DIETARY EFFECT OF GINGER (*Zingiber officinale*) ON GROWTH AND HAEMATOLOGICAL PERFORMANCE OF AFRICAN CATFISH (*Clarias gariepinus*)

By

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CERTIFICATION

This is to certify that the experiment reported here was conducted by:

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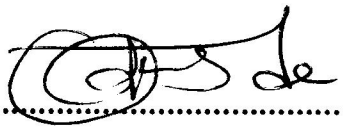
The report has been read and approved having met the requirements of the Department of Fisheries and Aquaculture, Federal University Oye-Ekiti, for the award of Bachelor of Fisheries degree (B. Fisheries).



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DEDICATION

This project is dedicated to *ALMIGHTY* GOD; The author and finisher of all things, the giver of life, the owner of breath, the provider of needs, the defender of the powerless, the helper of the helpless. He made my academic achievement a reality. He has been my present help in the time of trouble. And also, to my lovely and caring parents Mr. Sunday Olaolorunpo Akeredolu and Mrs. Stella Ibironke Akeredolu, for their roles in laying a strong foundation for my academic life.

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ABSTRACT

The aim of this study was to evaluate the effects of graded levels 1.3 %) of ginger *(Zingiber officinale, Roscoe)* (0%, 0.1%, 0.4, 0.7%, 1.0% and 1.3 %) as feed additive in the diets of *Clarias gariepinus* on growth performance and haematological parameters. This study was carried out to evaluate ginger (*Zingiber officinale*) for ten weeks to study its effects on *Clarias gariepinus* . Thus, two hundred and seventy juvenile catfish (*Clarias gariepinus*) were fed on various levels of supplemental ginger in addition to a control diet (treatment1) without ginger inclusion. The treatments had 0.1%, 0.4%, 0.7%, 1.0%, 1.3% supplemental ginger inclusion per 100 kg diet respectively.

There were differences ($p>0.05$) among treatments in all the performance parameters observed.

Fish fed 0.7% GPM diet performed significantly ($p<0.05$) better than others. The diets had no negative effect on growth performance of the fish on the long-run.

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CHAPTER ONE

1.0 INTRODUCTION

Nutrition plays an important role in intensive fish production depending upon the type of feed availability and its cost. In particular, nutritional status has been increasingly acknowledged as a crucial factor in host defence against pathogens. As such, use of feed supplements aiming to improve not only the growth but also the health of aquaculture species has gained widespread interest and acceptance (Esiobu *et al.*, 2002).

The global aquaculture fish production constituted a record 42.2 % of global fish production (total 158 million tonnes in 2012) from capture fisheries and aquaculture (FAO, 2014). Sub Saharan Africa contributed only 0.68% of the total global aquaculture production of eatable fish in 2012 (FAO, 2014). These insignificant aquaculture productions observed in aforementioned region can be attributed to issues that include poor aquaculture development policies; economic restrains; inappropriate technologies/approaches; lack of fish seed; unavailability of feed; weak extension services and limited coordination between research/development sectors (Machena and Moeh, 2001; Hecht, 2005). However, several countries in the Sub Saharan Africa have the physical and socio-economic situations that make them very suitable for the sector to flourish.

The story of aquaculture in Nigeria is essentially the story of catfish culture and the hope of fish supply in Nigeria hang on its development and culture. Recent trends all over the world, point to a decline in landing from capture fisheries, an indicator that fish stocks have approached or even exceeded the point of maximum sustainable yield. Aquaculture therefore remains the only viable alternative for increasing fish production in order to meet the protein need of the people. Catfishes of the family Claridae comprise the most commonly cultivated fishes in Nigeria. The growth of aquaculture in Nigeria now is largely being boosted by a

steady rise in catfish culture. Inadequate availability of seed for stocking and feed used to be major problems. Tremendous progress is now being made. The total value of the industry today is US$800 from the value of fingerlings, feed and farmed fish. Since the culture of *Clarias gariepinus* through hypophysation was initiated in Western Nigeria in 1973, the procedure has been widely practiced throughout Nigeria thus leading to increase of farm-raised catfishes from the 80's to date.

Growth promoters or feed additives are molecules that are added at low rate to animal feeds without changing considerably their composition. They speed up the growth and consequently increase the body size and weight of animals (Biovet 2005). Among all growth promoters, the most commonly used are antibiotics, although nowadays their use is decreasing towards total extinction (Biovet 2005). Some growth promoters act as pronutrients because of the role they play in enhancing the physiology and microbiology of the animals. Pronutrients are substances that could have the same effect as antibiotic feed additives and are defined as micro ingredients included in the formulation of animal feeds with physiological and microbiological functions different from any other nutrient (Biovet, 2005). Many active ingredients from plants are considered as pronutrients and are recently been tried in animal feeds (Biovet 2005). Pronutrients are also sometimes referred to as phytogenic feed additives. Phytogenic feed additives are plant-derived products used in animal feeding to improve their performance.

Plants such as herbs have long been used in traditional/folk medicine in various cultures throughout the world. *Zingiber officinale* is one of these traditional folk medicinal plants that have been used for over 2000 years for treating diabetes, high blood pressure, cancer, fitness, and many other illnesses. Also, ginger (*Zingiber officinale*) is widely consumed as a spice and food preservation.

Ginger (*Zingiber officinalis, Roscoe*), is generally considered as a safe herbal medicine (Weidner and Sigwart, 2000); contains alkaloids, flavonoids, polyphenols, saponin, steroids, tannin, fibre, carbohydrate, vitamins, carotenoids and minerals (Otunola *et al.*, 2010; Shirin and Prakash, 2010); natural antioxidants as gingerols, shogaols and zingerone (Hori *et al.*, 2003); essential oils which has potent anti-inflammatory effects and oleoresin (Zarate and Yeoman, 1996). Ginger is among the spices with reported antiplatelet, antibacterial, antifungal, antiviral, antiworm, anti-inflammatory, anti-oxidative activity, have effects on gastrointestinal, cardiovascular systems, antilipidemic and antihyperglycemic, anti-tumour properties and are known to be effective as an immuno-modulatory agent in human and animals, including fish

(Nya and Austin, 2009; Apines-Amar *et al.*, 2012 and Talpur *et al.*,2013). Supplementing ginger in fish diets may enhance disease resistance by reinforcing host innate immune functions that are necessary for protection against infectious diseases.

The beneficial health effects of ginger have been well documented. According to Yoshikawa *et al.*, the consumption of ginger led to reduction in blood cholesterol and also served as a potential anti-inflammatory and antithrombotic agent.

Ginger is an herbaceous rhizomatous perennial plant that is widely cultivated in warm climatic regions of the world such as Nigeria, Bangladesh, Taiwan, India, Jamaica, and the United States of America. The rhizome contains a spectrum of biologically active compounds such as curcumin, 6-gingerol, 6-shogoals, zingiberene, bisabolene, and several other types of lipids that confer on ginger the characteristics medicinal properties of being pungent and a stimulant. These properties have been reported to be responsible for its various medical applications as an analgesic, antiemetic, antiulcer, antipyretic, prostaglanding suppression, and cardio depressant among many others. Ginger is added to a

wide range of food as an indispensable curry powder or sauce. It is often used to flavour bread, tea, carbonated drinks, biscuits, pickles, and other confectionaries because of its aroma and flavour.

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Antimicrobials have been used in the poultry industry for growth promotion, disease prevention and treatment of infections for many years. However, evidence is mounting that resistant bacteria might be passed from animals to humans. The use of antimicrobials in poultry industry for growth promotion and treatment of infections for many years have caused microbiological and clinical evidence of resistant bacteria that might be passed from

animals to humans resulting in infections that are more difficult to treat (Mojtaba 2007). This situation has put tremendous pressure on the poultry industry to withdraw or limit antibiotic use in animal feeds and to look for viable alternatives (Mojtaba 2007). There are serious worries that through over use, the effectiveness of feed antibiotics might diminish and that strains of bacteria would arise which would be resistant to their effect, of greater concern is the possibility or risk that resistance generated on the farm could lead to a loss of effectiveness of key antibiotics in human medicine. Antibiotics and other drug residues in meat and milk are dangerous to hypersensitive consumers of these products and may subject all consumers to potentially dangerous amounts of these substances (Cole and Garrett 1980).

Because of the current perceived dangers of having drug resistant microbes from the use of antibiotics as feed additives and the current ban by some countries on using antibiotics in animal feeds it would be of great importance to find suitable substitute especially through the use of phytogenics. Also the advent of present day organic agriculture discourages the use of inorganic feed additives in animal feeds. *Zingiber officinale*is a perennial plant, commonly known as ginger. Ginger may act as a pro-nutrient because of the vast active ingredients it has been reported to contain. Herbs Hands Healing (2011) reported that ginger contains volatile oils like borneol, camphene, citral, eucalyptol, linalool, phenllandrene, zingiberine, zingiberol (gingerol, zingirone and shogaol) and resin. Some gingers' medicinal properties are contained in the chemicals responsible for the taste, the most noteworthy being gingerol and shogaol. A protein digesting enzyme (Zingibain) found in ginger is believed to improve digestion as well as kill parasites and their eggs. It was also reported to enhance antibacterial and anti inflammatory actions and it is thought to assist other antibacterials, such as antibiotics, by up to 50%. The nutrients found in ginger include carbohydrates, lipids, proteins, minerals and vitamins. Among these Phosphorus, potassium, riboflavin and vitamin C may be found. Ginger contains about 12 antioxidant constituents,

the combined actions of which have been regarded as being more powerful than vitamin C (Herbs Hands Healing 2011). The stem of this plant is used as a popular cooking spice throughout the world. Nigeria was rated as the number five in world ginger production with an estimated annual output of 138,000 tonnes (FAO 2008).

1.1 Biological features of clarias gariepinus

Body elongate. Head large, depressed and bony with small eyes. Narrow and angular cipital process; gill openings wide; air-breathing labyrinthic organ arising from gill arches; st gill arch with 24 to 110 gillrakers; cleithrum pointed, narrow with longitudinal ridges and th sharpness. Mouth terminal, large. Four pairs of barbels present. Long dorsal and anal fins; thout dorsal fin spine and adipose fin. Anterior edge of pectoral spine serrated. Caudal fin nded. Colour varies from sandy-yellow through gray to olive with dark greenish-brown rkings, belly white.

Plate 1.1: ***Clarias gariepinus***

1.2 OBJECTIVES OF THE STUDY

- The objective of the research was to evaluate the growth performance of African catfish (*Clarias gariepinus)* on varying levels of supplemental powdered ginger meal inclusion.
- To investigate the effects of these alteration with ginger powdered meal on haematological parameters of *C. gariepinus*

CHAPTER 2

LITERATURE REVIEW

2.0 Aquaculture

Aquaculture is a science, technology and business to produce live organisms in limited aquatic system (Pillay, 1993). It has long history with the start of commercial fish farming in China in the 12th century B.C. Then it extends throughout the world (Ling, 1977, Silva, 2012). In the past decade due to its fast development, aquaculture accounts 76% of global fresh water finfish production (El-Sayed, 2006; FAO, 2008). From world aquaculture production Asia accounted for 89 percent by volume in 2010 (FAO, 2012).

2.0.1 Aquaculture in Africa

Aquaculture was introduced into many countries of Africa to serve as a source of protein and avoid total dependence on crops in the 1950s. From 1960 to 1990s development of the sector was facilitated by the help of funds from FAO and other governments and nongovernmental organizations. Around $500million was raised by multilateral and bilateral donors to fund 300 projects throughout the continent (Brummett and Williams, 2000). Increased technical assistance was also observed during this time. Hecht (2005) divided the development of aquaculture into three distinct phases:

Phase 1: 1950–1970. The introductory phase: during which the sector was popularized but with limited knowledge and understanding. Most government stations were built during this era.

Phase 2: 1970–1995. The expansion phase: significant donor support, active R&D, government involvement in seed supply and extension. Commercialization of the industry in some African countries (e.g. Nigeria, Madagascar, Côte d'Ivoire, Zambia, and South Africa) also took place.

Phase 3: 1995 to present. The adjustment phase: reduced donor support, re-orientation of public support towards facilitation, emergence of the commercial sector.

Africa's contribution to world aquaculture in 2012 amounts to 1,485,367 tones (18 times as much as produced in 1990) which is 2.23% of the global production (FAO, 2014). Sub-Saharan Africa contributed only 0.68% of the total production, with Egyptian production of 1million 6 tones for the first time (FAO, 2014). However, the African aquaculture showed the fastest growth in the world at a rate of 11.7% since the turn of the millennium (FAO, 2014). The aquaculture sector in Africa employs more than 290,000 by 2012 accounting for 10% of the world fish farmers (FAO, 2014).

Egypt, Nigeria, Uganda, Madagascar and Zambia are major aquaculture producers in Africa (Bhujel, 2014). Nile tilapia (*Oreochromis niloticus*), Flathead grey mullet (*Mugil cephalus*), and the African catfishes (*Clarias gariepinus*) are the species produced in the highest quantity in the continent (FAO, 2012).

Farming system employed includes ponds, raceways, pens, cages and recirculation systems. Ponds range from $500m^2$ to 2.5ha with production levels of 3–10 tones/ha/year with inorganic or animal manure. Raceways are used mainly for trout and tilapia. Pens and cages (square and round) range from $15m^3$ to 1,600m3 and are used for farming of tilapia, trout, clariid and bagrid catfish and high-density water recirculation systems are used for fingerling and Table fish production of African catfish in Nigeria and South Africa. At 2.23% Africa stands as the continent with the lowest aquaculture production. (Brummett and Williams, 2000, Hecht, 2005).

Aquaculture development in Africa started at about the same time as Asia, but lags far behind in terms of production volume and revenue (Buhjel, 2014). Interplay of institutional, bio-technical and economical factors have been ascribed to the slower development of the sector in the continent. These factors include: lack of clear aquaculture development policy

poor governmental support, weak research and extension as well as research and development linkages, inappropriate and inflexible technical support, heavy dependence on donor support, unavailability of credit, inadequate seed and feed supply both in quality and quantity, lack of farmer participation in extension systems, poor and often unreliable data collection system (Machena and Moehl, 2001; Hecht, 2007).,

The declining capture fisheries of the region, the high population growth rate in Sub-Sahara Africa and the current shortfall of fish all emphasize the need for rapid aquaculture sector growth. Aquaculture in Africa need to be promoted to be able to meet the projected demand of 3 million metric ton annually, for which aquaculture production has to grow by 10% annually for the next five years until 2020 based on its current level of production of 1 million metric ton per 7 year. 30 million hectors of land was estimated to be suitable for aquaculture in Africa. An additional 12 million hectors of floodplains would also be suitable for fish production. There is also a potential for cage culture, given the availability of water bodies throughout the region (Machaena and Mohel, 2001).

The future for aquaculture in Africa is promising. A rapid decline in wild catch, along with an increase in public awareness and priority given by the government indicate that aquaculture may take off very soon (Buhjel, 2014, Munguti et al., 2014). Exponential growths that were seen in Egypt and Nigeria can be replicated in other parts of the continent. The following points have been suggested as possible directions for the development of the sector in the continent: careful planning is necessary to guide future aquaculture development and ensure that available resources are well used. A strategy for aquaculture development should be developed in these countries. Conducive policy frame work has to be created for the strategy to be implemented. Furthermore, strong ad appropriate research and extension system has to be fashioned. Readily flow of information between farmers and professionals and effective training and extension services have to be developed (Brummett & Williams, 2000, Atta-mills et al., 2004).

2.1 The African catfish

Clarias gariepinus, indigenous fish species of Ethiopia, can be defined as having an elongated cylindrical body with dorsal and anal fins being extremely long. The head is flattened, highly ossified, and the body is covered with a smooth scale-less skin. It has four distinctive pairs of unbranched barbels (Graaf and Janssen, 1996). The major function of the barbels is prey detection. A supra-branchial or accessory respiratory organ, composed of a paired pear-shaped air-chamber containing two arborescent structures is generally present. The accessory air breathing organ allows the fish to survive for many hours out of the water or for many weeks in muddy marshes (Haylor and Muir, 1998).

C. gariepinus is a widespread freshwater benthic species, found from Turkey, the Middle East, and throughout Africa (Spataru *et al.*, 1987).

It inhabits natural lakes, impoundments, fish ponds, streams, and natural ponds in both shallow and deep waters. Even though some of these habitats are subject to seasonal drying, the species is capable capable of living there due to the presence of the accessory breathing organs (Graaf and Janssen, 1996).

Bruton (1979) suggested that *C. gariepinus* is a euryphagy, an organism feeding on a wide variety of organisms according to their availability. *C. gariepinus* has a remarkable array of anatomical adaptations that made it capable of euryphagy. These adaptations allowed the species to feed on a wide variety of diet and size ranges, from a minute zooplankton to a fish half its own size (Bruton, 1979). The diet of the species included small crustaceans, insects, mollusks, oligochaetes and other fish (Bruton, 1978 and 1979; Wudneh, 1998, Dadebo, 2009). Fish, particularly tilapia, have been found to be important prey of African catfish in some waters (Dadebo, 2009 and 2014)). *C. gariepinus* is a slow foraging predator, with very small eyes, using their four pairs of barbels to feel their way around in the dark and find food detected by the array of sensitive taste buds covering the barbels and head. Approximately 70 percent of feeding activity takes place at night (FAO, 2014).

C. gariepinus shows a seasonal gonadal maturation which is usually associated with the rainy season. The maturation processes are influenced by annual changes in water temperature and photoperiodicity and the final triggering of spawning is caused by a raise in water level due to rainfall (Graaf *et al.,* 1995). Spawning usually takes place at night in the shallow inundated areas of the rivers lakes and streams. Courtship is preceded by highly aggressive encounters between males. Courtship and mating takes place in shallow waters between isolated pairs of males and females. A batch of milt and eggs is released followed by a vigorous swish of the female's tail to distribute the eggs over a wide area (Bruton, 1979). There is no parental care for ensuring the survival of the catfish offspring except by the careful choice of a suitable site.

2.1.1 Nutritional Requirements of African Catfis

2.1.1.1. Protein requirements of Catfish

The dietary protein and amino acid requirements of African catfish (*C. gariepinus)* have been extensively studied during the past three decades.

Protein is the most expensive component in supplementary fish feed (Fagbenro *et al.,* 1992). Dietary protein is used by fish for growth; energy and body maintenance (Kausshik and Medale, 1994). Generally speaking, fish meal constitutes the main protein source (some 40-60%), relinquished only when a protein-rich alternative is included, mostly of vegetable origin (e.g. groundnut cake, soybean meal) (Chuapoehuk, 1987; Balogun and Ologhobo, 1989; Fagbenro, 1992).

Results from various studies confirm that 40% protein as the requirement for *C. gariepinus* and also showed that increasing the dietary protein content of the fish to 45% did not have any statistical advantage.

Clarias gariepinus is generally considered to be one of the most important tropical catfish species for aquaculture. It has an almost Pan-African distribution, ranging from the Nile to WestAfrica and from Algeria to Southern Africa. They also occur in Asia Minor (Israel, Syria and South of Turkey). *C. gariepinus* at various geographical locations bears different names. It is called *C. lazera*in Northern and Central Africa, *C. senegalensis* in East Africa, *C. masambicus*in West Africa and *C. gariepinus* in South Africa (Viveen *et al.,* 1985).

The optimum protein levels in catfish diets are influenced by several factors, including fish age and size, dietary protein quality and source, non-protein energy in the feed, natural food availability, feeding levels and culture conditions (Page and Andrews, 1973; Winfree and Stickney, 1984; Cho and Lovell, 2002; Robinson and Li, 2002; Wu *et al.*, 2004). The

dietary protein requirement of channel catfish ranges from about 25–55 percent, depending on life stage (NRC, 1993). For example, Winfree and Stickney (1984) reported that channel catfish fry require 55 percent protein for optimum growth. Fingerlings and juveniles require a protein level of 36 to 40 percent, whereas 25 to 36 percent dietary protein is suggested for grow-out stages (Page and Andrews, 1973; Robinson and Li, 2002). Moreover, increasing dietary protein level in the diet of channel catfish broodstock from 32 to 42 percent did not influence spawning, fecundity or fertilization, but affected egg size and biochemical composition of the eggs (Quintero *et al.*, 2009).

Protein requirement of catfish is also affected by feed allowance. Li and Lovell (1992) showed that when pond-raised channel catfish were fed to satiation, they require 28 percent protein for maximum growth. The fish require 32 percent or 36 percent protein for maximum growth when they are fed to less than satiation. Similarly, Robinson and Li (1997) found that when catfish in ponds were fed to satiation daily with diets containing 16–32 percent protein, the weight gain of fish fed 24 to 28 percent protein was similar, and higher than that of fish fed 16 percent, 20 percent or 32 percent protein.

2.1.1.2. Amino Acid Requirement of Catfish

Various efforts have been made to establish the crude protein and amino acid requirement of *C. gariepinus*. Ayinla (1988) recommended 35 and 40% crude protein (CP) for raising table size and brood stock respectively. Of the 10 essential amino acids (EAAs) required by fresh water fish species, only three EAAs have been studied, these are arginine, methionine and lysine. In order to formulate and compound aqua feeds that will meet the nutrient requirements of the catfish. The first need is to supply the indispensable amino acid

requirement of the animal, and secondly to supply dispensable amino acids or sufficient amino nitrogen to enable their synthesis (Macartney, 1996). 3.2g of methionine per 100g of protein is required Fagbenro et al., (1998).

2.1.2 The Culture System of Catfish

Multiple sorting is essential because of the cannibalistic nature of *C. gariepinus.* As the fish grow, big ones of the same size-group are removed to another tank for rearing. Thus harvesting is done at different periods for the different groups sorted. For outdoor fry/fingerlings rearing, screening of the tanks with mosquito nets is recommended to prevent dragonfly and other predatory insects from breeding in the ponds. Poly-culture of *C. gariepinus* and Tilapia species is practiced. A poly-culture of *C. gariepinus* and *Oreochromis niloticus,* integrated with poultry with some supplementary feeding had been shown to be viable. (NIFFR, 2002)

2.2 Importance of Ginger

Ginger is the common name for *Zingiber officinale*, which was originally cultivated in China and now equally spread around the world. The ginger root is not actually a root, but a rhizome. The major producers of Ginger today are China and tropical/subtropical places in Asia, Brazil, Jamaica, Nigeria.

Ginger roots have been reported to contain a number of compounds that exert varying biological activities, including antioxidant (Nakatani, 2000; Rababah et al., 2004), antimicrobial (Akoachere et al., 2002; Jagetia et al., 2003; Mahady et al., 2003) and various pharmacological effects (Chrubasik et al., 2005; Ali et al., 2008). Powdered rhizome of

ginger has long been used to alleviate the symptoms of gastrointestinal illnesses as traditional medicine (Afzal et al., 2001). Ginger has been found to enhance pancreatic lipase activity (Platel and Srinivasan, 2000), intestinal lipase, disaccharidase, surcease and maltase activities in rat (Platel and Srinivasan, 1996). All of these have favorable effects on gut function, which is the primary mode of action for growth promoting feed additives (Windisch et al.,2008).

The health benefits of honey and ginger in treating respiratory problems are unmatched by any other concoction. The ginger plant is approximately 30 - 60 cm tall and is extremely rare to find in the wild. Even today Ginger is one of the most important spices world wide. Ginger is a herb but is often known as a spice, with a strong distinct flavor that can increase the production of saliva. The part that is used as spice on the plant itself is the rhizomes or ginger root. This ginger root is traditionally used with sweet foods in Western cuisine being included in popular recipes such as ginger ale, ginger snaps, gingerbread, ginger biscuits and ginger cake. It is also used in many countries as a medicinal ingredient which many believe in. Some say it can help cure diabetes, head aches, colds, fatigue, nausea and the flu when used in tea or food.

2.2.1. Nutritional Constituent of Ginger

The ginger rhizome has the following chemical composition:

- 60% starch,
- 10% proteins,
- 10% fats,
- 5% fibers,
- 6% inorganic material,

- 10% residual moisture,
- 1-4% essential oil5.

The percentage of essential oil varies with geographic origin. However, its chief elements, sesquiterpene hydrocarbons, remain constant. These include (-)-zingiberene, (+)-ar-curcumene, (-)-ßsesquiphellandrene, E, E- a -farnesene, and b -bisabolene. These essential oils occur alongside side monoterpene alcohols and aldehydes present as glycosides. A mixture of many terpenes and some nonterpenoid compounds make up the essential oil.1 It has been speculated that since there are a variety of chemical classes that these compounds can belong to, it is likely that ginger can eliminate symptoms associated with a variety of illnesses, such as arthritis, by interfering with the production and release of metabolic products from lipid membranes, peptides, proteins and amino acids.

Experimental data reveal that ginger may be a dual inhibitor of eicosanoid synthesis, inhibiting the synthesis of both prostaglandins and leukotrienes, which are inflammatory mediators produced from arachidonic acid.

Table 2.1. Proximate composition of ginger root

PARAMETER	AMOUNT %)
CRUDE PROTEIN	34.13
CRUDE FIBRE	4.02
ETHER EXTRACT	4.07
ASH CONTENT	7.64
MOISTURE CONTENT	13.75
VITAMIN C	1.036

Table 2.2 Mineral composition of ginger root

PARAMETERS	AMOUNT ng/100g)
ZINC	6.4
MANGANESE	5.9
IRON	279.7
COPPER	8.8
CALCIUM	280
PHOSPHORUS	8068

SOURCE: Latona et al., 2012

2.2.2 Biological Effects and Clinical Uses of Ginger

In recent years, researchers have scientifically validated many of the therapeutic uses of ginger.

•One study indicates that ginger is effective in reducing inflammation in arthritic conditions. In a study conducted with 56 patients experiencing either rheumatoid arthritis, osteoarthritis, or muscular discomfort, 75% experienced relief in pain and swelling after using powdered ginger. Furthermore, none of the patients complained of any side effects while using ginger to treat their symptoms.

It is suggested that ginger works as an inhibitor of prostaglandin and leukotriene biosynthesis to produce its ameliorative effects.

• Another case study presented ginger as a preventive agent for migraine headache. In this application, one subject was given non-steroidal anti inflammatory medication to permit her migraine headaches to subside. However, even though her headache was eliminated in time, other side effects including depression and redness of the eyes appeared. The subject was then given ginger. With 500- 600 mg of powdered ginger mixed with water, the migraine headaches ceased within 30 minutes. In addition, after the cessation of the migraine attack, the subject did not experience any side effects. Migraine headaches are an accumulation of pain syndromes.

Many anitihistamines are used to treat migraines. Ginger has been shown to contain antihistamine and antioxidant factors as well as possess anti-inflammatory action (Muhammed & Prakash et al., 2007).

• The effect of ginger on stimulation of bile secretion was studied to identify the basis of its action as a metabolism enhancer. Results of this specific study reported that the acetone extracts of ginger, comprised of the essential oils and the pungent principles, produce an increase in bile secretion. The two pungent principles that were chiefly accountable for the

cholagogic effect of ginger include gingerol. Bile acids facilitate absorption of fat and electrolytes and peristalsis of the small intestine. Since ginger has been reported to increase bile secretion, it may be beneficial in the excretion of gallstones (Muhammed & Prakash et al., 2007).

• Furthermore, a study was done on 20 healthy male individuals that were given 50 g of butter and 5g of ginger a day for seven days. Addition of five grams of ginger with a fatty meal inhibited the platelet aggregation induced by adenosine diphosphate and epinephrine to a large extent. Ginger has been reported to inhibit prostaglandin synthesis in *vitro*. It has been reported that dietary fat content affects platelet aggregation by modifying prostaglandin metabolism. Inhibiting the transformation of arachidonic acid to thromboxane and decreasing the sensitivity of platelets to many aggregating agents may be possible with the administration of ginger in a fatty diet (Muhammed & Prakash et al., 2007).

• In view of the fact that ginger root has been used in several parts of the world in the management of motion sickness, researchers attempted to elucidate the mechanism of action. In one of the earlier studies, it was proposed that ginger constituents may increase gastric motility and prevent the accumulation of toxic substances, thereby blocking the gastrointestinal reactions which trigger the nausea feedback8. A more recent study addressed the role of ginger in preventing the nausea feedback at the nerve receptor level. In motion sickness, nausea and vomiting are mediated by specific receptors in the central and peripheral nervous system. These receptors are activated by the chemical messengers, acetylcholine and histamine. Ginger produces antimotion sickness action probably through anticholinergic and antihistaminic effects (Muhammed & Prakash et al., 2007).

2.2.3 The Ginger Plant

Ginger (*Zingiber officinale*) is a perennial herb whose rhizome (i.e. underground stem) is used widely as a spice, for pickles, candies, preservatives and many medicinal purposes. It is also called red ginger. The plant belongs to the family *Zingibeaceae* which are aromatic herbs with fleshy, tuberous or non-tuberous rhizomes and often have tuber bearing roots (Ke *et al.*, 2000). Ginger is harvested between 6 and 12 months after planting and can be grown in many countries of the tropics under a moist ecology.

Ginger contains 44 constituents of nutritional importance, mostly zingebirine, beta sisquiphellandrence, terinole and various amounts of nutrients such as protein, lipids and minerals. The main components are a mixed composition of zingerone, shogaols and gingerols and paradol (Comell and McLachlan, 1972; Nidaullah *et al.*, 2010). Its aromatic principles are zingiberene and bisabolene, while the arylalkane - pungent substances are known as gingerols (chief components include gingerol,) and shogaols (chief components include shogaol, gingerdiols and diarylheptanoids which include among others, gingerenone A and B. Zingerone and shogaols are degradation products of gingerol. Fresh ginger contains the "gingerols" which when exposed to air and heat change into the "shogaols," which is more pungent. This chemical change is one of the most important aspects of ginger's therapeutic value.

2.2.4. Human Consumption Of Ginger (*Zingiber officinale)*

For over 2 thousand years Chinese medicine has recommended the use of ginger to help cure and prevent several health problems. It is known to promote energy circulation in the body while positively increasing the body's metabolic rate.

It can be concluded that ginger is a good source of antioxidant and most of the antioxidant components exhibit higher activities in alcoholic media as determined by different assays. Hence, apart from its medicinal properties, ginger can also be used as an antioxidant supplement.

Antiemetic/antinausea, anticlotting agent, antispasmodic, antifungal, anti inflammatory, antiseptic, antibacterial, antiviral, antitussive, analgesic, circulatory stimulant, carminative, expectorant, hypotensive, increases blood flow, promotes sweating, relaxes peripheral blood vessels.

Ginger is good for your health and has been said by some to be a plant directly from the Garden of Eden. It is also said that consuming Ginger before taking a plane flight can prevent motion sickness. It can make good tea, or you can use it as a spicy addition to almost any recipe.

Ginger (*Zingiber officinalis, Roscoe*), is generally considered as a safe herbal medicine (Weidner and Sigwart, 2000); contains alkaloids, flavonoids, polyphenols, saponin, steroids, tannin, fibre, carbohydrate,vitamins, carotenoids and minerals (Otunola *et al.*, 2010; Shirin and Prakash, 2010); natural antioxidants as gingerols, shogaols and zingerone(Hori *et al.*, 2003); essential oils which has potent anti-inflammatory effects and oleoresin (Zarate and Yeoman, 1996). Ginger is among the spices with reported anti platelet, antibacterial, antifungal, antiviral, anti-worm, anti-inflammatory, anti-oxidative activity, have effects on gastrointestinal, cardiovascular systems, antilipidemic and antihyperglycemic, anti-tumour properties and are known to be effective as an immuno-modulatory agent in human and animals, including fish (Nya and Austin, 2009; Apines-Amar *et al.*, 2012 and Talpur *et al.*,2013). Supplementing ginger in fish diets may enhance disease resistance by reinforcing host innate immune functions that are necessary for protection against infectious diseases.

Ginger has a wide variety of effects on the human body and is known to be effective for the treatment of cataracts, amenorrhea, heart disease, migraines, stroke, , angina, athlete's foot, colds, bursitis, chronic fatigue, tendinitis, flu, coughs, depression, dizziness, fever, erectile difficulties, infertility, kidney stones, Raynaud's disease, sciatica, and viral infections. Ginger has many uses in the home remedies department and can be used to help arthritis, diarrhea, flu, headache, heart and menstrual problems, diabetes, sore throat, stomach upset and motion sickness.

Table 2.3 Nutritional composition of *Z. officinale*

Constituent	Value
Moisture	**15.02**
Protein	**5.08**
Fat	**3.72**
Insoluble fibre	**23.5**
Soluble fibre	**25.5**
Carbohydrate	**38.3**
Vitamin C	**9.33**
Total Carotenoids	**79**
Ash	**3.85**
Calcium	**88.4**
Phosphorus	**174**
Iron	**8**
Zinc	**0.92**
Copper	**0.545**
Manganese	**9.13**
Chromium	**70**

Source: Nwinuka et al., 2005, Hussain et al., 2009, Odebunmi et al., 2001

CHAPTER THREE

MATERIALS AND METHODS

3.0 Processing of experimental ginger

The ginger used in this experiment was purchased fresh, washed and sliced. The sliced ginger was sun-dried and was later grounded into powder. The drying process reduced the moisture content of the ginger which will enhance the blending/ grinding of the ginger.

The powdered ginger was then sealed in polythene bag before incorporation into the feed. Two (2) kg of fresh ginger that was purchased gave 1.5kg of ginger.

The ginger was purchased in an open market at the Akure shasha market.

3.1. Experimental diets

Six diets were formulated for all the treatments. Diet 1: 0% served as control (without ginger inclusion). Diets 2:0.1%, Diet 3: 0.4%, Diet 4: 0.7%, Diet 5: 1.0% and Diet 6: 1.3% ginger inclusions per 100kg feed respectively.

3.2 Experimental procedure

Fish in each treatment were fed with experimental diet at 5% of their body weight. Weight changes were recorded weekly with sensitive electronic weighing scale and feed adjusted appropriately. At the end of 8weeks the effect of these experimental diet were observed.

3.3 Formulations of Diets.

The feed ingredients were Fish meal (FM),Ginger Powder (GP),Wheat offal (WO), Groundnut cake (GNC), Maize (M), Soya bean cake (SBC), Starch(S), Vegetable oil (VO)

Methionine (M),Premix (P),Salt (S), Chromic oxide (CO). Six isonitrogeneous (40% protein) rations were formulated as shown in Table 4. Diet 1 was the control and it contained fishmeal, soybean meal and groundnut cake as the main source of protein and supplemental methionine source respectively Diet 2, 3, 4, 5 and 6.

All diets were formulated to contain 40% Crude protein (Table 2).The other ingredients were added and the diets were thoroughly mixed manually.

Table 3.1 Percentage composition (%) of the experimental diets.

INGREDIENT	DIET 1	DIET 2	DIET3	DIET4	DIET5	DIET6
Maize/corn	10	12	12	10	7.64	6
Wheat offal	12	16	11.95	10.55	9	7.23
Fish meal	30	30	30	30	30	30
GINGER	0	1.14	4.55	7.95	11.36	14.77
Soybean meal	20.75	10.5	19.5	19.5	18	15
GNC	20	21.36	13	13	15	18
Meth	1	1	1	1	1	1
vit /min remix	1	1	1	1	1	1
salt	0.5	0.5	0.5	0.5	0.5	0.5
binder	2	2	2	2	2	2
vit. C	0.25	2	2	2	2	2
Veg oil	2	2	2	2	2	2
Chromic kide	0.5	0.5	0.5	0.5	0.5	0.5
TOTAL	100	100	100	100	100	100

3.4 Experimental fish and general stock management

Two hundred and seventy juvenile catfish were purchased from a reputable farm (Afe-Babalola farms, Ado-Ekiti, Ekiti-State) and used during the experiment. The fish were acclimatized for one week (7 days). During the period of acclimatization the fish were fed at 5% body weight twice daily (Okoye et al., 2001) with a formulated diet of 40% crude protein. At the end of the acclimatization period, the fish were randomly selected and stocked into 18 plastic aquaria with each aquarium holding 15 fish.

Fifteen juvenile fish were stocked in each tank for each of the six dietary treatments compared, with three (3) tanks per treatment as replicates and fifteen in each replicate using completely randomized design (CRD). Feeding was suspended for 24 hours before the feeding trial to increase appetite and reception for new diet (Madu and Akilo, 2001).

3.5 Feeding trial

The feeding trial begins after 24 hours starvation of the fish and the experimental diet was introduced to the fish at varying level of ginger inclusion; 0%, 0.1%, 0.4%, 0.7%, 1.0%, 1.3%. The 0% diet contain no ginger meal but fish meal, diet 2 contain only 0.1% of ginger inclusion, diet 3 contain only 0.4% of ginger inclusion, diet 4 contain only 0.7% ginger inclusion, diet 5 contain only 1.0% ginger inclusion and diet 6 contain only 1.3% ginger inclusion . The fish were fed twice daily at 5% of their body weight for a period of 8weeks and feed quantity was adjusted in accordance with their body weight. Each fish was weighed using an electric weighing balance on weekly basis.

3.6 Data collection

Weekly average feed intake was recorded by subtracting feed left over from quantity of feed given during the week. Body weight was also recorded on weekly basis by subtracting

previous week's body weight from the current weight for each week and average daily weight gain were also calculated. Mortality was recorded throughout the period of the study as it occurred.

During the fifty-six days of the experiment the following data were collected on the catfish juvenile placed on *Z. officinale* meal:

3.7 Feed intake (g)

Feed was weighed out on daily basis for fish in each replicate. At the end of the week, the leftovers were weighed. Feed consumed for the week was obtained by the difference. Weekly record of feed consumption per fish were obtained for each treatment by dividing the total amount of feed consumed by the number of fish in each treatment.

3.8 Body weight (g)

Fish were weighed in groups at the beginning of the experiment and were subsequently weighed weekly throughout the ten weeks of the experiment. The weight of each replicate were recorded at the end of weighing. The reading for each replicate were added to get total weight for the treatment and divided by the number of fish in the treatment to obtain the average body weight for the week. Average body weight per day was obtained by dividing average body weight for the week by seven (7).

3.9 Body weight gain (g)

The body weight gain for each week was obtained by taking the difference between the body weight for the given week and the body weight for the preceding. Body weight gain per day was obtained by dividing body weight gain per by the number of days.

3.1.0 Feed conversion efficiency

From the weight gained and the feed consumed by fish in ech treatments, the feed efficiency was computed using this formula:

F/G= Average feed intake per day/body weight gain per day

3.1.1 Protein intake (g): This was calculated by multiplying the feed intake by the diet protein i.e, protein contained in the diet;

Feed intake x diet protein

3.1.2 Feed Conversion Efficiency (F/G ratio)

From the weight gained and feed consumed by fish in different treatments, the feed efficiency was computed using the following expression

$$\mathbf{F/G} = \frac{\text{Average feed intake per day}}{\text{Body weight gain per day}}$$

3.1.3 Protein Efficiency Ratio (PER)

This was calculated using the data obtained from feed intake and weight gain.

$$\mathbf{PER} = \frac{\text{Body weight gain (g)}}{\text{protein intake (g)}}$$

Protein intake = Feed intake × Percentage protein in the Diet.

3.1.4 Sample collection

At the end of feeding trial, fish blood samples were collected with eparinized bottles. Blood samples were obtained from the caudal vein of fish from each tank. Blood for serum analysis were collected into bottles (EDTA Bottle).

3.1.5 Haematological profile

Immediately after sampling, blood smear were prepared, red blood and white blood cell count were carried out using standard haematological techniques (Dacie and Lewis 2001). Fifty µL haematocrit tubes was filled with blood samples, after centrifugation (7200 rpm for 10 min) of each blood sample, packed cell volume (PCV) was determined by the Wintrobe and Westergreen method as described by Blaxhall and Daisley (1973). Haemoglobin levels (Hb in grams per deciliters) were obtained by the cyanomethaemoglobin spectrometric method (Dorafshan et al., 2008). The blood indices including mean corpuscular volume (MCV in femtoliters), mean corpuscular heamoglobin (MCH in pictograms per cell), and mean corpuscular haemoglobin concentration (MCHC in grams per deciliter) were calculated according to the following formulars (Dacie and Lewis 2001):

$$\text{MCV (fl)} = \frac{\text{PCV (\%)}}{\text{RBC } (10^{-6}\mu l^{-1})}$$

$$\text{MCH (pg)} = \frac{[\text{Hb } (gdl^{-1})]}{\text{RBC } (10^{-6}\mu l^{-1})}$$

$$MCHC\ (gdl^{-1}) = \frac{[Hb\ (gdl^{-1})]}{PCV\ (\%)}$$

3.1.6 Statistical analysis

All data were subjected to analysis of variance and the significance of differences of treatment means were determined by applying Duncan's multiple range test (steel and Torrie, 1980). The growth and nutrient utilization was computed and the weight gained, mortality was observed and recorded and all data recorded was subjected to statistical analysis of variance (ANOVA).

Each of the six dietary treatments was assigned to three plastic tanks in a completely randomized design. Weight gain, feed intake, FCR, SGR and haematological parameters of fish were subjected to one-way Analysis of Variance (ANOVA). When significant differences among treatments were found ($p< 0.05$), Duncan's multiple range test (Duncan, 1955) was used to compare the treatment means using the software SPSS 16.0.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULT

Growth response, nutrient utilization and survival parameters of *Clarias gariepinus* fingerlings fed with varying levels of *Zingiber officinale* diet: - final body weight, specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Feed intake, and Protein Efficiency Ratio (PER), Percentage Mortality, Average Daily growth rate (ADG) and Protein Intake (PI) of *Clarias gariepinus* fingerlings fed the experimental diets are given in Table 5. The growth performance of fish fed with 0% and 0.1% ginger inclusion level was not significantly different from each other. However, fish fed with 0.4%, 0.7%, 1.0%, 1.3% of ginger powered meal are significantly different ($p<0.05$) from fish fed with 0% and 0.1% diets. The best growth result (Final body weight and SGR) of fish fed 0.1% and 0.7%. Specific Growth Rate (SGR) of fish fed with 1.0%and 0% were significantly lower than those fed with 0.1%, 0.4%, 0.7% and 1.3% diets.

Table 4.1 Growth performances of *Clarias gariepinus* fed with varying levels of ginger meal for 56 days

PARAMETERS	DIET 1	DIET 2	DIET 3	DIET 4	DIET 5	DIET 6
MIW (g)	**6.25±0.00^{c}**	**6.29±0.00^{e}**	**6.21±0.00^{a}**	**6.27±0.00^{d}**	**6.23±0.01^{b}**	**6.32±0.01^{f}**
MFW(g)	**10.65±0.74^{ab}**	**12.70±0.08^{cd}**	**11.06±1.66^{b}**	**13.34±0.03^{d}**	**9.56±0.45^{a}**	**11.43±0.06^{bc}**
BWG(g)	**4.40±0.74^{ab}**	**6.41±0.08^{cd}**	**4.85±1.66^{b}**	**7.07±0.03^{d}**	**3.33±0.45^{a}**	**5.11±0.06^{bc}**
%MR(%)	**44.99±21.34^{a}**	**44.44±15.39^{a}**	**55.56±27.76^{a}**	**44.45±16.78^{a}**	**42.22±34.21^{a}**	**31.11±36.71^{a}**
ADG(g)	**0.10±0.05^{a}**	**0.13±0.03^{a}**	**0.11±0.06^{a}**	**0.13±0.00^{a}**	**0.08±0.03^{a}**	**0.08±0.01^{a}**
PER	**0.10±0.44^{a}**	**0.13±0.04^{a}**	**0.15±0.07^{a}**	**0.11±0.02^{a}**	**0.09±0.05^{a}**	**0.10±0.05^{a}**
PI	**7.48±1.34^{a}**	**8.37±0.58^{a}**	**8.00±1.34^{a}**	**7.85±0.84^{a}**	**6.98±1.12^{a}**	**7.45±0.19^{a}**
SGR(g)	**0.95±0.05^{ab}**	**1.25±0.01^{cd}**	**1.03±0.12^{cd}**	**1.35±0.01^{d}**	**0.76±0.04^{a}**	**1.06±0.00^{cd}**
FCR	**1.50±0.22^{b}**	**1.08±0.02^{a}**	**1.17±0.43^{ab}**	**1.38±0.02^{ab}**	**1.34±0.19^{ab}**	**1.24±0.02^{ab}**
FI	**6.49±0.08^{c}**	**6.93±0.07^{d}**	**5.23±0.21^{b}**	**9.73±0.09^{e}**	**4.41±0.05^{a}**	**6.32±0.11^{c}**

Mean ± S.D with different superscript is significant different at $p<0.05$

Values are means ± SD. Means in the same row having different superscripts are significantly different ($P < 0.05$), while values in same row with same superscript are not significantly different ($P > 0.05$). MIW=Mean Initial Weight, MFW=Mean Final Weight, TWG=Total Weight Gain, FI = Feed Intake, FCR= Feed Conversion Ratio, PER= Protein Efficiency Ratio, SGR=Specific Growth Rate, ADG=Average Daily Weight Gain, PI=Protein Intake.

Significant differences ($P<0.05$) exist in mean final weight, Feed Conversion Ratio, Body weight gain, Specific growth Rate, with diet 2, 3 and 6 (0.1%, 0.4%, 1.3%). Ginger

inclusion level respectively not significantly different (P<0.05) from each other. Specific growth rate ranged from 0.41 and 0.46 with lower values in control and 1.0% ginger inclusion level.

Specific growth rate SGR of fish fed with 0.1% Ginger inclusion level was significantly different (P<0.05) from the fish fed diet with 1.0% Ginger inclusion level but not significantly different (P>0.05) from fish fed 1.3% Ginger inclusion level.

Feed intake of fish fed 0% Ginger inclusion level was not significantly different (P>0.05) from fish fed 1.3% Ginger inclusion level but significantly different (P<0.05) from the fish fed with other diets (0.1%, 0.4%, 0.7% and 1.0%).

Feed conversion ratio of fish fed 0.4% Ginger inclusion level was not significantly different (P>0.05) from fish fed 0.7%, 1.0%, 1.3% Ginger inclusion level but significantly different from fish fed 0% and 0.1% Ginger inclusion level.

Protein intake of fish fed 0%, 0.1%, 0.4%, 0.7%, 1.0%, 1.3% Ginger inclusion level was not significantly different from (P>0.05) each other.

Protein Efficiency Ratio of fish fed 0%, 0.1%, 0.4%, 0.7%, 1.0%, 1.3% Ginger inclusion level was not significantly different from (P>0.05) each other. Average daily weight gain of fish fed 0%,0.1%, 0.4%, 0.7%, 1.0%, 1.3% Ginger inclusion level was not significantly different (P>0.05) from each other. Percentage mortality of fish fed 0%,0.1%, 0.4%, 0.7%, 1.0%, 1.3% Ginger inclusion level was not significantly different (P>0.05) from each other. Body weight gain of fish fed 0%,0.1%, 0.4%, 0.7%, 1.0%, 1.3% Ginger inclusion level was significantly different from each other. Mean initial weight of fish fed 0%,0.1%, 0.4%, 0.7%, 1.0%, 1.3% Ginger inclusion level was significantly different from each other.

Mean final weight of fish fed 0%,0.1%, 0.4%, 0.7%, 1.0%, 1.3% Ginger inclusion level was significantly different from each other.

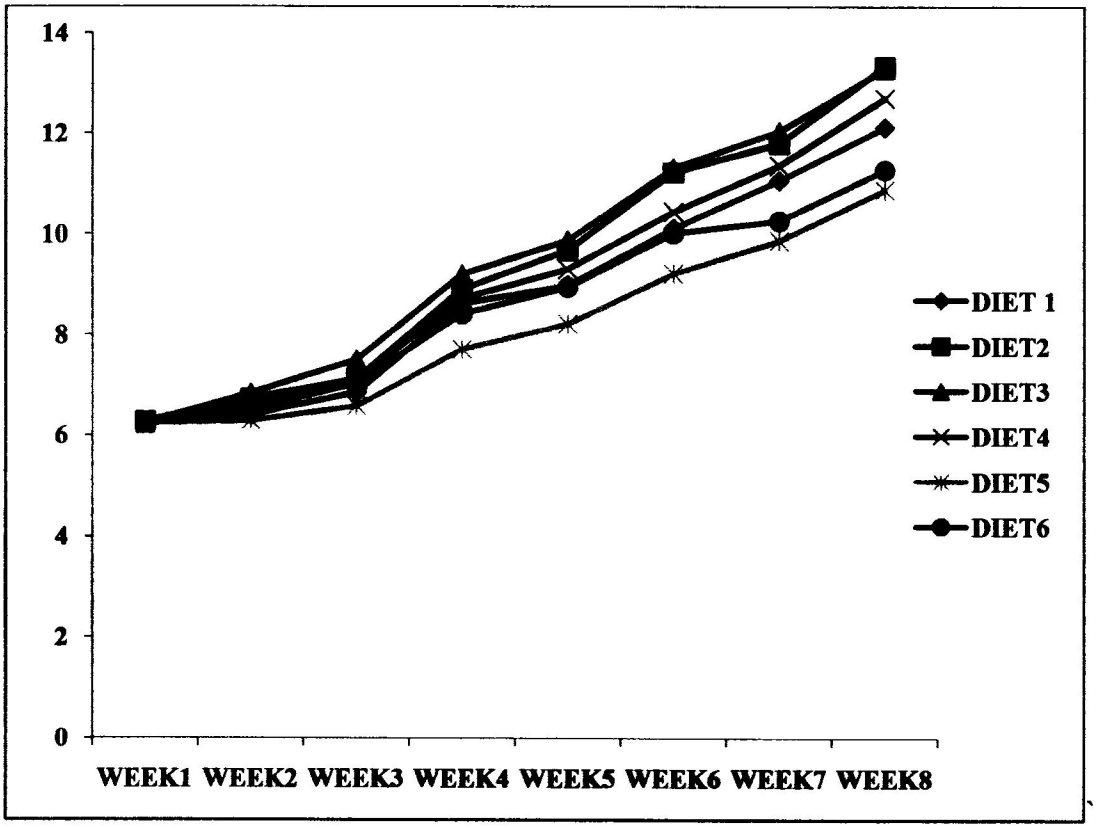

Figure 4.1 GRAPH OF FISH showing the GROWTH PATTERN on weekly basis

Table 4.2 Haematological indices of *Clarias gariepinus* fingerlings fed varying levels of *Zingiber officinale* meal diet.

	RBC (×10^{-} L^{-1})	WBC(×10^{-} L^{-1})	PVC (%)	Hb (g dL^{-1})	MCV(fl)	MCH(pg ll^{-1})	MCHC(g $^{-1}$)
DIET1	3.67±1.53^{a}	9.26±1.26^{a}	33.89±1.83	4.90±1.23^{a}	6.18±3.04^{a}	3.99±3.62^{a}	0.14±0.03^{a}
DIET2	6.00±1.00^{a}	12.72±1.96^{a}	30.00±4.00	5.90±0.20^{ab}	4.94±0.23^{a}	6.29±4.50^{a}	0.19±0.03^{ab}
DIET3	3.67±2.52^{a}	13.18±0.88^{a}	32.00±9.17	6.45±0.55^{b}	5.69±4.03^{a}	2.73±2.46^{a}	0.2±0.07^{b}
DIET4	5.00±1.00^{a}	39.06±33.9^{a}	31.00±1.00	5.87±0.38^{ab}	6.72±1.54^{a}	1.28±0.34^{a}	0.19±0.01^{ab}
DIET5	4.33±2.52^{a}	26.66±24.93^{a}	34.00±1.00	5.60±0.70^{ab}	5.18±3.76^{a}	1.60±0.82^{a}	0.16±0.02^{a}
DIET6	4.00±2.65^{a}	39.40±25.21^{a}	32.67±4.73	5.20±0.17^{ab}	4.63±1.19^{a}	2.07±1.95^{a}	0.16±0.03^{a}

DIET: 1= Control (0%), 2=0.1%, 3=0.4%, 4=0.7%, 5= 1.0%, 6=1.3%. Values in the same column followed by the same letter are not significantly different at $p>0.05$.

4.1.1 Haematological indices of *Clarias gariepinus* fingerlings fed varying levels of powdered Ginger meal.

The haematological Parameters of *C. gariepinus* fed *Z. officinale* based diets are presented in Table. The Packed cell volume; (PCV), red blood cell count (RBC), white blood cell (WBC),Mean corpuscular haemoglobin (MCH); observed in this study were not significantly different ($P>0.05$) among the treatments. The hemoglobin concentrations of fish fed 0% and 0.4% Ginger inclusion level in this experiment were significantly different ($P<0.05$) with relatively close range of differences but fish fed 0.1%, 0.7%, 1.0%, 1.3% Ginger inclusion level was not significantly different ($P>0.05$) from each other. There were no significant different ($P>0.05$) in the MCV of fish fed 0%, 0.1%, 0.4%, 0.7%, 1.0%, 1.3% Ginger inclusion level diet. It was also observed that the fish fed 0.7%Ginger inclusion level diet have higher MCV value than the control (0% Ginger inclusion diet). There was no significant difference ($P>0.05$) in the value of WBC but the values increase as the level of Ginger increased in the diets.

4.2 DISCUSSION

Growth performance of fish fed the experimental diets is shown in Table 4.1. The results revealed that the fish fed diets contained ginger powered meal had a significant ($P < 0.05$) increase in total final BW, body gain, body gain % and specific growth rate %, while a significant ($P < 0.05$) decrease in the total FCR than those fed the control diets. The average daily feed intake wasn't significantly ($P > 0.05$) different with all groups. Fish fed on diet contained 1.3% ginger in this study achieved the best significant final average body weight followed by fish groups fed on diet contained 0%, 0.1% and 0.4%, 0.7%, 1.0% powdered ginger inclusion levels while the least values were obtained in fish group fed on diet contained

1.0%. Compared to Talpur *et al.* (2013) in the study which fish that were fed on diet contained 1% ginger achieved the best significant final average body weight followed by fish groups fed on diet contained 0.5%, 0.3 and 0.2% ginger respectively, while the lowest values were obtained in fish group fed on diet contained 0.1% ginger and control group. Concerning the body gain, body gain % and specific growth rate % followed a similar trend. These results clearly showed that the ginger stimulated fish growth may be respond to ginger supplementation in a dose dependent manner. These results are also in accordance with Talpur *et al.* (2013) who suggested that the growth was dose-dependent; suggesting highest supplementation of ginger at 5 and 10 g/kg feed was most favourable for the growth and survival of Asian sea bass and FCR was significant which means that the ginger diet acted as an appetizer which led to increase the digestibility and in turn the energetic benefits enhanced the growth rate. Also, Apines-Amar *et al.* (2012) showed that oral administration of ginger in grouper for 12 weeks resulted in either improved growth, or enhanced innate immune defenses or both and improved resistance against *V. harveyi* infection. The positive growth promoting effects of ginger may be due to their chemical and physical properties; their positive immunostimulating effect or stimulates digestion as it influences positively the terminal enzymes of digestive process and improving protein and fat metabolism (Platel and Srinivasan, 2000); bioactive compounds on improving antioxidant status of the fish (Rababah *et al.*, 2004), antimicrobial (Mahady *et al.*, 2003) and various pharmacological effects (Ali *et al.*, 2008). All of these have favorable effects on gut function, which is the primary mode of action for growth promoting feed additives (Windisch *et al.*, 2008). This could be compared with the work of Moorthy et al (2009) and Onimisi et al (2005) who reported significantly better feed conversion ratio in ginger fed groups of broilers compared to control. There were no differences in cost of feed per kg gain for broilers on dietary supplementary ginger inclusion. These results could be

compared with the work of Minh et al (2010) who reported that supplementation of dried ginger to broiler diets led to improved performance and reduced feed cost.

The fish growth rate pattern observed in this study shows that the inclusion levels of ginger in the diet of *C. gariepinus* are though significantly different (>0.05) from each other but does not have significant trend of growth improvement as the concentration increases.

The feed conversion ratio observed to be significantly different from each other in the treatments. Fish fed 0.4, 0.7, 1.0 and 1.3 were not significantly different from each other. However, highest value of feed conversion ratio was observed in fish fed control diet and least FCR value was observed in fish fed 0.1% ginger powdered meal. This consequently implies that good significant variation does not exist in different inclusion levels of ginger in catfish diet. Also, it was observed that the feed intake of the fish were significantly different from each other with good feed acceptability from all the treatment. The fish fed 07% (9.73) ginger inclusion level have the highest feed intake value while the least feed intake was observed in fish fed 1.0% (4.41) ginger powder meal. This observation occurs as a result of low concentration of ginger in fish diet (0.1-1.3%) as the main active ingredient of ginger was not potent enough to effect any growth increase. Moreover, the specific growth rate of the experimental fish shows that significant different occurs but with little or no correlation with the levels of treatment variability. Since the viable source of protein in the diet was fixed (fish meal), and the test ingredient is not a protein source material, the best physiological effect can be adequately observed and discovered by carrying out haematology analysis of the animal.

In aquaculture, the application of dietary medicinal herbs as immunostimulants can elevate the innate defense mechanisms of fish against pathogens during periods of stress, such as, intensive farming practices, grading, sea transfer, vaccination and reproduction. Fish haematology is gaining increasing importance in fish culture because of its importance in monitoring the health status of fish (Hrubec *et al.,* 2000). Results of the haematological

parameters of previous studies, for instance *Heterobranchus longifilis* showed that there were significant differences ($P<0.05$) among different dietary groups. Therefore, my results are in agreement with the results obtained from mentioned researchers.

Although, there are slight differences but with close range in the differences. Hematological assays may provide an index of the physiological status of fish. Leucocyte count, erythrocyte count, hematocrit and hemoglobin are particularly recommended as tests that could be performed on a routine basis in fish farms to monitor the health of the stock. Compared to a study that indicated that rainbow trout fed powdered ginger rhizome for 12 weeks showed increased haematocrit, haemo-globbin, erythrocyte, MCH, MCHC, WBC values in comparison to the control group ($p<0.05$) , but this study indicated that *C. gariepinus* fed 0.1%-1.3% powdered ginger inclusion levels has increased Leukocytes, PCV but decreased MCHC, MCH, RBC. De Pedro et al. (2005) indicated that total and differential leukocyte counts are important indices of non-specific defense activities in fish. Also, they are centrally involved in phagocytic and immune responses to bacterial, viral and parasitic challenges (Houston, 1990). Rainbow trout was fed 1.0% powered ginger inclusion level in the study for 12 weeks and the RBC, MCV, MCH, MCHC, Hb, WBC are 2.3, 213.049, 49.13, 23.06, 11.3, 56.8 respectively. Compared to this fact for *C. gariepinus* recorded in this present study.

The haematological analysis shows that there was no significant different ($p>0.05$) in the RBC Red Blood Cell, WBC White blood Cell, PVC, MCV and MCH of *C. gariepinus* fed with powdered ginger meal. Hematological assays may provide an index of the physiological status of fish. Leucocyte count, erythrocyte count, hematocrit and hemoglobin are particularly recommended as tests that could be performed on a routine basis in fish farms to monitor the health of the stock. Blood indices MCH, MCV, MCHC are particularly important for the diagnosis of aneamia in most animals (Coles 1986). This study showed a significant decrease of MCH in fish fed 0.4, 0.7 and 1.0% diet, MCV was low in fish fed 0.1 and 1.3 ginger

powdered diet. Also a great decrease was observed in MCHC of fish fed 0.4%, 0.1% and 0.7% diets. The lower values of RBC and WBC in (fish fed 0% and 0.4%) and (0, 0.1 and 0.4%) ginger powdered meal respectively.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

In summary this study indicated that ginger did not show any negative or positive effect in long time feeding. This occurrence could probably be as a result of the sun drying employed in the processing of the experimental ginger. Though, Eze and Agbo (2011) reported that ginger is best preserved in its natural form under open-air sun drying conditions. However Ebewele and Jimoh (1981) reported that sun drying of ginger results in loss of some volatile oils by evaporation and destruction of some heat sensitive properties.

5.2 Conclusion

It is concluded that, under the experimental conditions described in this study, any of the diet treatment had no negative health impacts according to Table 4.2. It is feasible to include powered ginger in the diets of catfish without any negative effects on haematological profile of the fish. It could also be concluded that the supplementation of ginger in fish diets had significantly additive benefit in growth performance and immune status of fish compared with the control. High mortalities might be avoided if ginger could be provided to fish before the onset of diseases as suggested by Esiobu *et al.*, 2012. Ginger has been suggested as growth promoter and immune stimulatant due to their biological effects and was evident in the present study. Ginger has also been reported to have good effect against infections.

5.3 Recommendation

More researches should be carried out on the use of ginger in catfish diets by dietary supplementation of different cultivars of ginger, using various quantities and processing methods of ginger, using different strains of catfish and also using various sample stages and sizes of catfish.

Further studies should be carried out on the use of ginger as a feed additive in fish feeds. Test should be carried out in adult catfish to investigate the impact of ginger inclusion in the diet on the carcass quality and lipid lowering effects on fat deposition on the fish before going to the market.

REFERENCES

Agrawal M., Walia S., Dhingra S. & Khambay B.P.S. (2001) Insect growth inhibition anti feedant and antifungal activity of compounds isolated derived from *Zingiber officinale* Roscoe, ginger rhizome. Pest Manag. Sci. 57:289-300.

Apines-Amar, M.J.S.; Amar, E.C.; Faisan, J.P.Jr.; Pakingking, R.V.Jr., and S. Satoh, 2012. Dietary onion and ginger enhance growth, hemato-immunological responses, and disease resistance in brownmarbled grouper, *Epinephelus fuscoguttatus*. AACL Bioflux, 5 (4): 231-239.

Ali, B.H.;G. Blunden; M.O. Tanira and A. Nemmar, 2008. Some phytochemical, pharmacological and toxicological properties ofginger (*Zingiber officinale Roscoe*): A review of recent research. Food Chemistry and Toxicology, 46: 409 – 420.

AKOACHERE, J. F. T. K., NDIP, R. N., CHENWI,E. B., NDIP, L. M., NJOCK, T. E. and.ANONG, D. N. (2002). Anti-bacterialeffect of Zingiber officinale and Garcinia kola on respiratory tract pathogens.East African Medical Journal, 79: 588 –592.

AL-HOMIDAN, A. A. (2005). Efficacy of usingdifferent sources and levels of Allium sativum and Zingiber officinale on broiler chicks performance. Saudi Journal of Biological Sciences, 12: 96 – 102.

Biovet S A Laboratories 2005 The Intensive Production and the Spreading of High Productivity Genetic stocks have conditioned the common use of chemical Substances Known as "Growth Promoters". www.thepigsite.com/articles

Blaxhall P. C. & Daisley K. W. (1973). Routine hematological methods for use with fish blood. J. Fish Biol. 5:771-781.

Latona D. F., Oyeleke G. O. Olayiwola O. A. Chemical Analysis of Ginger Root **vol. (1)***(OSUN State Polytechnic, Departmnt of Applied Science, Pmb 301 Iree, Nigeria) 47-49.*

CHRUBASIK, S., PITTLER, M. H. and ROUFOGALIS, B. D. (2005). Zingiberis rhizoma: A comprehensive review on the ginger effect and efficacy profiles. Phytomedicine, 12: 684 – 701.

Collins, C.H; P.M. Lyne and J.M. Grange, 1991. Collins and Lyne's Microbiological Method 6th Ed. Butterworth-Heineman, Oxford, London.

Coles, E.H. (1986). Veterinary Clinical Pathology. 4th edn. (Ed. E.H. Coles). W.B. Saunders Company, Philadelphia, U.S.A. p.486.

Cole H and Garrett W N 1980 Animal Agriculture (2nd Edition). W.H Freeman and Company Publishers U.S.A.

Duncan, D.B. 1995. Multiple range and multiple F-tests. Biometrics, 11.

Endo K., Kanno E. & Oshima Y. (1990). Structures of antifungal diarylheptenons, gingernones A, B, C and isogingerenones, isolated from the rhizomes of *Zingiber officinale*, Phytochemistry 29:797-799.

Esiobu, N.; L. Armenta and J. Ike, 2002. Antibiotic resistance in soil and water environments. International Journal of Environmental Health Research, 12: 133–144.

Ebewele R O and Jimoh A A 1981 Feasibility study of Kaduna State ginger processing industry. Ahmadu Bello University, Zaria- Nigeria Chemical Engineering Consultant. L-45, 50-56, 63-80.

Eze J I and Agbo K E 2011 Comparative Studies of Sun and Solar drying of peeled and unpeeled ginger. American Journal of Scientific and Industrial Research 2(2):136-143.

Fagbenro O.A., Balogun A.M. and E.A. Fasakin, 1998b. Dietary methionine requirement of the African catfish, *Clarias gariepinus. J. Appl. Aquacult.,* 8(4):47-54.

Fagbenro O.A., Nwanna L.C. and O.T. Adebayo, 1999. Dietary arginine requirement of the African catfish, *Clarias gariepinus. J. Appl. Aquacult.*, 9(1):59-64.

Fagbenro O.A., 1998. Apparent digestibility of various oilseed cakes/meals in African catfish diets. *Aquacult. Int.,* 6:317-322.

FAO 2008 Food and Agricultural Organization of United Nations: Economic and Social Department: The Statistical Division. Top ten Ginger Producers.

FAO 2008 Food and Agricultural Organization of United Nations: Economic and Social Department: The Statistical Division. Top ten Ginger Producers.

Herawati Veterinary Medical School University of Brawijaya Malang 65145 Indonesia 2010 The Effect of Red Ginger as Phytobiotic on Body Weight Gain, Feed Conversion and Internal Organs Condition of Broiler. International Journal of Poultry Science 9(10): 963 – 967.

Herawati Veterinary Medical School University of Brawijaya Malang 65145 Indonesia 2010 The Effect of Red Ginger as Phytobiotic on Body Weight Gain, Feed Conversion and Internal Organs Condition of Broiler. International Journal of Poultry Science 9(10): 963 – 967.

Herbs Hands Healing Ltd 2011 Traditional Western Herbal Product. Ginger. Extracts from in a Nutshell 'Ginger' by Jill Rosemary Davies. www.herbs-hands-healing.co.uk. Retrieved July 12, 2011.

Hori, Y.; T. Miura; Y. Hirai; M. Fukumura; Y. Nemoto; K. Toriizuka and Y. Ida, 2003. Pharmacognostic studies on ginger and related drugs part 1: five sulfonated compounds from Zingiberis rhizome(Shokyo). Phytochemical, 62: 613-617.

Lovell R.T., 2002. *Nutrition and Feeding in Fish.* Van Nostrand Reinhold, NY.

Muhammed M, Lakshmi P: Product writeup. Ginger (*Zingiber officinale*) Sabinasa cooporation, 7pp.

NRC, 1993. *Nutrient Requirements of Fish.* National Research Council, National AcademyPress. Washington, D.C. 115 pp.

Nya E. J. & Austin B. (2009). Use of dietary ginger, *Zingiber officinale* Roscoe as an immunostimulant to control *Aeromonas hydrophila* infections in rainbow trout, *Oncorhynchus mykiss* (walbaum). J. Fish Dis. 32:971-977.

Otunola, G.A.; O.B. Oloyede; A.T. Oladiji and A.J. Afolayan, 2010.Comparative analysis of the chemical composition of three spices— *Allium sativum* L. *Zingiber officinale* Rosc. And *Capsicum frutescens* L. commonly consumed in Nigeria. African Journal of Biotechnology, 9: 6927–6931.

Platel, K. and K. Srinivason, 2000. Influence of dietary spices and their active principles on pancreatic digestive enzymes in albino rats Nahrung, 44: 42-46.

PLATEL, K. and SRINIVASAN, K. (1996).Influence of dietary spices or their active principles on digestive enzymes of small intestinal mucosa in rats. International Journal of Food Science and Nutrition, 47: 55 – 59.

Robinson, W.B. and Stotz, E. (1945) The indeophenolxy-lene extraction method for ascorbic acid and modifica-tions for interfering substances. *The Journal of Biological Chemisty*, **160**, 217-225.

Shirin, P.R. and J. Prakash, 2010. Chemical composition and antioxidant properties of ginger root (*Zingiber officinale*). *Journal of Medicinal Plants Research*, 4: 2674–267.

Windisch, W. M., Schedle, K., Plitzner, C. and Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science*, 86:140–148

Wilson R.P. and Y. Moreau, 1996. Nutritional requirements of catfishes (*Siluroidei*). *Aquat. Liv. Resources,* 9:103-111.

WINDISCH, W. M., SCHEDLE, K., PLITZNER, C. and KROISMAYR, A. (2008). Use of phytogenic products as feed additives for swine and poultry. Journal of Animal Science, 86: 140 – 148.

APPENDIX

Appendix 1: Growth Parameters

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
MIW	DIET 1	4	6.2500	.00000	.00000	6.2500	6.2500	6.25	6.25
	DIET 2	3	6.2900	.00000	.00000	6.2900	6.2900	6.29	6.29
	DIET 3	3	6.2067	.00577	.00333	6.1923	6.2210	6.20	6.21
	DIET 4	3	6.2700	.00000	.00000	6.2700	6.2700	6.27	6.27
	DIET 5	3	6.2267	.00577	.00333	6.2123	6.2410	6.22	6.23
	DIET 6	3	6.3167	.00577	.00333	6.3023	6.3310	6.31	6.32
	Total	19	6.2595	.03734	.00857	6.2415	6.2775	6.20	6.32
MFW	DIET 1	4	10.6475	.73722	.36861	9.4744	11.8206	10.07	11.61
	DIET 2	3	12.6967	.07506	.04333	12.5102	12.8831	12.62	12.77
	DIET 3	3	11.0600	1.66000	.95840	6.9363	15.1837	9.40	12.72
	DIET 4	3	13.3400	.03000	.01732	13.2655	13.4145	13.31	13.37
	DIET 5	3	9.5567	.44501	.25693	8.4512	10.6621	9.11	10.00
	DIET 6	3	11.4300	.06000	.03464	11.2810	11.5790	11.37	11.49
	Total	19	11.4126	1.42786	.32757	10.7244	12.1008	9.11	13.37
BWG	DIET 1	4	4.3975	.73722	.36861	3.2244	5.5706	3.82	5.36
	DIET 2	3	6.4067	.07506	.04333	6.2202	6.5931	6.33	6.48
	DIET 3	3	4.8533	1.66001	.95841	.7296	8.9770	3.19	6.51
	DIET 4	3	7.0700	.03000	.01732	6.9955	7.1445	7.04	7.10
	DIET 5	3	3.3300	.44508	.25697	2.2243	4.4357	2.88	3.77
	DIET 6	3	5.1133	.05508	.03180	4.9765	5.2501	5.06	5.17
	Total	19	5.1532	1.41075	.32365	4.4732	5.8331	2.88	7.10
MR	DIET 1	4	44.9975	21.34453	10.67226	11.0336	78.9614	13.33	60.00
	DIET 2	3	44.4433	15.39216	8.88667	6.2071	82.6796	26.67	53.33

	DIET 3	3	55.5567	27.75822	16.02621	-13.3986	124.5119	33.33	86.67
	DIET 4	3	44.4467	16.77586	9.68555	2.7731	86.1202	26.67	60.00
	DIET 5	3	42.2200	34.21252	19.75261	-42.7686	127.2086	13.33	80.00
	DIET 6	3	31.1100	36.71492	21.19737	-60.0949	122.3149	6.67	73.33
	Total	19	43.8589	23.44602	5.37889	32.5583	55.1596	6.67	86.67
ADG	DIET 1	4	.1025	.04717	.02358	.0274	.1776	.07	.17
	DIET 2	3	.1300	.02646	.01528	.0643	.1957	.11	.16
	DIET 3	3	.1100	.05568	.03215	-.0283	.2483	.05	.16
	DIET 4	3	.1300	.00000	.00000	.1300	.1300	.13	.13
	DIET 5	3	.0767	.03055	.01764	.0008	.1526	.05	.11
	DIET 6	3	.0833	.01155	.00667	.0546	.1120	.07	.09
	Total	19	.1053	.03657	.00839	.0876	.1229	.05	.17
PER	DIET 1	4	.0950	.04435	.02217	.0244	.1656	.06	.16
	DIET 2	3	.1267	.04163	.02404	.0232	.2301	.08	.16
	DIET 3	3	.1500	.07211	.04163	-.0291	.3291	.09	.23
	DIET 4	3	.1067	.02309	.01333	.0493	.1640	.08	.12
	DIET 5	3	.0867	.04619	.02667	-.0281	.2014	.06	.14
	DIET 6	3	.1000	.05196	.03000	-.0291	.2291	.07	.16
	Total	19	.1100	.04655	.01068	.0876	.1324	.06	.23
PI	DIET 1	4	7.4775	1.33687	.66844	5.3502	9.6048	6.76	9.48
	DIET 2	3	8.3667	.58398	.33716	6.9160	9.8174	7.87	9.01
	DIET 3	3	8.0033	1.33538	.77098	4.6861	11.3206	6.65	9.32
	DIET 4	3	7.8500	.84481	.48775	5.7514	9.9486	6.92	8.57
	DIET 5	3	6.9767	1.12784	.65116	4.1749	9.7784	5.78	8.02
	DIET 6	3	7.4467	.19425	.11215	6.9641	7.9292	7.28	7.66
	Total	19	7.6758	.97988	.22480	7.2035	8.1481	5.78	9.48
SGR	DIET 1	4	.4125	.05315	.02658	.3279	.4971	.37	.48
	DIET 2	3	.5433	.00577	.00333	.5290	.5577	.54	.55

	DIET 3	3	.4433	.12014	.06936	.1449	.7418	.32	.56
	DIET 4	3	.5867	.00577	.00333	.5723	.6010	.58	.59
	DIET 5	3	.3300	.04000	.02309	.2306	.4294	.29	.37
	DIET 6	3	.4600	.00000	.00000	.4600	.4600	.46	.46
	Total	19	.4600	.09724	.02231	.4131	.5069	.29	.59
FCR	DIET 1	4	1.5025	.21915	.10957	1.1538	1.8512	1.23	1.68
	DIET 2	3	1.0833	.01528	.00882	1.0454	1.1213	1.07	1.10
	DIET 3	3	1.1733	.43317	.25009	.0973	2.2494	.83	1.66
	DIET 4	3	1.3767	.01528	.00882	1.3387	1.4146	1.36	1.39
	DIET 5	3	1.3433	.19218	.11096	.8659	1.8207	1.17	1.55
	DIET 6	3	1.2367	.01528	.00882	1.1987	1.2746	1.22	1.25
	Total	19	1.2974	.23366	.05361	1.1847	1.4100	.83	1.68
FI	DIET 1	4	6.4900	.08042	.04021	6.3620	6.6180	6.43	6.60
	DIET 2	3	6.9300	.06928	.04000	6.7579	7.1021	6.85	6.97
	DIET 3	3	5.2333	.20817	.12019	4.7162	5.7504	5.00	5.40
	DIET 4	3	9.7267	.09074	.05239	9.5013	9.9521	9.63	9.81
	DIET 5	3	4.4067	.05033	.02906	4.2816	4.5317	4.36	4.46
	DIET 6	3	6.3167	.11015	.06360	6.0430	6.5903	6.21	6.43
	Total	19	6.5158	1.66677	.38238	5.7124	7.3191	4.36	9.81

MIW

	VAR00001	N	Subset for alpha = 0.05					
			1	2	3	4	5	6
Duncan[a]	DIET 3	3	6.2067					
	DIET 5	3		6.2267				
	DIET 1	4			6.2500			
	DIET 4	3				6.2700		
	DIET 2	3					6.2900	
	DIET 6	3						6.3167
	Sig.		1.000	1.000	1.000	1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size=3.130

MFW

	VAR00001	N	Subset for alpha = 0.05			
			1	2	3	4
Duncan[a]	DIET 5	3	9.5567			
	DIET 1	4	10.6475	10.6475		
	DIET 3	3		11.0600		
	DIET 6	3		11.4300	11.4300	
	DIET 2	3			12.6967	12.6967
	DIET 4	3				13.3400
	Sig.		.097	.244	.058	.310

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

BWG

	VAR00001	N	Subset for alpha = 0.05			
			1	2	3	4
Duncan[a]	DIET 5	3	3.3300			
	DIET 1	4	4.3975	4.3975		
	DIET 3	3		4.8533		
	DIET 6	3		5.1133	5.1133	
	DIET 2	3			6.4067	6.4067
	DIET 4	3				7.0700
	Sig.		.103	.284	.054	.296

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

MR

	VAR00001	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 6	3	31.1100
	DIET 5	3	42.2200
	DIET 2	3	44.4433
	DIET 4	3	44.4467
	DIET 1	4	44.9975
	DIET 3	3	55.5567
	Sig.		.312

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

ADG

	VAR00001	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 5	3	.0767
	DIET 6	3	.0833
	DIET 1	4	.1025
	DIET 3	3	.1100
	DIET 2	3	.1300
	DIET 4	3	.1300
	Sig.		.114

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

PER

	VAR00001	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 5	3	.0867
	DIET 1	4	.0950
	DIET 6	3	.1000
	DIET 4	3	.1067
	DIET 2	3	.1267
	DIET 3	3	.1500
	Sig.		.164

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

PI

	VAR00001	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 5	3	6.9767
	DIET 6	3	7.4467
	DIET 1	4	7.4775
	DIET 4	3	7.8500
	DIET 3	3	8.0033
	DIET 2	3	8.3667
	Sig.		.150

Means for groups in homogeneous subsets are displayed.

PER

	VAR00001	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 5	3	.0867
	DIET 1	4	.0950
	DIET 6	3	.1000
	DIET 4	3	.1067
	DIET 2	3	.1267
	DIET 3	3	.1500
	Sig.		.164

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

SGR

	VAR00001	N	Subset for alpha = 0.05			
			1	2	3	4
Duncan[a]	DIET 5	3	.3300			
	DIET 1	4	.4125	.4125		
	DIET 3	3		.4433	.4433	
	DIET 6	3		.4600	.4600	
	DIET 2	3			.5433	.5433
	DIET 4	3				.5867
	Sig.		.088	.331	.052	.350

Means for groups in homogeneous subsets are displayed.

PER

	VAR00001	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 5	3	.0867
	DIET 1	4	.0950
	DIET 6	3	.1000
	DIET 4	3	.1067
	DIET 2	3	.1267
	DIET 3	3	.1500
	Sig.		.164

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

FCR

	VAR00001	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	DIET 2	3	1.0833	
	DIET 3	3	1.1733	1.1733
	DIET 6	3	1.2367	1.2367
	DIET 5	3	1.3433	1.3433
	DIET 4	3	1.3767	1.3767
	DIET 1	4		1.5025
	Sig.		.142	.103

Means for groups in homogeneous subsets are displayed.

FCR

	VAR00001	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	DIET 2	3	1.0833	
	DIET 3	3	1.1733	1.1733
	DIET 6	3	1.2367	1.2367
	DIET 5	3	1.3433	1.3433
	DIET 4	3	1.3767	1.3767
	DIET 1	4		1.5025
	Sig.		.142	.103

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

FI

	VAR00001	N	Subset for alpha = 0.05				
			1	2	3	4	5
Duncan[a]	DIET 5	3	4.4067				
	DIET 3	3		5.2333			
	DIET 6	3			6.3167		
	DIET 1	4			6.4900		
	DIET 2	3				6.9300	
	DIET 4	3					9.7267
	Sig.		1.000	1.000	.074	1.000	1.000

Means for groups in homogeneous subsets are displayed.

FCR

	VAR00001	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	DIET 2	3	1.0833	
	DIET 3	3	1.1733	1.1733
	DIET 6	3	1.2367	1.2367
	DIET 5	3	1.3433	1.3433
	DIET 4	3	1.3767	1.3767
	DIET 1	4		1.5025
	Sig.		.142	.103

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.130.

APPENDIX 2

Haematological Parameters

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
RBC	DIET 1	3	3.6667	1.52753	.88192	-.1279	7.4612	2.00	5.00
	DIET 2	3	6.0000	1.00000	.57735	3.5159	8.4841	5.00	7.00
	DIET 3	3	3.6667	2.51661	1.45297	-2.5849	9.9183	1.00	6.00
	DIET 4	3	5.0000	1.00000	.57735	2.5159	7.4841	4.00	6.00
	DIET 5	3	4.3333	2.51661	1.45297	-1.9183	10.5849	2.00	7.00
	DIET 6	3	4.0000	2.64575	1.52753	-2.5724	10.5724	1.00	6.00
	Total	18	4.4444	1.88562	.44444	3.5067	5.3821	1.00	7.00
WBC	DIET 1	3	9.2617	1.26007	.72750	6.1315	12.3918	8.02	10.54
	DIET 2	3	12.7233	1.96158	1.13252	7.8505	17.5962	11.00	14.86
	DIET 3	3	13.1847	.88107	.50869	10.9960	15.3734	12.34	14.10
	DIET 4	3	39.0627	33.90467	19.57487	-45.1612	123.2865	18.68	78.20
	DIET 5	3	26.6577	24.93778	14.39783	-35.2912	88.6065	6.00	54.36
	DIET 6	3	39.3970	25.20772	14.55369	-23.2225	102.0165	12.50	62.48
	Total	18	23.3812	21.16647	4.98899	12.8553	33.9070	6.00	78.20
PCV	DIET 1	3	33.8900	1.83475	1.05929	29.3322	38.4478	32.67	36.00
	DIET 2	3	30.0000	4.00000	2.30940	20.0634	39.9366	26.00	34.00
	DIET 3	3	32.0000	9.16515	5.29150	9.2325	54.7675	22.00	40.00
	DIET 4	3	31.0000	1.00000	.57735	28.5159	33.4841	30.00	32.00
	DIET 5	3	34.0000	1.00000	.57735	31.5159	36.4841	33.00	35.00
	DIET 6	3	32.6667	4.72582	2.72845	20.9271	44.4062	29.00	38.00
	Total	18	32.2594	4.15322	.97892	30.1941	34.3248	22.00	40.00

Hb	DIET 1	3	4.9000	1.22882	.70946	1.8474	7.9526	4.00	6.30
	DIET 2	3	5.9000	.20000	.11547	5.4032	6.3968	5.70	6.10
	DIET 3	3	6.4500	.55000	.31754	5.0837	7.8163	5.90	7.00
	DIET 4	3	5.8667	.37859	.21858	4.9262	6.8071	5.60	6.30
	DIET 5	3	5.6000	.70000	.40415	3.8611	7.3389	5.10	6.40
	DIET 6	3	5.2000	.17321	.10000	4.7697	5.6303	5.00	5.30
	Total	18	5.6528	.75078	.17696	5.2794	6.0261	4.00	7.00
MCV	DIET 1	3	6.1800	3.04472	1.75787	-1.3835	13.7435	2.92	8.95
	DIET 2	3	4.9367	.23180	.13383	4.3608	5.5125	4.69	5.15
	DIET 3	3	5.6867	4.03277	2.32832	-4.3313	15.7046	1.89	9.92
	DIET 4	3	6.7167	1.54436	.89163	2.8803	10.5531	5.52	8.46
	DIET 5	3	5.1813	3.75975	2.17069	-4.1584	14.5211	1.65	9.13
	DIET 6	3	4.6267	1.19028	.68721	1.6698	7.5835	3.28	5.54
	Total	18	5.5547	2.38220	.56149	4.3700	6.7393	1.65	9.92
MCH	DIET 1	3	3.9933	3.61569	2.08752	-4.9885	12.9752	1.21	8.08
	DIET 2	3	6.2867	4.49905	2.59753	-4.8896	17.4629	1.21	9.78
	DIET 3	3	2.7267	2.46297	1.42200	-3.3917	8.8450	.91	5.53
	DIET 4	3	1.2800	.34828	.20108	.4148	2.1452	1.00	1.67
	DIET 5	3	1.6000	.82164	.47438	-.4411	3.6411	.89	2.50
	DIET 6	3	2.0667	1.95270	1.12739	-2.7841	6.9174	.87	4.32
	Total	18	2.9922	2.87933	.67866	1.5604	4.4241	.87	9.78
MCHC	DIET 1	3	.1437	.02802	.01618	.0741	.2133	.12	.18
	DIET 2	3	.1983	.03102	.01791	.1213	.2754	.17	.23
	DIET 3	3	.2140	.06842	.03950	.0440	.3840	.17	.29
	DIET 4	3	.1893	.00802	.00463	.1694	.2093	.18	.20
	DIET 5	3	.1647	.02031	.01172	.1142	.2151	.15	.19
	DIET 6	3	.1620	.02666	.01539	.0958	.2282	.13	.18
	Total	18	.1787	.03879	.00914	.1594	.1980	.12	.29

RBC

	VAR00008	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 1	3	3.6667
	DIET 3	3	3.6667
	DIET 6	3	4.0000
	DIET 5	3	4.3333
	DIET 4	3	5.0000
	DIET 2	3	6.0000
	Sig.		.220

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

WBC

	VAR00008	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 1	3	9.2617
	DIET 2	3	12.7233
	DIET 3	3	13.1847
	DIET 5	3	26.6577
	DIET 4	3	39.0627
	DIET 6	3	39.3970
	Sig.		.122

Means for groups in homogeneous subsets are displayed.

WBC

	VAR00008	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 1	3	9.2617
	DIET 2	3	12.7233
	DIET 3	3	13.1847
	DIET 5	3	26.6577
	DIET 4	3	39.0627
	DIET 6	3	39.3970
	Sig.		.122

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

PCV

	VAR00008	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 2	3	30.0000
	DIET 4	3	31.0000
	DIET 3	3	32.0000
	DIET 6	3	32.6667
	DIET 1	3	33.8900
	DIET 5	3	34.0000
	Sig.		.354

Means for groups in homogeneous subsets are displayed.

PCV

	VAR00008	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 2	3	30.0000
	DIET 4	3	31.0000
	DIET 3	3	32.0000
	DIET 6	3	32.6667
	DIET 1	3	33.8900
	DIET 5	3	34.0000
	Sig.		.354

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

Hb

	VAR00008	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	DIET 1	3	4.9000	
	DIET 6	3	5.2000	5.2000
	DIET 5	3	5.6000	5.6000
	DIET 4	3	5.8667	5.8667
	DIET 2	3	5.9000	5.9000
	DIET 3	3		6.4500
	Sig.		.110	.052

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

MCV

	VAR00008	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 6	3	4.6267
	DIET 2	3	4.9367
	DIET 5	3	5.1813
	DIET 3	3	5.6867
	DIET 1	3	6.1800
	DIET 4	3	6.7167
	Sig.		.404

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

MCH

	VAR00008	N	Subset for alpha = 0.05
			1
Duncan[a]	DIET 4	3	1.2800
	DIET 5	3	1.6000
	DIET 6	3	2.0667
	DIET 3	3	2.7267
	DIET 1	3	3.9933
	DIET 2	3	6.2867
	Sig.		.063

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

MCHC

	VAR00008	N	Subset for alpha = 0.05	
			1	2
Duncan[a]	DIET 1	3	.1437	
	DIET 6	3	.1620	.1620
	DIET 5	3	.1647	.1647
	DIET 4	3	.1893	.1893
	DIET 2	3	.1983	.1983
	DIET 3	3		.2140
	Sig.		.112	.128

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.