THE EFFECT OF GARLIC (*Allium sativum* L.) MEAL AS A FEED INGREDIENT IN THE DIETS OF BROILER CHICKENS

BY

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AHMADU BELLO UNIVERSITY, ZARIA.

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BY

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MAY, 2015

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DECLARATION

I hereby declare that this thesis titled **"**The Effect of Garlic (*Allium Sativum* l.) Meal as A Feed Ingredient in the Diets of Broiler Chickens**"** was performed by me in the Department of Animal Science Under the supervision of Prof. J.J. Omage and Prof. G.S. Bawa.

References made to published literature have been duly acknowledged in the text and a list of references provided. No part of this thesis has previously been presented for another degree or diploma in any application for any other qualification in the University.

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CERTIFICATION

The thesis titled "The Effect of Garlic (*Allium Sativum* L.) Meal as a feed ingredient in the diets of Broiler Chickens" By OGAH, Adakole Christopher meets the regulations governing the Award of the degree of Masters of Science of the Ahmadu

Bello University, Zaria and is approved for its literary presentation and contribution to scientific knowledge.

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DEDICATION

This work is dedicated to God Almighty, The Ogah Family and to my Friend Engr. Edward Ogbeta

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I wish to express my gratitude to God Almighty for His Grace and Provision He made available to me throughout the course of this work.

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ABSTRACT

Four experiments were carried out to evaluate the effect of Garlic supplementation in broiler chickens. In the first experiments 0-4 weeks, a total of 270 day old broiler chicks were used for the experiment which had six treatments and three replicates, each replicate was allotted 15 birds in a completely randomized design. Six broiler starter diets were formulated such that (Diet 1) contains 0.01% of an antibiotic, Neocloxsin. For Diets 2, 3, 4, 5 and 6, Garlic meal was included at 1.00, 1.50, 2.00, 2.50 and 3.00% in the Diets respectively. In the 2nd Experiment 5-9 weeks, 180 birds from experiment 1 were used. The experiment had six Diets and three replicates each; each replicate was allotted 12 birds in a completely randomized design. Six broiler finisher Diets were formulated, they contained the same level of antibiotics and Garlic meal as in experiment 1. There was significant ($P < 0.05$) difference in the finial body weight, weight gain, feed intake, feed to gain ratio, feed cost per kg gain and mortality across dietary treatments. At the end of the starter and finisher phase of the experiment, 1.5% dietary level of garlic meal supplementation had a better feed conversion ratio and better live weight while the least was obtained on birds fed 3.0 % garlic *inclusion.*

In the third experiment, the best graded level (1.5 %) of garlic meal from experiment 1 and 2 were compared with different antibiotics (N.C.O, Embazine, Vitacox and two natural ingredients, Garlic meal and Moringa leaves). The Experimental diets consists of Diets 1, No Antibiotic, No Garlic meal and Moringa leaves, Diets 2-6 *contained N.C.O (0.10 %), Embazin (0.10 %), Vitacox (0.10 %), Garlic (1.5%) and Moringa (1.5%) respectively. A total of 270 day old broilers chicks were used for the experiment which had six treatments and three replicates, each replicate was allotted 15 birds in a completely randomized design. The experiment lasted 0-4 weeks. There was significant ($P < 0.05$) difference in finial bodyweight gain and feed intake. Birds fed Garlic meal and Moringa leaves supplementation had the highest live weight of 810.6g and 799.07g which was statistically similar to birds on control, N.C.O and Embazine but significantly ($P < 0.05$) higher than birds on Vitacox. The least finial weight was observed for birds fed diets containing Vitacox (588.49g). In the 4^th^ experiment, 180 birds from experiment 3 were used. The experiment had six Diets and three replicates each; each replicate was allotted 12 birds in a completely randomized design. Six broiler diets were formulated; they contained the same level of antibiotic, garlic meal and Moringa as in experiment 3. The experiment lasted 5-9 weeks. The results in experiment 4, there were no significant differences ($P> 0.05$) in feed intake, weight gain, feed to gain ratio and finial body weight across Diets, better body weight over control and other dietary treatment were obtained in birds receiving diet supplemented with garlic meal and Moringa leaves (treatment 5 and 6) No significant difference were observed in carcass percentage and internal organs between birds fed experimental diets. From these results 1.5% garlic and 1.5% Moringa inclusion level both in starter diets and finisher diets supported optimal performance and compared favorable well with conventional antibiotics.*

TABLE OF CONTENTS

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

CHAPTER SIX

LIST OF TABLES

PAGE
TABLE

CHAPTER ONE

INTRODUCTION

There is increasing pressure to reduce or eliminate the use of antibiotics in poultry feed due to the claimed negative effects on human health arising from antibiotic resistance (Javandel *et al.,* 2008). In the United States, poultry producers are faced with a national regulation that prohibits the use of antibiotics (USDA, 2005). This has left poultry producers looking for alternatives to antibiotics that are relatively cheaper and with minimal residual effect. Use of antibiotic that might result in deposition of residues in meat, milk and eggs must not be permitted in food intended for human consumption. If use of antibiotics is necessary as in prevention and treatment of animal diseases, a withholding period must be observed until the residues are negligible or no longer detected. The use of antibiotics to bring about improved performance in growth and feed efficiency, to synchronize or control the reproductive cycle and breeding performance also often lead to harmful residual effect. Antibiotic residuce in food of animal origin occurs in two ways; one which produces potential threat to direct toxicity in human, second is whether the low levels of antibiotic exposure would result in alteration of microflora, cause disease and the possible development of resistant strains which cause failure of antibiotic therapy in clinical situations. Antibiotics have saved many lives over the past 45 years. We are truely fortunate to have them available for serious bacterial infections. Unfortunately, antibiotics are excessively prescribed, especially to children. The Center for Disease Control estimates that of the 235 million doses of antibiotics given each year, between 20 and 50 percent are unnecessary. Tragically, this overuse of antibiotics can cause devastating health consequences to children.

There is a variety of potentially useful feed additives that could be added to poultry feed to improve production or to reduce the spread of disease. One of such alternative feed additive is Garlic (*Allium sativum*).

Garlic (*Allium sativum*) is widely distributed and used in all parts of the world as a spice and herbal medicine for the prevention and treatment of a variety of diseases, ranging from microbial pharmacologic infections to respiratory diseases. Garlic is thought to have various properties. Horton and Prasad (1991) reported that garlic as a feed additive, improved broiler growth, feed conversion ratio (FCR) and decreased mortality rate. Similarly, Demir *et al.,* (2003) reported that garlic may be used as an alternative antibiotic growth promoters in broiler production. Javandel *et al.,* (2008) also reported that the use of natural feed additives like garlic has made it possible for one to avoid the harmful effects of synthetic antibiotics.

The antibacterial, antifungal, antiviral, larvicidal and enzyme inhibitory activities of garlic have been extensively studied (Wills, 1956; Amonkar and Banerji, 1971; Barone and Tansey, 1977; Moore and Atkins, 1977, Sato and Terao 1993; Rees *et al*., 1993; Sato *et al*., 1990; Wagar *et al*., (1994).The active inhibitory agent of garlic is allicin or dially thiosulphiniz Acid (Saleem and Al-Delaimy, (1982). Allicin is enzymatically produced from their precursor when the garlic bulbs are crushed.

Garlic is widely used as human food because it gives a repulsive odour and the taste is pungent. Since monogastric animals are able to incorporate dietary components directly in their tissues (Scaife *et al*., 1994; Onibi *et al.*, 2000), supplementary garlic for broilers could mediate in getting the bioactive compounds in garlic, through broiler meat into the human food chain, while avoiding the resentment due to its direct consumption.However, there is dearth of convincing studies on quantity and form of supplementary garlic in broiler nutrition. It was against these background that this study was conducted to evaluate the effect of feed supplementation with sun dried garlic powder on the growth performance and carcass characteristics, garlic aroma, palatability and oxidative stability of meat of broiler chickens.

This study was therefore designed to determine the growth promoting effect of garlic in broiler chickens.

1.1 OBJECTIVES OF THE STUDY:

The main objectives of this study are;

i. To evaluate the effects of garlic as a growth promoter on the growth performance of broiler chickens.

ii. Determine the effect of garlic supplementation on the carcass characteristics of broiler chickens.

iii. To examine the effect of garlic on intestinal microbial levels and haematological parameters of broiler chickens.

iv. The effectiveness of garlic as a growth promoter compared to synthetic antibiotics and other plant based growth promoters.

v. To determine the cost analysis of garlic supplementation in broiler production.

CHAPTER TWO

LITERATURE REVIEW

2.1 Antibiotics

The word antibiotics originates from the Greek word *anti* meaning ‘against’and *bios* meaning ‘life’. Antibiotics are also known as antibacterials, they are often drugs used to treat infections caused by bacteria. Bacteria are tiny organisms that can sometimes cause illness in humans and animals. Such illnessess include; typhoid, tuberculosis, syphilis, salmonella and meningitis (Nordqvist, 2009).

Antibiotics are medicinal products that have an anti-bacterial effect - they either kill bacteria in the system or keep them from reproducing, thus allowing the infected body to heal by producing its own defenses and overcomeing the infection (Nordqvist, 2009).

2.2 Some Commercial Antibiotics and Antivirals used in Poultry Industry

2.2.1 Antiviral

The immune system of the animal can find and kill many of the viruses that attack it, but sometimes a virus can multiply and overwhelm the immune system before the immune system "comes up to full speed" and inactivate the virus (Vandenbroucke, 1999). It is better to vaccinate against viral diseases, so that the animal`s immune systems have an early advantage. This seems to be the most successful way to kill viruses permanently. An example is smallpox, which has been eradicated due mainly to the use of vaccines against it -- without which the virus killed thousands, if not millions, in epidemics (Vandenbroucke, 1999).

2.2.2 Antifungal

Some microorganisms, known as fungi (fungus in the singular), are cells that are biologically more similar to animal cells than to bacteria. Since many of the bacterial antibiotics take advantage of the difference between bacterial cells and animal cells, the fungi's similarity to animal cells makes them immune to the antibiotics (Vandenbroucke, 1999)

However, some antibiotics are available to control fungi attacks such as Candida. They include nystatin, the azoles (including fluconazole, ketoconazole, and similar antibiotics), and amphotericin B. (Vandenbroucke, 1999).These work by disrupting the fungal cells' machinery. Some of these antibiotics may be applied to the skin or taken by mouth, while others must be given intravenous.

2.2.3 Anti-bacterial

Tetracycline are yet another family of antibiotics originally found in bacteria. They block the protein-making machinery of certain bacteria (Vandenbroucke, 1999).One known side effect of the tetracycline is that they affect development of bone and of tooth enamel in animals. However, tetracycline have been found to be the best antibiotic for some life-threatening infections, such as cholera (Vandenbroucke, 1999).

Erythromycin works by blocking the bacterial cell's machinery from making new proteins. Since proteins make up much of the cell's structure and the enzymes that direct all the cell's chemical reactions, blocking the synthesis of protein makes the cell unable to function. Erythromycin in low doses will stop bacteria from growing and multiplying, but higher concentration is needed to kill the bacteria.

Diseases are also caused by one of the two poultry-adapted strains of *Salmonella* bacteria, *Salmonella* Gallinarum. This can cause mortality in birds of any age. Broiler parents and brown-shell egg layers are especially susceptible. Chickens are most commonly affected but it also infects turkeys, game birds, guinea fowls, sparrows, parrots, canaries and bullfinches.

Morbidity is 10-100%; mortality is increased in stressed or immune compromised flocks and may be up to 100%. The route of infection is oral or via the navel/yolk. Transmission may be transovarian or horizontal by fecal-oral contamination, egg eating etc, even in adults.

2.2.4 Anti-Protozoan

Coccidiosis causes a great economic loss in the poultry industry due to high rate of morbidity and mortality, sub optimal growth, poor feed conversion efficiency and loss of egg production (Williams, 2005). Mortality is mostly marked in caecal form of the disease in young chicks whereas morbidity is well documented in the intestinal form of the disease in adult birds (Williams, 2005).

The disease is caused by a protozoan parasite known as Eimeria. A number of Eimeria species have been recorded from poultry and they affect a particular part of the intestinal tract. Each species is host specific and able to produce specific immunity in the bird, but there is no cross immunity between species (Williams, 2005).

2.3 Effect and benefits of Antibiotics on Feed Utilization

At the current time, there are three primary uses of antibiotics in animal agriculture:Prophylactic, growth promotion and therapeutic. The use of antibiotics to ward off infections and to promote growth in livestock is not new. For more than 40 years many farmers have fed their animals with small subtherapeutic doses of antibiotics (Stuart, 1992).

The discovery that antibiotics could be used for prevention of infection and growth promotion was a good thing. Veterinarians began administering antibiotics to sick animals in an effect to determine whether the “miracle drugs” that were saving humans lives could also help livestock (Khachatourians, 1998). These experiments led to the discovery that feeding animals small doses of the drugs not only inhibited diseases but also enhanced growth (Stuart, 1992). This discovery led in turn to an agricultural revolution, with farmers especially those in very large operations, relying increaseingly on subtherapeutic doses of antibiotics to keep their livestock healthy and to promote animal growth (Stuart, 1992).

In the past three decades, agricultural use of antibiotics has increased exponentially. Alex (1999) estimated that in the past thirty years, farmers have increased their use of penicillin-type antibiotics in farm animals by 600% and their use of tetracycline by 1500% (Alex, 1999). Recent statistical research continues to show an increasing reliance on the routine use of antibiotics for animal, larger operations are also more likely to use antibiotics and many rely on additives for periods of time in excess of ninety days (John and Timothy, 1998).

Part of the increase in antibiotics use is attributable to the declining effectiveness of the drugs as growth promoters. Over time, the amount of antibiotics needed to promote growth in farm animals has increased significantly. Some sources have suggested that “roughly 10 to 20 times the amount used four decades ago are required to produce the same level of growth in the 1990s” (Tollefson, 1997). Moreover, even at concentrations approaching therapeutic levels, the benefits of growth promotion are less now than those reported several decades ago (Stuart, 1992). However, other investigators have shown that the effect of subtheraputic levels of antibiotics on growth promotion has not changed with time (Dafwang *et al.*,1984).

2.4 Natural Sources of Growth Promoters

Herbs, spices, and plant extracts have been used to make humans foods more appetizing for centuries and many of them are recognized for their health benefits. Some of these compounds stimulate appetite (e.g. menthol from peppermint), provide anti-oxidant protection (e.g. cinnamaldehyde from cinnamon), or suppress microbial growth (carvacol from oregano). These plant-based antimicrobials compounds, which function fundamentally similar to antibiotic compounds produced by fungi, could be used to replace some antibiotic growth promoters. To be most effective as growth promoters, these herbal antimicrobial compounds must be supplemented to the feed in a more concentrated form than are found in their natural source (Koch and Lawson, 1996).

Allicin (diallylthiosulphinate) is one of the active compounds of freshly crushed garlic (*Allium sativum*). Allicin possesses a variety of biological activities such as antimicrobial, anti-inflammatory, antithrombotic, anti-atherosclerotic, serum lipid lowering and anticancer activities (Koch and Lawson, 1996). Allicin is produced by an enzymic reaction when raw garlic is crushed or injured. The enzyme, allicinase, stored in a separate compartment in garlic, combines with a compound called alliin in raw garlic and produces allicin. The antimicrobial mode of action of allicin is thought to be the inhibition of thiol-containing enzymes in the microorganisms.

In the amoebic parasite *Entamoeba histolytica*, allicin was found to strongly inhibit cysteine proteases, alcohol dehydrogenases and thioredoxin reductases (Ankri, *et al*.; 1997). The antifungal activity of garlic extracts has been observed *in vitro* against *Cryptococcus neoformans* (Davis *et al.;* 1990), *Candida* (Ghannoum, 1988) and *Aspergillus* spp. (Yoshida, *et al.;* 1987). The potential of allicin as an antifungal agent *in vivo* has not been clearly illustrated to date. Davis *et al.;* (1990) showed that the cerebrospinal fluid of two patients infected with *C. neoformans* and treated with a commercial garlic extract has anti-*C. neoformans* activity. Ghannoum (1990), demonstrated that an aqueous garlic extract diminished adherence of *C. albicans* to buccal epithelial cells. In Asia, *A. sativum* (garlic)-derived preparations are used alone or with amphotericin B to treat human systemic fungal infections and cryptococcal meningitis. *In vitro* synergy was demonstrated when both compounds were combined against *C. neoformans* (Davis, *et al*., 1994).

2.4.1 Bitter kola (*Garcina kola*)

Bitter kola is a traditional plant found in the forest of West Africa and eaten mostly among the elderly in Nigeria.It is known as Orogbo in Yoruba land, Namijin-goro among Hausa, and Akuilu in Igbo land.

G. kola stem bark has been shown to contain a complex mixture of phenol compound such as biflavonoids, xanthones and benzophenone (Iwu and Igboko, 1982) which have antimicrobial activity as kolanone (Hussain *et al.*, 1982), Kolaflavanone and garciniaflavanone (Iwu, 1993). The plants nuts contain a high proportion of tannins and guttiferin (Etkin, 1981). *G. Kola* is reported to have a protective effect against a variety of experimental hepatotoxins (Iwu, 1985; Akintowa and Essien, 1990). However, some histological alterations in the liver, kidney and duodenum of rats fed diets containing 10% *G. Kola* nut have been reported (Braide and Grill, 1990). Similarly, Oluwole and Obatomi (1992) observed an increase in both basal and histamine-mediated gastric acid secretion of rats fed *G. Kola* nut.

2.4.2 Moringa (*Moringa oleifera*)

Moringa is a tropical tree, fast growing, resistant to drought and an important source of food for people and animal in many countries. There are 13 known species of which *moringa oleifera* is particularly easy to reproduce and its growth is very fast Satwatt *et al.,(*2002). Modern scientific research now shows that the leaves are full of nutritious content – for example, gram for gram, Moringa leaves are an excellent source of calcium, vitamin C, vitamin A, Potassium and Protein. Studies have shown the leaves to be excellent source of vitamins, minerials and protein: perhaps more than any other tropical vegetable.

Moringa oleifera is currently spread almost world- wide. However, there is scanty information on its potential as an animal feed. Studies by Satwatt *et al.,(*2002) on supplementation of *Moringa oleifera* to poor quality hay fed to growing Small East African Goats showed the existence of a negative nitrogen balance compared to goats supplemented with 25 and 50% *Moringa oleifera* leaf meal. The preliminary results of effects of supplementing crops left overs with equal amount of *Leucaena* leaf meal (LLM), *Grilicidia* leaf meal (GLM) and *Moringa oleifera* leaf meal (MOLM) showed that goats fed on MOLM were outperformed in terms of growth rate by those fed on the other multipurpose trees. This is perplexing because MOLM has relatively higher crude protein (Sutherland *et al*.,1990, Makkar and Becker,1997, Sarwatt *et al*.,2002) and low antinutritional factors (Makkar and Becker, 1997). Kakengi *et al.,*(2003) evaluate and compared the nutritive value of different morphological components of *Moringa oleifera* with *Leucaena leucocephala* leaf meal in Tanzania. They observed high pepsin and total soluble protein in *Moringa oleifera* leaf meal (MOLM) than other parts of the plant. The high pepsin and total soluble protein makes MOLM more suitable to monogastric animals.

2.5 Garlic as Source of Antibiotics

Garlic, *Allium sativum,* belongs to the lily family whose relatives are onions. Once a wild herb, today's garlic is cultivated throughout the world, though some still grow wild. It consists of a bulb about the size of a child's fist. Covering the bulb are several layers of white or purplish papery membranes that protect the individual cloves inside that could number from two to six dozen in varying sizes. The Agronomic cultivation of garlic is 3 tons /ha/year for fresh and 1.2 tons /ha/year for dry (Kalu,1992). Apart from the inadequate supply and consumption of animal proteins, there has been a resurgence of interest in improving the physicochemical and sensory properties of meat, as well as its storage life. In pursuit of improved chickens healthiness and in order to fulfill consumer expectations in relation to food quality, poultry producers more and more commonly apply natural feeding supplements, mainly herbs (Garzielewska *et al.,* 2003) .The positive effects of herbal supplements on broiler performance, carcass quality and quality traits of meat have been demonstrated (Schleicher *et al*., 1998). A variety of herbal supplements including garlic have been widely used to maintain and improve the health of humans (Freeman and Kodera, 1995). Garlic supplements in broiler chickens have been recognized for their strong stimulating effect on the immune system and its very rich aromatic oils enhance digestion in birds (Gardzielewska *et al.,* 2003). The key active ingredients in garlic is a powerful chemical called allicin which rapidly decomposes to several volatile organosulphur compounds with bioactivities (Chang and Cheong, 2008). Garlic is used both as condiments and medicaments, anticoagulant, antioxidant, hypolipidaemic, antihypertensive, antiageing, antiplatelet and heavy metal detoxifier (Agarwal, 1996 and Marilynn, 2001). The antioxidative influence of garlic in meat becomes more imperatives in less developed nations, considering storage problems and increasing use of alternative feed resources without due consideration for meat quality (Onibi *et al*., 2007).

2.6 Benefits of using Garlic over synthetic Antibiotics

2.6.1 Resistant Bacteria

The major problem with pharmaceutical antibiotics is that they can promote the development of resistant strains of bacteria. Initially the antibiotic kills most of the bacteria being attacked. With repeated exposure, however, those few bacteria that by chance are genetically resistant to the antibiotic begin to multiply. Eventually a recurring infection becomes completely resistant to that antibiotic. After a half century of the massive use of antibiotics, and the indiscriminate over-prescription of them, potentially serious medical problems arose from resistant strains of bacteria.

Garlic does not seem to produce such resistant strains, and may be effective against strains that have become resistant to pharmaceutical antibiotics. European researchers in the late 1970s tested garlic juice against a group of ten different bacteria and yeasts (Moore and Atkins, 1977). They found that garlic was effective against all of them, and also found a "complete absence of development of resistance."

2.6.2 Antiviral activity

A weakness of conventional antibiotics is that they were not effective against viral infections. That is why they would not work against the common cold or flu. They also would not work against some serious viral infections like viral meningitis, viral pneumonia, or herpes infections. Garlic or its constituents will directly kill influenza, herpes, vaccinia (cowpox), vesicular stomatitis virus (responsible for cold sores), and human cytomegalovirus (a common source of secondary infection in AIDS.) Garlic will also cure or improve the symptoms of a variety of viral diseases in humans or animals. In an animal study, researchers first fed a garlic extract to mice and then introduced the flu virus into the nasal passages of the animals. Those animals that had received the garlic were protected from the flu, while the untreated animals all got sick. The researchers postulated that the effect of garlic was due in part to direct antiviral effects of garlic, and in part to stimulation of the immune system (Adetumbi and Lau, 1983).

2.6.3 Anti-Parasitic and Anti- Fungal Activity

Treatment of fungal infections are difficult like viruses and medicines used for this aim are generally toxic and a resistance can develop against the medicine in long term. It is stated that garlic, which consists of allicin a fungistatic substance, has proved itself against micro-organisms such as *candida*, *Aspergillus* and *cryptococci* as an effective anti-fungal substance (Griggs, and Jacob 2000). Chickens infected with *C.albicans* have healed after they have consumed garlic for 10 days and this effect has been linked to allicin components in garlic as well. In addition, since high glycaemia, therapy of garlic provides an extra advantage in the treatment of yeast infections (Ayaz and Alpsoy, 2007; Prasad and Sharma, 1980). An *et al*.,(2009) demonstrated that a combination of Amphotericin B (AmB), which is the gold standard of antifungal treatment for the most severe invasive mycoses, with allicin proved to be a promising strategy for the therapy of disseminated candidiasis. An *et al*.,(2009) and Ogita *et al*.,(2009) observed that allicin, an allyl sulphur compound from garlic has shown to significantly enhance the effect of AmB against *Candida albicans* and *Aspergillus fumigatus in vitro* and *in vivo*, although allicin did not exert a fungicidal effect.

2.6.4 Yeast infections

If you've ever had athlete's foot, you know how stubborn a yeast or fungal infection can be. A garlic wash can be very effective against fungi externally, but garlic can also treat systemic fungal infections (Yeo and Kim, 1997). Researchers from the University of New Mexico demonstrated that garlic was effective both in the test tube and in animals against infection with the fungus Cryptococcus neoformans. Chinese researchers also have shown that garlic as a intravenous extract can be effective against cryptococcal meningitis. The blood and cerebrospinal fluid of the patients in that trial was twice as effective against the fungus as before treatment with garlic

2.7 Effects of Garlic in Poultry Nutrition

A variety of herbal supplements including garlic have been widely used to maintain and improve health of humans (Freeman and Kodera, 1995). Garlic supplements in broiler chicken have been recognized for their strong stimulating effect on the immune system and the very rich aromatic oils enhance digestion of birds (Gardzielewska *et al.,* 2003).

The anti-oxidative influence of garlic in meat becomes more imperative in less developed nations, considering storage problems and increasing use of alternative feed resources without due consideration for meat quality (Onibi *et al*., 2007). Horton and Prasad(1991) reported that garlic as a natural feed additive, improved broiler growth, Feed Conversion Ratio (FCR) and decreased mortality rate. Similarly, Demir, (2005) in his experiment demonstrated that garlic may be used as alternatives to an antibiotic growth promoter in broiler production"also Javande *et al.*, (2008) reported that the use of natural feed additives like garlic has made it possible for one to avoid the harmful effects of synthetic antibiotics.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Experimental Site:

The trials were conducted at the Poultry Unit of the Animal Science Departmental Teaching and Research Farm, Ahmadu Bello University, Zaria, Kaduna State.

3.2 Source and processing of Garlic and Moringa leaves

The Garlic and Moringa used in the experiment were purchased from a Local Market in Samaru, Zaria, Kaduna State. The Garlic bulb was desegmented, deskinned, cut into pieces, sun dried and ground to powder. The Moringa leaves were cut, dried in shade and ground to powder.

3.3 Source of experimental birds

All birds used in the study were Day-old commercial Anak 2000 Broiler chicks Obtained from Obasanjo Farms sales outlet in Mando, Kaduna.

3.4 Experiment 1:Evaluation of the effect of feeding varying levels of garlic on growth performance of broiler chicks (0-4 weeks).

3.4.1 Experimental diets:

Six broiler stater diets were formulated such that the control diet (Diet 1) contained 0.01% Neocloxin. While diets 2, 3, 4, 5 and 6, contained garlic powder included at 1.00, 1.50, 2.00, 2.50 and 3.00% in the diets, respectively. The ingredient compositions of the experimental diets is presented in Table 3.1.

3.4.2 Design and Managements of Experimental Birds

A total of 270 day old broiler chicks were divided into six groups of 45 birds each and each group randomly assigned to one of the experimental diets in a completely randomized design. Each group was further subdivided into 3 replicates of 15 birds each and each replicate was kept in a compartment measuring 2m x 3m. Electricity and kerosene stove were used as main sources of heat for the chicks at the brooding phase. The birds were weighed to get their initial weight and subsequently they were weighed weekly to find weight gain per week. Birds were housed in pens under the deep litter system, Weekly weight gain, feed intake and feed to gain ratio were computed. Water intake was determined by supplying a known volume of water daily and subtracting the refused water. Evaporative loss was determined by placing equal volume of water in a similar drinker left in the gangway. Rate of evaporation was determined weekly by substracting the volume of water left in the drinker from the volume supplied. The evaporative water loss was subtracted from the weekly water supplied to the birds, Mortality records were taken as they occur. Feed cost per kg diet and feed cost per kg gain were determined at weekly intervals. Feed and water were supplied *ad libitum*. All the necessary vaccinations (intra ocular lasota and Gumboro vaccines) were administered at the appropriate time.

Table 3.1: Composition of Experimental Broiler Starter Diets for Experiment 1.

	Diets					
Ingredients	1	2	3	4	5	6
Maize	51.00	51.20	51.10	51.00	51.00	51.00
Soyabean Cake	12.00	12.00	12.00	12.00	12.00	12.00
Ground nut cake	27.95	26.85	26.45	26.05	25.55	25.05
Fishmeal	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00
Limestone	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30

Neocloxin	0.10	0.00	0.00	0.00	0.00	0.00
Garlic	0.00	1.00	1.50	2.00	2.50	3.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Cost/kg diet (N)	46.93	48.13	49.86	51.68	53.50	55.23
Calculated Analysis						
Metabolizable Energy(Kcal/kg)	2913	3000	3000	2998	2995	2990
Crude Protein	22.95	23.11	23.00	23.00	23.00	22.98
Crude Fiber(%)	3.78	3.89	3.80	3.82	3.83	3.84
Phosphorus(%)	0.89	0.89	0.89	0.89	0.89	0.89
Calcium(%)	1.31	1.31	1.31	1.30	1.30	1.30
Lysine(%)	1.33	1.33	1.33	1.33	1.33	1.33
Methionine(%)	0.61	0.61	0.61	0.65	0.61	0.60
Exther Extract(%)	3.48	3.51	3.53	3.57	3.60	3.64

*Vitamins and mineral premix provides per kg of diet:Vitamin A,13.340 i.u;D3,2680 i.u;Vitamin E,10 i.u; VitaminK,2.68i.u;Calciumpantothenate,10.68mg,VitB10.022mg;Folicacid,0.668mg;cholinechloride400mg; chlorotetracycline,26-28mg;manganese,133-34mg;iron,66.68mgzinc,53.34mg;copper,3.3mg; iodine,1.86mg; cobalt;0.268mg,selenium,0.108mg.

3.4.3 Blood collection and analysis

At the end of the 28 day feeding trial, 2.0 mls of blood sample were collected from two birds each from each replicate and put into Ethylene Di-amine Tetra Acetic Acid (EDTA) treated Bijou Bottles (1mg/ml) for the haematological assay. Blood samples were analyzed within 3 hours of their collection for Total protein (TP), Haemoglobin concentration (Hb) and pack cell volume (PVC) using the procedures outline by Lamb (1991).

3.5 **Experiment 2:** Evaluation of the effect of feeding varying levels of garlic on growth performance of broiler Finisher (5-9 weeks)

3.5.1 Experimental diets:

Six isonitogenous Broiler finisher diets were formulated in Experiment 2. The ingredients composition of the experimental diets is shown in Table. 3.2. Diets 1 (control) had 0.10% Neocloxin while diets 2, 3, 4, 5 and 6, had powder garlic meal included at 1.00, 1.50, 2.00, 2.50 and 3.00% levels in the diets, respectively.

3.5.2 Design and Managements of Experimental Birds

A total of two hundred and sixteen(216) 5-weeks old broilers held from Experiment 1 were used for the study. At the end of the first trial, the birds were pooled together and place on a common diets devoid of Garlic meal and antibiotics. The same birds were randomly allocated on the basis of group weights to six dietary treatments of 36 birds each with three replicates of 12 birds each in a completely randomized design (CRD). They were housed in pens under the deep litter system. All routine management were carried out. The same data collection method for Experiment 1 was also carried out in this experiment.

Table 3.2: Composition of Experimental Broiler Finisher Diets for Experiment 2.

Ingredients	Diets 1	2	3	4	5	6
Maize	49.80	49.95	49.50	49.45	49.00	48.55
Soyabean Cake	8.00	8.00	8.00	8.00	8.00	8.00
Ground Nut cake	28.10	27.05	27.00	26.55	26.50	26.45
Bonemeal	3.00	3.00	3.00	3.00	3.00	3.00
Wheat Offal	10.00	10.00	10.00	10.00	10.00	10.00
Limestone	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15	0.15
Lysine	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
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Neocloxin	0.10	0.00	0.00	0.00	0.00	0.00
Garlic	0.00	1.00	1.50	2.00	2.50	3.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Cost/kg diet	46.93	48.13	49.86	51.68	53.50	55.23
Calculated Analysis						
Metabolizable Energy(Kcal/kg)	2913	3000	3000	2998	2995	2990
Crude Protein	22.95	23.11	23.00	23.00	23.00	22.98
Crude Fiber(%)	3.78	3.89	3.80	3.82	3.83	3.84
Phosphorus(%)	0.89	0.89	0.89	0.89	0.89	0.89
Calcium(%)	1.31	1.31	1.31	1.30	1.30	1.30
Lysine(%)	1.33	1.33	1.33	1.33	1.33	1.33
Methionine(%)	0.61	0.61	0.61	0.65	0.61	0.60
ExtherExtract(%)	3.48	3.51	3.53	3.57	3.60	3.64

*Vitamins and mineral premix provides per kg of diet:Vitamin A,13.340 i.u;D3,2680 i.u;Vitamin E,10 i.u; VitaminK,2.68i.u; Calciumpantothenate,10.68mg,VitB10.022mg;Folicacid,0.668mg;cholinechloride400mgchlorotetracycline,26-28mg;manganese,133-4mg;iron,66.68mgzinc,53.34mg; copper,3.3mg; iodine,1.86mg; cobalt;0.268mg,selenium,0.108mg.

3.5.3 Carcass evalution

At the end of the feeding trial, 3 birds were selected from each replicate per pen based on their average weight, fasted for 10 hours, weighed, slaughtered and dressed at Animal products Laboratory of the Deparment of Animal Science. Carcass weight, relative cut-up parts and organ weights were also recorded. The carcass, prime cuts and organs were expressed as a percentage of dress weight.

3.6 Experiment 3: Evaluation of the effects of Garlic, Moringa and antibiotics on the growth performance of broiler chicks(0 – 4 weeks).

3.6.1 Experimental Diets:

Six identical diets as in Treatment 3 and Experiment 1 were formulated such that Diets 1 (Control) contained, No Antibiotic, Garlic meal and Moringa meal, Diets 2, 3, 4, 5 and 6 contained N.C.O(Neomycin, Chloranphenical and Oxoytertracycin) (0.10%), Embazin (0.10%), Vitacox (0.10%), Garlic (1.5%) and Moringa (1.5%), respectivly. The ingredient compositions for the feed is shown in Table 3.3.

3.6.2 Design and Management of experimental birds.

A total of 270 day old broiler chicks were divided in six groups of 45 birds each and each group randomly assigned to one of the experimental diets in a completely randomized design. Each group was further subdivided into 3 replicates of 15 birds each.The Design and management of the experimental birds is as described in Experiment 1.

Table 3.3. Composition experimental of Broiler Starter Diets for Experiment 3

	Diets					
Ingredients	1	2	3	4	5	6
Maize	51.10	51.10	51.10	51.10	51.10	51.10
Soya Cake	12.00	12.00	12.00	12.00	12.00	12.00
Grand Nut cake	26.45	26.45	26.45	26.45	26.45	26.45
Fishmeal	3.00	3.00	3.00	3.00	3.00	3.00
Wheat Offal	5.00	5.00	5.00	5.00	5.00	5.00
Limestone	0.20	0.20	0.20	0.20	0.20	0.20

Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30
N.C.O	0.00	0.10	0.00	0.00	0.00	0.00
Embazine	0.00	0.00	0.10	0.00	0.00	0.00
Victacox	0.00	0.00	0.00	0.10	0.00	0.00
Garlic	0.00	0.00	0.00	0.00	1.50	0.00
Moringa	0.00	0.00	0.00	0.00	0.00	1.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
Cost/kg diet	46.93	48.13	49.86	51.68	53.50	55.23
Calculated Analysis						
Metabolizable Energy (kcal/kg)	2885	2850	2848	2830	2844	2828
Crude Protein(%)	21.38	21.71	21.61	21.67	21.74	21.76
Crude Fiber(%)	4.09	4.11	4.12	4.12	4.13	4.13
Phosphorus(%)	0.81	0.88	0.88	0.88	0.88	0.88
Methionine(%)	0.56	0.59	0.59	0.59	0.59	0.58
Exther Extract(%)	3.43	3.53	3.55	3.59	3.64	3.64

*Vitamins and mineral premix provides per kg of diet:Vitamin A,13.340 i.u;D3,2680 i.u;Vitamin E,10 i.u; VitaminK,2.68i.u;Calciumpantothenate,10.68mg,VitB10.022mg;Folicacid,0.668mg;cholinechloride400mg; chlorotetracycline,26-28mg;manganese,133-34mg;iron,66.68mg zinc,53.34mg; copper,3.3mg; iodine,1.86mg; cobalt;0.268mg,selenium,0.108mg.

3.7 Experiment 4: Evaluation of the effects of garlic meal, Moringa and antibiotics on the growth performance of Broiler Chickens (Finisher phase)

3.7.1 Experimental Diets:

Diets were formulated to meet the requirements for broilers as in experiment 2, and particularly Diet 3 which gave the best performance from experiments 1 and 2. Six isonitrogenous Diets were formulated as in experiment 2 and particularly Diets 3 such that Diets 1 (Control) contained, No Antibiotic, Garlic and Moringa, Diets 2, 3, 4, 5 and 6 contained N.C.O (0.10%), Embazin (0.10%), Vitacox (0.10%), Garlic (1.5%) and Moringa (1.5%), respectivly. The ingredient compositions for the feed is shown in Table 3.4.

3.7.2 Design and Management of Experimental Birds.

A total of two hundred and sixteen 5-weeks old broiler finisher from Experiment 3 were used for the study. At the end of the third trial, the birds were pooled together and place on a common diet devoid of Garlic, moringa and antibiotics for a period of one week. Thereafter the birds were randomly allocated on the basis of group weights to six dietary treatments of 36 birds each with three replicates of 12 birds each in a completely randomized design (CRD). They were housed in pens under the deep litter system. All routine management were carried out. The same data collection method for Experiment 3 was also carried out in this experiment.

3.7.3 Blood Collection and Analysis

The Blood collection and analysis of the experimental birds was as described in 3.4.3

Table: 3.4. Composition of experimental Broiler Finisher Diets for experiment 4

	Diets					
Ingredients	1	2	3	4	5	6
Maize	50.46	50.45	50.45	50.45	49.95	49.95
Soya Cake	8.45	8.45	8.45	8.45	8.00	8.00
GrandNutcake	27.00	27.00	27.00	27.00	27.00	27.00
Fishmeal	3.00	3.00	3.00	3.00	3.00	3.00
Wheat Offal	10.00	10.00	10.00	10.00	10.00	10.00
Limestone	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15	0.15

Lysine	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
Salt	0.30	0.30	0.30	0.30	0.30	0.30
N.C.O	0.00	0.10	0.00	0.00	0.00	0.00
Embazine	0.00	0.00	0.10	0.00	0.00	0.00
Vitacox	0.00	0.00	0.00	0.10	0.00	0.00
Moringa	0.00	0.00	0.00	0.00	0.00	1.50
Garlic	0.00	0.00	0.00	0.00	1.50	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Cost/kg diet(N)	46.93	48.13	49.86	51.68	53.50	55.23
Calculated Analysis						
Metabolizing Energy (kcal/kg)	2885	2850	2848	2830	2844	2828
Crude Protein(%)	21.38	21.71	21.61	21.67	21.74	21.76
Crude Fiber(%)	4.09	4.11	4.12	4.12	4.13	4.13
Phosphorus(%)	0.81	0.88	0.88	0.88	0.88	0.88
Calcium(%)	1.30	1.30	1.30	1.30	1.30	1.30
Lysine(%)	1.33	1.33	1.33	1.33	1.33	1.33
Methionine(%)	0.56	0.59	0.59	0.59	0.59	0.58
Exther Extract(%)	3.43	3.53	3.55	3.59	3.64	3.64

*Vitamins and mineral premix provides per kg of diet:Vitamin A,13.340 i.u;D3,2680 i.u;Vitamin E,10 i.u; VitaminK,2.68i.u;Calciumpantothenate,10.68mg,VitB10.022mg;Folicacid,0.668mg;cholinechloride400mg;chlorotetracycline,26-28mg;manganese,133-34mg;iron,66.68mg zinc,53.34mg; copper,3.3mg; iodine,1.86mg; cobalt;0.268mg,selenium,0.108m

3.7.4 Carcass Evalution

At the end of the 9th week of the experiment, 2 birds were selected from each replicate based on the average group weight and used for carcass evaluation using the procedures described in experiment 3.2.3

3.8 Data Analysis

All data generated from the four experiments were subject to the analysis of variance using SAS package version 9 (SAS 2002). Significant differences among treatment means were separated by using the Duncan Multiple Range Test in the SAS package (SAS 2002).

CHAPTER FOUR

RESULTS

4.1 Experiment 1: Performance of Broiler starter chicks (0-4 weeks)

The performance of broiler chicks fed graded levels of garlic in the diets is presented in Table 4.1. There was significant ($P < 0.05$) difference in the final body weight, weight gain, feed intake, feed to gain ratio, feed cost per kg gain and mortality across diets. Birds fed 1.5% garlic supplementation had the highest live weight of 596.74g which was statistically similar to birds on Diets 1(0.00), 2(1.00) and 4(2.00) but significantly (P < 0.05) higher than birds on Diets 5(2.50) and 6(3.00) . The least final weight was observed for birds fed diets containing 2.5%(Diets 5) and 3.0%(Diets 6) garlic respectivetly (356.10g and 270.71g).

4.2. Experiment 2: Performance of Broiler finisher fed varying dietary levels of garlic meal (5-9weeks)

The result of effect of graded levels of garlic on the performance of the experimental birds are shown in Table 4.2. There was significant (P<0.05) difference in the final body weight, daily weight gain, daily feed intake, feed to gain ratio, feed cost per kg gain and mortality across the treatments. The highest body weight was observed on birds fed 1.5% garlic supplemented diet. The lowest value for body weight was recorded for Diet with 3.0 % garlic supplmementation. The daily weight gain results followed the same trend with that of the final body weight gain. Birds on Diet 1.5% Garlic supplementation had the best weight gain (45.89g / bird/day). This was followed by birds on Diet 0.00% (42.47g/bird/day) and Diet 2.00% (42.14b/bird/day). The lowest daily weight gain was observed on birds fed 3.0% of level of garlic (30.03g/bird/day).

4.3 Carcass Characteristics

The results of the effect of graded levels of garlic on the carcass characteristics of broilers is presented in Table 4.3. There were significant(P<0.05) differences in the liveweight, dressed weight, percentages of wings, back. heart, kidney, gizzard and abdominal fat. There were no significant differences in the dressing percentage, percentages of the breast, drum stick and length of the intestine.

4.4 Haematological Study

The effect of graded levels of garlic on the haematological parameters of broiler chickens is shown in Table 4.4. There was significant (P<0.05) difference in the haemoglobin concentration across the Diets. There were no significant differences in the packed cell volume, total protein and red blood cell counts across the Diets (P>0.05).

4.5 Experiment 3. Performance of Broiler Chickens feed garlic and antibiotics (0-4 weeks)

The effect of garlic and antibiotics on the performance of broiler chicks fed the experimental diets is presented in Table 4.5. The final body weight, weight gain and feed intake were significantly (P<0.05) lower in birds given 0.1% vitacox (Diet 4) compared to all other treatments. Birds fed Garlic(Diet 5) and moringa(Diet 6) supplementation had the hightest live weight of 810.6g and 799.07g respectively which was statistically similar to birds in Diets 1, 2, and 3 but significantly (P < 0.05) higher than birds on Diet 4**.** The least final weight was observed for birds fed diets containing vitacox(588.49g)**.** The feed intake followed similar trend with vitacox having the lowest value for feed intake of 55.71g, while Garlic and Moringa (Diets 5 and 6) values for feed intake of 28.85g and 27.89g are statistically similar to Diet 1(0.00), Diet 2(0.1) and Diet 3(0.1) (Control, N.C.O and Embazine). Feed to gain ratio of the various Diet means are as follows, 2.72, 2.81, 3.22, 2.88, 2.85 and 2.77 in Diets 1- 6 respectively, they were satistically similar.

The cost per kg gain was not significantly (P>0.05) different across the diets. The results showed that mortality rate was not significant across the dietary treatments.

Table: 4.1. Effect of graded levels of garlic on the performance of Broiler chickens (starter phase 0-4 weeks)

	Diets							
Parameter	1	2	3	4	5	6	SEM	LOS
Initial weight(g)	35.71	35.71	35.71	35.71	35.71	35.71	-	NS
Finial weight(g)	568.17^{a}	482.14^{a}	596.74^{a}	505.71^{ab}	356.1^{b}	270.71^{b}	38.04	*
Daily weight gain(g/bird/day)	222.63^{b}	188.10^{c}	259.53^{a}	178.57^{c}	128.57^{d}	90.49^{e}	7.78	*
Total weight gain(g/bird)	532.47^{a}	446.43^{a}	561.03^{a}	470.00^{a}	320.80^{b}	235.00^{b}	38.04	*
Water/bird/day(mls)	119.30	119.19	111.27	115.27	100.10	99.33	7.28	NS
Daily feed intake(g/bird/day)	34.96^{ab}	35.80^{a}	38.52^{b}	32.57^{ab}	27.49^{bc}	22.96^{c}	2.44	*
Feed to gain ratio	1.97^{b}	2.25^{ab}	1.92^{a}	1.94^{a}	2.39^{ab}	2.78^{ab}	0.16	*
Water/bird(mls)	3340	3337	3115	3227	2803	2781	203	NS
Feed cost/kg gain (N)	87.60^{a}	95.45^{bc}	108.56^{c}	111.26^{bc}	127.87^{ab}	153.54	8.66	*
Mortality(%)	9.52^{ab}	14.28^{ab}	7.14^{b}	21.43^{ab}	11.90^{ab}	23.81^{a}	4.76	*

*P<0.05 $^{abc=}$ means with different supercript in the same row are significantly different ($P < 0.05$)

NS=Not Significant LOS= Level of significant

SEM=Stardard error of mean

Table: 4.2. Effect of graded levels of garlic on the performance of Broiler chickens(Finisher phase 5- 8 weeks)

	Diets							
Parameter	1	2	3	4	5	6	SEM	LOS
Initial weight(g)	645.50	642.00	645.00	642.00	645.33	642.33	4.64	NS
Final weight(g)	1890.50[a]	1785.30[ab]	1946.70[a]	1822.30[ab]	1709.00[ab]	1483.00[c]	87.17	*
Total feed intake (g/bird)	1059.80	957.38	1036.90	1196.19	1034.74	1025.60	59.63	NS
Daily feed intake(g/b/day)	44.47[a]	40.33[ab]	39.89[ab]	42.14[ab]	37.96[ab]	30.03[b]	3.17	*
Weight gain(g/b/day)	42.47[a]	40.33[ab]	45.89[ab]	42.14[ab]	37.96[ab]	30.03[b]	3.17	*
Total weight gain(g/bird)	411.38	420.83	438.33	406.50	384.53	310.73	36.18	NS
Feed to gain ratio	2.34[a]	2.28[a]	2.23a	2.98[ab]	2.81[ab]	3.42[b]	0.21	*
Water/bird(mls)	7412.50	6955.80	7134.80	7606.00	7322.20	7291.70	293.8	NS
Water/b/day(mls)	264.74	248.42	254.81	271.65	261.51	260.48	10.51	NS
Feed cost/kg gain (N)	107.92[b]	106.48[b]	123.00[b]	150.08[ab]	146.90[ab]	176.31	11.30	NS
Mortality(%)	9.00	9.00	9.00	12.06	9.06	9.06	3.65	NS

*P<0.05 [abc=] means with different supercript in the same row are significantly different ($P < 0.05$)
NS=Not Significant LOS= Level of significant
SEM=Stardard error of mean

4.6 Experiment 4 Performance of Broiler finisher fed garlic and antibiotics (5-9 weeks)

The effect of garlic and antibiotics on the performance of the birds fed the experimental diets is shown in Table 4.6. The final body weight, weight gain and feed intake were not significantly (P > 0.05) influnced by the dietary treatments. Birds on Diets 3 with 0.10% Embazin had numerically better feed conversion ratio than birds in Diets 1, 2, 4, and 6. Birds on Diets 4, Diets 5, and Diets 6 had significantly higher(P< 0.05) feed conversion ratio than those on Diets 3 (Vitacox). Percent Mortality were significantly (P<0.05) higher in Diets 3 (0.1% Vitacox) compared to other diets

4.7 Haematological Study

The effect of garlic and other antibiotics on the haematological parameters of broilers chickens is shown in Table 4.8. The packed cell volume and haemoglobin contents were significantly (P<0.05) higher in birds fed 1.5% Moringa oleifera compared to other treatments. The total proteins were significantly (P<0.05) higher in Diets 6 compared to other treatments.

4.8 Carcass Evaluation

The carcass characteristics of birds fed graded levels of garlic is presented in Table 4.7. There was no significant (P>0.05) effect of dietary treatment on the prime cut parts and the relative weights of the organs. The results is in agreement with the finding of Lydia(2001) who reported that there was no significant differences on the carcass percentage and organ weight of birds fed varying levels of garlic.

Table:4.3 Effect of Garlic on carcass characteristics of Broiler Chickens (Expressed as % of liveweight)

	Diets							
Parameter	1	2	3	4	5	6	SEM	LOS
Live weight(g)	1800^{a}	1816^{a}	1816^{a}	1833^{a}	1866^{a}	1516^{b}	60.67	*
Dressed weight(g)	1250^{a}	1266^{a}	1266^{a}	1240^{a}	1266^{a}	1016^{b}	44.38	*
Dressing(%)	69.47	69.68	67.83	67.62	67.84	67.03	1.29	NS
Breast(%)	27.00	28.63	23.60	27.49	27.40	27.90	1.62	NS
Drum stick(%)	32.55	31.90	32.61	32.62	32.73	34.23	0.92	NS
Wings(%)	15.80^{bc}	17.27^{ab}	16.54^{abc}	16.20^{abc}	14.70^{c}	18.20^{a}	0.81	*
Back(%)	16.95^{c}	23.80^{a}	22.49^{abc}	20.32^{b}	20.67^{b}	21.93^{abc}	0.99	*
Heart(%)	0.58^{b}	0.83^{abc}	0.85^{a}	0.74^{ab}	0.76^{ab}	0.89^{a}	0.09	*
Kidney(%)	0.21^{b}	0.32^{ab}	0.32^{ab}	0.24^{b}	0.35^{ab}	0.46^{a}	0.07	*
Gizzard(%)	5.80^{bc}	6.63^{ab}	6.48^{abc}	6.30^{abc}	5.47^{c}	7.00^{a}	0.38	*
Abdominal fat(%)	1.74^{b}	2.18^{ab}	2.47^{ab}	1.97^{b}	1.93^{b}	1.70^{a}	0.35	*
Intestinal length(%)	7.77^{c}	7.00^{d}	7.44^{cd}	8.47^{a}	9.30^{a}	8.53^{a}	0.28	*
Intestinal lent(cm)	220.00	200.00	200.00	221.00	222.00	205.00	12.32	NS

$^{abc=}$ means with different supercript in the same row are significantly different ($P < 0.05$) $*P<0.05$
NS=Not Significant
SEM=Stardard error of mean
LOS= Level of significance

Table 4.4 Effect of Graded levels of Garlic on the Heamatological parameters of broilers chickens .5-9 wks

	Diets						
Parameters	1	2	3	4	5	6	SEM
PVC(%)	27.50	26.50	26.00	28.00	30.50	32.00	1.06
Heamoglobin(g/dl)	9.15[abc]	8.80[bc]	10.50[a]	10.15[a]	9.30[bc]	8.65[bc]	0.38[c]
Total Protein(g/dl)	3.50	4.10	4.70	4.20	3.75	4.10	0.40
RBC(%)	4.55	4.40	4.30	4.65	4.95	4.30	0.17

[abc=] Means with different supercript in the same row are significantly different (P<0.05) *=P<0.05

NS=Not significant

LOS=Level of signifecance

SEM= Stardard error of mean

PVC=Packed cell volume

Hb=Hemoglobin

RBC= Red Blood Cell

Table:4.5. Effect of garlic and antibiotics on the performance of Broilers Starter

Parameters	Diets 1	2	3	4	5	6	SEM	LOS
Initial body wt(g)	36.00	36.00	36.00	36.00	36.00	36.00	0.00	NS
Final body wt(g)	790.56[a]	745.08[a]	729.27[a]	588.49[b]	810.67[a]	799.07[a]	41.93	*
Weight gain(g/bird)	756.22[a]	709.08[a]	693.27[a]	552.49[b]	765.67[a]	759.07[a]	41.94	*
Average weight gain(g/bird/day)	27.01[a]	26.18[a]	24.76[ab]	19.73[b]	28.85[a]	27.89[a]	1.64	*
Feed intake (g/bird/day)	78.69[a]	71.91[a]	79.64[a]	55.71[b]	71.79[a]	77.55[a]	0.11	*
Feed to gain ratio	2.72	2.81	3.22	2.88	2.85	2.77	0.33	NS
Feedcost/kggain(N)	127.49	135.41	160.38	148.67	152.30	153.17	16.85	NS
Mortality(%)	9.52	9.85	9.00	10.20	8.52	11.90	6.87	NS

[abc=]means with different supercript in the same row are significantly different ($P < 0.05$) *$P<0.05$

NS=Not Significant

SEM=Stardard error of mean

LOS= Level of significance

Table: 4.6: Effect of garlic and antibiotics on the performance of Broilers Finisher

Parameter	Diets 1	2	3	4	5	6	SEM	LOS
Initial body wt(g)	946.67	950.00	946.67	950.00	950.00	950.00	38.49	NS
Final body wt(g)	1806.36	1897.58	1929.70	1825.46	1945.94	1996.97	3.45	NS
Weight gain(g/bird)	859.70	947.58	983.03	875.46	823.94	946.97	2.33	NS
weight gain(g/bird/day)	30.71	33.84	35.11	31.27	31.43	33.82	2.86	NS
Feed(g/bird/day)	143.78	151.15	144.54	163.84	142.44	148.15	7.49	NS
Feed to gain ratio	4.69^{ab}	4.47^{b}	4.15^{b}	5.30^{a}	4.86^{ab}	4.41^{b}	0.55	*
Feed cost/kg gain(N)	228.19^{ab}	222.74^{ab}	203.39^{b}	248.71^{b}	254.28^{a}	221.61^{ab}	12.32	*
Mortality(%)	11.11^{b}	16.67^{ab}	11.11^{b}	18.00^{a}	8.33^{b}	11.11^{b}	3.93	*

*P<0.05 $^{abc=}$ means with different supercript in the same row are significantly different (P<0.05)

LOS= Level of significance

NS=Not Significant

SEM=Stardard error of mean

Table:4.7. Effect of antibiotics on the Haematological Parameters and Bacterial count

Parameter	Diets 1	2	3	4	5	6	SEM	LOS
PVC(%)	28.50^{d}	36.5^{d}	33.50^{c}	33.50^{c}	34.55^{bc}	39.00^{a}	0.61	*
Haemoglobin(g/dl)	12.05^{b}	9.70^{d}	10.70^{c}	11.25^{bc}	11.40^{bc}	13.10^{a}	0.28	*
T/Protein(g/dl)	2.90^{b}	3.10^{ab}	2.90^{b}	2.90^{b}	3.35^{a}	2.90^{b}	0.11	*
RBC(%)	4.35	4.45	4.51	4.32	4.50	4.42	0.16	NS

$^{abc=}$ means with different supercript in the same row are significantly different (P < 0.05)

*P<0.05

NS=Not Significant

SEM=Stardard error of mean

LOS= Level of significant

Table:4.8. Effect of garlic and antibiotics on carcass characteristics of Broilers Chicken

Parameter	Diets 1	2	3	4	5	6	SEM	LOS
Live wt(g)	1975.00	2200.00	2050.00	2050.00	2350.00	2450.00	163.62	NS
Dress wt(g)	1350.00	1600.00	1425.00	1450.00	1725.00	1875.00	164.25	NS
Dressing Percentage(%)	68.34	72.21	69.44	70.57	73.23	76.54	2.27	NS
Breast(%)	27.11	30.77	27.16	26.43	30.22	29.43	2.88	NS
Drum sticks(%)	26.83	35.93	31.81	30.49	35.34	36.00	3.20	NS
Wings(%)	14.81	15.72	15.70	16.11	15.17	14.82	1.00	NS
Back(%)	20.02	19.21	19.11	18.78	17.26	16.61	1.33	NS
Heart(%)	0.59	0.71	0.69	0.69	0.72	0.77	0.06	NS
Liver(%)	3.09	3.43	3.06	2.95	3.74	3.79	0.35	NS
Kidney(%)	0.46	0.62	0.56	0.59	0.87	0.85	0.17	NS
Gizzard(%)	6.51	6.75	5.94	4.60	5.78	6.80	0.75	NS
Abdominalfat(%	2.50	2.20	2.51	2.25	2.01	2.15	0.11	NS
Intestine(%)	8.34	8.25	8.45	7.50	8.55	8.30	0.73	NS
Intestinallength (cm)	222.50	226.00	249.50	239.50	255.00	235.00	17.01	NS

$^{abc=}$ means with different supercript in the same row are significantly different ($P < 0.05$) $*P<0.05$

NS=Not Significant SEM=Stardard error of mean LOS= Level of significant

CHAPTER FIVE

DISCUSSION

The results obtained from this experiment " The Effect of Garlic as a Feed Ingredient in the Diets of Broiler Chickens is discuss below**.** Table 4.1. shows the results of effect of graded levels of garlic on the performance of the experimental birds in starter phase. There was significant (P < 0.05) difference in the final body weight, weight gain, feed intake, feed to gain ratio, feed cost per kg gain and mortality across dietary treatment. The result of the study showed that birds fed 1.5% garlic had the highest weight gain of 259.53g, while birds on 3.0% garlic had the least weight gain of 90.49g. The result is in agreement with the report of Aporn *et al*., (2008) who suggested that replacing garlic meal up to 1.3% for antibiotic as growth promoter could maintain productive performance of broilers and had no effect on sensory quality. There was significant (P < 0.05) difference in feed intake. Feed intake decreased as the level of garlic inclusion in the diets increased.This could be as a result of the harsh, pepperish taste and smell of garlic. Feed conversion ratio of the various Diets means are as follows, 1.97, 2.25, 1.92, 1.94, 2.39, 2.78 in Diets 1-6 respectively. Diet 5 with 1.5% level of garlic supplementation had a better feed conversion ratio although stastitically similar to those on Diets 1 and 4. The observed increase in body weight and weight gain of chicks with garlic supplemation is similar to the finding of Horton and Prasad (1991) who reported that garlic as a natural feed additive, improved broiler growth, feed Conversion ratio (FCR) and decreased mortality rate. There was significant (P < 0.05) difference in cost per kg gain across the dietary treatments. This may have been as a result of the cost of feed per kg as the level of garlic increased in the diets. The highest mortality was recorded in Diet 4. There was no particular trend in the mortality pattern across the treatments, however the lowest value of 7.14 percent occured in birds fed 1.5% garlic in the diet.

The results of Table 4.2. is as discuss below. The effect of graded levels of Garlic on the performance of the experimental birds in Finisher phase. There was significant (P < 0.05) difference in the final body weight, weight gain, feed intake, feed to gain ratio, feed cost per kg gain and mortality across dietary treatment. The result of the study showed that birds fed 1.5% garlic had the highest weight gain of 1946.70g, while birds on 3.0% garlic had the least weight gain of 1483.00g. This result is supported by the findings of Javandel *et al.*,**(**2008) who reported a decline in weight gain as the level of garlic inclusion incereased in broiler chickens diets. Shi *et al*., (1999) fed broiler chickens with diets containing 0.2, 1 or 2% garlic meal and reported that the highest total and individual weight gains were observed in birds fed 1% Garlic supplementd diet. There were significant differences among the Diets groups in feed conversion ratio. Birds on control diet, 1.0% garlic and 1.5% garlic utilized their feed significantly better (P<0.05) than those on the 2.0%, 2.5% and 3.0% inclusion levels of garlic. The result is similar to the findings of Aporn *et al*., (2008) who reported that

Supplementation of garlic up to 1.3% have no effect on feed conversion ratio.The cost per kg gain was significantly (P<0.05) different across the dietary treatments. The observed increased cost/gain across the diet could be due to increase in cost per kg of the diet as the level of garlic increased in the diet. The results showed that mortality was not significantly different across the dietary treatments.

The results of Table 4.3. which shows Carcass characteristics and Table 4.4 which shows Haematological study of The effect of graded levels of Garlic on the performance of the experimental birds in Finisher phase is discuss as follows. The differences observed in the dressed weight may have result from the differences in the liveweight of the birds across the Diets. The difference in the percentages of the wings, back, heart, kidney, gizzard and abdominal fat did not follow any particular trend. The present result is not in agreement with Lydia (2001) who reported that there were no significant differences on carcass percentage and organ weight of birds fed varying levels of garlic. The values obtained for Haematological study were within normal range of 27.27+ 1.56 for PCV, 9.01+ 0.49 for Hb and 8.43+ 0.45 for Total protein for healthy birds (Oladele and Ayo,1999).

The results obtained from this experiment " The performance of broiler chickens fed Garlic and Antibiotics is discuss below**.** Table 4.5 shows the performance of the experimental birds in starter phase. There was significant (P < 0.05) difference in the final body weight, weight gain, feed intake, feed to gain ratio, feed cost per kg gain and mortality across Diets. The final body weight, weight gain and feed intake were significantly (P<0.05) lower in birds given 0.1% vitacox compared to all other Diets. Birds fed Garlic and moringa supplementation had the hightest live weight of 810.6g and 799.07g respectively which was statistically similar to birds in Diets 1, 2, and 3 but significantly (P < 0.05) higher than birds on Diet 4**.** The least final weight was observed for birds fed diets containing vitacox(588.49). Hernandez *et al*., (2004) in their work stated that the use of herbal plant extract will give live performance levels similar to those on antibiotic growth promoters (AGP) which is in agreement with the observation in this study.

The results of Table 4.6. is as discuss below. The effect of Garlic, Moringa and antibiotics on finisher. There was significant (P < 0.05) difference in the final body weight, weight gain, feed intake, feed to gain ratio, feed cost per kg gain and mortality across dietary treatment. Result showed that birds fed 1.5% garlic and 1.5% moringa had the highest finial weight gain of 1946.94g and 1996.97g respectively while birds on Vitacox and control had least finial body weight of 1825.46 and 1806.36g respectively. Hernandez *et al*., (2004) in their work stated that the use of herbal plant extract will give live performance levels similar to those on antibiotic growth promoters (AGP) which is in agreement with the observation in this study. On the contrary, Yeo and Kim (1997); Silva *et al*.,(2000); Islam *et al*.,(2004); Akinleye *et al*.,(2008) and Bozkurt *et al*., (2008) showed that broilers fed herbal products have better feed conversion ratio than those on antibiotics. The results obtained showed that 1.5% Garlic and 1.5% Moringa compared farvourably with conventional antibiotics.

The results on Haematolgical paramenters which is shown on table 4.8 is discuss below.It has been established that packed cell volume(PVC), Haemoglobin (Hb) count and Total protein(Tp) are important blood parameters used in assessing the health status and nutrient intake of animals (Oladele and Ayo 1999). The authors stated that healthy birds are likely to have higher levels of these parameters as opposed to sick or unhealthy ones. Generally, packed cell volume haemoglobin count and total proteins were significantly ($P<0.05$) different among the treatments. Garlic and Moringa which are both natural sources of antibiotics relatively have higher levels of these parameters over the control diet and other diets which contain antibiotics in them.These high levels may indicate better nutrient availability and utilization by these birds coupled with the metabolic role of haemoglobin plays as carriers of oxygen used in the break down of feed.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

Four experiments were conducted to determine the best level of Garlic supplementation in broiler diets. In experiment 1 and 2 six graded levels (1%, 1.5%, 2.0%, 2.5%, 3.0%) of Garlic were compared with an Antibiotic (Neocloxin). The results showed that 1.5% Garlic supplementation level compared farvourably with conventional antibiotics.

In experiment 3 and 4, the best graded level of Garlic supplementation (1.5%) from experiment 1 and 2 were compared with common antibiotics(N.C.O, Embazine and Vitacox) in local market and another natural source of antibiotic (Moringa). The results obtained showed that 1.5% Garlic and 1.5% Moringa at both starter and finisher phase performed and compared farvourably with conventional antibiotics.

The following observations and recommendations were made from the feeding trail:

For the starter phase of experiment 1 and the finisher phase of experiment 2 , broiler chicks could not effectively utilize Garlic at 2.5 % and 3.0 % respectively.

For both starter and finisher phase of experiment 1 and 2 the best graded level of Garlic inclusion that gave optimum performance was at 1.5% inculsion rate.

At both starter and finisher phase of experiment 1 and 2 Garlic inclusion rate of 1.5% compared farvourable well with Neocoloxin which was a synthtic Antibiotics. Natural Antibiotic supplementation led to a better feed utilization over synthetic antibiotics. There was no economic advantage of using Natural Antibiotic over synthetic Antibiotics.

For both experiment 3 and 4 were we used synthetic antibiotics to compare Natural antibiotics, the natural antibiotics perform even better than the synthetic.

Farms may include 1.5% Garlic Meal and 1.5% Moringa leaves in rations in both starter and finisher diets since it support optimal performance and compared farvourably with conventional antibiotics. The weight gains reduction in birds fed 3.0% dietary garlic meal may be that herbal additives have their limitations too and needs more investigation.

Growing birds with natural source of antibiotics is more expensive than using synthtic,the table price should be different so the farmer can break even just as its done in Europe.

APPENDIX

Table 14: Proximate Composition of Garlic Meal

Parameters	Values(%)
Dry matter(%)	40.00
Crude Protein (%)	21.68
Crude Fiber(%)	3.00
Ether Extract(%)	11.22
Ash(%)	4.00
Nitrogen free extract (%)	20.10

Table 15: Analysis of Moringa Oleifera per 100 Grams of Edible Portion.

Mositure 7.5%	Calories 204	Histidine(g/16gN)0.61%	Carbohydrates(g)38.2
Ca 2,003(mg)	Cu 0.57(mg)	Lysine(g/16N)1.32%	VitaminB1-thiamin(mg)2.64
MG 368(mg)	Fe 28.2(mg)	Tryptophan(g/16gN)0.43%	VitaminB2-riboflavin(mg)20.5
P 204 (mg)	S 870(mg)	Phenylanaline(g/16gN)1.39%	Isoleucine(g/16gN)0.83%
K1324(mg)	Fat 2.3(g)	Methionine(g/16gN)1.19%	Valine(g/16gN)1.60gN)1.06%
Protein 27.1(g)	Oxalic 1.6%	Thronine(g/16gN)1.19%	
Fiber 2.3(g)	Vitamin B-choline(mg)	Leucine(g/16gN)0.83%	

Source:Moringa oleifera Natural Nutrition for the Tropics by Lowell Fuglie

www.miracleleaf.com/miracleleaf/Nutrients.html

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