameters considered were not significantly (P>0.05) affected by the dietary fibre levels; thus suggesting that the marginal increase in dietary fibre as observed in the study might not have a negative effect on egg quality.

Fafiolu, Oduguwa, Ikeobi, Onwuka and Adebule (2004) worked on the performance and egg quality assessment of laying hens fed malted sorghum sprouts based diets. Three diets were formulated to contain 0, 15, 30 ingredient malted sorghum (MSP). Fourty-eight 20-weeks old birds were assigned to each of the three diets formulated. Each treatment was further subdivided into four replicate groups. The results showed that percentage hen-day egg production varied significantly (P<0.05) across the dietary treatment. All parameters monitored in the external egg quality trait did not significantly (P>0.05) vary across the dietary treatment.

Sogunle, Fanimo, Abiola, and Bamgbose (2009) observed that the growing pullets performed poorly with increasing cassava peel meal in the diet, but when an improved cashew nut meal was included, the combination of 10 % cassava peal meal and 30 % cashew nut meal was appropriate for enhanced performance of growing pullets.

Oladunjoye, Ojebiyi and Amao (2010) observed that the hen- day production of pullets fed 50-70 % of sun dried cassava peel and lyre treated cassava peel compared favourably with the control diet. They concluded that up to 50-70 % of cassava peel meal can be used in layer diets to replace maize without any adverse effect on their performance.

Onifade, Tewe, Okunola and Fanimo (1999) worked on the performance of laying pullets fed cereal free diet based on maize offal, cassava peel and cashew nut meal and reported that egg weight, shell thickness and albumen height from all the eggs were similar.

Oleforuh-Okoleh, Adeolu and Egbuhelu (2010) studied the performance and economic benefits of cockerels fed diets containing graded levels of cassava peel meal CPM. Ninety- six day old white cockerels were allotted into 3 dietary treatments in a complete randomized design. The dietary treatments consisted of $C_0$ (control), $C_1$ (20 % CPM) replacement of maize and $C_2$ (40 % CPM) replacement of maize. The results obtained indicated significant ($P<0.05$) differences in final body weight, weekly feed intake and weekly weight gain amongst the treatments. The net returns (N/bird) of birds on $C_2$ compared favourably with birds fed $C_0$. They concluded that CPM can replace up to 40 % of cockerel ration without deleterious effect on either growth or economic benefit.

Babangida and Ubosi (2006) worked on the effects of varying dietary protein levels on egg quality of laying Japanese quail in a semi- arid environment. One hundred and twenty six week old Japanese quail were used in the study. In a completely randomized block design, they were divided into four treatments and replicated thrice. The dietary treatments ($T_1$- 22 % CP, $T_2$- 20 % CP, $T_3$- 18 % and $T_4$- 16 % CP) were varied in the crude protein content. The result showed that no significant (P>0.05) effect of the dietary protein levels was observed for hen-day egg production in the experiment. The result showed that dietary protein levels have significant (P< 0.05) effect on egg weight. Haugh unit was significantly (P<0.05) affected by dietary protein level. Protein level had no significant (P>0.05) influence on albumen index, shell weight and percent shell.

Tuleun and Darshe (2010) worked on the effect of different dietary levels of toasted mucuna seed meal (TMSM) on the performance and egg quality parameters of laying Japanese quails. The diets were formulated to contain toasted mucuna seed meal at 0, 5, 10 and 15 %. Each dietary treatment was replicated with 10 birds per treatment. The result showed that the quail layers fed up to 15 % dietary level of TMSM had percentage hen-day and hen-house egg production, average feed intake per gram egg production values that were not significantly different from those of 0 % TMSM diet.

Akinfenwa, Bawa and Sekoni (2011) worked on the laying performance and egg quality parameters of Japanese quails fed varying levels of dietary lysine. The diets were formulated to be isonitrogenous and isocaloric. The dietary lysine was varied at 0.80, 0.90, 1.00, 1.10, 1.20 and 1.30 % for treatments 1, 2, 3, 4, 5 and 6 respectively. A total of 270 Japanese laying quails aged 7 weeks were randomly allocated to six treatment groups each containing 45 quails. Each group was further divided into 3 replicates. Results showed that there were no significant (P>0.05) difference in daily feed intake, hen-day egg production and hen-house egg production. Hen-day egg production was statistically similar across the dietary treatment. The egg quality parameters showed no significant difference (P>0.05) with increasing lysine levels in quail laying diets. They concluded that 0.9 % total dietary lysine level appeared to be adequate in the diet of laying quails.

Odunsi, Onisile, Akinwunmi and Bakare (2010) worked on the evaluation of a corn soybean versus corn- cotton seed cake based diets for laying Japanese quails. A total of one hundred and twenty 10 week old laying Japanese quails were used. The quails were randomly divided into 3 dietary groups of 40 birds per group and each group further sub- divided into 4 replicates of 10 birds per replicate. Cotton seed cake (CSC) was used to replace soybean cake (SBC) at the rate of 0 %, 50 % and 100 % representing diets 1, 2 and 3 respectively. The results revealed that egg production was not affected ($P>0.05$) by inclusion of CSC in quail's diets. Haugh unit , yolk colour, shell weight, yolk weight and shell thickness were not significantly ($P>0.05$) influenced by the inclusion of CSC. Egg and yolk weights were lower ($P<0.05$) in quails fed SBC while proportion of albumen was higher. They concluded that layer quails reared in a derived savannah zone of Nigeria can tolerate and produce eggs economically on diets containing up to 100 % CSC as a replacement for soybean meal.

### 2.15 Effect of feed and feeding on carcass characteristics and quality.

Ijaiya, Fasanya and Ayanwale (2002) conducted an experiment with twenty five weaner rabbits with initial weight of 532.16±34.64 grams for both sexes used to examine the effects of substituting different levels of maize with fermented CPM on the carcass characteristics of rabbits. The rabbits were divided into five groups designated as A,B,C,D and E and were allotted to five diets formulated with ratio of 100:0, 75:25, 50:50, 25:75 and 0:100 maize fermented CPM respectively. Feed and water were provided *ad -libitum* throughout the eight weeks duration of the experiment. At the end of the experimental period, two rabbits, one male and one female from each of the five treatment groups were picked, kept off feed over night and slaughtered by severing the jugular vein. The rabbit were eviscerated and the internal organs such as the heart, liver, kidney, lungs, viscera and spleen were individually weighed. Slaughtered weight, carcass weight, weight of the hind limbs, fore limbs, breast (cervical thorax), lumbosacral, head, ears and skin (pelt) were taken and dressing percentage was also computed. The results showed that varying levels of fermented CPM inclusion in the diet of growing rabbit as no significant (P>0.05) effect on the dressing percentage and weight of the carcass parameters measured. It was concluded that carcass yield and characteristics are not influenced by the different levels of fermented CPM inclusion in the diet of rabbits.

Ijaiya and Fasanya (2004) used sixteen New Zealand white rabbits aged 9-10 weeks and weighing 0.72 – 0.99 kilograms to examine the effect of varying levels of dietary protein on carcass characteristics of rabbits. They were divided into four groups and allotted to four treatments (A, B, C and D) formulated with 10, 13, 16 and 20 % crude protein (CP) respectively. Average dressing percentage and weights (on live weight basis) of carcass, hind limbs, forelimbs, breast (lumbosacral), heart, liver, kidneys and lungs were not affected by the dietary treatments. The results indicated that different levels of dietary protein had no significant (P>0.05) effect on carcass yield in rabbits.

Alu, Umbugadu and Makinde (2009) conducted an experiment to evaluate the effects of different dietary fibre sources on the growth performance and carcass characteristics of growing rabbits. 24 crossbred New Zealand x Californian rabbits with an average weight of 520.5 grams were randomly allocated to four experimental rations compounded from conventional ingredients with maize as the major energy source. Ration $T_1$ served as the control and contained 20 % rice offal. Ration $T_2$, $T_3$ and $T_4$ contained 20 % groundnut shell, maize cob and cassava peel meal respectively. Each diet was fed to six replicates of 3 weeks old rabbits for 12 weeks in a completely randomized design experiment. Results obtained showed that the final body weight 525.00 ±121.45 versus 516.67 ±132.92 versus 525.00 ±108.39 versus 516.67±121.1 g/ rabbit average daily body weight gain 10.21±2.37 versus 9.08 ±1.99 versus 10.27 ±1.76 versus 8.78 ± 2.07 g/ rabbit/ day average daily feed intake 101.46±13.17 versus 96.15 ± 46.87 versus 101.55±6.34 versus 102.23 ± 9.0296 g/rabbit/day. Protein efficiency ratio 0.42 ± 0.25 versus 0.38 ± 0.12 versus 0.52 ± 0.08 versus 0.43 ± 0.10, feed to gain ratio 10.63 ± 3.32 versus 9.87 ± 4.79 versus 10.09 ± 1.64 versus 12.22 ± 3.07 and feed cost per kilogram 83.28 ± 12.79 versus 83.28 ± 12.79 versus 83.28 ± 12.79 versus 83.28 ± 12.79 versus 83.28 ± 12.79 N/kg were not significantly (P>0.05) influenced by different dietary fibre sources. The results of the carcass evaluation showed that the joined cuts (empty carcass weight, weight, kidney weight, empty stomach weight, liver weight, lungs weight and bled weight) and linear measurement (length of large and small intestine) did not show any significant variation (P>0.05) due to the dietary treatments. They concluded that the inclusion of any of the agro by – products (rice offal, groundnut shell, maize cob and cassava peel meal) at 20 % level in rabbit’s diet will support growth of rabbits without affecting their performance.

Oruwani, Arubo, and Nkanta (2003) conducted a feeding trial 240 day-old Anak broiler chicks in which cassava meal (CM) completely replace maize in the control diet to formulate five isocaloric and isonitrogenous diets. Diet CM blended with brewers dried yeast (BDY) formed cassava yeast with 2.704 parts of CM to 1 part of (BDY). The cassava yeast CM and BDY blend in the dietary treatment (B, C, D and E) were 30 CM ±11.1 % BDY, 35 CM ±12.94 % BDY and 45 CM ± 16.64 % BDY respectively and these treatments had no cassava yeast inclusion, thus demonstrating the total replacement of maize by cassava yeast treatment in the other dietary treatments. Result shows that significant (P<0.05) differences were observed in the control and at one cassava yeast treatment in feed intake (4.43 as against 4.22 kg), body weight (1.94 as against 1.65 kg ) efficiency of feed utilization (feed: gain ratio 2:19 as against 2.51 gain feed ratio 0.49 as against 0.43) respectively. However, gizzard weight was not significantly (P>0.05) affected. Economics analysis showed that the cost of producing a bird with the maize based diets was significantly (P <0.05) higher than that with cassava yeast diets but there was no difference among the cassava diets. The maize based diet was most expensive (29.68 kg/ diets) while diet C was the cheapest (25.57 kg).The study demonstrated that the use of cassava yeast has a place in broiler industry, thus indicating that with proper protein balancing, cassava can replace maize in broiler diets.

Shittu (2010) carried out a study to determine the carcass characteristics of Japanese quails fed graded levels of tallow (*Detarium microcarpum*) seed meal. A total of 360 Japanese quails were divided into four treatment groups. The dietary treatments were $T_1$ (control diet), $T_2$, $T_3$ and $T_4$ (in which groundnut cake was replaced with tallow seed at 15, 30, 45 % respectively). The results showed that live body weight, defeathered weight and dressed percentage were not significantly (P>0.05) different, but there was no significant (P<0.05) difference in the dressed weight with dietary inclusion of tallow (*Detarium microcarpum*) at 45 %. The weight of the internal organs such as heart, liver, gizzard, lungs, feet and head were also not significantly (P<0.05) different. He concluded that tallow (*Detarium microcarpum*) seed meal could replace groundnut cake without adverse effect on the carcass characteristics of Japanese quails.

# CHAPTER THREE

## 3.0 MATERIALS AND METHODS

### 3.1 Location of experiment

The research work was carried out at the poultry unit of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Niger state Nigeria. Minna lies on latitude 9° $28^1$ N to 9° $37^1$ N and longitude 6° $23^1$ E to 6° $33^1$ east. The mean annual rainfall is between 1000-1500 mm. The vegetation is southern guinea savannah zone. (FUTMIN, 2012)

### 3.2 Duration of the experiment

The research work was carried out for 12 weeks and in two phases. These two phases were the growing phase and the laying phase which lasted for 6 weeks each.

**EXPERIMENT 1**

**Growth performance and carcass characteristics of Japanese quail fed diets containing graded levels of fermented cassava peel meal.**

### 3.3 Feed preparation

#### 3.3.1 Sources and processing of cassava peel

Cassava peels were collected from cassava processing factory located around Mobile market in Minna, Niger State. They were soaked in room temperature water for 3 days in an enclosed drum to allow fermentation process to take place. After the 3 days the peels were removed and drained in a basket and then spread thinly on polythene sheets to sun-dry. The peels were turned at regular intervals to allow even drying. The dried cassava peels were milled and later stored in polythene bags until ready for use. (Tewe and Kasali, 1986).

### 3.3.2 Sources of other ingredients

Other ingredients used for the formulation of the diets like fish meal, vitamin premix, lysine and methionine were purchased from feed mill while maize, groundnut cake, bone meal, maize bran were purchased at the Minna Modern Market. These ingredients were measured, milled and used with the already fermented cassava peel meal for the feed formulation.

## 3.4 Management of experimental birds.

Three hundred (300) two weeks old Japanese quails were purchased from National Veterinary Research Institute Vom, Jos. These birds were housed in a deep litter pen. The brooder house was cleaned, washed and disinfected a week before the arrival of the birds. Drinkers, feeders and other equipment were also cleaned and washed before the arrival of the birds. 100 watts electric bulbs were used for the first one week to supply the required heat while these were later replaced with 60 watts bulbs to provide illumination at night for continuous feed intake. Additional heating sources were supplied using kerosene stove and lamps whenever there was electricity failure.

On arrival, they were gently unboxed into the brooding house that had previously been heated few hours to the arrival of the birds. Seventy five birds were allocated to each treatment and each treatment had three replicates (25 birds per replicate). Birds were brooded for 6 weeks of the growing phase. Litter was regularly turned and changed every 2 weeks to remove accumulated oocytes from bird’s droppings. Routine management operation carried out on daily basis included cleaning of drinkers, feeders and records of mortality. The feed given to the birds was weighed daily while the left over feed was also weighed. Cool clean fresh water was supplied *ad- libitum*.

### 3.4.1 Experimental diets

An experimental diet of 24 % crude protein was formulated for quails at the growing phase. The ingredients were weighed, mixed with shovel, bagged and stored for feeding the experimental birds. There were 4 dietary treatment groups as listed below:-

Treatment 1 (control):100% maize: 0% Fermented cassava peel meal

Treatment 2 :75% maize: 25% Fermented cassava peel meal

Treatment 3 :50% maize: 50% Fermented cassava peel meal

Treatment 4 :25% maize: 75% Fermented cassava peel meal

These diets on Table 3.1 were fed to the quails for the 6 weeks of the growing phase of the experiment.

Table 3:1 Composition of experimental diets fed to Japanese quails during the growing phase (%)

| Ingredients (kg) | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Maize | 44.40 | 33.30 | 22.20 | 11.10 |
| FCPM | 0.00 | 11.10 | 22.20 | 33.30 |
| Ground nut cake | 38.90 | 38.90 | 38.90 | 38.90 |
| Maize bran | 10.00 | 10.00 | 10.00 | 10.00 |
| Fish meal | 2.00 | 2.00 | 2.00 | 2.00 |
| Bone meal | 2.50 | 2.50 | 2.50 | 2.50 |
| Lime stone | 1.50 | 1.50 | 1.50 | 1.50 |
| Premix* | 0.25 | 0.25 | 0.25 | 0.25 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.10 | 0.10 | 0.10 | 0.10 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** |
| **Calculated values** | | | | |
| ME (Kcal/kg) | 2565.62 | 2409.77 | 2255.70 | 2100.75 |
| Crude protein (%) | 23.91 | 23.48 | 23.05 | 22.62 |
| Crude fibre (%) | 3.76 | 4.51 | 5.27 | 6.02 |
| Methionine | 0.30 | 0.28 | 0.22 | 0.23 |
| Lysine | 0.88 | 0.85 | 0.82 | 0.79 |

*Premix supplied per 2.5 kg/ tonne contains : Vit. A ( 7,500.00 iu), Vit. D ( 500,000 iu), Vit. E (1,000iu), Vit. $B_1$ (375mg), Vit. $B_2$ (125mg), Vit. $B_3$ (500mg), Vit. $B_6$ (150mg), Vit. $B_{12}$ (2.5mg),Vit. K (15mg),Vit. C (10mg) and folic acid (150mg), Ca ( 12.5mg),Cu ( 8.0mg), fe ( 32mg), I (0.8mg), Se (100mg), Mg (0.25mg), Chlorine (250mg), Panthotenic Acid (14.4mg).

**KEY**:
$T_1$ - 100 % maize: 0 % FCPM
$T_2$ - 75 % maize: 25 % FCPM
$T_3$ - 50 % maize: 50 % FCPM
$T_4$ - 25 % maize: 75 % FCPM
ME : Metabolizable energy

### 3.4.2 Experimental design

The experimental design used was a complete randomized design. (CRD)

### 3.4.3 Data collection

#### i. Feed intake (g)

Feed was weighed daily for quails in each replicate and the quantity consumed for the day was obtained by difference between the quantity supplied and the left over. Weekly record of average feed consumption per bird was obtained for each replicate by dividing the total quantity of feed consumed by the number of quails in each replicate.

#### ii. Body weight (g)

The quails in each replicate were weighed at the beginning of the experiment and subsequently at weekly intervals throughout the 6 weeks of this phase of the experiment.

#### iii. Body weight gain (g)

The body weight gain was obtained by calculating the difference between the body weight for the preceding week and current week.

#### iv. Feed conversion ratio

The feed conversion ratio was determined by dividing the quantity of feed consumed by the body weight gain of the birds in each replicate in grams.

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Average daily feed intake (g)}}{\text{Average daily weight gain (g)}}$$

### v. Digestibility trial

Digestibility study was carried out on the quails 7 days to the end of the first 6 weeks of the growing phase. Two birds were selected from each of the replicate; weighed, isolated and subjected to digestibility trial for seven days in a metabolic cage. Within the seven days, two days were used as an adjustment period while five days were used for data collection. Total droppings voided from each replicate were weighed and recorded. Wet droppings were oven dried at $65^{0}C$ for 36 hours and dry matter content determined. Droppings from the same treatment were thoroughly pooled and ground. Record of feed consumed was also taken.

The nutrient digestibility was determined using the formula:-

$$\text{Nutrient Digestibility} = \frac{\text{Nutrient in feed} - \text{Nutrient in droppings}}{\text{Nutrient in feed}} \times 100$$

### 3.4.4 Carcass proportions

On the last day of this phase of experiment carcass analysis was carried out. A total of eight birds were selected with two birds from each treatment and starved overnight. The birds were weighed to record the live weight after which they were slaughtered and weighed again. They were slaughtered by cutting the jugular vein around the neck and scalding was done after immersing in warm water for 30 seconds and then eviscerated. The measurements of carcass traits, organ weights were expressed as percentage of live weight.

## 3.5. Experiment 2:

**Egg production and egg quality characteristics of Japanese quails fed diets containing graded levels of fermented cassava peel meal.**

One hundred and twenty Japanese quails were used for this experiment. The males in each replicate were separated from the females such that females retain their original replicate. A maximum of ten females were left in each replicate such that any number in excess of ten was taken to make up a number of ten in any deficient treatment replicate. The separation (sexing) was done by identification of the cloacal gland which is a bulbous structure close to the vent in the male. This gland brings out white foaming substance when pressed (Shim, 2005).This is absent in the female.

### 3.5.1 Experimental diet

The four experimental diets were formulated such that fermented cassava peel meal (FCPM) supplemented maize at 25 %, 50 %, 75 % in treatments 2, 3, and 4 respectively with treatment 1 as the control. The crude protein in this phase was reduced to 22 %. The composition of the diets is as shown in Table 3.2

**Table 3.2: Composition of experimental diets fed to the laying quails (%)**

| Ingredients (%) | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| Maize | 48.72 | 36.54 | 24.36 | 12.18 |
| FCPM | 0.00 | 12.18 | 24.36 | 36.54 |
| Ground nut cake | 33.58 | 33.58 | 33.58 | 33.58 |
| Maize bran | 10.00 | 10.00 | 10.00 | 10.00 |
| Fish meal | 2.00 | 2.00 | 2.00 | 2.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 |
| Lime stone | 2.00 | 2.00 | 2.00 | 2.00 |
| Premix* | 0.25 | 0.25 | 0.25 | 0.25 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.10 | 0.10 | 0.10 | 0.10 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** |
| **Calculated values** | | | | |
| ME (Kcal/kg) | 2579.28 | 2161.26 | 1743.25 | 1325.23 |
| Crude protein (%) | 21.90 | 21.42 | 20.95 | 20.47 |
| Crude fibre (%) | 3.68 | 4.51 | 5.33 | 6.16 |
| Methionine | 0.29 | 0.27 | 0.24 | 0.23 |
| Lysine | 0.80 | 0.77 | 0.73 | 0.70 |

*Premix supplied per 2.5 kg / tonne contains : Vit. A ( 7,500.00 iu), Vit. D ( 500,000 iu), Vit. E (1,000iu), Vit. $B_1$ (375mg), Vit. $B_2$ (125mg), Vit. $B_3$ (500mg), Vit. $B_6$ (150mg), Vit. $B_{12}$ (2.5mg),Vit. K (15mg),Vit. C (10mg) and folic acid (150mg), Ca ( 12.5mg),Cu ( 8.0mg), fe ( 32mg), I (0.8mg), Se (100mg), Mg (0.25mg), Chlorine (250mg), Panthotenic Acid (14.4mg).

**KEY**:
$T_1$ - 100 % maize: 0 % FCPM
$T_2$ - 75 % maize: 25 % FCPM
$T_3$ - 50 % maize: 50 % FCPM
$T_4$ - 25 % maize: 75 % FCPM
ME : Metabolzable energy

### 3.5.2 Data collection

Data of daily feed intake and record of egg collection were taken, hen-day egg production, hen-house production while records of mortality were kept throughout the period of study. The internal and external egg quality parameters were measured and recorded; these included egg width, egg weight, egg length, shell thickness, yolk weight, yolk height, yolk width, albumen weight, albumen height, Haugh unit, yolk index, egg shape index. Procedure of the data collection was thus:-

**i. Yolk height (mm)**

Egg was carefully broken into a clean smooth flat-surface.The yolk height was measured at the highest point using spherometer without removing the yolk from the albumen. The yolk diameter was measured using a pair of vernier caliper.

The yolk index was calculated as the ratio of the yolk height to the diameter.

$$\text{Yolk index} = \frac{\text{Height of yolk (cm)}}{\text{Diameter of yolk (cm)}}$$

**ii. Albumen weight and Yolk weight (g)**

Egg was carefully broken into petri dish; the yolk and albumen were placed in a separate petri dish which was also weighed before use. The difference in the weight of each petri dish after and before the introduction of the yolk and albumen was taken as the weight of the yolk and albumen respectively. The weight was taken with the aid of mettler analytical balance calibrated in grams.

**iii. Egg shape index**

Two external parameters (Egg width and Egg length) were used to calculate the egg shape index.

$$\text{Egg shape index} = \frac{\text{Egg Width (cm)}}{\text{Egg Length (cm)}}$$

**iv. Egg weight (g)**

Two eggs were collected from each replicate on weekly basis and were individually weighed using sensitive digital top loading scale.

**v. Shell thickness (mm)**

The shell of broken eggs were air dried and were further broken into smaller pieces; while the shell membrane was manually removed and the thickness of the egg shell was measured using a micrometer screw gauge expressed in millimetres. (Adeyemo and Longe, 2008; Oladunjoye *et al*., 2010)

**vi. Albumen height (mm)**

This was measured by using a tripod micrometer calibrated in 0.01mm. The dimension was taken between the yolk edge and the external edge of the thick albumen.

**vii. Haugh unit**

The values obtained from Albumen height together with the egg weight were used to calculate the Haugh unit.

The Haugh unit of egg was calculated using the formula of Oluyemi and Robert (2000).

$$HU = 100\log (H + 7.57 - 1.7\ W^{0.37})$$

Where:

H = Condition of thick albumen height in haugh units

W = Weight of egg in gram

**viii. Egg length (cm)**

The egg length was measured with the aid of a vernier caliper. The length was measured as the distance between the broad end and the narrow end of the egg calibrated in centimeters.

**ix. Egg width (cm)**

The egg width was also measured using a vernier caliper. The width was measured between two ends of the widest cross sectional region calibrated in centimeters.

**x. Feed conversion ratio**

This was calculated as feed consumed per egg lay (Oladunjoye *et al.*, 2010) as shown in the formular below.

$$FCR = \frac{\text{Average feed intake (g)}}{\text{Average egg weight (g)}}$$

**xi. Hen-day production (%)**

This was calculated as the number of eggs laid per replicate on daily basis using the formula below (Bawa, Lombin, Karsin, Musa, Payi and Shamaki 2010).

$$\text{Hen-Day Production} = \frac{\text{Number of eggs produced}}{\text{Number of birds that survived x number of days in lay}} \times 100$$

This was done for each replicates.

**xii. Hen- house egg production (%)**

This was calculated for each replicate using the formula below. (Bawa *et al*., 2010)

$$\text{Hen-house egg production} = \frac{\text{Number of eggs produced}}{\text{Number of birds stocked initially x number of days in lay}} \times 100$$

## 3.6 Statistical analysis

Data collected from the two experiments were subjected to analysis of variance (ANOVA) using the computer software package SPSS 17.0; differences among treatment means were compared with Duncan's multiple range test (Duncan, 1995).

## 3.7 Proximate analysis

Proximate analysis to determine the dry matter (DM), crude protein (CP), crude fiber (CF) and ether extract of the test ingredient (fermented cassava peel meal) and the experimental diets for the two phases as well as the droppings from digestibility trial was carried out in accordance with AOAC (2000) standard procedure. Nitrogen free extract (NFE) was calculated by simple difference.

# CHAPTER FOUR

## 4.0 RESULTS AND DISCUSSION

The result of the proximate analysis of fermented cassava peel meal used in this study as shown in Table 4.1 showed that fermented cassava peel meal (FCPM) has a dry matter value of 89.50 %, Crude protein value 5.70 %, Crude fiber value 14.83 %, Ether extract 0.47 %, Ash 9.47 % and Nitrogen free extract 59.03 % while fresh cassava peel (FCAP) has a dry matter value of 18.90 %, Crude protein value 4.20 %, Crude fiber value 28.60 %, Ether extract 3.26 %, Ash 7.47 % and Nitrogen free extract value 55.50 %. Fermented cassava peel meal has higher protein content as compared to fresh cassava peel this is as a result of biosynthesis which has taken place during fermentation. Fermentation increases the protein, amino acids and vitamins as reported by Ganiyu (2006). The fiber content of the FCPM decreased as compared to the FCAP this is because fermentation helps in breaking down the cellulose content of cassava peel as reported by Dairo (2011).

There was a significant decrease in the fat content of the FCPM compare to the FCAP, from 3.26 % - 0.47 % this is due to the ability of enzyme to degrade or breakdown lipid during fermentation.

The result of the proximate composition of the experimental diets fed to Japanese quail during the growing phase which is showed in Table 4.2: The Dry matter in the diets was within the range 85.34 % and 95.95 %, the highest being that of $T_3$ (95.95 %) and $T_4$ has the lowest value (85.34 %). The Crude protein in the diets was within the range of 21.26 % to 25.11 %, the highest being that of $T_2$ (25.14 %) and $T_3$ (21.26 %) has the lowest value. Crude fiber is highest in $T_3$ and $T_4$ (7.00 % and 7.00 %) while $T_1$ has the lowest crude fiber (3.00 %). Ether extract in the diets was within the range of 5.00 % to 7.00 %, the highest being that of $T_2$ (7.00 %) and $T_4$ (5.00 %) has the lowest. Ash in the diets was within the range of 8.50 % to 10.00 %, the highest being that of $T_4$ (10.00 %) and $T_1$ (8.50 %) and $T_2$ (8.50 %) have the lowest. Nitrogen free extract in the diets was within the range 40.15 % and 53.19 %, the highest being that of $T_3$ (53.19 %) and $T_4$ (40.15 %) has the lowest.

The proximate composition of the experimental diets showed an increase in the fiber content from $T_1$ to $T_3$ as the level of inclusion of fermented cassava peel meal (FCPM) increases. The ash content increases from $T_1$ to $T_4$ as the level of inclusion of FCPM increases. The crude protein level of the diets in the study ranges from 21.26 % - 25.11 % this agrees with the report of Hyankova *et al*. (1997) that Japanese quails fed 26.00 % - 21.60 % crude protein had good performance from 1 to 21 and from 22 to 35days of age respectively.

**Table 4:1 Proximate composition of fermented cassava peel meal (FCPM) and fresh cassava peel (FCAP)**

| **Components** | **FCP** | **FCAP** |
|---|---|---|
| Dry matter | 89.50 | 18.90 |
| Crude protein | 5.70 | 4.23 |
| Crude fibre | 14.83 | 28.60 |
| Ether extract | 0.47 | 3.26 |
| Ash | 9.47 | 7.47 |
| Nitrogen free extract | 59.03 | 55.50 |
| Metabolizable energy (Kcal/g) | 263.15 | 268.14 |

KEYS

FCP = Fermented cassava peel

FCAP = Fresh cassava peel

**Table 4.2 Proximate composition of experimental diet fed to Japanese quail during the growing phase**

| | Replacement level of FCPM | | | |
|---|---|---|---|---|
| | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** |
| **Components** | | | | |
| Dry matter | 93.70 | 94.20 | 95.95 | 85.34 |
| Crude protein | 23.27 | 25.11 | 21.26 | 23.19 |
| Crude fibre | 3.00 | 3.50 | 7.00 | 7.00 |
| Ether extract | 6.00 | 7.00 | 5.50 | 5.00 |
| Ash | 8.50 | 8.50 | 9.00 | 10.00 |
| Nitrogen free extract | 52.93 | 50.09 | 53.19 | 40.15 |

**KEY:**

FCPM - fermented cassava peel meal

$T_1$ - 100 % maize : 0 % FCPM

$T_2$ - 75 % maize : 25 % FCPM

$T_3$ - 50 % maize : 50% FCPM

$T_4$ - 25 % maize : 75% FCPM

The performance of growing Japanese quails fed diets containing graded levels of FCPM is showed in Table 4.3. The result showed that the final body weight ranged between 125.44 g to 136.59 g. There was no significant differences (P >0.05) between the treatment means. The result also showed that there was no significant differences (P >0.05) between the treatment means for the daily weight gain and feed conversion ratio. The daily feed intake showed significant difference in the treatment means (P< 0.05) which was affected by the varying levels of FCPM inclusion with the highest in $T_4$ (75 % FCPM inclusion) and lowest in $T_2$ (25 % FCPM inclusion).

The increased feed intake of the birds which is as a result of the increase in the inclusion level of FCPM is understandable. FCPM contains more fiber than maize which tends to increase the total fiber contents of the diets and dilute other nutrients. The birds therefore consumed more to meet their energy requirements to sustain rapid growth and development hence the increased feed intake. This agrees with Ijaiya *et aI.* (2002) who recorded higher intake of feed with increasing level of fermented cassava peel meal in rabbit diets.

The daily weight gain ranged between 2.53 in $T_4$ (75 % FCPM) to 2.77 in $T_1$ (0 % FCPM). This also agrees with Stevenson and Jackson, (1995) that weight was unaffected by diet containing 50 % cassava root meal. The feed conversion ratio were not significantly (P>0.05) affected by the varying levels of FCPM inclusion. However, there was a linear decrease as inclusion level of FCPM increased.

**Table 4.3: Performance of growing Japanese quails fed diets containing graded levels of FCPM**

| Parameter | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | LS |
|---|---|---|---|---|---|---|
| Initial body weight (g) | 26.00 | 26.67 | 28.67 | 29.33 | 27.67 | NS |
| Final body weight (g) | 135.87 | 125.44 | 136.59 | 126.70 | 131.16 | NS |
| Body weight gain (g) | $109.87^{a}$ | $98.77^{b}$ | $107.92^{a}$ | $97.37^{b}$ | 103.49 | * |
| Daily weight gain (g) | 2.77 | 2.53 | 2.67 | 2.53 | 2.62 | NS |
| Total feed intake (g) | $685.49^{b}$ | $674.12^{b}$ | $772.87^{b}$ | $967.31^{a}$ | 774.95 | * |
| Daily feed intake (g) | $17.02^{c}$ | $16.73^{c}$ | $17.85^{b}$ | $23.06^{a}$ | 18.66 | * |
| Feed conversion ratio | 6.14 | 6.61 | 6.69 | 9.11 | 7.12 | NS |

abc = Means on the same row with different superscript are significantly ($p<0.05$) different

**<u>KEY</u>**:

NS = Non significant

SEM = Standard Error of Mean

LS = Level of significance

$T_1$ -100% maize: 0% FCPM

$T_2$ -75% maize: 25% FCPM

$T_3$ - 50% maize: 50% FCPM

$T_4$ -25% maize: 75% FCPM

Salami and Odunsi (2003) also noted that there was decrease in feed efficiency as the percentage of cassava peel meal increases which may be attributed to increase crude fiber and decrease metabolizable energy and thereby leading to increase in feed intake to meet metabolizable energy requirement.

The apparent nutrient digestibility of Japanese quails fed graded levels of FCPM is shown in Table 4.4. Significant differences ($P<0.05$) were observed among the treatment means of all parameters measured. Dry matter, Ash, Crude protein, Ether extract, and Crude fiber were observed to be significantly better digested by birds fed diet 3. Generally, all the treatments had digestibility values of over 50 % which means they all have high digestibility except $T_4$ with significantly ($P<0.05$) lower values than all of them.

It was generally observed that the nutrient digestibility were significantly ($P<0.05$) affected by the varying levels of FCPM with diet $T_3$ (50 %FCPM) having significantly highest values in crude protein, crude fiber, Ether extract, and Ash while diet $T_4$ (75 % FCPM) had significantly lowest values for all the nutrients. This observation was similar to earlier findings of Salami, (2000); Salami and Odunsi (2003) and Onyimonyi and Ugwu (2007) that birds could only tolerate cassava peel meal at levels up to 50 % replacement at the expense of dietary maize beyond which led to the reduction in weight gain, decrease in feed efficiency and poor digestibility which may be attributed to the high fiber content, dustiness and powdery nature of the cassava peel meal.

The result of the carcass characteristics of Japanese quails fed diets containing graded levels of fermented cassava peel meal in Table 4.5 showed that gizzard and intestine were not significantly ($P>0.05$) affected by the inclusion of fermented cassava peel meal in the diet. Head, liver, heart, lungs, legs, bile and crop showed significant ($P<0.05$)

differences among the treatment groups. For legs diet $T_2$ and $T_4$ recorded significantly higher value than the control (diet $T_1$) for crop quails fed diet $T_2$, $T_3$ and $T_4$ also obtained significantly higher values. A significantly higher value was obtained in the liver of birds fed diet $T_1$ (control) compare to other treatment groups. The live weight and dressing percentage of quails fed FCPM were significantly ($P<0.05$) observed to be higher than the control. No significant effect ($P>0.05$) were observed on the gizzard and the intestine which agrees with those of Oruwani *et al.* (2003) who reported no significant effect in the weight of the gizzard of broilers fed diet in which maize was completely replaced by cassava meal. However, the significant differences ($P<0.05$) observed in the weight of the head, liver, heart, lungs, crop, bile and legs are contrary to the findings of Shittu, (2010) who reported no significant differences in quails fed *Detarium microcapum* seed meal.

**Table 4.4 Apparent nutrient digestibility of Japanese quail fed diets containing graded levels of FCPM (%)**

| Parameter | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | LS |
|---|---|---|---|---|---|---|
| Dry matter | $88.40^{b}$ | $88.43^{b}$ | $90.36^{a}$ | $73.20^{c}$ | 2.61 | * |
| Crude protein | $80.47^{c}$ | $82.42^{b}$ | $85.15^{a}$ | $71.92^{d}$ | 1.87 | * |
| Crude fiber | $75.41^{c}$ | $76.81^{b}$ | $85.00^{a}$ | $59.23^{d}$ | 3.53 | * |
| Ether extract | $95.04^{b}$ | $95.65^{b}$ | $97.60^{a}$ | $83.93^{c}$ | 2.02 | * |
| Nitrogen free extract | $94.13^{a}$ | $94.33^{a}$ | $93.73^{a}$ | $78.33^{b}$ | 3.14 | * |
| Ash | $74.42^{b}$ | $70.24^{c}$ | $82.93^{a}$ | $59.82^{d}$ | 2.58 | * |

abc = Means on the same row with different superscript are significantly (0<0.5) different

**KEY:**

SEM = Standard error of mean; LS = Level of significance.

$T_{1=}$ (100% Maize: 0% FCPM)

$T_{2=}$ (75% Maize: 25% FCPM)

$T_{3=}$ (50% Maize: 50% FCPM)

$T_{4=}$ (25% Maize: 75% FCPM)

**Table 4.5 Carcass characteristics of Japanese quail fed diets containing graded levels of FCPM**

| Parameter | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | LS |
|---|---|---|---|---|---|---|
| Live weight (g) | $255.43^{c}$ | $263.76^{bc}$ | $275.00^{ab}$ | $287.50^{a}$ | 7.07 | * |
| Evicerated weight (g) | $190.28^{a}$ | $191.79^{a}$ | $192.29^{a}$ | $181.80^{b}$ | 2.91 | * |
| Dressing (%) | $76.11^{b}$ | $86.04^{a}$ | $76.54^{b}$ | $90.55^{a}$ | 2.85 | * |
| Head % | $12.70^{c}$ | $14.04^{a}$ | $13.28^{b}$ | $13.31^{b}$ | 12.79 | * |
| Legs % | $5.19^{b}$ | $5.49^{a}$ | $4.92^{c}$ | $5.47^{a}$ | 4.99 | * |
| Crop % | $1.09^{b}$ | $1.99^{a}$ | $2.06^{a}$ | $1.87^{a}$ | 1.33 | * |
| Bile % | $0.35^{a}$ | $0.34^{a}$ | $0.31^{b}$ | $0.31^{b}$ | 0.11 | * |
| Gizzard % | 8.99 | 8.75 | 8.46 | 8.59 | 0.24 | NS |
| Intestine % | 10.57 | 10.73 | 9.74 | 10.09 | 0.42 | NS |
| Liver % | $4.81^{a}$ | $3.41^{c}$ | $4.09^{b}$ | $3.40^{c}$ | 0.26 | * |
| Heart % | $2.65^{a}$ | $2.66^{a}$ | $2.36^{b}$ | $2.37^{b}$ | 0.08 | * |
| Lungs % | $2.61^{b}$ | $2.68^{ab}$ | $2.78^{ab}$ | $2.98^{a}$ | 0.37 | * |

abc = Means on the same row with different superscript differ ($P<0.05$) significantly

**KEY:**

NS= Non significant.

$T_{1=}$ (100% Maize: 0% FCPM)

$T_{2=}$ (75% Maize: 25% FCPM)

$T_{3=}$ (50% Maize: 50% FCPM)

$T_{4=}$ (25% Maize: 75% FCPM)

The result of the proximate composition of the experimental diet fed to Japanese quails during the laying phase is shown in Table 4.6. The Dry matter in the diets ranges between 91.70 % to 91.90 %.The highest values were recorded by $T_1$, $T_2$, and $T_4$ (91.90 %), and $T_3$ has the lowest value (91.70 %). The crude protein values ranges from 20.65 % to 22.50 %. Crude fiber and Ether extract in the diets had their values ranging from 5.33 % to 6.67 % and 9.50 % to 13.00 % respectively. In Ash values $T_1$ and $T_2$ were the lowest and highest (3.50 % and 5.50 %) respectively. Nitrogen free extract in the diets ranges from 46.38 % to 50.75 %.

**Table 4.6: Proximate composition of experimental diets fed to Japanese quail during the laying phase.**

| Component (%) | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|---|
| Moisture | 8.10 | 8.10 | 8.30 | 8.10 |
| Dry matter | 91.90 | 91.90 | 91.70 | 91.90 |
| Ash | 3.50 | 5.50 | 5.00 | 5.00 |
| Crude protein | 20.65 | 22.50 | 22.15 | 21.40 |
| Crude fiber | 6.00 | 5.54 | 6.67 | 5.33 |
| Ether extract | 11.00 | 9.50 | 11.50 | 13.00 |
| Nitrogen free extract | 50.75 | 48.95 | 46.38 | 47.17 |

**KEY**:

$T_1$ = 0% FCPM; 100% maize

$T_2$ = 25% FCPM; 75% maize

$T_3$ = 50% FCPM; 50% maize

$T_4$ = 75% FCPM; 25% maize

The result of hen- day, hen-house production, average feed intake, average egg weight and feed conversion ratio of layers (Japanese quails) fed varying levels of FCPM based diets in Table 4.7 showed that the average feed intake of the birds were $T_1$ (23.52 g), $T_2$ (26.02 g), $T_3$ (25.38 g) and $T_4$ (22.07 g). The highest feed consumption was recorded (26.02 g) by birds fed 25 % ($T_2$) fermented cassava peel meal. The least consumption (22.07 %) was observed by birds fed 75 % of fermented cassava peel meal. There was no significant difference (P>0.05) observed in the average feed intake of the birds as a result of the substitution of maize with fermented cassava peel meal. The result of the hen-day production showed that there was no significant difference (P>0.05) observed in the hen-day production of the birds as a result of the substitution of maize with fermented cassava peel meal in the diet. There was no significant difference (P>0.05) observed in the hen-house egg production of the birds as a result of substitution of maize with fermented cassava peel meal in the diet.

The non significant difference observed in hen-day egg production and hen housed egg production agrees with Tuleum and Dashe (2010) who reported in quails that there were no significance differences in these parameters. Oladunjoye *et al*. (2010) observed that birds are able to tolerate fermented cassava peel meal between the range of 50 % to 70 % after which egg production and feed utilization declines. They also attributed this to residual hydrocyanic acid.

**Table 4.7 Hen-day, Hen-house production and feed intake of laying Japanese quails fed diets containing graded levels of fermented cassava peel meal.**

| Parameters | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | LS |
|---|---|---|---|---|---|---|
| Hen-day production (%) | 17.76 | 22.24 | 20.86 | 15.48 | 2.08 | NS |
| Hen-house production (%) | 11.67 | 12.14 | 11.93 | 10.63 | 0.70 | NS |
| Avg. Feed intake(g) | 23.52 | 26.02 | 25.38 | 22.07 | 0.66 | NS |
| Avg. weight of egg (g) | 7.65 | 8.07 | 7.79 | 7.74 | 0.17 | NS |
| Feed conversion ratio | 3.12 | 3.37 | 3.33 | 3.10 | 0.12 | NS |

**KEY:**

NS = Non significant difference (P>0.05) among the treatment

SEM = Standard Error of Mean

$T_1$ = 0% FCPM; 100% maize

$T_2$ = 25% FCPM; 75% maize

$T_3$ = 50% FCPM; 50% maize

$T_4$ = 75% FCPM; 25% maize

The further decline in feed intake in $T_4$ (22.07 g) could probably be attributed to the residual hydrocyanide which probably might have reached an intolerable level in this diet. This agrees with Banjoko *et al*. (2008) who reported a decrease in feed intake by layers fed cassava products and attributed this to the likelihood of the presence of antinutritional factors particularly cyanide which according to Tewe (1977) reduce feed intake.

The internal and external egg quality of Japanese quails fed varying levels of FCPM is shown in Table 4.8. The yolk weight values ranged from 3.24 g in $T_1$ to 3.62 g in $T_2$. There was no significant difference (P>0.05) between the treatment means. The shell thickness values ranged from 0.20mm in $T_1$ to 0.21mm in $T_2$, $T_3$ and $T_4$.There was no significant difference (P>0.05) between the treatment means. The yolk width ranged from 2.78 mm in $T_3$ to 2.91 mm in $T_4$ and there was no significant difference (P>0.05) between the treatment means. The yolk height ranged from 8.86 mm in $T_4$ to 9.81 mm in $T_3$ and the values shows no significant difference (P>0.05). Albumen height ranged from 2.55 mm in $T_3$ to 2.96 mm in $T_1$.There was no significant difference (P> 0.05) in the albumen height among the treatments groups. The egg weight values were $T_1$ (7.65 g), $T_2$ (8.07 g), $T_3$ (7.79 g) and $T_4$ (7.74 g).Which shows no significant difference (P>0.05) among the treatments groups. Egg length ranged from 2.97 mm to 3.13 mm while egg width ranged from 2.42 mm in $T_2$ to 2.49 mm in $T_4$.The egg shape index showed that there was no significant difference (P>0.05) between the treatment means. The values ranged from 0.86 to 0.93.

**Table 4.8: Egg quality characteristics of Japanese quails fed diets containing graded levels of fermented cassava peel meal.**

| Parameter | $T_1$ | $T_2$ | $T_3$ | $T_4$ | SEM | LS |
|---|---|---|---|---|---|---|
| Yolk weight (g) | 3.24 | 3.62 | 3.29 | 3.31 | 0.10 | NS |
| Shell thickness (mm) | 0.20 | 0.21 | 0.21 | 0.21 | 0.004 | NS |
| Yolk width (mm) | 2.79 | 2.82 | 2.78 | 2.91 | 0.03 | NS |
| Yolk index | 3.23 | 3.45 | 3.54 | 4.13 | 0.27 | NS |
| Haugh unit (%) | 84.25 | 81.97 | 81.03 | 83.18 | 0.76 | NS |
| Yolk height (mm) | 8.94 | 9.71 | 9.81 | 8.86 | 0.28 | NS |
| Albumen height (mm) | 2.96 | 2.72 | 2.55 | 2.74 | 0.10 | NS |
| Albumen weight (g) | 2.20 | 2.49 | 2.66 | 2.76 | 0.13 | NS |
| Egg weight (g) | 7.65 | 8.07 | 7.79 | 7.74 | 0.17 | NS |
| Egg Length (mm) | 2.97 | 3.13 | 3.02 | 3.11 | 0.04 | NS |
| Egg width (mm) | 2.48 | 2.42 | 2.44 | 2.49 | 0.03 | NS |
| Egg shape index | 0.93 | 0.86 | 0.92 | 0.91 | 0.03 | NS |

**KEY:**

NS--Non significant ; SEM = Standard error of mean; LS = Level of significance.

SEM = Standard Error of Mean

$T_1$ = 0% FCPM; 100% maize

$T_2$ = 25% FCPM; 75% maize

$T_3$ = 50% FCPM; 50% maize

$T_4$ = 75% FCPM; 25% maize

The highest egg weight was observed in $T_2$ (8.07g) which was not significantly different from other dietary treatments. This agrees with Oladunjoye *et al*. (2010) who recorded no significant effect on weight gain, feed intake, egg weight and hen-day production in their work.

The shell thickness across dietary treatments was relatively similar which showed that there was no significant difference (P>0.05) among the treatment means, which also show that there was no difference in the amounts of calcium and phosphorus supplied by the diets. The inclusion levels of FCPM did not have significant effect on the shell thickness since all the treatment values were within the same range 0.20 to 0.21mm. Kul and Seker (2004) reported 0.231 mm as the value of shell thickness. The values obtained in this study agree with that of Akinfenwa *et al*. (2011) which ranged from 0.20 - 0.24 mm .

The required Haugh unit value should not be less than 75 % for an excellent quality eggs (Bien and thien, 2005; Babangida and Ubosi, 2006) which agrees with this result. The results was in agreement with that of Fafiolu *et al*. (2004) who reported a non significant dietary effect on haugh unit, also Akinfenwa *et al*. (2011) also reported that there was no significant dietary effect on haugh unit. There was no significant (P>0.05) difference in egg shape index which agrees with the report of Bawa *et al*., 2010. The yolk index increased as the inclusion level of FCPM increased. There was no significant (P>0.05) difference in yolk width. The non significant (P>0.05) difference in yolk weight, yolk width, Egg length and egg width indicate that the test ingredient (FCPM) has no significant effect on these egg quality traits and therefore can be used in quail diets.

The non-significant (P>0.05) differences observed in all the egg quality characteristics measured in this study agree with that of Akinfenwa *et al.* (2011) and Fafiolu *et al*. (2004).

The Feed cost analysis of Japanese quails fed diets containing graded levels of fermented cassava peel meal is shown in Table 4.9. $T_1$ (0 % FCPM) was the poorest in the economy of production by gaining 1 gram body weight with 0.69 while $T_3$ (50 % FCPM) was the best as 0.53 was expended to produce the same quantity of body weight. However, there was no significant (P>0.05) difference across the dietary treatments.

**Table 4.9: Feed cost analysis of Japanese quails feed diets containing graded levels of fermented cassava peel meal (FCPM)**

| Parameter | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | SEM | **LS** |
|---|---|---|---|---|---|---|
| Cost of feed per kg | 101.18 | 92.30 | 83.42 | 74.54 | 87.86 | NS |
| Avg. Daily feed intake (g) | $17.02^{c}$ | $16.73^{c}$ | $18.85^{b}$ | $23.06^{a}$ | 18.66 | * |
| Cost of Daily feed intake per Bird (₦) | $1.90^{a}$ | $1.48^{ab}$ | $1.43^{b}$ | $1.72^{ab}$ | 0.08 | * |
| Daily weight gain (g) | 2.77 | 2.53 | 2.67 | 2.53 | 2.62 | NS |
| Cost per daily weight (₦) | 0.69 | 0.58 | 0.53 | 0.67 | 0.62 | NS |

**KEY:**

NS--Non significant ; SEM = Standard error of mean; LS = Level of significance.

SEM = Standard Error of Mean

$T_1$ = 0% FCPM; 100% maize

$T_2$ = 25% FCPM; 75% maize

$T_3$ = 50% FCPM; 50% maize

$T_4$ = 75% FCPM; 25% maize

# CHAPTER FIVE

## 5.0 CONCLUSION AND RECOMMENDATIONS

### 5.1 Conclusion

The results from this study showed that Japanese quails responded positively to fermented cassava peel meal (FCPM) inclusion levels up to 50 % without any deleterious effect on their growth.

The nutrient digestibility of Japanese quails fed diets containing graded levels of FCPM were significantly highest at 50 % where the nutrients were better digested. It was therefore concluded that quails fed 50 % inclusion level of FCPM had the best digestibility. Also at 50 % FCPM inclusion level carcass characteristics were not adversely affected.

Up to 75 % FCPM replacement in terms of hen-day and hen-house production showed no significant difference therefore up to 75 % FCPM can be substituted in the diet of laying Japanese quails without having any deleterious effect on egg quality traits.

### 5.2 Recommendations

From the results obtained from this experiment, 50 % inclusion of FCPM is recommended in the diet of growing Japanese quails while 75 % inclusion of FCPM is recommended in diet of laying Japanese quails.

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## APPENDIX

Male and female quail showing the bulbous gland which differentiate the male from the female