EFFECT OF MANGO (*Mangifera indica L.*) SEED KERNEL MEAL WITH AND WITHOUT ENZYME SUPPLEMENTATION ON THE GROWTH AND LAYING PERFORMANCE OF JAPANESE QUAILS

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M.Sc.) DEGREE IN ANIMAL SCIENCE

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DECLARATION

I hereby declare that the work in this dissertation entitled "**Effect of mango (***Mangifera indica* L.**) Seed kernel meal with and without enzyme supplementation on the growth and laying performance of Japanese quails"** was carried out by me in the Department of Animal Science, Faculty of Agriculture Ahmadu Bello University, Zaria under the supervision of Prof. J.J. Omage and Prof. T.S. Olugbemi. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another Degree or Diploma at this and any University.

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Name of student Signature Date

CERTIFICATION

This dissertation entitled **"Effect of mango (***Mangifera indica* L.**) seed kernel meal with and without enzyme supplementation on the growth and Laying performance of Japanese quails"**by Hussaini Ahmad MUSA, meets the regulations governing the award of the degree of Master of Science (Animal Science) Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This dissertation is dedicated to Almighty Allah (SWT) the Lord of all created beings, animate and inanimate who has always and forever been my source of Strength, Comforter, Provider, Helper and all those innumerable angelic qualities which had been the spirit behind the success of all my careers in life, this study inclusive. It is also dedicated to my beloved late parents Mallam Musa Ahmad and Malama Hafsat Ahmad Tijjani, for the strict spiritual upbringing rendered unto me from my first day on earth, my spiritual counselor, Mallam Sani Abdulkarim for making me realize what it means to be a servant of Allah (S.W.T), my wife and children, Malama Salamatu Sulaiman, Abdulbasid, Muhammad, Hafsah, Hassan and Mardiyya for the patience, prayers, sacrifice and support rendered to me throughout the course of this work.

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ABSTRACT

Two sets of experiments were carried out to determine the effects of the inclusion of mango seed kernel meal (MSKM)*kanbiri*, processed by soaking for 72:00 hours with an eight hourly change of water to reduce the anti-nutrients factors on the growth and laying performances of Japanese quails with and without enzymes.Results of the laboratory analysis obtained after processing revealed values of 90.06 %, 4.78 %, 5.58 %, 1.96 %, 5.39 % and 68.40 % in the dry matter,crude protein, crude fiber, ether extract, ash and nitrogen free extract respectively and the following for the anti-nutrient factor contents; phytate, cyanide, tannins and saponins values of 0.16mg/100g, 0.02mg/100g, 0.04mg/100g and 0.06mg/100g respectively.In the first field experiment, 450 unsexed quails at one week old were placed in ten experimental set up of 3 x 3 factorial arrangement with three replicates of fifteen birds each with one control in a completely randomized design. Ten experimental growth diets of three levels of SMSKM inclusions at (10.00 %, 20.00 % and 30.00 %) and three enzyme types of (no enzyme, Maxigrain enzyme and Vegpro enzyme) with one control (no SMSKM, no enzyme) were offered to the birds throughout the growth phase. Results indicate significant ($P < 0.05$) differences for the final body weight, total feed intake and feed to gain ratio. The control had the highest final body weight of 178.40 g and best feed to gain ratio of 4.64, indicating preference for birds for the intake of non-conventional feed materials, due to the efficient feed to gain ratio. With the enzyme inclusion, significant ($P < 0.05$) differences were noticed in the final body weight, feed to gain ratio and total feed intake. Treatment with both enzyme had a significantly($P < 0.05$) similar least feed intakes of 495.88 g and the worst feed to gain ratio average of 5.77compared to the control.Carcass analysis reveals significant ($P < 0.05$) differences with and without enzymes in the average live weight,

carcass weight and dressing percent. The 20.00 % level having the highest average live weight gain of 147.17 g, carcass weight of 88.52 g and dressing percent of 61.04 %, indicating efficiency of the MSKM at this level of 20.00 %; vegpro enzyme recorded the highest values for the carcass (92.32 g), dressing percent (62.90 %) against the maxigrain enzyme. The 30.00 % inclusion levels had the highest digestibility values of 67.98 % dry matter, 78.63 % ether extract and 64.36 % ash retension.Treatment with maxigrain enzyme had the highest values of 68.40 % dry matter, 72.27 % crude protein, 77.63 % ether extract, 67.19 % ash and, confirming earlier reports on the efficiency of exogenous enzymes in unconventional feed uses in monogastric animals. The 20.00 % had the least feed cost at market weight of ₦102.23k after the control.In experiment two, similar experimental design, factorial arrangement with three replicates x ten birds were set up, the feeding and water intake regime were maintained. Results indicate 20.00 % SMSKM in all having the overall best performance; mainly in total feed intake (1921.49 g), final body weight (202.22 g), but a feed togain ratio of 1.02 was noticed by birds in the control treatment.Enzyme vegpro had the best performance in the total feed intake (1877.01 g), average age of bird at first lay (43.11 days) and hen day egg production (77.95 %),the overall egg external quality performance of 10.00 %, 20.00 % and 30.00 % were all significantly similar. It could be concluded that, the processing method used in this study reduces the tannin and phytate contents far below the toxic levels for poultries, which it tolerates up to 30.00 % without any adverse effects on the growth performance at the growth phase, with and without enzyme supplementation.

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CHAPTER ONE

INTRODUCTION

Global consumption of poultry and its products especially meat, has consistently increased over the years and this trend is expected to continue. Much of this increase in global demand will be in developing countries resulting in a profound effect on the demand for feed and its raw materials (Chinedu and Evans,2001). It had been established that the principal item in raising poultry is the price of the feed, amounting to about 70.00 – 80.00 % of the total production cost (Kehinde *et al.*, 2006; Bello *et al*., 2007), the livestock sub-sector contributed about 24.18 % from an initial value of 23.86 % in the fourth quarter of 2014 of the Gross Domestic Product (GDP) in Nigeria, (CBN, 2016).

Poultry in particular occupies an important position in the supply of animal protein to Nigerian's teeming and growing population (Chinedu and Evans, 2001). Unfortunately, the interest in chicken farming is dwindling steadily over the years as a result of the animal`s susceptibility to various epidemic diseases leading to records of its high mortality, coupled with its high feed intake and demand for larger space for production compared with other smaller birds such as quails,which have compelled farmers to seek for an alternative source of poultry meat, prompting the recent attention being shifted to quail farming mainly in developing countries, to enable its populace, meet the daily safe protein intake recommendation of FAO (1997) placed at 45.00 g/ 60.00 kg body weight per individual.

Japanese quails (*Coturnix coturnix japonica)* are small birds belonging to the *phasianoidea* family of the order *galliforme* of the class *aves* in the animal kingdom.

Since they were introduced into the Nigerian Poultry Industry in 1992 (Haruna *et al.,*1997), it has the potential to serve as an excellent and cheap source of animal protein for Nigerians (Babangida and Obosi, 2006; Ani *et al.*, 2009). They have very short generation interval, matures early (35 days), hence can lay between 200 to 300 eggs annually (Salim and Ibrahim, 2004). Owing to its very tender, tasty and highly acceptable meat and the uniform cholesterol in their eggs, they have become alternative animal protein sources (Sule *et al*., 2015).

They are one of the classes of poultry with potential as sources of good quality animal protein as egg and meat (Widya *et al.*, 2014). The meat type quail rearing is a common practice meant to bridge the gap between present demand and supply of animal protein. The efficiency of broiler quails to convert feed into meat, play a key role in the economics of the broiler industry (Chimote *et al.*, 2009). They provide developing countries with a stable source of protein and developed countries a suitable alternative to chicken. It however finds its true economic and commercial value in its egg production, as domesticated lines of the Japanese quails can lay up to 300 eggs a year, at an appreciably efficient feed to egg conversion ratio (Haruna *et al.*, 1997).

They have a short generation interval making it possible to propagate many generations in a year with an early sexual maturity, since they start laying as early as 5-6 weeks of age., They have a fast growth rate: attaining a market weight of 150 – 180 g at 6 weeks (Anon, 1991), with a high rate of lay, quails can produce between 250 – 280 eggs per year (NRC, 1991). Requires less floor space for management, because of their smaller body size, 8 – 10 adult quails can be reared in a space meant for one adult chicken, average of 1square feet/bird (Anon, 1991). Farmers in Vom

have found it very useful in enhancing soil fertility. Estimates have shown that 6 to 8 quails can produce 35.00 kg of manure per year (Haruna *et al.,* 1997).

It has and is still playing active role in the lives of humanity since the 12th century and has continued to play major roles in industries and scientific research institutes. They are easily managed, fast growing and can produce eggs at a high rate hence have been farmed in large quantities across the globe (Hubrecht and Kirkwood, 2010). They have enormous potentiality and could be an alternative to chicken farming particularly in providing gainful employments, supplementary income and as a valuable source of meat and eggs (Abu *et al.,* 2016).

In recent years, the supply of maize (the main source of energy in poultry feeds) which contributes the highest proportion of ingredients in poultry diet formulation (Agbede *et al.,* 2002) has not kept pace with demand. This may be attributed to inadequate production due to climate changes, coupled with the stiff competition for its utilization between man and livestock and its increased use for bio – fuel (fuels produced from plants) production in the developed countries due to its starch contents. It had been reported that the level of performance of livestocks in the livestock production industry have gone down remarkably below expectation due to the high cost of production, mainly arising from the costs of the conventional feed ingredients of protein and energy sources (Dairu and Ogunmodede, 2004).

There is therefore the need to explore alternative and cheaper energy sources for poultry feeding. Mango seed kernels have been found to be one of such alternative sources of energy (Diarra *et al.,* 2011).

Mango (*Mangifera indica L.)* belongs to the family *Amacardiacae.* It is a large green tree that can reach 15 to 30 m tall (Teguia, 1995).The seed is a good source of soluble carbohydrates, the protein content of the seed ranges between 7.00 – 8.75 % (Diarra *et al.,* 2008; Abdullahi *et al.,* 2012) comparable to that of maize, but it has a higher fat content (7.80 – 13.09 %) than maize (Bala, 2010).The kernel is very low in minerals. One major constraint to the effective utilization of this mango seed kernel meal in poultry diet is the presence of tannin (Bala, 2010) a chemical which exert anti-nutritional effect on feed utilization in poultry (Teguia, 1995) and in man (Teguia and Beynen, 2005).

Recently, so many researchers have devised different processing methods aimed at reducing the toxic effects of this chemical for an effective utilization by both the animals and man such as boiling (Diarra *et al.,* 2008), soaking (Bala 2010; Abdullahi *et al.,* 2012), use of exogenous enzymes (Fagbemi and Oluwasola, 1998; Ka`ankuka *et al.,* 2012), thermal processing and radiation (Farrag, 2001), cooking (Diarra and Usman, 2011) and the use of chemical reagents (Mueller, 2001).

1.1 Justification for the Study

Food and Agricultural Organization, FAO (1997) reported the recommended daily consumption of animal protein to be 56.00 g/60.00 kg body weight per day per person. However, Nigerians have not been able to meet this requirement due to the high cost of the products, meeting only about 15.00 gm of protein intake per day (Christopher and Diarrinitiah, 1997).

The high cost of feed still remains the greatest constraint to poultry production in the country. The ever increasing competition between man and livestock for energy

concentrates as feed stuff materials (cereal gains such as maize, millet, guinea corn, rice) prompted the search for an alternatively cheaper, easily available and toxic free unconventional feed sources with no direct nutritional value to man, composed mainly of non – cereal energy sources for poultry feeding (Diarra, 2014) this is coupled with the cost, supply, hence expensive nature of maize which is the main energy source for poultry (Diarra and Usman, 2011).

Mango seed as a by-product of mango pulp has been reported to be a good source of starch (Diarra *et al.,* 2008). The ease, availability and lower cost of processing the mango seed kernel meal makes it a cheaper alternative energy source. The findings of the present study will also contribute to the current clamour of "environmental safety" from pollution when livestock producers and feed millers begin to utilize mango seed kernel as a replacement for maize in feed processing. It will also reduce the hazard of environmental pollution of mango seeds particularly during the mango season.

This study was therefore designed to evaluate the effects of mango seed kernel meal (*L. Kanbiri*) processed by soaking with and without enzymes supplementation on the growth and laying performance of Japanese quails.

1.2 Objectives of the study

This study was designed with the following objectives:

1. To determine the effects of soaked local variety (*Kanbiri*) of mango seed kernel meal (SMSKM) without enzyme supplementation on the growth, laying performance and egg quality characteristics of Japanese quails.

2. To determine the effects of SMSKM with enzyme (Maxigrains, and Vegpro) supplementation on the growth, laying performance and egg quality characteristics of the Japanese quails.

3. To determine the economy of production of SMSKM (*kanbiri*) with and without enzyme supplementation in Japanese quail production.

1.3 Research hypothesis

Null hypothesis (H_O): The inclusion of soaked mango seed kernel meal (SMSKM) (*Kanbiri*) with and without enzyme supplementation, does not have any significant effect on the growth, laying performance and egg quality characteristics of Japanese quails.

Alternative hypothesis (H_A): Soaked mango seed kernel meal SMSKM (*kanbiri*) with and without enzyme supplementation have significant effects on the growth, laying performance and egg quality characteristics of Japanese quails.

Null hypothesis (H_o): Soaked mango seed kernel meal SMSKM (*kanbiri*) with and without enzyme supplementation have no significant effects on the economy of production of Japanese quails.

Alternative hypothesis (H_A): Soaked mango seed kernel meal SMSKM (*kanbiri*) with and without enzyme supplementation have significant effects on the economy of production of Japanese quails.

CHAPTER TWO

LITERATURE REVIEW

2.1 Japanese quails

Japanese quails (*Coturnix coturnix japonica)* are small birds belonging to the *phasianoidea* family of the order *galliforme* of the class *aves* in the animal kingdom. Since they were introduced into the Nigerian Poultry Industry in 1992 (Haruna *et al.*, 1997), they have gained tremendous interest among the Nigerian populace, especially because of their short generation interval, fast growth rate and less susceptibility to common poultry diseases (NVRI, 1996). In animal taxonomy hierarchy, it belongs to the kingdom *Animalia,* phylum *chordata,* Class *Aves*, Order *Galliformes,* Family *phasianidae,* Subfamily *Perdicinae,* and Genus *Coturnix.* It has the potential to serve as an excellent and cheap source of animal protein for Nigerians (Babangida and Obosi, 2006; Ani *et al.*, 2009). They have very short generation interval, matures early (35 days), hence can lay between 200 to 300 eggs annually (Salim and Ibrahim, 2004). Owing to its very tender, tasty and highly acceptable meat and the uniform cholesterol in their eggs, they have become alternative animal protein sources (Sule *et al*., 2015).

They are one of the classes of poultry with potential as sources of good quality animal protein as egg and meat (Widya *et al.,* 2014). The meat type quail rearing is a common practice meant to bridge the gap between present demand and supply of animal protein, the efficiency of broiler quails to convert feed into meat, play a key role in the economics of the broiler industry (Chimote *et al.,* 2009).

2.1.1 General uses of Japanese quails

As the Japanese quails is easily managed, fast growing, small in size, short generation interval and can produce eggs at a high rate, they have been farmed in large quantities across the globe (Mills *et al.,* 1997; Hubrecht and Kirkwood, 2010). Countries of Japan, China, India, Italy, Russia, and the U.S.A all have established commercial quail farm industries (Hubrecht and Kirkwood, 2010).

They provide developing countries with a stable source of protein and developed countries a suitable alternative to chicken. It however finds its true economic and commercial value in its egg production, as domesticated lines of the Japanese quails can lay up to 300 eggs a year, at an appreciably efficient feed to egg conversion ratio (Haruna *et al.,* 1997).

What makes quail eggs unique from other eggs is that they have very low cholesterol but have omega -3-fatty acids in higher proportion than in other eggs (Schwartz and Allen, 1991). Agwunobi and Ekpenyong (1990), reported that the meat of quails and their eggs have low cholesterol, lean fat and higher protein content. The good quality meat has been recommended for diabetic patients, hence having some public health significance (Edache *et al.,* 2007). They have a Short generation interval making it possible to propagate many generations in a year with an early sexual maturity, since they start laying as early as 5-6 weeks of age., They have a fast growth rate: attaining a market weight of 150.00 – 180.00 g at 6 weeks. (Anon, 1991), with a high rate of lay, quails can produce 250 – 280 eggs per year. (NRC, 1991), requires less floor space for management, because of their smaller body size, 8 – 10 adult quails can be reared in a space meant for one adult chicken, average of 1square feet/bird (Anon, 1991).

There is a less feed consumption requirement. Adult quails require only 20.00 – 25.00 g of feed per day (Haruna *et al*.,1997). In terms of egg production the total feed per kg eggs produced is 2.40 compared to 3.30 in chicken (Edache *et al.*, 2012). Noted for its shorter incubation period, 16 – 18 days compared to the 21 days for chicken and 28 days for ducks, guinea fowls, or turkeys; thus, 18 -19 hatches of quail eggs can be made in a year compared to 11 – 12 for ducks, turkey or guinea fowl eggs (Anon, 1991).Quail meat and eggs are reknowned for their high quality protein, high biological value and low caloric value thus making it a choice for hypertensive prone individuals (Edache *et al.*, 2012). They are highly resistant to notorious poultry diseases like gumboro disease, and moderately resistance to many others (Haruna *et al.*, 1997).

It's role in the agro –industries, is very new in Nigeria. The quails like any other poultry, produce by – products such as droppings, feathers, offal and eggshells. These have uses in feed manufacturing, fertilizer production, textiles and fashion design industries. Their droppings are high in nitrogen, thus forming good compost manure for vegetables and other crops. Quail droppings, are valuable manure, very rich in nitrogen and phosphorus. Farmers in Vom have found it very useful in enhancing soil fertility. Estimates have shown that 6 to 8 quails can produce 35.00 kg of manure per year (Haruna *et al.*, 1997). As feed ingredients, quail droppings have a potential for fish and monogastric animals (e.g. pigs). Proximate analysis of dried droppings yielded the following results:-Ash 21.18 %, Crude fibre 25.65 %, Crude protein 23.41 %, Nitrogen free extract 29.13 % (Haruna *et al.*, 1997). The feet, crop, intestines, lungs, etc., are used in preparing food for pet animals. When dried and ground these

become feed containing between 5.00 -6.00 % crude protein and 12.00 % fat (Haruna *et al.,* 1997).

Quails have colourful and fluffy feathers, which have value for making mattresses, pillows and ornamental dressing in fashion houses. Hydrolyzed feathers contained 70.00 % protein. They are deficient in methionine, lysine and tryptophan. Very little of feather meal are used in quail ration. The egg shell is an excellent source of calcium, which could be heat treated and incorporated into feed. Other uses are in fertilizer, paints, vanishes, ink and abrasives. Analysis of heated and dehydrated quail shell has shown that it contains 7.60 % protein, 36.40 % calcium, 0.10 % phosphorus and 0.20 % fat.(Haruna *et al*;1997)

2.1.2 Research on Japanese quails

The interest in quails as a research animal has greatly increased after 1957, due to groups at the University of California and Auburn University who proposed its value in biomedical research. Quails are now widely used for research purposes in both public and private universities. Laboratory fields in which Japanese quails is widely utilized include: genetics, nutrition, physiology, pathology, embryology, cancer, behaviour and the toxicity of pesticides (Ainswort *et al.,* 2010).

2.2 Non-conventional feed materials

The major pre-occupation of animal nutritionists have been to find alternative source to feed ingredients that are in direct competition with human foods. These ingredients, particularly those of protein and energy origin are becoming very expensive to incorporate into animal feed with a concomitant rise in the unit cost of meat, eggs and other animal products (Fasuyi, 2005). Coupled with the economic depression with its

adverse effects on the livestock sub sector, including scarcity and cost of feeds, labour, drugs and vaccines with a weak consumer purchasing power (Chinedu and Evans, 2001). Most of the conventional feed ingredients are highly demanded for human nutritional consumption, thereby creating a hectic competition between man and animals, leading to expensive feed ingredients that may not be affordable by the livestock farmers (Ozung *et al.,* 2015).

There are serious shortages in animal feeds of the conventional origin. The grains required are exclusively for human consumption. With the increasing demand for livestock product as a result of rapid growth in the world economy and shrinking land area, future hopes of feeding the animal and safe guarding their food security will depend on their better utilization of the non-conventional feed materials which do not compete with human food (Farag, 2001).

They refer to all feed resources that have not been traditionally used in animal feeding in rations for livestocks, they include variety of feeds from perennial crops and feeds of animal or industrial origin such as poor quality cellulosic roughages from farm residues such as stubbles, haulms, vines and other agro-industrial by-product such as those from slaughter houses and for the processing of sugar, cereal grains, citrus fruits and vegetables from the processing of food for human consumption (Bakshi and Fontenot, 1998).

The non – conventional feed stuff must be cheap, non – toxic, and not directly eaten by man in order to reduce the cost of poultry feed production. Dafwang *et al.*(2001), Sekoni *et al.* (2008) had earlier reported that the non - conventional feed stuff offer one of the best means of reducing the cost of finished feed, thereby reducing the cost

of eggs and meat. Many of these non – conventional feedstuffs are fibrous in nature and their use in monogastric farm animal diets is therefore limited due to the poor fibre handling abilities of the livestock, which is about 5.00 -7.00 % (Chinedu and Evans,2001).

Some of the most common unconventional major by-product being exploited by man are cocoa bean waste, coconut meals, dry oil palm sludge, cotton seed meal, maize bran, broken rice bran, husk, straw, tapioca waste, wheat bran and straw, dry poultry litters, rumen blood, meat meal and rumen content (Jackmolu, 2005).Others are pigeon pea seed meal (*Cajanus cajan*) (Akintunde *et al.,* 2012), African locust bean (*Parkia biglobosa*) (Mu'azu, 2013). Bovine blood and Rumen content mixture (Okpanachi *et al.*, 2012) all as replacement for protein sources and locust bean pulp, sugar cane scraping with and without enzyme supplementation (Alu *et al.,* 2012a), fermented Cassava peal meal (Ijaiya *et al.,* 2012), sun dried mango seed meal (Nsa *et al.,* 2012), palm kernel based diet (Fagbemi and Oluwasola, 2012) as replacement for energy sources among others.

2.3 Mango Seed Kernel Meal

Mango (*Mangifera indica L.*) is a tree crop, well adapted to all ecological zones in Nigeria, hence the trees are found all over the country. Mango Seed kernel Meal (MSKM), a by – product of mango pulp is reported to be a good source of starch (Diarra, 2014). In India, Mango seed is consumed by human beings in the form of food (Bala, 2010). But in Nigeria, it is regarded as a waste thus contributing to environmental pollution. Mango trees are grown and cultivated all over Nigeria. The fruit is under-utilized since much of it produced have to be consumed fresh and in

season, due to absence of adequate processing industry. Lesser known oil seeds such as wild mango, appear to be better utilized since the pulp surrounding the fibrous coated hard shell is eaten fresh, while the seed is dried and used as condiment in soup.

Varieties of the mango fruits exist in Nigeria, ranging from "*Paparanda", "Kanbiri", "Bakinaku", "Yarkamaru*" (Bala, 2010), *"Julie", Peter* among others. Variations exist in the proximate composition of Indian mango seed from different mango varieties. Values reported ranged from 6.90 to 8.80 % fat, 5.30 to 6.80 % protein, 1.30 to 2.40 % fiber and 2.20 to 2.80 % ash (Dhingra and Kapoor, 1985) and (Augustine and Ling, 1987). Odunsi (2005), reported that the physical component of mango were found to consist of 678.00 g/kg of kernel, 292.00 g/kg of testa, adding that meals from the seed kernel consist of 61.60 g of crude protein, 13.62 g of ether extract, 22.30 g of ash, 46.40 g of crude fibre and 673.50 g of nitrogen free extract. Results of feeding of MSKM to broiler chickens is well documented. Teguia (1995) reported adverse effect on weight gain and feed consumption of broiler chickens fed 20.00 % ground MSKM as replacement for maize. Recently, Amao and Siyanbola (2013) observed significantly lower feed intake, higher body weight gain and better feed conversion ratio in finishing broilers fed 30.00 % dry heat filtered MSKM as a replacement for maize compared to the maize fed control group.

Unlike broilers, documented information on the feeding of MSKM to laying hens is still limited. Odunsi (2005) observed depressed feed intake, rate of lay and feed conversion ratio in layer hens fed above 10.00 % replacement of maize with raw MSKM.

However, shell quality was maintained with up to 15.00 % replacement and internal egg quality were not affected even at 25.00 %. There were reports on the effect of feeding MSKM on organ weights, haematology and serum biochemical constituents on broiler chickens (Diarra, 2014).

Odunsi (2005) reported increase weight of the liver and lungs in broilers fed 20.00 % raw MSKM as a replacement for maize compared with the control, but the weight of the heart, kidneys, and spleen were not affected by the replacement. Abdullahi *et al.* (2012) noted significant differences in the final body weight, feed to gain ratio, feed cost/kg gain, with the final body weight, feed cost/kg decreasing accordingly with increasing levels of the MSKM inclusion as replacement for maize as energy source, while the feed to gain ratio did not follow any regular pattern.

Amino acid profile of the protein from mango seed showed that its content of some of the essential amino acids is higher than the FAO references protein (Augustine and Ling, 1987). This finding conformed to that by Dhingra and Kapoor (1985). There are few reports on the use of Mango seed in livestock feeding, but the level of inclusion in poultry diets has been low due to the presence of tannins (an anti-nutrient), (Diarra *et al.,* 2008). Poultry, unlike ruminants do not have the appropriate enzymes in their gastro intestinal tract (GIT) to destroy and neutralize the negative effects of these anti-nutrients, but several methods can be employed to reduce or eliminate these nutrients, so as to increase the efficiency of feed utilization. Such methods include heat treatment, fermentation, boiling, soaking, sun drying, chemical and physical treatment and the cultivation of cultivars, with low levels of these anti-nutrients (Abeke and Otu, 2008).

2.3.1 Effects of inclusion of soaked mango seed kernel meal on the growth performance of birds (growth phase)

Abdullahi *et al.* (2012) found significant differences up to 100 % inclusion level for starters in the final body weight, average weight gain, average feed intake, feed to gain ratio, average water intake, feed cost per kg gain with the 20 % inclusion level having the overall highest performance, similar result were also observed at the finisher phase. For the carcass characteristics, significant differences were observed in the live weight, slaughter weight and dressing percent. For the digestibility, significant differences were observed up to the 100.00 % inclusion level in all the parameters with the 20.00 % inclusion level having the best digestibility.

Diarra *et al.* (2010) evaluated four diets in which boiled mango kernel meal replaced maize at 0.00 %, 20.00 %, 40.00 % and 60.00 % for thirty five days to broilers, the result showed no significant difference in the daily weight gain, the daily feed intake and feed to gain ratio were significantly improved on the 60.00 % diet compared to the other treatments. The feed cost of meat production (N/kg gain) was significantly reduced on the 60.00 % diet followed by the 40.00 % inclusion diet.

Patil *et al.* (2008) observed that the substitution of 141.00 g/kg mango seed kernel meal for maize did not affect chick performance, adverse effects occurred at 282.00 g/kg or more.

2.4 Anti-nutritional factors in non-conventional feed materials

Most of the potential alternative plant derived nutrient sources are known to contain a wide variety of anti-nutritional substances such as soyabean meal which contain protease inhibitors, cotton seed meal which contains phytic acid and gossypol. They are substances which by themselves or through their metabolic products arising in living systems interfere with food utilization and affects the health and production of animals (Makkar, 1993).

Anti-nutritional factors are disease producing antigens which attack parts of the nuclei of cells including the deoxyribonucleic acid (DNA), presenting various side effects on the physiological and haematological processes of the animal. They are also defined as those substances generated in natural feed stuff by the normal metabolism of species and by different mechanisms, examples like inactivation of some nutrients, diminution of the digestive process of metabolic feed utilization, exerting effects contrary to optimum nutrition (Kumar, 2015a). Being an anti – nutritional factor is not an intrinsic characteristics of a compound but depends upon the digestive process of the ingesting animal (Kumar, 2015b). Trypsin inhibitors which are anti-nutritional factors for monogastric animals, do not exert adverse effect in ruminant animals because they are degraded in the rumen (Cheeke and Shull, 1985).

Plants commonly synthesize a range of secondary metabolites as part of their protection against attacks by herbivorous animals, insects and pathogens or as a means to survive in adverse growing conditions. If farm animals, domestic animals and humans consume these plants, these compounds may cause adverse physiological effects. The term “anti-nutrients” refers to defense metabolites having specific

biological effects, depending on the structure of specific compounds, which range from high molecular weight proteins to simple amino acids and oligosaccharides (Paul, 2014).

They are compounds which reduced the nutrients utilization and or feed intake of plants or plant products used as feeds in livestock Production. Numerous anti-nutritional factors in forages can cause toxicity in livestock. The tannin-protein complexes are astringent and adversely affect feed intake causing negative animal responses (Yilkal, 2015). Anti-nutritional factors are generated in natural feedstuff by normal metabolism of species and by different mechanism of inactivation of some nutrients (Cheeke and Shull, 1985). They either by themselves or through their metabolic product interfere with feed utilization and affect the health and production of animals or which act to reduce nutrient intake, digestion, absorption, utilization and may produce other adverse effects (Akande *et al.*,2010).

2.4.1 Anti-nutritional factors content of the mango seed kernel meal

The anti-nutritional factors content of any seed crop may serve as limitation to its proper and safe consumption, despite its high content of nutrients, the use of MSKM in poultry feeding is limited by the presence of several anti-nutrient factors (Diarra, 2014). The most important anti-nutritional factor that could possibly limit the utilization of MSKM for human and animal consumption is tannin. Other anti-nutrients such as phytate and cyanide may also contribute. The tannin content of MSKM ranges between 0.19 and 0.44 % on dry matter basis (Dhingra and Kapoor, 1985). Some of the anti-nutritional factor content of mango seed kernel meal as reported are condensed tannins 1.20-4.00 g/kg dry matter (Sannon and Kanwe, 2010;

Ashoushand, 2011 and Dakare *et al.*, 2012), tannic acid 56.50 g/kg -75.00 g/kg (Ravindran and Sivakanessan, 1996; Sannon and Kanwe, 2010; Ashoushand, 2011), hydrocyanic acid 64.00-71.00 g/kg dry matter (Ravindran and Sivakanessan, 1996 andFarag, 2001), phytates 1.44-487.30 mg/100g (Fowomolo, 2010 and Dakare *et al.*, 2012), Saponnin 4.00-60.50 mg/100g (Fowomolo, 2010 and Dakare *et al.*, 2012).

2.4.2 Methods of reducing the anti-nutritional factors in mango seed kernel

The abundance of anti-nutritional factors and its toxic influences in plants used as human foods and animal feeds certainly calls for concern, therefore ways and means of eliminating their toxic levels to the bearest minimum have been discovered (Soetan and Oyewole, 2009). Removal of undesirable components is essential to improve the nutritional quality of feeds and effectively utilize their full potential for animals. It is widely expected that simple and inexpensive processing techniques are effective methods of achieving the desirable changes (Akande and Fabiyi, 2010).

Various methods have been attempted to deactivate tannins in a wide range of browse species, grain seeds and agro-industrial by-products (Makkar, 2000). This includes mechanical and physical techniques (such as wilting, ensiling among others), inoculation with tannin resistant bacteria and chemical techniques. The use of polyethylene glycol for which tannins have higher affinity than for proteins is by far the most used reagent to neutralize these secondary compounds (Mueller, 2001).

Diarra *et al*. (2008) reported a reduction in the crude protein and ash contents when the kernels were boiled, similarly boiling reduced the tannin content of the kernel by up to 55.00 % (Diarra *et al*., 2008). Parsons *et al.* (1992) added that protein denaturation occurred possibly as a result of heat applied during soaking and boiling were reported

to significantly lower the anti-nutrient factor contents of MSKM (Teguia, 1995; Ravindran and Sirakasan, 1996; Diarra et *al*., 2011). An additional advantage of soaking and boiling was seen as an increase in the metabolizable energy content of the kernel (Teguia, 1995; Ravindran and Sirakasan, 1996; Diarra *et al*., 2011; Dakare *et al*., 2012).

Washing and drying in hot air at 60^0C for six hours, drying in hot air oven at 50^0C in air tight containers, soaking for six to seven hours in water and chopping into small pieces and blanching between one to two minutes, then drying at 160^0C for five hours, grinding into flour in an electric blender, sieved and stored in air tight containers have been known to increase the weight of the kernel by 66.20 %, increase in all the proximate components, Soaking in water for 18 to 20 hours for softening increased the weight of the kernel by 166.40 % (Shipla *et al.,* 2014).

Avora *et al.* (2016) evaluated the effect of drying method and Time-Temperature regime of extraction on quality of mango kernel lipid and found that the hot air drying requires longer intervals and exposure to higher temperature, whereas microwave drying was found to be quicker due to heating induced at the molecular level.

2.5 Tannins

Tannin is a large, astringent (meaning it tightens pores and draws liquids out) molecule found in plants that binds readily with proteins. Tannins are one of the many types of secondary compounds found in plants (McGee, 2004). They are oligometric compounds with multiple structured units and free phenolic groups, soluble in

water,with exception of some high molecular weight structures, with molecular weight ranging from 500 to 20, 000 and have the ability to bind proteins.

Table 2.1: Effects of selected processing methods on anti-nutritional factor reduction in mango seed kernel meal

Reduction of Toxic factor (%)	Soaking in H_2O		Boiling in H_2O (100^oC/ 30min)	Soaking 24 hrs + boiling (30 mins)	References
	24hrs	12hrs			
Tannins	48.20	-	61.10	80.20	Dakare *et al.* (2012)
	-	42.86	47.43	-	Abdullahi (2012)
	-	-	65.51	-	Diarra *et al.*(2010)
	61.00	-	-	-	El Boushy and Van der Boel (2000)
	-	-	84.00	-	Abdulrashid *et al.* (2007)
Cyanide	-	-	84.00	-	El Boushy and Van der Boel (2000)
	-	77.78	77.78	-	Abdullahi (2012)
	19.10	-	37.60	57.10	Dakare *et al.* (2012)
Trypsin inhibitor activity	33.80	-	98.20	100.00	Dakare *et al.* (2012)
Phytate	-	82.22	84.44	-	Abdullahi (2012)
	23.80	-	42.80	52.40	Dakare *et al.* (2012)
Oxalate	-	20.00	24.00	-	Abdullahi (2012)
	22.60	-	81.00	89.70	Dakare *et al.* (2012)

Source: Diarra, S. (2014)

Tannins are distributed all over the plant kingdom.Jansman *et al*. (1989) reported that the tolerated level of dietary tannic acid by chicks was 0.30 %. Diarra *et al*. (2011) observed that adult birds tolerate more tannic acid than young birds.

The toxic levels (lethal doses) of phytate, tannin and cyanide are 0.057 % (Casartall *et al.,* 2005), 0.50 to 2.00 % (Reed, 1995) and 2.00 mg/kg body weight (Rhian, 2016) respectively, in monogastric farm animals. It is commonly accepted that dietary tannins reduce digestibility in particular crude protein and consequently growth performance (Schiavone *et al*., 2007). In poultry, a considerable number of publications have shown that any of the tannins in chicken feeding induces a worsening of productive performance, as a consequence of decreasing volume of feed intake and organic matter digestibility, especially the protein component (Garcia *et al.*, 2004; Longstaff and McNab, 2007). Plants synthesize many aromatic substances, most of which are secondary metabolites. In many cases, these substances serve as plant defense mechanisms against predation (Leandro *et al.,* 2014), some such as terpenoids give plants their odours, others such as quinines and tannins are responsible for plant pigment, others are responsible for plant flavour such as terpenoid capsaicin from chili pepper (Leandro *et al.,* 2014).

Tannins are water soluble polyphenolic compound of variable molecular weights abundantly found in nature which have the ability to precipitate proteins (Spencer, 1988; Cowan, 1999). Tannin can be classified into condensed and hydrolysable (Scalbert, 1991; Haslam, 1996). Although tannins can have beneficial effects on the digestion and therefore animal performance when incorporated in their diets, their

primary mode of action is often not sufficiently known to explain the final in-vivo effects. Some authors suggested that low concentration of tannins can improve palatability of feed and raise performance of monogastric animals by stimulating feed intake (Windish and Kroismays, 2006).

Some examples of anti-nutritional effects of tannins in shrub and tree forages in some farm animals are; *Robiniapseudoacaciae* fodder/tree crop contains condensed tannins which reduce feed intake and growth caecotrophy, increased protein digestibility (Rahorjo *et al.,* 1990). *Leaucaenaleucocephalac* fodder/tree crop also contain condensed tannin leading to poor N-retention low metabolizable energy value (D-Mello and Acamovic, 1989).

2.6 Saponins

They are glycosides containing a polycyclic aglycone moiety of the other C_{27} steroid or C_{10} triterpenoid (Collectively called Sapogenins) attached to a carbohydrate (Kumar, 2015a). They are widely distributed in the plant kingdom, characterized by a bitter taste and foaming properties. The anti-nutritional factor effects of saponin have been mainly studied using alfafa saponins. In non-ruminants (chicks and pigs) it causes retardation of growth rate, due primarily to reduction in feed intake, is probably the major concern (Cheeke and Shull, 1985). Such effects have also been noted when *Sesbiansesban* leaf meal (saponin 0.71 %) was incorporated in chick diet (Shequen *et al.,* 1989).

2.7 Phytate

Phytic acid (known as inositol hexakis phosphate (IP6), inositol polyphosphate, or phytate when in salt form was discovered in 1903 (Mullaney and Jullah, 2012). A

saturated cyclic acid is the principal form of phosphorus in many plant, especially bran and seeds (Klopfenstein *et al*., 2002). It can be found in cereals and grains. Catabolite of phytic acid is called lower inositol polyphosphate. Phosphorus and inositol in phytate form are not in general bio available to non-ruminant animals because these animals lack the digestive enzyme phytase required to remove phosphate from the inositol in the phytate molecule. Ruminants are readily able to digest phytate because of the phytase produced by rumen micro-organisms (Klopfenstein *et al*., 2002).

In most commercial agriculture, non-ruminant livestock such as swine, poultry and fish (Romarheim *et al*., 2008) are fed mainly grains such as maize, legumes and soyabeans. The phytate from these grains and beans are unavailable for absorption which then passes through the gastro-intestinal tract elevating the amount of phosphorus in the manure (Klopfenstein *et al*., 2002) which can lead to environmental problems when in excess (Mallin, 2003).

2.8 Cyanides

Cyanide is any chemical compound that contains the monovalent combining group (CN). This group also known as the cyano group consist of a carbon atom triple bonded to a nitrogen atom. In inorganic cyanides such as sodium cyanide and potassium cyanide, this group is present as the negatively charged polyatomic cyanide ion (CN^-). These compounds which are regarded as salts of hydrocyanic acid are highly toxic. The cyanide ion is isoelectronic with carbonmonoxide and with molecular nitrogen (Greenwood and Earnshaw, 1997). Organic cyanides are usually called nitrides, in these the CN group is linked by a covalent bond to a carbon containing group such as methyl (CH_3) in methylcyanide. Since they do not release

cyanide ions, nitrites are generally less toxic, or in the case of insoluble polymers such as acrylic fiber, essentially non-toxic unless burned (Meissler and Tar, 2009).

2.9 Enzymes

Enzymes are protein catalysts that aid chemical reactions in biological systems. They are made up of long chains of amino acids with highly complex molecular structures. They play key roles in digestive processes of the animal. Enzymes have been used to degrade different structural carbohydrates found in cereals, particularly those that are not digested by avian and mammalian enzymes, and those that are highly viscous and have high water binding capacity (Warshal *et al.*, 2006).

It was first introduced into the poultry industry in the 1980s, they are now included in more than 90.00 % of broiler diets. Feed enzyme application in poultry diet is also one of the most researched fields today, with more than 2,500 independent enzyme trials in broilers alone (Roson, 2010).

Almost all metabolic processes in the cells need enzyme in order to occur at rates fast enough to sustain life (Warshal *et al.*, 2006). The set of enzymes made in a cell determines which metabolic pathways occur in that cell. The study of enzyme is called enzymology. Enzymes are known to catalyze more than 5,000 biochemical reaction types (Schomburg *et al.*, 2013).

They are biological catalysts composed of amino acids, vitamins and minerals, which help to speed up biochemical reactions without undergoing changes themselves. Enzyme addition to monogastric feeds reduces viscosity of ingesta in the intestine and

shows a marked improvement on the various morphological effects of feeding fibrous materials (Allen *et al.,* 1997).

Some of these enzymes are inherent within the gastro intestinal tract (GIT) of both ruminant and non-ruminant animals, these are referred to as endogenous enzymes. Cases do arise sometimes when these endogenous enzymes prove inefficient in quantity and quality to perform its normal functions, hence supplementation of these endogenous enzymes have been successfully undertaken (Classen, 1996;Classen and Bedford, 1999) by various industries, resulting in the manufacture of the following enzymes, maxigrains, vegpro, allzyme, roxazyme which all collectively impact the following benefits on birds, following the results of experimental researches.

They improve bird performance and their feed conversion ratio, reduce environmental problems due to a decrease in faecal output, decrease the size of the gastro intestinal tract (GIT), decreases intestinal viscosity, improve nutrient digestibility by improving gut performance, and neutralizes the harmful effects of certain anti-nutritional factors (ANF_s) in non-conventional feed materials (Classen and Bedford, 1999).Poultry do not produce enough endogenous enzymes to break down fibres completely, they therefore require the addition of exogenous enzymes to aid in their digestive processes (Classen, 1996, Classen and Bedford, 1999).

Supplementary enzymes may be a practical means to improve performance and permit utilization of higher levels of non-conventional feeds in poultry nutrition. Enzymes are added to facilitate the breakdown of larger molecular structures of the feed ingredients into smaller ones by their specific actions and make their nutrients more readily available to the digestive system for better absorption (Classen, 1996).

2.9.1 Benefits of using enzymes in poultry diets

Multi enzymes could improve feed utilization as well as overcome the anti-nutritional factors of feedstuffs and improve gut health and immune response. Chimote *et al.* (2009), reported that the supplementation of probiotics and enzymes revealed a significant improvement in live body weights and body weight gain as compared to the control; this they attributed to inhibition of growth of the enteropathogens in the gut by decreasing the intestinal pH and efficient utilization of nutrient by the beneficial microbes. Asmita *et al.* (2001) reported significant increase in body weight in quails. Straznicka (1992), Wantia (1993) and Edwin *et al. (*2004) reported improved live weight due to multi enzymes in diet.

Although enzymes are produced either by the animal itself or by the microbes that are naturally present in the digestive tract, specific activities necessary to break down some other compounds in feed are not found or are present at low levels in the digestive tract. Therefore exogenous enzymes are added to the diet to break down these compounds. Enzymes used as feed additives are now produced through commercial fermentation processes. The use of exogenous enzymes is known to help in the digestibility of feed ingredients and allow for the use of cheaper and poorer quality materials to obtain optimum performance (Wantia,1993).

Campbell and Bedford (1992) reported that factors that required consideration when using enzymes included the following, that the enzyme supplement must contain the proper spectrum and adequate amount (activities) of enzyme so that anti-nutritive effects of target substrate will be neutralized (i.e. β – galactosidase for barley and oats, xylanase for wheat, rye, β–galactosidase and amylase for corn, and phytase for

release of phytate Phosphorus).Different cereals contain different amounts of the enzyme sensitive anti – nutritional factors. Therefore, the response to enzyme treatment may vary within a given cereal (i.e. barley, corn and probably wheat).The enzymes must not be inactivated by processing or by low pH or by the digestive enzyme in the gastro intestinal tract. Results are affected by class and age of poultry as reported by Campbell and Bedford (1992).

Classen and Cooper (1998) categorized the use of feed enzymes into four areas:-

Removal of anti-nutritional factors (ANF_s), increasing the digestibility of existing nutrients, Increasing digestibility of non-starch polysaccharides (NSP) and supplementation of the activities of the host endogenous enzymes. Other beneficial effects of enzymes are: increasing body weight gain, improved feed efficiency, decreased occurrence of sticky droppings, lowered feed cost per kg live weight gain, improved metabolizable energy contents of diets, increased digestibility of feeds, reduction of anti – nutritional factors (Onimisi *et al.*,2016).In addition to increasing the feeding value of feed stuffs, reducing variation in nutrient quality of ingredients, increasing precision and flexibility of least cost feed formulation (Bedford, 2000; Khusheeba and Ajid, 2013).

Maxigrain enzyme is a multi-enzyme compound of β-glucanase, xylanase, phytase, arabinoxylase and a mixture of yeast and minerals produced by the bio-organic ltd. It originates from the bacteria *Aspergilus oryzae*. Monogastric animals cannot make use of phytin phosphorus due to the lack of phytase enzymes in their digestive system and consequently, phytin phosphorus is mostly excreted in the faeces (Sarcricek *et al.*,

2005). Therefore, it is suggested that phytase enzymes can be used in order to alleviate the negative effect of phytic acid (Chesson, 1993).

Esuga *et al.* (2008) reported in an experiment to investigate the effect of graded levels of palm kernel meal (PKM) in broiler chicken diets supplemented with maxigrain enzyme and observed a highly significant ($P<0.01$) difference in protein, fat, Nitrogen Free Extract and Metabolizable Energy retention in birds fed with treated diets than those on diet without Maxigrain.

Vegpro enzyme is a single purpose enzyme containing the enzyme protease, which acts mainly on proteins they are proteolytic in activity. Vegpro is an enzyme complex which breaks down vegetable proteins more efficiently, which are usually more complex in structure than animal proteins. It improves the digestibility of proteins, amino acids, and energy and gives flexibility in feed utilization. It also aids pigs and poultry in the digestion of vegetable proteins (Chesson,1993).

Romero (2013) stated that phytate has now been seen as a potent anti-nutrient factor which can form complexes with minerals and peptides, reducing the bird's utilization of protein and energy. Research have suggested that phytate is also responsible for the high indigenous loses of minerals and amino acids. The combination of these factors and the fact that birds cannot break down phytates sufficiently with its own enzymes, often results in variable negative effects on performance when phytate is sub-optimally used, even when available pH levels are sufficient, hence the needs to find more effective ways of tackling dietric phytic acid has increased. The latest *Buttaiyxalla* base phytases (an enzyme) offers additional benefits over *Escherichia coli* equivalent including much higher activity earlier in the digestive tract, minimizing the anti-

nutrient effect of phytate and maximizing the available time for nutrient digestion (Bedford,2012).

The “cage” effect theory associated with the effect of carbohydrate on cell walls, reducing the integrity and thus releasing nutrients that were previously encapsulated (Bedford, 2002). It is likely that both mechanisms are involved in the responses to xylanase and B-glucanase in nutrient retention, a reduction in incidences of sticky droppings and wet litter and desirable changes in the microbial flora in the distal GIT (Bedford, 2000; Graham and Sands, 2003). Currently research in the area of carbohydrates from diets based on wheat and barley is focused on a more detail mode of action.

Cowieson *et al.* (2005) stated that the use of exogenous enzymes to improve nutrient value of poultry diets is a relatively new concept. The technology is rapidly evolving with new enzyme combination, a novel application is being developed as rapidly as regulatory restrictions will allow.

Osei and Oduro (2000) reported that ‘the addition of dietary enzymes significantly reduced feed consumption, on the other hand, feed conversion efficiency and growth rate improved significantly with increasing levels of enzyme incorporation.Birds on a higher inclusion level of 200.00 g/kg enzyme diet were significantly higher at seven weeks than those on the100.00 g and 300.00 g/kg enzyme diets Kirkpinar *et al*. (2004)

CHAPTER THREE

MATERIALS AND METHODS

3.1 Location of the experimental site

The study was conducted at the demonstration farm of the Agricultural Education Department, of the Federal College of Education, Kano located along Madobi Road, under Kumbotso Local Government Area, within the municipality. The area lies between latitude 11^0 55' and longitude 8^0 36'E at an altitude of 460 m above sea level, falling within the Sudan geo - ecological zone, having an average annual rainfall of 600 –` 1000 mm, commencing from late may, to early october (Olofin, 1987 and KNARDA, 2001) with its peak in august. This is followed immediately by a cool dried harmattan period lasting from october to february and a hot dry season, between february to april. The mean maximum temperature varies between 21.21^0C to 41.16^0C depending on the season. The average annual relative humidity record is 52.80 % (UNEP, 2011).

3.2 Sources of the experimental materials

3.2.1 Experimental animals, mango seeds and enzymes

The quail birds were purchased at seven days old (one week of age) from Ibrahim and Musa poultry hatchery farm in Kano, while the local variety of *Kanbiri* mango seed kernel were collected from Challawa Local Government Area of Kano State, between the months of may and june representing the period of peak harvest. The exogenous enzymes (Maxigrain and Vegpro) were purchased from Tajudeen Agro – veterinary Department stores located within Kano town.

3.2.2 Processing of the experimental materials

The kernel of the mango seeds were obtained by cutting the seeds open, using a sharp knife. The kernels were soaked in water in open containers at the rate of 100.00 g of kernel/(equal 756.94 g/7.56 L of water used), with a periodic change of water after every eight hours for three days after which the kernels were removed and sun dried in the open air, milled into powder and then stored until when required (Abdullahi,2012).

3.3 Laboratory analyses

3.3.1 Proximate analysis

Proximate analysis of the kernels before and after processing, including the feeds were analyzed according to methods described by AOAC (2005) at the Animal Science Biochemical Laboratory of Ahmadu Bello University, Zaria. The individual determinant carried out were dry matter, crude protein, crude fibre, ether extract, minerals (ash), nitrogen free extract and moisture contents all expressed as percentage of the original sample.

3.3.2 Determination of hydrogen cyanide

Alkaline Titration Method (AOAC, 1980) was used. Ground sample (10g) was soaked in a mixture of 200cm^3 of distilled water and 10ml of orthophosphoric acid. The mixture was left for 12h to release all bounded hydrocyanic acid. A drop of antifoaming agent (paraffin) and antibumping agent were added and the solution distilled until 150cm^3 of the distillate was collected. Exactly 20$cm^3$of the distillate was taken into a conical flask and diluted with 40$cm^3$of distilled water and 8.0$cm^3$of 6.0 M ammonium hydroxide (NH_4OH) and 2$cm^3$of 5% (W/V) potassium iodide (KI) solution were added. The mixture was titrated with 0.02M silver nitrate solution using a micro

burette until a faint but permanent turbidity was obtained. (1ml 0.02M $AgNO_3$ = 1.8mg HCN). Three replicate determinations were performed.

3.3.3 Determination of phytate

Phytate was determined by the method of Reddy (1987). Exactly 4.00 g of ground sample was soaked in 100$cm^3$of 2.00 % hydrochloric acid for 5hours and filtered. The filtrate (25cm^3) was taken into a conical flask and 5$cm^3$of 0.30 % ammonium thiocyanate solution was added. The mixture was titrated with a standard solution of 0.025M, iron (III) chloride until a brownish-yellow colour persists for 5 minutes. Three replicate determinations were performed.

1$cm^3$of 0.025M $FeCl_3$ = 6.601mg phytate.

3.3.4 Determination of saponins

Ten grams (10g) of ground sample were added to 1.00L of 20.00 % aqueous ethanol in water and agitated with a magnetic stirrer for 12h at 55^oC.The solution was filtered using a whatman No.1 filter paper and the residue was re-extracted with 3.00L of 20.00 % aqueous ethanol. The extracts were combined and reduced to 4.00L under vacuum using a rotary evaporator. The extract and 2.00L diethyl ether were transferred into a 25.00L seperatory funnel and shaken vigorously, the aqueous layer was then discarded. The pH of the remaining aqueous solution was adjusted to 4.50 by adding 4.00 g of sodium chloride and the solution then shaken successively with butanol. The butanol extract was washed with 0.10L of 5.00 % (W/V) sodium chloride and evaporated to dryness in a fume cupboard, to give the saponin which was weighed and expressed as a percentage. I.Kwano (personal communication,July 13,2012).

3.3.5 Determination of tannins

Tannin was determined by the method of Allen *et al.* (1974). Procedure: 0.50 g oven dried sample was weighed into 100cm^3 conical flask. 50cm^3 ml of distilled water was added and allowed to boil gently for 1h on a hot plate. The solution was filtered while warm into a 50.00 cm^3ml volumetric flask. The filter paper washings were added into the solution and made to volume when cooled and 0.3cm^3aliquot of tannic acid was taken into a range of 0.50 cm^3, 1.00 cm^3, 1.50 cm^3, 2.00 cm^3, 2.50 cm^3, and 3.00 cm^3corresponding to 0.05 mg, 0.10 mg, 0.15 mg, 0.20 mg, 0.25 mg, and 0.30 $cm^3$of the sample was pipette into a 50.00 cm^3 volumetric flask. To both standards and sample, water was added until half full. 2.50 $cm^3$of folin-Denis reagent was added to each flask followed by the addition of 10ml 17% (W/V) sodium carbonate solution and diluted to 50.00 cm^3 marks and mixed. These were allowed to stand in water bath at 25^0C for five minutes. The optical density (absorbance) readings were taken at 760nm wavelength using water as reference.

3.4 Experiment one: Effects of soaked local variety (*Kanbiri*) of mango seed kernel meal (SMSKM) with and without enzymes supplementation on the growth performance of Japanese quails.

3.4.1 Source and management of the birds

Four hundred and fifty seven days old Japanese quail birds of mixed sexes, were used for the study. they were initially weighed and grouped into ten treatments consisting of fourty five (45) birds each, with three replicates per treatment, consisting of fifteen (15) birds per replicate, in a 3×3 factorial arrangement with one control in a complete randomized design (CRD).The birds were reared under the deep litter management system in pens.

3.4.2 Experimental diets

Ten nitrogenous and caloric diets were formulated as shown in Table 3.1 consisting of:

Treatment 1: Control diet without the mango seed kernel meal and Enzyme

Treatment 2: Diet with 10.00 % soaked mango seed kernel meal without enzymes

Treatment 3: Diet with 10.00 % soaked mango seed kernel meal with enzyme (Maxigrain)

Treatment 4: Diet with 10.00 % soaked mango seed kernel with enzyme (Vegpro)

Treatment 5: Diet with 20.00 % soaked mango seed kernel meal without enzyme

Treatment 6: Diet with 20.00 % soaked mango seed kernel meal with enzyme (Maxigrain)

Treatment 7: Diet with 20.00 % soaked mango seed kernel meal with enzyme (Vegpro)

Treatment 8: Diet with 30.00 % soaked mango seed kernel meal without enzyme

Treatment 9: Diet with 30.00 % soaked mango seed kernel meal with enzyme (Maxigrain)

Treatment 10: Diet with 30.00 % soaked mango seed kernel meal with enzyme (Vegpro)

The diets were formulated to meet the nutrient requirement for growing Japanese quail chicks (NRC, 1994)

The ME was calculated as 37 x % CP + 81.1 x %EE + 35.5 x % NFE according to Pauzenga (1985).

3.4.3 Data collection

Body weights were taken at the beginning, then weekly till the end of the experiment. The average body weight gain and feed intakes were determined by subtracting the initial body weight from the final body weight using a sensitive measuring scale to the nearest (0.01g) for measuring the various weights, feed intake were calculated daily by subtracting the left over feeds from the initial amount of feed provided. The values obtained were used to calculate the feed to gain ratio (FGR) as follows:

FCR = total feed intake (g)/ body weight gain (g)

Water intake was determined using a 100.00 ml measuring cylinder, after separating the average weekly evaporation rate, from the amount left over.

3.4.4 Carcass Analysis

At the end of the growing phase of the study, the quails were sexed and 3 male quails per replicate (with weights closest to the mean weight) were selected and fasted overnight. Their live weights were taken. They were then slaughtered by severing the jugular vein, and the feathers plucked manually, after immersing the birds in warm water at 75.00 ^{o}C for 10minutes. The live body weights, carcass weights were measured using a sensitive measuring scale to the nearest 0.01 g. The dressing percent was calculated and expressed as carcass weight/live weight X 100, the organ weight were calculated and expressed as percentage live weight while the cut part were calculated and expressed as percentage carcass weight.

Table 3.1: Experimental diets fed to the quails at grower phase

	Treatment									
Ingrédients (%)	$T_1$0% SMSKM	$T_2$10% SMSKM	T_3 10% SMSKM + Maxigrain	T_4 10% SMSKM + Vegpro	T_5 20% SMSKM	T_6 20% SMSKM +Maxigrain	T_7 20% SMSKM + Vegpro	T_8 30% SMSKM	$T_9$30% SMSKM +Vegpro	T_{10}30% SMSKM +Maxigrain
Maize	49.09	44.72	44.72	44.72	39.75	39.75	39.75	34.78	34.78	34.78
Mango seed kernel meal	0.00	4.97	4.97	4.97	9.94	9.94	9.94	14.91	14.91	14.91
Groundnut cake	14.07	14.07	14.07	14.07	14.07	14.07	14.07	14.07	14.07	14.07
Soybean meal	21.11	21.11	21.11	21.11	21.11	21.11	21.11	21.11	21.11	21.11
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	9.34	9.34	9.34	9.34	9.34	9.34	9.34	9.34	9.34	9.34
Limestone	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Bone meal	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Enzyme	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01
Calculated Analysis										
(ME Kcal /kg)	2197.24	2965.24	2969.24	2962.24	3015.78	3165.78	2990.78	2977.19	2972.19	3122.19
Crude Protein (%)	24.99	25.32	25.35	25.34	25.69	25.67	25.41	25.46	25.66	26.06
Crude Fibre (%)	3.05	3.08	3.06	3.08	3.36	3.34	3.32	3.45	3.45	3.45
Ether Extract (%)	3.95	3.45	3.42	3.44	3.81	3.83	3.86	4.27	4.29	4.26
Lysine (%)	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46
Methionine (%)	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Calcium (%)	2.06	1.88	1.88	1.88	1.67	1.67	1.67	1.43	1.43	1.43
Phosphorus (%)	0.36	0.32	0.32	0.32	0.29	0.29	0.29	0.26	0.26	0.26

Bromix premix supplied per kg of diet. Vit A 10,000 I.U, Vit D 2000 I.U. Vit E; 23mg, Vit K 2mg, Vit Bi (thamine) 1.8mg; Vit B2 (Riboxflaxin) 5.5mg; Vit B6, (pyridoxine) 3.0mg; Vit B12 0.015mg; Pantothenic acid 0.75mg, Biotin 0.06mg; Chloride 300mg; Cobalt 0.2mg, Copper 3.0mg; Iodine 1mg; Iron 20mg; Manganese, 40mg; Selnium 0.2mg; Zinc 30mg; antioxidant, 1.25mg.

3.4.5 Digestibility Trials

A digestibility trial was carried out at the end of experiment one. This was done by selecting three male birds from each replicate. The birds were housed in individual cages for ten days, allowing for a three days period of adjustment. Droppings were collected after providing the animal with a known quantity of experimental diets daily. The droppings were weighed and oven dried at 65.00 ^{o}C for twenty four hours. The dried droppings were assayed for their proximate composition, using the method described by A.O.A.C. (1995). Nutrient retention were determined for the dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract using the equation:

$$\% \text{ digestibility} = \frac{\text{amount of nutrients in feeds} - \text{amount of nutrients in droppings}}{\text{Amount of nutrients in feeds}} \times 100$$

3.5 Experiment Two: Effect of soaked local variety of mango *(Kanbiri)* seed kernel meal with and without enzyme supplementation on laying characteristics and egg quality of Japanese quails

3.5.1 Source and management of experimental birds

Three hundred (300) female Japanese quails at seven weeks of age obtained after sexing from experiment one, were allotted to ten dietary treatments in a 3 x 3 factorial arrangement, with one control in a completely randomized design (CRD). Each treatment had three replicates of ten birds each per replicate. The birds were reared in thirty pens, as in experiment one, adhering to similar routine management processes. The dietary treatments were similar to that of experiment one, formulated for laying birds to meet the (NRC 1994) recommendation, as shown in (Table 3.2). Feed and water were provided *ad-libitum*.

Table 3.2: Composition of the experimental diets fed to the quails at layer`s phase

	Treatment									
Ingredients (%)	T1 0% SMSKM	T2 10% SMSKM only	T3 10%SMSKM + max	T4 10% SMSKM + veg	T5 20% SMSKM only	T6 20% SMSKM + max	T7 20% SMSKM + veg	T8 30% SMSKM only	T9 30% SMSKM +Maxigrain	T10 30% SMSKM + Vegpro
Maize	51.12	46.01	46.01	46.01	40.89	40.89	40.89	35.79	35.79	35.79
Mango seed kernel meal	0.00	5.11	5.11	5.11	10.23	10.23	10.23	15.35	15.35	15.35
Groundnut cake	11.06	11.06	11.06	11.06	11.06	11.06	11.06	11.06	11.06	11.06
Soyabean meal	17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55	17.55
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69	10.69
Lime stone	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Bone meal	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Enzymes	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01
Calculated Analysis										
ME Kcal/kg	2706.21	2721.26	2718.15	2696.13	2715.23	2706.25	2703.34	2702.45	2701.52	2708.21
Crude protein (%)	22.28	22.52	22.49	22.61	23.14	23.18	23.14	23.78	23.80	23.78
Crude Fibre (%)	3.42	3.55	3.57	3.59	3.83	3.86	3.84	3.89	3.91	3.93
Ether Extract (%)	1.77	1.92	1.92	1.92	2.16	2.16	2.16	2.99	2.99	2.99
Lysine (%)	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Methionine (%)	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Calcium (%)	2.29	2.06	2.06	2.06	1.83	1.83	1.83	1.58	1.58	1.58
Phosphorus (%)	0.27	0.26	0.26	0.26	0.23	0.23	0.23	0.20	0.20	0.20

Biomix premix supplied per kg of diet, Vit A, 10,000 I.U, Vit D 2000 I.U Vit E; 23mg, Vit K, 2mg, Vit B1 (thamine) 1.8mg; Vit B2 (Riboxflaxin) 5.5mg; (pyridoxine) 3.mg; Vit B12.15mg; Pantothenic acid .75mg, Biotin 0.06mg: Chlorine Chloride 300mg: Cobalt 0.2mg, Copper 3.0mg: Iodine 1mg; Iron 20mg; Manganese 40mg; Selnium 0.2mg; Zinc 30mg; Antioxidant, 1.25mg

All experimental diets were analyzed for their proximate composition by the methods described by AOAC (1995). Prior to the commencement of the study, the birds were weighed weekly till the end of the experiment to obtain their initial weights.

3.5.2 Determination of egg quality parameters

At the end of the 8^{th}, 10^{th}, 12^{th}, 14^{th}, 16^{th}, 18^{th} and 20^{th}weeks of study, 5 eggs were randomly selected from each replicate and the following egg quality parameters were determined.

The Hen Day Egg Production (HDP) were calculated as follows:

$$\frac{\text{Total number of eggs laid}}{\text{Total number of hens in lay x number of days in lay}} \quad x \quad 100$$

The Hen House Egg Production (HHP) were calculated as follows:

$$\frac{\text{Total number of eggs laid}}{\text{Total number of hens initially housed x number of days in lay}} \quad x \quad 100$$

Egg weight

The eggs were weighed daily using a sensitive scale to the nearest 0.01 g. The values were used to determine the average weight of an egg per replicate.

Egg shape index

Egg length and width were measured with venier calipers; and the values obtained were used to calculate the egg shape index, using the formula by Savveur (1988):

ESI = EB/EL

Where ESI = Egg shape index

EB = Egg breadth (mm)

And EL = Egg length (mm)

Egg Haugh unit

Each egg was broken around the equator; care was taken to keep the yolk intact. The albumen heights were measured with the aid of venier calipers and values obtained were used to calculate the haugh unit values for each replicate, using the formula outlined by Haugh (1937).

$HU = 100\log^{10} (h - 1.7\ W^{0.37} + 0.76)$.

Where HU = Haugh unit

H = observed height of the albumen in (mm) (measured as the height of the albumen at mid – point with a vernier caliper)

W = weight of eggs in gram

Egg shell index

Egg shell from each replicate were dried for two days and weighted to determine the shell weight. This was used to calculate the egg shell index as described by Iposu *et al.* (1994).

$I = 100\ SW/S$

Where I = egg shell index

SW = shell weight (gm)

S = surface area (cm)

S were calculated from egg weight using the equation

$S = K.E.W.\ 2/3$

Where K has the value of 4.67 for egg weight less than 60gm.

Egg yolk index

Shell thicknesses were measured using micrometer screw gauge. Egg yolk height and weight were measured using venier calipers and the values obtained were used to calculate the yolk index as follows:

YI = YW/YH

Where YI = Yolk index

YW = Yolk width (measured as the widest horizontal circumference with a venier caliper)

YH = Yolk height (measured as the height of the yolk, at the midpoint with a venier caliper)

Percentage shell and yolk

Percentage shell was determined using the formula, shell percentage = (shell weight/egg weight) x 100

Percentage yolk was determined by the formula = (yolk weight/egg weight) × 100

Egg specific gravity

It was determined based on weight of egg and shell, where

ESG = EW/ (0.980 (EW - SW) + 0.4921)

Where ESG = Egg specific gravity

EW = Egg weight

SW = Shell weight

Egg mass

It was determined as follows= Number of eggs layed per hen X Average weight of an egg.

Feed to gain ratio

It was determined as total feed intake per bird / egg mass per bird.

3.5.3 Statistical analysis

The data generated from the study were analyzed by the one way analysis of variance (ANOVA) system using the general linear model of Statistical Analysis System (SAS, 1995) package and the differences between means, were separated, using the Duncan's Multiple Range Test (DMRT) in the SAS package.

Procedure for the general linear model is given as below:-

$Yijk = \mu + Mi, - Ej + (ME) ij + Eijk$

Where:

Yijk = Observation in level i of factor M (Mango seed kernel levels) and level j of factor E. (Enzyme level).

μ = Overall mean

Mi = effect of level i of factor M (Mango seed kernel levels)

Ej = effect of level j of factor E (Enzyme levels).

(ME) ij = interaction between the inclusion levels of mango seed kernel (Mi) and (Enzyme levels) (Ej) and;

Eijk = Random Error with mean and variance.

CHAPTERFOUR

RESULTS

4.1.1 Proximate composition of the raw and soaked mango seed kernel meal

The results of the proximate composition of the raw and soaked mango seed kernel meal are presented in Table 4.1**.** The results indicates a reduction in the dry matter, crude protein and crude fibre by 0.66 %, 31.38 % and 68.48 % respectively, while other parameters such as the ether extracts, ash, nitrogen free extracts and metabolizable energy contents were also reduced by 0.20 %, 0.59 %, 2.24 % and 0.04 % respectively.

4.1.2 Anti-nutrient content of the raw and soaked mango seed kernel meal

The results of the anti-nutritional factors present in the raw and soaked samples of the mango seeds kernel meal are presented in Table 4.2. The anti-nutritional factors analyzed were phytate, cyanide, tannin and saponin. Percentage reductions of 33.33 %, 50.00 %, 33.33 % and 25.00 % were observed for the phytate, cyanide, tannin and saponin respectively. With the cyanide content having the highest percent reduction value of 50.00 % and saponin having the least value of 25.00 %.

4.1.3 Proximate composition of the experimental diets at growth phase

The proximate composition of the experimental diet at the growth phase is presented in Table 4.3. A steady increase in thecrude fibre content from the control 5.71% upto the 30.00% level observed at 6.46 %. The percent minerals (ash) were reduced steadily with increasing inclusion levels, from 8.81 % the control down to 7.80 % at the 30.00 % inclusion levels.

Table 4.1 Proximate composition of the raw and soaked mango seed kernel meal (MSKM)

Parameters	Treatments		
	T_1 (Raw MSKM)	T_2 (Soaked MSKM)	% Reduction
Dry matter (%)	90.65	90.06	0.66
Crude protein (%)	6.28	4.78	31.38
Crude fibre (%)	17.98	5.58	68.48
Ether extract (%)	2.16	1.96	0.20
Ash (%)	5.98	5.39	0.59
Nitrogen free extract (%)	69.70	68.40	2.24
ME (k_{cal}/kg) (%)	2880.73	2764.02	0.04

MSKM = Mango Seed Kernel Meal

ME = Metabolizable Energy

Table 4.2 Anti-nutritional factors present in the raw and soaked mango seed kernel

Parameters (mg/100g)	Treatments		
	T_1 (Raw MSKM)	T_2 (Soaked MSKM)	% Reduction
Phytate	0.24	0.16	33.33
Cyanide	0.04	0.02	50.00
Tannins	0.06	0.04	33.33
Saponins	0.08	0.06	25.00

MSKM = Mango Seed Kernel Meal

Table 4.3: Proximate composition of the experimental diets at the quails at the growth`s phase

	Treatment									
Parameters (%)	$T_1$0% SMSKM +no Enzyme	$T_2$10%S MSKM only	$T_3$10% SMSKM +Maxigrain	$T_4$10% SMSKM + Vegpro	$T_5$20% SMSKM only	$T_6$20% SMSKM+ Maxigrain	$T_7$20%S MSKM+ Vegpro	$T_8$30%S MSKM only	$T_9$30%SMSKM +Maxigrain	T_{10}30% SMSKM+ Vegpro
Dry matter	93.44	93.74	93.76	93.73	93.33	93.38	93.37	92.80	92.86	92.82
Crude fibre	5.71	5.74	5.72	5.77	6.29	6.23	6.26	6.40	6.42	6.46
Crude protein	23.69	24.56	24.56	24.52	23.44	23.46	23.41	23.75	23.92	23.62
Ether extract	4.08	4.26	4.29	4.28	4.70	4.77	4.74	5.23	5.22	5.26
Ash	8.81	8.64	8.69	8.63	8.04	8.10	8.08	7.80	7.84	7.82
NFE	57.71	58.83	58.85	58.82	56.40	56.46	56.47	56.72	56.73	56.76

NFE= Nitrogen free extract

The fibre values increased from 5.71 % to 6.46 %, the ether extract also increased from 4.08 % to 5.26 %, from the 0.00 % to 30.00 % respectively.

4.1.4 Effect of soaked mango seed kernel meal levels on the growth performance of Japanese quails

The effect of soaked mango seed kernel meal levels on the growth performance of Japanese quails is presented in Table 4.4.Results indicates significant ($P<0.05$) differences in the final body weight, total feed intakes, body weight gain and feed to gain ratio only. Birds in the control Treatment 0.00 % SMSKM recorded the highest final body weight gain of 178.40 g, while those in the 30.00 % SMSKM inclusion levels have the least value of 156.50 g. The highest total feed intake and best feed to gain ratio were recorded in birds in Treatment with 30.00 % SMSKM levels of 513.80g and control value of 4.64 respectively.

4.1.5 Effect of enzyme types and soaked mango seed kernel meal on the growth performance of Japanese quails

The effect of enzyme types and soaked mango seed kernel meal on the growth performance of Japanese quails is presented in Table 4.5. Results indicates significant ($P<0.05$) differences observed in the total feed intake, body weight gain, feed to gain ratio and final body weights. The control Treatment 0.00 % SMSKM without enzyme recorded the highest value of total final body weight of 178.40 g. Treatment with maxigrain enzyme had the least value of 158.45 g. The highest total feed intake of 507.08 g was recorded in the Treatment with maxigrain enzyme inclusion. Birds in the control Treatment converted their total feed intake the best to 1.00 g body weight gain with value of 4.64.

Table 4.4: Effects of soaked mango seed meal levels on the growth performance of Japanese quails at growth phase

	Levels of SMSKM (%)				
Parameters	(0%)	(10%)	(20%)	(30%)	SEM
Initial body weight (g/bird)	84.91	75.07	84.45	78.13	0.00
Final body weight (g/bird)	178.40[a]	157.90[c]	167.74[b]	156.50[c]	7.29
Body weight gain (g/bird)	93.49[a]	82.83[b]	82.29 [b]	87.37 [b]	8.16
Total Feed Intake (g/bird)	439.00[b]	465.06[c]	481.88[a]	513.80[a]	11.28
Feed to Gain Ratio	4.64[b]	5.61[b]	5.89[a]	5.88[a]	0.33
Water intake(ml/Bird)	83.22	83.20	83.06	83.42	0.35
Mortality (%)	0.00	0.00	0.00	0.00	0.00

a, b, c, = means with different superscripts are significantly ($P<0.05$) different
SEM = Standard error of means

Table 4.5: Effects of enzyme type and soaked mango seed kernel meal on the growth performance of Japanese quails at growth phase

	Treatments				
Parameters	No SMSKM No Enzyme (Control)	SMSKM (No enzyme)	SMSKM + (Enzyme Maxigrain)	SMSKM + (Enzyme Vegpro)	SEM
Initial body weight (g/bird)	84.91	78.02	80.31	81.62	0.00
Final body weight (g/bird)	178.40[a]	169.12[b]	158.45[c]	159.89[c]	9.96
Body weight gain(g/bird)	93.49[a]	91.10[a]	78.14[b]	78.27[b]	8.24
Total Feed Intake (g/bird)	434.00[c]	459.76[b]	507.08[a]	484.68[a]	12.21
Feed to Gain ratio	4.64[a]	5.09[b]	5.05[d]	6.49[c]	1.23
Water Intake (ml/bird)	83.22	83.25	83.15	83.28	0.33
Mortality (%)	0.00	0.00	0.00	0.00	0.00

a, b, = Means with different superscripts within the same row are significantly ($P<0.05$) different

SEM = Standard error of mean

Treatment with SMSKM with enzyme maxigrain and SMSKM with enzyme vegpro recorded the highest amount of total feed intakes, average value of 688.41 g and 687.99 g respectively. The highest body weight gain of 93.49 g was recorded in the control treatment while the treatment with maxigrain enzyme inclusion had the least value of 78.14 g.

4.1.6 Effects of dietary levels of soaked mango seed kernel meal on the carcass characteristics of Japanese quails

The effect of soaked mango seeds kernel meal on the carcass characteristics of Japanese quails is presented in Table 4.6. All parameters measured were significantly ($P<0.05$) different across the treatments. The highest average live weight, dressing percent and carcass weights were recorded in birds in Treatment with 20.00 % SMSKM with values of 141.17 g, 61.04 % and 88.52 g respectivelywith the treatment having 10.00 % SMSKM having the least value for the average live weight of 137.20 g, while treatment with 0.00 % SMSKM recorded the least value of 84.23 % for the carcass weight which was similar to treatment with 10.00 % SMSKM. Highest value for the dressing percent of 61.04 % was recorded by birds in treatment with 10.00 % SMSKM and treatment with 20.00 % SMSKM.

For the organ weights however, the heart, liver, gizzard full and empty, intestine weight and intestine length all showed significant ($p<0.05$) differences across all the inclusion levels. Further analysis revealed that the 10.00 % and 20.00 % inclusion levels both have significantly similar highest values of 1.50 % and 1.36 % respectively for the heart, whereas the 30.00 % inclusion had the least value of 1.19 %. Heaviest gizzard weight of 6.22 % and 4.65 % full and empty respectively were noticed by

birds in the 30.00 % level, the 10.00 % inclusion level recorded the least values of 5.06 % and 3.60 % respectively.

Weight of the intestine was heaviest with a record of 9.19 % with the treatment with 30.00 % inclusion level, while the control (0.00 % SMSKM) weighed the least with a value of 7.52 %, though recording the longest intestine length of 62.87 cm, while the 20.00 % and 30.00 % SMSKM levels significantly had similar least values of 52.14 cm and 59.50 cm respectively.

For the weights of the cut parts significant ($P<0.05$) differences were observed in the breast and back only, the 20.00% and 30.00% having the highest values of 45.69% and 42.43% respectively.

4.1.7 Effect of enzyme types and soaked mango seed kernel meal on the carcass characteristics of Japanese quails at the growth phase

Table 4.7 represents the effects of enzyme types and soaked mango seed kernel meal on the carcass characteristics of Japanese quails. Results showed significant ($P<0.05$) differences in the average live weight, carcass weight and dressing percent. Treatment with SMSKM + vegpro had the highest dressing percent value of 62.90 % and carcass weight of 92.32 g, while the control 0.00 % SMSKM without enzyme had the least value of 58.14 % and 144.78 g respectively, though similar to treatment of SMSKM without enzymes in the dressing percent.

In the organ weights, significant ($p<0.05$) differences were observed in the following parameters; the liver, gizzard full and empty, intestine weight and intestine length. The treatment without enzyme recorded the highest values for the liver weights of 2.00 %

of the percent live weight, whereas treatments with vegpro enzyme inclusions recorded the least value of 1.67 % . Gizzard weights were similarly much heavier withtreatment without enzyme value of 5.87% and treatment with vegpro enzyme value of 5.53%,. The control treatment and treatment with maxigrain enzymes all similarly recorded the least values of 5.49% and 5.26% respectively, heaviest intestine weight full of 10.35% was recorded by the treatment with vegpro enzyme, whereas the control had the least value of 7.52%.

For the weights of the cut parts, significant ($p<0.05$) differences were observed in the breast,leg and back only.The maxigrain enzyme and control having highest values of 45.90%,4.38% and 42.43% respectively.

4.1.8 Effects of soaked mango seed kernel meals on nutrient digestibility and ash retention of Japanese quails

Effects of soaked graded levels of soaked mango seed kernel meals on the Nutrient digestibility and ash retention of Japanese quails is presented in Table 4.8. Results indicates significant ($P<0.05$) differences in all the parameters measured apart from the nitrogen free extract. The highest dry matter, ether extract and ash retention of 67.98 %, 78.63 % and 64.36 % respectively were noticed by birds fed the 30.00 % inclusion level, the control 0.00 % had the least values of 61.91 %, 71.61 % and 60.48 % respectively similar to the 20.00 % inclusion level, in terms of the dry matter and ash retention. The highest crude fiber digestibility of 73.38 % obtained was observed by birds in the 0.00 % inclusion level, with the 30.00 % having the least value of 67.85 %.

4.1.9 Effects of enzymes types and processed mango seed kernel meal on the nutrient digestibility and ash retention of Japanese quails

Results presented in Table 4.9 revealed significant (P<0.05) differences in all parameters analyzed apart from the nitrogen free extract. Treatment with maxigrain enzyme inclusion had the highest dry matter, crude protein, ash retention and ether extract digestibilities of 68.40 %, 72.97 %, 67.19 % and 77.63 % respectively, with the least value of 61.91 % for the dry matter observed in the control.

4.1.10 Interaction effect of soaked mango seed kernel meal on the nutrient digestibility and ash retention of Japanese quails

Interaction effects were observed in the crude fibre as presented in Table 4.10. Analysis of the results showed that the highest crude fibre digestibility of 81.05 % was observed by birds fed SMSKM with vegpro enzyme, all the other nine treatments had similarly least values average of 70.00 % statistically.

4.1.11 Effects of soaked mango seed kernel meal on feed cost of Japanese quails

Results as shown in Table 4.11 indicates significant (P<0.05) differences observed in the feed cost at market weight. The 20.00 % inclusion level, had the lowest feed cost of ₦102.23K after the control of ₦95.43K which was similar with the 30.00 % inclusion level value of ₦103.02K. The 10.00 % inclusion level, had the highest feed cost of ₦106.63K.

Table 4.6: Effects of processed mango seed kernel meal levels on the carcass characteristics of Japanese quails

	Levels of SMSKM				
Parameters	0%	10 %	20 %	30 %	SEM
Average live weight (g)	144.78^{b}	137.20^{c}	147.17^{a}	145.26^{b}	1.14
Carcass weight (g)	84.23^{c}	84.24^{c}	88.52^{a}	85.40^{b}	0.88
Dressing percentage (%)	58.18^{c}	61.40^{a}	61.04^{a}	59.57^{b}	0.88
Leg (%)	5.51	4.19	4.62	5.51	1.84
Breast (%)	39.40^{b}	42.33^{b}	45.69^{a}	47.49^{a}	3.09
Thigh weight (%)	3.01	3.14	3.28	2.89	1.21
Back (%)	42.43^{a}	37.96^{b}	37.62^{b}	39.83^{b}	2.57
Wing (%)	3.17	3.76	3.32	3.35	0.87
Neck (%)	2.34	2.38	2.87	2.89	0.57
Heart (%)	1.29^{b}	1.50^{a}	1.36^{ab}	1.19^{c}	0.21
Liver (%)	1.83^{a}	2.06^{a}	1.59^{c}	1.74^{c}	0.26
Gizzard full (%)	5.49^{b}	5.06^{c}	5.32^{bc}	6.22^{a}	0.28
Gizzard empty (%)	4.01^{b}	3.60^{c}	3.67^{c}	4.65^{a}	0.29
Intestne weight full (%)	7.52^{c}	8.67^{b}	8.64^{b}	9.19^{a}	0.44
Intestine length full (%)	62.87^{a}	58.56^{c}	52.14^{d}	59.50^{d}	0.80

a, b, c = means with different superscripts within the same row are significantly ($P<0.05$) different
SEM = Standard error of means

Table 4.7: Effects of enzyme types and soaked mango seed kernel meal on the carcass characteristics of Japanese quails

	Treatments				
Parameters	(0% SMSKM) Without enzyme	(SMSKM) without enzyme	SMSKM +Maxigrain	SMSKM + Vegpro	SEM
Average live weight (g)	144.78^{c}	150.24^{a}	132.62^{d}	146.77^{b}	1.14
Carcass weight (g)	84.23^{b}	84.24^{b}	84.09^{b}	92.32^{a}	0.88
Dressing percentage (%)	58.14^{c}	58.15^{bc}	58.18^{b}	62.90^{a}	0.88
Leg (%)	5.51^{a}	4.20^{b}	4.32^{b}	4.11^{b}	6.64
Breast (%)	39.40^{b}	45.17^{a}	43.61^{a}	44.35^{a}	4.50
Thigh weight (%)	3.17	3.10	3.28	3.15	0.19
Back (%)	42.42^{a}	38.49^{b}	37.39^{b}	36.46^{b}	4.62
Wing (%)	3.17	3.47	3.40	3.19	1.20
Neck (%)	2.34	2.71	2.53	2.80	0.51
Heart (%)	1.29	1.45	1.24	1.36	0.21
Liver (%)	1.83^{ab}	2.00^{a}	1.71^{bc}	1.67	0.26
Gizzard full (%)	5.49^{bc}	5.81^{a}	5.26^{bc}	5.53^{ab}	0.28
Gizzard empty (%)	4.01^{ab}	4.09^{ab}	3.64^{c}	4.19^{a}	0.29
Intestine weight full (%)	7.52^{c}	8.57^{b}	7.66^{c}	10.35^{a}	0.44
Intestine length full (%)	62.87^{a}	52.84^{b}	60.19^{ab}	57.17^{ab}	0.17

a, b, c = means with different superscripts within the same row are significantly ($P<0.05$) different
SEM = Standard error of means

Table 4.8: Effects of soaked mango seed kernel meal levels on the nutrient digestibility and ash retention of Japanese quails

	Levels of SMSKM (%)				
Parameters (%)	(0%) Control	(10%)	(20%)	(30%)	SEM
Dry matter	61.91^{c}	66.32^{b}	61.69^{c}	67.98^{a}	1.52
Crude protein	69.20^{c}	73.39^{a}	70.06^{b}	71.32^{b}	1.22
Crude fibre	73.38^{a}	69.85^{b}	68.83^{bc}	67.85^{c}	0.95
Ether extract	71.61^{d}	76.71^{b}	72.86^{c}	78.63^{a}	0.96
Ash retention	60.48^{b}	62.10^{ab}	60.87^{b}	64.36^{a}	5.10
NFE	55.77	55.98	60.48	62.89	9.77

a,b,c,d = Means with different superscript across the row are significantly ($P<0.05$) difference
SEM = Standard error of means
NFE = Nitrogen free extract

Table 4.9: Effects of enzyme types and soaked mango seed kernel meal on nutrient digestibility and ash retention of Japanese quails

	Treatments				
Parameters (%)	(0% Control)	SMSKM (without enzyme)	SMSKM +(Maxigrain)	SMSKM +(Vegpro)	SEM
Dry matter	61.91^{c}	62.29^{c}	68.40^{a}	65.17^{b}	1.52
Crude Protein	69.20^{b}	69.45^{b}	72.97^{a}	72.27^{a}	1.22
Crude Fibre	73.38^{a}	66.41^{c}	69.57^{b}	72.88^{b}	0.95
Ether Extract	71.61^{d}	74.08^{c}	77.63^{a}	75.66^{b}	0.96
Ash retention	60.48^{c}	58.65^{d}	67.19^{a}	62.09^{b}	5.10
NFE	56.77	56.92	65.90	58.81	9.77

a

a, b, c, d = Means with different superscripts across the row are significantly difference ($P<0.05$)
SEM = Standard error of means
NFE = Nitrogen free extract

Table 4.10: Interaction effects of soaked mango seed kernel meal on the nutrient digestibility and ash retention of Japanese quails

Parameters (%)	Treatments										
	T_1 0% SMSKM (Without enzyme)	T_2 10% SMSKM only	T_3 0% SMSKM + Maxigrain)	T_4 10% + Vegpro	T_5 20% SMSKM only	T_6 20% + Maxigrain	T_7 0%+ Vegpro	T_8 30% SMSKM only	T_9 30%+ Maxigrain	T_{10} 30%+ Vegpro only	SEM
Crude fibre	74.58^{b}	66.82^{b}	74.18^{b}	68.41^{b}	61.49^{b}	64.99^{b}	81.05^{a}	64.68^{b}	68.98^{b}	69.80^{b}	21.20^{b}

a, b, = Means with different superscripts within the same row are significantly ($P< 0.05$) different
SEM = Standard error of means

Table 4.11: Effects of soaked mango seed kernel levels on the feed cost of Japanese quails

Parameters	Levels of SMSKM (0%)	(10%)	(20%)	(30%)	SEM
Feed cost per kg feed (₦/kg)	223.16	224.41	226.96	228.81	0.21
Feed cost to attain market weight per bird (₦/K)	95.43^{c}	106.63^{a}	102.23^{b}	103.02^{b}	2.39

a, b = Means with different superscripts are significantly (P<0.05) different
SEM = Standard error of means

4.1.12 Effects of the feed cost of soaked mango seed kernel meal with various enzyme types of Japanese quails

The results as shown in Table 4.12 indicates significant ($P<0.05$) differences recorded in the feed cost at market weigh across all the treatments. The cost of feed in the treatment without enzyme, treatment with enzyme maxigrain and enzyme vegpro had similar values of ₦102.63K, ₦106.59K and ₦111.57K respectively which were all statistically higher than the control value of ₦95.43K.

4.2 Experiment Two: Effects of soaked mango seed kernel meal with and without enzyme supplementation on performance, laying characteristics and egg quality parameters of Japanese quails

4.2.1 Proximate Composition of the experimental diet

Table 4.13 shows the proximate composition of the experimental diet which showed a steady increase in the percent crude fibre content with increasing SMSKM inclusion levels from 7.15 % to 8.19 % from the 0.00 % to 30.00 % inclusion level. The percent ash contents witnessed a steady decline from the control treatment 0.00 % SMSKM without enzyme of 11.15 % down to treatments with 20.00 % SMSKM levels with and without enzymes, with a sudden rise again from treatments with 30.00 % SMSKM levels with and without enzymes with a value of 8.87 % on the average. The nitrogen free extract also declined steadily from the 10.00 % SMSKM levels with and without enzymes with values 60.78 % down to 55.00 % up to the 30.00 % SMSKM levels with and without enzymes.

Table 4.12: Effects of feed cost of soaked mango seed kernel meal levels with various enzyme types of Japanese quails at growth phase

Parameters	Treatment				SEM
	(No SMSKM, no enzyme)	(SMSKM, no enzyme)	(SMSKM + Maxigrain)	(SMSKM + Vegpro)	
Feed cost per kg feed (₦/kg)	223.16	227.21	224.26	225.24	0.27
Feed to attain market weight (₦/K)	95.43[a]	102.63[b]	106.59[b]	111.57[b]	5.27

a, b, c, d= means with different superscripts are significantly (P<0.05) different

SEM = Standard Error of Means

Table 4.13: Proximate composition of the experimental diets fed to the quails at laying phase

	Treatment									
Parameters (%)	T_1 (0% SMSKM)	T_2 (10% SMSKM only)	T_3 (10% SMSKM +max)	T_4 (10% SMSKM +Vegpro)	T_5 (20% SMSKM only)	T_6 (20% SMSKM +max)	T_7 (20% SMSKM + Vegpro)	T_8 (30% SMSKM only)	T_9 (30% SMSKM + max)	T_{10} (30% SMSKM + Vegpro)
Dry matter	93.96	93.90	93.91	93.92	86.65	86.66	86.62	94.33	94.32	94.34
Crude protein	21.94	21.75	21.76	21.74	22.05	22.03	22.06	22.56	22.52	22.53
Crude fibre	7.15	7.45	7.44	7.48	8.04	8.02	8.05	8.16	8.17	8.19
Ether extract	2.00	2.17	2.18	2.14	2.45	2.40	2.46	3.38	3.39	3.34
Ash	11.15	8.85	8.88	8.89	8.74	8.72	8.76	9.90	9.91	9.93
NFE	57.76	60.78	60.74	60.76	59.03	59.02	59.03	55.01	55.04	55.06

a, b, c, d= means with different superscripts are significantly ($P<0.05$) different
NFE = Nitrogen free extract

4.2.2 Effects of soaked mango seed kernel meal levels on the growth performance of Japanese quails at laying phase

Results as shown in Table 4.14 indicates significant ($P<0.05$) differences recorded in the final body weights, feed to gain ratio, total feed intake, water intake, average weight of eggs at first lay, hen house egg production and Hen day egg production. Treatment with 20.00 % SMSKM level recorded the highest final body weight of 202.22 g, which was similar to the control treatment 0.00 % SMSKM. Treatment with 10.00 % SMSKM recorded the least final body weight gain of 193.61 g. Treatment with 0.00 % SMSKM, had the least but best feed to gain ratio of 1.02 whereas the treatment with 30.00 % SMSKM had the worst feed to gain ratio of 1.94. Birds in treatment with 30.00 % SMSKM level consumed the highest amount of water of 89.44 ml during the course of the experiment whereas those in treatment with 0.00 % SMSKM, treatment with 10.00 % SMSKM and treatment with 20.00 % SMSKM consumed the least similar amount of water average value of 87.00ml which. For the average weight of egg at firstlay, treatment with 20.00 % SMSKM had the highest record of 10.50 g, while the control treatment 0.00 % SMSKM had the least value of 9.04 g. Birds reared in treatment with 30.00 % SMSKM were the first to drop their first eggs at 43.22 days on the average whereas those in treatment with0.00 % SMSKM were the last to drop their first eggs at 47.67 days on the average. The highest Hen house egg production and Hen day egg production were recorded by birds in treatment with 0.00 % SMSKM and treatment with 10.00 % SMSKM respectively of 81.04 % and 86.82 %, whereas those in treatment with 30.00 % SMSKM had the least values in both cases 68.44 % and 71.17 % respectively.

Table 4.14: Effects of soaked mango seed kernel meal levels on the growth and laying performance of Japanese quails

	Levels of SMSKM (%)				
Parameters	(0%)	(10%)	(20%)	(30%)	SEM
Initial body weight (g/bird)	168.87	162.46	166.67	161.48	6.39
Final body weight(g/bird)	199.87[a]	193.61[c]	202.22 [a]	197.61[b]	3.69
Body weight gain (g/bird)	31.08	46.43	34.36	36.30	12.75
Total Feed intake (g/bird)	983.71[d]	1329.62[c]	1921.49[a]	1857.01[b]	9.08
Feed to gain ratio	1.02[a]	1.70[b]	1.64[b]	1.94[c]	0.29
Water intake (ml/bird)	86.79[b]	87.03[b]	87.37[b]	89.44[a]	1.53
Average weight of eggs at first lay (g)	9.04[d]	9.37[c]	10.05[a]	9.68[b]	0.28
Average age of bird at first lay(days)	47.67[c]	43.33[a]	44.67[b]	43.22[a]	0.49
Number of eggs laid/quail	112.80	110.23	109.90	110.73	5.23
Hen-house egg Production (%)	81.04[a]	75.41[c]	75.95[b]	68.44[d]	0.53
Hen-day egg Production (%)	76.77[b]	86.82[a]	74.17[C]	71.19[d]	0.74
Mortality (%)	0.00	0.00	0.00	0.00	0.00

a

a,b, c, d = Means with different superscripts are significantly ($p<0.05$) different
SEM = Standard Error of Means

4.2.3 Effects of enzyme types and soaked mango seed kernel meal on the growth performance of Japanese quails at laying phase

The results as shown in Table 4.15 indicates significant ($P<0.05$) differences observed in the total feed intake, feed to gain ratio, average weight of eggs at first lay, average age of bird at first lay, hen house egg production and hen day egg production. Birds reared in the control treatment had the best feed to gain ratio of 1.02, whereas treatment with vegpro enzyme had the worst value of 1.90. Birds in treatment with SMSKM with vegpro enzyme and treatment with SMSKM with maxigrain enzyme were the first similarly to drop their first eggs at 43.11days and 43.33days respectively whereas treatment with no SMSKM no enzyme dropped their first eggs last at 46.67 days on the average. The highest values for the hen house egg production and hen day egg production of 81.04 % and 76.77 % respectively were recorded by birds in treatment with the control. The least values were recorded by birds in treatment with SMSKM plus vegpro enzyme with values of 73.38 % for the hen house egg production and treatment with SMSKM without enzyme for the Hen day egg production value of 76.24 %. Highest average weight of eggs at first lay was recorded by birds in treatment with SMSKM + maxigrain of 10.02 g, while the least was recorded in treatment with SMSKM, no enzyme and treatment with SMSKM + vegpro) which were all similar with average value of 9.05 g.

4.2.4 Interaction effects of the feed conversion ratio of the layer phase of Japanese quails

The interaction effect noticed among treatments in their feed to gain ratio at the layer phase is presented in Table 4.16. The result showed that the control treatment with 0.00 % without enzyme had the best record of 1.01 similar to the 10.00 % without enzymes

while the treatment with 20.00 % SMSKM with vegpro enzyme had the worst with 2.28 similar to treatment with 20.00 % SMSKM only.

4.2.5 Effects of the soaked mango seed kernel meal levels on external egg qualities of Japanese quails

Effect of the soaked mango seed kernel meal levels on external egg qualities of Japanese quails is presented in Table 4.17. The egg length, egg breadth, egg shell percent, egg shell index and egg mass were all significantly ($P<0.05$) different across the treatments. Treatment with 30.00 % SMSKM had the highest egg length of 3.59mm while the control treatment 0.00 % SMSKM recorded the lowest value of 3.37mm, similar to treatment with 10.00 % SMSKM and treatment with 20.00 % SMSKM. For the egg breadth and egg lengths, treatment with 30.00 % SMSKM, had the highest values of 2.89 mm and 3.59 mm respectively including the shell index with 22.05 mm, but similar with 10.00 % SMSKM and treatment with 20.00 % SMSKM for egg shell percent and egg shell index, while the control 0.00 % SMSKM had the least value for egg shell index and shell percent of 21.59 % and 7.59 % respectively. The control treatment had the highest egg mass of 969.75 g, while the 20.00 % SMSKM level had the least value of 940.56 %.

4.2.6 Effects of the enzyme types and soaked mango kernel meal on external egg qualities of Japanese quails

Effects of the enzyme types on external egg qualities of Japanesequails is presented in Table 4.18.The egg length, egg weight, egg shell percent, egg shell index and egg mass were the only parameters which were significantly ($P<0.05$) different across the treatments. Birds in treatment with SMSKM without enzyme laid eggs with the average longest length of 3.54 mm which was similar to those in treatment withSMSKM with

enzyme Maxigrain and treatment with SMSKM + Vegpro while the control 0.00 % SMSKM) had the least value of 3.37 mm. The largest average egg weights laid were recorded by birds in treatment with SMSKM only with 8.75 g but similar to treatment without SMSKM and enzyme and treatment with SMSKM + Vegpro while treatment with SMSKM with Maxigrainenzyme had the least value of 8.54 g. treatment with SMSKM with Maxigrainenzyme also recorded the highest egg shell percent value of 8.15 %, treatment with vegpro having the lowest value of 4.94 %. The highest egg shell index of 22.59 % was recorded in treatment with SMSKM and Maxigrain, while the control 0.00 % SMSKM, no enzyme had the least value of 21.59 %, it also had the highest egg mass value of 969.89 g while treatment with Maxigrain enzyme had the least value of 937.27 g.

4.2.7 Interaction effects of soaked mango seed kernel meal with and without enzyme supplementation on egg breath of Japanese quails

The interaction effect noticed across the Treatments on the egg breadth of Japanese quails is presented in Table 4.19. It shows that birds in Treatment with 30.00 % SMSKM without enzyme had the highest average egg breadth of 3.06 mm, while those in treatment with 10.00 % SMSKM without enzyme recorded the least egg breadth of 2.67 mm.

4.2.8 Effects of the soaked mango seed kernel meal levels on internal egg qualities of the japanesequails

Effects of the SMSKM levels on internal egg qualities of the Japanese quails is presented in Table 4.20. Results showed significant ($P<0.05$) differences occurring among the treatments in the albumen breadth, albumen index, yolk height, haugh units, yolk percent and yolk weights only.

Table 4.15: Effects of enzyme types and soaked mango seed kernel meal levels on the growth performance of Japanese quails at laying phase

Parameters	Treatment (no SMSKM and enzyme) (control)	(SMSKM no enzyme)	SMSKM (Maxigrain)	(SMSKM+ Vegpro)	SEM
Initial body weight (g/bird)	168.87	165.64	155.67	170.37	6.39
Final body weight (g/bird)	199.87	198.28	197.06	198.28	3.69
Body weight gain (g/bird)	31.00	32.95	40.42	43.24	12.75
Total Feed intake (g/bird)	983.71^{d}	1627.38^{b}	1544.26^{c}	1877.01^{a}	9.05
Feed to gain ratio	1.02^{a}	1.68^{b}	1.65^{b}	1.90^{b}	0.28
Water intake (ml/bird)	86.75	87.51	88.34	88.15	1.53
Average weight of eggsat first lay (g)	9.04^{b}	9.39^{b}	10.02^{a}	9.67^{b}	0.51
Average age of bird at first lay (g)	46.67^{c}	44.78^{b}	43.33^{a}	43.11^{a}	0.48
Number of eggs laid	112.80	110.73	109.75	110.51	5.23
Hen housed egg production (%)	81.04^{a}	74.49^{b}	74.12^{b}	73.38^{c}	0.53
Hen day egg production (%)	76.77^{a}	76.24^{b}	78.18^{a}	77.95^{a}	0.53
Mortality (%)	0.00	0.00	0.00	0.00	0.00

a,b,c = means with different superscripts are significantly ($P<0.05$) different.
SEM = Standard error of means.

Table 4.16 Interaction effects of the feed to gain ratio of the layer phase of Japanese quails at the laying phase

	Treatment										
Parameter	T_1 (No SMSKM no enzyme)	T_2 (10% only)	T_3 (10%+ Maxigrain)	T_4 (10%+ Vegpro)	T_5 (20% only)	T_6 20%+ Max.)	T_7 (20%+ Vegpro)	T_8(30% only)	T_9 (30%+ Max)	T_{10} (30%+ Vegpro)	SEM
Feed to gain ratio	1.02^{a}	1.03^{a}	1.46^{b}	2.16^{d}	1.95^{c}	1.95^{c}	2.39^{d}	2.22^{d}	2.22^{d}	1.89^{c}	0.32

aa, b, c, d, e = Means with different superscripts within the same row are significantly ($P< 0.05$) different.
FCR= Feed to gain ratio

Table 4.17: Effect of soaked mango seed kernel meal levels on external egg qualities of Japanese quails laying phase

Parameters	Levels of SMSKM (%)				
	(0%)	(10%)	(20%)	(30%)	SEM
Egg length (mm)	3.37[b]	3.47[b]	3.44[b]	3.59[a]	0.11
Egg breadth (mm)	2.72[b]	2.76[b]	2.75[b]	2.89[a]	0.11
Egg weight (g)	8.62	8.65	8.57	8.72	0.17
Egg shape index	0.76	0.80	0.80	0.79	0.33
Egg shell weight (g)	0.65	0.67	0.69	0.69	0.06
Egg shell thickness (mm)	0.36	0.36	0.37	0.36	0.03
Egg shell (%)	7.59[c]	7.82[b]	8.02[a]	7.94[ab]	0.19
Egg shell index	21.59[bc]	21.95[ab]	21.99[ab]	22.05[a]	0.42
Egg specific gravity	1.05	1.06	1.05	1.05	0.03
Egg mass (g)	969.75[a]	957.85[a]	940.56[a]	963.65[b]	21.25

a, b, c = Means with different superscripts within the same row are significantly($P<0.05$) different.
SEM = Standard error of means.

Table 4.18: Effects of enzyme types and soaked mango seed kernel meal levels on external egg qualities of Japanese quails

	Treatment				
Parameters	(No SMSKM)	(SMSKM, no enzyme)	(SMSKM +Maxigrain)	(SMSKM + Vegpro)	SEM
Egg length (mm)	3.37[b]	3.54[a]	3.52[a]	3.44[a]	0.11
Egg breadth (mm)	2.72	2.82	2.82	2.76	0.11
Egg weight (g)	8.62[a]	8.75[a]	8.54[b]	8.65[a]	0.17
Egg shape index	0.76	0.78	0.81	0.80	0.33
Egg shell weight (g)	0.65	0.67	0.70	0.69	0.06
Egg shell thickness (mm)	0.36	0.36	0.37	0.35	0.03
Egg shell (%)	7.59[b]	7.69[b]	8.15[a]	4.94[c]	0.19
Egg shell index	21.59[c]	21.36[b]	22.59[a]	22.03[b]	0.42
Egg specific gravity	1.05	1.05	1.06	1.05	0.03
Egg mass (g)	969.75[a]	968.89[a]	937.27[b]	955.92[b]	24.48

a, b, c, = Means with different superscripts within the same row are significantly ($P<0.05$) different.
SEM = Standard error of means.

Table 4.19: Interaction effects of soaked mango seed kernel meal levels with and without enzyme supplementation on egg breath of Japanese quails

	Treatment										
Parameters	T1 (0% SMSKM No enzyme)	T2 (10% SMSKM No enzyme)	T3 (10% SMSKM +Maxigrain)	T4 (10% SMSKM +Vegpro)	T5 (20% SMSKM)	T6 (20% SMSKM No enzyme)	T7 (20% SMSKM + Maxigrain)	T8 (30% SMSKM no enzyme)	T9 (30% SMSKM no enzymes+ Maxigrain)	T10 (30% SMSKM +Vegpro)	SEM
Egg breath (mm)	2.72^{d}	2.67^{e}	2.87^{b}	2.73^{d}	2.72^{d}	2.80^{c}	2.72^{d}	3.06^{a}	2.79^{c}	2.82^{b}	0.04

a, b, c, d, e, = Means with different superscripts within the same row are significantly (P<0.05) different.
SEM = Standard error of means.

Table 4.20: Effects of soaked mango seed kernel meal levels on internal egg qualities of Japanese quails

	Levels of SMSKM				
Parameters	(0% control)	(10%)	(20%)	(30%)	SEM
Albumen height (mm)	0.42	0.45	0.48	0.44	0.07
Albumen breadth (mm)	3.83^{b}	3.87^{b}	3.99^{b}	4.21^{a}	0.16
Albumen index	0.94^{a}	0.75^{b}	0.93^{a}	1.04^{a}	0.15
Yolk height (mm)	2.78^{b}	3.05^{a}	2.92^{ab}	3.02^{a}	0.15
Yolk breadth (mm)	2.77	2.82	2.85	2.78	0.11
Yolk index	1.01	1.00	1.00	0.95	0.08
Yolk (%)	37.25^{a}	35.23^{b}	32.68^{d}	34.17^{c}	0.73
Yolk weight (g)	3.16^{a}	3.03^{b}	3.04^{b}	2.99^{b}	0.10
Haugh unit (%)	62.50^{c}	62.77^{b}	63.18^{a}	62.60^{bc}	0.26

a, b, c = Means with different superscripts within the same row are significantly ($P<0.05$) different
SEM = Standard Error of Means.

Further analysis indicates that the albumen indices of the control i.e. treatmentwith 0.00 % SMSKM without enzyme, treatment with 20.00 % SMSKM and treatmentwith 30.00 % SMSKM were all similar average of 1.02, but significantly (P<0.05) greater than that of treatmentwith 10.00 % SMSKM. For the yolk height, Treatment with 0.00 % SMSKM was significantly (P<0.05) lowest with values of 2.78 mm, while treatment with 10.00 % SMSKM is highest with 3.05 mm. In terms of haugh unit, the 20.00 % SMSKM recorded the highest value of 63.18 %, while treatment with 0.00 % SMSKM had the least value of 62.50 %, similar to treatment with 30.00 % SMSKM. The Yolk weight had treatment with 0.00 % SMSKM recording a significantly (P<0.05) higher value of 3.16 g than the remaining three treatments which were similar. For the albumen breadth, treatment with 30.00 % SMSKM level had the highest values of 4.21 mm, but significantly (p<0.05) greater than treatment with 0.00 % SMSKM, 10.00 % SMSKM and 20.00 % SMSKM inclusions, which were all similar with average values of 3.85 mm.

4.2.9 Effects of enzyme types and soaked mango seed kernel meal on internal egg qualities of japanesequails

Effects of enzyme types and SMSKM on internal egg qualities of Japanese quails is presented in table 4.21**.** Significant (P<0.05) differences were obtained in the albumen breadth, yolk height, yolk breadth, haugh units, yolk percent and yolk weights only. The SMSKM without enzyme, recorded a significantly (P<0.05) higher albumen breadth of 4.08 mm, though similar to treatmentwith SMSKM + Maxigrain and treatment with SMSKM + Vegpro with average values of 2.91 mm. treatmentwith SMSKM without enzyme also recorded the highest values of 2.91 mm for yolk

breadth, yolk height, albumen breadth and haugh units of 3.07mm, 4.08 mm and 62.87 % respectively with treatmentwith SMSKM with enzyme Maxigrain having the least value for the yolk breadth, though similar to treatment0.00 % SMSKM without enzyme and treatmentSMSKM with Vegpro enzyme while treatmentSMSKM with Maxigrain enzyme having the least value for the haugh unit of 62.11 %. treatmentwith 0.00 % SMSKM without enzyme recorded the highest value for yolk weight of 3.16 g, with treatmentSMSKM with enzyme Vegpro of 2.95 g having the least.

4.2.10 Interaction effects of soaked mango seed kernel meal with and without enzyme supplementation on albumen breath of japanesequails

Interaction effects were only noticed in the albumen breadth as presented in Table 4.22.With treatmentwith the 30.00 % SMSKM with Maxigrain enzyme having a significantly ($P<0.05$) highest value of 4.58 mm, while the control 0.00 % SMSKM recorded the least value of 3.38 mm.

4.2.11 Effects of feed and egg cost of soaked mango seed kernel meal levels on the growth performance of Japanese quails at laying phase

The results as presented in Table 4.23 showed significant ($P< 0.05$) differences in the total feed cost per intake, feed cost per crate of eggs and feed cost per dozen eggs. Treatment with 10.00 % inclusion level had the least feed cost per intake value of ₦253.00 k after the control cost of ₦ 186.91 k. The least feed cost per crate of eggs was recorded by birds in the 20.00 % inclusion level of ₦1090.76 k after the control cost of ₦1084.13k likewise in the feed cost per dozen eggs with values of ₦288.80k compare with the control of₦ 286.24k.

Table 4.21: Effects of enzyme types and soaked mango seed kernel meal levels on internal egg qualities of Japanese quails

	Treatment				
Parameters	(0% SMSKM control)	SMSKM without Enzyme	SMSKM+ Maxigrain	SMSKM+ Vegpro	SEM
Albumen height (mm)	0.42	0.48	0.45	0.45	0.07
Albumen breadth (mm)	3.83^{b}	4.08^{a}	3.96^{ab}	4.02^{a}	0.16
Albumen index	0.94	0.95	0.89	0.89	0.15
Yolk height (mm)	2.78^{c}	3.07^{a}	2.89^{bc}	3.02^{ab}	0.15
Yolk breadth (mm)	2.77^{bc}	2.91^{a}	2.69^{bc}	2.87^{ab}	0.11
Yolk index	1.01	1.00	0.95	0.99	0.08
Yolk (%)	37.25^{a}	30.95^{d}	36.39^{b}	34.75^{c}	0.73
Yolk weight (g)	3.16^{a}	3.05^{b}	3.05^{b}	2.95^{c}	0.10
Haugh unit (%)	62.50^{b}	62.87^{a}	62.11^{c}	62.78^{a}	0.26

a, b, c, = Means with different superscripts within the same row are significantly ($P<0.05$) different.
SEM = Standard error of means.

Table 4.22: Interaction effects of soaked mango seed kernel meal levels with and without enzyme supplementation on albumen breath of Japanese quails

	Treatment										
Parameter	T_1 (0% SMSKM)	T_2 (10%only)	T_3 (10%+ max)	T_4 (10%+ Vegpro)	T_5 (20% only)	T_6 (20%+ max)	T_7 (20%+ Vegpro	T_8 (30% Only)	T_9 (30% +max)	T_{10} (30%+ maxi+veg)	SEM
Albumen breath (mm)	3.38^{f}	3.58^{e}	3.93^{cd}	4.09^{b}	4.09^{b}	4.08^{b}	4.01^{bc}	3.88^{d}	4.58^{a}	3.96^{c}	0.10

a, b, c, d, e = Means with different superscripts within the same row are significantly (P< 0.05) different.
SEM = Standard error of the mean.

Table 4.23: Effects of soaked mango seed kernel meal levels on feed and egg costs of Japanese quails

Parameters	Levels of SMSKM (0%)	(10%)	(20%)	(30%)	SEM
Total Feed cost /total feed intake/bird (₦/K)	186.91^{c}	253.00^{b}	362.74^{a}	352.83^{a}	16.21
Feed cost/crate eggs/bird (₦/K)	1084.13^{d}	1468.33^{a}	1090.76^{c}	1239.39^{b}	0.52
Feed cost/ dozen eggs/bird (₦/K)	286.24^{c}	394.25^{a}	288.80^{c}	330.35^{b}	0.74

a, b, c, d = means with different superscripts are significantly ($p<0.05$) different
SEM = Standard error of means

4.2.12 Effects of the feed and egg cost of soaked mango seed kernel meal and enzyme types of Japanese quails at laying phase

The result as shown in Table 4.24 indicates significant (P< 0.05) differences observed in the total feed cost per total feed intake, feed cost per dozen eggs and feed cost per crate of eggs. The treatment without enzyme inclusion having the least feed cost of ₦309.20K after the control of ₦186.91k,least feed cost per crate of egg of ₦1187.60k and ₦1156.96k were similarly recorded by birds in the treatment without enzyme and treatment with maxigrain enzyme respectively while control treatment had the least cost of ₦1084.31k,the least feed cost per dozen eggs also followed similar trends of₦316.09k and ₦308.52k respectively while the control recorded ₦286.24k.

Table 4.24: Effects of the enzyme types and soaked mango seed kernel meal levels on the feed and egg costs of Japanese quails

	Treatment				
Parameters	(% SMSKM no Enzyme)	(SMSKM no enzyme)	(SMSKM + Maxigrain)	(SMSKM +Vegpro)	SEM
Total Feed cost/total feed intake/bird ₦/K	186.91[d]	309.20[b]	293.41[c]	365.97[a]	14.09
Feed cost per Crate of eggs/bird ₦/K	1084.13[c]	1187.60[b]	1156.96[b]	1268.37[a]	63.79
Feed cost per dozen eggs/bird ₦/K	286.24[c]	316.69[b]	308.52[b]	338.23[a]	21.50

a, b = means with different superscripts within the same row are significantly ($P< 0.05$) different
SEM = Standard error of means

CHAPTER FIVE

DISCUSSION

5.1 Results of the laboratory analysis

Proximate composition of the soaked mango seed kernel meal obtained in this study were 90.06% dry matter, 4.78% crude protein, 5.58% crude fibre, 1.96% Ether extract, 5.39% Ash, 68.40% NFE and 2,764.02 kcal/kg. The values differed from those obtained by various authors and this may be due to the processing method adopted. Bala (2010) obtained the following results using the modified Dhingra and Kapoor, (1985) method, dry matter 54.95%, crude protein 6.44%, crude fibre 1.95%, Ether extract 12.99%, ash 2.02% and Nitrogen free extract 33.48%, whereas Abdullahi *et al.* (2012), obtained the following results after processing by soaking as in this experiment; dry matter 96.28%, crude protein 6.50%, crude fibre 3.39%, Ether extract 4.99%, ash 6.26% and Nitrogen free extract was 79.85% and similarly obtained the following results after boiling. Dry matter 95.27%, crude protein 7.38%, crude fibre 3.08% Ether extract 4.01%, ash 6.15% and Nitrogen free extract 77.38%, indicating that processing the local variety of Kanbiri MSKM by the method employed in this study (soaking) and boiling proved better in the final compositions of the Nitrogen free extracts and ash contents when compared to the modified Dhingra and Kapoor, (1985) method used by Abdullahi *et al.* (2010); this is also in conformity with the findings of Diarra *et al.* (2008), except for the ash (mineral) content, when the authors processed unnamed samples of mango seed meal by boiling. The crude protein value obtained after soaking in this study (4.78%) was below the ranges of (7.00 to 8.75%) reported

by Diarra *et al.* (2008) without making any reference to the particular variety and the processing method of the mango kernel.

Shipla *et al.* (2014) recorded a crude protein content of 7.53 %, 11.45 % fat, 2.20 % crude fibre, 1.00 % ash, 64.77 % carbohydrate and an energy value of 421.00 k_{cal} after soaking the mango kernel meal in water, for between 18.00 to 20.00 hours leading to an increase in the weight of the kernel by 66.40 % of its initial weight of 500.00 g. Though the variety used was not mentioned which would have provided a good basis for a proper comparison, similar processing method of soaking were however adopted in this study resulting in a lesser crude protein value of 4.78 % after 72:00 hours of soaking.

The value of the tannin content obtained after processing was 0.04mg/100g of sample equivalent to 0.04 X 10^{-4} %, a 33.33% reduction from its raw sample; Reed, (1995) reported "the toxic levels (lethal doses) of tannins to be (0.50 to 2.00%) in birds, adding that levels of up to (3.00 to 7.00%) could lead to death in the animal. The zero percent mortality recorded throughout the course of the experiment indicates the efficient reduction of the harmful effect of the tannin after appropriate processing by soaking and the enzymes included, was not in conformity with Haruna *et al.* (1997) who reported that the mortality rate among quails from day one to day four is about 10.00%, but reduced to as low as 2.00% when they are six weeks and above, though not been specific about the nature of feed composition offered. Dakare *et al.* (2012) observed a reduction of 23.80 % of the phytate content of mango kernel meal by soaking in water for 24.00 hours without indicating the name of the variety used

compared to the 33.33 % reduction value recorded in this study after 72:00 hours of soaking.

The tannin values obtained was lower than that reported by Abdullahi *et al.* (2012) i.e. 0.08mg/100g with a 42.86 % reduction and 0.04mg/100g by boiling, while Bala, (2010) obtained 0.09mg/100g with a 76.32 % reduction levels; this may be attributed to the location where the mango fruits were collected, since similar varieties and processing methods were used by all the authors, probably due to interaction of the tannin content with the various mineral elements absorbed from the soil, during the growth phases of the mango seeds. Stephan and Peter (2000) reported that several recent lines of evidence suggest that polyphenols (a plant secondary metabolite) also influences the pools and fluxes of inorganic soil nutrients into the crop plant themselves.

The amount of phytate in the sample after processing was 0.16mg/100gm equivalent to $0.16 \text{ X } 10^{-4}$ % of sample i.e. a 33.33%, falling below the lethal dosage level of (0.057%) as reported by Casartall *et al*. (2005) for monogastric animals with Bala, (2010) recording 0.01mg/100g and an 80.00% reduction by soaking, while Abdullahi *et al.* (2012) recorded 0.16mg/100g and 82.22% reduction by soaking for 72:00 hours and 0.14mg/100g and 84.44% reduction by boiling, indicating that processing the mango seed kernel meal by soaking for 72:00 hours proved more efficient in the reduction of the phytate content.

The 0.00% mortality recorded must be related to the sample not exceeding the toxic (lethal level) of phytate in the diet, which was reported by Carsatall *et al*. (2005) to be

0.057%, also an indication of the inherent ability of quails in the neutralization of the harmful effect of this chemical compound, an anti-nutrient with and without enzyme supplementation in their body systems (Classen, 1996), due to the activities of the enzymes in neutralizing the harmful effects of the phytate (Classen and Bedford, 1999), and their highly resistant nature to notorious poultry diseases like gumboro and moderately resistant to many others (Haruna *et al*., 1997).

5.2 Effects of soaked mango seed kernel meal with and without enzyme supplementation on the growth performance of Japanese quails

There were significant differences in the total feed intake, final body weight, body weight gain and feed to gain ratio, with the soaked mango seed kernel meal levels. Birds fed with 30.00 % SMSKM had the highest total feed intake value of 513.80 g with the 10.00 % SMSKM inclusion level having the least value of 465.08g not similar with the findings of Nsa *et al.* (2012), of decreasing feed intake with higher percent inclusion, when they fed sun dried mango seed kernel meal as a partial replacement for maize on growth performance and internal organ development of broiler finishers though recording a non-significant difference in their feed to gain ratios. Odunsi, (2005) also noticed similar results, with a significant decrease in the feed intake of broilers as the inclusion levels of mango seed kernel meal increased from 0.00% up to 25.00%, indicating preferences of birds for feeds without inclusion of any non-conventional feed ingredient coupled with its ability of an efficient feed to gain records, despite working with different varieties and different processing methods of mango seed kernel. Abdullahi *et al.* (2012) noticed non-significant differences in feed intake when maize was replaced with graded levels of local variety (*Kanbiri*) of

soaked mango seed kernel meal on the performance of broiler chickens, which may be related to the more efficient percent reduction level of 42.86% obtained by Abdullahi *et al*. (2012) as compared with the 33.33% obtained from this study.

The decrease in feed to gain ratio with increase in the levels from 5.89 and 5.88 respectively of SMSKM inclusion as observed withtreatment with 20.00 % SMSKM and 30.00 % SMSKM levels all significantly lower than treatment with 0.00 % SMSKM of 4.64could be attributed to the increasing content of the anti-nutritional factors, which acts as appetite depressants (Agunbiade *et al.,* 1999), which also reduced the availability and utilization of nutrients by the birds (Nsa, 2007). It could also be as a result of the astringent taste of the mango seed in the diet Abdullahi *et al.* (2012). This result however does have positive impact on the final body weight recorded.

With the inclusion of the various enzyme types, the final body weight, total feed intake,body weight gain and feed to gain ratio showed significant differences, with the control having the highest value in all apart from the total feed intake, which may not be unconnected with variations occurring in the nutrient quality of the feed ingredients due to the presence of the various enzymes types added (Bedford, 2000;Khusheeba and Ajid, 2013)which does not conform with the works of Alu *et al.*(2012) who reported no significant differences with and without enzyme supplementation on effects of exogenous enzyme supplementation of sugarcane scrapping meal based diets on the growth rate of Japanese quails chickens. The high value of the feed to gain ratio obtained from samples treated with enzymes compared to samples treated without

enzymes, does not support the reports of Saricicek (2005b) who stated that enzymes improves birds performance and their feed to gain ratio. The specific action of enzymes on selected substrates might be responsible for these variations.

5.3 Effects of soaked mango seed kernel meal with and without enzyme supplementation on the carcass characteristics of Japanese quails

All parameters measured for the carcass characteristics of the SMSKM levels were significantly different, the overall best performance of the carcass characteristics was noticed with birds fed, the 20.00 % SMSKM inclusion level having the highest average live weight, carcass weight and dressing percent values of 141.17 %, 88.52 % and 61.04 % respectively, might be due to the similar varieties and processing methods used by this author and Abdullahi *et al.* (2012), who reported significant differences only in the live weight, slaughter weight and dressed weight percent. The result also supported that of Nsa *et al.* (2012), who found non-significant differences in the heart, liver, lung, kidney and gizzard only with significant differences in other parameters, working with an un-named variety of mango seed kernel meal processed by sun drying in broilers. The heaviest values recorded for the weight of the gizzard full (6.22 %), weight of the gizzard empty (4.65 %) and the intestine weights of (9.19 %) noticed with the 30.00 % inclusion level of the SMSKM, is an indication of an improper utilization of the experimental feeds at this level due to its highest concentration of the crude fibre content (6.43 %) on the average. This shows that the visceral organs of Japanese quails responds to variations in the inclusion levels of SMSKM significantly as compared to those of chickens.

Abdullahi *et al.* (2012) also observed non significant ($p>0.05$) differences in the thigh weight, breast weight, back weight, neck and wing weight after feeding broilers with boiled SMSKM (*kanbiri*) at 100 ^{o}C for 30 minutes and soaking for 72:00 hours as replacement with maize. Anthony *et al.* (2014) observed non significant ($p>0.05$) differences in the wing weight, breast weight and thigh weight across all the treatments on the inclusion of SMSKM processed by boiling as replacement with maize.

With the inclusion of the various enzyme types, the average live weight, carcass weight and dressing percent were all significantly different, with the Treatment with vegpro having an overall best performance agreeing with report of Saricicek *et al*. (2005b), who stated that enzymes improve bird performance and their fed conversion ratio and also neutralizes the harmful effect of certain anti-nutrient factor in non-conventional feed materials. This result differs with that of Saricicek *et al.* (2005a) who reported significant differences in the heart only, upon replacing Soybean Meal (SBM) with Conola meal (CM): (which also contains Phytic acid as in the mango seed kernel meal) when they studied the effects of multi enzymes and phytase supplementation on the performance of growing and laying quails. Daudu, (2011) reported significant differences only in the intestine weight, whereas Alu *et al.*(2012) reported significant differences in the back, neck and the gastro intestinal tract, when Maxigrain enzyme supplementation on a low or high fibre diet on carcass characteristics of female quails was investigated compared with this result. Value for the dressing percent which was significantly different agreed with Alu *et al.* (2012b) and Adeola and Olukosi (2008) who both reported that enzyme supplementation

improves performance of animals, inability of the treatments with enzyme inclusions to efficiently convert the feed in takes to meat were effectively noticed where the control had the highest values for the leg 5.51% and back 42.41% a higher inclusion levels of the enzymes could probably reverse the trend (classen and cooper,1998)

5.4 Effects of soaked mango seed kernel meal with and without enzyme supplementation on the nutrient digestibility and ash retention of Japanese quails

Effects of the Soaked mango seed kernel meal levels and enzyme types on the nutrient digestibility and ash retention of the birds were all significantly different in all parameters across the treatmentapart from the nitrogen free extract both with and without enzyme supplementation agreeing with the reports of Campbell and Bedford (1992), Schomburg *et al.* (2013) and Warsha *et al.* (2006) indicating the efficiency of exogenous enzyme inclusion in feed utilization by birds, since birds under the control treatment all had the least nutrient digestibility values on the average. This was in agreement with Francis *et al.*(2002). Treatment with 10.00 % SMSKM had the overall best nutrient digestibility, especially the protein content of 73.39 due to its least tannin content, also due to the negative effect of tannin in reducing the digestibility of the crude protein (Schiavone *et al*., 2007)which supports the findings of (Longstaff and Mc Nab, 2007). Significant differences on the interaction were noticed on the digestible crude fibre in birds. Treatmentwith 30.00% SMSKM + Vegpro showed the best utilization 81.05% of nutrients, agreeing with Classen and Cooper (1998), who both reported the efficacy of enzymes in increasing the digestibility of feed nutrients. The generally moderate values of 66.25% recorded for the nutrient digestibility estimates in this study for both with and without enzymes was higher than

(Farag,2001), which was later enhanced by further processing through thermal treatment and irradiation leading to a reduction in trypsin inhibitory activities, cyanogenic glucoside and the tannin contents. Treatment with 0.00 % SMSKM withoutenzyme retained their ash retentionworst,value of 61.49 %,further supporting the conclusions of Francis *et al.* (2002) earlier cited. The 30.00 % inclusion level had the best overall digestibility of 68.84%, which continues to decline with decreasing levels, disagreeing with (Classen and Cooper, 1998) who both reported that non-conventional feed stuff reduces nutrient utilization by birds due to the high crude fibre content.

5.5 Economic analysis at growth phase

The feed costs to attain market weight at the growth phase with and without enzyme supplementation were significantly cheaper at the 20.00 % SMSKM levels with values of ₦102.63K after the control of ₦95.43K and ₦102.23K after the control of ₦95.43K respectively, not conforming with Dafwang *et al.* (2001) and Sekoni *et al.* (2008) who both stated that the addition of unconventional feed materials to livestock feeds tends to decrease the feed cost, without considering the fluctuation in the market price on the feed ingredients at the particular time of each study.

5.6 Effects of soaked mango seed kernel meal with and without enzyme on the growth performance of Japanese quails at laying phase

Significant differences were observed with the feed to gain ratio, where birds in the control 10.00 % diet converted their feeds better with a value of 1.02 followed by the 20.00 % inclusion level with 1.64intake to attain a 1.00 g body weight. The results support the findings of Afolayan *et al.* (2015) and Alu *et al.* (2012) when the former

fed Japanese quails on whole or ground millet with and without enzyme inclusion, while the latter observed the effects of exogenous enzyme supplementation of sugarcane scrapping meal based diet on growth rate of Japanese quails, agreeing also with Odunsi (2005) who observed a depressed feed intake, rate of lays and feed to gain ratio in layer hens above 10.00 % replacement of maize with raw MSKM. The raw nature of the MSKM might be responsible, due to the high concentration of the anti-nutrients compared to the processed samples as reported by Saricicek *et al.* (2005b).

The significant differences observed in the water intake of SMSKM without enzyme supplementation, revealed the birds fed the 30.00 % inclusion level consuming the highest volume of water of 89.44ml, while volume consumed for other treatments fed 0.00 %, 10.00 % and 20.00 % were similar, but lower than the 30.00 % inclusion level, this could be attributed to the increasing stiffness of the feed resulting from the higher concentration of the fibrous content of the mango seed kernel meal, causing stiffness in the Gastro intestinal tract of the animals, hence forcing them to consume more volume of water, supporting the findings of Alu *et al.* (2012), it could also be attributed to the age and sex of the birds, since this research earlier reported a non-significance difference in water consumption of the birds at the growth phase of the study (3-7weeks) where the animals were unsexed.

The average weight of egg layed was significantly different, disconforming with (Odunsi, 2005). The increase in the value of the average weight of eggs at firstlay from 9.04g to 10.04g from the control were disproportional to the value of the feed conversion ratio recorded and the birds age at first lay, all related to the processing

method adopted, indicating the positive effects of an efficient feed conversion on the weights and day of first lay by the birds,

Hen house egg production and hen day egg production all recorded significant differences across the treatments, with the hen day egg production record of 81.04% in line with that of Afolayan *et al.* (2015). At zero percent inclusion (control), the hen house egg production had the highest value of 81.04%, indicating the intolerance of the birds for higher inclusion of the SMSKM during the layer phase The total number of eggs laid by the birds under each treatment at this phase of the study (average of 200 eggs/bird/annum) i.e. average of 110 during the six month period of the experiment, fell on the lower level of the targeted production level of quail hens of between (200-300eggs/bird/annum); Salim and Ibrahim (2004), which may be attributed to the different management systems adopted in terms of the feed ingredients, composition and formulation.

With enzyme supplementation, birds provided feeds with maxigrain enzymes in their diets converted their feeds to body weight better than those provided with feed without enzyme supplementation at 1.64, compared to the vegpro enzyme supplementation value of 1.90, probably due to the single enzyme composition (protease) of the vegpro, which must have reduced its efficiency greatly in line with the findings of Onimisi *et al.,* (2016), who stated that enzymes have been known to be used in improving the feed utilization of birds. Similar trends was also noticed with the average age of birds at first lay, where birds provided the enzymes supplementation in their diets dropped their first eggs earlier at an average day of 43.22 than those whose feeds contains no

enzymes average of 45.00 days, since these enzymes perform some specific biochemical activities in the guts of the animal, which help in breaking down complex molecular compounds into their individual nutrients, making them readily available for the animals to use (Osei and Oduro, 2000).

5.7 Effects of soaked mango seed kernel meal with and without enzyme supplementation on the external egg qualities of Japanese quails at laying phase

The egg length, egg breadth, egg shell (%) and shell index, egg mass were the only parameters among the external egg qualities which show significant differences among the treatments with the varying levels of SMSKM inclusions. The weight of egg shell index yielded from the diets of 21.89 on the average were all the same as that of the control diet, but the control diet significantly gave the least egg shell percent of 7.59 %, which was in contrast with the findings of Widya *et al.* (2014), which they attributed to the content of polyesterol in katuk leaf (also containing tannin an anti-nutrient) meal which stimulates Ca deposit in the egg shell. The average weight and percentage of egg shell were lower than the values obtained by same authors, while the average shell index value of 21.00 was higher than values obtained by Song *et al.*, (2001); when they compared the egg quality of pheasant, quails and guinea-fowl. These variations might not be unconnected to the differences in feed composition offered to the animals by each author. The egg length, egg weight, egg shell index and egg shell percent were significantly different with the various enzyme types, contrasting with the works of Ka'ankuka *et al*. (2012), who found significant differences in egg weight only, when they investigated the internal and external

qualities of Japanese quails eggs due to enzyme supplementation on high or low fibre diet.

For the egg weight, performance of the diet with Vegpro enzyme was similar to that of the control and diet containing SMSKM without enzyme with an average value of 8.65 g, but significantly higher than the diet with Maxigrain addition value of8.54 g, contrasting with the findings of Fagbemi and Oluwasola, (2012), who reported significant differences up to 50.00 % inclusion of palm kernel cake with enzyme fed to layer chickens, but agreed with that of Saricicek *et al.* (2005a) and Kaankuka *et al.* (2012); indicating the inability of the enzymes in unlocking the fibre contents of the test diets for better utilization of their nutrients; probably a higher level of enzyme inclusion may serve the purposes, though the Maxigrain enzyme succeeded in improving the egg shell percent significantly by 8.15%, as recorded in this study. Interaction was noticed with the egg breadth alone, where Treatment with 30.00 % without enzyme had the highest value of 3.06 mm but the least value was recorded with the Treatment with 0.00 % SMSKM without enzymes with a value of 2.67 mm.

5.8 Effects of soaked mango seed kernel meal with and without enzyme supplementation on the internal egg qualities of Japanese quails at laying phase

On internal egg qualities, the albumen breadth, albumen index, yolk height, yolk breadth, haugh unit (%) and yolk weight were all significantly different with varying SMSKM inclusions. Significant differences in yolk weight was observed, where value recorded for the control 3.16 g was higher than that of all the inclusion levels which were similar. This conformswiththe work of Widya *et al.,* (2014), working with katuk

leaf meal which also contains tannins as in the mango kernel used in this study,providing the basis for comparison.

Significant differences in the haugh unit disagreed with the report of Ka'ankuka *et al.,* (2012) when they observed the effect of low or high fibre diets on internal and external egg qualities of Japanese quails. This may be attributed to the higher crude fibre content of their test diets (Sugarcane Scrapping meals) they obtained values between 10.19% to 10.96% as compared to values between7.15% to 8.16% of the SMSKM used in this study.

Albumen breadth was significantly different on addition of the enzymes types; where diet containing Vegpro and Maxigrain were similar with diets without enzyme, with the highest average performance record of 3.90 mm, which contrasts with the conclusions noted by Adeola and Olukosi (2008) that "feeds containing non-conventional ingredients pose limitations to their uses due to the presence of high fibre and anti-nutritional factors, whose performance could be normalized by enzyme supplementation", probably not taking into account that enzyme actions are specific on substrates and dosages included. Significant differences in yolk height and haugh unit contrasted with the report of Ka'ankuka *et al.,* (2012), due to a higher value of the crude fibre content of their test materials as compared with this study, interaction at the albumen breadth shows that 30.00 % SMSKM with enzyme Maxigrain had the highest value of 4.58 mm, agreeing with the reports of Adeola and Olukosi, (2008).

5.9 Economic analysis at laying phase

Significant differences were observed in the feed cost per total feed intake per bird, feed cost per crate of eggs and feed cost per dozen eggs both with and without enzymes. The control having the least cost in total cost per total feed intake of ₦186.91k,followed by the 10.00% inclusion level of ₦253.00k, in the feed cost per crate of eggs the 20.00% had the least feed cost of ₦1090.76k after the control value of ₦1084.13k likewise in the feed cost per dozen egg value of ₦288.80k after the control value of ₦286.24k.with the enzyme inclusion however,treatment with maxigrain enzymes had the least feed costs per crate of eggs of ₦1156.96k after the control cost of ₦1084.31k, in the feed cost per dozen egg,the least value of ₦308.52k was recorded in treatment with maxigrain enzyme after the control value of ₦286.24k which does not support the reports of (Classen and Cooper, 1998) and (Odunsi, 2005) who both stated that addition of enzymes and unconventional feed stuff in monogastric animal feeds reduces the feed cost at long run. The unstable nature of the countries' currency must have had a significant impact, due to fluctuations in the market prices of the feed ingredients as at the time each of the researches were carried out.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

Results obtained at the end of the experiment to determine the effects of the inclusion of mango seed kernel meal *kanbiri* as replacement for maize processed by soaking,with and without enzyme supplementation on the growth, laying performance,egg quality characteristics and economy of production of Japanese quails reveals that; The nitrogen free extract and ash values of 68.40% and 5.39 % respectively obtained from the SMSKM after the processing method used was higher than values obtained by other authors, using similar and other processing methods, unlike the crude protein value obtained, whose value was lesser by 2.42 % from that of other authors.

There was a percentage reduction by 0.04 % of the metabolizable energy obtained after the processing method used in this study.

There was a percent reduction of 33.33 % of tannins obtained which was lower than the 42.86 % obtained by other authors with similar variety and processing method.

The phytate reduction of 33.33 % obtained was also lower than the 82.22 % obtained from other authors using similar variety and processing methods.

At the growth phase of the study, SMSKM inclusion level of 20.00 % had the overall best performance for the total feed intakevalue of 481.88g while the control had the bestfeed to gain ratio of 4.64.

The treatment with maxigrain enzyme inclusion had the highest records of 507.08 g for the total feed intake while the control had the least but best feed to gain ratio of 4.64.the feed cost per bird to attain market weight at the 20.00% inclusion of ₦102.23k was the cheapest after the cost at the control inclusion cost of ₦95.43k, but cheapest was observed in the treatment without enzyme inclusion cost of ₦102.63k after the control cost of ₦95.43k.

At the laying phase, 20.00 % having the overall best performance with SMSKM level in the final body weight 202.22g andtotal feed intake 1921.49g while the control had the best feed to gain ratio of 1.02, while Treatment with Vegproenzymes had the overall best performance with enzyme inclusion,in the total feed intake 1877.01g,average age of bird at first lay 43.11 days and hen day egg production value of 77.95%.

For the internal egg quality, the 30.00% SMSKM inclusions gave the highest results in the albumen breath 4.21mm, albumen index 1.04mm and yolk height value of 3.02mm,with enzyme inclusion however, Vegpro enzyme had the highest performance at the albumen breath 4.02mm,yolk height 3.02mm,yolk breath 2.87mm and the haugh unit of 62.78.

External egg quality performance record at 30.00% SMSKM inclusion level had the overall highest performance in the egg length 3.59 mm, egg breath value of 2.89mm, egg shell percent of 7.94 % and egg shell index of 22.05.

The birds were best able to digest most of the nutrients at 30.00 % inclusion of SMSKM,most especially the dry matter 67.89%, ether extract 78.63 % and ash

retention values of 64.38%, while the treatment with maxigrain enzyme inclusion had the overall best nutrient digestibilities in parameters such as the dry matter 68.40 %,crude protein 72.97%, ether extract 77.63% and the ash retention of 67.19%.

For the carcass characteristics, parameters measured had their best performance at the 20.00 % SMSKM level,in the average live weight measured 147.71g,carcass weight had 88.52g and the dressing percent value was 61.04 % and breast weight of 45.69% , the treatmentwith Vegpro enzyme was the best in terms of the carcass weight of 92.32g and dressing percent of 62.90 %, while the control had the highest leg and back weights of 5.51 % and 42.42 % respectively.

At this phase of the study, the 20.00 % inclusion level had the cheapest cost of ₦1090.76k for the feed cost per crate of eggs after the control cost of ₦1084.13k likewise in the feed cost per dozen eggs of ₦288.80k against the control cost of ₦286.24k.with the enzyme inclusion,the maxigrain enzyme inclusion had the least cost of ₦1156.96k for the feed cost per crate of eggs after the control cost of ₦1084.31k,likewise in the feed cost per dozen of eggs where the costs were ₦308.52k for the maxigrain enzyme and ₦286.24k for the cost at the control inclusion.

6.2 Conclusions

1) Japanese quails can tolerate the inclusion of soaked mango seed kernel meal as replacement for maize up to 30.00 % inclusion without enzyme supplementation, with significant effects noticed on their growth performance, where birds in the control had the highest final body weight gain of 178.40 g, least but best feed to

gain ratio of 4.64, while those fed the 30.00 % inclusion consumed the highest total amount of feed of 513.80 g.

The laying performances were also affected significantly up to the 30.00 % replacement level where birds in the 30.00 % were the first to drop their eggs at 43.22 days, the biggest egg weight of 8.72 g was layed by birds fed the 30.00 % inclusion level while the control had the highest Hen house egg production of 81.04 %, the 20.00 % had the highest value of the Hen day egg production of 86.82 %.

External egg quality characteristics were also affected significantly with the control having the highest egg mass of 969.75 g. 30.00 % inclusion level recorded the highest egg lengths and egg breadths of 3.59 mm and 2.89 mm respectively.

For the internal egg quality characteristics, 20.00 % inclusion had the highest haugh unit value of 63.18 %, albumen index of 0.93 and yolk percent of 37.25 % was recorded in the control treatment.

2) With enzyme inclusion however, significant effects were observed at the growth performance, where the control had the highest final body weight of 178.40 g and feed to gain ratio of 6.71, treatment with vegpro had the highest total feed intake of 687.99 g.

For the laying performance, birds provided SMSKM without enzyme inclusion layed the largest egg weight of 8.75g, those with feed containing vegpro enzyme were the first to drop their eggs at 43.11 days, with the control having the highest

Hen housed and Hen day egg production values of 81.04 % and 76.77 % respectively.

Results for the external egg quality characteristics showed treatments with maxigrain and no enzymes having similar statistically highest egg lengths of 3.52 mm and 3.54 mm respectively, the control treatment had the highest egg mass of 969.75 g.

Internal egg quality characteristics indicates treatment with SMSKM without enzyme having the highest albumen breadth of 4.08 mm, yolk height of 3.07 mm, yolk breadth of 2.91 mm and haugh unit value of 62.87 %.

3) The economy of production of the birds were also significantly affected without enzyme supplementation, since the feed cost for the bird to attain market weight was cheapest in the 20.00% inclusion of ₦102.23k after the control value of ₦95.43k.feed cost per crate of eggs and feed cost per dozen eggs were more cheaper at the 20.00% inclusion level of ₦1090.76k and ₦288.80k after the control values of ₦1084.13k and ₦286.24k respectively.

   With enzyme supplementation however, Treatment without enzyme recorded the cheapest cost of ₦102.63k after the control cost of ₦95.43k for the feed cost to attain market weight,similar with treatment with both enzyme inclusions.Feed cost per crate and dozen eggs were more cheaper with maxigrain enzyme inclusion values of ₦1156.96k and ₦308.52k after the control values of ₦1084.91k and ₦286.24k respectively.

It could therefore be concluded that Japanese quails can tolerate the inclusion of soaked mango seed kernel meal upto 30.00 % inclusion with and without enzyme supplementation with significant effects on their growth performance, laying parameters, egg quality characteristics and their economy of production parameters, without any adverse effects on their health.

6.3 Recommendations

The following recommendations are proffered:

At the growth phase of Japanese quails, 20.00 % inclusion level of SMSKM is preferred due to its cheaper cost₦102.23k after the control cost of ₦95.43k.

With enzyme inclusion the Maxigrain enzyme is recommended due to its high record of performance, and average lesser cost of ₦106.59k compared to the Vegpro enzyme inclusion cost of ₦111.57k.

For an efficient nutrient digestibility, the utilization at the 30.00 % inclusion level of SMSKM is sufficient due to its record of highest performance in the dry matter 67.98 %,ether extract 78.63 % and ash retention value of 64.36 %.

Treatment with Maxigrain enzyme inclusion is the best alternative for efficient nutrient digestibility due to its concentration of five to six enzyme cocktails compared to the Vegpro enzyme which contains only one enzyme (protease).

Maxigrain enzyme inclusion should be maintained at the growth phase due its relatively cheapest feed cost of the bird to attain market weight of₦106.59k as compared with the Vegpro enzyme level of ₦111.57k.

At the laying phase 20.00 % level inclusion is most preferred for the growth performance level due to its highest final body weight of 202.22g and highest total feed intake value of 1921.49g, the 20.00 % level of inclusion was cheaper with the feed cost per crate of eggs of ₦1090.76k after the control cost of ₦1084.13k.

The Maxigrain enzyme inclusion is also recommended at this level due to its lesser cost ₦1156.96k for the feed cost per crate of eggs after the control cost of ₦1084.31k.

Further studies can still be carried out using other mango varieties with different processing methods on a comparative basis.

A longer hours of processing more than those adopted in this study (72:00hours) could be tried, which might lead to further reduction of the anti-nutrient factor, aimed at improving the digestibility values of the birds.

Haematological studies of the birds could be done to ascertain the effect of the feeds on their physiological status, despite recording no mortality in this study.

6.4 Contributions to scientific knowledge

Processing the SMSKM by soaking for 72:00 hours with an 8:00 hour change of water reduces the crude protein contents by 31.38 %, crude fibre by 68.48 %, ether extract and ash contents by 0.20 % and 0.59 % respectively.

The percent crude protein of 4.78 % obtained was lesser than the 7.00 % to 8.75 % obtained by other authors due to the differences in the mango seed kernel variety used, processing method adopted and the location where the mango kernels were collected from.

The price of the birds at market weight at the 20.00 % obtained at the growth phase was much better, differing from the control by ₦17.57k compared with other levels of inclusions, hence it is more affordable.

The processing method adopted reduced the tannin and phytate contents (the most toxic antinutritional factor contents of the mango seed kernel meal) by 33.33 % each with values of 0.04 mg/100g (0.04×10^{-4} %) and 0.16 mg/100g (0.16×10^{-4} %) respectively below the toxic levels of 0.5 to 2.0 % and 0.057 % for the tannin and phytate respectively, making them very tolerable to the birds.

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