PERFORMANCE EVALUATION OF JAPANESE QUAIL (*Coturnix coturnix japonica*) **FED TWO VARIETIES OF GARLIC (*Allium sativum*) AS FEED ADDITIVE**

BY

AMINU ADAMU
SPS/13/PAS/00001
M. Sc ANIMAL SCIENCE

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DECLARATION

I hereby declare that this work is the product of my research efforts undertaken under the supervision of Professor G. S. Bawa and has not been presented anywhere for the award of a degree or certificate. All sources have been duly acknowledged.

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AMINU ADAMU
SPS/13/PAS/00001

CERTIFICATION

This is to certify that the research work for this thesis and the subsequent write up by Aminu Adamu (SPS/13/PAS/ 00001) were carried out under my supervision.

Professor G. S. Bawa	Dr. N. B. Rano
Supervisor	Head of Department

APPROVAL PAGE

This thesis has been examined and approved for the award of PhD in Animal Science of Bayero University, Kano Nigeria by the following:

__________________ _______________
Professor Comfort Tuli Date
External Examiner

______________ ________________
Dr. N.B. Rano Date
Internal Examiner

___________________ _________________
Professor G. S. Bawa Date
Supervisor

___________________ _________________
Dr. N.B. Rano Date
Head of Department

__________________ ________________
Dr. M. U. Dawaki Date
Representative Board of the school of postgraduate Studies

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This thesis titled "Performance Evaluation of Japanese Quail (*Coturnix coturnix japonica*) Fed Two Varieties of Garlic (*Alliumsativum*) as Feed Additive" is dedicated to all those who believe in, is the ability of the microlivestock to alleviate poverty and malnutrition around the world.

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ABSTRACT

The study was conducted in two phases to evaluate the growth and egg laying performance of Japanese quail hens fed two garlic varieties as feed additives. A total of 960 Japanese quails one week old with an average initial weight of 15 g/bird were used in experiment I. Eight hundred and sixty four Japanese quail hens with an average initial weight of 151.25 g/bird were used in experiment II. The quail hens were assigned to eight dietary treatments and three replicates in each experiment. In experiment I there were one hundred and twenty quail hens per treatment and forty per replicate. In experiment II there were one hundred and eight quail hens per treatment and thirty six per replicate. The two experiments were laid in a 2x4 factorial arrangement of completely randomized design (CRD). The diets were designated as diet 1, 2, 3 and 4 containing 0, 2, 4, and 6 % of Ex – Kofa garlic variety respectively. Diets 5, 6, 7 and 8 also contained inclusion level of Ex – Lugu garlic variety. Diets 1 and 5 had no garlic and served as control. In experiment I the growth performance and nutrient digestibility of the Japanese quail were significantly ($P<0.05$) affected by the use of garlic as feed additive as the final weight, crude protein and nitrogen free extract digestibility were higher (120.00 g) (69.65 %) (62.56 %) in quails fed 6 % inclusion level. The Haemotological and serum biochemical parameters of both experiment 1 and II were significantly ($P<0.05$) affected by the garlic fed as feed additive as the red, white blood cell counts, packed cell volume, total protein, serum glutamic oxaloacetic transaminase were higher (2.90 10^6/mm^3) (3.08 10^6/mm^3) (17.87 10^3/mm^3) (33.28 %) (6.35 g/100ml) (131.45 IU/L) in quails fed 4 and 6% inclusion levels. The carcass and visceral organs characteristics were significantly ($P<0.05$) different as the dressing, breast, liver and heart weight were higher (52.00 g) (9.56 g) (2.50 g) (0.44 g) in quails fed 6 % inclusion level of garlic. In experiment II the egg performance and quality characteristics were significantly ($P<0.05$) affected as the hen day and house production, egg weight and shell thickness were higher (80.28 %) (77.82 %) (10.53 g) (0.40 mm) in quail hens fed 6 % garlic inclusion level. The carcass and visceral organs characteristics were also significantly ($P<0.05$) affected as the dressing and back weight, liver and gizzard weight were higher (195.25 g) (19.04 g) (3.12 g) (5.43 g) in quail hens fed 6 % inclusion level of the test ingredients. Therefore the experimental feed additives (Ex – Kofa and Ex – Lugu garlic varieties) improved the performance of Japanese quail at the different levels of inclusion (2, 4 and 6 %). However, higher growth, egg laying performance and quality were obtained in Japanese quails fed Ex - Lugu at 6 % (highest garlic concentration) level of inclusion. It is therefore recommended that Ex- Lugu garlic varieties could be fed as feed additives to Japanese quail especially at 6 % level of inclusion.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND INFORMATION

The demand for protein of animal origin has outstripped the supply. The need for an increase in the level of animal protein production cannot be over emphasized in order to bridge the gap between demand and supply (FAO, 1997; Smith, 2001). An average Nigerian for instance consumes only about 10 g per day of protein which is below the minimum daily protein intake of 35 g recommended by Food and Agriculture Organization (FAO, 1997; Smith, 2001).The solution to the problem of inadequate animal protein consumption by an average Nigerian is to increase the level of animal product by intensifying the produ,ction of highly reproductive animals with short generation interval such as poultry, pigs and rabbits (Fielding, 1991; Serres, 1992; Smith, 2001; Ani & Adiegwu, 2005).

Poultry is the quickest source of meat and its production involve the least difficulty compared to other livestock enterprises (Obioha, 1992). Poultry are able to adapt to most areas of the world with rapid generation interval and the high rate of productivity (Smith, 2001).

One poultry species that is receiving attention as a good source of protein is the Japanese quail (*Coturnix coturnix japonica*). Japanese quails are hardy birds that thrive in small cages, inexpensive to produce and are not prone to common poultry diseases. They mature in about six weeks and are usually in full egg production by 50 days of age, with 200-300 eggs in their first year of lay (NRC, 1991; Smith, 2001).In addition, they require less floor space (Musa, Haruna & Lombin, 2008), less feed consumption rate (20-25 g) compared to chicken (120 – 130 g) per day.

Numerous reports have been published, advocating the beneficial effect of garlic on feed efficiency and growth of broiler chickens. According to Mansoub (2011), feed conversion ratio (FCR) and body weight (BW) of broilers were improved when they were fed garlic 0.001kg in the basal diet. Aji, Ignaturus, Ado, Nuru and Abdulkarim (2011) reported that administration of 100 mg of garlic resulted in improved body weight gain at 7, 14 and 21 days of treatment in broiler chicks. Kumar, Sharadmma and Rado (2010) found that garlic supplemented diet (250 ppm) significantly increased the body weight gain of broiler chickens in a 42 day trial. Pourali, Mirheleng and Kermanshahi (2010) also reported that garlic powder improved average daily feed intake, body weight, FCR, performance index as well as survivability. Khan, Naz, Tufarelli, Selvaggi and Laudadies (2011) reported that egg production increased during the six weeks in which 0, 2, 6, or 8 % garlic powder was fed to laying hens.

Ahsan-ul-Haq, Meraj and Rasool (1999) reported that feeding garlic at the rate of 20 g/kg decreased blood cholesterol significantly in broiler chicks. Egg yolk cholesterol of laying hens decreased significantly in birds supplemented with 1 and 2 % garlic powder. Ried, Frank, Stock, Fackler and Sullivan (2008) and Conogullari, Baylan, Erdogan, Duzguner and Kucukgul (2010) reported that Garlic has many biological activities including protective roles in cardio vascular function in animal. Ried, *et al* (2008) and Mukaerjee, Lekli, Goswami and Das (2009) reported that garlic prevents heart disease in human and other animals.

Garlic is of the genus *Allium*, is a perennial plant from the family, Liliaceae (Arora, 1999). It has a powerful onion like aroma and pungent taste. Ex – Kofa variety of garlic locally called *Yar kofa* has white scaly leaves which cover the bulbs tightly together. Also each bulb is covered with white scaly leaf. Ex – Lugu variety of garlic locally called *Yar lugu* or *Yar sokoto* has thin light scaly leaves which cover the bulbs not so tightly together. Individually each bulb is covered with light pink scaly leaf.

Garlic is consumed as spice and condiment in many dishes (Reuter, Koch, Lawson & Godson. 2004). Garlic can be used to protect food and consumers from the risk of contamination from pathogenic microorganism (Srinivasan, Sangeetha & Lakshmana. 2009). Its essentials oils and other components have strong antibiotic, antifungal and antiviral properties (Jack, 2001). It contains more than one hundred biologically useful chemicals (Harris, 2001, Singh and Singh, 2008).

In ancient time, people ate garlic to control intestinal disorders, worm flatulence, headaches, tumor, bites and ageing. Today, fresh garlic is mixed with honey as an effective home remedy for colds, hoarseness, and inflammation of the throat, severe chest congestion and painful coughing. Garlic exhibits a broad antibiotic activity against both gram positive and gram negative bacteria (Srinivasan *et al.*, 2009).

Allicin, a major constituent of garlic was evaluated for its antihypertensive effects. Long time oral administration of allicin lowered blood pressure in hypertensive rats (Ali, Al-Qattan, Al-Eneze, Khanater & Mustafa, 2000). Allicin also caused pulmonary vasodilatation in lung of rat (Kim-Park & Ku, 2000). It has been reported that garlic and its extracts through their antioxidant activities prevent free radical damage in the body (Chung, 2006). Spices are well recognized to stimulate gastric function. They are generally believed to intensify salivary flow and gastric juice secretion and hence aid in digestion (Glatzel, 1968). Epidemiological studies have shown that higher intake of allium products is associated with reduced risk of several types of cancer, especially stomach, colon and rectal (Fleichauer & Arab, 2001).

Poultry feed additives are primarily included to improve the birds growth, laying capacity, prevent diseases and improve feed utilization (Anonymous, 2017).

Probiotics as live mono or mixed culture of microorganisms which are non pathogenic, resistant to gastric and bile acid when ingested can beneficially affect the host animal by improving the characteristics of intestinal microfilora. Prebiotics are defined as indigestible feed ingredients which stimulate growth or activity of selected number of bacteria in the gastrointestinal tract of host animal (Anonymous, 2017).

1.2 PROBLEM STATEMENT

Synthetic antibiotic - based feed additives have been used in poultry feed to improve growth, egg laying capacity, feed utilization as well as disease prevention even though they have side effects which affect poultry performance and human health. Sulphur containing feed additives such as coccidiostats, sulfanilamides, sulfaquinoxalines and sulfamethoxazoles could reduce egg laying capacity and weight gain of layer birds (Anonymous, 2011). Similarly long time uses of cloxacin, penicillin, virginiamycin, salinomycin, neomycin, Doxycin and avilamycin in broiler feed could have long term accumulative effect in the body of birds resulting in fever, joint pain, nausea, vomiting, stomach upsetting, diarrhea, rash and hives as humans upon consumption of the meat (Anonymous, 2017). Thus synthetic antibiotic – based feed additives have adverse effects especially when used for long period of time on both the birds and humans. The study was therefore conceived to address this problem by using natural materials as substitutes to the synthetic feed additives.

1.3 JUSTIFICATION FOR THE STUDY

Antibiotic- based poultry feed additives have been commonly used in animal feed for many years because they are well known to improve the efficiency of the birds growth, laying capacity, prevent diseases, feed digestion and improve feed utilization (Sojoudi, Dadashbeiki& Bouyeh, 2012). The use of synthetic antibiotic based poultry feed additives has faced serious criticisms that elicited global concern due to their harmful effects or their side effects on the performance of the birds and human health (Rahmatnejad, Roshanteller, Ahyayerizadeh, Mamooee & Ahyayerizadeh. 2009). These shortcomings lead to the search for alternative substances that eliminate these threats (Manesh, 2012).

Nowadays there is increasing interest in the use of plant based poultry feed additives such as garlic, onion and ginger or their combinations as feed additives in poultry diets to enhance the performance, feed utilization, digestion and disease prevention of poultry birds (Khan *et al.*, 2011). Garlic (*Allium sativum*) has been used as folk medicine for thousands of years in the history of Nigeria. It is best known as a spice and herbal medicine for treatment and prevention of an array of diseases (Aibmoradi, Navidshad, Seifdavati& Royan, 2006). The major active ingredients in garlic are allicin, ajoene, diallypolysulphides, sallykysteine, diallylsulphide, 5methyl – cysteine, sulphoxide and s- allylcysteinesulphoxide (Newall, Anderson & Phillipson, 1996). In view of these properties of garlic, it could be used in the diet of Japanese quails to substitute synthetic antibiotic - based feed additives by improving poultry performance, feed utilization, digestion, and disease prevention. The study was therefore conceived to utilize and determine the effect of garlic varieties as feed additives to substitutes the synthetic feed additives in poultry diets

1.4 OBJECTIVES OF THE STUDY

The objectives of this study were to determine:

1. Growth performance and nutrients digestibility of Japanese quail fed varying levels of two garlic varieties.
2. Haematological and serum biochemicalparametersof Japanese quail fed varying levels of two garlic varieties.

3. Carcass and internal organs characteristics of Japanese quail fed varying levels of two garlic varieties.
4. Egg laying performance and quality parameters of Japanese quail fed varying levels of two garlic varieties.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 QUAIL SCIENTIFIC CLASSIFICATION

Kingdom: Animalia Phylum: Chordata Class: Aves Order: Callifomes Family: Phasianidae, Odontophoridae Genus: Coturnix. Species: *C. japonica* (Banerjee, 2007).

2.2HISTORY AND DOMESTICATION OFJAPANESE QUAIL

The history of domestication of quail in the world has been documented in the literature. It has been reported that during 1250 – 1200 BC, Quails were common birds in Egypt and were used for meat purpose. The history of Japanese quail had its first written record of domestication in Japan (The naturalhabitant is the Islands), dated from the twelfth century. The birds were initially developed for song. It was claimed that a Japanese Emperor obtained relief from tuberculosis after eating quail meat and this led to the selection of domestic quail for meat and egg production in the latter part of the nineteenth century. By 1910, the Japanese quail was widely cultured for meat and eggs in that century (Musa *et al*., 2008). Between 1910 and 1941 the population of Japanese quail increased rapidly in Japan especially in Tokyo, Mishima, Nagoyo, Grifu and Toysehashi areas. The period also represented a time of imperial expansion in Japanese history and domesticated Japanese quail were established in Korea, China, Taiwan and Hong Kong and later spread to South East Asia. In the year 1957, United Kingdom government legalized Japanese quail farming. Due to the multipurpose utility of this species, Japanese quail gained importance and expanded since 1960 in United States of America, Italy, France and Hong Kong. In Italy commercial production started in late fifties and reached a population of 80 million per year (Musa *et al*., 2008).

In Nigeria, Japanese quail (*Coturnix coturnix japonica*) was introduced at National Veterinary Research Institute (NVRI), Vom – Jos Plateau State on 18th December 1992, with the support of Directorate for Food, Road and Rural Infrastructure (DFRRI). Four hundred and fifty fertile quail eggs were imported from Republic of Benin out of which 377 were found suitable for incubation. On candling 160 eggs were discovered infertile. After 17 days of incubation 141 chicks hatched with an average weight of 4.5gm per chick. The low chick weight was later associated with low egg weight due to dehydration as a result of poor handling, storage and the length of time it took before eggs were brought for incubation . These chicks were brooded using a wooden brooder to which four 100 watts electric bulbs were fixed. Water and commercial starter mash were fed *ad – libtum f*or up to 3 weeks of age and replaced with layer mash. At an average weight of 188 gm (at 8 weeks of age) the first egg was dropped at 8 weeks. Production rapidly improved as the first sets of eggs were set after seven days. Thereafter eggs were set on 3- day basis. Subsequent setting from the parents and filial generations led to stock number of 15,000 quail birds and 12,000 eggs in the incubator after five months. The age of lay was found to improve from 8 weeks to 5- 6 weeks with the first 2-3 filial generations, fertility and hatchability also improved from 58 % and 70.5 % respectively. This was probably due to acclimatization of the birds to the environment. More than ten years now, over five hundered thousand quail birds were produced by (NVRI) Vom and distributed to farmers. With vigorous encouragement and support of National Animal Production Research Institute (NAPRI) and Institutes of management, multiplication of quail was intensified and various research studies were undertaken especially in areas of Nutritional, Diseases, Adaptation and Biomedical research. At present quail have been acclimatized and adapted in places like Kano, Benue, Lagos, Oyo, Yobe, Enugu, Akwa Ibom, Kaduna, Kebbi, Borno, Abuja, Niger, Kwara, Jigawa and Plateau states (Musa *et al.*,2008).

2.3 BREEDS OF QUAILS

There are over hundred different species of quail all over the world.The numbers of species kept domestically, commercially or ornamentally are only 22.The most widely domesticated subgroup of the quail family is the cortunix and colinus species. The colinus subgroups made up of the Bobwhite quail have been bred as meat birds and have a body weight of 500 gm Four species are well recognized in the cortunix group, the European quail (*Cortunix cortunix cortunix*), usseri quail (*Cortunix cortunix usseriennsis*), Japanese quail (*Cortunix cortunix japonica*) and Bobwhite (*Colinus virginianus)* (Musa *et al.*, 2008).

2.4 ADVANTAGES OF QUAIL FARMING

Short generation interval: Making it possible to propagate many generations in a year. Early sexual maturity: Quail start laying as early as 5- 6 weeks of age. Fast growth rate: Attain market weight of 150- 180 gm at 6 weeks. High rate of lay: Quail can produce 250- 280 eggs per year (Musa *et al.*, 2008).

2.5 NUTRITIONAL REQUIREMENTS OF QUAIL BIRDS

Quails are primarily seed eaters, although their diet covers a wide range of plant and animal matter. Small hard mast weed seeds, tenders leaves, fleshy fruits, bugs, insects and snail are primary foods consumed throughout the year (Edwin, Lightsey & Maurence, 2001). Some common quail feeds such as plants and insects include lespedeza, beggar weed, corns, partridge pea, cowpea, rag weed milk pea, paspalum, soya bean, dog wood, long leaf pine, lobloky pine corn, beetles (*Heteroligus spp*), grasshopper, cricket, caterpillar and spiders (Maurice and Gerry, 2008).

A standard ration for either growing or breeding quail may not be available commercially. If this is the case, good quality fresh commercial turkey or game bird diets are recommended preferably fed as crumble to minimize feed wastage. For the first 6 weeks quails should be fed a diet containing approximately 25 % protein, about 12.6 mega joules (mj) of metabolisable energy (ME) per kilogram and 1.0 % calcium. A good quality commercial starter ration for game bird or turkeys contains about 25 %- 28 % protein. If this is not available a chicken starter ration (20 %- 22 % crudeprotein) can be used, but the bird will grow more slowly (Maurice and Gerry, 2008). The dietary requirements for birds nearing maturity are similar except that calcium and phosphorus levels must be increased. Shell grit or ground limestone can be added to the diet after 5 weeks of age, or it may be provided separately at free choice. Laying diets should contain about 24 % protein, 11.7 mj of metabolisable energy per kilograms and 2.5 % - 3.0 % calcium. The latter may need to be increased to 3.5 % in hot weather when the birds eat less food but still require calcium to maintain egg production. Adult Japanese quail eat between 14 g to 18 g per day. It is important to obtain fresh feed and it should be stored in covered containers with tightly fitting lids in a clean, dry, cool area free from animals and vermin. Feed stored longer than 8 weeks is subjected to vitamins deterioration and rancidity, especially in hottest months. The paper should be used to cover the brooder house before the arrival of chicks to avoid falling of the feed from the troughs when given to the birds. After about a week when the paper is removed and the chicks have learned to eat the feed in the trough, this reduces wastage and spoilageof the feed (Maurice.and Gerry, 2008).

2.6 FEED ADDITIVES

Feed additives are products used in animal nutrition for the purposes of improving the performance, disease prevention, feed utilization, digestion and quality of feed. They are categorized in to different groupsthese include the following:

2.6.1Antioxidants

Any substance that acts to slow or prevent the oxidation of another chemical. In nutrition, is one of the groups of vitamins tha act against the effect of free radicals. Antioxidants are compounds that prevent oxidative rancidity of polyunsaturated fats. In absence of antioxidants, rancidity causes the destruction of vitamins A, D, E and several of the B complex vitamins (Banerjee, 2007). The products of rancidity breakdownin some cases may react with the epsilon amino groups of lysine and there by decrease the protein and energy values of the diet. Some common antioxidants are BHT (Butylated hydroxitoluene). Santoquin, Ethoxyquin, BHA (Butylated hydroxyanisode). DPPD (Diphcnyl paraphenyl diamine). All are added at 0.01 % level in poultry feed (Banerjee, 2007). All feeds are susceptible to spoilage, but those which are high in fat content are especially proneto oxidationfollowed by rancidity. Most animals will refuse to eat spoiled feed. But when feed is limited, they may consume it and suffer digestive disturbances or disorder. To prevent the oxidation of feeds antioxidants are routinely added to many livestock feeds.

2.6.2 Flavouring Agents

These are feed additives that are supposed to increase palatability and feed intake. There is need for flavoring agents particularly (1) when highly unpalatable; mendicants such as Oxytetracyclin, Oxycin Neocloxin are being administered, (2) during disease infection, (3) when animals are under stress and (4) when a less palatable feed stuff is being used at 0.05 % to poultry diets particularly when less palatable ingredients are used.Poultry nectar; a flavouring agent has been studied initially at Mississippi University (U.S.A.) and proven to give consistent improvement in performance (Resurrection, 2004).

2.6.3Pellet Binders Feed Additives

Pellet binders are products that enhance the texture and firmness of pellet feeds; among them (1) molases or fat are sometimes added to feed as an aid in pelleting as well as a concentrated source of energy (2) guar meal is another example. They should beadded at rate of 2.5 % of the diet.

2.6.4 Additives that Enhance the Colour or Quality of the Poultry Products

Many marketing concerns have "brain washed" consumers into believing that broiler having a deep yellow coloured shank is of top quality. A similar situation exists relative to eggs, in which deep yellow yolks are considered to be highly desirable. Consequently, Xanthophylls are routinely incorporated into broiler feeds. Another synthetic carotinoid, canthaxanthin when added at 2- 10 grams per tonne of feed along with yellow maize and luceme helps to produce orange- yellow colour in the shanks skin of broilers along with yolks. (Banerjee, 2007).

2.6.5 Additives that Facilitate Digestion and Absorption

Grit

Since poultry do not have teeth to facilitate grinding of feed, most grinding takes place in the thick muscled gizzard. Grit is added to supply additional surface area of the feed by grinding those inside the gizzard. Oyster shell and limestone are common grits. Gravel and pebbles have been used successfully as sources of grit (Diez, 2003).

Chelates

Chelating agents, such as EDTA, are sometimes used to increase the availability and absorption of certain minerals in chicks. Zinc absorption is enhanced through addition of EDTA (Banerjee, 2007).

Enzymes

These are complex protein compounds produced in living cells which caused changes in other substances without being changed themselves. They are organic catalysis.For common poultry diets, the enzymes of the digestive system cause normal hydrolysis of the dietary proteins, carbohydrates and fats. Thus no benefit may be expected from the use of enzymes preparation as feed additives unless feed composed of higher amounts of barley, wheat, sunflower, rye, rice bran or oat grains are fed to chickens (Anonymous, 2017). Barley to a large extent than wheat containscompounds named beta-glucans which give viscocity to the contents of the digestive tract. Such viscous material interferes with the activity of all digestive enzymes. Very small concentration of beta-glucans, 0.75 to 1.0 % can produce this effect. The beta- glucanase in the enzyme products by breaking down the beta- glucans, reduces the viscosity of the feed in the digestive tract and thus facilitate the action of natural digestive enzymes. The celluloses in the enzyme products would act on the cellulose present in the cell walls of grain by- products like rice bran, rice polish, wheat bran and other crude fibres present in other feed ingredients in the feed and would improve availability of nutrients from the above listed products. The enzyme preparations which are being marketed are Agrozyme, Diazyme, Zymo-pabst, Porzyme and *Avizyme etc* (Anonymous, 2017).

Probiotics

Probiotics are live cultures of useful bacteria along with medicine in which they were grown. The organisms used are beneficial strains of lactobacillus and streptococcus. The reasoning behind the use of probiotic is that ingestion of these organisms would lend an increase in their number in the digestive tract. Their dominance would reduce the population of undesirable organisms like E. coli and thus save the bird from the toxins that these undesirable organisms produce in the digestive tract (Resurrection, 2004).

Antibiotics

These are substances which are produced by living organisms (moulds, bacteria or green plants) and which have bacteriostatic or bactericidal properties. As early as 1949, it was observed that chickens fed with vegetable protein gained more weight when they were fed antibiotics 5- 10 mg per kg of feed.

The probable modes of action of antibiotics follow:

1. They may spare certain nutrients. Studies in some cases indicated that Antibiotics can replace inadequate intake of certain vitamins and amino acids.

2 May selectively inhibits growth of nutrient- destroying organisms while promoting growth of nutrient producing organisms.

3. They increase feed and /or water intake

4. They may inhibit growth of organisms which produce toxic waste products or toxins.

5. They may kill or inhibit pathogenic organisms. (a) Within the gastrointestinal tract, or (b) systemically.

6. They may improve the digestion and subsequent absorption of certain nutrients. The normal levels of inclusion are 4 gm per tonne of feed for narrow spectrum ,viz. penicillin, streptomycin etc and 10 gms per tonne for the broad spectrum types, viz. tetracyclines, aureomycin etc. Higher levels of antibiotics (50 to 100 grms per tonne) may be used only after the careful consideration of disease level (Anonymous, 2017).

2.6.6 Additives that Improve Metabolism

Hormone:

Hormones are chemicals released by a specific area of the body that are transported to another region within the animal where they elicit a physiological response.

Hormonal preparations are added in the diet of chickens with a view to bring about desirable metabolic changes so that increased of egg production or carcass fat deposition in birds could be achieved. These fall into about following four categories:

(a) Anabolic compounds are chiefly progestrone and related steroids which may stimulate protein metabolism. The objectives are clear but to- date results have not been promising.

(b) Oestrogens in the form of Diethylstilbesterol (DES) were used for several years largely as a subcutaneous important in broiler chicken. It resulted carcass quality having more tender and tastier. However, since hormone residues remain present in carcass, its use in chicken feed is now prohibited in U.S.A.

Dienestrol diacctate is the only feed additive of this type that is currently approved at a level of 0.0023 to 0.0035 percent in the feed for the last 4- 10 weeks to improve the carcass quality of broilers and roasters. The practice must be discontinued at least 48 hours before slaughter. It must not be fed to laying hens or breeding stock (Banerjee, 2007).

(c) Thyroxine and related compounds are reported to stimulate growth and to improve egg production during the later part of the laying year. They are usually given in the form of iodinated casein at levels of 100 to 200 gms per tonne (110 to 220 mg /kg) of feed. Results from the use of iodinated casein have been varied may be due to the differing needs of individual birds. A slight excess dose may bring about moulting and drop in egg production.

2.6.7Additives that Affect Health Status

Antifungal additives: are agents that destroy fungi. Fungi can affect feed intake and subsequent production of toxin through contamination at one or more of four stages in the feeding chain (1) in the field before harvesting (2) during storage (3) at mixing and (4) within the animal itself. Once communicated, fungi can pose problems through the production of toxins, alterations of the chemical composition of the diet, or alterations of metabolic functioning of the animal ingesting or harboring the fungus. (Banerjee, 2007). Production of aflatoxin by Aspergillus flavus is a classical example which is casinogenic (tumor producing). The best method of controlling fungal infestation is to dry all feeds below 12 % moisture. Additionally, mold inhibitors should be added to high moisture feed that are exposed to air during storage. Sodium propionate, sodium benzoate, quaternary ammonium compounds, acetic acid and certain antifungal antibiotics as nystatin or copper sulfate etc are added to concentrate feed to prevent further growth by molds. The toxicity of aflatoxin contaminated feed can also be reduce by irradiation of ultraviolet light or exposed to anhydrous ammonia under pressure (Anonymous, 2017).

Anticoccidial drugs

These are used to control coccidial infections which is a parasitic disease caused by microscopic protozoan organisms known as coccidia, which live in the cells of the intestinal lining of liestock. At least eight species of coccidia affect chickens: Eimeria tenella, E. necatrix, E. maxima, E. acervulina, E. brunetti, E. hagani, E. praecox and E.mites. They are over two dozen coccidiostats combinition commercially available. Bifuran supplements, Amprol. 25 %, Embazin, Zonamix, Nitrofurazone, Furazolidone etc are very common coccidiostats. Most of these inhibit further proliferation of parasites during their sexual cycles. Coccidia tend to develop resistance to coccidiostat to which they are exposed over a long period of time. When resistance forms appear, a change to another coccidiostat will usually restore the disease.

Antihelmintic drugs

Chickens are subjected to infestation with a wide variety of parasites, external and internal. External parasite can be eliminated by use of available insecticides. Likewise intestinal worms can also be killed or expelled by feeding suitable vermifuges (wormers). The four most common internal parasites are large round worms (Ascaris), cecal worms (Heterakis). Capillary worms (Capillaria) and tape worms (Taenia). Of these the large round worms are more easily expelled. Cecal worms, capillary worms and tape worms, in the order given, are less easily expelled. Antihelminties generally require more than one administeration. The first admistration kills those worms which are present in body and subsequent dewormings kill those worms which hatched from eggs after the initial dose (Banerjee, 2007).

2.7 CLASSIFICATION OF GARLIC

Garlic belongs to the Kingdom: Plantae. Clade: Angiosperm / Monocots. Order: Asparagales. Family: Amaryllidaceae. Sub family: Allioideae Genus: Allium. Species: *Allium sativum* (Arora, 1999).

This plant has been used as food and feed additives for both human and livestock in Nigeria

2.8. USE OF GARLIC IN POULTRY DIET

2.8.1Immuno- Modulating Effects of Garlic

The immune system of poultry can be broadly divided in to two categories namely, the lymphoid and non – lymphoid system, bursa of fabricius and thymus are considered to be the primary lymphoid organs, where as spleen is usually termed as secondary lymphoid organ, The non – lymphoid parts of the immune system include cells that provide a non – specific immunological defense of the host. Blood monocytes and tissue macrophages are unique due to their ubiquitous distribution throughout the body fluids, organ and cavities (Khan, Naz, Tufarelli, Selvaaggi & Laudadio, 2011b). Recently, (Zialarimi, Naginnand & Arab, 2011), found that aqueous extract of garlic was more effective in inhibiting *E. coli* culture than mint (*Menthe spp*) and onion (*Allium cepa*) in broiler chicks, suggesting the role of garlic in suppressing pathogenic bacteria in broiler chicks. (Szigeti, Palfi, Nagy (…) & Raduanyi ,1998), found that a product containing garlic, acidifers and bacteria cell extracts enhances antibody production against NDV, whereas (*Jafari,* Razi, Ghorbanpoor & Marashan, 2008), reported that supplementing broiler with garlic (1 or 3 %) does not have any beneficial effect on antibody production. Hanieh *et al.* (2010), found that feeding garlic at the level of 10 g/kg diet enhanced titre rate against NDV in white leghorn chickens, although such effect were not recorded when the dose was as high as 30 g/kg. In the same line (Dorhoi, Dobrean, Zahran & Virag, 2006) observed that macro phage engulfing RBC percentage was higher when the laying hen were supplemented with 50 ug/ml of garlic and the engulfment was low when the dose was increased to 200 ug/ml. Recently,(Nidaullah, Durrani, Ahmad, Jan & Gul, 2010) found that a plant mixture containing garlic at the level of 4 g produced better antibody response against NDV and IBD in broiler chicks (Rahimi, Zadeh, Karimi, Omidbaigi & Rokni, 2011) found that 0.1 % garlic in the diet of broilers improved antibody response against sheep RBC and NDV, increased bursa of fabricious weight spleen weight and Augmented hypersensitivity coetaneous baso philic response . (Dorhoi *et al*., 2006), reported that garlic supplemented birds had heavier spleen and thymus weight and white blood cell (WBC) count. The increase in the weight of the spleen and thymus are attributed to the enhanced lymphocyte proliferation and the increase in the WBC productions. (Pourali *et al*., 2010) showed that different concentration of garlic powder improved antibody titre against NDV virus at 14th day of age. (Hanieh *et al.*, 2010), suggested that the immuno – modulating effect of garlic is associated with it ability to enhanced phagocytosis of peritoneal macrophages, increased production of interleukins, interferon (INF-Y) and turmour necrosis factors (TNF – a) secretary metabolism of macrophages antigen presenting cells nd antioxidant function of this plant.(Mohibbifar and Torki, 2011), demonsrated that adding 0 % or 2 g/kg garlic in the basal feed of Ross broilers did not affect the heterophil, lymphocyte, monocytes, eosinophil, basophil and heterophil to eosinophil ratio nor the serum antibody against NDV was positively changed. The discrepancies observed in the results are likely related to the preparation methods of garlic. In addition, the experimental design and dose of garlic used have a great deal in the differences of the results of immune function. (Hanieh *et al*., 2010).

2.8.2 <u>Anti – Cholesteremic Effect of Garlic</u>

In the scientific literature, the hypolipidic and hypocholesterolimic effects of garlic are well documented (Ahsan- ul – Haq *et al*., 1999), reported that feeding garlic at the rate of 20 g/kg decreased blood cholesterol significantly in broiler chicks. Egg yolk cholesterol of laying hens decreased significantly in birds supplemented with 1 and 2 % garlic powder (Canogullari, Bayland, Erdogan, Duzguner & Kukukgul, 2010).

Chowdhury, Chowdhury and Smith (2002) concluded that cholesterol concentration per gram of yolk decrased linearly with increasing levels of sun- dried dietary garlic paste.Recently, in the study of (Canogullary *et al*., 2010), garlic powder at the rate of 1, 2 and 4 % were found to reduced total lipid concentration and total triglyceride level was reduced by garlic powder supplementation at the levels of 1 and 2 % garlic in laying hens (Azeke and Ekpo, 2008). Similarly, (Yalcin, Onbasilar, Reisli & Yalcin, 2006), reported a significantdecrease in plasma triglycerides with the supplementation of garlic powder (Youn, Blot & Chang, 1996) concluded that serum triglyceride was lowered by supplementing garlic powder to the diet. (Horton, Anjum & Sardar, 1991), found that broilers fed garlic at 10,000m g/kg reduced plasma cholesterol in 35days treatment. Publication by Qureshi *et al* .(1983b), documented that the serum cholesterol concentration in white leghorn pullets was reduced from 20 to 25 % using supplements of garlic paste, solvent extracted from garlic paste and commercial garlic oil (Canogullari *et al*., 2010), found that 1, 2 and 4 % garlic powder increased high density lipoprotien (HDL) cholesterol in laying quails. However, (Lim *et al*., 2006), did not found any difference in HDL – cholesterol concenteration by feeding garlic (1, 3 and 5 %). Qureshi *et al*. (1983b), reported a 28 – 41 % reduction in a low density lipoprotein (LDL) cholesterol in an experimental diet containing 3.8 % garlic paste or solvent extract of garlic paste, the residue or commercial garlic oil fed for four weeks. Recently, (Mansoub, 2011), reported reduction in total cholesterol LDL – cholesterol and triglycerides when broilers were supplemented with 1 g/kg garlic.(Prasad, Ross, Anderson & Torki, 2009), observed that total cholesterol triglycerides, LDL and very low density lipoprotein (VLDL) were significantly decreases, while HDL was significantly increased by garlic supplementation in chicken up to eight (8) weeks of age in comparison to control group. (Rahimi *et a*l., 2011), noted that supplementation of 0.1 % garlic decreased cholesterol, triglycerides and LDL cholesterol but increased HDL level. Recently, (Rahman, Durrani, Chand, Khan & Rehman, 2011), noted that a mixture of plants containing garlic as an active ingredient improved the cholesterol profile in terms of cholesterol ,triglyceride, LDL cholesterol VLDL cholesterol, total cholesterol to HDL ratio, LDL to HDL ratio, VLDL to HDL ratio in broiler chicken serum. (Konjufea, Pesti & Bakalli, 1997), conducted an experiment on male Ross 208 which were fed basal diet supplemented with 1.5, 3.0 or 4.5 % commercial garlic powder from hatching to 21 days of age, and found that powder resulted in reduced level of plasma cholesterol, liver cholesterol, breast and thigh muscle cholesterol. Allicin has been proposed as active compound in garlic responsible for health promotion and hypocholesterollaemic benefits (Lawson, 1998). In terms of the mechanism of action it is believed to reduce cholesterol synthesis and platelet aggregation and prevent thrombosis (Canogullari *et al*., 2010). Allicin is a volatile organic compound which has been shown to reduce serum lipids, phospholipids and total cholesterol and suppress cholesterol synthesis in chickens (Horton *et al*., 1991). According to (Mahmoud, Saad, Gharaibeh, Zakaria & Amer, 2010), the difference in the results may be due to allicin degradation as it is an unstable compound and poorly absorbed from the gut, additionally, they suggested that the garlic preparation that involved hearting or solvent processes may destroy active allicin

2.8.3 Anti- Microbial Activity of Garlic

Several studies have pointed out the possibility to use essential oils and or their compounds for medical purposes as well as in the food industry for controlling microorganisms responsible for food spoilage (Cantore, Ferre, Kamel & Suzuki,2009). Today we know that the essential oils and plant extracts have broad activity against the Gram – positive and Gram – negative bacteria and also antifungal activity (Kotzekidou, Gupta, Khara & Wilsons, 2008). Garlic oil has antimicrobial activities (Feldberg, Shukla & Nagini, 1988) and a highdose of garlic could have detrimental effects on ruminal fermentation. For instance, (Banquet, Calsamigia, Ferret, Cardozo, & Kamel, 2005), reported that the molar proportion of acetate was reduced by 11 % and NDF digestibility was decreased by 22 % when 312 mg of garlic was added to invitro batch culture rumen fermentation at a constant PH (Banquet, *et al*., 2005). Several studies have suggested that essential oils may be conserves of degradation of amino acid (AA) in rumen by inhibiting microbial deamination (Newbold, Mcinotch, Williams, Losa & Wallace, 2004). Antibacterial properties of garlic and onion were described by Louis Pasteur. The sulphur – containing compounds from these plants act against both gram positive and gram negative bacterial (Carson, 1987). The extracts of garlic and onion are known to inhibit growth of many pathogenic fungi belonging to Aspergillus, candida and other species (Carson, 1987).

2.8.4 <u>Hypolipidemic/ Hypocholesterolemic Effect of Garlic</u>

A recent review (Srinivasan, 2004).Showed the spices Fenugreek, red pepper, nurmeric, garlic, onion and ginger were found to be effective as hypocholesterolemic agents under various conditions of experimentally induced hyperchoesterolemia/ hyperlipemia. Furthermore, Fenugreek, onion and garlic are effective in human with hyperlipemic condition. Curcumin and capsaicin, the active principles of turmeric and red peper, respectively are also effective at doses comparable to calculated human daily intake. Turmeric and curcumin showed excellent hypocholesteremic effect in experimental animals. However, endogenous cholesterol synthesis was not affected. Extracts of garlic and onion inhibit platelet aggregation and lower cholesterol levels.

The raw form is more effective than the cooked form. About 50 g of onion and garlic corresponding to 5- 6 cloves per day may be adequate to bring these beneficial effects. Other work also documents hypo- cholesterolemic effects of spices. Fenugreek seeds were hypocholesterolemic in rat with hyperlipidemia induced by either high fat or high cholesterol diet. (Sharma, 1984, 1986). Defatted fenugreek seed was effective in diabettic hyper- cholesterolemia in dog (Valette, Sauvaire, Baccon & Ribes, 1984) in resent study, dietary supplementation aged garlic extract showed better beneficial effects relative to flesh garlic on the lipid profile and blood pressure of moderately hyper cholesterolemic subjects (Steiner, Khan, Holbert & Lin, 1996). In another study, (Adler and Holub, 1997), garlic supplementation significantly decreased both total and LDL cholesterol in hyper cholesterolemic subjects. Co – administration of garlic with fish oil had a better beneficial effect on serum lipid and lipoprotein concentrations by providing a combined lowering of total cholesterol LDL. Cholesterol and Triglyceride concentration as well as the rations of total cholesterol to HDL cholesterol. According to (Lin, 1994), the ant plateletadhesion and the anti proliferation properties of aged garlic extracts appear to contribute more to cardiovascular protection than do the hypolipolemic properties. Apart from the hypo cholesterolemic effect on overall lipid metabolism under different conditions of lipmia has also been reported.

2.8.5 Antidiabetic Potential of Garlic

Garlic, onion and other spices that have been widely used for their anti-diabetic potential, both spices were shown to be hypoglycemic in different diabetic animal models and in limited human traits. The hypoglycemic potency of garlic and onion has been attributed to the sulphur compounds, namelydi (2- propenyl) disulphide and 2- propenylpropyl disulphide, respectively (Kumudkumari, Fakler, Framk &

Chandrasek, 1995; Augusti and Sheefa, 1996). Animal studies indicated that the isolated compounds possess as much as 60- 90 % of the hypoglycemic action probably involves direct or indirect stimulation of secretion of insulin by the pancreas. In addition, it is also suggested that these disulphide compounds have insulin – sparing effect by protecting – SH inactivation by reacting with endogenous thiol – containing molecules such as cysteine, glutathione and serum albumins (Srinivasan, 2004).

2.8.6Anti- Hypertensive Activity of Garlic

Garlic *Allium sativum* is reported to have many biological activities, including protective role in cardiovascular function (Mukhaerjee *et al*., 2009) as an antihypertensive (Ried *et al*., 2008). Allicin a major constituent of garlic was evaluated for its antihypertensive effects. Chronic oral administration of allicin lowered blood pressure in hypertensive rats (Ali *et al*., 2000). Allicin also caused pulmunary vasodilation in lung at rat (Kin- Park and KU, 2000).

2.8.7 Antioxidation Activity of Garlic

It has been reported that garlic and garlic extracts, through their antioxidant activities prevent free radical damage in the body. (Chung, 2006) investigated antioxidant properties of garlic compounds (Alliin, Allylcysteine, Allyl Disulphide and Allicin) prepared by chemical synthesis or purification. Allicin scavenge superoxide, Allicin suppresses the formation of superoxide by the xanthine oxidase system, likely through thiol exchange mechanism. Garlic compounds such as Allicin, Allyl cysteine and allyl disulphide scavenge hydroxyl radicals. Allicin and ally cysteine did not prevent microsomal lipid peroxidation but allicin and allycysteine were scourer of hydroxyl and allydisulphide were a lipid peroxidation terminators. In summary, ally disulphide, allicin, allicin and allyl cysteine indicates diffent patterns of antioxidants as protective compounds against free radicals damage (Chung, 2006).

2.8.8 Digestive Stimulant Action of Garlic

Spices are well recognized to stimulate gastric function. They are generally believed to intensify salivary flow and gastric juice secretion and hence, aid in digestion (Glatzel, 1968). Animal studies have revealed that a good number of spices, when consumed through diet, bring about an enhanced secretion of bile with a higher bile acid content, which play a vital role in fat digestion and absorption (Bhat, Srinivasan, Chandrasek & Hara, 1984, 1985: Sambaiah and Srinivasan, 1991; Platel and Srinivasan, 2000). Spices that stimulate bile acid production by the liver and its secretion into bile include curcumin (Turmeric), capsaicin (red pepper), ginger, cumin, coriander, Ajowen, fenugreek, mustard, onion and tamarind. Spices such as curcumin, capsaicin, piperine, ginger and mint have also been shown to stimulate pancreatic digestive enzymes like lipase, amylase, trypsin and chymotrypsin, which play crucial role in food digestion. A few spices have been shown to have beneficial effect on the terminal digestive enzymes of small intestinal mucosa (Platel and Srinivasan, 1996, 2000,). Thus, many of the common spices act as digestive stimulants by enhancing biliary secretion of bile acids, which are vital for fat digestion and absorption, and by stimulating the activities of pancreatic and intestinal enzymes involved in digestion.

2.8.9 Anti-Mutagenic and Anti- Carcinogenic Property of Garlic

Garlic is yet another spice widely studied in recent years for its chemo preventive potential. Epidemiological studies have shown that higher intake of allium products is associated with reduced risk of several types of cancers, especially stomach colon and rectal (Fleischauer and Arab, 2001). These epidemiological findings are well correlated with several laboratory investigations. Several mechanisms have been proposed to explain the cancer – preventive effects of garlic and its organosulphur compounds. As recently reviewed (Sengupta, Ghosh & Bhasttacharjee, 2004). Suggested mechanisms include inhibition of mutagenesis, modulation enzymes activities that suppress bioactivationof carsinogen molecules, inhibition of carcinogen-DNA adducts formation, free radical scavenging inhibitory effects on cell proliferation and turmo growth, and induction of a large apoptosis. Although there is a large body of evidence supporting these mechanisms, they are still speculative and further research is needed to support causality between such properties and cancer preventive activity in experimental animals.

2.9 VITAMIN REQUIREMENT OF QUAIL BIRDS

Housed quails are entirely dependent on the vitamins that are present in their compounded feed in the correct amount and proportion, for they have no access to the natural supply of these nutrients. Vitamins are only needed in small amounts and are needed by chickens for optimum growth (Martina, 1996). According to report from NRC (1994). Vitamins are always added to feed in amounts that meet minimum dietary requirements, during period of stress caused by diseases, shipping or sudden changes in the environment, it is recommended that vitamins and electrolytes be provided in the drinking water until the stress condition is corrected. The principal vitamins functions and requirement are as follows:

The principal feature of vitamin A is its function in ensuring adequate growth and as a means of assisting in the birds resistance to diease. Vitamin A is essential for normal vision, egg production and reproduction. NRC (1994) recomended 1650 IU per kg vitamin A for starter and grower birds 3300 IU for breeding purpose.

A deficiency of vitamin E causes a disease of the nervous system in chicken known as crazy chick disease (encephalomalacia). Vitamin E is also essential to breeding stock for good hatchability of their eggs. According to Shim and Bocy (1988). The fertility and hatchability of chicken eggs were severely depressed after the birds were fed a vocational diet containing glucose and soybean meal, but deficient in vitamin Efor 20 weeks.

Vitamin B is well distributed in cereals and grains deficiencies are normally unlikely to occur. The main functions of B vitamins are they assist the chicken in achieving its optimum growth.

Vitamins D exist in two forms (D2 Ergocalciferol and D3 Cholecalciferol). Vitamin D2 can be synthesized in the skin of birds from precursors when the birds are exposed to the sun. However, when birds are kept under intensive condition some form of supplementations are essential. These can be provided by addition of fish- oils to the diet or provided by a dry synthetic preparation. Synthetic vitamin D should be given to birds in form of D3 in feed formulation because birds use D3 more efficiently than D2 (Shim and Boecy, 1988).

2.10 MINERAL REQUIREMENT OF QUAIL BIRDS

Minerals are the inorganic elements remaining when the feedstuff is burned. Calcium and phosphorus account for about 78 % of the total mineral content of ash. (Dozier and Brandwell, 2002 and Luckstadt, Senkoylu, Akyurek & Agma, 2004) investigated the effects of dietary concentration of manganese in relation to that of calcium on growing performance of broiler chickens and reported 0.8 % calcium and 60 mg/kg manganese for optimum growth, feed efficiency, tibia weight, bone, ash and serum calcium and phosphorus.

Meanwhile, Srinivasan and Shukla, (1993), found that fertility was not related to the dietary manganese or zinc concentration; chicks require high levels of minerals for proper bone formation and development.

2.11WATER REQUIREMENT OF QUAIL BIRDS

The bird's body is made up of 60- 70 % water. They must be supplied with clean water at all times. They will die faster from lack of water than lack of feed. (Gefu, Rabinson, Li, & Ozkan, 2000). Lacks of water for an extended period will results in reduced feed intake, decreased and subsequently stoppage in egg production and weight loss. Mortality may result if the birds are starved of water on a very hot day (Atteh, 2004). Daily water intake will vary according to level of feeding consumption, type of feed, house temperature, physiological activities (e.g. egg laying) and consumption of salt.

Table 1: Average Daily Consumption of Water Per 1,000 Chickens

Age in week	Litres
0- 4	20-90
5- 8	90- 160
9- 12	160- 180
13- 16	180- 220
17- 20	220- 250
Adults	250- 315

Source (Musa *et al*., 2008)

Water is the most important nutrient for the overall health and performance of commercial broilers. It plays an essential role in every aspect of metabolism and is critical to the regulation of the bird's body temperature, food digestion and waste elimination. By weight, broiler consumes about 18 pounds of water, compared to approximately 10 pounds of feed (Lacy, 2002). Broiler water intake is directly related to a variety of factors, including water quality (Barton, 1996) and diet composition (Belay and Teeter, 1993). However, perhaps the most important factor affecting broiler water intake patterns is environmental temperature. Water evaporation through the respiratory system (panting) is one of the main ways birds regulate body temperature during heat stress conditions. Broilers increase water consumption approximately seven percent for each degree increase in temperature (Fairehild and Riz, 2012). Taste can have a big impact on water consumption in broiler. However, unlike most animal species, chicken's taste buds, for the most part, are not on the tongue. Taste buds in the chickens are distributed primarily on the back of the roof of the mouth, with only two to four percent located on the tongue (Ganchrow and Ganchrow, 1985). In addition to taste, water temperature plays a major role on water intake in birds. Birds will drink cold water that is near freezing in temperature. However, they will suffer from extreme thirst rather than drink water that is a degree or too above their body temperature (Jones and Watkins, 2009). As long as water temperature is below body temperature the bird receives some benefit from drinking because it helps with heat dissipation and body temperature regulation (Kare, 1970).

Water, in addition to being a vital nutrient, is involved in many aspects of poultry metabolism including body temperature control, digestion and absorption of food, transport of nutrients and the elimination of water products, via urine, from the body (Jafari, Fazlara & Govahi, 2006). Increasing dietary salt increases water consumption (Marks, 1987), whilst increasing the level of crude protein in the diet increases water intake and water. Feed rations (Marks and Pesti, 1984). Viera and Lima (2005) concluded that birds fed an all vegetarian diet had a higher water intake and produced more excreta which had an increased moisture content. It was identified in the Viera and Lima study that the levels of potassium were 20 % higher in avegetarian diet than in a diet which includes animal by- products. A vegetarian diet also increased total amount of excreta produced per bird by 18 % (Manning, Chadd & Berings, 2007). Research has demonstrated that there is a relationship between feed and water consumption; Further it has been argued that water consumption increases by 6 % for every 1 ^{0}C rise in temperature from 2O ^{0}C where it approximates to 1.8 - 2.0 times feed quantity and that feed intake is reduced by 1.23 % for every 1 ^{0}C rise in temperature and by 5 % for every 1 ^{0}C rise between 32- 38 ^{0}C (Singleton, 2004).

2.12 NUTRIENTS DIGESTIBILITY

Japanese quails are hardy birds that thrive in cages. They have less feed requirement of about 20- 25 g feed per day compared to chicken that requires 120- 130 g per day. Japanese quail attains market weight of 140- 180 g between 5 - 8 weeks of age and a high rate of egg production between 180 - 250 (Garwood and Diehi, 1987; Shwartz and Allen, 1981) and 200 - 300 eggs in the first year of lay (NRC, 1991). Animal studies have revealed that a good number of spices, when consumed through diet, bring about an enhanced secretion of bile with ahigher bile acid content which plays a vital role in fat digestion and absorption (Bhat *et al,* 1984,1985; Sambaiah and Srinivasan, 1991; Platel and Srinivasan, 2000). A few spices have been shown to have beneficial effect on the terminal digestive enzymes of small intestinal mucosa (Platel and Srinivasan, 1996, 2000). Thus, many of the common spices act as digestive stimulants by enhancing biliary secretion of bile acids, which are vital for fat digestion, absorption and by stimulating the activities of pancreatic and intestinal enzymes involved in digestion. Alteration in digesta properties may reduce nutrient digestibility, absorption and impairing animal development (Adrizal and Ohtani, 2000; Conte, Texeira & Fialho, 2003).

2.13 EFFECT OF GARLIC ON QUAIL PERFORMANCE

Numerous reports have been published, advocating the beneficial effects of garlic on feed efficiency and growth of broiler chickens. According to (Mansoub, 2011), feed conversion ratio (FCR) and body weight (BW) of broilers were improved when they were fed garlic (1g/kg) in the basal diet. Aji *et al.* (2011), reported that administration of 100 mg of garlic resulted in improved body weight gain at 7, 14 and 21 days of treatment in broiler chicken, although feed intake, FCR and carcass yield did not change, (Kumar *et al.*, 2010), found that a garlic supplemented diet (250 ppm) significantly increased the body weight gain of broiler chickens in a 42 days trial. In the same year, (Pourali *et al.*, 2010), reported that garlic powder improved average daily feed intake, body weight, FCR, performance index as well as survibility. (Mahmood, Hassan, Alam & Ahmad, 2009).Concluded that a basal feed containing 0.5 % garlic improved FCR and body weight gain in broilers but failed to produce positive effects on carcass yield in term of dressing percentage, relative weight of heart, gizzard, liver, spleen and pancrease. (Javed *et al.*, 2009), found feed intake, FCR, body weight and carcass quality (dressing percentage, breast weight and leg weight) were improved in a 35 days experimental trial, when broilers were supplemented (at a rate of 10 ml/litre of drinking water) with an aqueous extract of medicinal plants containing garlic.

2.14 BENEFITS OF MEASURING HAEMATOLOGICAL PARAMETERS IN POULTRY PRODUCTION

Measurement of haematological parameters provides valuable information which are routinely used in human‘s and veterinary medicines, but unfortunately due lack of information, blood profile have not been widely used in avian medicine (Mushi, Binta, Chabo & Nelebele, 1999). The evaluation of the levels of total protein and its fractions supply the information required to interpret the occurrence of dehydration, infections, immune diseases and inflammatory responses. The determination of blood component values using laboratory exams is an important procedure to aid the diagnosis of several diseases and dysfunctions, as they provide reliable results and many also give inputs for research studies on nutrition, physiology and pathology (Bounous, Wyaatt, Gibbs, Kilburn & Quist, 2000). Although there is limited information concerning the normal blood profiles of different broiler strains at different ages. However, some hematological studies in birds have been carried out by a number of authors and a few hematological parameters of some broiler strains (Lohmann, Hubbard and Abor- Acres) at very limited age of husbandry period have been studied (Qaisar, Hur, Razvi & Iqbal, 1996).

The loss of cell membrane integrity caused by hypoxia or traumatism causes enzymes to leak to the extracellular fluid, where they are measured, allowing to determine the degree of cell or tissue lesions. Therefore, intensive poultry husbandry system have provided a suitable atmosphere for using reference blood profiles of broiler chickens world- wide for interpretation of hematological analyses in regards to immunological status of birds (Scheele *et al*., 2003a), predicting potential resistance to environmental conditions (Silversides, Lefrancois & Villenuve, 1997), estimation of body weights in future diagnosis of diseases (Latimer, Tang & Goodwin, 1988), evaluation of health disorders already at the preclinical sage (Harper and Lowe, 1998), developing new broiler strains that generally resistant to poultry diseases (Samantas, Haldar & Ghosh, 2010) and hash environmental conditions (Silversides *et al*., 1997). Since the white blood cells in the avian species, in general, serve phagocytic function similar to their mammalian counterparts (Campbell and Coles, 1986).

One must have considered that blood components may be influenced by physiological factors, such as age, species and by pathological factors (Szabo *et al.,* 2005; Lioyd and Gibson, 2006). Available information indicate that haematological values of avian species are also significantly influenced by poultry diseases including fowl typhoid (Kokosharov and Todorova, 1987), mycoplasmosis (Branton *et al*., 1997; Burham, Peebles, Branton, Jones & Gelurd, 2003), avian coccidiosis (Koinaski, Biyse & Cabaner, 2001), infectious bursal disease (Panigraphy, Rowe & Corrier, 1986; Juranova, Ngo, Kulikova & Jurajda, 2001), Newcastle disease (Galindo- Muniz *et al*., 2001) and toxoplasmosis (Kaneto*et al*., 1997). On the other hand the intensive husbandry system of poultry industry excludes the most effective factors in alternation of blood parameters values by offering almost the same husbandry condition and nearly same dietary programs using the nutrients which are available world- wide. Hematological parameters contents observed in these genetically improved broiler strains were lower than those reported for indigenous chickens (Sturki, 1986; Uko and Ataja, 1996b; Mushi et al., 1999; Iheukwumere and Herbert, 2003), indicated that blood profiles varied among different breeds and while haemogram of these strains remained almost unchanged there is difference in leukogram of genetically developed strains with indigenous chickens as previously described (Islam*et al*., 2004). Avian blood differs in cell characteristics from their mammalian counterpart (Smith, West & Jones, 2000). Several factors including physiological and environmental conditions (Vecerek, Strakovo, Suchy & Voslarova, 2002), fasting, age, administration of drugs, anti- aflatoxin premixes and continuoussupplementations of vitamin E affect the blood profiles of healthy birds (Oguz, Kececi, Birdane,Onder & Kurtaghi, 2000).

2.15 SERUM BIOCHEMICAL REFERENCE VALUES OF JAPANESE QUAILS

Serum biochemical reference values may provide useful information about the physical condition of individuals, making them a useful tool in differentiating normal on healthy animals from abnormal or diseased states. For Japanese quail that are used for producing eggs and meat for human consumption and also as a laboratory animals. Clinical chemistry data (albumin, total protein, glucose, uric acid, cholesterol, bilirubin, cholinesterase, createnine, triglycerides, alanine aminotransferase, aspartate amino transferase and y- glutamyltransferase) in the blood serum are used for determining the condition of the animal. (Adler and Holub, 1997), garlic supplementation significantly decreased both total and LDL cholesterol in hyper choleserolemic subjects. Garlic had a better beneficial effect on serum lipid and lipoprotein concentration by providing a combined lowering of total cholesterol, LDL cholesterol and Triglyceride concentration. According to (Lin, 1994), the antiplatelet aggregation, the antiplatelet adhesion and the anti proliferation properties of aged garlic extracts appear to contribute more to cardiovascular protection than do the hypolipodemic properties. Allicin is a volatile organic compound which has been shown to reduce serum lipids, phospholipids and total cholesterol and suppress cholesterol synthesis in chickens (Horton *et al*., 1991). Garlic depresses lipogenic and cholesterolgenic activities of liver enzymes such as malic enzymes, fatty acid synthase, glucose- 6- phosphate dehydrogenases and 3- hydroxyl – 3 – methyl – glutaaryyl – coA (HMG- coA) reductase (Qureshi *et al*., 1983, 1983, Youn *et al.*, 1996). Garlic powder reduced theactivities of HMG –coA reductase and cholesterol 7a – hydroylase by 40 %. Allicin has been proposed as the active compound in garlic responsible for health promotion and hypocholesterolaemic benefits (Lawson, 1998). Garlic prevents thrombosis (Canogullari *et al*., 2010).

2.16 EFFECT OF GARLIC ON MICROORGANISMS

Microorganisms can be classified into five biological types such as protozoa, algae, viruses, microscopic fungi (moulds and yeasts) and bacteria (Banerjee, 2007). This list classified microorganisms according to their structure, it is sometimes more convenient to classify them according to their role in relation to human beings. In this functional classification there are four groups which include pathogens, spoilage organisms, beneficial organisms and inert organisms (Banerjee, 2007). Bacteria are very important group of microorganisms because of both their harmful and their beneficial effects. They are widely distributed in the environment. They are found in air, water, soil, intestine of animals, on the moist linings of the mouth, nose, throat, and surface of all animal and plant body (Banerjee, 2007). Bacteria produce a variety of substances as a result of their metabolisms some of these substances are harmful to man and animal and are known as toxins (i.e poisons) and are of two types endo toxins and exotoxins. Endotoxins are produced within the bacterial cell and are not released in to the body until the cell dies. Therefore they tend to have a localized effect and usually cause harm in the region of the body where the bacteria are living. Exotoxins are produced by bacteria and secreted in to the surrounding. The toxin may act in the area around the bacteria but after it is carried by the blood stream to produce its harmful effect in another part of the body. It is not necessary to ingest living bacteria, the illness is caused bythe toxin alone. Some types of food poisoning illnesses are caused by eating a food containing an exotoxin which has survived even though the bacteria which produced it have died (Banerjee, 2007). Generally microorganims causes a variety of diseases on poultry such as coccidiosis, Newcastle disease (ND), infectious bursal disease (IBD), salmonellosis, fowl cholera and others (Musa *et al.*, 2008). Several studies have pointed out the possibility to use garlic oils

/or their compounds for medical purposes as well as in the food industry for controlling microorganisms resposible for spoilage (Cantore *et al*., 2009). Today we know that the garlic oils and plant extracts have broad activities against the Gram positive and Gram negative bacteria and also antifungal activity (Kotzekidow *et al*., 2008).The extracts of garlic and onion are known to inhibit growth of many pathogenic fungi belonging to Aspergillus, Candida and other species (Carson, 1987).

2.17 EFFECT OF GARLIC ON EGG PERFORMANCE

Generally the female quail lays up to 300 eggs a year. Our experience in Vom shows that quail kept under tropical condition can produce between 215 – 235 eggs a year (Musa *et al*., 2008). Quail matured at six weeks and it is capable of producing up to 300 – 350 eggs in a year averaging about7.5 g–11 g weight per egg. For these reason, the quail is a useful species for increasing animal protein intake (Oluyemi and Roberts, 2007). (Khan, Sardau & Anjum, 2007), reported that egg production increased during the six weeks in which 0, 2, 6 or 8 % garlic was fed to laying hen. (Canogullari *et al*., 2010), demonstrated that egg production increased significantly by adding 1 % garlic powder in the feed of the laying hen although egg weight, yolk index, shell weight, shell thickness and yolk weight did not change. (Khan, Hassan, Sardau & Anjum, 2008) concluded that feeding 8 % dried garlic powder may result in better egg production in Densi laying hens, with no effect in egg mass and egg weight.

2.18 EFFECT OF GARLIC ON EGG QUALITY CHARACTERISTICS

The improvement in the egg quality is of paramount importance in the field of production and management (Mahmoud *et al*., 2010). There is a dearth literature available concerning the beneficial effects of garlic on egg quality. For example (Yalcin *et al*., 2006), found that egg weight increased when laying hen were fed 5 and

10g/kg garlic powder. (Lim, You, An & Kang, 2006) concluded that with increasing dietary garlic powder, the Haugh unit increased linearly after two weeks (Chowdhury *et al*., 2002) also reported that yolk weight responded in a quadratic manner to increasing level of sun – dried dietary garlic paste. According to (Mahmoud *et al*., 2010), egg albumin, yolk and shell weight as well as albumin height and haugh unit were improved when laying hens were supplemented with 0.25, 0.50 and 1 % garlic juice.

2.19 EFFECT OF GARLIC ON CARCASS EVALUATION

Javed *et al*., (2009), found that feed intake, FCR, body weight and carcass quality (dressing percentage, breast weight and leg weight) were improved in a 35 days experimental trial, when broilers were supplemented at the rate of 10 ml/litre of drinking water with an aqueous extract of medicinal plants containing garlic. (Ashayerizadeh, Dasterand & Shargh, 2009), demonstrated that garlic powder added to broiler feed had a significant effect on carcass yield, but feed intake efficiency body weight, thigh and breast weight did not change, althoughabdominal fat percentage decreased in garlic supplemented birds.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 EXPERIMENTAL SITE

The feeding trial was conducted at Abu Rukayya Farm located at Kwarinbarka opposite Sharada industrial Estate Phase 2, Kumbotso Local Government Area, Kano State. The area lies between longitude (11^0 57’ 9. 870” North) and latitude (8^0 30’ 16. 080” East). The State lies between longitude 9^0 30’ and 12^0 30’ North and latitude 9^0 30’ and 8^0 42’ East The area is characterized by tropical wet and dry climate. Kano state has three types of vegetation; in the extreme south is the Northern Guinea savannah, in the central part lies the Sudan savannah and strip of Sahelian vegetation belt is found in the extreme north part of the state. The vegetation type is composed of variety of trees, grasses and shrubs scattered over an expanse of grassland. Kano received an average of 690 mm of precipitation per year, the bulk of which falls from June to September. The temperature both on diurnal and annual range is slightly above 30^0C (K-SEEDS, 2004). The climatic conditions are suitable for livestock rearing. These include ruminants and non ruminants (wild and domesticated animals).

3.2 EXPERIMENT I:

3.3 SOURCE AND PROCESSING OF GARLIC

Two local varieties of garlic, Ex-Kofa (*Yar kofa*) and Ex-Lugu (*Yar sokoto* or *Yar lugu*) were purchased from kofa market in Bebeji Local Government Area of Kano State and Lugu market in Wurno Local Government Area of Sokoto state, respectively. The two varieties of garlic bulbs were sliced and dried under shed for 4 weeks and milled with grinding machine before being incorporated into the experimental diets.

3.4 SOURCE OF EXPERIMENTAL BIRDS

A total of nine hundred and sixty (960) day-old Japanese quail chicks were sourced from the National Veterinary Research Institute (NVRI) VOM, Plateau State, Nigeria and used for the experiment I which ran for 4 weeks.

3.5TEST INGREDIENTS (EX-KOFA AND EX-LUGU GARLIC VARIETIES)

Ex-Kofa and Ex-Lugu garlic powder were incorporated at 0, 2, 4 and 6 % in the diets as feed additives.

Table 2. Descrption of Test Ingredients Levels of Inclusion (2, 4 and 6 %)

Diet	Level of inclution (%)	Garlic Varieties
1	0	EX- Kofa
2	2	EX- Kofa
3	4	EX- Kofa
4	6	EX- Kofa
5	0	EX- Lugu
6	2	EX- Lugu
7	4	EX- Lugu
8	6	EX- Lugu

3.6 EXPERIMENTAL DESIGN AND TREATMENTS

The experiment was carried out in a 2 x 4 factorial arrangement in completely Randomized design (CRD). There were eight (8) treatments, four (4) inclusion levels (0, 2, 4 and 6 %) for each variety of garlic replicated three times for each treatment.

T_1 composed of one hundred and twenty (120) quails in three replicates each replicate composed of forty (40) quails. They were offered control diet containing 0 % of Ex – Kofa garlic variety.

T_2 composed of one hundred and twenty quails in three replicates each replicate composed of forty quails. They were offered diet containing 2 % of Ex – Kofa garlic variety.

T_3 composed of one hundred and twenty quails in three replicates each replicate composed of forty quails. They were offered diet containing 4 % of Ex – Kofa garlic variety.

T_4 composed of one hundred and twenty quails in three replicates each replicate composed of forty quails. They were offered diet containing 6 % of Ex – Kofa garlic variety.

T_5 composed of one hundred and twenty quails in three replicates each replicate composed of forty quails. They were offered control diet containing 0 % of Ex – Lugu garlic variety.

T_6 composed of one hundred and twenty quails in three replicates each replicate composed of forty quails. They were offered diet containing 2 % of Ex – Lugu garlic variety.

T_7 composed of one hundred and twenty quails in three replicates each replicate composed of forty quails. They were offered diet containing 4 % of Ex – Lugu garlic variety.

T_8 composed of one hundred and twenty quails in three replicates each replicate composed of forty quails. They were offered diet containing 6 % of Ex – Lugu garlic variety.

3.7 EXPERIMENTAL DIETS

Table 3: Composition of experimental diets

	Garlic variety							
	Ex-Lugu (%)				**Ex-Lugu (%)**			
Ingredients	**0**	**2**	**4**	**6**	**0**	**2**	**4**	**6**
Maize	45.80	43.80	41.80	39.80	45.80	43.80	41.80	39.80
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Ground nut Cake	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Soybean Cage	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Bone meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Lime stone	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Vitamin mineral Pre.	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Garlic varieties	00.0	2.00	4.00	6.00	0.00	2.00	4.00	6.00
Total	**99.95**	**97.95**	**95.95**	**93.95**	**99.95**	**97.95**	**95.95**	**93.95**
Calculated Analysis								
ME (Kcal /kg)	2866	2798	2729	2660	2866	2798	2729	2660
Protein (%)	24.16	24.00	23.84	23.68	24.16	24.00	23.84	23.68
Crude Fbre	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40
Ether Extract	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Lysine (%)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Methionine (%)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calcium (%)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Total Phosphorus (%)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40

ME = Metabolizable Energy ME = Sum of each ingredient metabolizable energy from the table prepared to show the contribution of the ingredients to the crude protein and metabolizable energy of the diet divided by 100 multiplied by the amount of each ingredient use in the experiment.

$ME = \frac{Matabolizable\ Energy}{100} \times ingrediens\ used$ *(Oluyemi and Roberts, 2007).*

Vitamin premix provided per kilogramme: Vitamin A 6,000; Vitamin D_3 1,320 icu; Riboflavin 4.4 mg Niacin 22 mg; Ca Panthothenate 8.8 mg; Choline 440 mg; Vitamin B_{12} 5 mg.

3.8 MANAGEMENT OF EXPERIMENTAL BIRDS

The birds were managed in deep litter system. They were dewormed (with piperazine 5 ml/4 litres of water), given Multivitamin powder (5 gm/4 litre of drinking water). They were offered diets which did not contain any garlic variety during the adjustment period (7 days).They were allotted to the experimental diets in the morning daily. Lighting was provided from 7pm to 6am daily. Feed and water were provided *ad libtum*. The poultry house doors and windows were covered with wire mesh to avoid escape of quails, entry of rodents, reptiles, and other predators that might kill the quails. Sanitary measures were strictly observed to prevent disease outbreak.

3.9 DATA COLLECTION

3.9.1 <u>Growth Performance</u>

Initial live weight

Initiaal live weight was derived by weighing of the birds in group and their total weight was divided by their total number.

Final weight

Final weight was obtained by measuring the weight of the birds in group then divided by their total number on weekly basis.

Feed intake

A known quantity of feed was given to each of the group of Japanese quail chicks while left over of feed was weighed to determine daily feed intake and consequently weekly feed intake.This was calculated using the formular:

$$\text{Feed intake per bird} = \frac{\text{Feed supplied} - \text{Left over of feed}}{\text{Number of birds}}$$

Weight gain

Weight gain was derived by deducting the initial (previous) weight from the final (present) weight of the Japanese quails

$$\text{Weight gain (WG))} = \text{Final weight} - \text{Initial weight}$$

Feed conversion ratio

The feed per gain of each of the group of Japanese quail chicks was determined by calculating the ratio of feed intake to weight gain and thus calculated as

$$\text{Feed conversionratio} = \frac{\text{Feed intake (g)}}{\text{Body weight gain (g)}}$$

Cost per gain determination

The cost per gain of each of the group of Japanese quail chicks was determined by calculating unit cost multiplied by the feed per gain or feed efficiency

Cost per gain = Unit cost x feed per gain or Unit cost x feed efficiency

3.9.2 Nutrients Digestibility Measurements

A total number of 48 Japanese quail chicks consisting of 6 birds per treatment were used for the study, two birds from each replicate. The birds were housed in individual apartment for 7 days, allowing for a 2 days adjustment period. Fecal collection was carried out throughout the experimental period. The birds were provided with a known amount of experimental diets daily. The faecal samples were weighed and oven dried at 65^0C for 24 hours. The dried faecal samples were assessed for their nutrient contents, using the method described by (AOAC, 1995). Nutrient digestibility was determined for dry matter, crude protein, crude fibre, ether extract, and nitrogen free extract. Nutrients digestibility was calculated using the formula below.

$$\text{\% Nutrient digestibility} = \frac{\text{Nutrient intake (g)} - \text{Nutrient in faeces (g)}}{\text{Nutrient intake (g)}} \times 100$$

3.9.3 Blood Sample Collection and Analysis

Blood samples (2ml) were collected from 2 birds per replicate into sterile bottles that contained Ethylene Diamine Tetra-Acetate (EDTA) for the analysis of hematological and serum biochemical parameters as outlined by Schalm (1986).

The following parameters were measured: Red Blood Cells, White Blood Cells, Packed Cell Volume and Haemoglobin Concentration.

Red Blood Cells (RBC)

The estimate of red blood cells in the blood was determined using haematocrit centrifuge method as outlined by Jain (1986).

Packed cell volume (PCV)

The percentage of packed cell volume in the blood was determined using haematocrit centrifuge method as outlined by Wilson and Bridgstocke (2002).

White blood cells (WBC)

The estimate of the total number of white blood cells was carried out immediately after collection of blood sample from the experimental birds using Neubauerhaemocytometer counting chambers as outlined by Monica (2000).

Haemoglobin (Hb)

The Hb concentration of each blood sample was determined using cyanomethaemoglobin method as described by Banerjee (2007).

Serum Biochemical Analysis

The following parameters were analyzed:

Total serum protein

To each test tube 0.3 ml of burette reagent was added and all tubes were incubated in 37^0C water bath for 10 minutes. The reading was taken at 540 mm after setting the instruments to zero with the blank solution. Total plasma protein of each sample was calculated using the formula of Kaneko (1989).

$$\text{Total serum protein } (\text{g}/100\text{m}_1)$$
$$= \frac{\text{Optical density of test}}{\text{optical density standard}} \times \frac{\text{Concentration standard}}{1}$$

Serum albumin and globulin

The bromocresol green method was used to determine the serum albumin. The bromocersol green is a stable complex with abundance maximum at 600 mm. The content of each tube was mixed and left at room temperature for 10 minutes at pH 4.2 ± 0.05. After 10 minutes the test solution was read at a wave length of 640 mm in a spectrophotometer set to zero with the blank solution. Value of the samples were calculated using the formula:

Serum albumin $(5/100\text{m}_1) = \frac{\text{Optical density of test}}{\text{Optical density of standard}} \times \frac{\text{Concentration of standard}}{1}$

$$\text{Serum globulin} = \text{Total serum protein (TSP)} - \text{Albumin (AB)}$$

Serum glutamic oxaloacetic transaminase (SGOT) or Aspartate transaminase (AST)

This was determined using spectrophotometeic method as described by Bergmeyer, Scelibe & Washlefed, 1978).

Serum Glutamic Pyruvic Transaminase (SGPT) or Alanine Transaminase (ALT)

This was determined using spectrophotometeic method as described by Bergmeyer *et al*., 1978.

Alkaline phosphatase (ALP)

This was determined using spectrophotometic method as described by (Bergmeyer *et al*., 1978).

3.9.4 Carcass Characteristics

At the 5th week of age, three Japanese quails were selected based on their average weight from each of the treatment for carcass evaluation. The birds were starved for 18 hours to empty it gut, weighed, slaughtered and allowed to bleed freely for about 5 minutes. Absolute weight of carcass and visceral organs such as heart, gizzard, liver, drumstick and intestine were expressed as a carcass weight.

Carcass dressing (%) = $\frac{\text{Dressed carcass weight}}{\textit{Live weight}}$ x 100

3.9.5 STATISTICAL ANALYSIS

All the data generated in the study were subjected to analysis of variance (ANOVA) using SAS Package (SAS, 1999) and the differences between means were separated using the Tukey's Test at 5 % level of probability.

Procedure for the Linear Model is given below:

Yij = u + ai + Bj + eijk

Where:

Yij = observed value of a dependent variable;

u = Overall mean

ai = Main effect of the ith (inclusion levels of the Ex – Kofa and Ex - Lugu garlic varieties)

(0, 2, 4 and 6%)

Bj = Effect of the jth garlic varieties (j = Ex – Kofa and Ex - Lugu)

eijk = Random error associated with each observation

3.10 EXPERIMENT II:

3.11 EXPERIMENTAL SITE

The experiment was conducted in the same farm with that of experiment one (3.1)

3.12 SOURCE ANDPROCESSING OF GARLIC

This was conducted asdescribed in experiment I (3.3).

3.13 SOURCE OF EXPERIMENTAL BIRDS

A total of nine hundred and sixty (960) day old Japanese quail birds were purchased from National Veterinary Research Institute (NVRI) Vom Plateau State and used in experiment I (at 1week old to 5 weeks old). A total of eight hundred and sixty four (864) adult (5weeks old) Japanese quail birds of experiment I were selected and used in experiment II at 6 weeks old.

3.14 EXPERIMENTAL DESIGN

This was the same as described in experiment I (3.5)

3.15 EXPERIMENTAL DIETS

The diets were formulated to contain 23 % crude protein. The gross composition of the experimental diets is presented in Table 4.

Table 4: Composition of experimental diets

	ExKofa			**Garlicvarieties**		**ExLugu**		
Ingredients	**0**	**2**	**4**	**6**	**0**	**2**	**4**	**6**
Maize	48.40	46.40	44.40	42.40	48.40	46.40	44.40	42.40
Wheat offal	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Groundnut Cake	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
Soy bean Cake	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Common salt	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Garlic variety	0.00	2.00	4.00	6.00	0.00	2.00	4.00	6.00
Total	**100**	**98.00**	**96.00**	**94.00**	**100**	**98.00**	**96.00**	**94.00**
Calculated Analysis								
ME (kcal kg)	2878	2809	2740	2672	2878	2809	2740	2672
Protein (%)	22.70	22.54	22.51	22.50	22.70	22.54	22.51	22.50
Crude Fibre	5.35	5.35	5.35	5.35	5.35	5.35	5.35	5.35
Ether Extract	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17
Methionine (%)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Lysine (%)	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
Calcium (%)	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Total Phosphorus (%)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40

ME = Metabolizable Energy ME = Sum of each ingredient metabolizable energy from the table prepared to show the contribution of the ingredients to the crude protein and metabolizable energy of the diet divided by 100 multiplied by the amount of each ingredient use in the experiment.

$ME = \frac{Matabolizable\ Energy}{100} \times ingrediens\ used$ *(Oluyemi and Roberts, 2007).*

Vitamin premix provided per kilogramme: Vitamin A 6,000; Vitamin D_3 1,320 icu; Riboflavin 4.4 mg Niacin 22 mg; Ca Panthothenate 8.8 mg; Choline 440 mg; Vitamin B_{12} 5 mg.

3.16 MANAGEMENT OF EXPERIMENTAL BIRDS

This was conducted as described in experiment 1

3.17 DATA COLLECTION

3.17.1 Determination of the Egg Laying Performance of Japanese Quails Fed Two Garlic Varieties as Feed Additives

Egg laying commenced at the 6th week where feed consumption, weight gain, percent weight changes, hen day egg production, hen house egg production, feed conversion ratio, cost per crate of egg, egg weight, egg number and mortality were measured and recorded up to the end of the experiment (13 weeks in laying). The computations were carried out using the following formulae as developed by *Musa et al*. (2008).

Feed conversion ratio (FC R) = $\frac{\text{Feed Intake/g egg production}}{\text{Egg Weight x Number of eggs (g/egg)}}$

% Change in weight = $\frac{\text{final weight – initial weight}}{\text{Final weight}} \times 100$

Cost/ crate of egg = FCR x unit cost/ crate of egg

Hen day egg production (HDEP): = $\frac{\text{Egg laid in a day}}{\text{No of Birds alive}} \times \frac{100}{1}$

Hen House Egg Production: $\frac{Egg\ Laid\ in\ a\ Day}{No\ of\ Birds\ housed} \times \frac{100}{1}$

Laying house mortality: =

$$\frac{No\ of\ layers\ that\ died}{Total\ No\ of\ layers\ housed} \times 100\%$$

3.17.2 Determination of the Egg Quality Parameters of Japanese Quails Fed Two Garlic as Feed Additives

Six (6) eggs were taken from each replicate for the evaluation of egg quality characteristics on weekly basis to four weeks.

Egg weight: This was measured using mettler top – loading weighing balance.

Egg length and Width: The length and width of each egg was measured using Vernier calipers

Egg width was measured as the distance between two ends of the egg at the widest cross sectional region using Vernier calipers. The length was measured as the distance between the broad and narrow ends of the egg. (This was measured by putting the broad and narrow ends of egg between two calipers of Vernier caliper then tightened and the distance between them was measured)

Egg shape index (ESI): The egg shape index (ESI) was determined according to Anderson, Tharrington, Curtis and Jones (2004), the formula that was used is given below; $Egg\ Shape\ Index = \frac{Width\ of\ Egg}{Length\ of\ Egg} \times \frac{100}{1}$

Shell thickness: The thickness of individual air – dried shells was measured to the nearest 0.01 mm using micrometer screw gauge (Chowdhury, 1987).

Shell weight: Egg shells were air – dried in the crates for 10 days. The relative shell weight was calculated by relating the shell weight to the weight of the egg.

Albumen height: The eggs were broken out and the maximum albumen height was measured using a tripod micrometer (Dayon, Bemier –Gardou, Hamilton, Castaigne & Randall, 1986).

Yolk height: = was measured using a tripod micrometer

Yolk weight – yolk was separated from albumin and weighed using mettler top-loading weighing balance.

Albumen weight: This was the difference between the egg weight and the sum of weight of yolk and dry egg shell.

% albumen: This is the difference between the egg weight and the sum of weight of yolk and dry eggs shell expressed as a percentage of the whole egg.

% Yolk: This was calculated as the percentage of the yolk weight to the egg weight.

Haugh unit (Hu): This was calculated using the value obtained for the egg weight and albumen height as expressed by Haugh (1937) and enunciated by Asuquo, Okon and Ekong (1992) in the following formula:

$$\mathrm{HU} = 100 \log \ (\mathrm{H} + 7.5 - 1.7\mathrm{W}^{0.37})$$

Where

H = albumen height in mm

W = egg weight in gram

3.17.3 Blood Sample Collection and Analysis

This was conducted as described in experiment 1 (3.8.3).

3.17.4Haematological Analysis

This was conducted as mentioned in experiment 1 (3.8.4).

3.17.5Serum Biochemical Analysis

This was conducted as mentioned in experiment 1 (3.8.5).

3.17.6 Carcass Characteristics

This was conducted as described in experiment 1 (3.8.6)

3.18 STATISTICALANALYSIS

This was conducted using the same proceduer as described in experiment one (3.8.7).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

The experiments (I and II) of this study were conducted to find out the effect of garlic on Japanese quail birds fed as feed additives. The results obtained are presented in the following tables.

4.1.1 Proximate Composition of Experimental Diets

Table 5Showed the proximate composition of experimental diets. The diets formulated contained different values of Dry matter from 89.95 % to 88.70 %; Crude protein 24.00 in each treatment; Crude fibre varied from 2.50 % to 4.40 %; Ether extract varied from 3.30 % to 4.20 %; Ash varied from 10.00 % to 12.50 %; Nitrogen free extract varied from 50.30 % to 56.94 %.

Table 5. Proximate Composition of Experimental Diets

	Diets							
	ExKofa(%)				**Ex-Lugu** (%)			
Parameter	0	2	4	6	0	2	4	6
Dry matter	88.90	88.70	89.95	88.89	89.00	89.00	88.70	89.10
Crude protein	24.00	24.02	24.06	24.02	24.06	24.06	24.16	24.27
Crude Fibre	4.40	3.30	2.50	3.20	3.50	3.30	3.20	2.50
Ether extract	3.30	3.00	3.40	4.00	3.50	4.10	4.20	3.30
Ash	13.00	14.00	14.05	13.50	12.00	13.00	12.50	14.00
NFE	55.30	55.68.	55.99	55.28	56.94	55.54	55.94	55.93

NFE = Nitrogen Free Extract

4.1.2 Proximate Composition of the Garlic Varieties

The proximate composition of the experimental garlic varieties (Ex – Kofa and Ex – Lugu garlic) is presented in Table 6. The Ex – lugu garlic variety had higher value of (20.00 %) crude protein. Ex – Kofa garlic variety had least value of 16.55 % crude protein.

Ex – Kofa garlic variety had higher value (5.20 %) of crude fibre than Ex – Lugu garlic variety with 5.05 % crude fibre.

Ex – Kofa garlic variety had higher value (4.98 %) of ether extract than Ex – Lugu garlic variety with 4.67 % ether extract.

Ex – Kofa garlic variety had higher value (64.26 %) of nitrogen free extract than Ex – Lugu garlic variety with 59.25 % nitrogen free extract.

Table 6: Proximate Composition of the Garlic Varieties

	Garlic Varieties	
	Ex-kofa	**Ex-Lugu**
Parameter(%)		
Dry matter	92.93	92.18
Crude protein	16.55	20.00
Crude Fibre	5.20	5.05
Ether extract	4.98	4.67
Ash	9.01	11.03
NFE	64.26	59.25

NFE = Nitrogen Free Extract

4.1.3 Growth Performance of Quail Chicks Fed Garlic Varieties as Feed Additives

The results of main effect of garlic levels of inclusion on growth performance of Japanese quail chicks fed as feed additives is presented in Table 7. The average daily feed intake, final body weight, weight gain, feed conversion ratio and cost per gain were significantly ($P<0.05$) different across the dietary treatment means. The mortality was not significantly ($P>0.05$) affected across the dietary treatment means.

Quails on 6 % level of inclusionof garlic varieties had highest value of Final weight (120.00 g/bird) this followed by 4 % level of inclusion with (115.00 g/bird) then 2 % level of inclusion with (110.00 g/bird) then quails on 0 % which had least value (100.00 g/bird) of Final weight.

Quails on 6 % level of inclusion of garlic varieties had highest value of weight gain (3.75 g/bird/day)this followed by 4 % level of inclusion with (3.57 g/bird/day) then 2 % level of inclusion with (4.06 g/bird/day) then quails on 0 % which had least value (3.04 g/bird day) of weight gain.

Quails on 0 % level of inclusionof garlic varieties had highest value ofdaily feed intake (17.00 g/bird/day) this followed by 2 % level of inclusion with (16.00

g/bird/day) then 4 % level of inclusion with (14.50 g/bird/day) then quails on 6 % which had least value (14.00 g/bird day) of daily feed intake.

Quails on 0% level of inclusion of garlic varieties had highest value of feed conversionration (5.59) this followed by 2 % level of inclusion with (4.71) then 4 % level of inclusion with (4.06) then quails on 6 % which had least value (3.73) of feed conversion ratio.

Quails on 0 % level of inclusion of garlic varieties had highest value of cost per gain (₦44.72) this followed by 2 % level of inclusion with (₦37.76) then 4 % level of inclusion with (₦32.49) then quails on 6% which had least value (29.87) of cost/gain.

Table 7: Main Effect ofGarlic Levels of Inclusion on Growth Performance of Japanese Quail ChicksFed as Feed Additives (from 1week to 5weeks old)

	Garlic Levels of Inclusion (%)					
Paremeters	0	2	4	6	SEM	LOS
Initial weight (g/bird)	15.00	15.00	15.00	15.00	0.000	NS
Final weight (g/bird)	100.00^{d}	110.00^{c}	115.00^{b}	120.00^{a}	0.092	*
Weight gain (g/bird/day)	3.04^{d}	3.39^{c}	3.57^{a}	3.75^{a}	0.003	*
Daily feed intake (g/b/d)	17.00^{a}	16.00^{b}	14.50^{c}	14.00^{d}	0.106	*
Feed conversion ratio	5.59^{a}	4.71^{b}	4.06^{c}	3.73^{d}	0.129	*
Cost/ gain (₦)	44.72^{a}	37.76^{b}	32.49^{c}	29.87^{d}	0.873	*
Mortality (%)	0.00	0.00	0.00	0.00	0.000	NS

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Means, LOS = Level of significance. B = Bird D = Day

The results of effect of garlic varieties on growth performance of Japanese quail chicks fed as feed additives is presented in Table 8. Showed that final weight, average daily feed intake, weight gain, feed conversion ratio and cost per gain were significantly (P<0.05) affected across the dietary treatment means. There was no significant (P>0.05) difference in mortality across the dietary treatment means.

Quails on Ex – Lugu garlic variety had higher final weight mean value (115.60 g/bird) than quails on Ex – Kofa garlic variety with lower final weight mean value (105.10 g/bird).

Quails on Ex - Kofa garlic variety had higher average daily feed intake (g/b/day) mean value (16.50 g/bird) than quails on Ex – Lugu garlic variety with lower daily feed intake mean value (15.00 g/b/day).

Quails on Ex – Lugu garlic variety had higher Weight gain mean value (3.59g/bird/day) than quails on Ex – Kofa garlic variety with lower weight gain mean value (3.22 g/bird/day)

Quails on Ex - Kofa garlic variety had higher feed conversion ratiomean value (5.12) than quails on Ex – Lugu garlic variety with lower feed conversion ratio mean value (4.18).

Table 8: Effect of Garlic Varieties on Growth Performance of Japanese Quail Chicks Fed as Feed Additives (from 1week to 5 weeks old)

Parameters	Variety		SEM	LOS
	Ex-Kofa	Ex-Lugu		
Initial weight (g/bird)	15.00	15.00	0.000	NS
Final weight (g/bird)	105.10^{b}	115.60^{a}	0.094	*
Daily feed intake (g/b/d)	16.50^{a}	15.00^{b}	0.321	*
Weight gain (g/bird/day)	3.22^{b}	3.59^{a}	0.004	*
Feed conversion ratio	5.12^{a}	4.18^{b}	0.105	*
Cost/ gain (₦)	40.99^{a}	33.43^{b}	0.064	*
Mortality (%)	0.72	0.72	0.000	NS

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Means, LOS = Level of significance. NS = No significant Av = Average, B = Bird, D = Day

The results of main effect of garlic levels of inclusion on nutrient digestibility by Japanese quails fed as feed additives is presented in Table 9. Dry matter digestibility, Crude protein digestibility, crude fibre digestibility, either extract digestibility and nitrogen free extract digestibility were significantly (P<0.05) different across dietary treatment means.

Quails on 6 % level of inclusionof garlic varieties had highest value of Dry matter digestibility (67.86 %), followed by 4 % level of inclusion with (64.35 %) then 0 % level of inclusion with (56.71 %) then quails on 2 % which had least value (50.58 %) ofDry matter digestibility.

Quails on 6 % level of inclusionof garlic varieties had highest value of Crude protein digestibility (69.65 %) this followed by 4 % level of inclusion with (68.70 %) then 2 % level of inclusion with (66.96 %) then quails on 0 % which had least value (63.70 %) of Crude protein digestibility.

Quails on 4 % level of inclusion of garlic varieties had highest value of Crude fiber digestibility (63.06 %) followed by 2 % level of inclusion with (56.70 %) then 6 % level of inclusion with (50.13 %) then quails on 0 % which had least value (45.55 %) of Crude fiber digestibility.

Quails on 4 % level of inclusion of garlic varieties had highest value of ether extract digestibility (79.02 %) this followed by 0 % level of inclusion with (68.91 %) then 6% level of inclusion with (68.34 %) then quails on 2 % which had least value (64.92 %) of ether extract digestibility.

Quails on 6 % level of inclusion of garlic varieties had highest value of nitrogen free extractdigestibility (62.56 %) this followed by 2 % level of inclusion with (62.18 %) then 4 % level of inclusion with (62.17 %) then quails on 0 % which had least value (56.54 %) ofnitrogen free extract digestibility.

Table 9: Main Effect ofGarlic Levels of Inclusion on Nutrient Digestibility by Japanese Quail Chicks fed as Feed Additives (from 1week to 5weeks old)

	Garlic Levels of Inclusion (%)					
Parameters	0	2	4	6	SEM	LOS
Dry matter digestibility (%)	56.71^{c}	50.58^{d}	64.35^{b}	67.86^{a}	4.710	NS
Crude protein digestibility (%)	63.70^{d}	66.96^{c}	68.70^{b}	69.65^{a}	0.974	*
Crude fiber digestibility (%)	45.55^{d}	56.70^{b}	63.06^{a}	50.13^{c}	3.640	*
Ether extract digestibility (%)	68.91^{b}	64.92^{c}	79.02^{a}	68.34^{b}	2.070	*
Nitrogen free extract digestibility (%)	56.54^{d}	62.18^{b}	62.17c^{a}	62.56^{a}	1.925	*

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error Means, LOS = Level of Significance.

The results of effect of garlic varieties on nutrients digestibility by Japanese quails fed as feed additives is presented in Table 10. Showed no significant (P>0.05) differences in all the parameters observed across the dietary treatment means.

Table 10: Effect of Garlic Varieties on Nutrient Digestibility by Japanese Quail Chicks Fed as Feed Additives (from 1week to 5 weeks old)

	Variety			
Parameters (%)	Ex- Kofa	Ex- Lugu	SEM	LOS
Dry matter digestibility	58.40	61.40	3.330	NS
Crude protein digestibility	67.40	67.10	0.688	NS
Crude fiber digestibility	54.20	53.50	2.580	NS
Ether extract digestibility	70.30	70.30	1.460	NS
Nitrogen free extract digestibility	60.81	60.91	1.361	NS

The results of main effect of garlic levels of inclusion on haematological parameters of Japanese quails fed as feed additives in their diets is presented in Table 11. Showed that red blood cells, white blood cell and packed cell volume were significantly ($P< 0.05$) affected across the dietary treatment means.

Quails on 2 % level of inclusion of garlic varieties had highest red blood cells mean value ($2.90x10^6mm^3$) followed by birds on 6 % level of inclusion with ($2.79x10^6mm^3$) then quails on 4 % level of inclusion with ($2.72x10^6mm^3$) then quails on 0 % level of inclusion with least value ($2.71x10^6$mm3) red blood cells.

Quails on 2 % level of inclusion of garlic varieties had highest value of white blood cells (17.87 10^3 /mm^3) this was followed by 6 % level of inclusion with (17.41 10^3 /mm^3) then 4 % level of inclusion with (17.21 10^3 /mm^3) then quails on 0 % which had least value (13.32 10^3 /mm^3) of white blood cells.

Quails on 4 % level of inclusion of garlic varieties had highest packed cell volume mean value (30.95 %) followed by birds on 6 % level of inclusion with (29.85 %) then quails on 0 % level of inclusion with (29.60 %) then quails on 2 % level of inclusion with least value (29.48 %) packed cell volume.

Table 11: Main Effect of Garlic Levels of Inclusion on Haematological parameters of Japanese Quail Chicks Fed as Feed Additives (from 1week to 5weeks old)

	Garlic Levels of Inclusion (%)					
Parameters (%)	0	2	4	6	SEM	LOS
Red blood cells (10^6 /mm^3)	2.71^d	2.90^a	2.72^c	2.79^b	0.038	*
White Blood Cells (10^3 /mm^3)	13.32^d	17.87^a	17.21^c	17.41^b	0.232	*
Haemoglobin (g /dl)	10.5	10.7	9.8	9.43	0.430	NS
Packed Cell Volume (%)	29.60^c	29.48^d	30.95^a	29.85^b	0.247	*

Means in the same row with different superscripts are significantly different (p< 0.05). SEM = Standard Error Means, LOS = Level of Significance.

The results of effect of garlic varieties on haematological parameters of Japanese quails fed as feed additive is presented in Table 12. The Red Blood Cell (RBC).White Blood Cell (WBC) and Packed Cell Volume were significantly ($P< 0.05$) different across the dietary treatment means. There was no significant ($P>0.05$) differences in haemoglobin across the dietary treatment means.

Quails on Ex – Lugu garlic variety had higher red blood cells mean value (2.89x10^6mm^3) than quails on Ex – Kofa garlic variety with lower red blood cells mean value (2.64x10^6mm^3)

Quails on Ex - Lugu garlic variety had higher white blood cells mean value (19.57 10^3 /mm^3) than quails on Ex – Lugu garlic variety with lower white blood cells mean value (15.33 10^3 /mm^3).

Quails on Ex - Lugu garlic variety had higher packed cell volume mean value (29.72 %) than quails on Ex – Kofa garlic variety with lower packed cell volume mean value (27.19 %).

Table 12: Effect of Garlic varieties on Haematological parameters of Japanese Quail Chicks Fed as Feed (from 1week to 5weeks old)

	Variety			
Paramenters	Ex- Kofa	Ex- Lugu	SEM	LOS
Red blood cells (10^6 mm^3)	2.64^b	2.89^a	0.012	*
White Blood Cells (10^3 /mm^3)	15.33^b	19.57^a	0.012	*
Haemoglobin (g /dl)	9.78	8.96	0.087	NS
Packed Cell Volume (%)	27.19^b	29.72^a	0.137	*

Means in the same row with different superscripts are significantly different ($p<0.05$). SEM = Standard Error Means, LOS = Level of Significance.

The results of main effect of garlic level of inclusion and varietyon serum biochemical parameters of Japanese quails chicks fed as feed additives is presented in Table 13. Showed that Serum Glutamic Oxaloacetic Transaminase was significantly ($P>0.05$) affected in this study.

Quails on 4 % level of inclusion of garlic varieties had highest SGOT mean value (131.45IU/L) followed by birds on 0 % level of inclusion with (121.18IU/L) then quails on 6 % level of inclusion with (113.85IU/L) and quails on 2 % level of inclusion with least value (106.10IU/L) SGOT.

Table 13: Main Effect of Garlic Levels of Inclusion on Serum Biochemical parameters of Japanese Quail Chicks Fed as Feed Additives (from 1week to 5 weeks old)

	Garlic Levels of Inclusion (%)					
Parameters (%)	0	2	4	6	SEM	LOS
Total Protein (g /100ml)	6.1	5.65	5.85	5.68	0.077	NS
Albumin (g /100ml)	2.45	2.54	2.5	2.33	0.068	NS
S G OT(IU /L)	121.18^b	106.10^d	131.45^a	113.85^c	0.497	*
S G P T(IU /L)	20.6	17.48	15.15	16.98	0.257	NS
Alkaline Phosphatase (IU / L)	31.88	29.2	31.63	29.13	0.213	NS

Means in the same row with different superscripts are significantly different ($p<0.05$). SEM = Standard Error Means, LOS = Level of Significance.NS = Not Significant, S = Serum, G = Glutamic, O = Oxaloacetic, T = Transaminase, P = Pyruvic

The results on effect of garlic varieties on serum biochemical parameters of Japanese quails fed as feed additivesis presented in Table 14. There were significant (P<0.05) differences in the following parameters obtained toatal protein, albumin and serum glutamic oxaloacetic transaminase across the dietary treatment means.

Quails on Ex - Kofa garlic variety had higher total proteinmean value (5.86 g/100ml) than quails on Ex – Lugu garlic variety with lower total protein mean value (2.89 g/100ml).

Quails on Ex - Lugu garlic variety had higher albumin mean value (19.57 g/100ml) than quails on Ex – Kofa garlic variety with lower albumin mean value (2.49 g/100ml).

Quails on Ex - Lugu garlic variety had higher SGOT mean value (8.96 IU/L) than quails on Ex – Lugu garlic variety with lower SGOT mean value (1.20 IU/L).

Table 14: Effect of Garlic Varieties on Serum Biochemical of Japanese Quail Chicks Fed as Feed Additives(from 1week to 5weeks old)

	Variety			
Parameters	Ex- Kofa	Ex- Lugu	SEM	LOS
Total Protein (g /100ml)	5.86[a]	2.89[b]	0.065	*
Albumin (g /100ml)	2.49[b]	19.57[a]	0.057	*
S G O T (IU /L)	1.20[b]	8.96[a]	0.418	*
S G P T (IU /L)	17.84	17.26	0.216	NS
Alkaline Phosphatase (IU / L)	30.81	30.1	0.179	NS

Means in the same row with different superscripts are significantly different (p<0.05). SEM = Standard Error Means, LOS = Level of Significance.NS = Not Significant, S = Serum, G = Glutamic, O = Oxaloacetic, T = Transaminase, P = Pyruvic
NS = Not Significant, S = Serum, G = Glutamic, O = Oxaloacetic, T = Transaminase, P = Pyruvic

The results of main effect of garlic levels of inclusion on carcass measurements of Japanese quails fed as feed additives is presented in Table 15. All the parameters observed were significantly (P<0.05) diffent across the dietary treatment means.

Quails on 6 % level of inclusion of garlic varieties had highest value (60.50 g) of live weight followed by quails on 4 % level of inclusion with value (56.00 g) then quails on 2 % with value (50.20 g) and quails on 0 % with least value (40.02 g) live weight.

Quails on 6 % level of inclusion of garlic varieties had highest value of dressing weight (52.00 g) this followed by 4 % level of inclusion with (45.20 g) then 2 % level of inclusion with (40.10 g) and quails on 0 % which had least value (30.01 g) of dressing weight.

Quails on 6 % level of inclusion of garlic varieties had highest value of dressing percent (85.95 %) this followed by 4 % level of inclusion with (85.71 %) then 2 % level of inclusion with (79.88 %) and quails on 0 % which had least value (74.98 %) of dressing percent.

Quails on 6 % level of inclusion of garlic varieties had highest value (3.50 g) of thigh this followed by 4 % level of inclusion with (3.28 g) then 2 % level of inclusion with (3.13 g) then quails on 0 % which had least value (2.55 g) of thigh.

Quails on 6 % level of inclusion of garlic varieties had highest value (0.95 g) of drumstick this followed by 4 % level of inclusion with (0.83 g) then 2 % level of inclusion with (0.80 g) and quails on 0 % which had least value (0.75 g) of drumstick.

Quails on 6 % level of inclusion of garlic varieties had highest value of back (5.73 g) this followed by 4 % level of inclusion with (5.48 g) then 2 % level of inclusion with (5.43 g) then quails on 0 % which had least value (5.35 g) of back.

Quails on 6 % level of inclusion of garlic varieties had highest value of breast (9.56 g) this followed by 4 % level of inclusion with (8.77 g) then 2 % level of inclusion with (7.63 g) then quails on 0 % which had least value (6.65 g) of breast.

Quails on 6 % level of inclusion of garlic varieties had highest value of wing (2.38 g) this followed by 4 % inclusion level with (2.18 g) then 2 % level of inclusion with (2.10 g) then quails on 0 % which had least value (2.73 g) of wing.

Quails on 6% level of inclusion of garlic varieties had highest value (2.53 g) of neck followed by quails on 4 and 2 % with same level of inclusion (2.45 g) each then quails on 0 % level of inclusion with least value (1.85 g) neck weight.

Quails on 2 % level of inclusion of garlic varieties had highest value (2.78 g) of head weight followed by quails on 6 % level of inclusion with (2.75 g) then quails on 4 % level of inclusion with (2.40 g) then quails on 0 % level of inclusion with least value (2.33 g) of head weight.

Table 15: Main Effect of Garlic Levels of Inclusion on Carcass Characteristics of Japanese Quail Chicks fed as Feed Additives (from 1week to 5 weeks old)

	Garlic Levels of Inclusion (%)					
Parameters	0	2	4	6	SEM	LOS
Live weight (g)	40.02^{d}	50.20^{c}	56.00^{b}	60.50^{a}	0.089	*
Dressing Weight (g)	30.01^{d}	40.10^{c}	45.20^{b}	52.00^{a}	0.079	*
Dressing Percent	74.98^{d}	$79..88^{c}$	80.71^{b}	85.95^{a}	0.122	*
Thigh (g)	2.55^{d}	3.13^{c}	3.28^{b}	3.50^{a}	0.020	*
Drumstick (g)	0.75^{b}	0.80^{b}	0.83^{b}	0.95^{a}	0.024	*
Back (g)	5.35^{b}	5.43^{b}	5.48^{b}	5.73^{a}	0.038	*
Breast (g)	6.65^{c}	7.63^{b}	8.77^{b}	9.56^{a}	0.037	*
Wing (g)	1.73^{c}	2.10^{b}	2.18^{b}	2.38^{a}	0.036	*
Neck (g)	1.85^{b}	2.45^{a}	2.45^{a}	2.53^{a}	0.214	*
Head (%)	2.33^{b}	2.78^{a}	2.40^{b}	2.75^{a}	0.036	*

Means in the same row with different superscripts are significantly different ($P<0.05$). SEM = Standard Error Means, LOS = Level of Significance

The results on effect of garlic varieties on carcass measurements of Japanese quail chicks fed as feed additives is presented in Table 16. The back was significantly

(P<0.05) diffent across the dietary treatment means. There were no significant (P>0.05) differences in all other organs observed during this study.

Quails on Ex – Lugu garlic variety had higher value (4.88 g) of back than quails on Ex – Kofa garlic variety with lower value (4.61 g) of back weight.

Table 16: Effect of Garlic Varieties on Carcass Characteristics of Japanese Quail Chicks Fed as Feed Additives(from 1week to 5weeks old)

	Variety			
Parameters	Ex-Kofa	Ex-Lugu	SEM	LOS
Live weight (g)	40.02	40.02	0.075	NS
Dressing Weight (g)	30.03	30.50	0.067	NS
Dressing Percent	75.04	76.21	0.102	NS
Thigh (g)	3.13	3.1	0.017	NS
Drumstick (g)	0.81	0.85	0.020	NS
Back (g)	4.61^{b}	4.88^{a}	0.032	*
Breast (g)	6.43	6.38	0.031	NS
Wing (g)	2.09	2.1	0.027	NS
Neck (g)	2.35	2.29	0.030	NS
Head (g)	2.64	2.49	0.030	NS

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error Means, LOS = Level of Significance

The results of the main effect of garlic levels of inclusion on visceral organs of Japanese quail chicks fed as feed additives is presented in Table 17. The quails fed diet containing garlic varieties (Ex – Kofa and Ex – Lugu) at 6 % had highest liver weight (2.50 g) which was significantly (P<0.05) higher than quails on 0 % (2.08 g), 2 % (2.25g) and 4 % (2.33 g) levels of inclusion of garlic varieties. Quails on diets without garlic varieties as feed additives had the least liver weight compared to those on diets with garlic varieties as feed additives.

Quails on 6 % level of inclusion of garlic varieties had highest value (1.65 g) of lung followed by quails on 4 % level of inclusion with (1.45 g) then quails on 2 % level of inclusion with (1.43 g) and quails on 0 % level of inclusion with least value (1.28 g) of lung weight.

Quails on 2 % level of inclusion of garlic varieties had highest value (0.45 g) of heart followed by quails on 6 % level of inclusion with (0.44 g) then quails on 4 % level of inclusion with (0.38 g) and quails on 0 % level of inclusion with least value (0.33 g) of heart weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (4.23 g) of gizzard followed by quails on 4 % level of inclusion with (3.70 g) then quails on 2 % level of inclusion with (3.35 g) and quails on 0 % level of inclusion with least value (2.93 g) of gizzard weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (0.05 g) of spleen followed by quails on 4 % level of inclusion with (0.04 g) then quails on 2 % level of inclusion with (0.03 g) then quails on 0 % level of inclusion with least value (0.02 g) of spleen weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (4.68 g) of intestine followed by quails on 4 % level of inclusion with (4.65 g) then quails on 2 % level of inclusion with (4.28 g) then quails on 0 % level of inclusion with least value (4.05 g) of intestine weight.

Table 17: Main Effect of Garlic Levels of Inclusion on Visceral Organs of Japanese Quail Chicks Fed as Feed Additives (from 1week to 5weeks old)

	Garlic Levels of Inclusion (%)					
Internal organs (%)	0	2	4	6	SEM	LOS
Liver (g)	2.08^{d}	2.25^{c}	2.33^{b}	2.50^{a}	0.026	*
Lung (g)	1.28^{d}	1.43^{c}	1.45^{b}	1.65^{a}	0.027	*
Heart (g)	0.33^{d}	0.45^{a}	0.38^{c}	0.44^{b}	0.018	*
Gizzard (g)	2.93^{d}	3.35^{c}	3.70^{b}	4.23^{a}	0.048	*
Spleen (g)	0.02^{d}	0.03^{c}	0.04^{b}	0.05^{a}	0.010	*
Intestine (g)	4.05^{d}	4.28^{c}	4.65^{b}	4.68^{a}	0.029	*
Intestine Length (cm)	49.25	51.25	44.23	52.75	0.334	NS

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error Means, LOS = Level of Significance.

The results of effect garlic varieties on visceral organs of Japanese quails fed as feed additives is presented in Table 18. Generally quails on Ex – Kofa garlic variety had significantly (P<0.05) higher value (0.43 g) of heart weight compared to quails fed Ex – Lugu garlic variety with (0.37 g) heart weight.

Quails on Ex – Lugu garlic variety had higher value (4.31 g) of intestine compared to Ex – Kofa with lower value (4.01 g) of intestine weight.

Table 18: Effect of Garlic Varieties on Visceral Organs of Japanese Quail Chicks Fed as Feed Additives(from 1week to 5weeks old)

	Variety			
Internal organs (%)	Ex-kofa	Ex-lugu	SEM	LOS
Liver (g)	2.3	2.28	0.022	NS
Lung (g)	1.45	1.45	0.023	NS
Heart (g)	0.43^{a}	0.37^{b}	0.015	*
Gizzard (g)	3.56	3.54	0.040	NS
Spleen (g)	0.03	0.04	0.008	NS
Intestine (g)	4.01^{b}	4.31^{a}	0.025	*
Intestine Length (cm)	48.86	49.88	0.281	NS

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error Means, LOS = Level of Significance.

The experiment II in this study was conducted to find out the effect of garlic on Japanese quail hens fed as feed additives.

The proximate composition of the experimental diets is presented in Table 19. The crude protein content of the diets was (23.00 to 23.30 %) across experimental diets.

The crude fibre obtained in this study had highest value of (4.30 %) at 2 % level of inclusion followed by (3.50 %) at 4 % level of inclusion then (3.40 %) at 0 % level of inclusion followed by least value of (3.20 %) at 6 % level of inclusion of Ex – Kofa garlic variety. Meanwhile diets containing Ex – Lugu garlic variety had (4.00 %) at 2 % level of inclusion followed by (3.40 %) at 0 % level of inclusion then least value of (3.00 %) at 4 and 6 % levels of inclusion.

The ether extract obtained in this study had highest value of (4.50 %) at 4 % level of inclusion followed by (3.40 %) at 6 % level of inclusion then (3.20 %) at 0 % level of inclusion followed by least value of (3.10 %) at 2 % level of inclusion of Ex – Kofa garlic variety. Meanwhile diets containing Ex – Lugu garlic variety had (4.00 %) at 4 % level of inclusion followed by (3.40 %) at 0 and 4 % level of inclusion then least value of (3.30 %) at 2 % level of inclusion.

The nitrogen free extract obtained in this study had highest value of (55.58 %) at 2 % level of inclusion followed by (55.40 %) at 0 % level of inclusion then (54.95 %) at 4 % level of inclusion followed by least value of (54.89 %) at 6 % level of inclusion of Ex – Kofa garlic variety. Meanwhile diets containing Ex – Lugu garlic variety had (55.68 %) at 2 % level of inclusion followed by (55.10 %) at 6 % level of inclusion followed by (54.87 %) at 0 % level of inclusion then least value of (54.70 %) at 4 % level of inclusion.

Table 19: Proximate Composition of Experimental Diets

	Experimental Diets							
	Exkofa(%)				**ExLugu(%)**			
Parameter	0	2	4	6	0	2	4	6
Dry matter	90.00	89.78	89.95	89.89	89.35	89.42	90.00	89.11
Crude protein	23.10	23.20	23.20	23.30	23.30	23.20	23.20	23.30
Crude Fibre	3.40	4.30	3.50	3.20	3.40	4.00	3.00	3.00
Ether extract	3.20	3.10	3.50	3.40	3.40	3.30	4.00	3.40
Ash	15.00	14.00	15.05	15.50	15.30	14.00	15.20	15.50
NFE	55.40	55.58	54.95	54.89	54.87	55.68	54.70	55.10

NFE = Nitrogen Free Extract

The results of main effect of garlic levels of inclusion on nutrient digestibility by Japanese quail hens fed as feed additives is presented in Table 20.

Showed that all of the parameters observed were significantly ($P<0.05$) different except dry matter digestibility across the dietary treatment means.

Quails on 6 % level of inclusion of garlic varieties had highest value (73.07 %) of Crude protein digestibility followed by quails on 4 % level of inclusion with (71.78 %) then quails on 2 % level of inclusion (69.61 %) then quails on 0 % level of inclusion with the least value (66.51 %) of crude protein digestibility.

Quails on 4 % level of inclusion of garlic varieties had highest value (64.36 %) of crude fibre digestibility followed by quails on 2 % level of inclusion with (58.49 %) then quails on 6 % level of inclusion with (53.80 %) and quails on 0 % level of inclusion with the least value (49.37 %) of crude fibre.

Quails on 4 % level of inclusion of garlic varieties had highest value (80.24 %) of ether extract digestibility followed by quails on 6 % level of inclusion with (73.21 %) then quails on 0 % level of inclusion with (71.45 %) then quails on 2 % level of inclusion with least value (70.67 %) of ether extract digestibility.

Quails on 4 % level of inclusion of garlic varieties had highest value (65.17 %) of nitrogen free extract digestibility followed by quails on 6 % level of inclusion with (64.33 %) then quails on 2 % level of inclusion with (61.52 %) then quails on 0 % level of inclusion with least value (59.73 %) of nitrogen free extract digestibility.

Table 20: Main Effect of Garlic Levels of Inclusion on Nutrient Digestibility by Japanese Quail Hens fed as Feed Additives (from 6weeks to 10 weeks old)

	Garlic Levels of Inclusion (%)					
Parameters (%)	0	2	4	6	SEM	LOS
Dry matter digestibility	60.09	62.44	63.86	68.34	2.79	N S
Crude protein digestibility	66.51^{d}	69.61^{c}	71.78^{b}	73.07^{a}	2.89	*
Crude fiber digestibility	49.37^{d}	58.49^{b}	64.36^{a}	53.80^{c}	7.63	*
Ether extract digestibility	71.45^{c}	70.67^{d}	80.24^{a}	73.21^{b}	4.43	*
Nitrogen free extract digestibility	59.73^{d}	61.52^{c}	65.17^{a}	64.33^{b}	6.09	*

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error Means, LOS = Level of Significance.

The results of effect of garlic varieties on nutrient digestibility by Japanese quail hens fed as feed additives is presented in Table 21.

Showed that all the parameters observed were not significantly (P>0.05) affected in this study.

Table 21: Effect of Garlic Varieties on Nutrient Digestibility of Japanese Quail Hens Fed as Feed Additives (from 6 weeks to 10 weeks old)

	Variety			
Parameters (%)	Ex-kofa	Ex-lugu	SEM	LOS
Dry matter digestibility	62.90	64.50	1.97	N S
Crude protein digestibility	70.50	70.00	2.04	N S
Crude fiber digestibility	56.1	56.90	5.39	N S
Ether extract digestibility	74.00	73.80	3.13	N S
Nitrogen free extract digestibility	61.70	63.70	2.18	N S

The result of main effect of garlic levels of inclusion on egg performance of Japanese quail hens fed as feed additives is presented in Table 22. There were significant

(P<0.05) differences in all of the variables observed across the dietary treatment means except mortality which was not significantly (P>0.05) different.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (330.08 g) of final weight followed by quail hens on 4 % level of inclusion of garlic varieties with value of (280.04 g) then quail hens on 2 % level of inclusion with value of (260.03 g) then quail hens on 0 % level of inclusion with least value (240.00 g) of final weight.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (80.28 %) of hen day egg production followed by quail hens on 4 % level of inclusion of garlic varieties with value of (76.96 %) then quail hens on 2 % level of inclusion with value of (73.39 %) and quail hens on 0 % level of inclusion with least value (68.63 %) of hen day egg production.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (77.82 %) of hen house egg production followed by quail hens on 4 % level of inclusion of garlic varieties with value of (74.90 %) then quail hens on 2 % level of inclusion with value of (71.29 %) and quail hens on 0 % level of inclusion with least value (66.67 %) of hen house egg production.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (10.20 g) of egg weight followed by quail hens on 4 % level of inclusion of garlic varieties with value of (9.50 g) then quail hens on 2 % level of inclusion with value of (9.00 g) and quail hens on 0 % level of inclusion with least value (8.75 g) of egg weight.

Quail hens on 4 and 6 % levels of inclusion of garlic varieties had highest value of (3.00) number of eggs followed by quail hens on 0 and 2 % levels of inclusion of garlic varieties with the same lower value of (2.00) number of eggs.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (50.01 %) of percent change in weight followed by quail hens on 4 % level of inclusion with value

(44.65 %) then quail hens on 2 % level of inclusion with value (42.31 %) then quail hens on 041.67 % level of inclusion with least value (50.01 %) of percent change in weight.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (36.00 g) of feed intake per gram egg production followed by quail hens on 4 % level of inclusion with value (34.00g) then quail hens on 0% level of inclusion with value (25.00 g) then quail hens on 2 % level of inclusion with least value (24.00 g) of feed intake per gram egg production.

Quail hens on 0 % level of inclusion of garlic varieties had highest value (1.43) of feed conversion ratio followed by quail hens on 2 % level of inclusion with value (1.33) then quail hens on 6 % level of inclusion with value (1.26) then quail hens on 4 % with least value (1.22) of feed conversion ratio.

quail hens on 0 % level of inclusion of garlic varieties had highest value (#210.21) of cost per crate of eggs followed by quail hens on 2 % level of inclusion with the value of (#195.51) then quail hens on 4 % level of inclusion with value (#180.56) and quail hens on 6% level of inclusion with least value (#180.18) of cost per crate of eggs.

Table 22: Main Effect of Garlic Levels of Inclusion on Egg Performance of Japanese Quail Hens Fed as Feed Additives

Variables	Garlic Levels of Inclusion (%) 0	2	4	6	SEM	LOS
Initial weight (g/bird)	140.00^{d}	150.00^{c}	155.00^{b}	165.00^{a}	0.704	*
Final weight (g/bird)	240.00^{d}	260.03^{c}	280.04^{b}	330.08^{a}	0.232	*
Weight change (%)	41.67^{d}	42.31^{c}	44.65^{b}	50.01^{a}	0.179	*
Feed intake/g egg prod.	25.00^{c}	24.00^{d}	34.00^{b}	36.00^{a}	0.200	*
Hen day egg prod. (%)	68.63^{d}	73.39^{c}	76.96^{b}	80.28^{a}	0.141	*
Hen house egg prod. (%)	66.67^{d}	71.29^{c}	74.90^{b}	77.82^{a}	0.149	*
Feed conversion ratio	1.43^{a}	1.33^{b}	1.22^{d}	1.26^{c}	0.037	*
Cost/crate of eggs (#)	210.21^{a}	195.51^{b}	180.56^{c}	180.18^{d}	0.112	*
Egg weight (g)	8.75^{d}	9.00^{c}	9.50^{b}	10.20^{a}	0.018	*
No of eggs/bird	2.00^{c}	2.00^{c}	3.00^{a}	3.00^{a}	0.011	*
Mortality (%)	0.00	0.00	0.00	0.00	0.000	NS

Means in the same row with different superscripts are significantly different (P<0.05).Prod. = production SEM = Standard Error of Means, LOS = Level of Significance.
NS = Not Significant

The effect of garlic varieties on egg performance of Japanese quail hens fed as feed additives is presented in Table 23.There were significant (P<0.05) differences in all of the variables observed except final weight, Feed Conversion ratio, number of eggs, Cost per crate of eggs, egg weight and mortality which were not significantly (P<0.05) different across the dietary treatment means.

Quail hens on Ex – Lugu garlic variety had higher value (75.64 %) of hen – day egg production than quail hens on Ex – Kofa garlic variety with lower value (73.98 %) of hen – day egg production.

Quail hens on Ex – Lugu garlic variety had higher value (73.49 %) of hen house egg production than quail hens on Ex – Kofa garlic variety with lower value (71.87 %) of hen house egg production. Quail hens on Ex – Kofa had higher value (51.73 %) of percent change in weight than quail hens on Ex – Lugu garlic variety with lower value (45.10 %) of percent change in weight.

Quail hens on Ex – Lugu garlic variety had higher value of (35.00) feed intake per gram egg production than quail hens on Ex – Kofa garlic variety with lower value (34.00) feed intake.

Table 23: Effect of Garlic Varieties on Egg Performance of Japanese Quail Hens Fed as Feed Additives

Variables	Variety		SEM	LOS
	Ex-Kofa	Ex - Lugu		
Initial weight (g/bird)	145.00[b]	165.00[a]	0.860	*
Final Weight (g/bird)	300.40	300.56	0.908	N S
Weight change (%)	51.73[a]	45.10[b]	0.163	*
Feed intake/g egg production	34.00	35.00	0.123	*
Hen day egg production (%)	73.98[b]	75.64[a]	0.178	*
Hen house egg production (%)	71.87[b]	73.49[a]	0.182	*
Feed conversion ratio	1.33	1.30	0.045	NS
Cost/ crate of egg (#)	195.51	195.00	0.275	NS
Egg weight (g)	8.50	9.00	0.037	N S
No of eggs/bird	3.00	3.00	0.13	NS
Mortality (%)	0.00	0.00	0.000	N S

Means in the same row with different superscripts are significantly different (P<0.05).Prod. = production SEM = Standard Error of Means, LOS = Level of Significance.
NS = Not Significant

The main effect of garlic levels of inclusion on egg quality parameters of Japanese quails fed as feed additives is presented in Table 24.There were significant (P<0.05) differences in all of the variables observed except percentage yolk which was not significantly (P>0.05) different across the dietary treatment means.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (10.53 g) of egg weight followed by quail hens on 4 % level of inclusion with value (10.33 g) then quail hens on 2 % level of inclusion with value (9.86 g) and quail hens on 0 % level of inclusion with value (9.46 g) of egg weight.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (3.24 mm) of egg length followed by quail hens on 4 % level of inclusion with value (3.21 mm) then birds on 2 % level of inclusion with value (3.16 m) and quail hens on 0 % level of inclusion with value (3.12 mm) of egg length. In term of egg width, hens on 6 % level of inclusion of garlic varieties had highest value (2.51 mm) of egg width followed by quail hens on 4 % level of inclusion with value (2.48 mm) then quail hens on 2 % level of inclusion with value (2.41 mm) and quail hens on 0 % level of inclusion with value (2.38 mm) of egg width. The results of egg shape index similarly indicate that hens on 6 % level of inclusion of garlic varieties had highest value (77.49 mm) of egg shape index followed by quail hens on 4 % level of inclusion with value (77.16 mm) then quail hens on 2 % level of inclusion with value (76.46 mm) and quail hens on 0 % level of inclusion with value (76.36) of egg shape index. The values for egg shell thickness also indicate that quail hens on this level of inclusion (6 %) had highest value (0.40 mm) of shell thickness followed by quail hens on 4 % level of inclusion with value (0.37 mm) then quail hens on 2 % level of inclusion with value (0.35 mm) and quail hens on 0 % level of inclusion with value (0.29 mm) of shell thickness.

Quail hens on 6 % level of inclusion of garlic varieties had highest value (1.21g) of shell weight followed by quail hens on 4 % level of inclusion with value (1.18 g) then quail hens on 2 % level of inclusion with value (1.14 g) and quail hens on 0 % level of inclusion with value (1.09 g) of shell weight. Thislevel of inclusion recorded the highest value (0.49 mm) of albumen height followed by quail hens on 4 % level of inclusion with value (0.47 mm) then quail hens on 2 % level of inclusion with value (0.45 mm) then quail hens on 0 % level of inclusion with value (0.43 mm) of albumen height. The same trend was observed in respect of albumen weight as the 6 % level of inclusion of garlic varieties had highest value (5.54 g) of albumen weight followed by quail hens on 4 % level of inclusion with value (5.44 g) then quail hens on 2 % level of inclusion with value (5.25 g) then quail hens on 0 % level of inclusion with value (5.13 g) of albumen weight.

Quail hens on 2, 4 and 6 % level of inclusion of garlic varieties had the same value (0.06 %) of albumen high than those on 0 % level of inclusion with lower value (0.05 %) of albumen. However, the results for yolk weight indicated that quail hens on 6 % level of inclusion of garlic varieties had highest value (3.27 g) followed by quail hens on 4 % level of inclusion with value (3.20 g) then quail hens on 2 % level of inclusion with value (3.15 g) and quail hens on 0 % level of inclusion with value (3.10 g) of yolk weight. Similarly, the values for yolk height indicated that quail hens on 4 % level of inclusion with value (0.85 mm) then quail hens on 2 % level of inclusion with value (0.81mm) and quail hens on 0 % level of inclusion with value (0.80 mm) of yolk height. Furthermore, the result for Haugh unit revealed that quail hens on 6 % level of inclusion of garlic varieties had highest value of 83.50 % followed by quail hens on 4 % level of inclusion with value of 83.37 % then quail hens on 2 % level of inclusion with value (83.15 %) and quail hens on 0 % level of inclusion with value (82.97 %) of Haugh unit.

Table 24: Main Effect of Garlic Levels of Inclusion on Egg Quality Parameters of Japanese Quail Hens fed as Feed Additives

Variables	Garlic Levels of Inclusion (%)				SEM	LOS
	0	2	4	6		
Egg weight (g)	9.46^{d}	9.86^{c}	10.33^{b}	10.53^{a}	0.022	*
Egg length (mm)	3.12^{d}	3.16^{c}	3.21^{b}	3.24^{a}	0.007	*
Egg width (mm)	2.38^{d}	2.41^{c}	2.48^{b}	2.51^{a}	0.009	*
Egg shape index (mm)	76.36^{d}	76.46^{c}	77.16^{b}	77.49^{a}	0.055	*
Shell thickness (mm)	0.29^{d}	0.35^{c}	0.37^{b}	0.40^{a}	0.009	*
Shell weight (g)	1.09^{d}	1.14^{c}	1.18^{b}	1.21^{a}	0.009	*
Albumen height (mm)	0.43^{d}	0.45^{c}	0.47^{b}	0.49^{a}	0.014	*
Albumen weight (g)	5.13^{d}	5.25^{c}	5.44^{b}	5.54^{a}	0.016	*
Albumen %	0.05^{b}	0.06^{a}	0.06^{a}	0.06^{a}	0.005	*
Yolk weight (g)	3.10^{d}	3.15^{c}	3.20^{b}	3.27^{a}	0.037	*
Yolk height (mm)	0.80^{d}	0.81^{c}	0.85^{b}	0.86^{a}	0.007	*
Yolk (%)	31.66	31.19	31.69	30.3	0.145	N S
Haugh unit (%)	82.97^{d}	83.15^{c}	83.37^{b}	83.50^{a}	0.034	*

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Means, LOS = Level of Significance.

The effect of garlic varieties on egg quality parameters of Japanese quail hens fed as feed additives is presented in Table 25.There were significant (P<0.05) differences in all of the variables observed across the dietary treatment means except egg length albumen percent and percentage yolk which were not significantly (P>0.05) different across the dietary treatment means.

The results indicate that Quail hens on Ex – Lugu garlic variety had higher value (10.20 g) of egg weight than those fed diets containing Ex – Kofa garlic variety (9.89 g). In terms of egg weight, quail hens on Ex – Lugu garlic variety diets had higher value (2.45 mm) compared to birds fed diets containing Ex – Kofa garlic with lower value (2.44 mm). The results of egg shape index also indicated that birds fed diets containing Ex – Lugu recorded higher value (77.02 mm) than those on Ex – Kofa garlic (76.67 mm). Quail hens fed diets containing Ex – Lugu garlic variety had higher value (0.36 mm) of shell thickness compared to those on Ex – Kofa garlic variety (0.34 mm). Similar trend was observed in the values for shell weight, albumen height and weight, yolk weight and height and Haugh units as quail hens on diets containing Ex – Lugu garlic variety recorded higher values (1.17 g) shell weight, (0.47 mm) albumen height and (5.37 g) weight, (0.84 mm) yolk height, (83.31 %) Haugh unit compared to those fed diets containing Ex – Kofa garlic variety with lower values (9.89 g) shell weight, (0.45 mm) albumen height and (5.31g) weight, (0.82 mm) yolk height. Quail hens fed diets containing Ex – Kofa garlic variety had higher values (3.14 g) of yolk weight compared to those on diets containing Ex – Lugu garlic variety with lower value (3.04 g) of yolk weight.

Table 25: Effect of Garlic Varieties on Egg Quality Parameters of Japanese Quail Hens Fed as Feed Additives

Parameters	Variety		SEM	LOS
	Ex - Kofa	Ex – Lugu		
Egg weight (g)	9.89^{b}	10.20^{a}	0.0183	*
Egg length (mm)	3.18	3.18	0.0061	NS
Egg width (mm)	2.44^{b}	2.45^{a}	0.0076	*
Egg shape index (mm)	76.67^{b}	77.07^{a}	0.0466	*
Shell thickness (mm)	0.34^{b}	0.36^{a}	0.0078	*
Shell weight (g)	1.14^{b}	1.17^{a}	0.0073	*
Albumen height (mm)	0.45^{b}	0.47^{a}	0.0113	*
Albumen weight (g)	5.31^{b}	5.37^{a}	0.0132	*
Albumen %	0.06	0.06	0.004	NS
Yolk weight (g)	3.14^{b}	3.04a	0.031	*
Yolk height (mm)	0.82^{b}	0.84^{a}	0.0057	*
Yolk (%)	31.74	30.67	0.122	NS
Haugh unit (%)	83.18^{b}	83.31^{a}	0.0284	*

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Means, LOS = Level of Significance.

The main effect of garlic levels of inclusion on haematological parameters of Japanese quail hens fed as feed additives is presented in Table 26. Showed no significant (P>0.05) differences in most of the variables observed except red blood cells and packed cell volume which were significantly (P<0.05) different across the dietary treatment means.

Quails on 6 % level of inclusion of garlic varieties had highest red blood cells mean value ($3.08x10^{6}mm^{3}$) followed by birds on 4 % level of inclusion with ($2.78x10^{6}mm^{3}$) then quails on 2 % level of inclusion with ($2.58x10^{6}mm^{3}$) and quails on 0 % level of inclusion with least value (2.58x10mm3).

Quails on 6 % level of inclusion of garlic varieties had highest value of packed cell volume (33.28 %), this followed by 4 % level of inclusion with (30.67 %) then 2 % level of inclusion with (27.25 %) tand quails on 0 % which had least value (25.56 %) of packed cell volume.

Table 26: Main Effect of Garlic Levels of Inclusion on Haematological Parameters of Japanese Quail Hens Fed as Feed Additives

	Garlic Levels of Inclusion (%)					
Parameters (%)	0	2	4	6	SEM	LOS
Red blood cells (10^6 /mm^3)	2.58^d	2.61^c	2.78^b	3.08^a	0.038	*
White Blood Cells (10^3 /mm^3)	14.87	20.07	17.23	17.63	0.232	NS
Haemoglobin (g /dl)	10.13	9.58	8.57	9.18	0.143	NS
Packed Cell Volume (%)	25.56^d	27.25^c	30.67^b	33.28^a	0.323	*

Means in the same row with different superscripts are significantly different (p< 0.05).
SEM = Standard Error of Means, LOS = Level of Significance.

The effect of garlic varieties on haematologcal parameters of Japanese quail hens fed as feed additives is presented in Table 27. Showed no significant (P>0.05) differences in most of the variables observed except red blood cells and packed cell volume which were significantly (P<0.05) different across the dietary treatment means.

Quails on Ex – Kofa garlic variety had higher red blood cells mean value (2.80x10^6mm^3) than quails on Ex – Lugu garlic variety with lower red blood cells mean value (2.77x10^6mm^3)

Quails on Ex - Kofa garlic variety had higher packed cell volume mean value (30.15 %) than quails on Ex – Lugu garlic variety with lower packed cell volume mean value (24.40 %).

Table 27: Effect of Garlic Varieties on Haematological Parameters of Japanese Quail Hens Fed as Feed Additives

Parameters	Variety		SEM	LOS
	Ex – Kofa	Ex – Lugu		
Red blood cells (10^6 mm^3)	2.80^a	2.77^b	0.012	*
White Blood Cells (10^3 /mm^3)	15.91	16.99	0.012	NS
Haemoglobin (g /dl)	10.11	10.10	0.087	NS
Packed Cell Volume (%)	24.40^b	30.15^a	0.256	*

Means in the same row with different superscripts are significantly different (p< 0.05).
SEM = Standard Error of Means, LOS = Level of Significance.

The results of main effect of garlic levels of inclusion on serum chemistry parameters of Japanese quail hens fed as feed additives is presented in Table 28. There were significant (P<0.05) differences in all the parameters observed

Quail hens on 4 % level of inclusion of garlic varieties had highest value (6.35 g/100ml) of Total protein followed by quail hens on 6 % level of inclusion with value (5.58 g/100ml) then quail hens on 2 % level of inclusion with value (5.55 g/100ml) and quail hens on 0 % level of inclusion with value (5.07 g/100ml) of Total protein.

Quail hens on 0 % level of inclusion of garlic varieties had highest value (2.70 g/100ml) of Albumin followed by quail hens on 2 % level of inclusion with value (2.68 g/100ml) then quail hens on 4 % level of inclusion with value (2.61 g/100ml) and quail hens on 6 % level of inclusion with value (2.43 g/100ml) of Albumin.

Quail hens on 4 % level of inclusion of garlic varieties had highest value (136.93 IU/L) of SGOT followed by quail hens on 6 % level of inclusion with value (127.85 IU/L) then quail hens on 0 % level of inclusion with value (120.05 IU/L) and quail hens on 2 % level of inclusion with value (107.72 IU/L) of SGOT.

Quail hens on 2 % level of inclusion of garlic varieties had highest value (36.30 IU/L) of SGPT followed by quail hens on 4 % level of inclusion with value (18.47 IU/L) then quail hens on 6% level of inclusion with value (16.43 IU/L) then quail hens on 0 % level of inclusion with value (11.77 IU/L) of SGPT.

Quail hens on 0 % level of inclusion of garlic varieties had highest value (44.00 IU/L) of Alkaline phosphatase followed by quail hens on 4 % level of inclusion with value (34.13 IU/L) then quail hens on 6 % level of inclusion with value (31.15 IU/L) then quail hens on 2 % level of inclusion with value (27.63 IU/L) of Alkaline phosphatase.

Table 28: Main Effect of Garlic Levels of Inclusion on Serum Biochemical Parameters of Japanese Quail hens Fed as Feed Additives (from 6weeks to 10weeks old)

	Garlic Levels of Inclusion (%)					
Parameters (%)	0	2	4	6	SEM	LOS
Total Protein (g /100ml)	5.07^{d}	5.55^{c}	6.35^{a}	5.58^{b}	0.0975	*
Albumin (g /100ml)	2.70^{a}	2.68^{b}	2.61^{c}	2.43^{d}	0.0717	*
S G O T(IU /L)	120.05^{c}	107.72^{d}	136.93^{a}	127.85^{b}	0.6587	*
S G P T (IU /L)	11.77^{d}	36.30^{a}	18.47^{b}	16.43^{c}	0.5411	*
Alkaline Phosphatase (IU / L)	44.00^{a}	27.63^{d}	34.13^{b}	31.15^{c}	0.3485	*

Means in the same row with different superscripts are significantly different (p< 0.05). SEM = Standard Error of Means, LOS = Level of Significance, S = Serum, G = Glutamic, O = Oxaloacetic, T = Transaminase, P = Pyruvic

The results of effect of garlic varieties on serum biochemical parameters of Japanese quail hens fed as feed additives is presented in Table 29. There were significant (P<0.05) differences in all of the parameters observed except SGOT across the dietary treatment means.

Quails on Ex – Lugu garlic variety had higher Total protein mean value (5.74 g/100ml) than quails on Ex –Kofa garlic variety with lower Total protein mean value (5.48 g/100ml).

Quails on Ex – Kofa garlic variety had higher Albumin mean value (2.68 g/100ml) than quails on Ex – Lugu garlic variety with lower Albumin mean value (2.53 g/100ml).

Quails on Ex – Kofa garlic variety had higher SGPTmean value (27.20 IU/L) than quails on Ex – Lugu garlic variety with lower SGPT mean value (15.78 IU/L).

Quails on Ex – Lugu garlic variety had higher Alkaline Phosphatase mean value (38.91 IU/L) than quails on Ex – Kofa garlic variety with lower Alkaline Phosphatase mean value (29.68 IU/L).

Table 29: Effect of Garlic Varieties on Serum Biochemical Parametersof Japanese Quails Fed as Feed Additives (from 6 weeks to 10 weeks old)

	Variety			
Parameters	Ex- kofa	Ex – lugu	SEM	LOS
Total Protein (g /100ml)	5.48^{b}	5.79^{a}	0.082	*
Albumin (g /100ml)	2.68^{a}	2.53^{b}	0.060	*
S G O T (IU /L)	123.85	122.43	0.554	N S
S G P T (IU /L)	27.20^{a}	15.78^{b}	0.455	*
Alkaline Phosphatase (IU / L)	29.68^{b}	38.91^{a}	0.293	*

Means in the same row with different superscripts are significantly different (p< 0.05). SEM = Standard Error of Means, LOS = Level of Significance, S = Serum, G = Glutamic, O = Oxaloacetic, T = Transaminase, P = Pyruvic

The main effect of garlic levels of inclusion on carcass characteristics of Japanese quail hens fed as feed additives is presented in Table 30.All the variables observed were significantly (P<0.05) different across the dietary treatment means.

Quails on 6 % level of inclusion of garlic varieties had highest value (220.25g) of live weight followed by quails on 4 % level of inclusion with value (215.11g) then quails on 2 % with value (210.00 g) and quails on 0 % with least value (200.00 g) live weight.

Quails on 6 % level of inclusion of garlic varieties had highest value of dressed weight (195.25 g) this followed by 4 % level of inclusion with (190.11g) then 2 % level of inclusion with (180.00 g) and quails on 0 % which had least value (165.00 g) of dressed weight.

Quails on 6 % level of inclusion of garlic varieties had highest value of dressing percent (88.65 %) this followed by 4 % level of inclusion with (88.38 %) then 2 % level of inclusion with (85.71 %) and quails on 0 % which had least value (82.50 %) of dressing percent.

Quails on 6 % level of inclusion of garlic varieties had highest value (21.00 g) of thigh this followed by 4 % level of inclusion with (20.00 g) then 2 % level of inclusion with (19.10 g) then quails on 0 % which had least value (18.25 g) of thigh weight.

Quails on 4 % level of inclusion of garlic varieties had highest value (2.10 g) of drumstick this followed by 6 % level of inclusion with (2.00 g) then 2 % level of inclusion with (1.94 g) then quails on 0 % which had least value (1.49 g) of drumstick weight.

Quails on 6 % level of inclusion of garlic varieties had highest value of back (19.04 g) this followed by 4 % level of inclusion with (19.02 g) then 2 % level of inclusion with (18.11 g) then quails on 0 % which had least value (17.83 g) of back weight.

Quails on 6 % level of inclusion of garlic varieties had highest value of breast (23.06 g) this followed by 4 % level of inclusion with (22.01 g) then 2 % level of inclusion with (21.15 g) then quails on 0 % which had least value (20.60 g) of breast weight.

Quails on 6% level of inclusion of garlic varieties had highest value of wings (13.60 g) this followed by 4 % level of inclusion with (13.40 g) then 2 % level of inclusion with (13.30 g) then quails on 0 % which had least value (13.13 g) of wings weight.

Quails on 2 % level of inclusion of garlic varieties had highest value (6.20 g) neck weight followed by quails on 6 % inclusion levels with (5.95 g) then quails on 4 % inclusion levels with (5.85 g) then quails on 0 % level of inclusion with least value (5.28 g) neck weight.

Quails on 4 % level of inclusion of garlic varieties had highest value (6.00 g) of head weight followed by quails on 0 % level of inclusion with (5.92 g) then quails on 2 % level of inclusion with (5.91 g) then quails on 6 % level of inclusion with least value (5.00 g) of head weightt.

Table 30: Main Effect of Garlic Levels of Inclusion on Carcass Characteristics of Japanese Quail Hens fed as Feed Additives

	Garlic Levels of Inclusion (%)					
Parameters	0	2	4	6	SEM	LOS
Live weight (g)	200.00^{d}	210.00^{c}	215.11^{b}	220.25^{a}	0.262	*
Dressed Weight (g)	165.00^{d}	180.00^{c}	190.11^{b}	195.25^{a}	0.350	*
Dressing percent	82.50^{d}	85.71^{c}	88.38^{b}	88.65^{a}	0.159	*
Thigh (g)	18.25^{d}	19.10^{c}	20.00^{b}	21.00^{a}	0.085	*
Drumstick (g)	1.49^{d}	1.94^{c}	2.10^{a}	2.00^{b}	0.026	*
Back (g)	17.83^{d}	18.11^{c}	19.02^{b}	19.04^{a}	0.069	*
Breast (g)	20.60^{d}	21.15^{c}	22.01^{b}	23.06^{a}	0.090	*
Wings (g)	13.13^{d}	13.30^{c}	13.40^{b}	13.60^{a}	0.066	*
Neck (g)	5.28^{d}	6.20^{a}	5.85^{c}	5.95^{b}	0.034	*
Head (g)	5.92^{b}	5.91^{c}	6.00^{a}	5.00^{d}	0.030	*

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Means, LOS = Level of Significance.

The effect of garlic varieties on carcass characteristics of Japanese quails fed as feed additives is presented in Table 31. There were significant (P<0.05) differences in all the variables measured across the dietary treatment means except live weight, drumstick breast and wing were not significantly (P>0.05) different across the dietary treatment means.

Quails on Ex – Lugu garlic variety had higher dressed weight mean value (180.25 g) than quails on Ex – Kofa garlic variety with lower dressed weight mean value (165.63 g) .

Quails on Ex – Lugu garlic variety had higher dressing percent mean value (87.82 %) than quails on Ex – Kofa garlic variety with lower dressing percent mean value (82.55 %).

Quails on Ex – Lugu garlic variety had higher thigh weight mean value (20.40 g) than quails on Ex – Kofa garlic variety with lower thigh weight mean value (19.00 g).

Quails on Ex – Lugu garlic variety had higher back weight mean value (21.62 g) than quails on Ex – Kofa garlic variety with lower back weight mean value (17.66 g).

Quails on Ex – Lugu garlic variety had higher neck weight mean value (7.25 g) than quails on Ex – Kofa garlic variety with lower neck weight mean value (5.32 g).

Quails on Ex – Lugu garlic variety had higher head weight mean value (7.37 g) than quails on Ex – Kofa garlic variety with lower head weight mean value (5.86 g).

Table 31: Effect of Garlic Varieties on Carcass Chracteristics of Japanese Quail Hens Fed as Feed Additives

Parameters	Variety Ex- Kofa	Ex- Lugu	SEM	LOS
Live weight (g)	200.63	205.25	0.297	NS
Dressed Weight (g)	165.63[b]	180.25[a]	0.289	*
Dressing percent	82.55b	87.82[a]	0.145	*
Thigh (g)	19.00b	20.40[a]	0.068	*
Drumstick (g)	2.36	2.36	0.017	NS
Back (g)	17.66[b]	21.62[a]	0.068	*
Breast (g)	20.30	20.30	0.067	NS
Wings (g)	13.12	13.13	0.054	NS
Neck (g)	5.32[b]	7.25[a]	0.033	*
Head (g)	5.86[b]	7.37[a]	0.33	*

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Means, LOS = Level of Significance.

The main effect of garlic levels of inclusion on visceral organs of Japanese quails fed as feed additives is presented in Table 32. There were significant (P<0.05) differences in all the variables observed except intestinal length across the dietary treatment means.

Quails on 6 % level of inclusion of garlic varieties had the highest value (3.12 g) of liver weight followed by quails on 4 % level of inclusion with (2.99 g), then quails on 2 % level of inclusion with (2.95 g) and quails on 0 % level of inclusion with least value (2.78 g) of liver weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (1.98 g) of lung followed by quails on 4 % level of inclusion with (1.70 g) then quails on 2 % level of inclusion with (1.14 g) and quails on 0 % level of inclusion with least value (1.12 g) of lung weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (2.35 g) of heart followed by quails on 4 % level of inclusion with (2.13 g) then quails on 2 % level of inclusion with (1.88 g) and quails on 0 % level of inclusion with least value (1.77 g) of heart weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (5.43 g) of gizzard followed by quails on 4 % level of inclusion with (5.22 g) then quails on 2 % level of inclusion with (4.70 g) and quails on 0 % level of inclusion with least value (4.12 g) of gizzard weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (0.09 g) of spleen followed by quails on 4 % level of inclusion with (0.08 g) then quails on 2 % level of inclusion with (0.06 g) and quails on 0 % level of inclusion least value (0.04 g) of spleen weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (8.23 g) of intestine followed by quails on 4 % level of inclusion with (7.85 g) then quails on 2 % level of inclusion with (7.60 g) and quails on 0 % level of inclusion with least value (7.32 g) of intestine weight.

Quails on 6 % level of inclusion of garlic varieties had highest value (69.68 cm) of intestine length followed by quails on 2 % level of inclusion with value of (65.47 cm) then 0 % level of inclusion with value of (60.42 cm) and quails on 4 % level of inclusion with the least value (47.05 cm) of intestine length.

Table 32: Main Effect of Garlic Level of Inclusion on Visceral Organs of Japanese Quail Hens Fed as Feed Additives

	Garlic Levels of Inclusion (%)					
Internal organs	0	2	4	6	SEM	LOS
Liver (g)	2.78^{c}	2.95^{b}	2.99^{b}	3.12^{a}	0.021	*
Lung (g)	1.12^{d}	1.14^{c}	1.70^{b}	1.98^{a}	0.20	*
Heart (g)	1.77^{d}	1.88^{c}	2.13^{b}	2.35^{a}	0.018	*
Gizzard (g)	4.12^{d}	4.70^{c}	5.22^{b}	5.43^{a}	0.029	*
Spleen (g)	0.04^{d}	0.06^{c}	0.08^{b}	0.09^{a}	0.010	*
Intestine (g)	7.32^{d}	7.60^{c}	7.85^{b}	8.23^{a}	0.029	*
Intestine Length (cm)	60.42	65.47	47.05	69.68	0.068	*

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Means, LOS = Level of Significance.

The results of effect of garlic varieties on visceral organs of Japanese quail hens fed as feed additives is presented in Table 33. There were significant (P<0.05) differences in all of the variables observed across the dietary treatment means except lung and spleen which were not significantly (P>0.05) affected across the dietary treatment means. Quails on Ex – Lugu garlic variety had higher value (2.99 g) of liver weight compared to Ex – Kofa with lower value (2.93 g) of liver weight. Quails on Ex – Kofa garlic variety had higher value (2.15 g) of heart weight than quails on Ex – Lugu garlic variety with lower value (1.88 g) of heart weight. Quails on Ex – Lugu garlic variety had higher value (4.93 g) of gizzard compared to Ex – Kofa with lower value (4.81 g) of gizzard weight. Quails on Ex – Lugu garlic variety had higher value (7.81 g) of intestine compared to Ex – Kofa with lower value (7.69 g) of intestinal weight.

Quails on Ex – Lugu garlic variety had higer value (65.88 cm) of intestinal length compared to Ex – Kofa with lower value (65.43 cm) of intestinal length.

Table33: Effect of Garlic Varieties on Visceral Organs of Japanese Quail Hens Fed as Feed Additives

	Variety			
Internal Organs	Ex- Kofa	Ex- Lugu	SEM	LOS
Liver (g)	2.93^{b}	2.99^{a}	0.018	*
Lung (g)	1.34	1.26	0.034	NS
Heart (g)	2.15^{a}	1.88^{b}	0.034	*
Gizzard (g)	4.81^{b}	4.93^{a}	0.021	*
Spleen (g)	0.07	0.07	0.008	NS
Intestine (g)	7.69^{b}	7.81^{a}	0.023	*
Intestine Length (cm)	65.43^{b}	65.88^{a}	0.058	*

Means in the same row with different superscripts are significantly different (P<0.05). SEM = Standard Error of Means, LOS = Level of Significance.

4.2 DISCUSSION

The proximate composition of the experimental diets in experiment 1 is presented in Table 5. The crude protein content of the diets obtained in this study is (24.00 %). This agrees with the findings of Musa *et a.l* (2008) who reported that quail needs diet with high crude protein from 22 to 24 %.The crude fibre and ether extract values (4.40 and 4.20 %) obtained in this study agreed with the findings of Omole *et al.* (2006) who reported that fibre and ether extract of poultry feed should not exceed 5 %The ash value (14.05 %) obtained in this study is in agreement with the findings of Ekanem and Ebe (2006) Musa *et al*.(2008) who reported that ash content of quail feed should be from 9 to 18 %.The nitrogen free extract value of 56.94 % obtained in this study was higher than the value of 55.65 % found by (Musa *et al*, 2008).

The proximate composition of the two experimental garlic varieties is presented in Table 6. The crude protein, fibre and ether extract obtained in this study were in agreement with (16-23 % CP, 5 – 5.5 % CF and 4 – 5 % EE) obtained by (Arora, 1999).

The main effect of garlic levels of inclusion on growth performance of Japanese quail chicks fed as feed additives is presented in Table 7.

As the dietary levels of inclusion of garlic varieties increased the final weight was increased. This indicated the activitiesof garlic varieties to improve the final weight of the quail birds this could be due to the fact that garlic improves the final weight of quail birds. This agrees with the finding of Aji *et al.*(2011) who reported that administration of 100 mg of garlic resulted in improved body weight gain at 7, 14 and 21 days of treatment in broiler chickens.The raised in weight gain of the quail birds in line with the increase in levels of inclusion of the garlic varieties. This could be related to the fact that the garlic varieties promote the weight gain of the quail birds. This also agrees with the finding of Aji *et al.*(2011) who reported that administration of 100 mg of garlic resulted in improved body weight gain at 7, 14 and 21 days of treatment in broiler chickens. The decrease in daily feed intake of the quail birds as the levels of inclusion of the garlic varieties increased this could be due the fact that the temperature was too high during the period of conducting the experiment, that cause the birds to reduce their feed intake. This agrees with the finding of Oluyemi and Roberts. (2007) who reported that bird's response to high temperatures includes seeking shade and reducing feed intake to reduce metabolic rate. The decrease in feed conversion ratio of the quail birds when the levels of inclusion of the garlic varieties increased could be related to the fact that higher value of feed conversion ratio indicates the less efficiency of the bird to convert the feed to edible meat. This agrees with the finding of Jagdish, (2006) who reported that the lower the feed per gain the better the feed.The reduce in cost per gain of the quail birds as the levels of inclusion of the garlic varieties increased could be due to the fact that feed conversion ratio obtained in this study has corresponding effect in determining the cost per gain of the feed. This agrees with the finding of James, (2003) and Omole *et al*. (2006) who reported that the high value of feed per gain could contribute to high value of cost per gain.

The results of effect of the garlic varieties on growth performance of Japanese quail chicks fed as feed additives is presented in Table 8.

The augment in the final weight of the quails fed Ex - Lugu garlic variety than those fed Ex – Kofa garlic variety could be due to the fact that Ex – Lugu garlic variety has a little bit higher crude protein content which makes it to improve more on final weight than Ex – Kofa garlic variety. This agrees with the finding of Aji *et al.* (2011) who reported that administration of 100 mg of garlic resulted in improved body weight gain at 7, 14 and 21 days of treatment in broiler chickens.The accrue in the daily feed intake of the quails fed Ex - Kofa garlic variety than those fed Ex – Lugu garlic variety could be due to the fact that Ex – Kofa garlic variety has less pungent taste that make it to improve more daily feed intake than Ex – Lugu garlic variety. This agrees with the finding of Pourali *et al.* (2010) who reported that garlic powder improved average daily feed intake, body weight and feed conversion ratio when added to bird diets at 2, 3, 4, 5 or 6 %.The increase in the weight gain of the quails fed Ex – Lugu garlic variety than those fed Ex - Kofa garlic variety could be due to the fact that Ex – Lugu garlic variety has a little bit greater crude protein that make it to improve more weight gain than Ex – Kofa garlic variety. This agrees with the finding of Pourali *et al. (*2010) and John, (2011) who reported that garlic powder improved average daily feed intake, body weight and feed conversion ratio when added to bird diets at 2, 3, 4, 5 or 6 %.

The results of the main effect of garlic levels of inclusion on nutrient digestibility by Japanese quails fed as feed additives is presented in Table 9.

The increase dietary levels of inclusion of the garlic varieties make the garlic varieties to improve the crude protein digestibility of the quail birds, this could be due to the fact that garlic improves the crude protein digestibility of the quail birds. This agrees with the finding of Khan *et al.* (2011) who reported that plant feed additives such as garlic, onion and ginger or their combination as feed additives in poultry diets enhance the performance of the poultry birds.The fluctuating in the value of crude fibre digestibility when the dietary levels of inclusion of the garlic varieties increased could be related to the fact that poultry birds could not digest fibre as ruminant animals. This agrees with the finding of Omole *et al.* (2006) and Kapoor (2007) who reported that fibre and ether extract of poultry feed should not exceed 5 % The fluctuating in the value of ether extract digestibility as the levels of inclusion of the garlic varieties increased could be due the fact that garlic reduce high cholesterol content in the body of birds This agrees with the finding of Omole *et al.* (2006) and Ranjhan, (2008) who reported that fibre and ether extract of poultry feed should not exceed 5 %. The fluctuating in the value of ash digestibility when the dietary levels of inclusion of the garlic varieties increased could be due the fact that ash content of poultry feed should not exceed eighteen percent. This agrees with the finding of Musa *et al.* (2008) who reported that of ash content of poultry feed should not exceed 18 %

The increased value of nitrogen free extract digestibility as the dietary levels of inclusion of the garlic varieties increased could be due the fact that the garlic varietiespromote nitrogen free extract digestibility.This agrees with the finding of Khan *et al.* (2011) who reported that plant feed additives such as garlic, onion and ginger or their combination as feed additives in poultry diets enhance the performance of poultry birds.

The results of effect of garlic varieties on nutrients digestibility by Japanese quails fed as feed additives is presented in Table 10.

The results of main effect of garlic levels of inclusion on haematological parameters of Japanese quails fed as feed additives is presented in Table 11.

The fluctuating in red blood cells within the normal range values as the dietary levels of inclusion of the garlic varieties increased could be related to the fact that the garlic varieties had no harmful effect on red blood cells. This agrees with the finding of Monica (200) and Banerjee (2007) who reported that red blood cells range from (2.0 – 4.0 x $10^6/mm^3$) is within the normal range.The fluctuating in white blood cells within the normal range values when the dietary levels of inclusion of the garlic varieties increased this could be due the fact that the garlic varieties had no harmful effect on white blood cells. This agrees with the finding of Holness (2005) and Banerjee (2007) who reported that white blood cells range from (9.0 – 31.0 x $10^3/mm^3$) is within the normal range.The fluctuating in packed cells volume within the normal range values as the dietary levels of inclusion of the garlic varieties increased could be due the fact that the garlic varieties had no harmful effect on packed cells volume. This agrees with the finding of Anonymous and Borron (2008) who reported that red blood cells range from (25 – 45 %) is within the normal range.

The results of effect of garlic varieties on haematological parameters of Japanese quails fed as feed additive is presented in Table 12.

The value of red blood cells obtained from the quails fed garlic varieties were within the normal range value of quail birds could be due the fact that the garlic varieties had no harmful effect on red blood cells. This agrees with the finding of Wilson and Bridgstocke (2002) and Banerjee (2007) who reported that red blood cells range from (2.0 – 4.0 x $10^6/mm^3$) is within the normal range.The value of white blood cells obtained from the quails fed garlic varieties within the normal range value could be due the fact that the garlic varieties had no harmful effect on white blood cells. This agrees with the finding of Banerjee (2007) who reported that red blood cells range from (9.0 – 31.0 x 10^3/mm^3) is within the normal range.The value of packed cell volume obtained from the quails fed garlic varieties within the normal range value could be due the fact that the garlic varieties had no harmful effect on packed cell volume. This agrees with the finding of Monica (2000) and Banerjee (2007) who reported that red blood cells range from (9.0 – 31.0 x 10^3/mm^3) is within the normal range.

The results of main effect of garlic levels of inclusion on serum biochemical parameters of Japanese quails fed as feed additives is presented in Table 13.

The fluctuating in Serum Glutomic Oxaloacetic Transaminase (SGOT) within the normal range values when the dietary levels of inclusion of the garlic varieties increased could be due to the fact that the garlic varieties had no harmful effect on SGOT. This agrees with the finding of Monica (2000) and Holness (2005) who reported that SGOT range from (88 –208 IU/L) is within the normal range.

The results of effect of garlic varieties on serum biochemical parameters of Japanese quails fed as feed additive is presented in Table 14.

The value of total protein obtained from the quails fed garlic varieties within the normal range value could be due the fact that the garlic varieties had no harmful effect on total protein. This agrees with the finding of Borron (2008) who reported total protein range from (5 – 7 g/100ml) is within the normal range.The value of albumin obtained from the quails fed garlic varieties were within the normal range value could be due the fact that the garlic varieties had no harmful effect on albumin. This agrees with the finding of Monica (2000) and Borron (2008) who reported that albumin range from (2 – 3.5 g/100ml) is within the normal range. The value of SGOT obtained from the quails fed garlic varieties were the normal range value could be due the fact that the garlic varieties had no harmful effect on SGOT. This agrees with the finding of Holness (2005) who reported that SGOT range from (88 –208 IU/L) is within the normal range.

The results of the main effect of garlic levels of inclusion on carcass Characteristics of Japanese quail chicks fed as feed additives is presented in Table 15.

The increase in live weight when the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves body weight. This agrees with the finding of Mansoub (2011) who reported that feed conversion ratio (FCR) and body Weight of broilers were improved when they were fed garlic (1 g/kg) in the basal diet. The increasein dressing weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic promote carcass yield. This agrees with the findings of Ashayerizadeh *et al* (2009) who reported that garlic powder added (300 g/kg diet) in the broilers feed had higher positive effect on dressing weight. The fluctuating dressing percent as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves dressing percent. This agrees with the finding of Sheldon (2001) and Javed *et al* (2009) who reported that dressing percent of broilers improved when they were fed 6 % per kg diet garlic powder within 40 days of experimental study. The increase in thigh weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic powder promotes thigh weight when fed to quail birds. This agrees with the finding of Ashayerizadeh *et al.* (2009) who reported that thigh of quail birds were significantly increased when they were fed 2 to 6 % garlic powder per kg diet. The increase in drumstick as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves drumstick when fed to quail birds. This agrees with the finding of Sonaiya (2008) and Javed *et al* (2009) who reported that drumstick of quail chickens was improved in a 25 days experimental study, when they were fed garlic powder at 2 to 6 % per kg diet. The increase in back weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic increase back weight when fed to quail birds. This agrees with the finding of Khan *et al*. (2008) who reported that back and breast of broilers were improved when they were fed garlic powder at 2 to 8 % per kg diet. The increase in breast weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic increase breast weight when fed to quail birds.This agreed with the findings of Khan *et al*. (2008) who reported that back and breast of broilers were improved when they were fed garlic powder at 2 to 8 % per kg diet. The increase in wings weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves wing weight when fed to quail chicken. This agrees with the finding of Mohibbifar and Torki (2011) who reported that wing of broilers was improved when they were fed garlic powder at 600 g to 800 g per kg diet. The increase in neck weight as the levels of inclusion of garlic varieties increased could be due the fact that garlic improves body weight when fed to quail birds. This agreed with the findings of Ashayerizadeh *et al* (2009) who reported that garlic powder added (300 g/kg diet) in to broilers feed had higher positive effect on dressing weight. The fluctuating in head weight as the levels of inclusion of garlic varieties increased could be due the fact that garlic reduces lipid concentration in quail birds. This agreed with the findings of Canogullari *et al*. (2010) who reported that feeding garlic powder at the rate of 1, 2 and 4 % were found to reduce lipid concentration in quail birds.

The results of the effect of garlic varieties on carcass characteristics of Japanese quails fed as feed additives is presented in Table 16.

The higher value of dressing weight observed on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more carcass yield than Ex – Kofa variety. This agrees with the finding of Ashayerizadeh *et al* (2009) and Glencross (2009) who reported that garlic powder added (300 g/kg diet) in to broilers feed had higher positive effect on dressing weight. The higher value of dressing percent observed on Quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more carcass yield than Ex - Kofa. This agreed with the findings of Javed *et al* (2009) and Searcy (2012) who reported that dressing percent of broilers improved when they were fed 6 % per kg diet garlic powder within 40 days of experimental study. The higher values of back weight observed on quails fed Ex –Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more back weight than Ex – Kofa garlic variety This agreed with the findings of Khan, *et al* (2008) who reported that back and breast of broilers were improved when they were fed garlic powder at 2 to 8 % per kg diet.

The results of main effect of garlic levels of inclusion on visceral organs of Japanese quails fed as feed additives is presented in Table 17.

The increase in liver weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves liver weight when fed to quail chickens. This agreed with the finding of Javed *et al* (2009) and Mahmood *et al* (2009) who reported that carcass yield of quail chickens was increased when they were fed garlic powder at 8 % per kg diet. The increase in lung weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves lung weight when fed to quail chickens. This also agreed with the finding of Mello (2007) and Javed *et al* (2009) who reported that carcass yield of quail chickens was increased when they were fed garlic powder at 8 % per kg diet.The increased in heart weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves heart weight when fed to quail chickens. This agrees with the finding of Khazaal (2006) and Javed *et al* (2009) who reported that carcass yield of quail chickens was increased when they were fed garlic powder at 8 % per kg diet. The increase in gizzard weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves gizzard weight when fed to quail chickens. This agrees with the finding of Beever (2002) and Mohibbifar and Torki (2009) who reported that carcass yield of broiler chickens were increased when they were fed garlic powder at 8 % per kg diet. The increased in spleen weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves spleen weight when fed to quail chickens. This agreed with the finding of Sastry (2005) and Mohibbifar and Torki (2009) who reported that carcass yield of broiler chickens were increased when they were fed garlic powder at 8 % per kg diet. The increase in intestine weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves intestine weight when fed to quail chickens. This agreed with the findings of Mould (2004) and Javed *et al* (2009) who reported that carcass yield of quail chickens was increased when they were fed garlic powder at 8 % per kg diet.

The effect of garlic varieties on visceral organs of Japanese quails fed as feed additives is presented in Table 18.

The higher value of heart weight obtained on quails fed Ex – Kofa garlic variety could be due to the fact that Ex – Kofa garlic variety increase more heart weight than Ex - Lugu garlic variety. This agrees with the finding of Srinivasan (2004) and Johnson (2006) who reported that garlic produce positive effects on carcass yield in term of relative weight of liver, spleen, lung, heart, gizzard, pancreases, intestine percent and length. The higher value of intestine weight obtained on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety improves more intestine weight than Ex - Kofa garlic variety. This agrees with the finding of Srinivasan (2004) and Jenet (2007) who reported that garlic produce positive effects on carcass yield in terms of relative weight of liver, spleen, lung, heart, gizzard, pancreases, intestine weight and length.

Theproximate composition of the experimental diets in experiment II is presented in Table 19.

The crude protein content of the diets obtained in this study is (23.00 %). This agreed with the findings of Marks (2003) and Musa *et al* (2008) who reported that quail needs diet with high crude protein from 22 to 24 %.The crude fibre and ether extract values (4.00 and 4.00 %) obtained in this study agreed with the findings of Omole *et al* (2006) and Laurent (2007) who reported that fibre and ether extract of poultry feed should not exceed 5%. (The ash content obtained in this study was in agreement with the findings of Michele (2006) and Musa *et al* (2008) who reported that ash content of quail feed should be from 9 to18 %). The nitrogen free extract obtained in this study was higher than the value of 55.65 % found by (Musa *et al.*, 2008; Raj, 2008).

The result of the main effect of garlic levels of inclusion on nutrient digestibility by Japanese quails fed as feed additives is presented in Table 20.

The increase in crude protein digestibility when the levels of inclusion of garlic varieties increased could be related to the fact that garlic aid in digestion of nutrients when fed to poultry. This was in agreement with the findings of Ahron (2009) who reported that feeding garlic at 6 % to broiler chicken improve it degree of nutrients digestion. The fluctuation of crude fibre digestibility as the levels of inclusion of garlic varieties increased could be related to the fact that garlic aid poultry to digest nutrients. This agreed with the findings of Anthony (2008) who reported that garlic inclusion at 5 to 6 % in poultry diets reduce difficulty in fibre digestion. The fluctuating of ether extract digestibility when the levels of inclusion of garlic varieties increased could be related to the fact that garlic reduces excess fat content of the feed. This was in agreement with the findings of Lake (2003) who reported that garlic reduces excess fat contents in plant and animal bodies. The fluctuating of ash digestibility when the levels of inclusion of garlic varieties increased could be related to the improve nutrients digestibility. This agreed with the findings of Randel (2006) who reported that feeding garlic at 2,3,4,5 and 6 % improve broiler`s digestion of feed. The fluctuating of nitrogen free extract digestibility as the levels of inclusion of garlic varieties increased. This could be related to the fact that garlic improves carbohydrate digestion. This agrees with the findings of Hue (2008) who reportet that garlic improves nutrients digestion when fed to broiler chicken at 2 to 8 % levels of inclusion.

The result of effect of garlic varieties on nutrient digestibility by Japanese quails fed as feed additives is presented in Table 21.

There were no significant changes in all the parameters observed. This could be related that adult birds have nearly the same mood of digestion. This agreed with the findings of Omole *et al* (2006) who reported that digestion in chick birds is a little bit faster than in adult birds.

The result of main effect of garlic levels of inclusion on egg performance of Japanese quails fed as feed additives is presented in Table 22.

The increase in final weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves final weight when fed to quail chickens.

This agreed with the finding of Karish (2000) and Aji *et al* (2011) who reported that administration of 100 mg of garlic resulted in improved body weight gain at 7, 14 and 21 days of treatment in broiler chickens.The increase in percentage change in weight as the levels of inclusion of garlic varieties increased could be due to the fact that garlic had positive effect on percentage change in weight when fed to quail chickens. This agreed with the findings of Mansoub (2011) who reported that percent change in weight of birds was improved when they were fed garlic (1g/kg) in the basal diet.The increase in feed intake per gram egg production as the levels of inclusion of garlic varieties increased could be due to the fact that garlic had positive effect on feed intake per gram egg production when fed to quail chickens. This agreed with the findings of Aji *et al* (2011) and Larry (2007) who reported that diet containing 2 to 6 % garlic powder improves feed intake of broiler chicks.The increase in hen day egg production as the levels of inclusion of garlic varieties increased could be due to the fact that garlic improves hen day egg production when fed to quail chickens. This agrees with the findings of Khan *et al* (2008) who reported that egg production increased during the six weeks in which 2, 4, 6 or 8 % garlic powder was fed to laying hens. The increase in hen house egg production as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves hen house egg production when fed to quail chickens. This agreed with the findings of Jackie (2003) and Khan *et al.* (2008) who reported that egg production increased during the six weeks in which 2, 4, 6 or 8 % garlic powder was fed to laying hens.The decrease in feed conversion ratio as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves feed conversion ratio when fed to quail chickens. This agreed with the findings of Mansoub (2011) and Ahmad (2006) who reported that feed conversion ratio of broiler birds was improved when they were fed garlic 6

% /kg in the diet. The decrease in cost per crate of eggs as the level of inclusion of garlic varieties increased could be due to the fact that garlic had positive effect on cost per crate of eggs when fed to quail chickens. This agrees with the findings of Ahmad (2006) who reported that the addition of 0, 2, 4, 6 and 8 % garlic powder per kg diet significantly decreased cost per crate of eggs. The increase in egg weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves egg weight when fed to quail chickens. This agreed with the findings of Kazim (2004) and Khan *et al.* (2008) who reported that feeding dried garlic powder at 2 to 8 % per kg diet result in better egg production, mass and weight. The increase in number of eggs as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves number of eggs when fed to quail chickens. This agreed with the findings of Khan *et al.* (2008) who reported that feeding dried garlic powder at 2 to 8 % per kg diet result in better egg production, mass and weight.

The effect of garlic varieties on egg performance of Japanese quails fed as feed additives is presented in Table 23.

The higher value of percent change in weight obtained on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more percent change in weight than Ex – Kofa garlic variety. This agrees with the findings of Mansoub (2011) who reported that percent change in weight of birds was improved when they were fed garlic (1 g/kg) in the basal diet. The higher value of feed intake per gram egg production observed on quail hens fed Ex – Kofa garlic variety could be due to the fact that Ex – Kofa garlic variety promote more feed intake per gram egg production than Ex – Lugu garlic variety. This agreed with the findings of Aji *et al* (2011) and Terry (2002) who reported that diet containing 8 % garlic powder improved feed intake of broiler chickens.The higher value of hen day egg production obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more hen day egg production than Ex – Kofa garlic variety. This agreed with the findings of Ticely (2008) and Khan *et al.* (2008) who reported that egg production increased during the six weeks in which 2, 4, 6 or 8 % garlic powder was fed to laying hens.

The main effect of garlic levels of inclusion on egg quality characteristics of Japanese quails fed as feed additives is presented in Table 24.

The increase in egg weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves egg weight when fed to quail chickens. This agreed with the findings of Yakin, Onbasilar and Reisli (2006) who reported that egg weight increased when laying hens were fed 5 to 10 g/kg garlic powder. The increase in egg length as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves egg length when fed to quail chickens. This agreed with the findings of Nazugul, Turkyil, Maz, and Bardakcloglu (2001) who reported that egg length, width, albumen weight, height and percent increased with the quail age. The increase in egg width as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves egg width when fed to quail chickens. This agreed with the findings of Nazugul *et al* and Dukes (2001; 2002) who reported that egg length, width, albumen weight, height and percent increased with the quail age. The increase in egg shape index as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves egg shape index when fed to quail chickens. This agreed with the findings of Chowdhury *et al*. (2002 and Mahmound (2010) who reported that adding garlic powder at 2, 3, 4, 5 and 6 % per kg diet significantly increased egg shape index, shell thickness and weight. The increase in shell thickness as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves shell thickness when fed to quail chickens. This agreed with the finding of Chowdhury *et al*. (2002) who reported that adding garlic powder at 2, 3, 4, 5and 6% per kg diet significantly increased egg shape index, shell thickness and weight. The increase in shell weight as the inclusion levels of two garlic varieties increased could be due to the fact that garlic improves shell weight when fed to quail chickens. This also agreed with the finding of Chowdhury *et al*. (2002) who reported that adding garlic powder at 2, 3, 4, 5 and 6 % per kg diet had significant effect on increasing egg shape index, shell thickness and weight.The increased in albumen height as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves albumen height when fed to quail chickens. This agreed with the finding of Mahmond *et al*. (2010) who reported that albumen height, weight and percent were improved when laying hens were fed with 0 to 8 % garlic powder. The increase in albumen weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves albumen weight when fed to quail chickens. This agreed with the finding of Mahmond *et al*. (2010) who reported that albumen height, weight and percent were improved when laying hens were fed with 0 to 8 % garlic powder. The similar values obtained in albumen percent as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves albumen percent when fed to quail chickens. This agreed with the finding of Khan *et al. (*2008*)* and Mahmond *et al*. (2010) who reported that albumen height, weight and percent were improved when laying hens were fed with 0 to 8 % garlic powder. The increase in yolk weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic promotes yolk weight when fed to quail chickens. This agreed with the finding of Canogulari *et al*. (2010) who reported that yolk weight and height were improved when laying hens were fed 6 % garlic powder.

The increase in yolk height as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves yolk height when fed to quail chickens. This agreed with the findings of Solomon (2004) and Canogulari *et al*. (2010) who reported that yolk weight and height were improved when laying hens were fed 6 % garlic powder.The increase in Haugh unit of quails fed with garlic varieties as feed additives could be due to the fact that garlic promotes Haugh unit when fed to laying hens. This agreed with the findings of Lim, You, An and Kang (2006) who concluded that with increasing dietary garlic powder, the Haugh unit score increased linearly after two weeks.

The effect of garlic varieties on egg quality parameters of Japanese quails fed as feed additives is presented in Table 25.

The higher value of egg weight obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety improves more egg weight than Ex – Kofa garlic variety. This agreed with the findings of Yakin *et al*. (2006) who reported that egg weight increased when laying hens were fed 5 to 10 g/kg garlic powder. The higher value of egg width obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more egg width than Ex – Kofa garlic variety. This agreed with the findings of Nazugul, Turkyil, Maz, and Bardakcloglu (2001) who reported that egg length, width, albumen weight, height and percent increased with the quail age. The higher value of egg shape index obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety improves more egg shape index than Ex – Kofa garlic variety. This agreed with the findings of Chowdhury *et al*. (2002) and Mahmound *et al.* (2010) who reported that adding garlic powder at 2, 3, 4, 5 and 6 % per kg diet had significant effect on increasing egg shape index, shell thickness and weight. The higher value of shell thickness obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more shell thickness than Ex – Kofa garlic variety. This agreed with the finding of Chowdhury *et al*. and Murrey (2002) who reported that adding garlic powder at 2, 3, 4, 5and 6 % per kg diet had significant effect on increasing egg shape index, shell thickness and weight. The higher value of shell weight obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety increase more shell weight than Ex – Kofa garlic variety. This agreed with the findings of Chowdhury *et al*. (2002) and Ahmad (2005) who reported that adding garlic powder at 2, 3, 4, 5and 6 % per kg diet had significantly effect on increasing egg shape index, shell thickness and weight. The higher value of albumen height obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more albumen height than Ex – Kofa garlic variety. This agreed with the findings of Nazugul *et al (2001)* and Zaid (2013) who reported that egg length, width, albumen weight, height and percent increased with the quail age. The higher value of albumen weight obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety improves more albumen weight than Ex – Kofa garlic variety. This agrees with the findings of Nazugul *et al*. (2000) and Chowdhury *et al.*(2002) who reported that egg length, width, albumen weight, height and percent increased with the quail age. The higher value of albumen percent age obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more albumen percent than Ex – Kofa garlic variety. This agreed with the findings of Nazugul *et al* (2001) and Suraj (2014) who reported that egg length, width, albumen weight, height and percent increased with the quail age. The higher value of yolk weight obtained on quail hens fed Ex – Kofa garlic variety could be due to the fact that Ex – Kofa garlic variety promote more yolk weight than Ex – Lugu garlic variety. This agreed with the findings of Chazanfav (2007) and Canogullari *et al.* (2010) who reported that yolk weight and height were increased when laying hens were fed 6 % garlic powder.The higher value of yolk height obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more yolk height than Ex – Kofa garlic variety. This agreed with the findings of Liener (2006) and Canogullari *et al* (2010) who reported that yolk weight and height were increased when laying hens were fed 6 % garlic powder. The higher value of Haugh unit obtained on quail hens fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety improves more Haugh unit than Ex – Kofa garlic variety. This agreed with the findings of Lim *et al*. (2006) who reported that with increasing dietary garlic powder from 0 to 8 % per kg diet, the Haugh unit increased after three weeks in laying.

In the present study main effect of garlic levels of inclusion on haematological parameters of Japanese quails fed as feed additives is presented in Table 26.

The increase in red blood cells as the level of inclusion of garlic varieties increased could be due to the fact that garlic stimulates blood circulation. The increase in red blood cells found in this study indicated that quails birds were not anaemic. This agreed with the finding of Jack (2001) who reported that feeding broiler chickens with garlic powder at 2 to 8 %/ kg diet could stimulate blood circulation. The increase in packed cell volume as the level of inclusion of garlic varieties increased could be due to the fact that garlic stimulates blood circulation, this could be related to the clear indication that the birds were not anaemic and they maintained normal supply of blood in the body. The increase in packed cell volume found in this study agreed with the finding of Jacob (2000) and Jack (2001) who reported that feeding broiler chickens with garlic powder at 2 to 8 %/ kg diet could stimulate blood circulation.

The effect of garlic varieties on haematological parameters of Japanese quails fed garlic as feed additives is presented in Table 27.

The increase in red blood cells of quails fed Ex – Kofa garlic is a clear indication that the birds were not anaemic. This could be due to the fact that Ex - Kofa garlic variety stimulate more blood circulation than Ex – Lugu garlic variety, the increase in red blood cells found in this study agreed with the finding of Jack (2001) and Rahimi *et al* (2011) who reported that feeding broiler chickens with garlic powder at 2 to 8 %/ kg diet could stimulate blood circulation. The higher value of packed cell volume obtained in quails on Ex – Lugu garlic variety could be due the fact that Ex – Lugu garlic variety stimulate more blood circulation than Ex – Kofa garlic variety. This agreed with the finding of Jack (2001) and Rajah (2003) who reported that feeding broiler chickens with garlic powder at 2 to 8 %/ kg diet could stimulate blood circulation.

The main effect of garlic levels of inclusion on serum biochemical parameters of Japanese quails fed as feed additives is presented in Table 28.

The fluctuating in total protein valuesas the levels of inclusion of garlic varieties increased could be due to the fact that garlic did not poison the quail birds when fed to them as feed additive. This agreed with the finding of Banerjee (2007) who reported that 5 – 7 g/100ml of total protein is within the normal range value of chickens. The fluctuating of albumin values as the level of inclusion of garlic varieties increased could be related to the fact that garlic did not harm the quail hens when fed to them as feed additive. This agreed with the findings of Philips (2008) who reported that 2 – 3.5 g/100ml of albumin is within the normal range value for chickens.The fluctuating in values of serum glutamic oxaloacetic transaminase as the levels of inclusion increased found in this study indicated that garlic is not toxic to quails birds. This agreed with the findings of Jack (2001) and Nicolos (2007) who reported that 88 – 208 IU/L of SGOT is within the normal range value for chickens. The fluctuating in values of serum glutamic pyruvic transaminase as the levels of inclusion increased could be due to the fact that garlic has no harmful effects to quail hens. This agreed with the finding of Dickson (2011) who reported that 10 – 37 (IU/L) of SGPT is within the normal range value of chickens. The fluctuating in values of alkaline phosphataseas the level of inclusion of garlic varieties increased could be due to the fact that garlic did not induce adverse effects to quail hens. This agreed with the findings of Bray (2000) who reported that 25 – 44 (IU/L) of alkaline phosphatase is within the normal range value of chickens.

The results of effect of garlic varieties on serum biochemical parameters of Japanese quail hens fed as feed additives is presented in Table 29.

The increase in total protein of quails fed Ex – Lugu garlic variety than those fed Ex – Kofa garli variety is a clear indication that garlic did not harm the quail hens. This agreed with the finding of Chain (2006) and Banerjee (2007) who reported that 5 – 7 g/100 ml of total protein is within the normal range value for chickens. The increase in albumin of quails fed Ex – Kofa garlic variety indicated that garlic did not poison the quail hens. This agreed with the findings of Geoge (2004) and Philips (2008) who reported that 2 – 3.5 g/100 ml of albumin is within the normal range value for chickens.The increase in serum glutamic pyruvic transaminase of quail hens fed Ex – Kofa garlic could be related to the fact that garlic did not harm the quail birds. This agreed with the finding of Remsey (2009) and Dickson (2011) who reported that 10 – 37 (IU/L) of SGPT is within the normal range value for chickens. The increase in alkaline phosphatase of quails fed Ex – Lugu garlic variety is a clear indication that the birds were not harm.This agreed with the findings of Bray (2000) and Raop (2006) who reported that 25 – 44 (IU/L) of alkaline phosphatase is within the normal range value for chickens.

The main effect of garlic levels of inclusion on carcass characteristics of Japanese quails fed as feed additives is presented in Table 30.

. The increase in live weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves body weight. This agreed with the findings of Mansoub (2011) who reported that feed conversion ratio (FCR) and body weight of broilers were improved when they were fed garlic (1 g/kg) in the basal diet. The increase in dressing weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic promote carcass yield. This agreed with the findings of Ashayerizadeh, Daster and Shargh (2009) who reported that garlic powder added (300 g/kg diet) to broilers feed had higher positive effect on dressing weight. The increase in dressing percent as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves dressing percent. This agreed with the findings of Parr (2003) and Javed *et al.* (2009) who reported that dressing percent of broilers improved when they were fed 6 % per kg diet garlic powder within 40 days of experimental study.The increased in thigh weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic powder promotes thigh weight when fed to quail birds. This agreed with the finding of Crampton (2002) and Ashayerizadeh *et al.* (2009) who reported that thigh of quail birds were significantly increased when they were fed 2 to 6 % garlic powder per kg diet. The increase in drumstick as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves drumstick when fed to quail birds. This agreed with the finding of Richter (2000) and Javed *et al*. (2009) who reported that drumstick of quail chickens was improved in a 25 days experimental study, when they were fed garlic powder at 2 to 6 % per kg diet. The increase in back weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic increase back weight when fed to quail birds. This agreed with the findings of Schurz (2002) and Khan *et al*. (2008) who reported that back and breast of broilers were improved when they were fed garlic powder at 2 to 8 % per kg diet. The increase in breast weight as the level of inclusion of garlic varieties increased could be due to the fact that breast weight was increased when garlic was fed to quail birds. This agreed with the findings of Kohler 2004) and Khan *et al.* (2008) who reported that back and breast of broilers were improved when they were fed garlic powder at 2 to 8 % per kg diet. The increase in wings weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves wings when fed to quail chicken. This agreed with the findings of Jahrais (2010) and Mohebbifar and Torki (2011) who reported that wing of broilers was improved when the birds were fed garlic powder at 600 g to 800 g per kg diet. The decrease in neck weight as the level of inclusion of garlic varieties increased could be due the fact that garlic reduces lipid concentration in quail birds. This agreed with the findings of Bitsch (2006) and Canogullari *et al*. (2010) who reported that feeding garlic powder at the rate of 1, 2 and 4 % were found to reduce lipid concentration in quail birds. The decrease in head weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic reduces lipid concentration in quail birds. This agreed with the findings of Jagan (2997) and Canogullari *et al*. (2010) who reported that feeding garlic powder at the rate of 1, 2 and 4 % were found to reduce lipid concentration in quail birds.

The effect of garlic varieties on carcass characteristics of Japanese quails fed as feed additives is presented in Table 31.

The higher value of dressed weight observed on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more carcass yield than Ex – Kofa variety. This agrees with the finding of Sonakish (2005) and Ashayerizadeh, *et al*. (2009) who reported that garlic powder added (300 g/kg diet) in to broilers feed had higher positive effect on dressing weight. The higher value of dressing percent observed on Quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more carcass yield than Ex - Kofa. This agreed with the findings of Pooja and Javed *et al.* (2009) who reported that dressing percent age of broilers improved when they were fed 6 % per kg diet garlic powder within 40days of experimental study. The higher value of thigh observed on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more thigh percent than Ex - Kofa garlic variety. This agreed with the finding of Sakshi (2007) and Ashayerizadeh *et al.* (2009) who reported that thigh of quail birds were significantly increased when they were fed 2 to 6 % garlic powder per kg diet. The higher values of back weight observed on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more back weight than Ex – Kofa garlic variety. This agreed with the findings of and Khan, *et al*. (2008) and Sheel (2011) who reported that back and breast of broilers were improved when they were fed garlic powder at 2 to 8 % per kg diet. The higher value of neck weight observed on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote neck weight than Ex – Kofa garlic variety. This agreed with the findings of Ashayerizadeh *et al*. (2009) and Amit (2012) who reported that neck and head of quail chicks were improved when they were given garlic at the rate of 2 to 6 % per kg diet. The higher value of head weight observed on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more head weight than Ex – Kofa garlic variety. This agreed with Kapoor (2008) and Ashayerizadeh *et al*. (2009) who reported that neck and head of quail chicks were improved when they were given garlic at the rate of 2 to 6 % per kg diet.

The main effect of garlic levels of inclusion on visceral organs of Japanese quails fed as feed additives is presented in Table 32.

The increase in liver weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves liver when fed to quail chickens. This agreed with the findings of Brunthavers (2006) and Javed *et al.* (2009) who reported that carcass yield of quail chickens was increased when they were fed garlic powder at 8 % per kg diet. The increase in lung weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves lung when fed to quail chickens. This also agreed with the findings of Abeke (2003) and Javed *et al.* (2009) who reported that carcass yield of quail chickens was increased when they were fed garlic powder at 8 % per kg diet. The increase in heart weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves heart when fed to quail chickens. This agreed with the findings of Mardsden (2004) and Javed *et al.* (2009) who reported that carcass yield of quail chickens was increased when they were fed garlic powder at 8 % per kg diet. The increase in gizzard weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves gizzard when fed to quail chickens. This agreed with the findings of Doglas (2006) and Mohibbifar and Torki (2009) who reported that carcass yield of broiler chickens were increased when they were fed garlic powder at 8 % per kg diet. The increase in spleen weight as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves spleen when fed to quail chickens. This agreed with the findings of Vijay (2007), Mohibbifar and Torki (2009) who reported that carcass yield of broiler chickens were increased when they were fed garlic powder at 8 % per kg diet. The increase in intestine as the level of inclusion of garlic varieties increased could be due to the fact that garlic improves intestine when fed to quail chickens. This agreed with the findings of Joseph (2008) and Javed *et al.* (2009) who reported that carcass yield of quail chickens was increased when they were fed garlic powder at 8 % per kg diet The increase and decreased in intestinal length as the level of inclusion of garlic varieties increased could be due to the fact that garlic promote more intestinal length at 6 % level of inclusion. This agreed with the findings of Paul and Srinivasan (2004) who reported that garlic produce positive effects on carcass yield in term of relative weight of liver, spleen, lung, heart, gizzard, pancreases, intestine percent and length.

The effect of garlic varieties on visceral organs of Japanese quails fed as feed additives is presented in Table 33.

The higher value of liver weight obtained on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more liver weight than Ex - Kofa garlic variety. This agreed with the findings of Javendal, Arab and Belman (2008) who reported that garlic improve viscera yield in terms of liver, heart, intestine weight and length. The higher value of lung weight obtained on quails fed Ex – Lugu could be due to the fact that Ex – Lugu garlic variety promote more lung weight than Ex - Kofa garlic variety. This agreed with the findings of Bickel (2000) and Ralph (2007) who reported that garlic promote carcass yield in terms of spleen, lung, gizzard and pancreases. The higher value of heart weight obtained on quails fed Ex – Kofa garlic variety could be due to the fact that Ex – Kofa garlic variety increase more heart weigt than Ex - Lugu garlic variety. This agreed with the finding of Deboer (2006) and Govinda (2009) who reported that garlic extract improve viscera yield in terms of spleen, lung, heart and gizzard. The higher value of gizzard weight obtained on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more gizzard weight than Ex - Kofa garlic variety. This agreed with the findings of Bamgbose and Ralph (2007) who reported that garlic promote carcass yield in terms of spleen, lung, gizzard and pancreases. The higher value of intestinal weight obtained on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety improves more intestinal weight than Ex - Kofa garlic variety. This agreed with the findings of Sonny (2003) and Srinivasan (2004) who reported that garlic produce positive effects on carcass yield in terms of relative weight of liver, spleen, lung, heart, gizzard, pancreases, intestine and length. The higher value of intestinal length obtained on quails fed Ex – Lugu garlic variety could be due to the fact that Ex – Lugu garlic variety promote more intestinal length than Ex - Kofa garlic variety. This agreed with the findings of Rai (2007) and Javed*et al* (2008) who reported that garlic improve viscera yield in terms of liver, heart, intestine percent and length.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

In the experiments (one and two) a total of nine hundred and sixty (960) and eight hundred and sixty four (864) Japanese quail birds at 1 and 6 weeks old with an initial average weight of 15.0 g and 150.25 g were used to evaluate growth performance, egg laying and quality of Japanese quails fed garlic varieties as feed additives. Growth performance, nutrients digestibility, haematological and serum biochemical parameters, carcass and visceral organs characteristics, egg performance and quality parameters were determined. The Japanese quails were divided in to eight groups in each of the two experiments and allotted to eight dietary treatments designated as 1, 2, 3, 4, 5, 6, 7 and 8 where 1 and 5 were control. Each of the test ingredients Ex– Kofa and Ex - Lugu garlic varieties was included in the experimental diets at the levels of 0,2, 4 and 6 %. In experiment I main effect of levels of inclusion of garlic varieties on growth performance of Japanese quails fed as feed additives. The following (Final weight, weight gain, average daily feed intake, feed per gain and cost per gain) were significantly ($P<0.05$) affected by the levels of inclusion of garlic varieties as feed additives. In terms of effect of garlic varieties on growth performance by Japanese quails fed as feed additives, (final weight, weight gain and average daily feed intake) were significantly ($P<0.05$) affected by the addition of garlic varieties as feed additives. In nutrients digestibility all the parameters (crude protein, crude fibre, ether extract and nitrogen free extract digestibility) were significantly ($P<0.05$) different except dry matter digestibility by the addition of garlic varieties as feed additives. The haematological and serum biochemical parameters such as (red blood cells, white blood cells, packed cell volume, total protein, albumin, serum glutamic oxaloacetic transaminase, serum glutomic pyruvic transaminase and alkaline phosphatase) were significantly ($P<0.05$) affected by the addition of garlic varieties as feed additives. In terms of carcass and visceral organs characteristics all the parameters were significantly ($P<0.05$) diffent except intestinal length by the addition of garlic varieties as feed additives.

In experiment II main effects of levels of inclusion of garlic varieties on nutrients digestibility of Japanese quails fed as feed additives. All the parameters were significantly ($P<0.05$) different except dry matter digestibility by the levels of inclusion of garlic varieties as feed additives. Main effect of levels of inclusion of garlic varieties on egg performance and quality characteristics of Japanese quails fed as feed additives. all the parameters were significantly ($P<0.05$) different except yolk percent by the levels of inclusion of garlic varieties as feed additives. In terms of effect of garlic varieties on egg performance and quality characteristics of Japanese quails fed as feed additives, all the parameters were significantly ($P<0.05$) affected except egg length albumen percent and yolk percent by the addition of garlic varieties as feed additives, however, in egg performance effect ofgarlic varieties on Japanese quails fed as feed additives only percent weight change, feed intake, hen day egg production and hen house egg production were significantly ($P<0.05$) affected by the addition of garlic varieties as feed additives. In main effect of levels of inclusion of garlic varieties on haematological and biochemical parameters of Japanese quails fed as feed additives. The following (red blood cells, packed cell volume, total protein, albumin, serum glutamic oxaloacetic transaminase, serum glutomic pyruvic transaminase and alkaline phosphatase) were significantly ($P<0.05$) different by the levels of inclusion of garlic varieties as feed additives. In terms of effect of garlic varieties on haematological and serum biochemical parameters of Japanese quails fed as feed additives also (red blood cells, packed cell volume total protein, albumin, serum glutomic pyruvic transaminase and alkaline phosphatase) were significantly (P<0.05) affected by the addition of garlic varieties as feed additives.Inmain effect of levels of inclusion of garlic varieties on carcass and viscera characteristics of Japanese quails fed as feed additives. all the parameters were significantly (P<0.05) affected by the levels of inclusion of garlic varieties as feed additives. In terms of effect of garlic varieties on carcass and visceral organs characteristics of Japanese quails fed as feed additives. All the parameters were significantly (P<0.05) different except live weight, drumstick, breast, wing, lung and spleen by the addition of garlic varieties as feed additives. The results indicated that using garlic varieties as feed additives in the diets of Japanese quails enhance the performance of the quail birds. Thus it had no detrimental effect on all the parameters of Japanese quails observed.

5.2 Conclusion

In conclusion, the results of this study indicates that garlic varieties(Ex – Kofa and Ex – Lugu) when fed as feed additives at 2, 4 and 6 % to quail birds improve growth performance, egg laying capacity, quality and carcass yield without adverse effects.

However, higher growth, egg laying performance and quality were obtained in quails fed Ex – Lugu garlic variety at 6% (highest concentration of garlic) level of inclusion.

5.3 Recommendation

The recommendetion based on the results of this study:

It is therefore recommended that both Ex – Kofa and Ex – Lugu garlic varieties should be fed as feed additives to quail hens at 2,4 and 6 % level of inclusion since improved growth performance, egg laying capacity, quality and carcass yield without side effects were observed at these level. In terms of garlic variety, it is therefore recommended that Ex- Lugu garlic varieties could be fed as feed additives to quail hens especially at 6 % level of inclusion when related to the performance of the quails as mentioned above. This also indicates that the test ingredients (Ex – Kofa and Ex – Lugu garlic varieties) could be used as substituteto synthetic poultry feed additives to avoid adverse effects.

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APPENDICES

APPENDIX I

A PHOTOGRAPH OF THE TEST INGREDIENT (Ex – Kofa Garlic variety) (*Yar kofa*)

Botanical Name: *Allium sativum*
Local Name: *Yar kofa*
English Name: Garlic
Variety: Ex – Kofa

APPENDIX II

A PHOTOGRAPH OF THE TEST INGREDIENT (Ex – Lugu Garlic variety) (*Yar sokoto or Yar lugu*)

Botanical Name: *Allium sativum*
Local Name: *Yar sokoto*
English Name: Garlic
Variety: Ex – Lugu

APPENDIX III

A PHOTOGRAPH OF THE OF THE EXPERIMENTAL BIRDS

Scientific Name: *Coturnix coturnix japonica*
Local Name: Salwa
English Name: Quail
Breed: Japanese Quail

APPENDIX IV

A PHOTOGRAPH OF EGGS LAID BY THE EXPERIMENTAL BIRDS