GROWTH PERFORMANCE AND EGG PRODUCTION OF JAPANESE QUAILS FED DIETS CONTAINING VARYING LEVELS OF MOLASSES FLAVOURED SUN – DRIED CASSAVA PEEL MEAL

BY

ADIO, Seun

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ABSTRACT

A total of 400 two weeks old Japanese quails of mixed sexes with mean initial body weight of 37.83 g± and 160, six weeks old female Japanese quails were used to evaluate the effect of replacing molasses flavoured sun - dried cassava peel meal for maize on the growth and egg production performance of the birds, respectively. The birds were randomly allotted to four dietary treatments designated T_1 (0 % MFSCPM), T_2 (50 % MFSCPM), T_3 (75 % MFSCPM) and T_4 (0 % MFSCPM) containing replacement levels of 0, 50, 75 and 100 % of maize with molasses flavoured sun - dried cassava peel meal. Each dietary treatment group had five replicates of 20 birds each for the growth phase study; but at the laying phase, each treatment had four replicates of 10 birds each in a completely randomized experimental design model. The crude protein level was set at 24 and 20 % for growth and laying phases respectively; feed and water were given *ad-libitum.* The growth phase lasted for 4 weeks while the laying phase lasted for ten weeks. The data collected during the feeding trial include initial body weight, daily feed intake, daily body weight gain, weekly body weight, feed conversion ratio, nutrients digestibility, carcass characteristics, egg production and egg quality characteristics. All data collected were subjected to one way analysis of variance (ANOVA) using SPSS 2007, The results of growth performance showed that all the parameters measured were not significantly (P>0.05) different. However, birds on 75 % replacement level of molasses flavoured sun – dried cassava peel meal had the highest numerical values for final body weight (116.70 g), daily feed intake (11.69 g), daily weight gain (3.60 g) but poorer feed conversion ratio (1.33). The results of nutrients digestibility showed that there were no significant (P>0.05) differences in the apparent digestibility of the nutrients except for crude protein which showed that Quails fed 0 % MFSCPM (82.59 %) and 50 % MFSCPM (82.54 %) had the best apparent protein digestibility while those fed 75 % MFSCPM had the lowest protein digestibility of (79.94 %). The results of carcass characteristics showed significant (P<0.05) differences among all body parts except the head. Birds fed 100 % replacement of MFSCPM had better (p<0.05) dressed weight, thigh, drumstick and shank values compared to birds fed the other treatment diets. The results of the internal organs showed significant (P<0.05) differences among all organs except the lungs. The results of the egg production and egg quality parameters showed significant ((P<0.05) differences across dietary treatments except egg shape index and shell thickness. From the results obtained in this study, it was concluded that molasses flavoured sun - dried cassava peel meal could completely replace maize in the diets of growing and laying Japanese quails without any adverse effects on growth, egg production and egg quality of the birds.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Concerns have been raised on protein supply especially in tackling nutritional deficiencies in the world. Also consumers are interested in the nutritional compositions of whatever they consume (Swanepoel *et al.,* 2016). Introduction of birds such as pheasant, chukar, guinea fowl, geese and quails in tackling food insecurity has been suggested, especially for developing countries (Geldenhuys *et al.*, 2013). So much quest and effort to substitute maize in poultry feed with other less costly energy sources are targeted at significantly reducing the cost of production in poultry (Bamgbose *et al.,* 2004).

Poultry is any type of bird that is raised either intensively or extensively for the purpose of meat and egg production or both for human consumption. Examples include chicken, quails, turkeys, pheasants, peafowl, pigeons, partridges, ducks, geese and ostriches. Broilers (chickens and turkeys) and layers have been raised on commercial scale in intensive system for over 70 years. Poultry production on a commercial scale has lead to discovery and application of advanced technical knowhow that has kept prices of egg and meat constant to some extent for years. (Waldroup, 2001).

Poultry meat accounts for close to 38 % protein of animal origin supplied in most countries. The need to increase the production capacity of this industry, both at household and commercial scales has been identified by Khatun *et al.* (2003). Japanese quail has been described as a small, brown-coloured, chubby and terrestrial migratory bird (Campi *et al.,* 2013). Japanese quail (*Coturnix coturnix japonica*) is grouped in the order, family and genus (*Galiformes*, *Phasianidae* and *coturnix*) respectively. It has been classified to be one species of the common quail (Okada, 2010). Japanese quail has high prolific tendencies, short generation interval, fast growth rate and can survive in small cages (Odunsi *et al.*, 2007). Japanese quail was introduced to Nigeria in 1992 and this has expanded the scope for availability of high rich protein food for her citizenry (National Veterinary Research Institute NVRI, 1994).

Cassava (*Manihot esculenta crantz*) is grouped in the natural order *Euphabiaceae* and genus *manihot.* It is believed to have been brought to Africa by early Portuguese migrants from Brazil (Garcia and Dale, 1999). One among the highly important staple food crops cultivated in tropical Africa is cassava. Because it is available all year round, it is a cheap and efficient energy source that can tolerate extreme ecological conditions and stress. Cassava is also suitable to current farming and food systems in Africa. It plays a key role in attempts to reduce food crisis in Africa (Lukuyu *et al.*, 2014). Peels of cassava are the outer layer of the tuber and this can be removed manually using a sharp object such as knife without scraping much of the pulp along with the peel (Idowu *et al.*, 2006).

Feed cost for intensive poultry production is said to be the highest between (60 – 80 %) of the total production cost (Oruseibio and Smile, 2001). The increasing cost of feed ingredients in livestock production have been identified as a serious constraint to meeting the demand for animal protein especially in developing countries (Adejinmi *et al*., 2000). This challenge has lead to researches focused at reducing the cost of feed without negative implication on the performance of the birds. This approach involves compounding feed in a way that all the required nutrients come from cheap alternative energy and protein sources. The search for such alternatives has been the focus of animal nutritionists for over a decade (Onyimonyi and Okeke, 2005).

According to Food and Agriculture Organization (FAO), maize serves as the major source of energy in the diets of monogastric animals in Nigeria, and contributes up to 60 % of a commercial poultry ration (FAO, 2014). The increasing demand for maize by the humans and other industrial users often result in an escalating price of maize in Nigeria. The search for alternatives to maize as a feed source has led to the utilization of cassava root (*Manihot spp*). Peels are the highest by-product obtained after cassava processing and constitutes between 10 – 13 % of the weight of the whole root (Satar *et al*., 2011). Cassava leaves are farm residues after root harvest and comprises the leaves and petioles of cassava plants.

1.2 Statement of the Research Problem

There are some limitations on the utilization of cassava by - products in poultry diets formulation because it is dusty, poses difficulty in milling which often lead to reduced feed intake. Cassava by - product also possess some level of anti nutritional factors (hydrocianic acid) (Salami, 1999 cited by Oladunjoye *et al.*, 2010).

Researchers over the years have tried to improve utilization of cassava by-products in poultry diets by incorporating additives such as palm oil and honey to reduce its dustiness and also improve acceptability (Ijaiya *et al*., 2018). There is need to source for less expensive powder - binder for cassava by - products utilization in poultry diets that will serve as alternatives to palm oil and honey which are also keenly competed for by animals with man. One of such less expensive powder - binders is molasses which is less consumed by man and animals.

1.3 Justification for the Study

There is need to substitute honey and palm oil with a less expensive powder - binder that will improve the utilization of cassava by – products in poultry diets. Molasses is one of such less expensive alternative powder - binder that is not so much competed for between man and animals. Also there is scanty information on the use of molasses as powder – binder in the diets of Japanese quails.

1.4 Aim and Objectives of the Study

The aim of this study is to investigate the growth performance, carcass characteristics and egg production of Japanese quails (*Coturnix coturnix japonica*) fed diets containing varying levels of molasses flavoured sun – dried cassava peel meal.

The objectives of the study are to:

i. determine the growth performance of growing Japanese quails fed diets containing graded levels of molasses flavoured sun – dried cassava peel meal

ii. evaluate the nutrients digestibility of growing Japanese quails fed diets containing graded levels of molasses flavoured sun – dried cassava peel meal

iii. determine the carcass characteristics of growing Japanese quails fed diets containing graded levels of molasses flavoured sun – dried cassava peel meal

iv. determine the egg production performance of laying Japanese quails fed diets containing graded levels of sun molasses flavoured sun – dried cassava peel meal

v. evaluate the egg quality parameters of Japanese quails fed the different inclusion levels of molasses flavoured sun – dried cassava peel meal

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Quails (*Coturnix coturnix*)

The most common quail also known as European quail is a small ground-nesting game bird that belongs to the pheasant family. These are terrestrial species; they feed on insects and seeds on the ground. They are not easily seen; they hide in grasses and crops; they don't fly easily and prefer to crawl away instead. Even if they are threatened, they keep calm and lie low and soon drop back into cover. Most often its identity is revealed by the unique "wet-my-lips" song of the male. They utter the song mostly in the mornings and evenings or at night sometimes. Unlike most game birds, it is a strongly migratory bird (Iucn, 2006). It is usually small, round, essentially streaked brown with a white stripe on the eye, and the male has a white chin. it has long wings, unlike the typically short-winged game birds which befits its migratory nature. It weighs 91 – 131 g and measures roughly 18.0 – 21.9 cm on attaining an age of 6 - 8 weeks, this breeds of quail are found on open grassland and arable farmland across most of Asia and Europe, they lay between 6-12 eggs in a nest on the ground. It takes between 16 – 18 days for the eggs to hatch (Khan and Mian, 2012).

Linnaeus in his 1758 *Systema naturae* firstly describes the species as *Tetrao coturnix* (Linnaeus, 1758). The Eurasian subspecies, *C. c. coturnix,* is found over winters in India and towards the south of Africa's Sahel. *Coturnix coturnix Africana* is the African subspecies described by Temminck and Schlegel in 1849 as the African quail. Some moves from south towards north Africa. The Comoros and common quails of Madagascar belongs to the same African subspecies, but those found in Ethiopia and its environs makes up a different subspecies (Jobling, 2010). About 131 species of wild quail are currently found all over the world (Nasar *et al.*, 2016).

2.2 Japanese Quail

Japanese quails are hardy birds and fast growing, they belong to the order *Galiformes*. The first record of domesticated Japanese quails were from the twelfth centuries in Japan and it appears that the species was first domesticated there during the eleventh century or imported from China in an already domesticated form (Chang *et al.*, 2005). In the eleventh century, the birds served as a pet song bird but suddenly, it has become a valuable food animal (Kayang *et al.*, 2004). The Japanese quails has over the years has become an important laboratory animal in the study of endocrinology, physiology, toxicology, embryology, genetics and nutrition due to their hardiness, ability to survive in small cages, resistance to endemic poultry diseases and excellent egg production (Shim, 2004). Japanese quail was recently added to poultry farming in Nigeria. Unlike in Japan, Korea, Hongkong, China, Singapore, India, Britain, Thailand, Indonesia, France, Malaysia, Italy, Russia and Germany where Quail farming for egg and meat is popular. It was first introduced in Nigeria for the first time in 1992 (NVRI, 1994).

2.3 Benefits of Quail Farming

Quail farming has numerous benefits. Quails requires minimum space for rearing and less startup capital compared to chicken, they attain maturity at 5 – 6 weeks after hatching weighing about 120 -160 g. The female starts laying at approximately six weeks of age and lays up to 300 eggs/year, Quail's meat is tastier than that of chicken and has low fat content, it promotes body and brain development in young ones. Quail farming is a cheap enterprise compared to chicken farming, Quail is an important bird for scientific research, it requires less vaccinations and medications compared to chicken. Also its litter is of higher fertilizer value and when used it can increase crop produce, Quail eggs are far better compared to that of chicken eggs, it has low cholesterol percentage and finally, Quail's meat and eggs are good for the pregnant and nursing mothers (Mishra and Sukla, 2014)

2.4 Young Japanese Quails

A newly hatch quail chick weigh about 7 g; they grow very fast in the first week and flight feathers start to grow after about three days and the full feathers appear when they are one month old. The young chicks appear yellowish with brown stripe that resembles turkey poult except for its body size (Shim, 2004). They can be sexed from three weeks of age based on feather colour which is distinct for male and female (Odunsi *et al.*, 2008). As chicks, both male and female have the same kind of plumage and colouring. Young quail heads appear tawny in colour, with small patches of black scattered above the beak. A pale brown colouration appear on the wings and the back of the chicks, it has four stripes of brown running along its length on the back. On top of the head is a pale yellowish-brown stripe clustered by small stripes of black that runs down (Hubrecht and Kirkwood, 2010)

2.5 Adult Male Japanese Quails

The males seems to be smaller in body size compare to the females (Mills *et al.*, 1997). Wild adult male may weighs between 90 – 100 g but the domestic birds typically weigh between 100 - 120 g (Hubrecht and Kirkwood, 2010). However, weight varies considerably among domesticated lines; some strains can weigh up to 300 g especially those bred for commercial meat production. The breast feathers of the male show off a pattern of uniformly dark reddish-brown colour without any dark spots (Hubrecht and Kirkwood, 2010).

2.6 Adult Female Japanese Quails

Japanese quail exhibit sexually dimorphic plumage colour and this allows easy differentiation of male from the female. The adult male and female shows plumage that is predominantly brown in colour. However, markings on the breast, throat and the particular brown shade of the plumage, usually vary a bit (Mills *et al.*, 1997). The feathers on breast of females are characterized with generally pale feathers with dark spots. Feathers on the cheek of the female are more cream coloured, some males also show the formation of a white collar, whereas this does not occur in any female members of the species. (Hubrecht and Kirkwood, 2010).

2.7 Reproduction in Japanese Quails

Japanese quails display both monogamous and polygamous relationships between male and female and this has generated mixed reactions. A study on some domesticated quails shows that the females try to stick to one or two males, though extra-pair copulations may also be noticed (Hoppitt and Laland, 2013). The bird exhibit peak of breeding activities during the rainy season, when concentrations of testosterone hormone hit their peak and the size of the testes also increases (Akbar *et al.*, 2012). They lay eggs few hours before dusk. Incubation of the egg commences immediately after the clutch is emptied and incubation lasts between 16 - 17 days. Female Japanese quails carry out the incubation of the eggs and becomes unreceptive throughout the incubation process. Most often the male get driven away by the female before the eggs hatch (Mills *et al.*, 1997). Thus, the newly hatched young chicks are provided with all of the parental care by the females (Correa *et al.*, 2011).

2.8 Japanese Quail Egg

The eggs of Japanese quails weigh between 9 – 13 g (Chepkemoi *et al.*, 2016). Irrespective of its size, the eggs are said to be packed with nutrients which are 3 – 4 times greater than the nutrient value of the eggs of chicken (Abduljaleel *et al.*, 2011a). Also Japanese quail eggs are believed to have therapeutic effects due to the presence of bioactive compounds such as lysozymes, ovomucoid and cystatin in the eggs (Kovacs-Nolan *et al.*, 2005; Douglas, 2013). In this regard, the consumption of Japanese quail eggs may become a practical substitute to the traditionally consumed chicken eggs. The quality and composition of farmed Japanese quail eggs may be affected by factors such as stocking density, layer's age, feed compositions, storage time, trait and environmental effects among others (Douglas, 2013). Kumari *et al.* (2008) found quality parameters of Japanese quail eggs to be highly heritable.

2.9 Nutrition of Japanese Quails

Japanese quail diets include various species of seed of grasses such as panicum and white millet. They feed on a variety of larvae of insects and other small invertebrates (Pappas, 2013). Japanese quail mostly feeds and drinks at the morning and at the end of the day. However, they will still eat and drink throughout the day as well. Chicks like dried mealworms, cracked millet, cracked sunflower seeds and live crickets. Within the first week of hatching Quail chicks are capable of catching small to medium sized crickets and can consume much larger crickets by the following week (Mills *et al.*, 1997).

2.10 Cassava

Cassava is mainly cultivated in the tropical parts of Thailand, Brazil, South India, Philippines, Malagasy, Malaya, Indonesia, China and Africa (Ajibola, 2000; Adetan *et al.*, 2006). Cassava can tolerate drought, heat and also do well on marginal soils. World annual cassava production stands at about 268 million tonnes from the year 2000. This is because cassava food products are highly demanded for in Africa and dried cassava starch used in livestock feed in Asia is on the increase. Cassava is the hope for future food security in many developing countries. About 500 million people currently depend on cassava as their carbohydrate source (Montagnac *et al.*, 2009). Between 2013 and 2014 world cassava output increased by 4.6 % (FAO, 2014), Nigeria, Brazil, Indonesia, DR Congo and Thailand are where the majority of the world's cassava are produced (FAO, 2014). And of the estimated 13 million hectares of cultivated land in Africa and Asia 70 % has cassava growing on it (El-Sharkawy, 2003). The current world average yield of cassava is estimated to be about 12.8 tonnes per hectare, but there is potential to produce an average of 23.2 tonnes of cassava roots per hectare. This would result to more than 500 million tonnes in a year and yield could reach 80 tonnes per hectare under optimal favourable conditions (FAO, 2014).

Cassava has become the most important crop in the tropical part of Africa in terms of both the total land area devoted to its production and its contribution to human diet which is mostly carbohydrate. As a subsistence crop, after rice and maize, cassava is the third most important food that supplies carbohydrate in the tropics, providing more than 60 % of the daily calorific needs of the populations in tropical Africa (Richardson, 2011). It is mostly processed traditionally, into *garri, fufu, lafun, akpu* and *abacha* in Nigeria, and in Ghana *kokonte* and *agbelima* (Quaye *et al.*, 2009).

According to a report by Ajibola (2000) the economic potential of cassava in Nigeria is currently under-utilized. The author pointed out the fact that Nigeria is the largest producer of the crop in the world with 34 million tonnes of fresh tubers being produced annually. Also, Hillocks *et al*.. (2002) reported that the total production of cassava in Africa has increased from 35 – 80 million tonnes between 1965 to 1995, Olukunle (2006), said that Africa now produces more cassava than the rest of the world combined with biggest increase from 22 to 35 % in Nigeria and 4 to 8 % in Ghana (of African total production).

2.10.1 Cassava products

The nutrient content of cassava is dependent on the age and variety of plant, specific tissues, geographical location and environmental conditions (Garcia and Dale, 1999). Cassava tubers can be left under the ground for more than a year with little or no input, it can be harvested when food supply is low or price of substitutes becomes very high. Unlike other crops, cassava can be cultivated on soils with poor fertility and other problems, such as erosion, phosphorus fixation, high aluminum content and low exchangeable base content (Alves and Setter, 2000) and this allows the better soils to be used more profitably for other cash crops. Cassava is resistant to extreme environmental conditions and can tolerate a wide range of rainfall. The roots, when matured can retain its nutritional value for a longer period even in the absence of water (El-Sharkawy, 2003; Montagnac *et al*., 2009). Also cassava can thrive well on soils that receive less than 500 mm of rainfall annually (FAO, 2014). When cassava is compared with other cereal crops, cassava has low and poor quality protein that lacks the essential amino acids. Consequently, any diet that has cassava at its main energy source must be fortified with other protein sources that will supply methionine and lysine, and this can be very costly (Olugbeme *et al.,* 2010).

i. Roots

Cassava root production has increased gradually since the 1960s and cassava root production has increased by over 40 % between 1997 and 2007, and its incorporation in animal ration has increased by about 76 million tonnes (FAO, 2014). According to Stupak *et al.* (2006) the major constituent of the root is carbohydrate and about 1-3 % protein. The metabolisable energy of cassava root reported by many researchers ranged between 3,000 - 3,200 kcal/kg (Buitrago *et al*., 2002; Egena, 2006; Khajarern and Khajarern, 2007; Olugbeme *et al*., 2010).

Commonly produced poultry feedstuff of cassava roots origin are pellets and chips and these are widely produced in parts of Africa, Indonesia, Thailand and Malaysia (Chayunarong *et al*., 2009). Roots are the dried and shredded into chips, usually produced from fresh roots that have been sun-dried for about 2 to 3 days achieve moisture content less than 14 % (Morgan and Choct, 2016). The chips can be used in either pellet or mash diets after grinding. The 14 % moisture, a minimum of 65 % starch and maximum of 5 % fibre plus 3 % soil contaminants are the specifications of cassava chips for export (Balagopalan, 2002). Turning the chips into pellets is more advantageous for animal feed as it reduces cost of transportation and also improves performance. The chips differ substantially in size, shape depending on rate of drying and the quality depends on contamination during processing. Cassava meal is a powdered residue derived from processed roots. Cassava meal is often used in Africa, but other cassava products are preferred in Europe over cassava meal due to the low soil contaminants and low starch contents (Chauynarong *et al*., 2009).

Cassava roots are normally peeled to get rid of the leathery parenchyma thin cover that constitutes about 15 - 20 % of the root (Obadina *et al*., 2006; Onyimonyi and Ugwu, 2007). The peels generated constitute a waste disposal problem, but it is a potential source of wealth if properly exploited by biotechnological processing (Obadina *et al*., 2006). Cassava peel meal has low dietary energy and crude protein contents and it also contains high cyanogenic glucosides contents than root meal (Ngiki *et al*., 2014). According to Tewe (1991) hydrogen cyanide levels were approximately 651 and 309 mg/kg and 201 and 39 mg/kg for the peels and pulps, in bitter tasting and sweeter varieties of cassava respectively. The peel meal has a protein content of 46 to 55 g/kg, which is lower than what is obtainable in most cereal grains and this implies that its use as a replacement for cereals requires that the protein deficiencies be ameliorated.

Cassava root products also lacks carotene and carotenoids, so there is need to supplement with feedstuffs containing these products to sustain normal broiler skin pigmentation and egg yolk colouration (Khajarern and Khajarern, 2007). Cassava pulp has 60 to 70 % moisture content of and contains 50 % carbohydrates on dry matter basis. Dried cassava pulp has approximately 2 % protein, low in carotene and has high fibre levels making it difficult to be successfully utilized by poultry (Aro *et al*., 2008). Cassava pulp, the solid, moist by-product of cassava starch manufacture, represents approximately 10 to 15 % of the root (Thongkratok *et al*., 2010).

ii. Leaf

The production of dry cassava foliage stands at about 10 tonnes per hectare (Khieu, 2005),. Cassava leaf is packed with high nutrients compared to the peels they have high protein content that ranges between 16.7 to 40 % (Khieu, 2005), and minerals, as well serves as a useful source of vitamin B_1, B_2 and C and carotenes (Adewusi and Bradbury, 1993). Additionally, the amino acid concentration of cassava leaf is very similar to that of alfalfa (Lukuyu *et al.*, 2014) and the metabolisable energy ranges from approximately 1590 - 1800 kcal/kg (Khajarern and Khajarern, 2007; Morgan and Choct, 2016). Harvesting the leaf at 4 - 5 months after planting does not pose any negative effect on the root. The crude protein and amino acid levels decrease as the leaf ages but crude fibre, hemicellulose and cellulose levels increase. Cassava leaves have a significant level of the antinutrient HCN (hydrocyanic acid), high tannin and phytate content, low digestible energy which limits their use in poultry diets (Morgan and Choct, 2016). Hence, sun - dried cassava leaves can be ground into meal to be incorporated in poultry feed as a source of carotene or protein or both (Khajarern and Khajarern, 1992).

2.10.2 Nutrient composition of cassava

Gomes *et al*. (2005) and Promthong *et al*. (2005) compared cassava starch with maize starch and found that cassava starch contains 17 % amylose and 83 % amylopectin while maize starch has 28 % amylase and 72 % amylopectin. The high amylopectin level means that the digestible starch in cassava may be higher compared with other common starch sources fed to poultry. Resistant starch refers to starch and starch degradation products that escape digestion in the small intestine. Cassava chips contain approximately 40.91 % resistant starch compared with maize which has 47.55 % (Promthong *et al*., 2005), and raw cassava contains approximately 75.38 % resistant starch (Onyango *et al*., 2006). Kiatponglarp and Tongta (2007) found that the high resistant starch levels in raw cassava was likely because it is composed of 82.85 % amylopectin with branch linkage of 5.79 to 17.25 % amylose with branch linkage of 0.48 %. Another possible explanation is that the amylopectin in cassava has a comparatively longer chain length (Raphael *et al*., 2011).

Cassava roots have low protein content (0.7 to 1.3 % fresh weight) (Ngiki *et al*., 2014). The protein content of cassava flour, peels and leaves are also low at approximately 3.6, 5.5 and 21 %

respectively (Iyayi and Losel, 2001). Cassava based diets must therefore be supplemented with methionine and lysine (Tewe and Egbunike, 1992). As reported by Nagib and Sousa (2007), the total amino acid content of cassava is approximately 0.254 g per 100 g and lysine content is approximately 0.010 g per 100 g. The protein in cassava has a high arginine content but low methionine, cysteine, threonine, isoleucine, phenylalanine and proline content (Stephen, 2017).

Gomes *et al*. (2005) reported that cassava contains just 0.1 % lipids, compared with maize which has approximately 6 %. The flour from cassava roots contains approximately 2.5 % lipids, but only half of this is extractable with conventional solvent systems, and the fatty acids in cassava are primarily saturated. The low amount of lipids found in cassava means that it is a poor source of fat soluble vitamins with low content of vitamin A, B1, B2 and niacin but has high levels of vitamin C (Morgan and Choct, 2016)

2.10.3 Anti nutritional factors in cassava

It is a known fact that anti-nutritional factors are potential harmful and serves a source of concern for human and animal health because they prevent proper digestion and absorption of nutrients in diets. They are sometimes toxic and tend to reduce the nutritional value of feed by preventing thorough digestion when consumed or cause a deficiency in essential nutrients (Francis *et al*., 2011). Alkaloids, saponins, tannins, phlobatinnins, flavonoids, cardiac glycosides, anthraquinone and anthrocyanosides have been reported in aqueous and ethanolic extracts of raw cassava roots, peels and leaves (Ebuehi *et al*., 2005). Kobawila *et al*. (2005) also reported that phaseolunatin is found in both sweet and bitter cassava varieties.

According to the report of Taylor and Hefle (2017), cyanogenic glycosides is the most commonly found anti-nutritional factors in cassava roots, which must be removed or inactivated through processing before they are suitable for livestock and aquaculture feeding (Falaye 1992; Ebuehi *et al*., 2005; Agbor-Egbe and Mbome, 2006). Cyanide prevents proper functioning of several enzyme systems including metalloenzymes (Enneking and Wink, 2000) through cytochrome oxidase, it also depresses growth by interfering with certain essential amino acids and impedes utilization of some nutrients (Lateef & Gueguim-Kana, 2012). Excessive exposure to cyanide as a result of consuming non detoxified cassava products has been linked with a number of diseases including dwarfism, goiter and the Tropical Ataxic Neuropathy (TAN) (Onabolu *et al*., 2001). It is a peculiar problem in countries where cassava is the chief source of calories (Balagopalan *et al*., 2002; Lukuyu *et al.*, 2014; Ngiki *et al*., 2014).

About 75 to 1,000 mg/kg of cyanide is found in cassava, but this depends on the variety, age of the plant, use of fertilizer, the soil conditions or agronomic practices and climatic/weather conditions among other factors (Ngiki *et al*., 2014). The two types of cyanogenic glucosides found in cassava; linamarin and either lotaustralin or ethyl linamarin (93 and 7 % respectively). These are sources of aspartic and glutamic acids and glutamine, but are not harmful to the plant. Linamarin is similar to glucose chemically but is conjugated to cyanide ions. The level of linamarin varies from 2 to 395 mg/100 g in fresh cassava roots, depending on the variety (Yeoh and Yruong, 1993). Linamarin and lotaustralin are synthesised from valine and isoleucine respectively (Andersen *et al*., 2000). When cassava roots are sliced or mashed, linamarin and lotaustralin are changed to hydrogen cyanide by the enzyme linamarase which is found in the root (Santana *et al*., 2002; Cardoso *et al*., 2005). The cyanogenic glucoside content found in the leaf is six times higher than that found in the roots and this decreases as leaf matures (Ngiki *et al*., 2014).

2.11 Processing Methods of Cassava Products

Sun drying: When sun dried, cassava products loss total cyanide as against oven-drying at 60° C for 48 hours. When oven dried the stability of linamarase is apparently affected and decomposes at 72° C, sun drying produces higher loss of bound cyanide due to slow drying rate compared to oven drying (Lukuyu *et al.,* 2014). Sun drying exposes the glucosidase and the glucoside in the aqueous medium to a longer contact period. The effectiveness of enzyme/substrate interaction is dependent on the size of particle and environmental factors such as wind, insulation, ambient temperature, relative humidity and velocity. To achieve proper drying, 1–3 days in the dry season and up to 8 days in the rainy season is required (Lukuyu *et al.,* 2014)

Sun drying of cassava peel enhances the continuation of the process of fermentation and it is cost efficient, but slow and sometimes often allows the growth of mould and other microorganisms such as *Aspergillus flavus* (pathogenic), *A. teirenus*, *A. cherahen*, *A. japonicus*, *A. flaripes*, *A. niger*, *A. ochracuss*, *A. fumigates* and *Penicillium rubrum* (Lukuyu *et al.,* 2014). The growth of microbe exposes the animals to aflatoxicosis and/or mycotoxic infection. Due to the poor microbiological attributes of sun drying cassava products, there is the need for faster drying methods which can reduce to the barest minimum or eliminate completely microbial proliferation and ensure optimal cyanide detoxification (Lukuyu *et al.,* 2014). A technology that is promising is the development of solar/hybrid drying systems to reduce much of the delay experienced with weather conditions, and consequent potential degeneration of cassava products and by-products. If biofuels are utilized hybrid driers may be particularly sustainable (Sanni *et al*., 2012).

Ensiling: The process of ensiling disintegrates the intact glucoside via marked cell disruption, intense heat generation and a drop in pH of the ensiled medium. Ensiling cassava leaves, root pulp and peels; if maintained anaerobically, molding of substrate is less problematic. Olugbemi, (2010) found out that when cassava chips are ensiled hydrogen cyanide content is reduced by about 36 % of the initial value after 26 weeks of ensiling. Also Tewe (1992), reported that approximately 98 % of the free cyanide is lost when cassava roots are ensiled with poultry droppings for 8 weeks. Ensilation of ground cassava pomace can be achieved through the addition of either rapidly fermentable carbohydrates such as milled maize or molasses before being placed under anaerobic conditions (in pits or plastic bags) or 0.5 % salt (fresh weight basis). Urea and other minerals could be added with the aim of increasing the utilization of the ensiled products (Ubalua, 2007). Incorporating silage components such as (cassava chips/pulp//peels) with adequate nitrogen sources such as poultry droppings (Tewe 1991); or leaves (Kavana *et al*., 2005) to encourage continuous microbial growth which reduces cyanide to a safe level for using the high starch by-products of cassava in feeding animals.

Fermentation: Majority of food products from cassava pulp in Africa e.g. *garri*, *fufu* and *pupuru* are derived from fermenting the pulp, a crucial step to reduce the cyanogenic glucosides to relatively minimal level is fermentation. The assumption is that some cyanidrophilic/cyanide tolerant microorganisms may activate the disintegration of the cyanogenic glucoside (Lukuyu *et al.,* 2014). If the retention of starch in grated cassava is high and a longer fermentation results in better detoxification process and the residual cyanide becomes lower (AgriPinoy.net, 2011). A combined acid hydrolysis and fermentation was developed, a process which achieved an approximate 98 % reduction in total hydrogen cyanide after dehydration of the cassava flour. In general, fermented cassava products can be better stored Lukuyu *et al.* (2014).

In recent times, cassava peels feeding value has recorded tremendous increase by treatment with root liquor ferment containing *Aspergilus niger*, *Aspergilus flavus*, and *Lactobacillus spp* (Oboh, 2006; Adamafio *et al*., 2010), and this has resulted in decrease of the hydrogen cyanide content by 88 % and also raising the nitrogen levels. Cattle microbes have also demonstrated ability to break down hydrogen cyanide in cassava leaves; fermentation of bitter cassava varieties using 6 % *Aspergilus niger* in a 2-stage fermentation process was examined, with different levels of cattle rumen inoculum added after 4 days. Crude protein in the leaves increased from 28 to 34 % of DM; Hydrogen cyanide concentration was observed to have dropped 34 % from wilting of leaves, and 64 % from initial levels following the 2 stage fermentation and *in vitro* Dry Matter Digestion was improved (Prayitno *et al*., 2011). The development of targeted fermentation technologies and microbial cultures, optimized for various feed fractions, holds solid promise for expansion of cassava utilization in both livestock feed programmes and for human nutrition products (Boonnop, 2009; Ferreiera *et al*., 2013).

2.12 Utilization of Cassava Products in Livestock Feed

Wachirapakorn *et al*. (2001) fed crossbred Holstein–Friesian cattle in an *ad libitum* ration, consisting of roughage (6 %) and concentrate at a ratio of 30:70, the dairy concentrate containing cassava root chips at 25, 35, 45, and 55 % levels was developed and tested. Level of cassava root chips in the study did not affect rumen pH (6.6 – 6.7) and had no significant effect on total dry matter intake, digestion or milk components; cows produced 8.4 to 10 kg milk/day. Contrary to previous suggestions that limited inclusion rates of 20 – 30 % of the diet for dairy cattle (Morgan and Choct, 2016) cassava root chips were used as an energy source in lactating cow diets at quite high levels (55 % in concentrate or 38 % of total diet), without affecting feed intake, milk production and milk composition.

In an attempt to modify the rumen environment to optimize pH and nitrogen metabolism, dairy steers fed a basal diet comprising a high-cassava concentrate (65 % cassava chips) and local forage were offered a feed block containing 30 % cassava hay or rice bran, at 0.5 % dry matter intake, with malate added at 500 or 1000 g (Sittisak *et al*., 2009). Addition of the cassava hay (with malate) to the overall diet had no effect on dry matter intake, but ruminal bacterial concentrations were significantly increased and fungal and protozoal populations were lowered, thus demonstrating potential to further improve rumen efficiency through addition of malate in high cassava diets.

Maize was replaced by cassava sievate and included between 18 – 20 % in grower rabbit's diets and it resulted in growth performance slightly better than or similar to that obtained with the maize based diet (Ngodigha *et al*., 1995; Ekwe *et al*., 2011). A higher inclusion level (40 %) reduced growth rate by 9 % in comparison with the maize based diet, but the unit cost of feed to weight gain remained in favour of cassava sievate utilization (Ngodigha *et al*., 1995).

Okoruwa *et al*. (2012) carried out a feeding trial on 15 growing West African Dwarf (WAD) sheep, by replacing 70 % of guinea grass diets with dried cassava peels and rice husk in different ratios (60:10 and 55:15). The dry matter digestibility was not significantly affected by the inclusion of dried cassava peels and metabolizable energy was highest on the 55:15 diets, this suggests that combining cassava peels and rice husks at 55:15 may successfully replace guinea grass in diets of WAD sheep.

Ekwe *et al.* (2011) evaluated the efficiency of including different rates of sun-dried cassava peel supplementation on the performance of weaner pigs, with alternating the ratios of cassava peel to maize (50:0, 40:10, 30:20, 20:20 %). Significant ($P>0.05$) differences were not observed in feed efficiency or growth performance across the four treatments, with pigs consuming 1.3 to 1.5 kg and gaining about 500 g/day. The best economics of production were realized at inclusion levels of 30 % for cassava peels, and 20 % maize in the diet. Inclusion of dried cassava peel at 50 % was not detrimental to performance, but resulted in poorer (P>0.05) profitability due to high feed cost.

2.12.1 Utilization of cassava by – product in poultry diets

Morgan and Choct (2016) conducted a study and reported that low-cyanide cassava root meals can be incorporated in poultry diets between 500 and 600 g/kg without reducing weight gain or egg production. Hydrogen cyanide levels of 100 mg/kg have been found to impact a negative effect on the performance of broiler chickens and as low as 25 mg/kg can negatively affect layer production, egg quality and hatchability (Fakir *et al*., 2012).

Aniebo (2012) investigated the performance of broiler chickens fed composite cassava root meal-based starter diets fortified with palm oil, methionine or palm oil and methionine. The results showed that palm oil complemented DL-methionine as a cyanide detoxification agent in cassava root meal-based diets but was apparently ineffective as the sole detoxification agent at 4 % or lower inclusion rates.

According to Kana *et al*. (2012) body weight was highest in birds fed diets in which 50 % of the maize was replaced by cassava flour meal (with 3 % palm oil and 1 % cocoa husk). This was not statistically different when compared with birds fed diets containing 100 % or 75 % maize or 100 % cassava flour meal. Cassava meal can also potentially replace other carbohydrate sources. For instance, it was observed that 15 % cassava meal can replace coconut meal in broiler chicken diets with no adverse effect on growth performance (Morgan and Choct, 2016).

Abu *et al*. (2015) observed 20 % inclusion of cassava leaf meal and 20 % cassava peels could be used to replacement maize and soybean meal. Body weight significantly reduced when broilers were fed whole cassava. Using cassava leaf and chips to feed guinea fowl was shown to be profitable with respect to feed cost and production, particularly at the finisher phase (Dahouda *et al*., 2009). In the study, it was observed that cassava chips and leaves had no negative effect on carcass quality or feed conversion, and feed cost per kg live weight gain were reduced ($P<0.05$) by approximately 25 % in the birds fed the cassava based diets compared with the control group.

Replacement of maize with cassava appears to positively impact duck performance. Saree *et al*. (2012) found that from 0 to 16 days of age Cherry Valley ducks fed cassava diets had better ($P<0.05$) body weight and body weight gain, average daily gain and feed conversion ratio compared with those fed maize diets. Cost of feed per weight gain was also significantly ($P<0.05$) reduced in birds fed the cassava diets. In the older birds (17 to 47 days) feed intake and gizzard size were comparatively higher ($P<0.05$) in the birds fed the cassava based diets.

Sahoo *et al*. (2014) studied the performance of White Pekin ducklings when water soaked and untreated cassava root meals replaced maize in varying levels. Significantly ($P<0.05$) higher growth rates and lower feed conversion ratio were observed in birds fed the water-soaked cassava root meal diets compared with those fed the diets without cassava or with untreated cassava root meals. Also, significantly ($P<0.05$) higher percentage of breast meat yield was observed in the study in the ducklings fed the diets with 40 % or 60 % water soaked or 40 % raw cassava root meal compared with those fed the control diet. No differences were seen between the treatments for apparent digestibility of dry organic matter, crude protein and energy.

Inclusion of cassava into diets of geese appears to have little effect on their performance. Sahle *et al*. (1992) reported that inclusion of up to 450 g/kg cassava meal in geese diets had no significant (P>0.05) effect the performance of the bird and carcass quality, although protein digestibility decreased significantly (P<0.05) with increasing levels of cassava meal. It was noted in this study that average metabolisable energy and nitrogen corrected true metabolisable energy (TMEn) of cassava meal were 12.48 and 12.59 MJ/kg, respectively in growing geese at 9 weeks of age.

2.12.2 Utilization of cassava peel meal in growing and laying Japanese quails diets

Abdullahi *et al.* (2018) replaced maize with sun – dried cassava peel meal flavoured with honey in growing Japanese quails diets at 0, 50, 75 and 100 %, and reported no significant (p>0.05) differences in average body weight gain and feed conversion ratio but recorded significant (p<0.05) differences in average daily feed intake, final body weight and apparent nutrients digestibility. Therefore, it was concluded that sun – dried cassava peel meal flavoured with honey could be used to replace maize up to 75 % in the diets of growing Japanese quails.

A study by Malik *et al.* (2018a) where maize was replaced by fermented cassava peel meal at 0, 25, 50 and 75 % in growing and laying Japanese quails diets observed significant (p<0.05) differences in feed intake and apparent nutrients digestibility but daily weight gain and feed conversion ratio were not significantly (p>0.05) different among treatments during the growth phase. For the laying phase there were no significant (p>0.05) difference in daily feed intake, hen day egg production and all the egg quality parameters. Therefore, it was concluded that fermented cassava peel meal could replace maize up to 50 and 75 % in growing and laying Japanese quails diets respectively.

A two – phase experiment was carried out by Malik *et al.* (2018b) where maize was replaced by sun – dried cassava peel meal at 0, 25, 50 and 75 % respectively. The results obtained showed significant ($p<0.05$) difference in daily feed intake and feed conversion ratio during the growth phase. Significant ($p<0.05$) differences were also observed in daily feed intake, hen day egg production, feed conversion ratio and egg quality traits. It was recommended that dietary maize could be replaced by sun – dried cassava peel meal up to 50 and 25 % for optimum growth performance and egg production at growing and laying phases respectively.

2.13 Molasses

2.13.1 Definition of molasses

Molasses has been defined as the major by – product of the sugar industry. The term molasses specifically refers to the final effluent obtained in the separation of sucrose by repeated evaporation, crystallization and centrifugation of juices from sugar cane or sugar beets (Jain and Venkatasubramanian, 2017). Generally any liquid feed ingredient that contains sugar in excess of 43 % is termed molasses.

2.13.2 Types of molasses

a. Cane molasses:

This is a by- product of manufacture or refining of sucrose from sugar cane. It is specified by American Feed Control Officials (Elgilani, 2007) to contain not less than 46 % total sugars expressed as invert, its moisture content exceeds 27 %, and its density, determined by double dilution method, must not be less than 79.5 brix.

b. Beet molasses:

Beet molasses is a by- product of the manufacture of sucrose from sugar beet. It carries the same specifications as cane molasses.

c. Citrus molasses:

Is the dehydrated juices obtained from the manufacture of dried citrus pulp.

d. Hemicellulose extract:

This is a by- product of the manufacture of pressed wood, obtained by the treatment of wood at elevated temperature and pressure (Elgilani, 2007).

e. Starch molasses:

This is a by- product of dextrose manufacture from starch derived from corn or grain sorghum, where the starch is hydrolyzed by enzymes and acid.

2.14 Type of Sugar Cane Molasses:

According to early literature on production and processing of cane molasses, as presented by Elgilani (2007), there are many types of sugar cane molasses. The molasses available for animal feeding is known as Black strap (or Final molasses).

i. Black strap (final molasses)

It is a by- product of cane sugar industry, from which the maximum crystalline sugar has been extracted by the normal methods. It is most commonly used in animal feeding. In addition to sucrose, it contains glucose and fructose which are fermentable. Black strap molasses also contain substances which are not fermentable by yeast. The non fermentable reducing content of molasses may be present as high as 17 % of the black strap molasses (Elgilani, 2007).

ii. Integral molasses

It is the unclarified molasses, made by partially inverting sugar cane juice to avoid crystallization of sucrose.

iii. High test molasses

High test molasses result from the conversion of clarified whole sugar cane juice into molasses. The process involves application of 5 invertase enzyme and sulphuric acid to the cane juice resulting in syrup. Because the sugar was not excreted, the high –test molasses has a greater concentration of sugars and lower concentration of minerals compared to other types of molasses.

iv. Condensed molasses

This is the by- product developed by condensing the residue from yeast fermentation to commercial alcohol.

Molasses is composed of 22 % water, 75 % carbohydrates, and no protein or fat. In a 100 gram reference amount, molasses is a rich source (20 % or more of the Daily Value, DV) of vitamin B6 and several dietary minerals, including manganese, magnesium, iron, potassium, and calcium. The sugars in molasses are sucrose (29 % of total carbohydrates), glucose (12 %) and fructose (13 %)

2.15 Use of Molasses in Poultry Feed

The early report that shows the use of cane molasses in poultry feed was published by Omer (2014) in North America. Sugar cane final molasses proved to be suitable when included in quite high levels in diets for both broilers chicken and layers with no detrimental effect on health or performance (Rahman, 2018). However, certain limitations were shown with total replacement of cereal grains by molasses, due to difficulties in mixing diets containing high levels of molasses, in addition to its laxative effects (Rahman, 2018). Inclusion of high levels of molasses in broiler diets increased body weight and feed consumption at 0-4 weeks of age, but the increase of feed intake was not statistically ($P>0.05$) significant; whereas at 4-8 weeks of age molasses inclusion has no effect on either feed intake, body weight gain, feed efficiency or live weight (Kabuage *et al.*, 2000). Similarly Rahman (2018) indicated that up to 20 % molasses could be used in broiler chicken diets with no reduction in body weight. The same authors concluded that sugar molasses can be included safely at 15 and 20 % in finishing diets of broiler. Storage of diets with high levels of molasses causes loss in the nutritive value of mixed feeds (Rahman, 2018) which would reduce the growth rate of birds and feed efficiency.

2.15.1 Effect of sugar cane feeds on the internal organs of broiler chickens

Anatomical modifications have been found in broilers fed increasing levels of sugar cane final molasses (Valdés, 2015). Remarkable increase ($P<0.05$) in the crop, proventricle, small intestines, empty caecum and kidney weights were reported by (Čolović *et al.,* 2019) and the reverse occurred with gizzard weight.

2.15.2 Digestion of sugar cane molasses by poultry

Poultry shows a fast rate of passage of digesta through the gastrointestinal tract when sugar cane final molasses are included in large proportion in diet (Valdés, 2015). The laxative effect of sugar cane final molasses, defined as a rapid rate of passage of digesta through the entire gastrointestinal tract, brings about a sharp decrease in the digestibility of diets, thus causing deterioration in the daily body weight gain and feed utilization efficiency. This laxative effect can be neutralized by mixing the molasses with raw sugar or high-test molasses which contains large amounts of sugar (Rahman, 2018). When a laxative condition appears in chicken fed cane molasses, there is no change in the ratio of water excretion in the droppings (Elgilani, 2007).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental Site

The research work was conducted at the Quail unit of the old Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Bosso Campus, Minna, Niger State, Nigeria. Minna lies between latitude 9˚ 28' N and 9˚ 37' N and longitude 6˚ 23' E and 6˚ 33' E with annual rainfall of 1000 – 1500 mm, and temperature range of 28 °C – 42 °C. The vegetation is Southern Guinea Savanna. (Climate-data.org, 2019).

3.2 Experimental Materials

The materials and ingredients used for the experiment includes deep litter pen, wooden cages, feeders and drinkers, charcoal, rechargeable lamps, clean water, weighing balance, Japanese quails, sun – dried cassava peel meal, molasses, groundnut cake, maize offal, fish meal, bone meal, limestone, premix salt, synthetic methionine, lysine and vitalyte®.

3.3 Source of Experimental Birds, Molasses and Other Ingredients

Four hundred (400) two weeks old Japanese quails were purchased from National Veterinary Research Institute, Vom Plateau State Nigeria for the purpose of this study. All the ingredients used for the diet formulation were purchased locally from Gwadabe Market, along Western by-pass, Minna. Groundnut cake, vitamin – mineral premix, lysine, methionine, fish meal and bone meal were purchased at Farida Shop in Gidan Matasa, Bosso, Minna while molasses was purchased from Massohi farms and livestock development company, adjacent

Federal University of Technology, Minna – Bida road. These ingredients were milled and mixed for the feed formulation. Drugs and medications were purchased at Step-By-Step Integrated Services along Western by-pass Minna.

3.4 Preparation of Experimental Site

The quail pens were constructed using wooden frame materials with dimension of 2x2x1.75 m (length, width and height) with wire mesh of 2 cm covering the side and doors for adequate ventilation. The pen and cages were washed, disinfected and allowed to dry prior to the arrival of the experiment birds. Each cage was furnished with feeders, drinkers and charcoal pot was used to provide heat while rechargeable lamps were used for lighting for the pen.

3.5 Duration of the Experiment

The research work was in two phases, the growth phase and the laying phase which lasted for four and ten weeks respectively. The whole experiment lasted 14 weeks. The quails were two weeks old at the start of the experiment.

3.6 Experimental Design

On arrival, the birds were fed for four days with commercial feed for acclimatization. The birds were weighed, randomly assigned to four dietary treatment groups; each treatment had one hundred birds consisting of five replicates (20 birds per replicate) arranged in a Completely Randomized Experimental Design for the growth phase. During the laying phase 160 female Japanese quails were randomly allotted to four dietary treatments having four replicates of 10 birds per replicate group. During the fourteen weeks experimental period, the birds were fed *ad* *libitum* with growers mash for 4 weeks and thereafter with layers mash for 10 weeks. The quails were sexed at six weeks of age to separate the males from the females at point of lay.

3.7 Preparation of Experimental Diets

Diets were formulated such that treatment 1 (T_1) contained no sun - dried cassava peel meal and molasses (control), while treatments 2, 3 and 4 (T_2, T_3 and T_4) contained 50 %, 75 % and 100 % sun - dried cassava peel meal flavoured with 6 % molasses respectively. The viscosity of molasses was lowered by heating it slowly on a flame for 10 minutes at 60 ˚C to ease the mixing of molasseswith the cassava peel meal (Obun *et al*., 2008). The experimental diets for the growth and laying phases are as shown in Tables 3.1 and 3.2 respectively.

3.8 Management of Experimental birds

Fresh clean drinking water was supplied *ad libitum* throughout the experimental period. Routine observation of bird’s behaviour and cleaning of the pen, drinkers, feeders, provision of fresh clean drinking water and feed were carried out daily to prevent any form of infection. Anti-stress (Vitalite®) was administered in drinking water throughout the experiment due to weather changes. At two weeks of age, antibiotic was administered (Tetracycline) for 5 days through drinking water as prevention against bacterial infection.

Table 3.1**:** Composition of experimental diets fed Japanese quails during the growth phase of the experiment

Ingredients (g)	**T_1 (0 %)**	**T_2 (50 %)**	**T_3 (75 %)**	**T_4 (100 % MFSCPM)**
Maize	44.40	21.30	10.39	0.00
MFSCPM	0.00	21.23	31.16	40.67
Groundnut cake	38.90	40.84	41.75	42.63
Maize offal	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
Limestone	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Premix	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis				
Phosphorus	0.82	0.77	0.74	0.72
Calcium	1.62	1.62	1.62	1.62
Methionine	0.41	0.37	0.35	0.33
Lysine	0.98	0.95	0.94	0.93
Crude fibre	3.76	5.23	5.91	6.57
Crude protein	24.00	24.00	24.00	24.00
ME(Kcal/kg)	2664.71	2396.71	2271.35	2151.47

*****Premix supplied per 25kg/ton contains: vitamin A (7,500,00iu), vitamin D (500,00iu), vitamin E (1,000 iu), vitamin B1 (3.75mg). vitamin B2 (125mg), vitamin B3 (500mg), vitamin B6 (150mg), vitamin B12 (2.5mg), vitamin K (15mg), vitamin 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:

MFSCPM-Molasses flavoured sun - dried cassava peel meal

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

Table 3.2: Composition of the experimental diets fed Japanese quails during the laying phase of the experiment

Ingredients (g)	T_1 (0 %)	T_2 (50 %)	T_3 (75 %)	T_4(100 % MFSCPM)
Maize	54.27	25.95	12.69	0.00
MFSCPM	0.00	25.95	38.09	49.72
Groundnut cake	28.03	30.40	31.52	32.58
Maize offal	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
Limestone	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Premix	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis				
Phosphorus	0.82	0.87	0.77	0.74
Calcium	1.92	1.92	1.92	1.92
Methionine	0.31	0.34	0.32	0.30
Lysine	0.88	0.85	0.74	0.83
Crude fibre	3.65	5.53	5.81	6.97
Crude protein	20.00	20.00	20.00	20.00
ME(Kcal/kg)	2708.89	2381.33	2228.00	2081.21

*****premix supplied per 25kg/ton contains: vitamin A (7,500,00iu), vitamin D (500,00iu), vitamin E (1,000 iu), vitamin B1 (3.75mg). vitamin B2 (125mg), vitamin B3 (500mg), vitamin B6 (150mg), vitamin B12 (2.5mg), vitamin K (15mg), vitamin 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:

MFCPM-Molasses flavoured cassava peel meal

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

3.9 Experiment One: Growth Performance and Nutrient Digestibility of Grower Japanese quails fed Molasses Flavoured Sun – Dried Cassava Peel Meal

A total of 400, two weeks old unsexed Japanese quails were used for this phase of the experiment. Birds were allotted to four dietary treatments in a five replicate groups containing 20 birds each.

3.10 Data Collection

Initial weight

The initial weights of the birds were taken after they have been randomly allotted to various treatments. This was done by weighing an empty carton first then each replicate birds were weighed as a group and the weight was divided by the number of birds to get the average initial weight per bird.

Feed intake

A known amount of feed was weighed daily for the birds in each replicate and the quantity consumed for the day was obtained by subtracting the left over from the quantity offered. Daily record of average feed consumption per bird was obtained for each replicate group by dividing the total quantity of feed consumed by the number of quails in each replicate.

Final body weight

The quails in each replicate were weighed at the beginning and end of the experiment using an empty carton that was weighed to determine its weight before using it to weigh the birds and subsequently at weekly intervals throughout the experimental period.

Body weight gain

Body weight gain was determined by calculating difference between the body weights for the previous day and the weight of the present day and pooled together weekly to determine weekly weight gain.

Feed conversion ratio (FCR)

The feed conversion ratio was calculated at the end of the experiment basis by dividing the quantity of feed consumed by the corresponding weight gain of the birds in each replicate in grams using formulae as cited by Malik *et al.* (2010).

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

Digestibility trial

Digestibility study was carried out at the end of the growing phase of the experiment (fourth week). The birds in each of the treatment groups were weighed and sacks were placed in each of the replicate pens for seven days for the total collection of excreta samples, with an adjustment period of two days. The total sample collection lasted for five days. Each day's collection was sun-dried for five days and sealed in a foil paper in a desiccator jar for laboratory analysis. Fresh drinking water was supplied daily and feed was given to all the birds in each treatment measured equally and the total droppings were collected, for proximate analysis using (Association of Official Analytical Chemist AOAC, 2000) methods. The formular used to calculate the digestibility is shown below.

$$\text{Nutrient digestibility} = \frac{\text{Nutrient in feed consumed} - \text{Nutrient in faeces}}{\text{Nutrient in feed consumed}} \times 100$$

Carcass characteristics

The determination of carcass characteristics was carried out on the last day of the 4 - week experiment. When the birds were six weeks of age, a total of 40 birds were selected, two birds from each replicate group and were kept off – feed for 12 hours (6pm – 6am), adequate water was provided. The live weight of the birds were taken before and after slaughtering. The jugular vein around the neck was severed with razor blade after which the bled birds were scald in warm water at temperature of 80 ^{0}C for 10 seconds. They were then eviscerated and organs were removed. The measurement of the carcass retail cut parts and organ weights were express as the percentage of live weight.

3.11 Experiment Two: Productive Performance and Egg Parameters of Laying Japanese quails

A total of 160, six weeks old female Japanese quails harvested from experiment 1 were used for this phase of the experiment. The birds were allotted on weight equalization basis to four dietary treatments as in the growth phase but with four replicate group of ten birds per replicate making forty birds per treatment

3.12 Data Collection

a. Egg laying parameters

i. Feed intake (g)

Feed was weighed daily for the birds in each replicate and the quantity consumed for the day was obtained by subtracting the left over from the quantity supplied. Daily 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. Hen-day egg production (HDEP)

This was calculated as the number of eggs laid per replicate on daily basis using the formula given by Bawa *et al. (*2010).

$$HDEP = \frac{\text{Total number of eggs laid in a day}}{\text{Total number of birds alive} \times \text{Number of days in lay}} \times 100$$

iii. Hen-housed egg production (HHEP)

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

$$HHEP = \frac{\text{Total number of eggs laid in a day}}{\text{Number of birds stocked initially} \times \text{Number of days in lay}} \times 100$$

iv. Feed per dozen eggs:

This was computed as feed intake per weight of egg laid (Oladunjoye *et al.*, 2010) as given in the formula below

$$FCR = \frac{\text{average feed intake(g)}}{\text{dozen egg laid (g)}}$$

b. Egg quality parameters

Egg weight (g)

Two eggs were collected from each replicate pen on weekly basis and were individually weighed using sensitive digital top loading scale also known as Mettler Analytic Balance (Mettler Instrument Limited, model type PM: 2000, Switzerland).

Egg length (cm)

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

Egg width (cm)

The egg width was measured using a Vernier Calipper. The width was measured between two ends of the widest cross sectional region. The Venier Calliper is calibrated in centimeters.

Egg shape index

Two external parameters (egg width and egg length) were used to calculate the egg shape index (Adeyemo and Adeyemo, 2009).

$$\text{Egg shape index} = \frac{\text{Egg width (cm)}}{\text{Egg length (cm)}}$$

Yolk height (mm), Yolk diameter and Yolk index

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 Calipper. Yolk index was calculated as the ratio of the yolk height to the diameter (Bawa *et al.*, 2010).

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

Albumen height (mm)

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

Haugh unit

The values obtained from albumen height together with the egg weight was used to calculate the Haugh unit. The Haugh unit of egg was calculated using the formula given by Haugh, as cited by Oluyemi and Roberts (2000).

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

Where:

H = Albumen height (mm)

W = Weight of egg (g)

Yolk and Albumen length (mm)

Egg was carefully broken into a flat dish. The lengths were measured from the points where they meet to the point where it ends by using a pair of Vernier Calipper.

Albumen weight and yolk weight (g)

Egg was carefully broken into a petri dish, the yolk and albumen were placed in separate petri dishes which were weighed before use. The difference in the weight of each petri dish before and after 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 (Mettler Instrunments Limited, model type PM 2000, Switzerland) was used; calibrated in grams.

Shell weight (g)

The shell weight was taken after air drying. The Mettler analytical balance made by Mettler Instrunments Limited, model type PM 2000 and made in Switzerland was used; calibrated in grams.

Shell thickness (mm)

The shell of broken eggs was air-dried and then 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 Guage, expressed in millimeters (Adeyemo andAdeyemo, 2009)

3.13 Proximate Analysis

This analysis was to determine the Dry Matter (DM), Crude Protein (CP), Crude Fibre (CF), Ash and Ether Extract (EE) of the experimental diets used in growing and laying phases of the experiment as well as that of the droppings for the digestibility trial in accordance with the AOAC (2000) standard procedures. Nitrogen Free Extract (NFE) was calculated by simple deduction.

3.14 Data Analysis

Data collected from the two experiments were subjected to One-Way Analysis of Variance (ANOVA) at 5 % probability level. Significantly different means were separated using Duncan Multiple Range Test. The Statistical Package for Social Scientists (SPSS, 2007) Version 17 was used to analyze the data.

CHAPTER FOUR

4.0 RESULTS

4.1 Proximate Composition of Sun - dried Cassava Peel Meal Flavoured with Molasses

The results of the proximate composition of the test ingredient; sun - dried cassava peel meal flavoured with molasses is presented in Table 4.1. The results showed that the test ingredient had the following on dry matter basis, crude protein, crude fibre, ether extract and calculated nitrogen free extract values of 88.60, 5.20, 12.20, 3.90 and 60.10 %, respectively.

4.2 Experiment One: Growth Performance and Nutrient Digestibility of Grower Japanese quails fed Molasses Flavoured Sun – Dried Cassava Peel Meal

4.2.1 Proximate composition of experimental diets fed to Japanese quails during the growth phase

The results of the proximate composition of the experimental diets fed to Japanese quails during the growth phase of the experiment are presented in Table 4.2. The results showed that dry matter values ranged between 90.40 – 92.00 %, crude protein values were between 23.33 – 26.18 %, crude fibre values were between 6.50 – 14.22 %, ether extract values were between 8.00 – 13.04 %, ash values were between 7.50 – 9.38 % while the calculated nitrogen free extract values were between 31.43 – 43.82 % across the treatments, respectively.

Table 4.1: Proximate composition of test ingredient (molasses flavoured sun – dried cassava peel meal) and maize

Parameters (%)	MFSCPM	Maize
Dry matter	88.60	86 - 87
NFE	60.10	70 – 71.3
Ash	7.20	1.2
Crude fibre	12.20	2.8
Crude protein	5.20	9 – 12.9
Ether extract	3.90	3.8 – 4.5

Key

MFSCPM = Molasses flavoured sun - dried cassava peel meal

NFE = Nitrogen free extract

Table 4.2: Proximate composition of experimental diets fed to growing Japanese quails

	Treatments			
Parameters (%)	T_1 (0 %)	T_2 (50 %)	T_3 (75 %)	T_4 (100 %)
Dry matter	92.00	92.00	90.40	91.40
Ash	7.50	8.50	8.68	9.38
NFE	43.82	39.46	35.58	31.43
Crude fibre	6.50	9.00	9.50	10.22
Crude protein	26.18	24.83	24.14	23.33
Ether extract	8.00	10.21	12.50	13.04

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

NFE= Nitrogen Free Extract

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

4.2.2 Growth performance of growing Japanese quails fed diets containing graded levels of molasses flavoured sun – dried cassava peel meal

The results of the growth performance of Japanese quails fed diets containing graded levels of Molasses flavoured sun – dried cassava peel meal as a replacement for maize are presented in Table 4.3. The results showed no significant ($p>0.05$) differences among the dietary treatments for all parameters measured. However, birds fed 75 % replacement level of sun - dried cassava peel meal flavoured with molasses had the highest numerical values for final body weight (116.70 g), daily feed intake (11.69 g), daily weight gain (3.60 g) but poorer feed conversion ratio (1.33).

4.2.3 Apparent nutrients digestibility of growing Japanese quails fed diets containing graded levels of sun - dried cassava peel meal flavoured with molasses

The results of the apparent nutrients digestibility of diets containing graded levels of molasses flavoured sun – dried cassava peel meal by growing Japanese quails are presented in Table 4.4. The results showed that there were no significant ($p>0.05$) differences in the apparent digestibility of the nutrients except for crude protein. Quails fed control diet (82.59 %) and 50 % MFSCPM (82.54 %) had the best apparent protein digestibility while those fed 75 % MFSCPM had the lowest protein digestibility (79.94 %). The results of total digestible nutrients (TDN) shows that birds on 100 % MFSCPM had the highest value (78.78 %) while the control (0 %) had the lowest value (75.07 %).

Table 4.3: Growth performance of growing Japanese quails fed molasses flavoured sun – dried cassava peel meal based diets

Parameters	Treatments T_1 (0 %)	T_2 (50 %)	T_3 (75 %)	T_4 (100 %)	SEM	P-value
Ave initial weight (g/b)	49.80	50.70	50.30	50.80	0.32	0.70
Ave daily feed intake (g/b)	11.00	10.71	11.69	11.05	0.22	0.86
Ave daily weight gain (g/b)	3.40	3.60	3.60	3.45	0.09	0.86
Ave final weight (g/b)	110.59	115.20	116.70	111.70	3.57	0.92
FCR	3.24	2.98	3.25	3.20	0.04	0.86

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

FCR= Feed conversion ratio

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

SEM= Standard error of mean

Significant ($p<0.05$)

Not significant ($p>0.05$)

Table 4.4: Apparent nutrients digestibility (%) of growing Japanese quails fed Molasses flavoured sun - dried cassava peel meal based diets

	Treatments					
Parameters	T_1 (0 %)	T_2 (50 %)	T_3 75 %)	T_4 (100 %)	SEM	P-value
NFE	75.42	72.12	70.32	71.24	0.58	0.13
Ash	73.04	70.91	71.10	72.81	0.74	0.20
Crude fibre	72.01	76.27	72.76	74.81	0.49	0.18
Crude protein	82.69^{a}	82.54^{a}	79.94^{c}	80.69^{b}	0.36	0.00
Dry matter	76.90	77.12	74.69	77.19	0.32	0.25
Ether extract	87.36	91.19	94.08	92.31	0.74	0.10
Total Digestible Nutrient	75.07^{d}	76.77^{c}	77.80^{b}	78.78^{a}	0.42	0.00

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

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

NFE= Nitrogen free extract

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

SEM= Standard error of mean

ns = Not significant ($p>0.05$)

Significant ($p<0.05$)

Not significant ($p>0.05$)

4.2.4 Carcass characteristics of growing Japanese quails fed diets containing graded levels of molasses flavoured sun – dried cassava peel meal

The results of the effect of feeding molasses flavoured sun – dried cassava peel meal based diets on the carcass retail cut parts of Japanese quails are shown in Table 4.5. The results showed that slaughter weight, eviscerated weight, breast, thigh, wings, neck and drumstick were all significantly ($p<0.05$) affected by the dietary treatments. The dietary treatments had no significant ($p>0.05$) effect on head. The results of live and eviscerated weight showed that birds fed the control and 50 % MFSCPM had similar values which were significantly ($p<0.05$) higher than birds fed 75 % MFSCPM and 100 % MFSCPM. Birds fed 100 % MFSCPM had significantly ($p<0.05$) higher dressed weight, thigh, drumstick and shank values compared to birds fed the other treatment diets. The results of the breast showed that birds fed 0, 75 and 100 % MFSCPM were significantly ($p<0.05$) lower than those fed 50 % MFSCPM diets.

4.2.5 Internal organ characteristics of growing Japanese quails fed diets containing graded levels of sun – dried cassava peel meal flavoured with molasses

The results of the effect of feeding molasses flavoured sun – dried cassava peel meal on the internal organ of Japanese quails are presented in Table 4.6. The results showed that the dietary treatments had no significant ($p>0.05$) effect on lungs. However, intestine, liver, heart, gizzard and crop were significantly ($p<0.05$) affected by dietary treatments. The values of the intestines showed that birds fed 75 % MFSCPM had significantly ($p<0.05$) higher value than those fed control diet. The results of the liver showed that birds fed 75 % MFSCPM had similar ($p>0.05$) with birds fed the control diet but values obtained for those fed diets 50 % and 100 % MFSCPM, were significantly ($p<0.05$) lower.

Table 4.5: Carcass characteristics of growing Japanese quails fed MFSCPM

Parameters	Treatments					
	T_1 (0 %)	T_2 (50 %)	T_3 (75 %)	T_4 (100 %)	SEM	P-value
Live weight (g)	110.40^{a}	113.40^{a}	104.49^{b}	96.04^{c}	1.26	0.00
Eviscerated weight (g)	72.38^{a}	71.94^{a}	65.32^{b}	64.56^{b}	0.93	0.00
Dressed weight (%)	61.02^{b}	46.56^{d}	55.16^{c}	63.61^{a}	1.09	0.00
Cut-off parts (% of live weight)						
Head	5.35	5.23	5.46	4.44	0.04	0.18
Breast	26.70^{b}	29.92^{a}	21.64^{c}	21.73^{c}	0.79	0.00
Drumsticks	5.72^{b}	5.85^{b}	6.19^{b}	8.55^{a}	0.20	0.00
Neck	5.19^{a}	4.18^{c}	4.02^{c}	4.82^{b}	0.09	0.00
Shanks	2.26^{b}	2.23^{b}	2.35^{b}	6.87^{a}	0.32	0.00
Thigh	9.45^{b}	9.14^{b}	9.28^{b}	13.63^{a}	0.32	0.00
Wings	6.35^{a}	6.39^{a}	6.22^{a}	2.58^{b}	0.27	0.00

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

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

Significant ($p<0.05$)

Not significant ($p>0.05$)

SEM= Standard error of mean

Table 4.6: Internal organ characteristics of growing Japanese quails fed MFSCPM (% of live weight)

	Treatments					
Parameters	T_1 (0 %)	T_2 (50 %)	T_3 (75 %)	T_4 (100 %)	SEM	P-value
Crop	1.74^d	2.87^b	2.16^c	3.28^a	0.12	0.00
Gizzard	4.29^b	4.67^a	4.02^b	$4.08^{\mathbf{b}}$	0.07	0.01
Heart	0.94^a	0.96^a	0.92^a	0.67^b	0.03	0.01
Intestine	3.76^c	4.11^c	5.31^a	4.71^b	0.11	0.00
Liver	1.99^a	1.46^b	2.01^a	1.57^b	0.06	0.00
Lungs	0.93	0.87	0.84	0.80	0.02	0.27

abc: Means in the same row with different superscript are significantly (p<0.05) different

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

NFE= Nitrogen free extract

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

SEM= Standard error of mean

Significant (p<0.05)

Not significant (p>0.05)

4.3 Experiment Two: Productive Performance and Egg Parameters of Laying Japanese quails fed Molasses Flavoured Cassava Peel Meal Based Diets

4.3.1 Proximate composition of the experimental diets fed to Japanese quails during the laying phase

The results of the proximate composition of experimental diets fed to laying Japanese quails are presented in Table 4.7. The results showed that dry matter values range between 91.80 % in (100 % MFSCPM) to 92.60 % (50 % MFSCPM) while the crude protein values were between 19.25 % in both (0 and 50 % MFSCPM) and 21.00 % in both (75 and 100 % MFSCPM) respectively. The highest value for crude fibre was observed in 50 % MFSCPM (4.00 %) while the highest values for ether extracts and ash 8.00 and 21.50 %, respectively were observed in 0 % MFSCPM. The nitrogen free extract (NFE) values for 0, 50, 75 and 100 % MFSCPM are 40.65, 49.35, 44.02 and 44.50 %, respectively.

4.3.2 Egg production performance of Japanese quails fed diets containing graded levels of molasses flavoured cassava peel meal based diets

The results of egg production performance of Japanese quails fed diets containing graded levels of molasses flavoured sun - dried cassava peel meal as a replacement for maize is presented in Table 4.8. The statistically highest average daily feed intake per bird was observed in 75 % MFSCPM which was significantly ($p<0.05$) higher than the control. The average egg weight values showed that birds fed 100 % MFSCPM (9.10 g) was significantly ($p<0.05$) heavier than egg weights from birds fed 0 % (8.65 g), 50 % (8.01 g) and 75 % MFSCPM (8.30 g) respectively. The hen day egg production values was such that birds fed control (0 % MFSCPM) recorded a value of 41.50 % which was similar ($p>0.05$) to 50 % MFSCPM with a value of 35.07

%. Both values (41.50 and 35.070 was higher than for birds fed 75 % MFSCPM (24.34 %) and 100 % MFSCPM (11.82 %). The hen house egg production values also showed that the birds fed control diet and 50 % MFSCPM with values (41.50 % and 35.07 %) were significantly ($p<0.05$) higher than birds fed 75 % and 100 % MFSCPM (23.71 % and 9.61 %) respectively. The results of feed per dozen egg laid showed that birds fed control diet and 100 % MFSCPM had the lowest values of (2.21 and 2.26) which were significantly ($p<0.05$) better than for birds fed 50 % and 75 % MFSCPM with values of 2.65 and 2.74 respectively.

4.3.3 Egg quality parameters of Japanese quails fed diets containing graded levels of molasses flavoured cassava peel meal based diets

The results of the effects of feeding molasses flavoured sun - dried cassava peel meal as a replacement for maize is presented in Table 4.9. The results showed that all parameters measured were significantly ($p<0.05$) influenced by dietary treatments except egg shape index and egg shell thickness. The results showed that quails fed T_4 had better performance for egg volume, egg density, egg length, egg width and egg shell weight than the control and the other dietary treatments. However, quails fed T_1 and T_4 were statistically ($p>0.05$) similar in egg volume, while quails fed T_1 and $_{T3}$ were statistically ($p>0.05$) similar for egg density and egg width.

4.3.4 Internal egg quality parameters of Japanese quails fed diets containing graded levels of sun – dried cassava peel meal flavoured with molasses

The results of internal egg quality parameters of Japanese quails fed sun - dried cassava peel meal flavoured with molasses as a replacement for maize are presented in Table 4.10. The results showed significant ($p<0.05$) differences in all the parameters measured. Quails fed 100 % MFSCPM had significantly ($p<0.05$) higher values than the control and the other dietary

Table 4.7: Proximate composition of experimental diets fed to Japanese quails during the laying phase

Parameters (%)	T_1 (0 %)	T_2 (50 %)	Treatments T_3 (75 %)	T_4 (100 %)
Dry matter	92.40	92.60	92.20	91.80
Crude protein	19.25	19.25	21.00	21.00
Crude fibre	3.00	4.00	3.50	3.50
Ether extract	8.00	6.50	5.00	6.50
Ash	21.50	13.50	18.68	16.50
NFE	40.65	49.35	44.02	44.30

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

NFE= Nitrogen free extract

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

Table 4.8: Egg production performance of Japanese quails fed MFSCPM

Parameters	Treatments					
	T_1 (0 %)	T_2 (50 %)	T_3 (75 %)	T_4 (100 %)	SEM	P-value
Ave daily feed intake/bird/egg laid (g)	19.00^{b}	21.18^{ab}	22.78^{a}	20.60^{ab}	0.36	0.02
Ave egg weight (g)	8.65^{b}	8.01^{d}	8.30^{c}	9.10^{a}	0.04	0.00
Hen day egg production (%)	41.50^{a}	35.30^{a}	24.34^{b}	11.82^{c}	1.54	0.00
Hen house egg production (%)	41.50^{a}	35.07^{a}	23.71^{b}	9.61^{c}	1.56	0.00
Feed conversion ratio	2.21^{a}	2.65^{b}	2.74^{b}	2.26^{a}	0.05	0.00

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

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

NFE= Nitrogen free extract

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

SEM= Standard error of mean

Significant ($p<0.05$)

Not significant ($p>0.05$)

treatments for yolk weight, albumen weight, yolk height and yolk index while quails fed 0 % and 100 % MFSCPM had higher ($p<0.05$) albumen height and haugh unit. Quails fed T_1 (control) had the highest ($p<0.05$) value for yolk diameter but not statistically ($p>0.05$) different from quails fed 75 % MFSCPM.

Table 4.9: External egg quality parameters of Japanese quails fed MFSCPM

Parameters	Treatments					
	T_1 (0 %)	T_2 (50 %)	T_3 (75 %)	T_4 (100 %)	SEM	P-value
Egg weight (g)	8.65^b	8.01^d	8.30^c	9.10^a	0.04	0.00
Egg volume (cm^3)	7.82^a	7.60^b	7.62^b	7.96^a	0.02	0.00
Egg density (g/mL)	1.11^b	1.05^c	1.09^b	1.15^a	0.00	0.00
Egg length (cm)	2.96^b	2.94^b	2.92^c	2.99^a	0.01	0.05
Egg width (cm)	2.27^b	2.23^c	2.26^b	2.31^a	0.00	0.01
Egg shape index	0.77	0.76	0.78	0.77	0.00	0.36
Shell weight (g)	0.99^b	0.96^b	0.99^b	1.03^a	0.00	0.00
Shell thickness (mm)	0.21	0.21	0.21	0.21	0.00	0.38

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

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

NFE= Nitrogen free extract

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

SEM= Standard error of mean

LS= Level of significant

Significant ($p<0.05$)

Not significant ($p>0.05$)

Table 4.10: Internal egg quality parameters of Japanese quails fed MFSCPM

			Treatments			
Parameters	T_1 (0 %)	T_2 (50 %)	T_3 (75 %)	T_4 (100 %)	SEM	P
Yolk weight (g)	3.62^{b}	3.32^{c}	3.48^{bc}	3.73^{a}	0.03	0.00
Albumen weight (g)	3.61^{b}	3.34^{c}	3.40^{c}	3.93^{a}	0.03	0.00
Yolk height (cm)	1.77^{b}	1.70^{c}	1.69^{c}	1.86^{a}	0.08	0.00
Albumen height (cm)	1.41^{a}	1.33^{b}	1.34^{b}	1.44^{a}	0.08	0.00
Yolk diameter (cm)	2.90^{a}	2.79^{b}	2.88^{a}	2.79^{b}	0.01	0.00
Yolk index	0.62^{b}	0.61^{b}	0.59^{c}	0.67^{a}	0.04	0.00
Haugh unit	125.18^{a}	123.54^{b}	123.63^{b}	125.76^{a}	0.19	0.00

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

Key

MFSCPM= Molasses flavoured sun - dried cassava peel meal

NFE= Nitrogen free extract

Treatment 1; (control): 100 % maize: 0 % replacement of maize with MFSCPM

Treatment 2; 50 % maize: 50 % replacement of maize with of MFSCPM

Treatment 3; 25 % maize: 75 % replacement of maize with of MFSCPM

Treatment 4; 0 % maize: 100 % replacement of maize with of MFSCPM

SEM= Standard Error of Mean

Significant ($p<0.05$)

Not significant ($p>0.05$)

CHAPTER FIVE

5.0 DISCUSSION

5.1 Discussion

5.1.1 Proximate composition of sun - dried cassava peel meal flavoured with molasses

The results of proximate composition of sun - dried cassava peel meal flavoured with molasses showed that it had dry matter value of 88.60 % which is higher than the value of 80.75 % obtained by Adesehinwa *et al.* (2008), but is similar to the values (88.80, 89.20, 90.94 and 90.75 %) obtained by Oladunjoye *et al.* (2010); Mayaki *et al.* (2014); Adeyemo *et al.* (2014) and Oladunjoye *et al.* (2014) respectively. The crude protein value (5.20 %) is within the range of 5.10 % and 5.24 % obtained by Oladunjoye *et al*. (2010) and Oladunjoye *et al*. (2014) but disagrees with Mayaki *et al*. (2014) who obtained crude protein values of 4.24 when cassava leaf meal was fed to snail. The crude fibre value of 12.20 % agrees with the result of Oladunjoye *et al.* (2010) who reported crude fibre value of 12.38 % but disagrees with the reports of Babayemi *et al.* (2009); Mayaki *et al.* (2014); Adeyemo *et al.* (2014) and Oladunjoye *et al.* (2014) who reported 10.00, 10.48, 3.35, and 16.50 %, respectively for cassava peal meal. The value obtained for ether extract (3.90 %) is the same with the value reported by Oladunjoye *et al.* (2014) but is higher than the 0.75, 0.87 and 0.84 % reported by Adesehinwa *et al.* (2008); Mayaki *et al.* (2014) Adeyemo *et al.* (2014) respectively for cassava peel meal. The value for ash is (7.60 %) is higher than the 5.16, 5.15, 6.40, 4.37 % reported by Oladunjoye *et al.* (2010); Mayaki *et al.* (2014); Oladunjoye *et al.* (2014) and Adeyemo *et al.* (2014), respectively but the nitrogen free extract value (60.10 %) is lower than the values 73.25, 70.01, 68.30, and 67.70 % obtained by Oladunjoye *et al.* (2010); Mayaki *et al.* (2014); Oladunjoye *et al*., 2014 and Adeyemo *et al.*

(2014), respectively. The variations in the compositions could be due to the addition of molasses, variety of cassava used, processing method and or other agronomic practices employed in the cultivation of the cassava.

5.1.2 Proximate composition of the experimental diets fed to Japanese quails during the growth and laying phases

The result of the proximate composition of the experimental diets used during the growth phase of this study showed that the crude protein content (23.33 % and 26.18 %) falls within the recommended 24 - 26 % protein requirements for growing Japanese quails as reported Omidiwura *et al*. (2016). The protein content of the diets fed during the laying phase (19.25 to 21.00 %) is in agreement with the reports of Edache *et al.* (2010) and Bawa *et al.* (2010) who recommended 20 and 22 % crude protein level for optimum egg production of Japanese quails. This implies that diets based on cassava peel meal flavoured with molasses supplied the required crude protein for optimum growth, carcass characteristics and egg production of Japanese quails.

5.1.3 Performance of growing Japanese quails fed diets containing varying levels of sun dried cassava peel meal flavoured with molasses as a replacement for maize

The non – significant difference in the values obtained for growth performance traits of Japanese quails fed graded levels of sun - dried cassava peel meal flavoured with molasses as replacement for maize conforms with the findings of Abdullahi *et al.* (2018) who reported no significant difference in initial body weight, average weight gain and feed conversion ratio when sundried cassava peel meal flavoured with honey was used to replace maize at 0, 50, 70 and 100 % in the diets of growing Japanese quails. The results obtained from the present study also agrees with the reports of Ijaiya *et al.* (2018) who reported no significant difference in all parameters measured except for final weight when sundried cassava peel meal flavoured with honey was fed to growing Japanese quails at 0, 50, 75 and 100 %. The present results however disagrees with the findings of Malik *et al.* (2018a) who reported significant difference in body weight gain and total feed intake when fermented cassava peel meal was fed to growing Japanese quails at 0, 25, 50 and 75 % replacement for maize and Malik *et al.* (2018b) reported significant differences in daily feed intake and feed conversion ratio (FCR) among the treatments in the growing phase when sundried cassava peel was fed to Japanese quails at 0, 25 50 and 75 % replacement for maize. The disagreements in the results could be due to the processing methods adopted or the addition of molasses in the present study.

5.1.4 Apparent nutrients digestibility of growing Japanese quails fed diets containing varying levels of sun - dried cassava peel meal flavoured with molasses as a replacement for maize

The insignificant results of the apparent nutrients digestibility of diets by growing Japanese quails except for crude protein is in contrast with the findings of Salami and Odunsi (2003) and Onyimonyi and Ugwe (2007) who reported that birds could only tolerate cassava peel meal at levels up to 50 % replacement for maize; and Abdullahi *et al.* (2018) who reported significant differences among nutrients digestibility of Japanese quails when fed sundried cassava peel meal flavoured with honey at 0, 50, 75 and 100 % replacement for maize. The results obtain also disagrees with the reports of Ijaiya *et al.* (2018) who fed sundried cassava peel meal flavoured with honey at 0, 50, 75 and 100 % to growing Japanese quails and observed significant differences among dietary treatments for all parameters measured, Malik *et al.* (2018a) also fed fermented cassava peel meal to growing Japanese quails at 0, 25 50 and 75 % and reported that all nutrients digestibility values were significantly influenced. The total digestible nutrients increased as the molasses flavoured sun – dried cassava peel meal level increases. It is worthy to note however, that all the nutrients had apparent digestibility values above 50 % which implies that the birds had high apparent nutrients digestibility. The high utilization of the nutrients could have been due to the addition of molasses.

5.1.5 Carcass and internal organ characteristics of Japanese quails fed varying levels of sun dried cassava peel meal flavoured with molasses as a replacement for maize

The results of carcass and internal organ characteristics showed that the inclusion of sundried cassava peel flavoured with molasses significantly influenced all parameters measured except the head and lungs. The present results is in contrast with the findings of Malik *et al.* (2018a) who reported that inclusion of fermented cassava peel meal at 0, 25 50 and 75 % had no significant influence on the weight of gizzard and intestine of Japanese quails. The outcome of the present study also disagrees with the findings of Oruwani *et al.* (2003) who noted no significant effect on the weight of the gizzard of broilers fed diets in which maize was replaced by cassava/brewers' dried yeast blend at 100 %. The results of live weight disagrees with the reports of Ojewola *et al.* (2006) who reported significant decline in live weight as the inclusion level of cassava peel meal increased in broiler diets while the results of dressing percentage, neck and breast of the current study disagree with the with Ojewola *et al.* (2006) who fed supplemented and unsupplemented cassava peel meal with palm oil as a replacement for maize to broilers and reported that dressing percentage, neck and breast weight declined significantly with increase in the inclusion level of cassava peel meal. The disagreement in the results could be due to the use of molasses in the present study.

5.1.6 Effect of replacing maize with sun - dried cassava peel meal flavoured with molasses on egg production and egg quality parameters of Japanese quails

The statistical significant difference in the results of egg production and egg quality were noted in all parameters except egg shape index and shell thickness. This disagrees with the findings of Malik *et al.* (2018a) who reported that there were no significant differences in all parameters measured when fermented cassava peel meal was fed to laying Japanese quails at 0, 25, 50 and 75 %. The value for feed intake in this study is similar to the report of Malik *et al.* (2018b) who fed sun - dried cassava peel meal to laying Japanese quails at 0, 25, 50 and 75 % and reported significant differences in daily feed intake, Feed conversion ratio, hen-day production and egg quality parameters. The significant differences observed in the egg quality parameters does not agree with the findings of Malik *et al.* (2018a) who reported no significant difference among all egg quality parameters when fermented cassava peel meal was fed to laying Japanese quails. The result of the egg shape index and shell thickness agrees with the reports of Bawa *et al.* (2010) who reported no significant difference in egg shape index and shell thickness when breeder Japanese quails were fed different protein levels. The significant difference observed in the present results could be due to the addition of molasses and the processing method adopted.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Based on the findings of this research work, the following conclusions were drawn:

The feeding of molasses flavoured sun – dried cassava peel meal to growing Japanese quails did not (p>0.05) affect average daily feed intake, average final weight and average weight gain. Feeding of molasses flavoured sun – dried cassava peel meal to growing Japanese quails compared favourably with the control in the digestibility of all nutrients except for crude protein. Molasses flavoured sun – dried cassava peel meal based diets fed to growing Japanese quails significantly improved dressed weight, thigh, drumstick and shanks weight. Molasses flavoured sun – dried cassava peel meal based diets significantly (p<0.05) improved average daily feed intake, average egg weight and feed conversion ratio when fed to laying Japanese quails. Feeding of molasses flavoured sun – dried cassava peel based diets to Japanese quails significantly (p<0.05) improved internal and external egg quality parameters.

6.2 Recommendations

Based on the above conclusions, the followings are recommended:

Molasses flavoured sun – dried cassava peel meal could be fed to growing Japanese quails at 100 % replacement for maize without negatively impeding growth performance, nutrients digestibility, carcass and organ characteristics, egg production and egg quality. Molasses flavoured sun – dried cassava peel meal has high fibre content, further work should be carried out on fortification with enzymes to improve crude fibre digestibility.

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