EFFECT OF AUTOCLAVED CASTOR SEED CAKE IN MAIZE AND SORGHUM BASED DIETS WITH ENZYME SUPPLEMENTATION ON PERFORMANCE OF JAPANESE QUAIL (*Coturnix coturnix japonica*)

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NOVEMBER, 2015

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DEPARTMENT OF ANIMAL SCIENCE,
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NOVEMBER, 2015

DECLARATION

I declare that the work in this dissertation entitled "Effect of Autoclaved Castor Seed Cake in maize and sorghum based diet with enzyme supplementation on performance of Japanese Quail Birds" has been carried out by me in the Department of Animal Science.

The information derived from 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 any university/institution.

Durowaiye George Gbenga Date

CERTIFICATION

This dissertation entitled "Effect of Autoclaved Castor Seed Cake in maize and sorghum based diet with enzyme supplementation on performance of Japanese Quail Birds" by Durowaiye George Gbenga meets the regulations governing the award of the degree of Master of Science of the Ahmadu Bello University Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This project work is dedicated to God Almighty for giving me wisdom and enablement throughout my study period and my parents Mr and Mrs. Ojo Durowaiye for their daily prayer to make me successful in life.

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ABSTRACT

Two feeding trials were conducted to evaluate the growth performance, carcass characteristics, haematological profile, egg production parameters, egg quality characteristics and economic advantage of Japanese quails fed diets containing autoclaved castor seed cake (CSC) in maize/sorghum based diet (MSBD) with enzyme supplementation in the feeding trials. Three hundred and fifty seven (357) two weeks old quail chicks (average weight of 30.00g) were allocated to seven dietary treatments in a completely randomized design (CRD). Each treatment contained 51 chicks with three replicates of 17 birds per pen in the first trial for 28 days. Treatment 1 (T1) serves as the control containing maize based diet (MBD), T2 and T3 contain maize, CSC and enzyme respectively, T4 contains MSBD with CSC, T5 contains MSBD with CSC and enzyme while T6 and T7 contain sorghum and CBC and sorghum and CSC with enzyme respectively for both starter/grower and laying phase. The diets were iso- nitrogenous (25%CP) and iso-caloric (2800 ME Kcal/Kg). Water and feed were given *ad libitum*. The result of the growth performance indicates that the final body weight, total weight gain, daily weight gain, were significantiy ($P<0.05$) higher in the control group (T1) compared to T2, T3, T4, T6 and T7 but similar to T5. The total feed intake and the daily feed intake were significantly ($P<0.05$) higher in T1 compared to all other treatments. The results of the haematological parameters showed that the pack cell volume (PCV) and haemoglobin (Hb) values were significantly ($P<0.05$) higher in T3 compared to T1, T4 and T7 but similar to T2, T5 and T6. The red blood cells (RBC) was significantly $p<0.05$) higher in T2 compared to T4 but similar to that other treatments. The white blood cells (WBC) was significantly ($P<0.05$) higher in T4 compared to T1, T2, T6 and T7 this is similar to T3 and T5. The result of the carcass evaluation indicates that the carcass weight (CW) was significantly ($P<0.05$) higher in T1 compared to all other treatments but similar to T7. The dressing percentage was significantly ($P<0.05$) higher in T7 compared to T2, T4, T5 and T6 but similar to T1 and T3. There were no significant ($P>0.05$) differences in thigh, breast, gizzard, and lungs across the treatments. The results on growth performance, haematology, and carcass characteristics indicated that quails on autoclaved castor seed cake in a maize and sorghum based diets with vegpro supplementation (T5) were similar to those on the control diet (T1). Two hundred and ten (210) six weeks old quails at the point of lay were allocated to seven dietary treatments in a completely randomized design (CRD) for the second trial. Each treatment contained 30 quail hens with three replicates of 10 quail hens per pen which lasted for 6-20 weeks. The diets were formulated to be iso-nitrogenous (22%CP) and iso- caloric (2700 Kcal/Kg. Water and feed were given *ad libitum*. The result of egg production parameters indicated significant difference ($P<0.05$) in egg production parameters measured. Hen-day egg production, hen housed egg production and peak egg production of quail birds fed 10% CSC + 46.51 sorghum without enzyme (T6) performed significantly ($P< 0.05$) better compared to T2, T3 , T4, T5 and T7 but is similar to T1. There were no significant difference ($P>0.05$) in Yolk index; Yolk %, Yolk height, albumen%, albumen height, shell weights and shell thickness across the treatments. Hence utilization of CSC at 10% inclusion in sorghum based diet without enzyme (T6) in egg laying phase result in improved egg production at the least cost.

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CHAPTER ONE

1.0 INTRODUCTION

The protein intake of Nigerians has been on the decline as a result of the ever increasing population. In Nigeria, the average daily animal protein intake per adult is still far less than the 65g per adult per day recommended by FAO (Adewumi *et al.*, 2010). The need to abridge the animal protein intake is a major problem especially in developing countries where population growth practically outweighs food production leaving little grains to compound livestock feeds. Feed cost alone in poultry enterprise is estimated to be about 70% of the total cost of production (Ogundipe *et al.*, 2003). At present, the astronomic rise in the prices of conventional protein ingredients especially soya bean and groundnut cake has put enormous pressure on the poultry farmers to look for alternatives (Longe, 2006).

In an attempt to source for the locally available nonconventional low cost and nutritionally adequate feedstuff for poultry, considerable attention is being focused on assessing the nutritive and anti-nutritive quality of different seeds (Mc Donald *et al.*, 1995). Castor seed may offer a good hope in addressing the challenge of feeding farm animals.

Castor oil seed meal has high level (11.40-38.21%) of abrasive fibre (Okorie *et al*., 1985; Browning *et al.*, 1990). Okorie *et al.* (1985) showed that roasting at 40°C for 30 minutes was an effective detoxification method, Okorie and Anugwa (1987), Okoye *et al*., 1987 and Okorie *et al.* (1988) later reported cases of mortality of some chicks fed with diets containing such heat treated castor bean meal (CBM).

Many processing methods of detoxification of castor seed have been used which include fermentation, Lye, hot water treatment, roasting of which had not given satisfactory result (EFSAJ, 2008). Recently it has been discovered that tannin react with Ricin which is a protein that is highly toxic to the animals (Anandan *et al.*, 2009). The complex formed by the reaction of tannin with Ricin reduces the toxic effect of ricin in the body of the quail birds (Gandhi and Mulky, 1994).

Quails originated from Asia and Europe, it belongs to the species galliformis. The most common well known species are *Coturnix coturnix* and Bob white quail (*Colinue virginians*) which are kept for meat and egg production (Thear, 1987). Quail birds have potential to serve as excellent and cheap source of animal protein (Cooper, 1989). Quail birds have short generation interval and attain market weight of 150-180g and lay between 180-250 eggs per year (Garwood and Dielhi, 1987). Also quail birds require smaller space about 8-10 adult quails can be reared in a space meant for one adult chicken (Haruna *et al.*, 1997). Considering the problem of toxins in castor seed, the present study was designed to investigate the effect of autoclaved castor seed cake in maize and sorghum based diet supplemented with enzyme on the performance of quail birds.

1.1 Justification

Due to scarcity of feeds for livestocks, there is need to source for cheaper alternative especially vegetable protein such as castor seed cake which is a byproduct of vegetable oil extraction industry to replace ground nut cake and soya bean cake which are costly to reduce the cost of poultry feed. Therefore, the present study was designed to

investigate the effect of autoclaved castor seed cake in maize and sorghum based diet supplemented with enzyme on the performance of quail birds.

1.2 Objectives

The objectives of this study include to determine the effect of:

1 autoclaved castor seed cake in maize and sorghum based diet with vegpro supplementation on growth performance characteristics of quail birds.

2 autoclaved castor seed cake in maize and sorghum based diets with vegpro supplementation on egg production parameters, egg quality characteristics and economic advantage of quail birds.

3 autoclaved castor seed cake in maize and sorghum based diet with vegpro supplementation on haematological profile and carcass characteristics of quail birds.

1.3 Research Hypothesis

Ho: Autoclaved castor seed cake in maize and sorghum based diets with vegpro supplementation has no effect on the growth performance of Japanese quails.

Ha: Autoclaved castor seed cake in maize and sorghum based diets with vegpro supplementation has effect on the growth performance of Japanese quails.

Ho: Autoclaved castor seed cake in maize and sorghum based diets with vegpro supplementation has no effect on the egg production parameters, egg quality characteristics and economics advantage of Japanese quails.

Ha: Autoclaved castor seed cake in maize and sorghum based diets with vegpro supplementation has effect on egg production parameters, egg quality characteristics and economics advantage of Japanese quails.

Ho: Autoclaved castor seed cake in maize and sorghum based diets with vegpro supplementation has no effect on haematological profile and carcass characteristics of Japanese quails.

Ha: Autoclaved castor seed cake in maize and sorghum based diets with vegpro supplementation has effect on the haematological profile and carcass characteristics of Japanese quails.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 History and origin of castor plant

Castor oil seeds have been found in Egyptian tombs dating back to 4000BC and the oil gotten from the seed was used in wick lamp for lighting (Wikipedia, 2008).

It has a similar species called *Fantasia japonica* which is a false castor oil plant. It belongs to the purge family Euphorblacea (Wikipedia, 2008). Castor oil plant is indigenous to southern Eastern Mediterranean Basin, East African and India. Castor oil plant grows as perennial in the tropics and as an annual crop in the temperate climate (Vaughan, 1970).

According to (Wikipedia, 2008) castor oil plant was found in Egyptian tomb as far back as 4000 BC and the oil was used in wick lamps for lighting, it was named palm of Christ or palm Christi because of its ability to heal wound and cure ailments.



2.2 Description of Castor Oil Plant

Castor belongs to Euphorbiaceous family and is grown for its non edible oil seed. Castor oil plant can grow up to between 10-13m tall depending on the varieties (Reed, 1976). It has high photosynthetic capacity with high relative humidity (Dai *et al.*, 1992). Castor oil plant has been bred to adapt to mechanized cultivar and can be cultivated in dry areas with a height between 160-120m and (Rehm and Espig, 1991). It has large star shaped leaves which make a bold foliage plant (Reed, 1976). The leaves have slightly serrated edged and prominent central veins. It has numerous flowers in long inbred sences, with male flower at the base and female flowers on the tips (Reed, 1976). The fruit has a globule capsule which is about 2-5cm in diameter on an elongated pedicel, usually spring green turning brown on ripening, in dehiscent in modern cultivar (Reed, 1976).

2.2.1 Cultivation of castor plant.

Castor oil plant is grown as a shrub and a perennial plant that could attain the height up to 10 m high. It is grown as both annual and perennial plant (Ombrello, 2007). Castor oil plant does well in a well drained sandy or clay soil and alluvial soil (Ben, Agro, 2008). It requires rainfall between 800-1000mm and matured between 5-8 months after germination. The collection of the mature fruits are both dry (December- march) and raining (May to September) seasons (W.J.A.S, 2012).

Castor oil plant seed rate is reported to be as much as 12-15kg per hectare. The spacing should be between 1-2m apart (Ben Agro, 2008). Fertilizer application can be side placement with ammonium phosphate. It require regular weeding, it matures between 5-8 months and harvesting is done in raining (May to September) and dry (December to March) (W.J.A.S., 2012).

2.2.2 Diseases and pests of castor plant

Castor oil plant is affected by different types of diseases and pests which can be controlled using chemicals.

1. Capsule Borrer *Dichrocrosis puncitriferalis*. It destroys the shoot by boring hole to destroy plant. It can be controlled by using Gammexane and wood ash.
2. Trips, army worms, spider mites (Ben Agro, 2008). Disease that affect the castor oil plants are seedling blight which is caused by *Phythora colocusae* and *Cercospora colocusae* which can be controlled by using Beaudeaux mixture.

2.3 Castor Production in Nigeria

Nigeria has a tropical climate with sharp seasons which are governed by the movement of the inter-tropical discontinuity; a zone converges with hot and dry air from the Atlantic Ocean. Small seeded variety usually grows wild and commonly found along road side, river bank, residential area and waste land. The large seeded variety is traditionally cultivated in Easter part of Nigeria as backyard farming system (W.JA.S. 2012). The seed contains gross Energy (kcal/g large size 6.69 while small size 6.8 (W.J.A.S., 2012).

Antinutritive factors in castor seed (large size variety) composed of 4.7 lectin (Rlcin) Hu mg/ml, 0.41% oxalate,0.74% phytic acid, 0.35% Tannin (W.J.A.S.,2012).

Castor seed contains some enzymes which includes lipase, amylases, maltase, endo trypsin, glycolic acids, oxidase, ribonuclease, and a fat soluble zymogene activated by acids. Catalase peroxides and reductase are reported in germinated seeds (Kulkarni, 2005). The seed is popularly used as food condiment ogiri (W.J.A.S., 2012). In Nigeria, apart from some parts of the middle belt notably Kogi state (where it is cultivated),

castor oil plant grows in the wild and is treated as weed (Oyeleye, 2003). The plant grows wild in Kano, Kebbi, Plateau, Rivers and Sokoto states. The local names of castor oil plants depend on location. It is called castor in Kogi state generally. It is called "Ukpaka" in Ibo, Zurman in Hausa, Ewe laa, in Yoruba (Ben Agro, 2008).

2.4 Chemical composition of castor seeds

The kernel is highly oleaginous and of a sweetish taste and is slightly acidic. Proximate analysis of the whole seed indicates the following composition; large size varieties; moisture 7.32%, crude protein 24.3%, crude fibre 2.41%, crude oil 47.18%, Ash 3.26% NFE 15.19% and the small size variety: moisture 7.89%, crude oil 48.56%, Ash 3.89%, NFE 15.11%.(W.J.A.S, 2012). Globulins constitute 60% of the total proteins in the seeds. Ricin can also be detected and determined by chemical method involving mass spectrometry which is based on LC/MC or MALDI-T for classification followed by the uses of same instrument for the analysis of cryptic digest. The content of ricin in castor beans showing that the identification of the alkaloid ricinine by GC/MS can be a good complementary technique for the determination of castor bean extracts (Seto and Kanamori, 2005) and Frederickson *et al*. (2005) have further investigated the use of different MS methods in the identification of ricin in different samples among others in crude castor extracts. Specific alkaloid ricinine (3-cyano – 4- methoxy- N- methyl 1-2 pyridine) as a marker of contamination of feed with materials from *Ricinus communis* can be detected using mass spectrometry. Darby *et al.* (2001) analysed both crotin using high performance gel filtration chromatography (GFE). It has been reported that lipase can be obtained from grounded decorticated castor seeds in form of emulsion or as fluffy powder. It can be used to hydrolyze fats in chemical reaction. It can remain active at low temperature of about- 5°C (Altshul, 1958).

2.5 Toxic principles in castor seeds

Castor seeds contain some toxic components which are poisonous to man and animals. The most dangerous toxic is ricin which varies depending on the variety of castor seed, large size seed contains 3.7 Hu mg/m/ while small size variety contains 3.1 Hu mg/ml/ (W.J.A.S., 2012). Ricin is held among the top two deadliest poisons available (Allswede and Mirarchi, 2003). Ricin is a toxic glyco protein, with several minor variants, which consists of two polypeptide chain each of appropriately 30 KDa and joined by a disulfide bond. Ricin is a type 11 ribosomal inhibitory proteins (EIP 11) (EFSA, 2008). Ricin had *et al.*, 2008).

2.6 Methods of Analysis of Ricin in castor seed

Ricin has been described as potent protein polysaccharide allergens (Onimisi *et al*., 2008). Ricin and related compounds are determined using conventional methods for protein such as immunochemical methods of various kinds such as Electrophoresis. This is demon pak 60 + protein pak 125 Column using phosphate buffer. (0.2 mol /l), PH 6.5. The purity of the constituents was assessed by their spectra. The molecular weight of crotin 1 and 11 were estimated as 40 kDa and 19 kDa, respectively and amino acid sequences of both crotin were determined with OPA- post column derivation. Also biological methods which are immunological methods are also used for determination of ricin. These methods are based on monoclonal and polyclonal antibodies. But analyzes seems not to have been performed on feed samples. (EFSA, 2008). Ricinine is one of the toxic present in castor seed which has a chemical formula (C8H8 02 N2; I-MethyL-3- cyano- 4- methyoxy-2-pyridone; M.P, 205 ^{O}C) is a water

soluble alkaloid concentrated mostly in seed coat. It also present in leaves and stems. It is slightly bitter to taste and is irritant to the throat. It is only mild toxic to human being.

2.6.1 General Toxicological effects of Ricin on different species of animals

Munroe (2006) reported that ricin has a lethal dose of 3g/kg body weight aerosol and parental and 30g/kg body weight ingestion and is twice as poisonous as cobra venom. Following the uptake of ricin into the cells by endocytosis causes acute cell death by inactivating of ribosomal RNA, inhibiting protein synthesis. The destruction of ricin in the intestinal tract, makes it approximately 1000 fold more toxic following parental administration or inhalation, than by the oral route. Oral LD50 values in rats and mice were 20-30mg/kg body weight and the corresponding intraperitoneal LD 50 value for mice is 22ug/kg body weight (EFSAJ, 2008). Akande *et al*. (2011) reported that, untreated castor causes enlargement of liver and kidney due to anti-metabolic substance. Ricin is crystllisable, soluble in chloroform pepsin and Insoluble in alcohol. It resists degradation by hydrochloric acid, pepsin, chemotripsin and paparine. It is a potent cytotoxin but a weak haemagglutinating agent and is one of the most toxic substances of plant origin (Wikipedia, 2008).

Another toxic compound in castor seed is an alkaloid ricinine or ricines communis agglutinin (RCA) which a powerful haemagglutinin but weak cytotoxin. Munroe (2006) revealed that RCA does not penetrate the intestinal wall and not affect red blood cell but causes haemolysis and agglutination of red blood cells through injection intravenously.

2.6.2 Adverse Effects of Ricin in target animals

Cattle are reported to tolerate relatively high levels of ricin in feed for long time exposure. Heifer tolerate as much as 20mg/kg body weight per day of ricin , in sheep, approximately 1.4mg/kg body weight per day of ricin causes morphological changes in several tissue (EFSAJ,2008).

Acute ricin poisons have been reported in horses. A single dose of 2.5g castor seeds (7-8mg ricin/kg body weight causes reduced feed intake and death in horses. Pig poisoned from a mash made of meal contaminated with 12g husk/kg meal corresponding to 0.5g/kg body weight, exhibited vomiting, diarrhoea, weakness, some incoordination and signs of abdominal pain. In birds, approximately 10g/kg body weight per day of castor beans reduced feed intake, weight gain and led to high mortality in growing chicks. Pullets were poisoned by about lg/kg body weight of castor husk. In mall and ducks, approximately 0.7-1.2g castor beans per kg body weight were lethal (EFSAJ, 2008). Pullet poisoned from a mash made of meal contaminated with castor bean husks showed dullness, dropping wings, ruffled feathers, and greenish coloured wattles and combs with a single dose of approximately 1g /kg body weight. Jensen and Allen (1981) described an outbreak of castor bean poisoning which killed several thousand of ducks in USA during 1969-71. The clinical signs resembled those of botulism, except for lucid, blood tinged excreta. The commonest lesions were fatty change in the liver, widely distributed internal petechial hemorrhages or eccymose, and catarrhal enteritis. It was reported that, 2.5 – 20 raw seeds can kill an adult human; 4 seeds in a rabbit; 5 seeds in a sheep; 6 seeds in an ox; 6 seeds in a horse; 7 seeds in a dog; 8 seeds in

cocks and ducks; one seed which is approximately 0.5 grammes may be fatal to a child (Ukachukwu *et al.,* 2011).

Ricin is extremely toxic when introduced into the nervous system administered by oral drenching and the symptoms in birds include dizziness, closed eyes, and staggering in walking (Ukachukwu *et al*., 2011). Ricin can alter blood nerve barrier. Other Symptoms of ricin include weakness, tachy cardiac, muscle cramps, dysponeal and lethargy (Ukachukwu *et al*., 2011). Hydro-cyanide is another toxin in castor seed that may have contributed to the dizziness effect, unconsciousness, weakness, vertigo as well as severe nose irritation. It is suggested that increased motility and irritations of gastro intestinal tract may be responsible for diarrhoea. Fram and Jaax (1997) had reported that serious cases of castor been ingestion resulted in nausea, vomiting and abdominal pain. Oxalate causes oral irritation. Single molecules of ricin in a cell can cause cell death (apoptosis) in pulmonary endothelial cells and in lymphatic tissues of poisoned rats. Ricin poison in human causes cardiac injury which result to heart blockage. Oral injection of ricin is less potent because of poor absorption with the body.

A single dose of the seeds (g) per kg body weight for birds is 14g/kg and the latent period between ingestion of seed and the onset of symptom is about 48 hours (Ukachuku *et al*., 2011). In birds, 48 of seeds per kg body weight of chicks when administered orally are acutely toxic. Chicken can tolerate ricin at levels above 400ppm. There is central nervous system mechanism for ricin toxicity. Clinically, there is substantial distribution of ricin to muscle tissues after administration which is responsible for muscle cramps and weakness experienced in animals (Richard and

Anthony, 1991). Munroe (2006) reported that a whole seed swallowed without seed coat broken most likely pass harmlessly through the digestive tract.

Ricin administration causes necrosis and hemorrhage in the heart, stomach, lungs, liver, and kidney, pancreases of animals while ducks and chickens are somewhat more tolerant. Ricin looses its toxicity and antigenic action on treatment with potassium permanganate, most heating at 20-200°C for 30 minutes or treatment with hydrogen peroxide, iodine which destroys the lethal factor in ricin without affecting its haemaglutation activity (Cadha, 2006).

Toxins such as lectins which agglutinate red blood cells are in seeds and leaves, tannins, phytases, oxalates and protease (Cadha, 2006). Injected ricin has a very low LD50 in dogs (1-1.75 ug/kg body weight) (Fodstad *et al*., 1984). A total of 98 cases were reported during 12 years period. In dog, ingestion of one castor seed bean was sufficient to cause clinical signs such as vomiting depression, diarrhoea, death or euthanasia after 0.5 to 48 hours of ingestion. Dog intoxication from organic fertilizer was reported (Alberetsen *et al*., 2000). Ricin has been administered orally in rats at 10mg/kg body weight of ricin D (corresponding to 1/3 L D50) and ricin present in the body of the rat can be determined by an enzyme immuno assay which is done by gel filtration followed by sodium dodecyl sulfate treatment. lshiguro *et al*. (1992) revealed that, lectin activity of ricin plays an important role in the absorption of ricin from the small intestine and enhanced by its high toxicity on intestinal mucosa.

Ricin in tissues of animal can be measured using E L I S A (sensitivity limit approximately 200pg/ml) in conjunction with pure ricin standards after inhalation and oral dosing in rats.

Analysis showed that after 24 to 48 hours of ingestion of ricin in rat, there is progression of ricin from surfaces of the lung into the lung tissue (Cook *et al*., 2006)

2.6.3 Carry-over and residues of ricin in animal

There may be presence of ricin in the milk of lactating guinea pigs which was injected with the agglutinin after the birth of the litters because the suckling young become resistants to injections of toxins. There was no clear indication that ricin consumed by livestock is transferred to livestock products (milk, meat or eggs) (Jaffe 1969). Robb *et al* (1974) revealed that ricin does not affect production and reproduction of lactating dairy cows fed with 10 and 20% detoxified castor bean meal. Also, there was no apparent transfer of ricin to milk. Calves and rats fed milk from test cows showed neither apparent muscle residue accumulation nor abnormalities of internal organs

2.7 Castor oil

The oil content of the seed vari`es from 35 to 55 percent of the weight of the seeds. The oil is obtained by mechanical pressing with hydraulic press which could only remove about 70% of the available oil in the seed. But further extraction with petroleum or ether will remove the residual oil (W.J.A.S, 2012). Also, mechanical expelling in combination with press cake hexane extraction is an effective method to recover more than 99% of oil present in the seed. The seed could be crushed to increase surface area for better oil extraction and then pressed mechanically with hydraulic machine for an hour for better oil extraction. Oil from the seed can be produced locally by boiling the seed meal in water and separating the oil which is used for medicinal purposes in the rural areas (Kulkarni and Kesharamurth, 2005). The average yield of oil by different methods of extraction includes expellers and hydraulic presses (40-41%), rotatory mills

and screw presses (39%), village gbanis (35%) and by boiling the seed meal in water (30%). The oil is graded as first grade oil which is pale yellow to colour less and is prized for medicinal purposes, while the poorer grade is used for industrial purposes.

Ombrello (2007) reported that castor oil last longer if not expose to excessive heat. India is the world leading exporter of castor oil followed by china and Brazil. Castor oil has been an impetus to a country like Nigeria such that Benue state government, received over two billion naira for castor oil seed production imitative in 2008 (W.J.A.S. 2012). Ukachuku *et al*. (2011) reported that cross river state of Nigeria has gone into a project of producing castor oil seed for its oil. Castor oil is mostly ricinoleic acid with small amount of Dihydroystearic, linoleic,stearic and Eicosanonic acids it's high viscosity (Ombrello, 2007)

2.7.1 Storage of Castor oil

Cadha (2006) revealed that castor oil is durable which do not go rancid for 2years storage. Refined castor oil can be stored for 6-12months.

2.7.2 Industrial and Medicinal purposes of Castor Oil.

The hydrogenated oil serves as a lubricant in jet fuels and air craft hydraulics. The oil is used purposely as a standard lubricant in food processing plant. Castor oil is also used in the process of production of nylon, weather resistant paints and cosmetic (Browning *et al*, 1990). Rehm and Espig (1991) revealed that castor oil is used as an ingredient in natural flavour and fragrance. It is used for soap making, illumination and medical purpose. The leaves are used to cure boils, sores and smelling (Cadha, 2006). The oil was been used in internal combustion engines in world war air planes.

2.8 Castor Seed Cake

This is a byproduct of castor oil extraction industry (Ani and Okorie, 2005). It is called "pomac" or "poonac" (Cadha 2006). The whole seeds of castor oil plant yield about 58 to 70% cake but varied from 35 to55% (on an average 40%) in the case of dehulled seeds. It is used as soil fertilizer due to improve soil pH index and increase crop yield, increase cane yield of sucrose content of juice, increasing nitrogen content in grain and straw, controlling nematodes and increase tuber yield. The cake is rich in trace minerals such as manganese, zinc and copper (Cadha, 2006). The cake is rich in protein but unsuitable for feeding livestock due to it's toxin which dangerous to animals. It is found that extracted cake is more poisonous than expeller cake. To make the cake suitable for livestock consumption the toxins must be detoxified by processes such as autoclaving, boiling or cooking with water, steaming, water and lime, or treated with salt solution, ammonium sulphate, sodium sulphate and bisulphate, hydrochloric acid, formaldehyde or alkali, fermentation and other methods

Purushothan *et al.* (1986) reported that autoclaving the cake at 125°C for 15 minutes or 60 psi for 20 minutes completely detoxifies ricin in the cake. Okoye *et al.* (1987) reported that roasted castor seeds at 100°C for 20 minutes in feeding to broiler chicks reduced feed intake and weight gain at all levels of inclusion. Broiler chicks fed with fermented cake had no deleterious effect on growth response, nutrient digestibility, blood cell counts, serum enzymes and carcass yield at 5% inclusion level.

Ani and Okorie (2009) reported that broiler finisher birds fed at 10% inclusion with castor seed meal processed by two stage cooking had similar feed intake and weight

gain as control. Heat treatment destroy some amino acids particularly lysine, threonine, tyrosine, cystine and methionine (Polit and Sgarlienri, 1976).

2.8.1 Nutrient profile of castor Seed cake

Castor meal makes an excellent bio-fertilizers owning to its optimal composition of nutrients especially nitrogen, phosphorous and potassium (NPK). The toxicity in castor meals makes it unsuitable for use as animal feed, thus resulting in a low price for the meal while compared with prices of competing oilseed meals such as soya meal or rape seed meal. This combination of high fertilizer value and a low price has resulted in an ever increasing demand for castor meal from the organic fertilizer worldwide (Anandan, 2009). Adedeji (2013) revealed that castor bean cake contains 39% crude protein, 18% crude fibre, 4% Ether extract and 7.5% Ash. Recently, castor bean cake has been analyzed as contains moisture (9.34-9.59), crude protein (38.58-39.43), crude fibre (2.53-3.92), Ether extract (9.97-11.15), Ash (5.36-6.11), NFE (31.54-31.74), Gross energy kcal/g (5.493-5.624).

Mineral content; calcium (0.47-0.62%), phosphorus (0.34-0.45). Anti nutritional factors lectin mg/ml (2.5-7.40), Tannin (0.20-0.32%), phytic acid (0.17-0.42%), oxalate (1.0-1.2%), cyanogenic glycoside mg/kg (26.17-33. 45%) (W.J.A.S, 2012).

2.8.2. Utilization of castor seed cake in animal nutrition.

Castor seed cakes have been successfully used in livestock feeding after detoxification both in monogastric and ruminants. Poultry appear to be more tolerant to castor toxins than other mammals. Up to 40% of the cake has been used in chick ration. Boiled castor bean meal supplemented with Beta-xylanase was fed to broiler finisher birds at

15% levels of inclusion and the weight gain were comparable to the control but higher levels led to reduced weight gain (Ani and Okorie, 2009).

(Purushothan *et al*., 1986) reported that autoclaving castor seed at 125^0C for 15 minutes or 60psi for 20 minutes completely destroy ricin which was used to replace peanut and beyond 1/3 inclusion in the diet of sheep resulted in suboptimal performance. Ani and Okorie (2005) reported that 10-15% of castor seed meal could be satisfactorily used in poultry rations when properly detoxified.

2.9 Domestic uses of castor beans

Some people in parts of south-Eastern Nigeria have long developed a method for treating and detoxifying untreated seed and use it for human consumption. The seeds are boiled for 18 hours, cooled, wrapped with leaves, ferment for five days, pounded with mortar and pestle, ash from burnt palm kernel husk is added to give it dark colour and kept for another five days and packaged for sale. It is believed that fermentation remove toxins from the seeds which involve spore forming bacterial such as members of the genus *Bacillus* (Anandan, 2009).

Roasted ripe seed of castor are eaten as food in Indonesia (Odunfa, 1985). The seeds are detoxified through fermentation and used as seasoning agent (Uzogara *et al.*, 1990). Fermented bean are pasted and used as condiments in soup, salad and stew for rice and yam meals. The use of castor seed as a means of birth control was tried in rabbits. Cadha (2006) reported that roasted castor seeds are used in veterinary practice and the seeds are made into paste which are applied to sore, boils or rheumatic swellings. Castor oil is used in medicine as a cathartic. It is used as food in the time of scarcity in Eastern Nigeria after series of detoxification. The oil is used by the poor class people

for cooking purpose. The oil is used in the field of medicine as cathartic and other pharmacopoeias. The castor oil is often given (60ml) orally, alone or in quinine sulphate to induce labour during pregnancy.

The oil can be used as a vehicle for parenteral administration of steroidal hormones. Ricinoleic acid is used in contraceptic creams and gellies. The oil is used to control seborrhaic dermatitis and other cutaneous infections. The oil is employed as a solvent for removing irritating substances in the eyes. Medicines such as atropine, cocaine are often suspended in the oil for ophthalmic applications. Sodium ricinoleate solutions are used as injection in sclerosing treatment of varicose veins (Indian wealth of industrial raw material (Ecyclopedia).

2.10 Quail bird

Quail is a small bird that originated from Asia and Europe. It belongs to species known as *Gailliformes*. The two common species are Japanese quail (*Cortiunix Cortunix Japonica)* and bob white *(Colinue virginianus*) which are kept for meat and egg production. They have short generation interval and produce eggs between180-250 per year (Garwood and Diehi, 1987). They require smaller space than chicken and require less feed and their meat is low in cholesterol (Haruna *et al*., 1997). The average female weight is about 250 grammes and male is the less. The average weight of egg is 14 grammes. The average weight of table quail at 40 days is 250 grammes.

2.10.1 Nutrient Requirement of quail birds.

Nutrient requirement of quail birds depend on the stage of growth. When feed meant for chicken is used to feed quail it has to be fortified with 2kg of fish meal, 5kg of groundnut cake and 8kg of vitamin E for every tone of feed. Layer ration should contain 3% calcium and 45% phosphorus for egg production and strong shell formation. Quail may not survive chicks ration for long time because it needs high protein. Mortality can reach as high as up to 70% from day old to 45 days of age (Mohammed. 2005). Quail birds reared for meat is given *ad libitum* turkey rations. Most grower use a turkey super starter ration from day old to 14days and change to turkey finisher above 14days of age. The best form of feed is a small crumb at first stage of life and smaller than is usually given to turkey poults or chicks. The birds require approximately 25g per head per day (David, 1992).

2.10.2 Protein Requirement of Quail

Breeder requires a diet of 20 percent protein (David, 1980). The quail birds increase in protein intake can be associated with decrease in carcass. Marks (1993) reported that quails fed crude protein between 18 to 30g/kg feed does not have affect on percent carcass, moisture, fat or protein. The protein requirement of quails varies with age. Quails require 24%CP for both growing and breeders. Quails do well on turkey starter ration containing 27-28% CP. They also do well on ration between 24-25% CP. Reports showed that layer quails can be fed diets containing between 18-24% CP, but do well on 18% CP. Grower quails thrive well on diet containing 22-24%CP. (Mohammad, 2005).

2.10.3 Energy requirement of Quails

A quail bird requires 2800 to 3000 metabolizable energy (kcal/kg) at starting/growing stage and 2700 to 2800 metabolizable energy (kcal/kg) at breeding stage. Kirkpinar and Oguz (1995) reported that quails require between 11.87(2658) - 12.06(2700)kcal ME/kg.

2.10.4 Vitamin and mineral requirement of Quails.

Quail birds require 3% of calcium and 0.45% phosphorus and 8kg of vitamin E for every tonne of feed (Mohammad, 2005). It requires 0.8% calcium for starter/grower and 2.5% calcium for breeding stage. It requires 0.65% phosphorous for starter/grower and 0.8% phosphorus for breeding stage.

2.10.5 Effect of enzymes on performance of quail birds.

Recent studies have shown that enzyme supplementation has the potential to improve the nutritive value of feed stuffs for monogastric animals (Annison, 1993). To reach their potential in improving the nutritive value of feed stuffs enzymes have to be biologically active in the gastro-intestinal tract. Patterson *et al.* (1990) revealed that supplementing broiler diets with enzymes allowed a reduction in crude protein level without affecting growth rate. A cocktail of enzyme in the diets of growing turkeys improved performances, bone mineralization and retention of phosphorus and calcium (Krzysztof *et al*., 1995). Iji *et al.* (2001) reported that enzyme of animal origin does not succumb to fibre of non starch polysaccharide but vegetable protein enzyme which is plant origin may do. Gippert, *et al.* (1997) reported that enzyme supplementation slightly improve weight gain, feed conversion and apparent digestibility of crude protein and fat in birds.

Superiority of control diet containing maize + GNC compare to others diets is inline with (Mac donald *et al*., 1991) who observed lower weights gain on birds fed with higher crude fibre diet.

Ndams (1991) reported that feed consumption and body weight gain especially in meat type quails decrease when birds were fed high fibre diets. There is less dry matter retention due to less metabolic action of enzyme on birds. This is because of high amount of non statch polysaccharides in the high fibre diet which does not succumb to enzymes of animal origin (Iji *et al*., 2001). Ishibashi and Ohta (2000) observed that phytase supplementation improved the utilization of chelate (ash) minerals and proteins. The addition of enzyme in diet has little effect on egg mass but improve efficiency and energy utilization (Wyatt, and Goodman, 1994 and laying rate (Poultry International, 1996).

2.11 Effect of processing on crude fibre.

Cooking generally reduces crude fibre content of legumes. There is decrease in crude fibre with increase in duration of cooking (Akinmutimi and Oke, 2002). The reduction in crude fibre content of seeds is an advantage to monogastric that lack the ability to utilize high fibre. The fibre is defined as the sum of lignin and the polysaccharide that are not digested by the endogenous secretions of the digestive tract. These include cellulose and the so called non starch polysaccharides and the most predominate being hemicelluloses. The chickens are capable of high degree of anatomical and physiological adaptation to compensate for variation in nutrients concentration of diets (Iji *et al*., 2001).

The gizzard weight is significantly increased when a high fibre sun flower meal was substituted for soya meal. There was a significant decrease in feed consumption and in body weight when birds are fed diet that contains 19.6% crude fibre in meat and egg type chicken, increase in crude fibre led to increase in weight of part of the digestive tract and has little effect on feed efficiency on quail birds (2-5 weeks) (Kondrai, *et al.*, 1983).

2.12 The effect of tannin on poultry birds.

Tannin is an anti-nutritional factor which causes reduced growth rate of birds by limiting the availability of certain nutrients such as protein and carbohydrate in the gut (Imik *et al.*, 2006). The severity of the impact on birds depends on the content of the tannin in the diet. Diet with high tannin concentration more than 1% may cause decrease in feed intake, body weight, egg production and high mortality.

Tannin seems to reduce laying rate, egg weight and body weight in hen and ducks. The concentration of tannin in various varieties of sorghum varies between 0.02-5.3% depending on the colour of the testa. White testa has low concentration of tannin, while dark testa sorghum has high concentration of tannin (Harvey and McAllan, 1992). Tannin reduces egg production, egg weight and has a significant effect on egg shell thickness and egg breaking strength, Tannin has negative effect on egg albumen quality and yolk index value. Tannin causes incidence of blood and meat spot. Pigmentation of legs, beak and yolk was reduced in birds fed diet with high concentration of tannin (1.5-3%). Tannin significantly reduces concentration of egg cholesterol, blood serum, total protein, albumen and globulin values are affected by tannin concentrations.

2.13 Tannin and Ricin interaction.

Recently, tannin-Ricin interaction has been proposed as a suitable detoxification method. Tannin is an allelochemicals synthesized by plants to reduce attack by the animals (Marija *et al.,* 2011). Tannin is grouped into two that is the condensed tannin which consists of flavan-3-ols (oligoflavanols made of catechin), also called pro-antocyanidins which are predominant on leaves and roughages. The second group is known as hydrolyzable tannin which are polyesters of phenolic acids such as gallic acid, hexahydrocydipenic acid and quinic acid which are present in cereal grains (Imik *et al*., 2006). The effect of this tannin on animal production had been a concern due to its ability to bind protein, nucleic acid, polysaccharides and steroids. Tannin form complexes with proteins by covalent, hydrogen and ionic bonding and hydrophilic bonding (Oh *et al.,* 1980). They are assumed to hinder digestion and absorption of nutrients (Lashera *et al*., 1980a; Imik *et al*., 2006). Not until recent that it was discovered that tannin react with Ricin which is a protein that is highly toxic to the animals (Anandan *et al*., 2012). The complex formed by the reaction of tannin with Ricin enables the ricin to by-pass the digestive system without releasing the toxin (Gandhi and Mulky, 1994). It has been reported that animal diets should be fortified with high protein level and energy level to reduce the effect of this bypass protein.

2.14 Egg Production

Oluyemi and Roberts (1979) have mentioned that the widespread of poultry production in the tropics is appreciable but egg production and consumption have not reached temperate region standards.

2.14.1 Importance of Quail Egg

The white shelled eggs are used for biological research and are preferred by consumers due to easy candling, they have little or no cholesterol (Mohammed, 2005). It has a medicinal value (Sangilimadan *et al*., 2012). It has been reported that external and internal quality of the eggs in both hens and quails had significant effects on the hatchability of incubated and fertilized eggs, and weight and development of the laying chicks. Also, the weight of eggshell, albumen and the yolk affects the price of the product in egg processing industries. As there are increase in demand for frozen egg, liquid egg, egg powder, and yolk oil, the interior characteristics such as yolk index, haugh unit and chemical composition are also important in egg product industry.

2.14.2 Weight of Quail Egg

Between layers dietary proteins, as the protein level increases, the egg weight also increase, the highest weight (12.6g) was recorded with 22% CP. The egg weight of Japanese quail ranges from 9 to 12 grammes (Sangilimadan *et al*., 2012). The average weights of quail egg as reported by Mohammed (2005) was between 10-14g which represent 8% of live weight of Japanese quail hen. The various values related to egg weight, shape index, shell weight, shell ratio, shell thickness, egg length , egg width, shell index and shell surface area (cm^2) were found respectively as 7.041g, 79.590%, 0.973, 14.193mg, 0.307, 2.825, 2.24mm, 10.044cm and 8.205cm while the internal values as albumen index , albumen height, albumen weight, albumen ratio, albumen width, albumen length, albumen average, yolk diameter, yolk height, yolk weight, yolk index, yolk ratio and yolk : Albumen ratio were found respectively as 12.056, 3.204cm, 2.5g, 35.515, 2.308cm, 2.195g, 17.601,cm 36.746mm, and 1.120 (Mudhar, 2011).

2.14.3 Exterior and Interior Quality of Quail Egg

Chicken egg has been very well studied for its quality characteristics which are not documented in other poultry species (Dudusola, 2009). The external factors such as cleanliness, freshness, egg weight and shell quality are important for consumer's acceptability of shell eggs, and interior characteristics such as yolk index, albumen index, proportions of egg components and chemical compositions are also important for egg production industry (Song *et al*., 2000). Information on egg quality characteristics has been limited mostly to chicken eggs.

Egg white weight (Albumen) is 2/3 (two-third) of total weight of egg while yolk weight is 33% of the liquid content of egg (Wikipedia, 2008). Albumen quality is the standard measure of egg quality (Silversides and Scott, 2001). Egg shell, egg shell thickness was found to be between 15.6-17 µm or 0.15- 0.17 mm) (Narayanan *et al*., 1989 and Oh *et al*., 1980).

2.15.0 Hematological values in quail

Blood examination has a significant reason in poultry production in that it reveals the pathological status and the presence of metabolites. Dawn (2010) reported that the normal packed cell volume (PCV) value of quails range from 37 to 55%. High PCV indicates dehydration, excessive red blood destruction due to toxins or immune disorders.

2.15.1 Hemoglobin (Hb).

Hemoglobin molecules are responsible for binding and releasing oxygen on to the red blood cells. A high level of hemoglobin shows high red blood cell count. Low levels of Hb indicate anaemia, iron deficiency and bleeding. Normal range from 9 to 16g/dl (Dawn, 2010).

Ani and Okorie,(2009) reported that there were no significant differences between birds fed control diet and those fed diets containing castor seed cake in park cell volume but there were increase in hemoglobin count due to production of excess red blood cells. Dawn (2010) reported that low red blood cells values shows anaemia, loss of blood or disease infection. The value of normal red blood cell is $5.7x10^{12}$. Dawn (2010) stated that white blood cells are responsible for fighting disease. High white blood cell counts may be due to infection, cancer, or leukemia. Low white blood count indicates viral infections, blood poison.

2.15.2 White Blood Cell Differential

It is the analysis of different types of white blood cells. The distribution of these types of cells shows underlying cause of disease in animal. Basophils are common in parasitic infection. The normal values of basophil ranges from 0-0.2%) high level of basophil indicates possible parasitic infection. Low level indicates absence of parasites. Eosinophils fight against allergies and parasites. High eosinophil count indicates an allergy or parasite causing illness.

Lymphocytes are white blood cells which develop anti-bodies to prevent against future attacks. High lymphocytes may be due to infection by virus. Neutrophil are primary white blood cells responsible for fighting infection. High neutrophil count indicates infection while low neutrophil indicate sepsis (Dawn,2010).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental site

The experiment was conducted at the poultry unit of the Department of Animal Science, Ahmadu Bello University, Zaria. It is located at latitude 11° 9' 45'' N and longitude 7° 38' 8" E, at an altitude of 610m above sea level (Ovimaps, 2012).

3.2 Sources of experimental materials

Large seeded castor beans were purchased from Odogi market in Kabba, Kogi State, Nigeria and a total of 357 quail chicks used for this study were purchased from the National Veterinary Research Institute (NVRI) Vom, Jos, Nigeria.

3.3 Experimental design

A simple completely randomized design (CRD) was used with seven treatments containing two hundred and ten (210) quail chicks and three replicates containing ten (10) quail chicks each.

3.4 Oil Extraction of the large seeded castor seed beans by Cold Screw Press method

The seeds were taking to the National Research Institute for Chemical Technology, Bassawa, Zaria, Nigeria for oil extraction. The castor seeds were pounded with a mortar and pestle to break the seeds in order to increase the surface area for oil extraction; it was wrapped with cheese cloth

The cake obtained after oil extraction was pressure cooked and subjected to cold processing. The oil was allowed to drip for 6 hours.

3.5 Preparation of castor cake for feeding trials.

The cake obtained after oil extraction was pressure cooked using autoclaving machine using the method described by Purushothan *et al.* (1986).The autoclaving machine lid was lifted open and the water level was gauged with distil water. A perforated iron bucket was placed inside the autoclaving machine slightly above the water. Another iron bucket was ceiled with foil paper and was filled with castor seed cake to a level and placed inside the perforated iron bucket. The autoclaving machine was locked properly and connected with source of light and all connections were properly done and put on. The timing of the autoclaving machine started when steam was rushing out properly and collected inside a container. The control lock was closed to compress the steam to pressure cooked the castor seed cake for 20minutes. The process was repeated twice to complete the processing.

3.6 Determination of the chemical composition of experimental diets used

Samples of experimental diets were taken to the Animal Science Biochemical Laboratory for proximate analysis using the methods described by A.O.A.C (1995). The analysis was done to obtain the nutrient composition (dry matter, crude protein, ether extract, crude fibre, ash and nitrogen free extract) of the diets. Crude protein was determined by the Kjedahl procedure, ether extract was determined by subjecting the samples to petroleum ether extraction at 60-100°C using the soxhlet extraction apparatus. Dry matter was determined by oven drying the samples at 60°C over a 12-hour period. Crude fibre was determinate by boiling the samples under flux in weak sulphuric acid (0.255N H_2S04), then in a weak sodium hydroxide (0.312N NaOH) for 1 hour. The residues which consist of cellulose, lignin and mineral matter were dried and weighed. The ash content was determined by igniting a weighed sample in a Muffle

furnance at 600°C. The nitrogen free extract (NFE) was obtained by the difference after the percentages of the other fractions were subtracted from 100%. Gross Energy (GE) was calculated.

3.7 Experimental Diets for experimental 1

Effects of feeding autoclaved castor seed cake in maize and Sorghum based diet supplemented with enzyme (Vegpro) on performance of quail birds (2-6 weeks). The diets for experiment 1 were as follows:

Diet 1 (control) contained maize based diet.

Diet 2 contained maize based diet with 10% CSC

Diet 3 contained maize based diet with10% CSC + 0.01 vegpro

Diet 4 contained sorghum based diet with10% CSC.

Diet 5 contained sorghum based diet with 10% CSC + 0.01% vegpro

Diet 6 contained maize and sorghum based diet with10% CSC

Diet 7contained maize and sorghum based diet with10% CSC + 0.01% vegpro.

The diet were formulated to be iso-nitrogenous (25% CP) and iso-caloric (2800 Kcal/kg ME) the ingredient composition of the experimental diets are presented in Table 3.1

Table 3.1: Composition of Experimental Diet for growth phase of quail birds (2-6 weeks)

Ingredient (%)	TREATMENT						
	T1 MBD	**T2** MBD	**T3** MBD	**T4** SBD	**T5** SBD	**T6** MSBD	**T7** MSBD
Maize	42.42	42.42	42.42	-	-	14.14	14.14
Sorghum	-	-	-	42.42	42.42	28.28	28.28.
GNC	33.13	23.13	23.13	23.13	23.13	23.13	23.13
CSC	-	10.00	10.00	10.00	10.00	10.00	10.00
SBM	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Wheat offal	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Lime stone	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Methione	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Enzyme	-	-	0.01	-	0.01	-	0.01
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis							
ME(Kcal)/kg	2800	2800.0	2800.0	2800	2800	2800.0	2800.0
C P(%)	25.00	25.00	25.00	25.00	25.00	25.00	25.00
EE(%)	5..01	5.63	5.37	4.99	5.36	5.02	5.85
Crude fibre(%)	5.98	5.21	5.99	5.33	4.73	5.74	6.44
Calcium(%)	1.11	1.11	1.11	1.11	1.11	1.11	1.11
Lysine(%)	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Methionine(%)	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Cost/Kg diet(N)	84.00	79.00	81.00	75.00.	78.00	76.00	79.00

*Biomix premix provided per Kg of diet:vit.A10,000i.u; vit,D3,2000i.u; vit.E,23mg: vit.K,2mg calcium pantothenat,7.5mg:vit.B12,0.o51mg:folic acid ,0.75mg: sodium chloride,300mg; vit.B11.8mg; Vit.B2,5mg;manganese,40mg;iron,20mg;zinc,30mg;copper,3mg;iodine,1mg;cobalt,0.2mg;selenium,0.3mg , CSC=Castor Seed Cake, GNC=Groundnut Cake, SBM=Soyabean Meal, MBD=Maize based diet, MSBD=Maize-sorghum,. CP=Crude protein, EE=Ether extract, N=Nara

3.8. Experimental procedure for experimental 1:

Three hundred and fifty seven (357) two weeks old quail chicks obtained from National Veterinary Research Institute, Vom Jos, were used for the experiment. The birds were weighed and fed the control diet for 3 days to acclimatize to their new environment. The birds were randomly assigned to seven treatment groups and fed seven iso-nitrogenous and iso-caloric experimental diets. Each treatment was replicated three times with seventeen (17) quails in each replicate. Feed and water were supplied *ad libitum* during the trial period which lasted for 28days. During the growth phase, the birds were weighed weekly and the following parameters were calculated, average daily feed intake, average daily weight gain, feed conversion ratio. Mortality was recorded as it occurred.

3.9 Experimental diets for Experiment 2

Effect of feeding autoclaved CSC in maize and sorghum based diets supplemented with vegpro (R) enzyme on egg laying characteristics of Japanese quail hens (6-20 weeks).

Seven quail layer diets were formulated as follows:

Diet 1 (control) contained maize based diet.

Diet 2 contained maize based diet with 10% CSC.

Diet 3 contained maize based diet with 10% CSC + 0.01% enzyme.

Diet 4 contained sorghum based diet with 10% CSC.

Diet 5 contained sorghum based diet with 10% CSC + 0.01% enzyme

Diet 6 contained maize and sorghum based diet with 10% CSC.

Diet 7 contained maize and sorghum based diet with 10% CSC + 0.01% enzyme.

The diet were formulated to be Iso-nitrogenous (22% CP) and Iso-caloric (27 00 Kcal/kg ME) the ingredient composition of the experimental diets are presented

Table 3.2: Composition of Experimental Diet for laying phase of quail birds (6-20 weeks)

Ingredient (%)	TREATMENTS						
	T1 MBD	**T2** MBD	**T3** MBD	**T4** SBD	**T5** SBD	**T6** MSBD	**T7** MSBD
Maize	42.42	42.42	42.42	-	-	14.14	14.14
Sorghum	-	-	-	42.42	42.42	28.28	42.42
GNC	33.13	23.13	23.13	23.13	23.13	23.13	23.13
CSC	-	10.00	10.00	10.00	10.00	10.00	10.00
SBM	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Wheat offal	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Lime stone	5.10	5.10	5.10	5.10	5.10	5.10	5.10
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Methione	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Enzyme	-	-	0.01	-	0.01	-	0.01
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis							
ME(Kcal)/kg	2700.00	2700.00	2700.00	2700.00	2700.00	2700.00	2700.00
C P(%)	22.00	22.00	22.00	22.00	22.00	22.00	22.00
EE(%)	4..19	4.12	4.84	4.94	4.52	5.62	5.65
Crude fibre(%)	4.56	5.19	5.69	5.89	4.69	6.03	6.97
Calcium(%)	3.40	3.40	3.40	3.42	3.42.	3.43	3.43
Phosphorus(%)	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Lysine(%)	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Methionine(%)	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Cost/Kg diet(N)	94.00	89.00	91.00	85.00.	88.00	86.00	89.00

*Biomix premix provided per Kg of diet:vit.A10,000i.u; vit,D3,2000i.u; vit.E,23mg: vit.K,2mg calcium pantothenat,7.5mg :vit.B12,0.o51mg,:folic acid,0.75mg: sodium chloride,300mg; vit.B11.8mg; Vit.B2,5mg ;manganese,40mg ;iron,20mg; zinc,30mg; copper,3mg; iodine,1mg ;cobalt,0.2mg; selenium,0.3mg , CSC=Castor Seed Cake, GNC=Groundnut Cake, SBM=Soyabean Meal, .MBD=Maize based diet, MSBD=Maize sorghum based diet, SBD=Sorghum based diet, N=Naira.

3.10 Procedure for Experimental 2

After the birds were sexed at the end of the growth trial (6 weeks of age), two hundred and ten (210) quail hens were used for this experiment. The females were mixed up again and placed on a common diet for seven days. Thereafter, the birds were randomly allotted to seven dietary treatments with three replicates of ten birds per pen. The birds were weighed into each pen and average initial weights were recorded. Seven iso-nitrogenous experimental diets were formulated to contain 22%CP and iso-caloric 2700Kcal/KgME respectively. The quails were weighed at two weeks intervals. Water and feeds were given to the birds *ad libitum* throughout the experimental period(6-20 weeks).

3.11 Data collection for egg production parameters.

The feed supplied were weighed and daily feed intake was calculated. The birds were weighed at one week interval for two weeks. Thereafter, birds were weighed two weeks intervals. Eggs were counted, weighed and recorded according to each pen. The following parameters were measured and calculated, initial weight, final weight, daily feed intake, cost of daily feed intake, cost per dozen egg, average egg production per quail per week, hen housed egg production (total egg production/bird, age at peak and percent age egg production at peak, and egg quality determination. Mortality

3.12 Egg quality determination

The egg quality characteristics were determined four times throughout the experimental period. Three eggs representing the average weight of the eggs from each replicated were used for determining egg quality parameters throughout the period. The eggs were weighed using a sensitive electronic compact balance FEJ, 1500 series citizen scale on the rear string. The qualities of the eggs were determined after weighing by been

broken around the equator, care being taken to keep the albumen and yolk intact. Egg length, egg breath, albumen height ,yolk diameter and height were determined with the aid of a venier caliper and the values obtained were used to calculate the haugh unit scores according to the formula outlined by Haugh (1937).

$H U = 100 \log 10 (h - 1.7 Wo^{37} + 7.6)$

Where, H U= Haugh unit

h = observed height of albumen in millimeters.

wo = weight of eggs in grammes

Eggs shell thickness was determined using a micro meter screw gauge.

Each egg shell was dried for 2 days and weighed to determine the shell weight. This was used to calculate the shell index using the formula outlined by Iposu *et al*.(1994):

I= 100SW/S

Where I= egg shell index

SW= shell weight

S= surface area (cm)

S was calculated from egg weight using the equation

S= k.EW2/3

Where k has value of 4.67 for egg weight less than 60g.

Egg yolk height and width was measured using vernier callipers and the values obtained was used to calculate the yolk index.

YI=YW/YH

Yi= yolk index

YW= yolk width

YH=yolk height

Percentage shell was determined by using the formula:

Shell percentage= (shell weight/egg weight)/100

Percent yolk was determined using formula

Percentage yolk= (yolk weight/egg weight) x100

3.13 Haematological examination

At the end of the laying phase (20 weeks), one (1) bird was randomly selected from each replicate making three birds per treatment and a total of twenty one (21) birds for collection of blood for determination of haematological parameters. The blood samples were collected directly as soon as the birds were slaughtered and the blood samples were collected into sterilized sample bottles containing heparin, covered and shaken to mix the blood with the anti-coagulant. The samples were taken to the Microbiology Department of Ahmadu Bello University Teaching Hospital, Zaria for Analysis.

The following parameters were analyzed: pack cell volume (PCV), haemoglobin (Hb), white blood cells (WBC), red blood cells (RBC) neutrophils, lymphocytes and basophils.

3.14 Carcass analysis

At the end of the laying phase, one bird per replicate (3 per treatment) was selected with each bird having weights closest to the average weight for the pen. The birds were deprived of feed overnight but given water *ad libitum.* Birds were weighed and slaughtered by ventral neck cut. They were bled thoroughly, weighed and de-feathered by dipping in hot water at 65°C temperature. The feathers were removed manually and the birds were properly labeled and eviscerated. Hot carcass weight was taken and expressed as dressing percentage. The weight of breast, wing, back, gizzard, liver, intestines, and leg and head were taken and expressed as percentages.

3.15 Statistical analysis

All data obtained from the trial were subjected to analysis of variance (ANOVA) using general linear model procedure of SAS (2008). Significant levels of differences among treatment means were determined using the contrast statements.

The statistical model used was a one-way analysis of variance.

$Y_{ij=} \mu + B_i + E_{ij}$

Y_{ij} = the jth observation of the $i^{th.}$ treatment

μ= the overall estimate of population mean

Bi= the effect of the ith treatment

E_{ij} = the random error.

CHAPTER FOUR

4.0 RESULTS

4.1 Nutrient composition of raw and processed castor seed cake

The nutrient composition of raw and processed castor seed cake (PCSC) is presented in table 4.1. The values of dry matter (97.50%), crude protein (23.89%), ash (6.19%) and nitrogen free extract (39.94%) of the processed castor seed cake was higher compared to raw castor seed (dry matter 96.67%, crude protein 13.87%, and ash 3.18%, and nitrogen free extract 36.58%). The crude fibre of 21.72% and ether extract of 24.65% in raw castor seed was higher compared to the values of 21.08% crude fibre and 8.90% ether extract in processed castor seed.

4.2 Effect of autoclaved castor seed cake in maize and sorghum based diet supplemented with vegpro on growth performance of quail birds (2-6 weeks)

Table 4.2 showed the growth performance of quail birds fed autoclaved castor seed cake in maize and sorghum based diets with vegpro supplementation. The final body weight (FBW), total weight gain (TWG), daily weight gain (DWG) were significantly ($P<0.05$) higher in quails fed the control diet (T1) compared to quails fed diets containing autoclaved CSC but similar to quails fed autoclaved CSC containing 28.28% sorghum in MSBD supplemented with vegpro. The FBW, TWG and DWG were similar in all quails fed diets containing autoclaved castor seed cake. The total feed intake (TFI) and daily feed intake (DFI) were significantly ($P<0.05$) higher in quail birds fed the control diet compared to all other quails fed diets containing autoclaved CSC with the lowest values occurring in quails fed autoclaved CSC in maize based diets (MBD) (T2) . The feed to gain ratio was significantly ($P<0.05$) better in quails fed autoclaved CSC in MBD (T2) compared to quail birds fed autoclaved CSC in sorghum based diets (SBD) (T4 and T5) but similar to those quails fed control diet (T1) and

Table 4.1 Proximate composition of raw and processed castor seed cake

Parameters (%)	**R C S**	**P C S C**
Dry matter %	96.67	97.50
Crude protein %	13.87	23.89
Crude fibre %	21.72	21.08
Ether extract %	24.65	8.90
Ash %	3.18	6.19
Nitrogen free Extract %	36.58	39.94

RCS= Raw castor seed, PCSC= Processed castor seed cake

Table 4.2: Effect of autoclaved castor seed cake in maize and sorghum based Diets with Vegpro-supplementation on growth Performance of quail Birds (2-6weeks)

	Treatments						
Parameters	T1(MBD)	T2(MBD)	T3(MBD)	T4(SBD)	T5(SBD)	T6(MSBD)	T7(MSBD)
IWT(g)	30.33	30.33	30.33	31.00	30.67	30.67	30.33
F W(g)	124.33^{a}	85.23^{b}	94.49^{b}	79.06^{b}	86.01^{ab}	88.21^{b}	101.40^{ab}
DWG(g)	3.36^{a}	1.97^{b}	2.29^{b}	1.97^{b}	1.99^{b}	2.69^{b}	2.54^{ab}
TFI(g)	541.28^{a}	299.55^{d}	353.20^{c}	397.32^{bc}	420.32^{b}	433.38^{bc}	435.27^{b}
DFI(g)	19.35^{a}	10.64^{d}	12.52^{c}	14.25^{b}	15.15^{b}	14.85^{b}	15.00^{b}
FCR	5.81^{b}	5.40^{a}	6.69^{b}	7.58a^{b}	7.56^{ab}	8.56^{b}	6.13^{b}
AAFE(days)	50.67	54.67	54.33	53.33	56.67	57.33	52.33
FC/bird (N)	90.40^{a}	45.96^{b}	50.89^{b}	70.23^{b}	70.44^{b}	60.05^{b}	70.18^{b}
FEWT(g)	8.33	8.00	7.17	7.63	8.33	7.87	7.83

$^{abc=}$ Means with different superscript along the row differs significantly($p<0.05$)

SEM=Significant error of means, DWG= Daily weight gain, TFI= Total feed intake, DFI= Daily feed intake, FCR= Feed conversion ratio, AAFE= Age at first egg, FEWT= First egg weight. FW=Final weight. IWT= Initial Weight, MBS=Maize based diet, MSBD=Maize-sorghum based diet, SBD=Sorghum based diet, FC=Feed cost, N=Naira.

quail birds fed diets containing autoclaved CSC (T3, T6 and T7). There were no significant (P>0.05) differences in the age at first egg (AFE) and weight of first egg (WFE) across the treatments. There was a decrease in final weight gain, total weight gain, daily weight gain, and total feed intake, daily feed intake of quail birds fed diets containing autoclaved CSC (T2, T3, T6, T7, T4 and T5).

There was an increase in final weight gain, total weight gain, daily weight gain, total feed intake, daily feed intake of quail birds fed autoclaved CSC containing 28.28% sorghum in MSBD with enzyme supplementation (T7) compared to other quails fed diets containing autoclaved CSC.

There were increased in values of feed conversion ratio across the treatment in quail birds fed diets containing autoclaved castor seed cake.

The final life weight of quail birds fed autoclaved CSC containing 28.28% sorghum in MSBD with vegpro supplementation (T7) were significantly (P<0.05) higher than other treatments and were similar to those on the Control diet (T1). There were reduction in cost per bird in quails fed autoclaved CSC containing sorghum (T6, T7,T4 and T5) which have significantly (P<0.05) lower prices compared to quail birds fed diets without sorghum (T1, T2 and T3).

4.3 Effect of Autoclaved CSC in maize and sorghum based diet supplemented with vegpro on egg production parameters of quail layers (6-20 weeks)

Observations on the egg production parameters of quail layers during the laying phase (6-20 weeks) is as shown in Table 4.3. The result showed that there were significant (P<0.05) differences between all parameters measured in egg production (final weight, total weight gain, daily feed intake, total feed intake, hen house egg production, hen

Table 4.3: Effect of autoclaved castor seed cake in a maize and sorghum based diet supplemented with vegpro on egg production parameters of Quail hens (6-20weeks)

Parameters	Treatments							SEM
	T1 MBD	T2MBD	T3 MBD	T4SBD	T5SBD	T6 MSBD	T7 MSBD	
Initial weight(g)	121.33	121.33	121.67	122.00	121.33	121.33	121.67	5.71
Final weight(g)	167.67^{a}	122.33^{b}	100.00^{b}	101.11^{b}	121.22^{b}	100.00^{b}	116.66^{b}	12.10
Total weight change(g)	46.33^{a}	1.00^{b}	-21.67^{b}	-26.89^{b}	-11.11^{b}	-21.33^{b}	-05.01^{b}	10.62
Daily feed intake (g)	26.09^{a}	18.80^{c}	20.44^{c}	21.22^{cb}	21.69^{ab}	20.77^{bc}	22.86^{ab}	1.13
Total feed intake(g)	2538.80^{a}	1692.10^{c}	1837.40^{bc}	1907.50^{c}	2051.00^{b}	1841.30^{bc}	2042.04^{b}	99.85
HHEP(%)	61.63^{a}	46.97^{b}	32.53^{c}	57.88^{a}	46.57^{b}	42.52^{b}	40.87^{b}	2.40
Average egg weight(g)	9.91	8.75	8.22	8.38	8.59	11.84	8.15	1.26
HDEP(%)	61.63^{a}	46.95^{b}	32.53^{c}	57.88^{a}	46.57^{b}	42.52^{b}	40.87^{b}	2.40
AAPP(days)	108.00^{abc}	118.00^{ab}	118.00^{ab}	78.00^{c}	128.00^{a}	78.00^{c}	^{88}.00^{c}	10.00
EPAP(%)	76.57^{a}	56.18^{bcd}	45.37^{cd}	62.69ab^{cd}	63.70^{a}	44.00^{cd}	40.36^{d}	5.60
Cost/dozen(N)	28.40^{a}	17.96^{b}	19.89^{b}	19.05^{b}	21.18^{b}	18.73^{b}	21.44^{b}	1.06
Egg mass(g)	6.10^{a}	4.25^{b}	2.67^{b}	3.21^{b}	3.49^{b}	6.12^{a}	3.51^{b}	0.52

a, b, c= means with different superscript along the row differs significantly($p<0.05$).

EPAP=Egg production at peak, AAPP= Age at peak production, HDEP=House day egg production,,, AEW=Average egg weight , HHEP=Hens house egg production, MBD=Maize based diet, MSBD=M-sorghum based diet, SBD=Sorghum based diet.

day egg production, age at peak production, egg production at peak, cost per dozen egg, egg mass and feed to egg ratio) except average egg weights. There was an increase in final weights of quail hens fed control diets (T1) which was significantly ($P<0.05$) higher compared to quails fed diets containing autoclaved CSC (T1, T2, T3, T6, T7, T4 and T5).

Quail hens fed control diets (T1) are significantly ($P<0.05$) higher in feed intake compared to quails fed diets containing autoclaved CSC (T2, T3, T6, T7, T4 and T5). The feed intake, final weights and hen house egg production of quail hens fed diets containing autoclaved CSC are similar (T2, T3, T6, T7, T4 and T5). The hens house egg production, hens day egg production and egg mass were significantly ($P<0.05$) higher in quail hens fed control diet (T1) compared to other quails fed diets containing autoclaved CSC (T2, T3, T6, T7, and T5) but is similar to quail hens fed autoclaved CSC containing 46.51%sorghum in SBD (T4). Quails fed control diet and quail hens fed autoclaved CSC containing 46.51%sorghum in SBD with vegpro supplementation (T5) had significantly ($P<0.05$) higher age at peak production compared to other quails fed diets containing autoclaved CSC (T2, T3, T6, T7, and T4). There were reduction in cost per dozen eggs in quail hens fed autoclaved CSC containing sorghum (T6, T7,T4 and T5) which have significantly ($P<0.05$) lower prices compared to quail hens fed diets without sorghum (T1, T2 and T3).

4.4 Effect of autoclaved castor seed cake CSC in maize and sorghum based diet on the egg quality of quail birds (6-20weeks)

Results on the egg quality characteristics of quail layers during the laying phase (6-20 weeks) is presented in Table 4.4. Results showed that quails fed control diet (T1) had significantly ($P<0.05$) higher mean egg weight value compared to quail hens fed diets containing autoclaved CSC (T2, T3, T6, T7, T4 and T5).

Table 4.4: Effect of Autoclaved Castor Seed Cake in maize and sorghum based diet supplemented with vegpro on Egg Quality Characteristics of Quail hens (6-20weeks)

	Treatments							
Parameters	**T1MBD**	**T2MBD**	**T3MBD**	**T4SBD**	**T5SBD**	**T6MSBD**	**T7MSBD**	**SEM**
Egg wt(g)	10.2^{a}	8.97^{bc}	8.96^{bc}	8.51^{c}	8.74^{bc}	9.03^{b}	8.56^{bc}	0.14
Egg LHT(mm)	31.6^{a}	29.66^{b}	30.05^{b}	30.02^{b}	29.69^{b}	30.21^{b}	29.27^{b}	0.33
Egg Width(mm)	24.2^{a}	23.64^{ab}	23.46^{ab}	22.89^{ab}	$23.69a^{b}$	23.46^{ab}	22.86^{c}	0.22
Shape Index	76.1^{b}	79.96^{ab}	79.05^{ab}	77.63^{b}	84.94^{a}	78.95^{b}	76.37^{b}	1.93
Shell wt(g)	0.92^{a}	0.78^{bc}	0.75^{bc}	0.73^{c}	0.76^{c}	0.86^{bc}	0.70^{bc}	0.03
Shell (%)	8.96^{ab}	9.02^{ab}	8.38^{ab}	8.59^{ab}	8.89^{ab}	9.39^{a}	7.89^{ab}	0.42
SHT(mm)	0.30	0.24	0.18	0.16	0.17	0.35	0.15	0.07
HU Score	77.92	81.31	82.35	80.53	81.78	82.15	73.40	3.86
Albumen HT(mm)	2.97	3.00	3.08	2.04	3.14	3.97	3.10	0.29
albumen LHT(mm)	35.9^{a}	34.01^{ab}	33.88^{ab}	33.46^{ab}	36.11^{a}	31.00^{ab}	33.63^{ab}	1.24
Albumen wt(g)	5.14^{a}	4.84^{ab}	4.37	4.33^{b}	4.29^{b}	4.35^{b}	4.27^{b}	0.19
Albumen (%)	49.20	54.08	48.37	49.21	49.89	48.30	50.08	1.70
Albumen Width(mm)	25.6^{ab}	24.33^{b}	25.00^{ab}	25.47^{ab}	27.14^{a}	25.75^{ab}	26.37^{ab}	0.74
Albumen Index	0.045	0.049	0.040	0.052	0.048	0.052	0.054	6.83
Yolk HT(mm)	9.66	9.18	10.41	9.33	9.41	9.48	10.29	0.49
Yolk LHT(mm)	22.04	23.78	21.09	21.94	23.02	22.19	22.12	1.10
Yolk wt(g)	3.37^{a}	2.62^{bc}	2.89^{bc}	2.78^{bc}	2.72^{bc}	2.94^{b}	2.82^{bc}	0.09
Yolk (%)	32.83	29.07	31.76	33.16	31.41	32.83	30.26	1.43
Yolk Index	0.441	0.433	0.497	0.429	0.429	0.461	0.486	0.04

^{a,b,c}= means with different superscript along the row differs significantly($p<0.05$).

LWT:=live weight, CWT:=carcass weight, MBD=Maize based diet, MSBD=Maize-sorghum based diet, SBD=Sorghum based diet, SHT=Shell thickness.

There were decreases in egg weight in birds fed diets containing autoclaved CSC (T2, T3, T6, T7, T4 and T5). There were decreases in egg length, shell weight, albumen weight, and yolk weight in quail hens fed diets containing autoclaved CSC (T2, T3, T6, T7, T4 and T5) which were significantly ($P<0.05$) lower compared quail hens fed control diet (T1). The egg width was significantly($P<0.05$) higher in quails fed autoclaved CSC (T2, T3, T6, and T5) compared to quails fed autoclaved CBC containing 28.28% sorghum in MSBD with vegpro supplementation (T7) and quail hens fed autoclaved CSC containing 46.51% sorghum in SBD without vegpro supplementation (T4).The shell weight of quail hens fed control diet (T1) and quail hens fed autoclaved CSC containing 46.51% sorghum in SBD without vegpro supplementation (T6) were similar but significantly ($P<0.05$) higher compare(T2), There were no significant ($P>0.05$) differences in shell thickness, haugh unit score, albumen height, albumen percent, albumen index, yolk index, yolk height, yolk length, and yolk percent across the treatments.

4.5 Effect of autoclaved CSC in maize and sorghum based diet supplemented with on the haematological parameters of quail bird (6 – 20 weeks)

The result of the haematological parameters is presented in Table 4.5 There were significant ($P<0.05$) differences in all the parameters measured except the basophils. The packed cell volume (PCV) and haemoglobin (HB) values were significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in MBD (T3) compared to quail birds fed control diet (T1) and quail birds fed autoclaved CSC in MSBD (T6 and T7) but were similar to those quail birds fed autoclaved CSC in MBD (T2), MSBD (T7) and SBD (T4). The red blood cell (RBC) was significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in MBD (T2) compared to quail birds fed autoclaved CSC in

Table 4.5: Effect of autoclaved castor seed cake in maize and sorghum based diet supplemented with vegpro on the haematological parameters of quail birds (6-20 weeks)

Parameters	Treatments					
	T1MBD	T2MBD	T3 MBD	T4 SBD	T5 SBD	T6 MSBD
PCV (%)	48.00^{bc}	51.00^{ab}	55.00^{a}	51.50^{ab}	43.00^{c}	47.00^{bc}
Hb (g/dl)	16.00b^{c}	17.00^{ab}	18.30^{a}	16.65^{ab}	14.30^{c}	15.80^{bc}
RBC x 10^{12}/ l	65.00^{ab}	88.00^{a}	77.500^{ab}	73.15^{ab}	77.45^{ab}	59.55^{b}
WBC x10^{9}	14.736^{b}	14.7240^{b}	17.1240^{ab}	13.0080^{bc}	8.6190^{c}	20.9280^{a}
Neutrophil (%)	91.00^{cd}	99.65^{cd}	78.83^{d}	114.50^{b}	103.00^{a}	84.85^{cd}
Lymphocyte (%)	93.50^{cd}	112.00^{bc}	116.50^{b}	137.50^{ab}	114.50^{b}	121.00^{ab}
Basophil (%)	76.50	73.50	73.5	85.50	78.75	74.50

$^{abcd=}$ Means with different superscript along the row differs significantly($p<0.05$). PCV=Packed Cell Volume, WBC= White Blood Cell. HB=Haemoglobin.RBC=Red blood cell. MBD=Maize based diet, MSBD=Maize-sorghum based diet, SBD=Sorghum based diet.

MSBD (T6) but was similar to that of other treatments. The white blood cells (WBC) was significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in MSBD (T6) compared to quail birds fed control diet (T1), autoclaved CSC in MBD (T2) and SBD (T4 and T5) but was similar to that of quail birds fed autoclaved CSC in MBD (T3) and MSBD (T7). The neutrophils and lymphocyte counts were significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in SBD (T4) compared to all other treatments.

Quail birds fed autoclaved CSC in MSBD (T6) and SBD with enzyme (T5) had PCV, Hb and RBC values similar to those on the control (T1). Quail birds fed autoclaved CSC without mixture of maize and sorghum had higher neutrophil counts compared to other treatments. There was increased haemoglobin count of quail birds fed diets containing autoclaved CSC. The result of blood count differential showed that quail birds fed diets containing autoclaved CSC had high blood count differentials compared to other quail birds to that of other treatments. The white blood cells (WBC) was significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in MSBD (T6) compared to quail birds fed control diet (T1), autoclaved CSC in MBD (T2) and SBD (T4 and T5) but was similar to that of quail birds fed autoclaved CSC in MBD (T3) and MSBD (T7). The neutrophils and lymphocyte counts were significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in SBD (T4) compared to all other treatments.

Quail birds fed autoclaved CSC in MSBD (T6) and SBD with enzyme (T5) had PCV, Hb and RBC values similar to those on the control (T1). Quail birds fed autoclaved CSC without mixture of maize and sorghum had higher neutrophil counts compared to other treatments. There was increased haemoglobin count of quail birds fed diets containing autoclaved CSC. The result of blood count differential showed that quail

birds fed diets containing autoclaved CSC had high blood count differentials compared to other quail birds.

to that of other treatments. The white blood cells (WBC) was significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in MSBD (T6) compared to quail birds fed control diet (T1), autoclaved CSC in MBD (T2) and SBD (T4 and T5) but was similar to that of quail birds fed autoclaved CSC in MBD (T3) and MSBD (T7). The neutrophils and lymphocyte counts were significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in SBD (T4) compared to all other treatments.

Quail birds fed autoclaved CSC in MSBD (T6) and SBD with enzyme (T5) had PCV, Hb and RBC values similar to those on the control (T1). Quail birds fed autoclaved CSC without mixture of maize and sorghum had higher neutrophil counts compared to other treatments. There was increased haemoglobin count of quail birds fed diets containing autoclaved CSC. The result of blood count differential showed that quail birds fed diets containing autoclaved CSC had high blood count differentials compared to other quail birds.

4.6 The effect of autoclaved Castor seed cake (CSC) in maize and sorghum based diet with enzyme supplementation on the carcass characteristics of quail birds (6-20 weeks)

The result of the effect of autoclaved CSC in maize and sorghum based diets with enzyme supplementation on the carcass characteristics of quail birds is presented in Table 4.6. The results of the carcass evaluation indicated that the carcass weight (CW) was significantly ($P<0.05$) higher in quail birds fed control diet (T1) compared to all other treatments but was similar to quail birds fed control diet (T1) and those quail

Table 4.6: Effect of autoclaved castor seed cake (CSC) in maize and sorghum based diet supplemented with vegpro on Carcass Characteristics of Quail Birds (6-20 weeks)

	Treatments						
Parameters	**T1(MBD)**	**T2(MBD)**	**T3(MBD)**	**T4(SBD)**	**T5(SBD)**	**T6(MSBD)**	**T7(MSBD)**
LWT (g)	175.03^{a}	135.97^{b}	144.87^{b}	141.97^{b}	150.10^{b}	142.50^{b}	136.78^{b}
CWT (g)	97.17^{a}	72.17^{bc}	80.40^{bc}	74.30^{bc}	87.03^{ab}	74.70^{bc}	71.13^{c}
Dressing(%)	55.47^{ab}	53.09^{b}	55.50^{ab}	52.30^{b}	58.13^{b}	52.41^{b}	51.75^{b}
Thigh (%)	13.01	11.89	14.45	12.28	14.00	12.28	19.01
Breast (%)	20.22	20.07	19.26	19.80	20.85	19.05	19.66
Back (%)	16.61^{ab}	19.29^{a}	13.70^{ab}	14.06^{ab}	16.24^{ab}	13.67^{ab}	12.55^{b}
Wing (%)	5.27^{c}	6.22^{b}	6.63$^{b`}$	5.96^{bc}	7.87^{a}	5.92^{bc}	5.91^{bc}
Neck (%)	4.93^{a}	3.63^{bc}	3.16^{c}	3.66^{bc}	4.56^{a}	3.31^{bc}	2.82^{c}
Liver (%)	2.62^{c}	3.80^{a}	3.34^{abc}	3.44^{abc}	3.12^{bc}	2.93^{bc}	2.82^{bc}
Heart (%)	0.90^{ab}	0.95^{ab}	0.78^{b}	0.83^{ab}	1.00^{a}	0.84^{ab}	0.83^{ab}
Gizzard (%)	2.54	5.55	2.46	2.46	2.19	2.27	2.40
Intestine(%)	4.07^{bc}	4.48^{abc}	5.29^{a}	3.92^{c}	4.95^{ab}	4.25^{bc}	4.54^{abc}
Lungs (%)	0.63	0.81	0.71	0.71	0.74	0.70	0.76
Leg(%)	1.66^{b}	2.80^{a}	1.98^{ab}	1.82^{b}	1.87^{ab}	1.71^{b}	1.79^{ab}
IL (cm)	56.06^{ab}	57.04^{b}	60.30^{a}	57.30^{ab}	58.21^{ab}	58.30^{ab}	58.27^{ab}

^{a,b,c}= means with different superscript along the row differs significantly($p<0.05$).

LWT:=live weight, CWT:=carcass weight, MBD=Maize based diet, MSBD=Maize-sorghum
based diet, SBD=Sorghum based diet**,** IL=Intestinal length, CM=Centimeter**.**

birds fed autoclaved CSC in MBD with enzyme supplementation (T3). The liver weight was significantly ($P<0.05$) higher in quail birds fed autoclaved CSC in MBD (T2) compared to quail birds fed control diet (T1) and quail birds fed autoclaved CSC in MSBD (T6 and T7) but similar to quail birds fed autoclaved CSC in MBD (T3) and quail birds fed autoclaved CSC in SBD (T4 and T5).

CHAPTER FIVE

5.0 DISCUSSION

5.1 Effect of autoclaved CSC in maize and sorghum based diets supplemented with vegpro on growth performance characteristics of quail birds (2-6 weeks)

The nutrient composition of autoclaved castor seed cake (CSC) agreed with the report of Okorie *et al. (*1985) who reported that castor seed cakes contain crude protein of between 20 – 46% and that the crude protein decreased from 32.8 to 24.4% due to roasting. The result of nutrient composition of castor seed cake in the present study disagreed with the report of Adedeji (2013) who reported that the dehausted castor bean meal contains crude protein of 34.20%, crude fibre 27.40%, ether extract 12.30%, nitrogen free extract of 19.20% and Ash 6.90% where as the proximate composition of autoclaved CSC contains crude protein (23.89%), crude fibre (21.08%), ether extract (8.90%), nitrogen free extract.39.94%, Ash (6.19%) differences may be due to the processing methods.

The general decrease in final weight gain, total weight gain, daily weight gain, total feed intake, daily feed intake of birds fed autoclaved CBC in a maize and sorghum based diets may be due to fibre level and the presence of residual ricin in the diet. This agreed with the report of Ndams (1991) who observed that feed consumption and body weight gains especially in meat type birds decreased when birds were fed high fibre diets. It also agreed with the report of Ani and Okorie (2009) who reported depressed feed intake, for birds fed castor based diets. Tannin in the diets in the present study may not be responsible for the reduced final weight, daily weight gain, and feed intake since tannin content in the sorghum varieties in Nigeria (0.12 to 0.215%) (Aduku, 2004) is much lower than the thresh hold of 1.35% reported to compromise the

growth performance of broiler chicks (Monge *et al.*, 2007). The relatively higher final weight gains, total weight gain, daily weight gain, total feed intake of birds fed autoclaved CSC in MSBD and SBD with enzyme supplementation observed in this study agreed with report of Timbrel (1993) who stated that there could be instances where enzyme treatment or supplementation add little value to particular ingredients or failed to improve their performance. The birds in these treatments had values similar to those on the control diets. The increase in final weight gain, total weight gain, daily weight gain, total feed intake, daily feed intake of birds fed autoclaved Castor seed cake containing 28.28% sorghum in MSBD with enzyme supplementation may be due to the effect of tannin and ricin which reduces the toxic effect of castor seed cake in diet of the birds. This agrees with the report of Gandhi and Mulky (1994) that tannin has the ability to form a complex with ricin to reduce the toxic effect of ricin.

The numerical increases in values of feed conversion ratio across the treatments fed diet containing autoclaved castor seed cake and sorghum may be due to the presence of anti-nutritional factors in the diet which may have reduced digestibility of the nutrient and some may have by- passed without being digested due to tannin- ricin complex. This is in line with the report of Gandhi and Mulky (1994) on formation of tannin protein complex in the digestive tract of the animal which may escape digestion. There was improvement in feed conversion ratio of the birds fed autoclaved CSC containing 28.28% sorghum in MSBD and 46.51% sorghum in SBD both supplemented with vegpro and this is in line with the report of Timbrel (1993) who reported improvement in performance of animals fed diet with enzymes supplementation.

The final life weight of quails fed autoclaved CSC containing 28.28%sorghum in MSBD increased and was similar to those on the Control diet. This suggests that

inclusion of autoclaved CSC at 10% level in quail diet with enzymes supplementation will improve life weight gains. This result agreed with the report of Ani and Okorie (2009) who observed that birds fed 10% castor seed cake had similar feed intake and weight gain as the control.

5.2 The effect of autoclaved castor seed cake in maize and sorghum based diets with enzyme supplementation on the egg production parameters (6-20weeks)

The significant differences observed in feed intake, hen day production, egg weight, egg mass and feed to egg ratio is in agreement with the findings of Olayeni *et al*. (2006) who reported significant differences in egg production parameters mentioned above which was due to ingestion of autoclaved castor seed cake that caused loss of appetite and reduced palatability. It is also in line with the view of Ani and Okorie (2009) who reported low feed intake and weight gain of birds fed diets containing castor seed meal. There was an increase in final weights of quail hens fed control diet which was higher compared to the other treatments. This is in line with the report of Ani and Okorie (2005) who reported increase in weight of broiler chickens fed maize based diet as control compared to those fed diet containing castor bean meal. These differences might be caused by superiority of the control diet which contain maize and ground nut cake compared to other treatments.

Quail hens fed control diets had higher feed intake compared to quail hens fed diets containing autoclaved CSC. This is in line with the finding of Ani and Okorie (2009). This may be due to the presence of residual nutritional factors in diets containing autoclaved CSC. The feed intake, final weights and hen house egg production of quail hens fed diets containing autoclaved CSC are similar. The hen house egg production, hen day egg production and egg mass of quails fed autoclaved CSC containing

46.51% sorghum in SBD without vegpro was similar to quail hens on control diet. Quails fed autoclaved CSC containing 28.28% sorghum in MSBD had higher age at peak production and is similar to control This is in line with the report of Gandhi and Mulky (1994) which may be due to the effect of ricin –tannin interaction that reduced the harmful effect of ricin on the quail birds. There were reductions in cost per dozen eggs in quail hens fed autoclaved CSC in SBD which have lower prices compared to quail hens fed diets without sorghum. This is in line with the report of Ebadi *et al.* (1998) who indicated that birds fed diets with partial replacement of maize with sorghum resulted in reduction in cost of production. This may be due to reduction in price of sorghum as at the time of the experiment in Zaria.

Quails fed autoclaved CSC containing 46.51% sorghum in SBD without vegpro supplementation had higher egg mass which is similar to quails on control diet. This is in line with the view of Prochaskal *et al.* (1996) and is contrary to the report of Olayeni *et al.* (2006) who indicated that there was a declined in egg mass in hens fed castor seed based diets. The increase in egg mass may be as a result of dietary fortification with synthetic amino acids and lysine which eliminated adverse effect of tannin and ricin (Imik *et al.*, 2006) and may also be due to interaction of tannin and ricin which may reduce the toxic effect of ricin in the body of the hens (Gandhi and Mulky, 1994). The feed to egg ratio is better in quails fed autoclaved CSC in MBD without enzyme supplementation and quails fed autoclaved CSC containing 28.28% sorghum in MSBD without vegpro supplementation and are similar to quails on control diet. This is in line with the report of Ani and Okorie (2009) who reported that birds fed 10% CBM had similar result with the control. This may be due to immunity developed by the hens to the effect of ricin and formation of complex between tannin and ricin which masked the

toxic effect of the anti nutritional factors in the diets (Gandhi and Mulky, 1994 and Imik *et al.,* 2006).

5.3 Effect of autoclaved castor seed cake CSC in maize and sorghum based diet with enzyme supplementation on the egg quality characteristics of quail layers (6-20 weeks)

The result showed that quails fed the control diet had higher mean egg weight values compared to quail hens fed diets containing autoclaved CSC. This is in line with the findings of Olayeni *et al.* (2006); Ani and Okorie (2009); Ani and Okorie (2005) who reported decrease in egg weight in birds fed castor based diets. This may here been caused by decrease in palatability of castor based diets. There were decreases in egg length, shell weight, albumen weight and yolk weight in quail hens fed diets containing autoclaved CSC which were lower compared with quail hens fed control diet. This is in line with the report of Adedeji (2013) that ingestion of castor fruit meal in the diet of layers had a negative effect on the performance characteristics. This may be due to residual ricin in diets containing autoclaved CSC. The inclusion of autoclaved CSC had no negative effect on shell thickness, haugh unit score, albumen height, albumen percent, albumen index, yolk index, yolk height, yolk length, and yolk percent across the treatments. This is in line with the view of Olayeni *et al.* (2006) who reported that castor seed meal had no effect in the parameters measured above. This showed that dietary treatments had no negative effect on the parameters mention above. This may be as a result of birds developing immunity against toxins from ricin by the birds (Ani and Okorie, 2005).

There were decreases in shell weight in quails fed diets containing autoclaved CSC except those fed autoclaved CSC in MBD without vegpro supplementation and quails fed autoclaved CSC containing 46.51% sorghum in SBD without vegpro

supplementation which were similar to quails fed control diet which is in line with the report of Imik *et al.* (2006) who indicated decrease in egg shell thickness in layers fed sorghum based diets. This may be caused by the reaction between tannin and ricin which decreased amino acids, and some minerals availability therefore cation-anion balance of blood change and HCO_3^- availability and shell thickness reduction. Quails fed autoclaved CSC containing 28.28%sorghum in MSBD without vegpro supplementation had increased shell percent and shell weight which was is similar to quails fed control diet. This is in line with the report of Imik *et al.* (2006) who indicated that partial replacement of maize with sorghum in the basal diet did not affect egg shell. This may be caused by presence of high digestible maize in the diet, immunity of the hen to toxic effect of ricin in the diet. This may be as a result of fortification of the diets with high energy and protein level in the diets which may have masked the effect of anti nutritional factors in the diet.

5.4 Effect of feeding autoclaved castor seed cake CSC in a maize and sorghum based diet on the haematological parameters of quail bird (6 – 20 weeks)

The increased haemoglobin count in quail birds fed diets containing autoclaved CSC diet is in line with the report of Ani and Okorie (2009) who reported that there were increase in haemoglobin of birds fed castor bean meal which may suggest the production of more blood cells in birds as they tried to develop immunity against toxins in the diets. Ani and Okorie (2002) also reported that ricin as a protein is capable of inducing immunity in animals that consumed it in small quantities over a long period of time.

The PCV value observed is within the normal range which is in line with the report of Ani and Okorie (2009) who reported that castor seed meal has no significant effect on the PCV of birds. it is however, contrary to the report of Dawn (2010) who reported

PCV for quail bird's values between 37% to 50%. The result of the blood count differential shows that birds fed diets containing autoclaved CBC had higher differential blood count compared to other birds and this is in line with the report of Ani and Okorie (2009) which may be as a result of birds developing immunity again ricin in the diets containing autoclaved CSC based diet. It was also observed that birds on diets containing MSBD had lower differential blood count which may be due to the effect of interaction of tannin and ricin complex which reduces the toxin in the diets (Gandy and Mulky, 1994).

5.5. The effect of feeding autoclaved castor seed cake CSC in maize and sorghum based diet with enzyme supplementation on the carcass characteristics of quail birds (6-20 weeks)

The improvements in the live weight, carcass weight, dressing percentage and breast % of quail birds fed diets supplemented with enzyme is in agreement with the report of Gippert *et al.* (1997) that enzyme supplementation slightly increase weight gain, feed conversion ratio of broiler birds. Annision (1993) reported that enzyme supplementation has the potential to improve the nutritive values of feed for monogastric animals.

The result of this feeding trial showed that diets containing autoclaved CSC had no negative effect on gizzard, lungs, breast, and thigh.

6.0 CHAPTER SIX

6.1 SUMMARY, CONCLUSION AND RECOMENDATION

Daily feed intake and live weights of quail birds fed diets containing autoclaved CSC with enzyme supplementation increased during grower phase. The average daily weight gain of quails fed autoclaved castor seed cake containing 28.28% sorghum in MSBD supplemented with enzyme (vegpro) were higher compared to other treatments and similar to those on control diets during the grower phase.

The feed conversion ratio of quails fed the control diet was similar to those quails fed autoclaved CSC containing 46.51%sorghum in SBD without enzyme during egg lying phase. There were no significant differences in first egg weight, age at first egg.

Autoclaved (CSC) did not result in any deleterious effect on Japanese quail birds performance. Though there were mortality but quail birds were able to tolerate up to 10% autoclaved CSC without adverse effect. Diets containing autoclaved CSC Castor seed cake based diet did not show any adverse effect on the egg quality parameters measured. Quail birds on diets containing CSC without sorghum perform poorly in terms of hen housed egg production and prolong age at peak production. Cost per dozen egg decreased as sorghum replaced maize and without supplementation of enzyme.

6.2 CONCLUSION

- Ten percent (10% Autoclaved CSC containing 28.28% sorghum in MSBD supplemented with vegpro gave the best results with higher weights of quail birds during the grower phase.

- Utilization of autoclaved CSC at 10% inclusion level containing 46.51% sorghum in SBD without enzyme performed best in term of egg production.
- There were economic advantage of including autoclaved CSC and sorghum in quail's diets with lower feed cost per dozen eggs. Therefore, their usage should be encouraged.

6.3 RECOMMENDATIONS.

- Ten percent (10%) autoclaved CSC+ 28.28%sorghum in MSBD should be included in quail birds diets during grower phase.
- Enzyme should be used to supplement quail diets during growing phase.
- Ten percent (10%) autoclaved CSC +46.51% sorghum in SBD should be included in quail bird's diet during egg laying phase without enzyme supplementation.
- Sorghum is recommended in replacing maize in the diet of quail due to low cost effectiveness and profitability.
- Further studies should be conducted into utilization of autoclaved CSC in feeding quail birds.

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APPENDICES

Appendix 1: Proximate composition of Experimental diet for starter/grower Japanese quails 2-6 weeks)

	Treatments						
Composition(%)	T1MBD	T2MBD	T3MBD	T4MSBD	T5MSBD	T6SBD	T7SBD
DM	93.41	92.20	87.46	93.59	93.21	92.03	93.44
CP	25.21	25.56	24.98	25.11	25.19	25.08	24.94
CF	5.30	6.03	3.63	6.84	5.45	7.01	8.10
EE	5.04	5.66	5.39	4.88	5.32	5.01	5.66
ASH	11.67	8.57	10.28	9.75	12.26	12.03	10.00
NFE	52.78	54.80	55.72	53.42	50.87	36.58	39.94

Dry matter= DM, Crude protein= CP, Crude fibre= CF, Ether Extract= EE, Nitrogen free extract, MBD=Maize based diet, MSBD=Maize sorghum based diet, SBD=Sorghum based diet.

Appendix ii. Proximate composition of experimental diet for laying of Japanese quail (6-20 weeks)

	Treatments						
composition(%)	**T1MBD**	**T2MBD**	**T3MBD**	**T4SBD**	**T5SBD**	**T6MSBD**	**T7MSBD**
DM	94.97	94.72	94.21	94.45	94.89	93.11	94.95
CP	22.25	22.06	22.31	22.40	22.46	22.36	22.37
CF	6.98	6.09	4.47	5.35	7.53	6.24	5.53
EE	4.19	4.12	4.04	5.14	5.37	4.94	4.52
ASH	7.35	7.45	8.50	8.10	8.50	5.74	8.27
NFE	4.68	4.33	4.61	4.66	4.86	4.81	4.69

Dry matter= DM, Crude protein= CP, Crude fibre= CF, Ether Extract= EE, Nitrogen free extract= NFE, MBD=Maize based diet, MSBD=Maize sorghum based diet., SBD=Sorghum based diet.