Sudan University of Science and Technology

College of Animal Production Science and Technology

Department of fisheries and Wildlife Science

Effects of Water Quality on Aquaponic System

أثر نظام الأكوبونيك علي جودة المياه في الإستزراع السمكي

A Thesis Submitted in Partial Fulfillment of the Requirement of

B.Sc.Degree in Fisheries and Wildlife Science

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الاستهلال :

قال تعالي :

وهو الذي سخر البحر لتأكلوا منه لحما طريا وتستخرجوا منه حلية تلبسونها وترى الفلك مواخر فيه ولتبتغوا من فضله ولعلكم تشكرون (14)

صدق الله العظيم

سورة النحل

الايه(14)

ABSTRACT

The main target of this study was to design the aquaponic system and to evaluate its capability to produce more than one crop (plant and fish) in integrated system production with soil less and without use of verminous or chemical pesticide also to determine ability of plants to uptake the ammonia after converted it to nitrate and effects of aquaponic on water quality. The experiment was conducted for 60 days; from June/ 9/ 2016 to August/ 8/ 2016 and an aquaponic system was developed at the fish hatchery, Department of fisheries science and wildlife, college of animal production Science and technology, Sudan University of science and technology. Forty aquaponic fish were distributed in 2 fiber glass tanks at a density of 20 fish/tank; fish were fed on 3% of body weight twice a day. Ten days after experimental stared there's no mortality on fish and no replacement but mortality started 13 days later and no replacement was done. The percentage of mortality at the end of the experimental was 17.5%. Statistical analysis was performed using the Analysis of variance one way (ANOVA) and Duncan's multiple Range Test, to determine differences between parameters means at significance rate of $P < 0.05$. All statistics was carrying out using Statistical Analysis program (SPSS, 16). The result of water quality obtained from this study shown significant difference in all parameters measured during this study were ($p \leq 0.05$) between T.A, T.B and plat tray treatment.

Key words: aquaponic, Nile tlapia,Water qualty , Nitrate ,Ammonia.

الخلاصة:

هدف البحث تصميم نظام الأكوابونيك وتقييم قابليته لإنتاج أكثر من محصول (أسماك ونباتات) في نظام إنتاج متكامل وبدون إستخدام تربة أو مبيدات حشرية وكيميائية ،وأيضاً لتحديد قابليةالنباتات على أخذ الأمونيا بعد تحويلها الى نترات ،وتأثير الأكوابونيك على جودة الماء.

إمتدت التجربة لمدة ستين يوماً من9/6/2016الى8/8/2016،وقد صمم نظام الأكوابونيك في مفرخة الأسماك التابعة لقسم علوم الأسماك والحياة البرية ،كلية علوم وتكنلوجيا الإنتاج الحيواني،جامعة السودان للعلوم والتكنلوجيا.

وزعت أربعون سمكة من أسماك البلطي النيلي على حوضين بكثافة عشرون سمكة لكل حوض ، وتمت تغذية الأسماك بنسبة 3%من وزن جسمها بمعدل مرتين في اليوم.

بعد عشر أيام من بداية التجربة لم تحدث أي وفيات أوتعويض للأسماك لكن الوفيات بدأت بعد ثلاث عشر يوماً ولم نقم بأي تعويض.

تم عمل تحليل إحصائي بإستخدام طريقة تحليل التباين الأحادي (ANOVA)وإختبار دانكن المتعددلتحديد التباين بين القياسات وذلك ببرنامج التحليل الإحصائي(SPSS,16) .

بينت النتائج وجود فروق معنوية في جميع قياسات جودة الماء المأخوذة من الثلاثة أحواض بنسبة ($P<0.05$) .

كلمات مفتاحية : اكوابونك ،بلطي ،جودة الماء،نترات،امونيا .

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DEDICATION

To my parents for their continuous support and encouragement throughout my study and life.

To my brotherhood for they love, companionship, and endless support.

To all those who have touched my life and interacted with me to make the times I shared enjoyable .You know who you are.

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CHAPTER ONE
INTRODUCTION

1.1 Back ground of the study:

Aquaculture is the captive rearing and production of fish and other aquatic animal and plant species under controlled conditions.

Many aquatic species have been cultured, especially fish, crustaceans and mollusks and aquatic plants and algae.

Aquaculture production methods have been developed in various regions of the world, and have thus been adapted to the specific environmental and climatic conditions in those regions.

The four major categories of aquaculture include open water systems (e.g. cages, long-lines), pond culture, flow-through raceways and recerculating aquaculture systems (RAS) **(FAO, 2014)**.

In a RAS operation water is reused for the fish after cleaning and filtering process.

Aquaculture is an increasingly important source of global protein production. In fact, aquaculture accounts for almost one-half of the fish eaten in the world, with aquaculture production matching capture fisheries landings for the first time in 2012.

Aquaculture has the potential to decrease the pressure on the world's fisheries and to significantly reduce the footprint of less-sustainable terrestrial animal farming systems in supplying humans with animal protein **(FAO, 2014)**.

1.2 Problems of the study:

A major problem for the sustainability of aquaculture is the treatment of nutrient-rich wastewater, which is a by-product of all the aquaculture methods mentioned above.

Depending on the environmental regulations set by each country, farmers must either treat or dispose of the effluent, which can be both expensive and environmentally harmful.

Without treatment, the release of nutrient-rich water can lead to eutrophication and hypoxia in the watershed and localized coastal areas, as well as macroalgae overgrowth of coral reefs and other ecological and economical disturbances.

Growing plants within the effluent stream is one method of preventing its release into the environment and of obtaining additional economic benefits from crops growing with costless by-products through irrigation, artificial wetlands, and other techniques **(FAO, 2014)**.

Fish produce a variety of wastes including solids, ammonia, carbon dioxide and other materials. These wastes must be removed from the culture water or they become toxic to the fish. Many methods have been developed to remove the wastes fish produce **(Water Polution Control Federation, 1983)**.

1.3 Significances of the study:

RAS is the most applicable method for the development of integrated aquaculture agriculture systems because of the possible use of by-products and the higher water nutrient concentrations for vegetable crop production **(FAO, 2014)**.However, in this work we will concentrate on removal of ammonia and nitrite, both of which are highly toxic to fish and other aquatic organisms **(Water Polution Control Federation, 1983)** .And we are going to use aquaponic.Aquaponics is the integration of recalculating aquaculture and hydroponics in one production system.

In an aquaponic unit, water from the fish tank cycles through filters, plant grow beds and then back to the fish **(FAO, 2014)**.

The biofilter provides a location for bacteria to convert ammonia, which is toxic for fish, into nitrate, a more accessible nutrient for plants. This process is called nitrification.

As the water (containing nitrate and other nutrients) travels through plant grow beds the plants uptake these nutrients, and finally the water returns to the fish tank purified **(FAO.2014).**

This process allows the fish, plants, and bacteria to thrive symbiotically and to work together to create a healthy growing environment for each other, provided that the system is properly balanced.

Aquaponic is a technique that has its place within the wider context of sustainable intensive agriculture, especially in family-scale applications. It offers supportive and collaborative methods of vegetable and fish production and can grow substantial amounts of food in locations and situations where soil-based agriculture is difficult or impossible.

Aquaponic does not rely on chemicals for fertilizer, or control of pests or weeds which makes food safer against potential residues **(FAO.2014).**

There are five key water quality parameters for aquaponic: dissolved oxygen (DO), pH, water temperature, total nitrogen concentrations and hardness (KH). Knowing the effects of each parameter on fish, plants and bacteria is crucial. Compromises are made for some water quality parameters to meet the needs of each organism in aquaponics. The target ranges for each parameter as PH:6–7 ; Water temperature:18–30 °C; DO:>5 mg/liter ; Ammonia: <1 mg/liter ; Nitrite: <1 mg/liter ; Nitrate: 5–150 mg/liter**(FAO ;2014)**.

1.4 Objectives:

1. -To design the aquaponic system with tilapia fish.
2. - To evaluate its capability to produce more than one crop(plant and fish)in integrated system production with soil less and without use of verminous or chemical pesticide.
3. - Ability of plants to uptake the ammonia after converted it to nitrate.
4. - effects of aquaponic on water quality .

CHAPTER TOW
LITERATURE REVIEW

2.1 Aquaculture

Global production of fish from aquaculture has grown substantially in the past decade, reaching 52.5 million tones in 2008, compared with 32.4 million tones in 2000 **(FAO.2014).**

Aquaculture continues to be the fastest-growing animal food producing sector and currently accounts for nearly half (45.6 percent) of the world's food fish consumption, compared with 33.8 percent in 2000**(FAO 2011).**

Tilapia are the third most important cultured fish group in the world , after carps and salmons, Tilapia culture is also one of the fastest growing farming activities, with an average annual growth rate of 13.4% during 1970–2002. They are widely cultured in about 100 countries in the tropical and subtropical regions. As a result, the production of farmed tilapia has increased from 383,654 m.t in 1990 to 1,505,804 m.t in 2002, representing about 6% of total farmed finfish in **2002 (El-Sayed A.M (2002).**

The aquaculture sector is vital to maintain fish supply, especially with the decline in capture fish industry due to unsustainable practices **(FAO 2006)**. Important cultured fish in the world after carps **(El-Sayed, 2006).**

The culture of tilapia started as early as 2000 – 2500 BC **(Chimits, 1957).** Since then the growth trend of cultured O. niloticus has increased consistently. Today, more than 22 tilapia species are being cultured in

many tropical and subtropical regions with an expanded penetration of a variety of tilapia products in markets **(El-sayed, 2002).**

Sixty percent of the fish captured worldwide are used in the fresh fish market or processed as frozen, canned or cured foods, (**Rebeca et al, 1991**).

Aquaculture production methods have been developed in various regions of the world, and have thus been adapted to the specific environmental and climatic conditions in those regions.

The four major categories of aquaculture include open water systems (e.g. cages, long-lines), pond culture, flow-through raceways and recirculating aquaculture systems (RAS)**(FAO.2014).**

In a RAS operation water is reused for the fish after a cleaning and a filtering process.

2.2 Tilapia: environmental biology and nutritional requirements

Tilapia is one of the most widely cultured fish in the world. Currently , farmed tilapia represents more than 75% of world tilapia production **(FAO, 2009)**, and this contribution has been exponentially growing in recent years.

Several factors have contributed to the rapid global growth of tilapia. Tilapia is easily cultured and highly adaptable to a wide range of environmental conditions.

Tilapia feed on a wide variety of dietary sources, including phytoplankton, periphyton, zooplanktons, larval fish, and detritus.

Adult tilapia is principally herbivorous but readily adapt to complete commercial diets based on plant and animal protein sources.

In the United States, the most commonly farmed tilapia species are, in order, Nile (Oreochromis niloticus), Mozambique (O.mossambicus), blue

(O. aureus), and hybrids **(Green, 2006).** This publication provides a brief overview of environmental and nutritional requirements of tilapia.
(Reproduction and growth) are attained at salinities up to 19 parts per thousand **(El-Sayed 2006).**

Tilapia are, in general, highly tolerant of low dissolved oxygen concentration, even down to 0.1 mg/L (**Magid and Babiker, 1975)**, but optimum growth is obtained at concentrations greater than 3 mg/L **(Ross, 2000).**

Temperature is a major metabolic modifier in these fish. Optimal growing temperatures are typically between 22° C (72° F) and 29° C (84° F); spawning normally occurs at temperatures greater than 22° C (72° F). Most tilapia species are unable to survive at temperatures below 10° C (50° F), and growth is poor below 20° C (68° F).
Blue tilapia are the most cold tolerant, surviving at temperatures as low as 8° C (46° F), while other species can tolerate temperatures as high as 42° C (108° F; **(Sarig, 1969; Caulton, 1982; Mires, 1995).**
Other water quality characteristics relevant to tilapia culture are pH and ammonia.

2.3 Biological filters:

Fish produce a variety of wastes including solids, ammonia, carbon dioxide and other materials. These wastes must be removed from the culture water or they become toxic to the fish. Many methods have been developed to remove the wastes fish produce.

However, in this research we will concentrate on removal of ammonia and nitrite, both of which are highly toxic to fish and other aquatic organisms.

In fresh water systems there are two common methods used to remove ammonia: ion exchange and biological filters.

In brackish or salt water systems ion exchange is not a viable method because salt in the culture water quickly (usually in a matter of minutes) saturates all of the adsorption sites on the ion exchange media.

Thus, biological filters are the only widely used method of removing ammonia and nitrite from all types of aqua cultural systems. Biological filters consist of some solid media that serves as a surface on which bacteria can attach and live.

Water containing ammonia and/or nitrite flow over this media (and the bacteria attached to it). The bacteria remove the ammonia from the water and use it as an energy source to drive their life processes.

These bacterial excrete nitrite, require oxygen and produce carbon dioxide as byproducts of their respiration.

A different group of bacteria remove the released nitrite and convert it to nitrate. These bacteria use the nitrite to nitrate conversion for an energy source; they use nitrite and oxygen, and produce nitrate and carbon dioxide. The ammonia to nitrite conversion produces hydrogen and rise up alkalinity.

Although many bacteria species can participate in these conversions it is usually assumed that the ammonia to nitrite conversion is carried out primarily by nitrosomona sp. and the nitrite to nitrate conversion by nitrobacter sp. **(Water Pollution Control Federation, 1983).**

Thus, the primary purpose of biological filters is to remove ammonia and nitrite from aquatic culture systems.

Management of water chemistry is one of the most important considerations in recirculating aquacultural systems.

Proper system management results in the minimization of stress, which in turn leads to healthier fish and more profitability. The different components in a recirculating system are designed to control one or more

water quality functions, such as ammonia, temperature, dissolved oxygen, or solids.

Biological filters are designed to maintain the various forms of inorganic nitrogen (e.g., ammonia, nitrite, and nitrate) at levels that are healthy for the fish being cultured.

2.4 Impact of nitrogen on aquaponic:

2.4.1 Total nitrogen:

Nitrogen is the fourth crucial water quality parameter. It is required by all life, and part of all proteins.

Nitrogen originally enters an aquaponic system from the fish feed, usually labeled as crude protein and measured as a percentage.

Some of this protein is used by the fish for growth, and the remainder is released by the fish as waste. This waste is mostly in the form of ammonia (NH3) and is released through the gills and as urine.

Solid waste is also released, some of which is converted into ammonia by microbial activity. This ammonia is then nitrified by bacteria and converted into nitrite (NO2-) and nitrate (NO3-) **(FAO.2014).**

Nitrogenous wastes are poisonous to fish at certain concentrations, although ammonia and nitrite are approximately 100 times more poisonous than nitrate. Although toxic to fish, nitrogen compounds are nutritious for plants, and indeed are the basic component of plant fertilizers. All three forms of nitrogen (NH3, NO2-and NO3-) can be used by plants, but nitrate is by far the most accessible.

In a fully functioning aquaponic unit with adequate biofiltration, ammonia and nitrite levels should be close to zero, or at most 0.25–1.0 mg/liter.

The bacteria present in the biofilter should be converting almost all the ammonia and nitrite into nitrate before any accumulation can occur **(FAO.2014).**

2.4.2 Impact of ammonia:

Ammonia is toxic to fish. Tilapia and carp can show symptoms of ammonia poisoning at levels as low as 1.0 mg/liter.

Prolonged exposure at or above this level will cause damage to the fishes' central nervous system and gills, resulting in loss of equilibrium, impaired respiration and convulsions **(FAO.2014).**

The damage to the gills, often evidenced by red coloration and inflammation on the gills, will restrict the correct functioning of other physiological processes, leading to a suppressed immune system and eventual death.

Other symptoms include red streaks on the body, lethargy and gasping at the surface for air.

At higher levels of ammonia, effects are immediate and numerous deaths can occur rapidly. However, lower levels over a long period can still result in fish stress, increased incidence of disease and more fish loss **(FAO.2014).**

2.4.3 Impact of nitrite:

Nitrite is toxic to fish. Similar to ammonia, problems with fish health can arise with concentrations as low as 0.25 mg/liter. High levels of NO_2^- can immediately lead to rapid fish deaths.

Again, even low levels over an extended period can result in increased fish stress, disease and death. Toxic levels of NO_2^- prevent the transport of oxygen within the bloodstream of fish, which causes the blood to turn a chocolate-brown color and is sometimes known as "brown

blood disease". This effect can be seen in fish gills as well. Affected fish exhibit similar symptoms to ammonia poisoning, particularly where fish appear to be oxygen-deprived, seen gasping at the surface even in water with a high concentration of DO **(FAO.2014).**

2.4.4 Impact of nitrate:

Nitrate is a far less toxic than the other forms of nitrogen. It is the most accessible form of nitrogen for plants, and the production of nitrate is the goal of the biofilter.

Fish can tolerate levels of up to 300mg/liter, with some fish tolerating levels as high as 400 mg/liter. High levels (> 250 mg/liter) will have a negative impact on plants, leading to excessive vegetative growth and hazardous accumulation of nitrates in leaves, which is dangerous for human health.

It is recommended to keep the nitrate levels at 5–150 mg/liter and to exchange water when levels become higher (**FAO.2014)**.

Jason Licamele, etal, 1951reported that significant difference in nutrient composition of lettuce (L. sativac.v. Rex) grown with aquaponics water plus nutrient supplementation and hydroponic solution. The nutrient dynamics of the aquaponic system was examined through water chemistry analysis. The nutrient flows were monitored and tailored to achieve nutrient concentrations for optimal plant growth.

The amount of nitrogen removed from the aquaponic system through lettuce biomass accumulation was determined the mean water temperature for the duration of the trial was 28oC (28.9 ± 1.8). The mean dissolved oxygen was 5 mg/l (5.6 ± 0.3 mg/l). , the pH was 6.8(6.8 ± 0.1), and in fish tank was 6.5. NH4, NO2, NO3, PO4 was respectively in plant tray was 0.00, 0.00, 50.00, 50.00.

(Radu Mihai, et al, 2016). The plant used for water treatment in the system was basil (Ocimum basilicum). Fish species grown in the system was culture carp (Cyprinus carpio). Indicators measured to assess water quality in the system were:

Temperature, pH, dissolved oxygen, total ammonia, nitrites, nitrates and phosphates. The values determined pH (7.4-7.6), dissolved oxygen (8-10 mg / l), NH4 (0.05-05 mg/ l), NO2 (0.1-3.2 mg / l), NO3 (0-80 mg / l), PO4 (0.02-0.3 mg/l) were not too high**.**

(R.Rahmatullah, 2010) found that the integrated culture of two types of vegetables morning glory, *Ipomoea replans* and taro, *Colocasia esculenta* in a recirculating system for 15 weeks with Tilapia fry. The ranges of water quality parameters such as temperature, dissolved oxygen, pH, nitrite-nitrogen, and nitrate-nitrogen during the experiment Value range are: Temperature (28-33 0C) Dissolved oxygen (6.2-8.5 mg/1) pH (8.07-8.53), Nitrite-Nitrogen (0.01-0.50 mg/1), Nitrate-Nitrogen (0.03-1.16 mg/1)

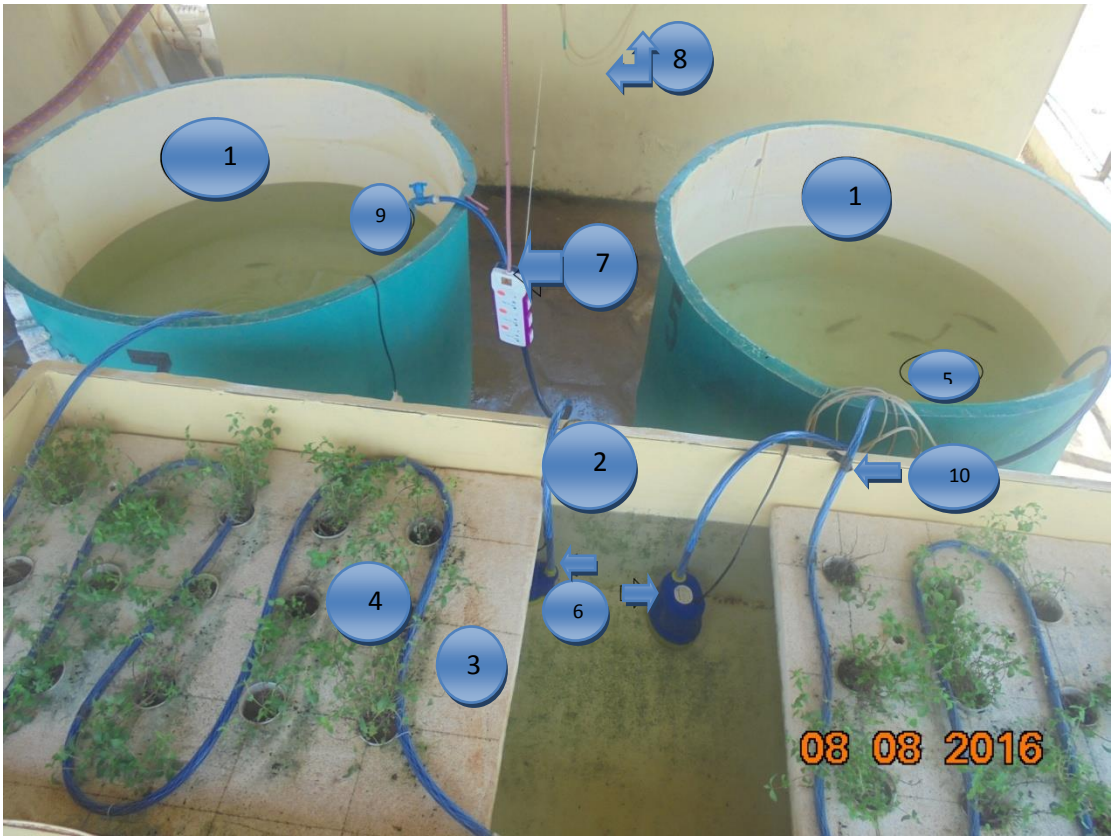
CHAPTER THREE

MATERIALS AND METHOD

3.1 Study area

The experiment was carried out a period of 60 days; from June/ 9/ 2016 to August/ 8/ 2016 and an aquaponic system was developed at the fish hatchery department of fisheries science and wildlife, college of animal production science and technology, Sudan University of science and technology.

3.2 Materials:



1. Fiber glass tank.

2. Plant tray.

3. Polystyrene sheets.

4. Mint plant.

5. Nile tilapia fish.

6. Water pump.

7. Electric wire.

8. Air tubing.

9. Tap.

10. Water tubing.

3.2 Experimental design and conditions and methods:

40 Nile tilapia fish(Oreochromis niloticus) were distributed in 2 fiber glass tanks at a density of 20 fish in each; fish were fed on 3% of body weight with same feed every day.10 days after experimental stared there's no mortality on fish and no replacement but mortality started 13 days later and no replacement was done. The percentage of mortality at the end of the experimental was 17.5%.

Aeration was provided by an air pump for each tank. Water was changed entirely every month. Raft aquaponics or floating bed system was used, where mint ***(Mentha spicata)*** plants were suspended above in a tray of water using a floating raft.

Four water pumps were used and two of them were puted on the plant raft and remainders were distributed in each fish tank. Water was exchange d between the plant raft and fish tanks through these water pumps.

Table3.1. ***Formulation and composition of the experimental diets***

Ingredient (%)	Experimental diets
Fishmeal	35
Groundnut cake	19.5
Sorghum meal	10
Wheat bran meal	15
Vegetable oil	06
Mineral mix	1.5
Vitamin mix	0.3
Bread flour	10
Total	100
Chemical composition	**Experimental diets**
Dry matter (%)	94.61
Crude protein (%)	16.30
Crude fat (%)	5.22
Ether extract (%)	4.40
Ash (%)	22.48
Nitrogen free extract (%)	46.23

3.3Water quality testing monitoring:

Samples were taken every week for the following test:

3.3.1 PH:

1. A clean test tube was filled with 5 ml of water to be tested (to the line on the tube).
2. 5 drops of high range pH Test solution were added, holding dropper bottle upside down in a completely vertical position to assure uniformity of drops.
3. The test tube was caped and inverted tube several times to mix solution.
4. The test result was readied by comparing the color of the solution to the appropriate High Range pH Color Card (freshwater or Saltwater was

choosed). The tube was viewed in a well- lit area against the white area of the card. The closest match indicators the pH of water sample

3.3.2 Dissolved Oxygen:

I.D.O. Fixing: the dissolved Oxygen requires to be fixed before testing.

1. The **D.O**. test bottle was rinsed 2 – 3 times with sample water .and filled till it overflows with the sample water then stoppered the bottle and ensure that no air bubbles were trapped inside.
2. 10 drops of **D.O.1**were added and were followed by 10 drops of **D.O.2**. And mixed well. Waited for a minute. A brown precipitate was formed and setted. The bottle was firmly stoppered and shacked thoroughly. The bottle was kept in a safe place for a minimum 20 minutes.
3. 10-12 drops of **D.O.3**were added. And the bottle was shacked till the precipitate dissolved. More drops were added if required to dissolve the precipitate.

Sample was used for tested.

Proceed for D.O. determination as described in **II**

II.D.O. determination:

1. 10 ml. of sample (from step 3 of **D.O**. fixing) in the test jar was taken.
2. 4 drops of D.O.4were added .and mixed well.
3. **D.O.5**was added, counted the number of drops while mixing, until the blue color disappears.

Calculation:

Dissolved Oxygen ppm = 0.65 × [No. of drops of **D.O.5**]

3.3.3 Total ammonia (NH_3/NH_4):

1. A clean tube was filled with 5 ml of water to be tested (to the line tube).
2. 8 drops from Ammonia Test Solution Bottle #1were added, holding the dropper bottle upside down in a completely vertical position to assure uniform drops.

3. 8 drops from Ammonia Test Solution Bottle #2were added, holding the bottle upside down in a completely vertical position to assure uniform drops.
4. The test tube was caped and shacked vigorously for 5 seconds.
5. 5 minutes were waited for the color to develop.
6. The test result was readied by compared the color of the solution to the appropriate ammonia Color Card (the fresh water color card was used). The tube was viewed in a well – lit area against the white area of card. The closest match indicates the ppm (mg/l) of ammonia in the water sample.

3.3.4 Nitrite test

1. Aclean test tube was filled with 5 ml of water to be tested

2. 5 drops of nitrite test solution were added, holding dropper bottle upside down in a completely vertical position to assure uniformity of drops added to the water sample.

3. The test tube was caped and shacked the tube for 5 seconds.

4. 4 minutes for the color to develop Waited.

5. The test result was readed by matched the color of the solution against those on the nitrite color chart.

3.3.5 Nitrate test

1. A clean test tube was filled with 5 ml of water to be tested.

2. 10 drops from nitrate test solution bottle #1were added, holding dropper bottle upside down in a completely vertical position to assure uniformity of drops added to the water sample.

3. The test tube was caped and inverted tube several times to mixed solution.

4. The nitrate test solution bottle #2 was shacked vigorously for at least 30 seconds.

5.10 drops from nitrate test solution bottle #2 were added, holding dropper bottle upside down in a completely vertical position to assure uniformity of drops added to the water sample.

6. The test tube was caped and shacked vigorously for one minute.

7. 5 minutes for the color to develop were waited.

8. The test result was readed by matching the color of the solution against those on the nitrate color chart.

3.3.5 Phosphate

1. A clean test tube was filled with 5 ml of water to be tested.

2. 6 drops from phosphate test solution bottle#1were added .The test tube was caped and shacked vigorously for 5 seconds.

3. 6 drops from phosphate test solution bottle #2were added .The test tube was caped and shacked vigorously for 5 seconds.

4. 3 minutes for the color to develop were waited.

5. The test result was readied by matched the color of the solution against those on the phosphate color chart.

3.4. Statistical Analysis

Statistical analysis was performed using the Analysis of variance one way (ANOVA) and Duncan's multiple Range Test, to determine differences between parameters means at significance rate of $P < 0.05$. All statistics was carrying out using Statistical Analysis program (SPSS, 16).

CHAPTER FOUR

RESULT

4.1 Water quality Parameters:

The water and air environmental parameters for the trial are listed .The mean water temperature for the duration of the trial ranged from (28.95 –29.9 °C). The average dissolved oxygen was 10.75 to 11.11 mg/l, the pH was ranged from 7.6 - 7.8.

The nitrite concentration for the trail ranged from 0.0 mg/l to5.0 mg/l. Ammonia ranged from 0.25mg/l to 5.0mg/l .Nitrate ranged from 20.0mg/l to 0.0mg/l .PO4 ranged from 0.25mg/l to 0.0mg/l.

Table4.1. Physio-chemical parameters measured from different treatment during study period:

Parameters							
Treatments	**NH_4**	**NO_2**	**NO_3**	**PO_4**	**PH**	**D.O**	**Temperature**
Fish T.A	0.75 ± 0.35^{b}	1.25 ± 1.06^{a}	5.0 ± 0.0^{b}	0.25 ± 0.0^{a}	7.6 ± 0.85^{a}	10.75 ± 0.0^{b}	29.45 ± 3.46^{a}
Fish T.B	$0.75\pm O.35^{b}$	1.13 ± 1.24^{a}	7.5 ± 3.5^{a}	0.13 ± 0.1^{a}	7.7 ± 0.78^{a}	11.11 ± 0.0^{a}	28.95 ± 3.89^{b}
Plant Tray	3.5 ± 2.50^{a}	1.13 ± 1.24^{a}	5.0 ± 0.0^{b}	0.13 ± 0.1^{a}	7.8 ± 0.57^{a}	-	29.9 ± 3.68^{a}

[a ,b] Means in the same column with superscripts are significant different at level ($p< 0.05$).

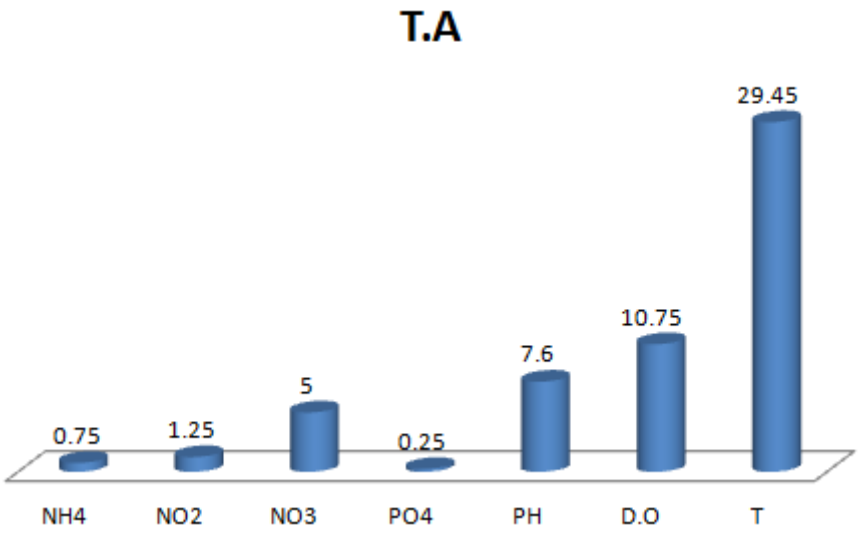


Figure (4.1): Mean values of water quality parameters samples collected from treatment A.

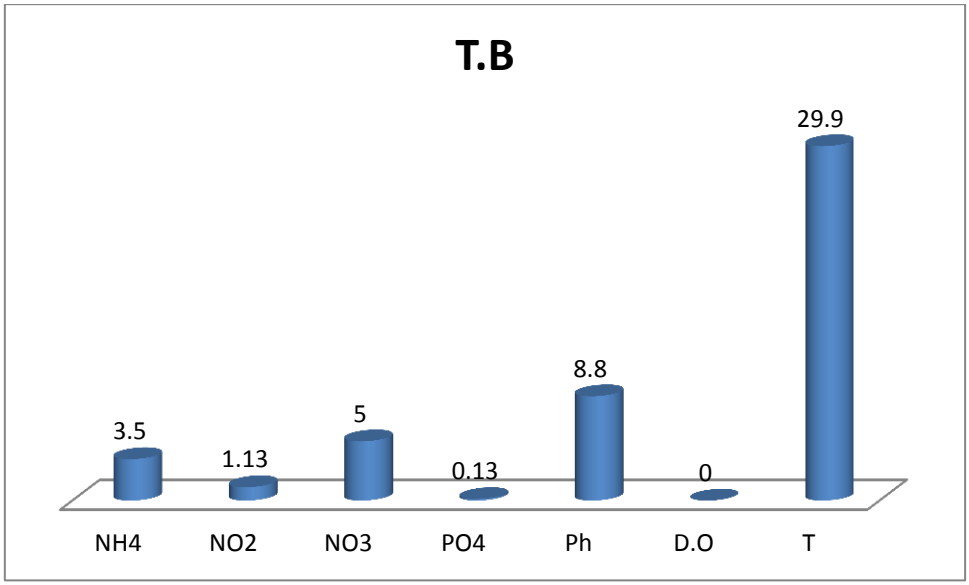


Figure (4.2): Mean values of water quality parameters samples collected from treatment B.

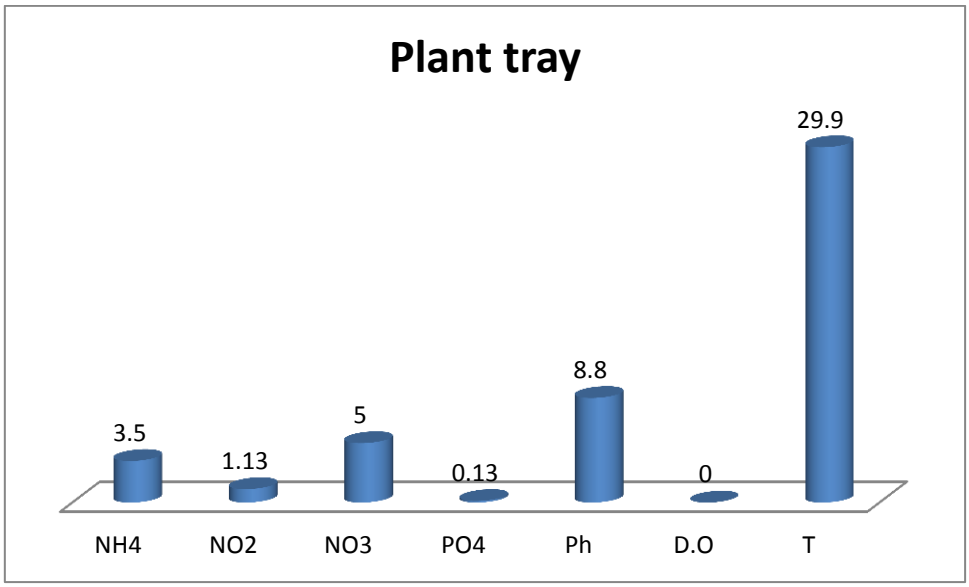


Figure (4.3): Mean values of water quality parameters samples collected from treatment plant tray.

CHAPTER FIVE
DISCUSSION

The result of water quality obtained from this study shown significant difference in all parameters measured during this study were ($p \leq 0.05$) between T.A, T.B and plat tray treatment.

Radu Mihai, *et al* (2016) stated that the plant used for water treatment in the system was basil (*Ocimum basilicum*). Fish species grown in the system was culture carp (Cyprinus carpio). Indicators measured to assess water quality in the system were: temperature, pH, dissolved oxygen, total ammonia, nitrites, nitrates and phosphates the values determined pH (7.4-7.6), dissolved oxygen (8-10 mg / l), NH4 (0.05-05 mg/ l), NO2 (0.1-3.2 mg / l), NO3 (0-80 mg / l), PO4 (0.02-0.3 mg/l) were not too high**.**

The dissolved oxygen obtained from this study was found to be (10.75±0.0 and 11.11±0.0) this result showed that there is significant difference at $p \leq (0.05)$ in dissolved oxygen in T.A, T.B and Plant tray and has high level of dissolved oxygen this results agreement with (**Magid and Babiker, 1975)** who reported that tilapia are, in general, highly tolerant of low dissolved oxygen concentration, even down to 0.1 mg/L but optimum growth is obtained at concentrations greater than 3 mg/L **(Ross, 2000).**

The amount of nitrogen removed from the aquaponics system through lettuce biomass accumulation was determined the mean water temperature for the duration of the trial was 28oC (28.9 ± 1.8). The mean dissolved oxygen was 5 mg/l (5.6 ± 0.3 mg/l), the pH was 6.8(6.8 ± 0.1), and in fish tank was 6.5. NH4, NO2, NO3, PO4 was respectively in plant

tray was 0.00, 0.00, 50.00, 50.00 according to **(Jason Licamele, et al, 1951)**.

The Ammonia was found to be (0.75±0.35, 0.75±0.35 and 3.5±2.50) respectively in T.A, T.B and plant tray this result showed significant difference at $p \leq (0.05)$ in the ammonia concentration at the three treatments. According to **(FAO.2014)** at higher levels of ammonia, effects are immediate and numerous deaths can occur rapidly. However, lower levels over a long period can still result in fish stress, increased incidence of disease and more fish loss**.**

The nitrate-nitrogen ($N0_3$) revealed from this study was found to be (5.0±0.0, 7.5±3.5, 5.5±0.0) respectively in the three treatments and there is significant different at $p \leq (0.05)$ between three treatments in nitrate levels. Nitrite is toxic to fish. Similar to ammonia, problems with fish health can arise with concentrations as low as 0.25 mg/liter. High levels of NO2- can immediately lead to rapid fish deaths.

PO_4 was found to be (0.25±0.0, 0.13±0.1 and 0.13±0.1) in the three treatments respectively this result was simpler to finding of **Kaplan and John (1993)**, made similar findings in Cross River state in Eastern Nigeria.

The high dry season mean value of phosphate phosphorus (PO4-P) could be due to concentration effect because of reduced water volume. It could also be due to lower water hardness, thus less co-precipitation of phosphate with calcium carbonate, a phenomenon that has often been reported to occur in many fresh water rivers **(House, 1990; Heleen et al., 1995).**

CHAPTER SIX
CONCLUSION AND RECOMMENDATION

6.1. Conclusion

There are some marked variations in the water quality parameters observed for the samples measured during the present study. The result of water quality obtained from this study shown significant difference in all parameters measured during this study between ($p \leq 0.05$) T.A, T.B and plant tray treatment.

6.2. Recommendation

According to the finding obtained from this study it recommend that:

- There is desirable need to analyze the effect of aquaponic on proximate composition of the studied fish.
- To determine the effect of aquaponic on growth performance and feed utilization of the studied fish.
- Future study will be needed for aquaponic and their effect on water quality parameters and fish.

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Appendices:

Plate1:Aquaponic system

Plate 2. Multi test Kit