بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Evaluation of the Additions Gum Arabic on the Growth Performance Indices of Mix-Sex Tilapia *O. Niloticus* Fingerlings

تقييم إضافة الصمغ العربي على مؤشرات النمو لأصبعيات البلطي النيلي خليط الجنس

Thesis submitted for partial fulfillmint for the requirements of the degree of master of scince and technology of fish

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2016

DEDICTION

To

My mother

A strong and gentle soul who taught me to trust in Allah, believe in hard
Work and that so much could be done with little

My father

For earning an honest living for us and for supporting and encouraging me to
Believe in my self
To my parents I would not to be who I am today without them

My Sisters and Brothers

For their endless love, support, and encouragement, giving me strength to
Reach for the stars and chase my dreams

My friends

Hind, hasnaa, randaandsamia to make my life a wonderful experience.

ACKNOWEDGEMENT

I would like to thank **ALLAH**for indescribable blessing and good health to give **ME** the opportunity to complete thisthesis.

In the first place, I would like to express my sincere thanks to my supervisor **Dr.ASAAD HASSAN WIDAA MOHAMED** for giving me the opportunity to carry out this thesis, for the numerous advices and discussions as well as for the constructive critique regarding my work.

I am very grateful to **Dr. RAWDA** from the National Laboratory of Veterinary Research for her work on theproximate analysis composition of diet. And to **SHIMA** and **MAB ADM**who helped me to bring water kits.

Also I Acknowledge my colleagues: **OBANY OKOKY, MAGDI AJEB, MOHAMMED EBRAHIM, NADAL SIDIGE, ENAS DIFALL, EATDAL ABDALLA, SARA GEBRIL,ESAM ALDIN MOHAMMED**and **AWAD BGADI** for helping me during my experiment,very special thanks to **MOHAMED KAMAL** for hisspecial assistence.

No words can express the thanks and gratitude to **MAM** and **DAD**, so thanks very muchfor their support throughout my academic life.

To all my brothers and sisters (**REHAB, MOHAMMED, MARWA and OMER**) whocontinue encouraging me.

ملخص الأطروحة

أجريت هذه التجربة في مختبر الأسماك التابع لجامعة السودان للعلوم والتكنولوجيا خلال الفترة من 6 يوليو إلى 7 سبتمبر 2015. كان هدف الدراسة تقييم تأثير التغذية بمستويات متدرجة من الوجبات الغذائية متضمنة الصمغ العربي على أداء نمو أصبعيات البلطي النيلي . حُدد ما مجموعه 150 بلطي بشكل عشوائي للمعاملات الغذائية الخمس (0ـ 3ـ 6ـ 9، و 12% صمغ عربي) ، وتتألف كل معاملة من ثلاث مكررات (10 سمكات / مكرر). معاملات جودة المياه في هذه التجربة لم تكن في المستوي المناسب مما اثر بشكل سلبي علي مؤشرات أداء النمو. لم يلاحظ أي فروق ذات دلالة إحصائية (ف > 0.05) في كل المعاملات . ولوحظ أدنى مستويات معدل البقاء على قيد الحياة 63.33% في الأسماك التي تتغذى على الحمية المحتوية على مستوى الصمغ العربي (12٪)، على الرغم من أنها سجلت أفضل النتائج في مؤشر نمو.

ABSTRACT

This experiment was conducted in the Fisheries lab of the Sudan University of Science and Technology during the period from 6 July to 7 September 2015 .The objective of the study was evaluate the effect of feeding graded levels of diets contained gum Arabicon the growth performance of *Oreochromis niloticacus* fingerlings. A total of 150 tilapia were randomly assigned to five dietary treatments (0, 3, 6, 9, and 12% gum Arabic), each treatment was composed of three replicates (10 fish/replicate).Water quality parameters in this experiment were not at an appropriate level, that causing a negative impact on growth performance in dex. No significant differences (p>0.05) were observed in all treatments. Lowest levels of survival rate 63.33%was noted in fish fed with the diet containing the level of gum Arabic (12%), although it recorded the best effect in growth index.

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LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
FM	Fish meal
G	Gram
GA	Gum Arabic
GDP	Gross Domestic Production
L	Liter
LC50	Lethal concentration 50%
Mg/l	Milligram/liter
O.	*Oreochromis*
ºC	Degree Celsius/ centigrade
pH	potential hydrogen
Ppm	Parts per million
T. C. A	Trichloroacetic Acid
UIA-N	Un-Ionised Ammonia Nitrogen

CHAPTER ONE

1.INTRODUCTION

Aquaculture is one of the fastest growing industries in the world, with an annual growth rate of almost 9%, it is estimated that roughly half of all seafood consumed in the world is now farm raised (Food and Agriculture Organization (FAO), 2008).

Aquaculture is capable of increasing the total production and fulfilling the high demand for fish protein (FAO, 2014a).

Fisheries and aquaculture is a source not just of health but also of wealth. Employment in the sector has grown faster than the world's population. The sector provides jobs to tens of millions and supports the livelihoods of hundreds of millions. Fish continues to be one of the most-traded food commodities worldwide. It is especially important for developing countries, sometimes worth half the total value of their traded commodities. (FAO, 2014a)

Global fish production continues to outpace world population growth, and aquaculture remains one of the fastest-growing food producing sectors. In 2012, aquaculture set another all-time production high and now provides almost half of all fish for human food. (FAO, 2014a)

World aquaculture production attained another all-time high of 90.4 million tons (live weight equivalent) in 2012(FAO, 2014a). Consumption of farm raised seafood is expected to increase further due to an increase in demand as well as static, or in some cases declining, capture fishery landings.

Seafood represents the cheapest and most readily available protein source for much of the world.On some areas of Asia seafood may make up to 25% of protein intake among the population (FAO, 2008).

Tilapias are the world's second most important fish species for aquaculture after the carp and this is due to their high growth rates, being prolific breeders, completing their life cycle in captivity, tolerance to environmental stress and high market demand (El-Sayed, 2002).Tilapia that is native to Africa and Middle East has emerged from mere obscurity to one of the most productive and internationally traded food fish in the world (Guptaand Acosta, 2004)

Gum Arabic (GA) is derived from exudates of *Acacia senegal* or *Acacia seyal* trees. It consists of a mixture of polysaccharides (major component) plus oligosaccharides and glycoproteins (Goodrum, *et al*., 2000; AndersonandStoddart, 1966) however; its composition can vary with its source, climate and soil. Sudan is the world's largest producer, followed by many other African countries. It readily dissolves in water to form solutions characterized by low viscosity. This allows its use in various applications (Dziezak, 1991).

Gum Arabic (*Acacia Senegal*) is a complex polysaccharide indigestible to both humans and animals. It has been considered as a safe dietary fiber by the United States, Food and Drug Administration (FDA) since the 1970s (Babiker*et al*. 2012). It is used as an emulsifier, thickening agent and flavor stabilizer in both the pharmaceutical and food industries. It is also used in textile, pottery and cosmetics industries. The FAO/WHO Joint Expert Committee for Food Additives defined it as a dried exudation obtained from the stems of *A. Senegal* or closely related species of Acacia (FAO, 1990).

Gum Arabic was evaluated for acceptable daily intake for man by the Joint FAO/WHO Expert Committee on Food Additives since 1969 (FAO/WHO, 1969); however, Sudanese people in Western Sudan have been using it for long time without limitations. It is indigestible to both humans and animals, not degraded in the intestine, but fermented in the colon to give short-chain fatty acids, leading to a large range of possible health benefits (Phillips, Phillips, 2011). One of these benefits is its prebiotic effect (Phillips *et al*, 2008; and Calame*et al.*, 2008). It has been claimed that four week supplementation with Gum Arabic (10 g/day) led to significant increases in Bifidobacteria, Lactobacteria, and Bacteriodes indicating a prebiotic effect (Calame*et al.*, 2008). Other effects include reduction in plasma cholesterol level in animals and humans (Sharma, 1985),ant carcinogenic effect (Nasir, Wang, Föller, 2010) and anti-oxidant effect (Al-Majed*et al* 2002 and Ali, *et al*., 2003) with a protective role against hepatic and cardiac toxicities. In addition to that, it has been claimed that Gum Arabic alleviates effects of chronic renal failure in humans; however, further studies are needed for confirmation (Glover, *et al*2009; Ali, Ziada and Blunden, 2009; and Ali, *et al*2003).

1-2 Objectives

Overall objective

To investigate the effect of graded dietary Gum Arabic powder levels on growthas a promoting agent for Nile tilapia (*Oreochromis niloticus)* fingerlings.

Specific objectives

- To investigate the effects of Gum Arabic powder on feed conversion ratios (FCR) of Nile tilapia reared under controlled conditions.
- To compare the growth (daily weight gain (DWG) and specific growth rate (SGR)) at different level of Gum Arabic powder additions.

- To determine the survival rate of Nile tilapia fingerlings at five dietary treatments using Gum Arabic powder.

CHAPTER TWO

2. LITERATURE REVIEW

2-1 Aquaculture

Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants, in freshwater, brackish-water and seawater environments, in inland and coastal areas, involving intervention in the rearing process to enhance production (Tacon, 2003 and FAO, 2012ab).

Sudan is one of the largest countries in Africa with an area of 1861 500 km². The contribution of fisheries to the GDPis currently marginal ,however, Sudan is endowed with water resources and lands that can support vigorous capture fisheries and aquaculture. (FAO, 2014b)

Sudan’s capture fisheries production was estimated to be about 34000 tonnes in 2012, 29000 tonnes from inland water catches and 5000 from marine catches. (FAO, 2014b)

The aquaculture sector is still incipient and the annual production was estimated at 2000 tonnes in 2012. Capture fisheries activities are centered around the River Nile and its tributaries, seasonal flood plains and four major reservoirs as well as the territorial waters of Sudan on the Red Sea. Freshwater fish culture is primarily based on the pond culture of the Nile tilapia *Oreochromis niloticus*. (Infosamak, 2015)

Aquaculture in the Sudan dates back to the early 1990s with respect to mariculture and to 1953 for freshwater culture.(Infosamak, 2015)

Freshwater fish culture is primarily based on the pond culture of the indigenous species *Oreochromisniloticus*. Other local species such as *Latesnilotius*, *Labeospp* and *Clariaslazira* have been experimented with, but have not as yet been released to farmers. Exotic species have been introduced for experimental culture in combination with *Oreochromisniloticus* (e.g. *common carp)*, or for use as biological control agents for the eradication of aquatic weeds that infest the irrigation canals of large agricultural structures (grass carp). Freshwater fish culture has not as yet developed into a vertically-integrated economic activity, despite the fact that the prerequisites for it are available. Several state and private sector farms were established around the capital, Khartoum and other towns in various states. The current recorded production of these farms has not exceeded 1000 tons/year. (Infosamak, 2015).

2-2 Gum Arabic

Acacia gum, also called gum Arabic is complex arabinogalactan-type polysaccharide exuded by acacia trees, It is mainly produced in sub-desert region of Africa including countries such as Sudan, Senegal, Mauritania, Mai, Cameroon and Chad.(Caius and Radha, 1942).

Gum Arabic mixture of polysaccharides and glycoproteins gives it the properties of a glue and binder which is edible by humans (Smolinske, Susan,1992), GA is a dried exudates of the acacia tree (*Acacia senegal*or *Acacia seyal*), a tree commonly encountered in various tropical and subtropical parts of the world, especially in Africa. It is a hetero polysaccharide of high molecular weight (approximately 350–850 kDa) containing galactose, rham-nose, glucuronic acid and arabinose residues, but also minerals like calcium, potassium and magnesium. The total amount of protein is limited to less than 3%. Gum Arabic is highly soluble in water, concentrations up to 40% are feasible without a major impact on viscosity (Williams and Phillips, 2000),Gum Arabic powder contained (w/w) 90.17% dry solid, 3.44% moisture, 0.338% nitrogen, and 3.39% ash (0.044% Na^{+}, 0.76% K^{+}, 0.20%Mg^{2+}, and 0.666% Ca^{2+}) (Weinbreck, *et al*., 2004). Rendering it an attractive candidate compound for various applications, like beverages. One of the most promising applications linked with gum Arabic, due to its relative inaccessibility to the various enzymes within the small intestines, concerns its use as prebiotic, being defined as a non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon without stimulating that of unwanted bacteria, and thus contributes to host well-being and health (GibsonandRoberfroid, 1995, Roberfroid, 2007). Various studies mentioned its potential as a prebiotic agent (Wyatt *et al.*, 1986).

Acacia gum is widely used for its nutrition and surface properties by the food industry (Snowden *et al.*, 1987; Whistler, 1993; Phillips, 1998; buffo and Reineccius, 2000).

The special natural characteristics of Gum Arabic help it to be the best candidate as a natural prebiotic. It can resist the acidic effect inside the stomach and withstand the alkaline effect of bile salts and other digestive enzymes inside the lower bowel. It is considered to be a full spectrum probiotic, which ferments inside the entire large intestine helping the development of beneficial micro flora and elimination of bad bacteria. Thus can influence in developing the immune system of the body (InstPure, 2014).

Polysaccharides are natural biopolymers formed by high molecular weight carbohydrates (Aspinall, 1982).

Non-digestible carbohydrates are insoluble, like cellulose, or soluble, like pectin, gum, β-glucan, mucilage, algal polysaccharides (Atkins, 1985; Clark and Ross-Murphy, 1987).Technologically, they are needed for altering the texture and consistency of foods (Drochner*et al.*, 2004) and show properties that make them suitable for use in increasing food shelf-life (Volpe *et al.*, 2010).

2-3 Gum Arabic as a Prebiotics

Prebiotics are a category of nutritional compounds grouped together, not necessarily by structural similarities, but by ability to promote the growth of specific beneficial (probiotic) gut bacteria (Kelly, 2008). Many dietary fibers, especially soluble fibers, exhibit some prebiotic activity; however, non-fiber compounds are not precluded from being classified as Prebiotics presuming they meet the requisite functional criteria (Kelly, 2008).

Roberfroid (2007) updated this definition in a review article on prebiotics: a selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora that confers benefits upon host well-being and health.

Definitions of prebiotics typically have in common an emphasis on the compound being non-digestible (and hence subject to colonic enzymatic activity and fermentation by colonic bacteria) and able to selectively stimulate the growth of one or more desirable or health-enhancing types of gut bacteria (Kelly, 2008). While definitions of prebiotics do not emphasize a specific bacterial group, the number and/or activity of Bifidobactria and other lactic acid-producing bacteria must be increased for the compound to qualify as a prebiotic (Kelly, 2008).While many nutritional compounds have some degree of prebiotic activity, (Roberfroid, 2007) identified two groupings of nutritional compounds that met his definition, inulin-type prebiotics and galactooligosaccharide (GOS). Other nutritional compounds suggested as prebiotics, but not included by (Roberfroid, 2007) as prebiotics, include Gentiooligosaccharides (GOS), glucooligosaccharides (GOS), Isomaltooligosaccharides (IMOS), Mannanoligosaccharides (MOS), N-acetylchitooligosaccharides(ACOS), oligosaccharides from melibiose, Pecticoligosaccharides(POS), Xylooligosaccharides(XOS), gums (like gum Arabic), hemicellulose-rich substrates, resistant starches (such as resistant maltodextrin), lactosucrose, oligodextrans, polydextrose, germinated barley, gluconic acid, glutamine, lactose, and the simple sugar tagatosea mirror image of fructose (Roberfroid, 2007;Calame*et al.,* 2008).

Prebioticis are promoted to be one of the health promoting compounds in developing dietary supplementation strategies in diet preparation compared to antibiotics. Prebiotic compound is referred to as a non-digestible feed ingredient that beneficially affects the host by stimulating the growth and improving its intestinal balance (Ringo*et al.* 2010).

Although prebiotic compounds are mostly plant-derived additives and contain fibers, the potential of oligosaccharides and other dietary fibers as a prebiotic may have interesting applications in aquaculture to stimulate gut health as well as to suppress deleterious bacteria. In addition to the prebiotics effect on gut macrobiotic in fish, its effect on the morphology of intestine is also being studied (Torrescillas*et al.,* 2007; Yilmaz*et al.,* 2007).

Currently probiotics and prebiotics have been used to improve the health of their host and increment of growth rate (Roberfroid, 2000). The usage of probiotic and prebiotic in aquaculture were positive (Gibson and Roberfroid, 1995).

2-4 Tilapia

The increased aquaculture scenario assumes aquaculture can grow 50 percent faster than under the baseline scenario. Tilapia production would be about 30 percent higher than in the baseline case, while that of molluscs, salmon and shrimp would increase by about 10 percent. (FAO, 2014).

The farming of tilapias, including Nile tilapia and some other cichlids species, is the most widespread type of aquaculture in the world. FAO has recorded farmed tilapia production statistics for 135 countries and territories on all continents. The true number of producer countries is higher because commercially farmed tilapias are yet to be reflected separately in national statistics in Canada and some European countries (FAO, 2014).

Tilapia (including all species) is the second most important group of farmed fish after carps, and the most widely grown of any farmed fish (FAO, 2016; Antache*et al.,* 2013),WhileTilapia (*Oreochromisniloticus*) is important species in freshwater aquaculture. It is the third most widely cultured fish, after carp and salmonids (Zhang *et al*, 2012).

Oreochromisniloticus (Nile Tilapia) the most widely cultured species of tilapia in Africa is a good fish for warm water aquaculture(Kayode and Shamusideen,2010). Most important and abundant in production, capture and aquaculture, is the Nile tilapia (*Oreochromisniloticus)*; followed by the Blue tilapia

(Oreochromisaureus); Mango tilapia *(Sarotherodongalilaeus)* and Sabaki tilapia *(Oreochromisspilurus)*. These are native to Africa and the Middle East (Globefish, 2010).

Tilapia culture has been growing at an outstanding rate during the past two decades (El-Sayed*et al.*, 2010). As a result, the production of farmed tilapia has witnessed a 6-fold increase during the past 15 years, jumping from 383,654 Mt in 1990 to 2,348,656 m in 2006 (FAO, 2008).

Tilapias are a freshwater group of fish species originating exclusively from Africa (excluding Madagascar) and from Palestine (Jordan Valley and coastal rivers) (Philippart and Ruwet, 1982). They are distributed all over Africa, except the northern Atlas Mountains and South-West Africa (McAndrew, 2000).

Tilapia is an important food fish in many tropical areas of Africa, America and Asia. Many species of tilapia have been cultured in developing countries, where animal protein is lacking. Tilapias are considered suitable for culture, because of their high tolerance to adverse environmental conditions, their relatively fast growth and the ease with which they can breed. Good utilization of artificial diets, resistance to disease, excellent quality of its firmly textured flesh and finely appetizing fish to consumers (Corpei, 2001)

2-4-1Biology

The Nile tilapia *Oreochromisniloticus*is a deep-bodied fish with cycloid scales. Silver in color with olive/grey black body bars, the Nile tilapia often flushes red during the breeding season (Picker and Griffiths, 2011). It grows to a maximum length of 62 cm, weighing 3.65 kg (at an estimated 9 years of age) (FAO, 2012). The average size (total length) of *O. niloticus*is 20cm (Bwanika*et al.*, 2004). The

Nile tilapia is still the most widely cultured species oftilapia in Africa (Popma and Masser, 1999).

2-4-2Classification

The name ‘tilapia’ was derived from the African Bushman word meaning ‘fish’ (Trewavas, 1982). Tilapias represent a large number of freshwater fish species within the family Cichlidae According to Kaufman and Liem (1982), the family is one of the four families (Cichlidae, Embiotocidae, Pomacentridae and Labridae), which includes between 5-10% of all known fish species. the evolutionary relationships of the families within the labrodae are still in some doubt.

The taxonomic classification of tilapia is still confusing and the subject of continuous changes. This is mainly because of the similarity and overlap of their morphological characteristics, and also due to the fact that many species of tilapia freely hybridize in nature (El-Sayed, 2006).

The genus *Tilapia* was first described by Smith (1840).and the genus *Sarotherodon* (brush toothed) and *Oreochromis (*mountain cichlid) were first described by Rüppel (1852). Tilapia is both a genus of fishes in the *Cichlidae* family and the common name for nearly a hundred species of freshwater and some brackish water cichlid fishes belonging to the three genera Tilapia, *Sarotherodon*, and *Oreochromis*(Globefish, 2010).

2-5 Nutritional Requirements

Fish in the genus *Tilapiaare* macrophagous feeders, consuming mainly algae, macrophytes and other aquatic plants. These fish are substrate-spawners that can lay up to 7,000 eggs at a time.

Fish in the genus *Oreochromis*are mainly omnivorous and microphagous, feeding largely on phytoplankton, zooplankton, and detritus organisms (Lim,1989). These tilapia are mouth-brooders, producing about 500 eggs per spawning (Baylosis and Herrera, 1993).

The low trophic level and the omnivorous food habits of tilapia make them a relatively inexpensive fish to feed, unlike other finfish, such as salmon, which rely on high protein and lipid diets based on more expensive protein sources like fish meal. In addition, tilapias are similar to channel catfish (*Ictaluruspunctatus*), in that they can tolerate higher dietary fiber and carbohydrate concentrations than most other cultured fish. To ensure high yield and fast growth at least cost, a well-balanced prepared feed is essential to successful tilapia culture. Slight variations exist among tilapia species, but nutrient requirements are primarily affected by the size of the fish (Mjoun, *et al*., 2010)

The preparation of diets not only provide the essential nutrients that are required for normal physiological function but may also serve as the medium by which fish receive other components that could be supplem affected their health, resistance to stress and disease causing agents (Gatlin, 2002 and Kilgour, 1987).

The major problems confronting the fish farming industry are the increasing cost of feed ingredients in the local market. Selection of ingredients for the formulation of fish feed is very crucial and it should be cheap and available in the local market (Zamal*et al.*, 2009).

Formulation of diets for any fish species requires understanding of the nutritional requirements of the species. However, minimum crude protein in tilapia feed depends on the rearing system used (Twibell and Brown, 1998).

2-5-1 Protein

Nile tilapia requires the same ten essential amino acids as other finfishes. Several factors including fish size or age, dietary protein source, energy content, water quality and culture conditions have been reported to affect protein requirements of tilapia. For example, many studies indicated that protein requirement for maximum performance of tilapia during larval stages is relatively high (35 - >50%), and decreases with increasing fish size (Winfree and Stickney, 1981; Jauncey and Ross, 1982; Siddiqui*et al.,* 1988; El-Sayed and Teshima, 1992). For tilapia juveniles, the protein requirement ranges from 30-40%, while adult tilapia requires 20-30% dietary protein for optimum performance. On the other hand, tilapia broodstock requires 35-45% dietary protein for optimum reproduction, spawning efficiency, and larval growth and survival (Gunasekera*et al.,* 1996a, b; Siddiqui*et al.,* 1998; El-Sayed*et al.,* 2003).

Most nutritional studies have been confined to diseased and mature fish although the supplementary feed has been used during fingerlings and fry phase. Furthermore, understanding the protein requirement during the early growing period is an important aspect in fish culture management. Realization of the optimum protein level for cultured fish would help reduce the costs and maximize the feedconversion efficiency (Charles *et aI.,* 1984; Sampath, 1984)

Fish meal (FM) has been traditionally used as the main protein source in the aquafeed industry. However, the increased demand for FM, coupled with a significant shortage in global FM production has created sharp competition for its use by the animal feed industry. As a result, FM has become the most expensive protein commodity in aquaculture feeds in recent years (Tacon, 1993).

Many developing countries have realized that, in the long-run, they will be unable to afford FM as a major protein source in aquafeeds. Therefore, many attempts have been made to partially or totally replace FM with less expensive, locally available protein sources.

The profile of dietary protein is important when formulating diets for tilapia. Dietary proteins are used continuously by fish for maintenance, growth, and reproduction functions. When fed in excess, protein may be used as energy; however, the latter function is not desirable because of the expensive cost of proteins. (Mjoun, *et al.*, 2010)

2-5-2Lipids

Dietary lipids provide a major source of energy, facilitate the absorption of fat soluble vitamins, play an important role in membrane structure and function, serve as precursors for steroid hormones and prostaglandins, and serve as metabolizable sources of essential fatty acids. (Winfree and Stickney, 1981) found that for tilapia up to 2.5 g, the optimum dietary lipid concentration was 5.2%, decreasing to 4.4% for fish up to 7.5 g (Jauncey, 2000).

2-5-3 Carbohydrates

The exact carbohydrate requirements of tilapia species are not known.Carbohydrates are included in tilapia feeds to provide a cheap source of energy and for improving pellet binding properties. Tilapia can efficiently utilize as much as 35-40 percent digestible carbohydrate. Carbohydrate utilization by tilapia is affected by a number of factors, including carbohydrate source, other dietary ingredients, fish species and size and feeding frequency (El-Sayed, 2006).

Carbohydrates are the most economical source of dietary energy for terrestrial animals; however, the ability of fish to utilize carbohydrate varies among fish (NRC, 1993). The utilization of dietary carbohydrate by fish appears to be related to their digestive and metabolic systems adapted to the different aquatic environment (Walton and Cowey, 1982) and dietary carbohydrate level and complexity (Bergot, 1979; Hutchins *et al.*, 1998). Generally, warmwater herbivorous or omnivorous fish utilize much higher levels of carbohydrate than carnivorous coldwatersalmonids and marine fish (Wilson, 1994). Addition, dietary carbohydrates in fish diets provide inexpensive energy and also allow for pellet expansion during extrusion (Webster, and Lim, 2002). On the other hand, the relative use of dietary carbohydrates by fish varies and appears to be associated with the complexity of the carbohydrate (Ighwela.*et al*, 2011). However, there are instances of nutritional problems However; there are instances of nutritional problems fish (Vielma, *at el.*, 2003).

2-5-4 Fiber

Fiber isusually considered indigestible, as tilapia do not possessthe required enzymes for fiber digestion (although somecellulase activity from microbes has been found in the gutof*O. mossambica*) (Saha*et al.*, 2006).For thisreason, andto attain maximum growth, crude fiber levels in tilapia diets should probably not exceed 5% (Anderson *et al.*, 1984).

2-5-5**Vitamins**

Vitamin supplementation is not necessary for tilapia in semi-intensive farming systems, while vitamins are generally necessary for optimum growth and health of tilapia in intensive culture systems where limited natural foods are available.

Several vitamin requirements of tilapia are known to be affected by other dietary factors and these must be taken into consideration in diet formulations. The presence of antioxidants in the diet, such as vitamin C, has been reported to spare vitamin E in diets for hybrid tilapia. Choline can be spared to some extent by betaine. β-carotene can be bio-converted to vitamin A with a conversion ratio of about 19:1 (Hu *et al.*, 2006)

2-5-6 **Minerals**

There is little information on the mineral requirements of tilapia. Like other aquatic animals, tilapias are able to absorb minerals from the culture water which makes the quantitative determination of these elements difficult to carry out. when Nile tilapia reared in fertilized ponds were fed with diets either containing complete mineral mixes or one deficient in Ca, P, Mg, Na, K, Fe, Zn, Mn or I and it was found that only the addition of phosphorous significantly affected weight gain, food conversion ratio and protein efficiency ratio (Stickney, 1997).

2-5-7 Energy Requirements

Energy is not a nutrient but is a property of nutrient that is released during metabolic oxidation of proteins, carbohydrates, and lipids. Generally, protein is given the fish priority in formulating fish feeds because it is the most expensive component of the prepared feeds. The energy should be the first nutritional consideration in feed formulation since tilapias, like other fish, eat to satisfy their energy needs. If insufficient non-protein energy is available, part of the protein will be broken down into energy. An excess of energy in the diet can limit feed consumption, thus reducing the intake of protein and other nutrients(NRC, 1993).

2-6 Environmental requirements

Water quality management becomes a key factor for successful aquaculture practices. It is necessary therefore to understand the major water quality parameters and their interrelationships, which affect fish growth and health and determine the failure or success of overall culture practices (EL-Sayed, 2006).

2-6-1 Temperature

Temperature is one of the most important factors affecting the physiology, growth, reproduction and metabolism of tilapia.

The temperature range for the normal development, reproduction and growth of tilapia is about 20 to 35º C, depending on fish species, with an optimum range of about 25–30º C (Balarin and Haller, 1982; Chervinski, 1982; Philippart and Ruwet, 1982),however, a tremendous difference in the growth and feed efficiency of tilapia may occur even within this narrow range of water temperatures.

El-Sayed and Kawanna(2008) evaluated the effects of three water temperatures (24, 28 and 32ºC) (lying within the optimum range of tilapia tolerance) on the growth and feed conversion of Nile tilapia fry, reared in an indoor, recirculating system. The growth of the fish at 28ºC was almost double the growth at 24 and 32ºC. Fish performance at 24 and 32ºC was not significantly different. It is clear that optimum water temperature (not only optimum temperature range) is essential for maximum fish growth.

Tilapia can also tolerate temperature as low as 7–10ºC, but only for brief periods (Balarin and Haller, 1982; Chervinski, 1982; Jennings, 1991; Sifa*et al*., 2002).

2-6-2 Dissolved Oxygen

Dissolved oxygen (DO) is one of the limiting environmental factors affecting fish feeding, growth and metabolism. These factors must be fully considered where DO is concerned. Ambient DO range produces the best fish performance, while low DO levels limit respiration, growth and other metabolic activities of fish (Tsadik and Kutty, 1987).

Tilapias are known to withstand very low levels of DO. Most tilapias can tolerate DO levels as low as 0.1–0.5 mg/l for varying periods of time (Magid and Babiker, 1975; Tsadik and Kutty, 1987). They can even survive at zero DO concentration, if they are allowed access to surface air. But tilapias usually suffer from high mortality if they fail to reach surface air. On the other hand, tilapia can tolerate conditions of high oxygen supersaturation (up to 400%), which usually occurs because of high photosynthesis resulting from phytoplankton and macrophytes blooming (Morgan, 1972). but optimum growth is obtained at concentrations greater than 3 mg/L (Ross, 2000).

2-6-3 Ammonia

Most of the nitrogenous wastes of fish are excreted via gills in the form of ammonia. Excreted ammonia exists in un ionized NH_3 form (UIA-N), which is toxic to fish, and ionized NH^{4+}, which is nontoxic (Chervinski, 1982). The toxicity of ammonia depends on DO, CO_2 and PH. The toxicity increases with decreasing DO and decreases with increasing CO_2 (Chervinski, 1982). Fish species and size, acclimatization time and culture systems also affect the toxicity of ammonia to fish.

El-Shafai*et al*. (2004) evaluated the effect of prolonged exposure to sub lethalUIA-N on the growth performance of Nile tilapia fed on fresh duckweed.They found that the toxic level of NH_3-N and its negative effect on the growth performance ranges from 0.07 to 0.14 mg UIA-N/l.

Evans *et al*. (2006) reported the LC50's of NH_3 for *O. niloticus* were 1.46 mg/L at 24 h, 1.33 mg/L at 72 h and 0.98 mg/L at 96h.

2-6-4 Nitrite

Ammonia is oxidized into nitrite (NO_2) and then into nitrate (NO_3) through nitrifying bacteria grown on suspended organic matter. The bacteria remove the organic matter from the culture system by using it as food, while the bacteria themselves can be used as natural food for filter-feeding fish such as tilapia and carp. Nitrate is relatively non-toxic to tilapia; however, prolonged exposure to elevated levels of nitrate may decrease immune response and induce mortality (Plumb, 1997).

Nitrite is highly toxic to fish, including tilapia, because it disturbs the physiological functions of the fish and leads to growth retardation. (Sudharsan*et al*., 2000)

The tolerance of tilapia to nitrite is also influenced by fish size. Atwood *et al*. (2001) found that small-sized Nile tilapia (4.4 g) were more tolerant to nitrite than large fish (90.7 g). The 96 h LC50 of NO_2^-N were 81 and 8 mg/l in small and large fish, respectively. The addition of a chloride source (500 mg/l $CaCl_2$ or NaCl) to culture water protected both small and large fish from nitrite toxicity. Such protection was achieved at a chloride: nitrite ratio of 1.5: 1 (by weight).

2-6-5 pH

While pH of seawater is closely conserved, in freshwater it can vary more widely for a number of reason, tilapia of different species are found naturally in a fairly wild pH rang.

Low or high water pH may lead to behavioral changes, damage of gill epithelial cells, reduction in the efficiency of nitrogenous excretion and increased mortality. In support, Wangead*et al* (1988) reported that fingerling and adult Nile tilapia exposed to pH 2–3 showed rapid swimming and opercular movements, surfacing and gulping of air, lack of body position and mass mortality within 1–3 days. Similarly, Chen *et al*. (2001) found that *O. mossambicus* exposed to high pH for 7 days decreased ammonia nitrogen excretion, but increased urea nitrogen excretion.

Bardach(1972) stated that tilapia did not grow in the acid waters of west Congo, whereas *O. alclicusgrahami*survives from pH 5 to 11 without adverse effects. It is well known that this can be alleviated by system management.

Murty*et al.*(1981) found that lethal limits of pH for *O.mossambicus*to be between 3.7 and 10.3. Best growth of tilapias is achieved between ph 7 to 9 and some growth reduction occurs below pH 6. In acid water, pH 4 and below mortalities occur. Associated with a fall in plasma osmolarity, sodium and calcium level.

2-6-6 Phosphate

Phosphorus (P) is an essential element for life on earth; a nutrient required for growth by plants and animals.

Dissolved orthophosphate is the predominating phosphorus species in. fresh and sea water. Typical concentrations in natural uncontaminated fresh and sea water range from 5 to 30 ~g/L referring to phosphorus (Grobkopf, 1998).

In aquaria these concentrations can be dramatically exceeded due to increased supply with phosphate combined with insufficient fresh water exchange. Main sources for phosphorus are the fish food, esp. when containing proteins (mussel, krill), the excreted food and dying organisms, which contain phosphate in their cell membranes. As a consequence an increased growth of algae can be observed. Furthermore, increased phosphate concentrations influence the synthesis of limestone due to precipitation of calcium phosphates and therefore complicate the growth of corals. (lng. M. J., 2015)

Phosphate can be introduced to your aquarium mainly from tap water, dead plants and fish food. High phosphate levels can cause algae outbreaks. There are products on the market to remove phosphates and you can do your part by keeping up with your aquarium maintenance and performing regular water changes. Saltwater reef tank keepers and freshwater plant keepers may want to invest in a phosphate test kit. (lng. M. J., 2015)

CHAPTER THREE

3. MATERIAL AND METHOD

3-1 Study site

The experiment was conductedonSudan University of Science and Technology, College of Animal Production Science and Technology atFisherieslaboratory at the Department of Fisheries and Wildlife Sciences.

3-2 Research design

The case study involved Nile tilapia; (*Oreochromisniloticus*), feed with 5 levels of dietary Gum Arabic powder diet (0, 3, 6, 9 and 12 %) for 64 days.Data was collected every 10 days to assess impact of Gum Arabic powder diet on growth of fingerlings.

3-3 Experimental design

Nile tilapia (*Oreochromisniloticus)*was collectedfrom farm of Sudan University of Science and Technology, Total 150 *O. niloticus* fingerlings were randomly selected and divided into 15 aquaria (**photo1)** (each 48x 34 x 30cm)with 5treatments (3 aquaria/treatment) and 10 fish (39 g) per aquarium,and these were fed on 7% of body weight, this wasdone using a 20% crude protein feed.

Culture aquaria were continuously provided with aeration through an air compressor.

Aquaria were cleaned every morning and evening, by used hose, before the first feeding and after last feeding to remove feces and feed remnants, water was replaced by 10% of new fresh water daily, after the sample 2 every 5 days were changed20% of the water by new fresh water. Every sampling waschanged 80% of water.

3-4 Water quality parameters

Water quality parameters, including temperature (T), pH, dissolved oxygen (Do), total ammonia (NH_3\NH_4^+), nitrites(NO_2^-) and phosphate (po_4^{3-}) were monitored every 10 days.

3-4-1 Temperature

The temperature of aquariumwater measure by puttingmercury thermometer**(photo 1)**in water after that record the degree of temperature.

3-4-2 Dissolved Oxygen (DO)

The DO of the water was determined by using dissolved oxygen meter 5509 input from 0-20 mg/l by putting prop in the watersample**(photo3).**

3-4-3 pH

pH was testedby using pond master test kit as follows:

clean test tube was Filled with 5 ml of pond water (to the line on the tube), Added 5 drops of Wide Range indicator Solution, holding dropper bottle upside down in a completely vertical position to assure uniformity of drops, after that Caped the test tube and invert tube to mix solution, at the end Determined the pH by compared the color of the solution with those on the pH color chart. The tube viewed against a white background in a well-lit area **(photo4).**

*pH of Pond Master Test Kit ranged from 5-9

3-4-4 Ammonia Levels

Were tested by using pond master test kit as follows:

Filled a clean test tube with 5 ml of water to be tested(to the line on the tube), Added 8 drops from Ammonia Test Solution Bottle #I, holding the dropper bottle upside down in a completely vertical position to assure uniformity of drops added to the water sample, Added 8 drops from Ammonia Test Solution Bottle#2, holding the dropper bottle upside down in a completely vertical position to assure uniformity of drops added to the water sample, Caped the test tube and shake vigorously for 5 seconds.

Waited 5 minutes for the color to develop Read the test results by matching the test solution against the ammonia color chart. The tube viewed against the white area beside the color chart Color comparisons are best made in a well-lit area **(Photo5).**

*ammonia level of pond master test kit ranged from 0-8ppm (mg/L)

3-4-5 Nitrite levels

Testing by using pond master test kit as follows:

Filled a clean test tube with 5 ml of pond water(to the line on the tube),Added 5 drops of Nitrite Test Solution, holding dropper bottle upside down in a completely vertical position to assure uniformity of drops, Caped the test tube and shake well for 5 seconds.

Waited 5 minutes for full color to develop, Hold the test tube against the white area above the color chart, and compare the sample with the printed colors. The closest match indicates the total nitrite in the water sample**(photo6).**

* Nitrite levels of pond master test kit ranged from 0-5ppm (mg/L)

3-4-6 Phosphate

Testing By using pond master test kit as follows:

Rinsed a clean test tube with water being tested, Filled the test tube with 5 ml of water to be tested (to the line on the tube), after that Holding the bottle vertically add 6 drops from Phosphate Test Solution Bottle #I. Cap the test tube and shake vigorously for 5 seconds, holding the bottle vertically add 6 drops from Phosphate Test Solution Bottie#2.Cap and shake the test tube vigorously for 5 seconds. Wait 3 minutes for color to develop **(photo7).**

* Phosphate levels of pond master test kit ranged from 0-10 ppm (mg/L)

3-5 Experimental diets

The fingerlings were starved for one day before the start of experiment while during the experimental period; the fingerlings were fed at feeding level 7%of total body weight six day in week at three equal installments at 9:00 AM, 12:30 pm and 4:00 pm. To satisfy the need of fish.

Fish were weighed in bulk,all fish in each aquarium weighed together by used weight net and balance, the measuretakeevery10 days intervals to adjust the new feeding levels. Measurementswere carried out for fingerlings between 09:00 -1:00 pm. Standard body weights was taken by using an electronic balance preciseness 0,001g maximum weight 200g.

Gum Arabic powder was used for feed formulation and analysis as well as other components of the diets were purchased from local market (koko). Prior to feed formulation, the approximate analysis of gum Arabic powder was tested and is presented in Table 1.

Table (1): A proximate analysis composition of Gum Arabic powder

Item	**Gum%**
DM	92.5
Moisture	7.5
CP	2.1
EE	3.25
ASH	1.25

DM=Dry Mater, CP=Crude Protein EE= Ether Extract

The diets**(photo 8)** were produced in the Fisheries laboratory of the Department of fisheries and wildlife sciences, College of Animal Production Science and Technology, Sudan University of Science and Technology, The diets contained fish meal and wheat bran meal as sources of proteins, bread flour and Groundnut cake as source of carbohydrate, Vegetable oil as sours of fat and starch as supplement binder, vitamin and mineral premix was kept constant in all diets, All ingredients were ground through a 0.5 mm sieve before final mixing and pelleting drying . it crumbled before feeding to the fish.

The diets were analyzedin central Veterinary Research Laboratoryfor proximate composition according to standardmethods of the Association of Official Agricultural chemist **AOAC** (1994)(Table 2). Crude protein was determined using a KjeldahlAnalyser after digestion with concentrated H_2SO_4 in a digester. Crude lipids were estimated by extracting in chloroform: methanol (2:1) using a Soxhlet extraction unit.

Crude fiber was determined using T.C.A fiber by igniting at 550ºC in a muffle furnace for 12hours.

Moisture was determined by using an oven at 105ºc for 24 hours and ash content was determined by burnetoff in furnace heated 550ºc for 4hours.

3-6 Metabolite Energy Calculation

After preparation of the diets formulae, they were subjected to a full proximate analysis, and the metabolite energy was calculated according to the equation described by (Lodhi GN, *et al;* 1976).

$$ME\ (P) = 1.549 + 0.0102\ CP + 0.0275\ OIL + 0.0148\ NFE - 0.0034\ CF$$

Table (2): Formulation of the experimental diets with Gum Arabic powder inclusion.

Percentage of components in experimental diets					
Treatment Ingredient	**Control Gum 0%**	**Treatment 1 Gum 3%**	**Treatment 2 Gum 6%**	**Treatment 3 Gum 9%**	**Treatment4 Gum 12%**
Fish meal	30	30	30	30	30
Groundnut cake	21	21	21	21	21
Wheat bran	20	20	20	20	19,5
Bread flour	10	10	10	9	7
Vegetable oil	5	5	5	5	5
Starch	10	7	4	2	1.5
Premix	4	4	4	4	4
Gum Arabic	0	3	6	9	12
Total	100	100	100	100	100

Gum arabic replacements were supplemented for starch.

Table (3)proximate analysis and metabolite energy of the experimental diets Gum Arabic powder.

Determined analyzed composition					
Treatment Ingredient	**Control Gum 0%**	**Treatment 1 Gum 3%**	**Treatment 2 Gum 6%**	**Treatment 3 Gum 9%**	**Treatment4 Gum 12%**
Moisture	9	8.5	9.5	11	11.5
DM	91	91.5	90.5	89	88.5
CP	22.45	20.7	20.98	20	20.365
EE	3.9	3.55	3.35	3.6	3.95
CF	3.005	2.9	2.715	2.705	2.7
NFE	46.145	52.85	51.955	49.195	45.485
Ash	15.5	11.5	11.5	13.5	16
metabolite energy					
ME(P)	37.10403	34.48325	34.89885	33.34689	33.86701

3-7 Growth performance analysis

The body weight (g) for the fish was measuredby using weightdigital Electronic balance **(photo 9)** at the start, every 10 days and at the end of experiment.

Fish Growth Performance was calculated using the formulae below

WeightGain (WG)

Weight gain = Mean ofFinal weight (g) - Mean ofinitial weight (g)

Daily Weight Gain (DWG)

$$DWG = \frac{weight\ gain(g)}{experimental\ period}$$

Relative weight gain (RWR %)

$$RWR\ \% = \frac{weight\ gain(g)}{initial\ weight\ (g)} \times 100.$$

Specific Growth Rate (SGR)

$$\text{SGR (\% per day)} = \frac{(Logn\,Wf - Longn\,Ws)}{T} \times 100$$

Where:

WF = Final weight of fish

Ws = Weight of fish at Start

T = Duration of nursing

Food Efficiency (FE)

$$FE = \frac{weight\ gain}{feed\ intake}$$

Feed conversion Ratio (FCR)

$$FCR = \frac{amount\ of\ dry\ food\ intake(g)}{Fresh\ weight\ gain \in fish}$$

Survival Rate (SR)

$$SR\ (\%) = \frac{Final\ harvested\ amount}{Stocked\ amount} \times 100$$

3-8 Statistical analysis

Data collected from the experimentwas analyzed using one-way analysis of variance (ANOVA), the software of statistics calculations and model Statistical Package for Social Sciences (SPSS) statistics version 21. Using complete randomize design (CRD).The plots were made in Microsoft Excel.

CHAPTER FOUR

4. RESULTS

4-1 Water quality

The water quality in the experimental period 64 days is show in table (4) the temperatureare in the normal range for development, reproduction and growth of tilapia, DO is in optimum level greater than 3 mg/L, but ammonia ranged in the toxin level up to 0.14 mg UIA-N/l,nitrite was in the normal rang, the pHoptimum rang found in treatment containing12% gum and the phosphate ranged from 0-0,25 that is mean the aquarium was poor of phytoplankton and the fish depended just on manufacturer diets.

Table 4: Water quality parameters range for treatments during the experimental period

TRAETMENT	**Ph**	**NO_2(mg/L)**	**NH_3/NH_4(mg/L)**	**PO(mg/L)**	**DO(mg/L)**	**T(ºc)**
0%	5-9	0-5	0-4	0.0 - 0.25	3-4.30	22-30
3%	5-9	0-2	0-4	0.0 -0.25	4.1-4.90	23-29
6%	5-9	0-5	0-4	0.0 -0.25	3.8-5.40	22-30
9%	5-9	0-5	0-2	0.0 - 0.0	3.7-5.10	22-29
12%	7-9	0-2.50	0-4	0.0 - 0.25	4-5	22-29

Potential Hydrogen (pH), Nitrite (NO_2), Ammonia (NH_3/NH_4),Phosphate(ph), Dissolved Oxygen (DO) and temperature (T).

4-2 Growth performance

The study demonstrated that there were no significant differences (*p*>0.05) in the initial weight of fish. The experimental fingerlings fed actively on each diet showed increase in weight of fish was observedin the final weight from each diet. The growth parameters weight gain, daily weight gain,relative growth rateand Specific growth rate were analyzed and presented in Table (5)

Table 5: Growth Performance and Survival rateof Tilapia (*O. niloticus*) feddiets containing different levels of Gum Arabic powder

Treat	Initial Weight	Final Weight	WG	DWG (g/d)	RGR%	SGR(%/d)	SR
0%	3.93±0.15	6.18±0.29	2.25±0.36	0.03±0.00	57.50±11.04	1.90±0.03	76.66±15.27
3%	3.83±0.11	5.21±1.37	1.38±1.44	0.02±0.02	36.61±38.21	1.79±0.15	76.66±25.16
6%	3.90±0.00	5.69±0.32	1.79±0.32	0.02±0.00	46.13±8.21	1.85±0.03	70.00±10.00
9%	3.90±0.00	5.65±0.72	1.75±0.72	0.02±0.01	45.04±18.68	1.84±0.08	83.33±15.27
12%	3.88±0.11	6.18±0.50	2.35±0.45	0.03±0.00	61.38±11.06	1.90±0.057	63.33±15.27

Weight gain (WG), Daily Weight Gain (DWG), relatively growth rate (RGR) andSpecific growthrate (SGR) and Survival rate (SR).
Means of three replicates ± stander deviation (SD) no significantly different (P>0.05).

While therewere no significant ($P > 0.05$) differences among these feeding treatments. Growth of fish receiving grater percent of gum dietcontent12% was superior in comparison withother treatments,this was reflected in the value of WG, DWG, SGR and RGR but the survival rate was low in the treatment content12% gum arabic than the other treatments.

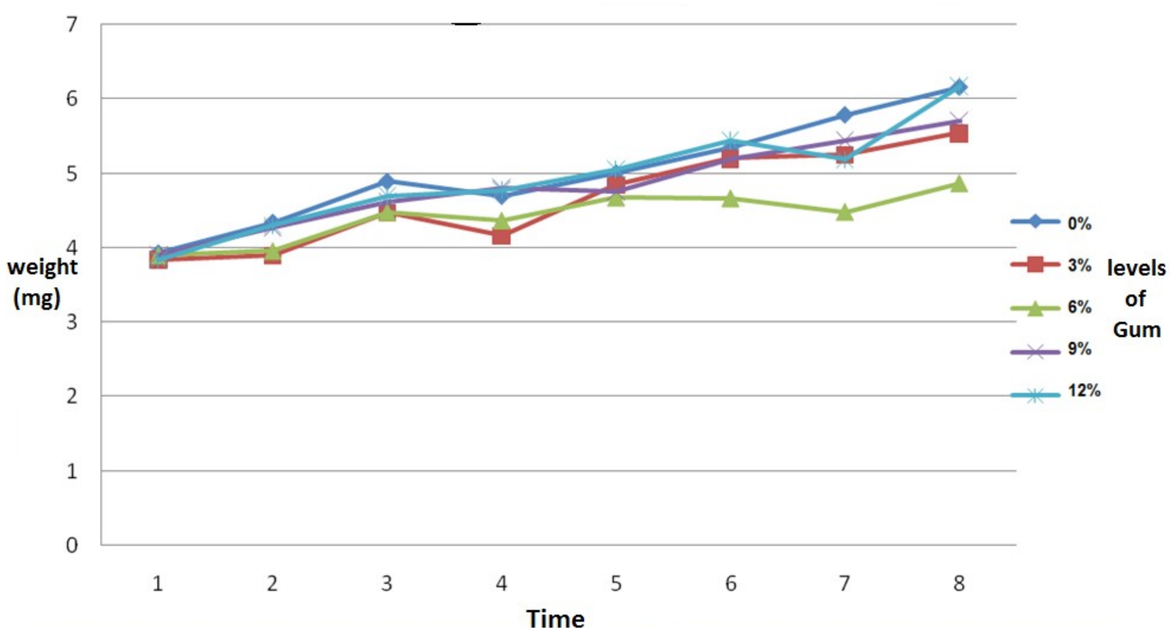
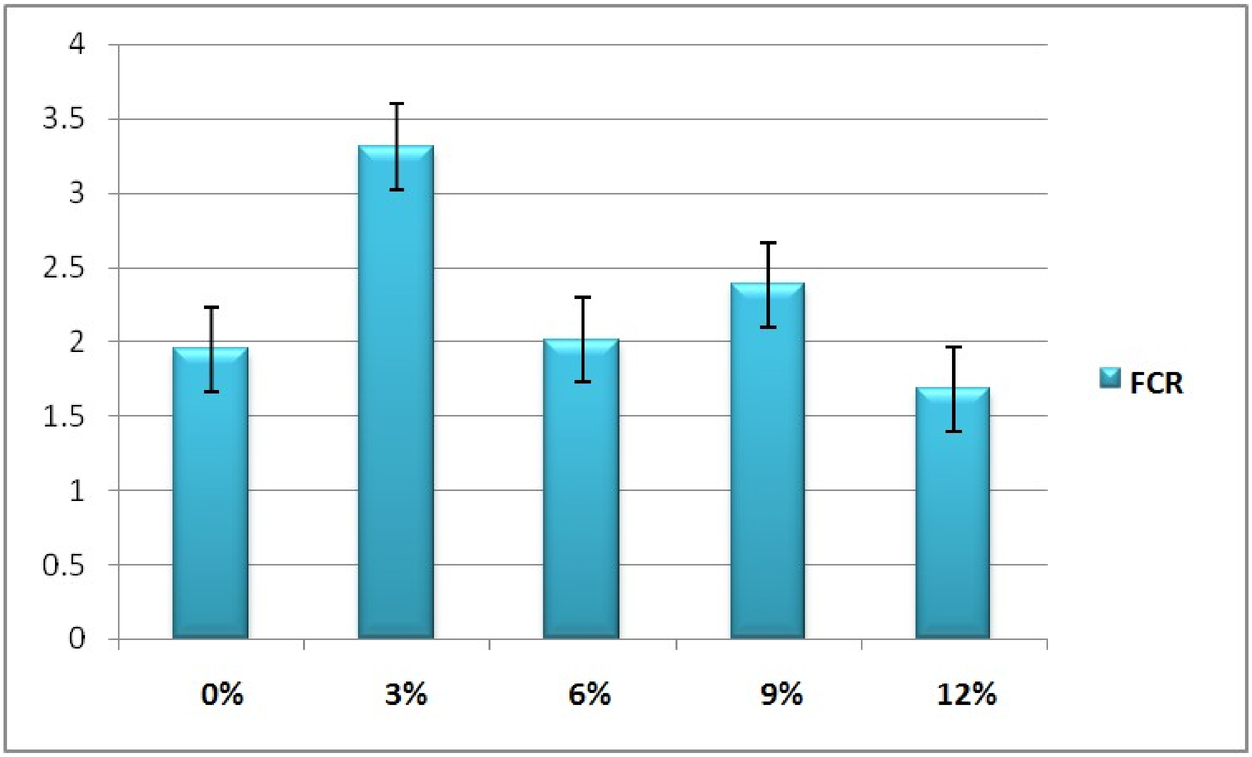


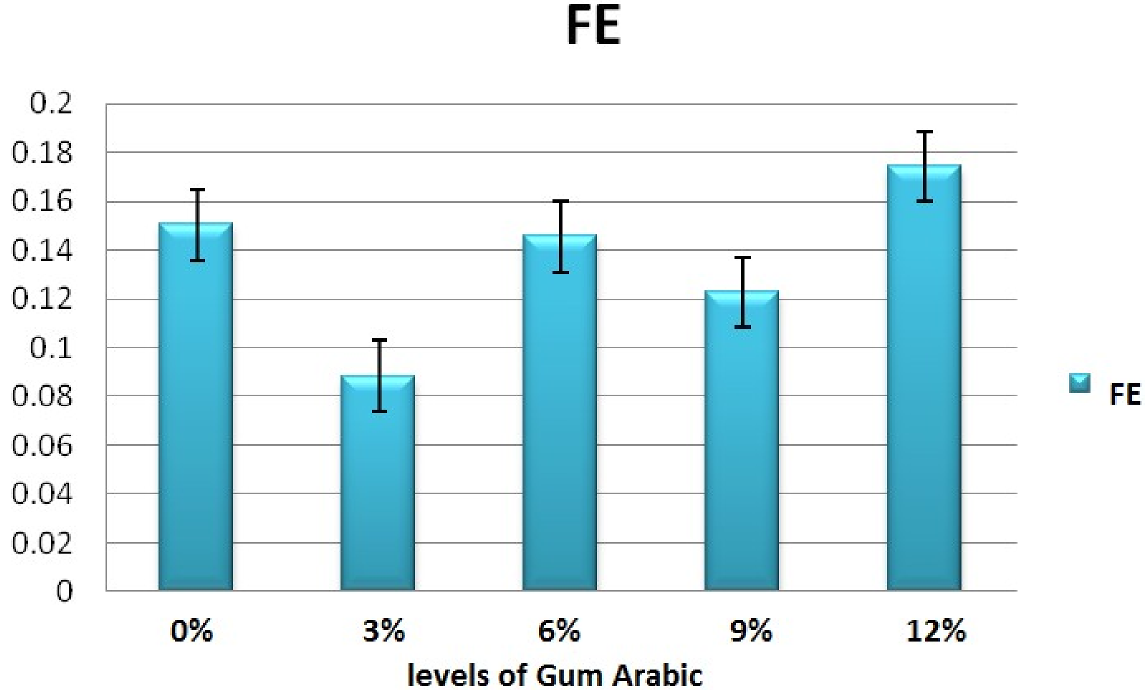
Figure 1. Effect of Gum Arabic diets on weights of Nile tilapia *(Oreochromisniloticus)* atdifferentlevels

The comparative growth performance (FCR) of the experimental fish on each diet throughout the experimental period was determined and expressed as Figure 2



0% = diet containing 0% of gum, 3% = diet containing 3% of gum, 6% = diet containing 6% of gum, 9%= diet containing 9% of gum and 12% = diet containing 12% of gum

Figure 2. Feed Conversions Ratio (FCR) with bar of standard error of the experimental fish on different Gum Arabic diets



0% = diet containing 0% of gum, 3% = diet containing 3% of gum, 6% = diet containing 6% of gum, 9%= diet containing 9% of gum and 12% = diet containing 12% of gum

Figure 3. Feed Efficiency (FE) with bar of stander error of the experimental fish on different Gum Arabic diets

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5-1 Discussion

The result of water qualityin Table (4) water temperature during the monitoring period was ranged from 22 to 30° C, the general influence of temperature on tilapia was summarized by Balarin and Haller (1982), Chervinski (1982), Philippart and Ruwet (1982), and Wohlfarth and Hulata (1983). Optimal growth temperatures should range from 30-32ºC (Popma and Masser, 1999). Tilapia exhibit three times more growth at 30-32ºC than at 22ºC.

In this study pH ranged from 5 to 9 in all treatments except diets that contained 12% gum Arabic ranged from 7 to 9. The pH range should be managed for best growth in the range of 6 to 9 (Guerrero, 1997; Popma and Masser, 1999), however, tilapia can tolerate pH from 5 - 11 (Bardach*et al.*, 1972).

Ammonia (NH_{3}/NH_{4})levels ranged from 0-4mg/L throughout the experiment show in table (4), Un-ionized ammonia (NH_3) levels can suppress feeding at 0.08 mg/L (Popma and Masser, 1999). Chronic exposure to NH_3 levels ≥ 1 mg/L cause mortality especially among juveniles and fry (Popma and Masser, 1999).

Table (4) present that Nitrite (NO_2) at the adequate range. Yanbo*et al* (2006) reports the LC50 of nitrite (NO_2) for *O. niloticus*at 28.18 mg/L.

Dissolved oxygen level was up to 3 mg/l in this experiment Table (4), Nile tilapia can tolerate dissolved oxygen (D.O.) levels down to 0.3 mg/L (Popma and Masser, 1999).

Despite this ability to survive acute low D.O. concentrations, tilapia systems should be managed to maintain D.O. above 2 mg/L because chronic exposure to low D.O. depresses metabolism, growth and disease resistance (Teichert-Coddington and Green, 1993).

It could be noticed that, the initial body weight of tilapia in all treatments were approximately similar, Growth performance in terms of body weight gain (WG), specific growth rate (SGR), relative growth rate (RGR) and daily weight gain (DWG) are presented in Table (5) show that the performance of the fish fed with higher levels of gum (12%) was slightly highest to those of fish fed with the other diets.

Growth observed in the present study was in agreement with studies done with Abdalla *et al.,* (2014) who found that birds fed high level of gum Arabic increased weight gain.However, the effect of dietary prebiotic supplementation on aquatic organism growth exhibits negative results in certain reports (Grisdale-Hetland*et al*. 2008; Mahious*et al*. 2006). Fish fed with (3% gum Arabic diet) showed slight decrease in weight gain compared other diets.

Reduced growth rate was recorded in terms of weight gain and increased FCR value that caused fish to have lower feed intake and consequently deterioration of water quality. According to Vetter (2007).

In the present study protein of diet is lower than 22% that effect in all growth performance index. FCR related to dietary protein intake and its conversion into fish weight gain (Koumi*et al.*, 2009).

The survival rate table (5) and FCR figure (2) values of all diets were not significantly different (*p*>0.05). This was in agreement with a report from Samrongpan*et al*. (2008) who mentioned that mannan – oligosaccharides has not affected the Nile tilapia fry in terms of survival rate and feed conversion ratio.

Furthermore, the idea of prebiotic in aquaculture feed originated from the observation that inulin and oligosaccharides stimulated the growth of bifidobacteria selectively in human nutrition. However, application of prebiotic in aquatic organism was limited in its use due to lack of information until earlier studies being conducted in 1995 (Hanley *et al*. 1995). Some reviews on potential of dietary fiber used as prebiotic in aquaculture were done by Ringo*et al*. (2010). Earlier studies in prebiotic application was done by using the commercial prebiotic, Grobiotic that significantly increased feeding effectiveness, improved the survival rate, immunological response and the resistance against pathogen in striped bass (Pengand Gatlin 2003).

Electricity was unstable during the experiment, so the water quality parameters was change, this led to negative effect in growth performance. The best result of growth performance in the present study was showed in the diet content 12% gum Arabic, this may promising good productivity in case improved water quality aquaculture system.

5-2 Conclusion

The study concluded that the difference in growth performance of tilapia (*Oreochromis niloticus*) may be associated with environmental factors and water quality as a result, overall growth was not as expectedthat, but the high dietary levels of diet content12%Gum arabic as feed to Nile tilapia show a slight increase in growth performance index of Nile tilapia.

5-3 Recommendations

Differences obtained in results as a response to the different treatments growth performance we recommended that:

- Study more about the effect of gum Arabic on fish production and digestive enzymes forgut of Niletilapia.
- Suggested to monitor and improve water quality in order to provide a good environment for the growth of fish.
- Further studies should be doneunder semi intensive culture conditions is necessary in order to perfectly assess their values.
- Recommend Possibility of conducting further studies using Gum Arabic powder inclusion for more data gathering toward the application of this ingredient for other fish species in aquaculture.

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APPENDIXS

Photo (1) plastic aquariums

Photo (2) thermometer

Photo (3) dissolved oxygen meter 5509

Photo (4) pHpond master test kit

Photo (5) Ammoniapond master test kit

Photo (6) Nitrite pond master test kit

Photo (7) Phosphate pond master test kit

Photo (8)particles of feed

Photo (9) Electronic Balance.