Growth Performance and Proximate composition of Nile Tilapia *Oreochromis niloticus* (Linnaeus 1758) using *Moina macrocopa* (Straus 1820) as live feed

A thesis submitted to the Department of Fisheries, University of Dhaka in partial fulfillment of the requirement for the degree of Master of Science (MS) in Fisheries

Department of Fisheries
University of Dhaka
Dhaka-1000
Bangla desh

Submitted By
Examination Roll: 4201
MS session 2013-14
Registration: HA-2207 (2009-10)

31 January 2016

DEDICATED TO

MY BELOVED PARENTS

(MD. NURISLAM SHAIKH AND RUPOSHE BEGUM)

Certificate

This is to certify that the research study entitled **"Growth Performance and Proximate composition of Nile Tilapia *Oreochromis niloticus* (Linnaeus 1758) using *Moina macrocopa* (Straus 1820) as live feed"** was done by **Md. Rafiqul Islam,** Roll No-4201, Registration No. Ha-2207, MS Session: 2013-14, under our supervision.

This is further to certify that it is an original work and suitable in partial fulfillment of the requirements for the degree of **Master of Science (MS) in Fisheries** from University of Dhaka.

We wish every success in his life.

Dr Mohammad Shamsur Rahman

Supervisor

Associate Professor

Department of Fisheries

University of Dhaka

Dhaka-1000.

Bangladesh

Md. Rakibul Hasan

Supervisor

Scientific Officer (SO)

Zoology Section

Biological Research Division

BCSIR Laboratories, Dhaka

Dhaka-1205

Acknowledgement

All my admiration to **Almighty Allah Rabbul Al-Amin**, the most merciful and beneficial who have enabled to carry out this thesis work successfully in time in spite of numerous distresses.

I would like to express my heartfelt thanks, sincere and indebtedness to my supervisor, **Dr Mohammad Shamsur Rahman**, Associate Professor, Department of Fisheries, University of Dhaka for his constant guidance, advice, constructive criticisms, encouragement and valuable discussions during the course of the study.

I am grateful to my supervisor **Mr Md Rakibul Hasan,** Scientific Officer (SO), Biological Research Division, BCSIR Laboratories, Dhaka for designing and implementing the research work with valuable suggestions and supports.

I would acknowledge to all of my **Honorable and Respected Teachers** especially Chairperson **Mrs Wahida Haque** and Chairman of the examination committee **Prof Md Ghulam Mostafa** of the Department of Fisheries, University of Dhaka for their helpful suggestions, encouragement, academic collaboration and blessing to well wishes.

My best regard to **Mrs Mahmuda Begum and Mrs Nahid Sultana** Scientific Officer (SO) Biological Research Division, BCSIR Laboratories, Dhaka for their sincere co-operation throughout the course of the work.

I am also grateful to **Tahmina Haq**, Ex-Scientific Officer (SO), Biological Research Division, BCSIR Laboratories, Dhaka for her sincere co-operation.

Personal thanks are offered to Nusrat Jahan Punom, Md. Babul Hossain, Iqbal Hossain, Ishak Gazi, my well-wishers, classmates and others of Department and Hall for their encouragement during the study.

I am highly delighted to express my cordial gratitude and veneration to **My Parents**, brothers and sisters for their affection, blessing and sacrifices. All of their helps, inspiration and encouragement have facilitated me to reach at this stage of education

The Author

31 January 2016

ABSTRACT

Tilapia is one of most widely cultured fish in the world. According to FAO, 2009 farmed tilapia represents more than 75% of world tilapia production. Tilapia is considered suitable for culture, because of their high tolerance to adverse environmental condition, their relatively fast growth and resistance to disease, excellent quality of its firmly textured flesh and finely appetizing fish to the consumer. Tilapia feed on a wide of dietary sources, including phytoplankton, zooplanktons, larval fish and detritus. The objective of the present study was to assess the better growth performance of tilapia fry with live feed *Moina macrocopa* in comparison to commercial feed. Three feeds were used in three treatments where treatment T1 using hand made feed (control), Treatment-T2 using commercial feed and treatment-T3 *Moina macrocopa* as live feed. Thirty fry were stocked in each 60 L aquarium for 56 days rearing. The fishes were fed twice a day of body weight for first 20 days 10%, then 8% for 15 days and 5% for remaining days. Sampling was done at 14 days interval.

The rearing and feeding trail in the experimental condition the changes in growth and feed utilization by tilapia fry fed on live feed and other feed have been assessed by the determination of condition factor (K%), average daily gain (ADG), feed conversion ratio (FCR), specific growth rate (SGR), survival rate (SR).

The average growth performance of *moina macrocopa* was more in spirulina, 710 individuals/ L of water, 600 individuals/L of water was found at 12 days. After culturing 30 days proximate composition of m macrocopa was found moisture protein fat ash content 87.32%, 8.5%, 3.22% and 0.6% respectively

The highest average daily gain 0.13± 0.01 g/day, specific growth rate 3.90±0.88, survival rate 91.5±1.5% were found after rearing of 56 days in treatment T3 (live *M. macrocopa* as feed). The lowest average daily gain 0.04± 0.02, specific growth rate 1.72 ± 0.82, feed conversion ratio 0.69 ± 0.41, survival rate 88.5% was found at treatment T1 (control). Highest protein content 15.91% was found in treatment T3, Where the protein content in commercial feed and handmade feed were 11.88% and 10.96 % respectively.

From the present study it may be stated that live *M. macrocopa* may be used as a good feed for tilapia fry rearing.

Contents

List of tables

List of Figures

List of plates

List of symbols and abbreviations

Symbols or Abbreviations	Details
Tem	Temperature
%	Percentage
G	Gram
L	Length
T1	Treatment one
T2	Treatment two
T3	Treatment three
Cm	Centimeter
KL	Kilo lux
pH	Concentration of hydrogen ions in liquid
DO	Dissolved oxygen
MS	Master of science
Fig	Figure
K	Condition factor
ADG	Average Daily Gain
FCR	Feed Conversion Ratio
SGR	Specific Growth Rate
SR	Survival Rate
Ml	Millimeter
Nacl	Sodium chloride
NaOH	Sodium Hydro-oxide
H_2SO_4	Sulfuric Acid
BCSIR	Bangladesh council of Scientific and Industrial Research

Chapter 1
Introduction

1.1 Background

About 350 million people of the world population depend on fish as a principal source of animal protein (Corpei 2001). In many tropical and subtropical areas of Africa, America and Asia Tilapia is an important food fish. In developing countries, where animal protein is lacking many species of tilapia have been cultured. Monosex tilapia is one of the important culture fish of the world. Tilapia is considered suitable for culture, because of their high tolerance to adverse environmental condition, their relatively fast growth and resistance to disease, excellent quality of its firmly textured flesh and finely appetizing fish to the consumer (Corpei 2001).

Tilapia is common name for name for a hundred species of cichlid fish from the tilapiine cichlid tribe. Tilapia are mainly freshwater fish, inhabiting shallow streams, ponds, rivers and lakes, and less commonly found living in brackish water. Tilapia typically has laterally compressed, deep bodies. Like other cichlids, their lower pharyngeal bones are fused into a single tooth-bearing structure. A complex set of muscles allows the upper and lower pharyngeal bones to be used as a second set of jaws for processing food, allowing a division of labor between the “true jaws” and the “pharyngeal jaws”. The jaws have conical teeth. Typically tilapia have a long dorsal fin, and a lateral line which often breaks towards the end of the dorsal fin, and starts again two or three rows of scales below.

Tilapia is an important food fish in many tropical and sub-tropical countries. It provides one of the most important sources of animal protein and income throughout the world (Sosa *et al.* 2005). They are considered suitable for culture because of their high tolerance to adverse environmental conditions, relatively fast growth and the ease with which they can be bred .Pakistan has vast areas of salt waters which can be best utilization for culturing tilapia, as this fish is very hardy, more tolerant than most commonly farmed freshwater fish to high salinity, high water temperature, low fish has become one of the more commercially important groups (Coward and Bromage 2000). Protein is the main constituents of the fish body thus sufficient dietary supply is needed

for optimum growth. Protein is the most expensive macronutrient in fish diet (Pillay 1990). So the amount of protein in the diet should be just enough for fish growth where the excess protein in the fish diet may be wasteful and cause unnecessarily expensive (Ahmed 2000).

The exponential growth of the aquaculture sector during the past two decades is a result of the progressive intensification of production systems and use of quality feeds, which meet the nutritional requirements of cultured fish (FAO 2006). Stimulated by higher global demand for fish, world fisheries and aquaculture production reached 157million tons in 2012 and is projected to reach about 172 million tons in 2021, with most of the growth coming from aquaculture (FAO 2013). This increase of aquaculture production must be supported by a corresponding increase in the production of designed diets for the cultured aquatic animals (Rahman *et al.* 2013). Tilapia is the common name given to three genera of fish in the family *Cichlidae* namely *Oreochromis*, Sarotherodon and Tilapia (Santiago and Laron 2002). The genus *Oreochromis* includes Nile tilapia (*Oreochromis niloticus*), Mozambique tilapia, (*Oreochromis mossambicus*) and blue tilapia (*Oreochromis aureus*). Regionally, tilapia is the most preferred cultured fish in East Africa but are the second most important cultured fish in the world after carps (Dan and Little 2000; El-Sayed 2006). The culture of tilapia started as early as 2000 – 2500 BC (Chimits 1957).Among tilapias, Mozambique tilapia, *Oreochromis mossambicus* was first species, was introduced into Bangladesh from Thailand in 1954. The fish did not flourish and proved to be a pest due to its early maturation prolific breeding habitats in the ponds. As a result, producers and consumers regarded the fish as naissance fish. During the 1970's a renewed interest in Tilapia culture developed in some Asian countries including Bangladesh with the introduction of Nile Tilapia, *Oreochromis niloticus*. Overall performances of Nile Tilapia and fast growing tilapias have proved that they are no longer pests but have come to be known as aquatic chicken. In 1974, the *chitralada* strain of Nile Tilapia, a promising farm species, was introduced of the fish in this country, also from Thailand in 1984 (Hussain 2004).

1.2 Nutrients in fish

Fish contributes enormously to the supply of both macro and micronutrients in our diet. It is considered to be the potential source of proteins and many other micronutrients, such as vitamins and minerals. Fish have some unusual composition features that do not

apply to many other foods (Nettleton 1985). The first is that many do not have appreciable carbohydrates. For all practical purposes, the caloric values of fishes are based only on the fat and protein content. The feature is that a few species have their fat predominantly in the form of wax esters instead of triglycerides. These wax esters are believed to be resistant to digestion by human system so that the fat content would contribute considerably to the caloric value of fish (Nettleton 1985).

Proximate composition of fishes is an important ecological measure of condition that integrates both feeding condition and habitat quality (Jobling 1980; Wicker and Johnson 1987). Proximate composition can also have important implication in the study of fish bioenergetics (Craig 1977; van Pelt *et al.* 1997*)* as well as the study of contaminations, given the propensity of many compounds to be related to lipid levels (Lanno *et al*). Further, certain components such as fat levels have also have important in aquaculture and food technology, where the fish grading, fish quality and value are linked to fat levels in the tissue (Rasmussen 2001). The biochemical composition of fish-flesh may very within the same species of fish depending upon the fishing season, age, sex and habitat (Srivastava 1985). The variation is also found within the different region of the body (Jacquot 1961).

1.3 Water (Moisture)

Water is the major component of all species of fish. Usually water content ranges from 70-80% of the fresh weight, although some deep water species may have some excess of 90%. There are seasonal variations and slight increase occurs when the fish is starving (Clucas and Ward, 1996).In most bony fish, fat and water content make up to 80% of the fresh weight. In simple terms, the high water content can be held responsible for the perishability of fish (Clucas and Ward 1996).

1.4 Protein

The cardinal virtue off all fish is their high protein. Fish protein is 85-95% digestible and all dietary essential amino acids are present in fish (Nilson 1946). Fish supplies not only abundant of protein, but also kinds of protein most efficiently used by the body. With few exceptions, most proteins from animal products are complete. All fish provide complete protein having all essential amino acids so that less of it is required by the body to meet its daily protein requirement. Cereal grains are usually low in lysine and sulphur

containing amino acids (Methionine and Cysteine) whereas fish protein is an excellent source of these amino acids. In diets based mainly on cereals, a supplement of fish can raise the biochemical value significantly (Hans Henric Huss 1988). Another feature of fish protein is that it is highly digestible. This means that it is readily digested by the body and easily absorbed. People of all ages from children over a year to older can enjoy fish, because its protein is highly digestible (Nettleson 1985).

1.5 Fat (Lipid)

Most fishes are relatively low in total fat and relatively high in its proportion of polyunsaturated fatty acids. This feature gives fish a clear health advantage (Nettleton 1985).

Fats, especially vegetable oils, contain an essential fatty acid called linolenic acid that the body cannot make for itself. The amount of linolenic acid required in small and is easily obtained from the foods we commonly eat, especially vegetables and fish. It also appears that linolenic acid, a second fatty acid, is probably essential in human (Nettleton *et al.* 1984; Holman *et al*. 1982). Fats are made of different kinds of fatty acids that in turn differ in the amount and arrangement of the carbon and hydrogen atoms they contain. There is still great to learn about how the body processes different fatty acids, but it seems clear that some fatty acids are more beneficial for health than others (Nettleton 1985). In particular, polyunsaturated fatty acids have been shown to be more favorable for healthy blood lipid levels than saturated fats. In many people, achieving a better blood lipid pattern can lower the chance of heart attack or stroke (Grundy *et al*. 1982).Fishes have been used in diets designed to prevent and treat cardiovascular disease, one of the leading causes of mortality in today's world. The best ways to achieve a healthy blood lipid pattern are to eat less fat in total to limit the amount of saturated fats consumed and to keep cholesterol intake below 300mg per day (Emst 1985).

The implications from the observations among Greenland Eskimos is that fish oils are protective against heart disease, stroke and possibly diabetes and other diseases as well (Goodnight *et al*. 1982; Bang *et al*. 1980).

1.6 Ash (Minerals)

Fish are the important sources of essential minerals such as zinc, copper, iron, magnesium, sodium, calcium, phosphorus, potassium (Nettleton 1985. Banu *et al.*1985. Nurullah *et al.* 2003).

Fish provides a well-balanced supply of minerals in a readily usable form (Murry and Burt 1982). In most species, the total mineral of ash content ranges from 1 to 286. There is a wide variety of minerals in fish flesh and they are usually present in a form, which is readily available (Clucas and ward 1996).Fish flesh is regarded as a valuable in particular, but also of iron and copper (Hans Henris Huns 1998).

1.7 Importance of Live Food Organisms in Aquaculture

Zooplanktons are important food items for the young and some adults of many freshwater fishes which represent a major component of the human diet (Kennth 1990). Among freshwater zooplankton, rotifers, cladocerans and copepods are dominant group throughout the year (Hutchinson 1967). Naturally, fishes in the wild depend on plankton for the survival of their hatchlings throughout their fry growing seasons. Some zooplanktons are essentially used to feed fry of fish species that do not accept artificial feeds (Bryant & Matty 1980). Live food micro-organisms are important food sources for many fish species and the success of culturing zooplanktivorous fish fry depends primarily on zooplankton, their composition and density (Fernando 1994).

Zooplankton, which most fry depend naturally upon as their live food, depends on phytoplankton that constitutes the major primary producer in the aquatic food web. Many species of live food organisms used in larvae culture have superior and natural nutritional value than formulated diets. However, some live food zooplankton are selected as food sources in larvae culture based on certain qualities such as purity, availability, acceptance, nutritional indicators (digestibility and organism nutrients/ energy), easily availability, easy reproduction and economically viability (Watanabe & Kiron 1994).

Sipaúba-Tavares and Bachion (2002) reported that the culture of Cladocerans offers the possibility of obtaining a large number of live food organisms within short periods of time under optimum conditions of temperature, food, and water quality. These live food micro organisms are valuable source of protein, lipids, fatty acids, mineral and enzymes. They are inexpensive and should serve as alternative to the brine shrimp which are expensive non-freshwater organisms. Normally, fish fry grow in the wild where preys are readily available. In the hatcheries, where most of the activities are artificial, the

survival of fry depends on availability of right food. Fry requires high protein food (42.0% and 52% for omnivorous and carnivorous fish respectively) for survival and growth (Tacon 1990). It is important to note that not all zooplankton are suitable for fry rearing but live Rotifer, Moina and Daphnia species are reported to be good freshwater zooplankton that can enhance protein and other food content for the rearing of fry in our hatcheries (Olojo *et al*. 2003).

Zooplankton are suitable live fish food sources used in aquaculture industry due to abundance, tolerance to environmental condition high nutritional quality, pathogenic, reproduction short generation time rich in digestive enzyme and high caloric value (Nandini and Sharma 2003).Most of early fish larvae consume rotifers in large amount and they need large prey such as moina, daphnia with increasing age and size of fish larvae (Khadka and Rao 1986). Zooplankton is valuable source of crude protein, amino acids, lipids, fatty acids, minerals and enzymes for fry. Yurkowski and Tabachek (1979) reported that zooplankton satisfy all food requirements of fish and supported fry growth. Lysine and methionine, which are known to be the most limiting amino acids in feeds, are present in appreciable quality in zooplankton (Dabrowski & Rusiecki 1983). High ratio of unsaturated fatty acids to saturated fatty acid of zooplankton shows that zooplankton is good quality food for rearing fish larva (Lokman 1994). The polyunsaturated fatty acid (PUFA) contents showed high concentrations of eicosapentanoic acid (20:5ω3) and docosahexanoic acid (22:6ω3) with moderate amounts of linoleic acid (18:2ω6) in zooplankton. As ratios of ω3 to ω6 PUFA are high, the zooplankton is regarded as desirable food (Lokman 1994). It was reported that zooplankton is source of carotene and they improve flavor, colour and texture of fish fed on them (Spenelli 1979). Live zooplankton is also reported to contain enzymes like amylase, protease, exonulease, esterase that play important roles in larval digestion (Munilla – Moran *et al.* 1990). Mims *et al.* (1991) revealed that the exoskeleton of the live organism (as roughage) is necessary for food digestion in fish fry. Cladocerans have been found to be rich in essential nutrients, are easily ingested and digested by fish larvae, fulfill the larval dietary requirements and improve water quality by minimizing the need for artificial feeding (He *et al*. 2001). Most of Rotifers, Moina and Daphnia species are found in freshwaters. Since these various live feed, zooplankton are diets for fish fry in freshwater, the culture and utilization of these potentials are vital in fish fry production in hatcheries.

1.8 Objectives of the Study

Overall objective

The overall objective of the proposed study was to check the growth performance of tilapia fry fed with live feed (*Moina mcarocopa*) that was culture in various growth media.

Specific objectives

- Culture of *M. macrocopa* using various growth media (spirulina, yeast, cabbage leafs and handmade feed).
- Culture of tilapia fry using *M. macrocopa* (zooplankton) from culture media.
- Evaluate the growth performances such as Condition factor (K), Average Daily Gain (ADG), Feed Conversion Ratio (FCR), Specific Growth Rate (SGR) and Survival rate of Tilapia fry fed with various feed.
- Evaluate the proximate composition (moisture, protein, fat and ash) of tilapia fry fed with various kind of feed.

CHAPTER 2

Materials and Methods

2.1 Culture of *Moina macrocopa*

2.1.1 Collection of sample

Sample (Zooplankton) was collected from various place of Dhanmondi Lake in Dhaka.

2.1.2 Experimental site

The experiment was carried out in the wet laboratory at Zoology section, Biological Research Division, Bangladesh council of Scientific and Industrial Research.

2.1.3 Experimental Design with different feed

The experiment was conducted for 30 days. Each treatment had two replications. The stocking density of *Moina macrocopa* was 200 ind/aquarium. Feeding was done twice daily at 10.00 am and 5.00 pm.50% of water exchange from each aquarium after seven days. The experiment was conducted for 30 days. The wet laboratory is situated near to the office building where eight aquariums were used for the experiment (Plate 2). Each of the aquariums was three and half feet length and one and half feet in width depth was about two feet. All the aquariums were filled with tap water and labeled according to the experimental design. Each of the aquariums was filled up with tap water in the quantity 60 liters. Aerator was used for 24 hour during the experiment period. Each treatment had two replications. Treatment-1 (aquarium A1+ aquarium A2) was feed with handmade feed, Treatment-2 (aquarium B1+ aquarium B2) was feed with cabbage leafs, Treatment-3 (aquarium C1+ aquarium C2) was feed with yeast, Treatment-4 (aquarium D1+ aquarium D2) was feed with spirulina respectively.

2.1.4 Culture Species (*Moina macrocopa*)

Photograph 1: *Moina macrocopa*

Classification

Kingdom- Animalia

Phylum- Artropoda

Subphylum-Crustacea

Class-Branchiopoda

Order- Cladocera

Family- Moinidae

Genus-*Moina macrocopa* (Straus 1820)

2.1.5 Experimental layout of *Moina macrocopa* culture

Treatment	Replication	Aquarium size	Stocking density
T1	A1	(3×1.5× 2)	200
	A2		200
T2	B1	(3×1.5× 2)	200
	B2		200
T3	C1	(3×1.5× 2)	200
	C2		200
T4	D1	(3×1.5× 2)	200
	D2		200

2.1.6 Feed formulation

The selected ingredients for this experiment were collected from local market. Feed ingredients for handmade feed are given below:

Feed ingredients	Percentage (%)
Rice bran	14.5
Corn grain	14.5
Wheat	14.5
Shrimp grain	13.7
Fish grain	13.7
Oil cake	13.7
Soybean	13.7
Fat	0.84
Vitamin and minerals	0.84

2.1.7 Method and Materials for Zooplankton culture

The experiment was conducted for 30 days in the wet laboratory which is situated near the office building in the zoology section of the BCSIR laboratories, Dhaka. Cultures were carried out in eight aquariums of size 3 ft× 1.5ft × 2ft complete with 24 hours aeration. These aquariums were washed, left to air dry, and then filled with 60 liters of tap water. The tap water was left one day for seasoning. One the second day feed was applied on the aquarium according to the experimental design. On the third day, 200 individual of *Moina macrocopa* was added to each tank. Feed was supplied regularly. Cell count of the organism was done every three days interval. Physico-chemical parameters (DO, TDS, conductivity, light intensity, ammonia, nitrite, temperature and pH) were done twice every week. The population of *Moina macrocopa* generated from Ovie (1991) and used to determine population density of zooplankton

$$P_d = \frac{100 \times Bx}{V\,ml}$$

P_d =population density of M. macrocopa in 1000 ml of water.

V= Average volume of water sample using automatic pipette.

B_x = Average number of *M.macrocopa* counted in various random sampling

2.2 Culture for Tilapia fry

Systematic position of *Oreochromis niloticus* (Linnaeus, 1758) (Figure)

Classification

Kingdom- Animalia

Phylum- Chordata

Sub-phylum- Vertebrata

Super-class- Gnathostomata

Class- Actinopterygii

Order- Perciformes

Family- Cichlidae

Genus- *Oreochromis*

Species- *O.niloticus* (Linnaeus,1758)

2.2.1 Sample collection

Fry of Tilapia (*Orechromis niloticus*) were collected from Shotota Matsho Projonon Kandro O Fishery at Noldighi Chairman Bari, Tarakanda, Mymensingh. Live fish were collected in November 2015 and carried in oxygenated bags with sample water.

2.2.2 Experimental site

The experiment was carried out in the wet laboratory at Zoology section, Biological Research Division, Bangladesh council of Scientific and Industrial Research (BCSIR)

2.2.3 Experimental Design with different feed

The experiment was conducted for 56 days. The wet laboratory is situated near to the office building where five aquariums were used for the experiment (Plate 1). Each of the aquariums was three and half feet length and one and half feet in width depth was about two feet. All the aquariums were filled with tap water and labeled according to the experimental design. Each of the aquariums was filled up with tap water in the quantity 60 liters. Aerator was used for 24 hour during the experiment period. Each treatment had two replications. The fry of Tilapia had an initial weight of gm. The fry were randomly distributed at a rate of 30 fish per aquaria. Feeding was done twice daily at 10.00am and 5.00pm. Partial change of water from each aquarium was done daily during the removal of uneaten feed and faeces. The aquarium was also cleaned per week and clean water was supplied in each of the aquariums

Treatment	Feed (commercial & live)
T1	Commercial feed
T2	*Moina macrocopa* (Zooplankton)
T3	Handmade feed

2.2.4 Experimental layout of tilapia (*Oreochromis niloticus*) fry rearing

Treatment	Replication	Aquarium size (L)	Total stocking	Stocking size (g)
T1	R1	60	30	0.42
T2	R1	60	60	0.33
	R2	60		0.29
T3	R1	60	60	0.55
	R2	60		0.58

Plate 1: An Experimental set up of Aquaculture Aquarium for Tilapia Culture

A : Ammonia kits

B: Nitrite kits

Plate 2: Showing Ammonia kits (A) and Nitrite kits (B)

A: pH meter

B: Digital lux meter

C. DO meter

D: Electric kettle

Plate 3: Showing the pH meter (A), Digital light intensity meter (B), DO meter (C) and Electric kettle (D).

A. Commercial feed

B. Hand made feed

C. Live feed

D. Feed for zooplankton

Plate 4: Showing different types of feed including commercial feed (A), Hand made feed (B), Live feed (C) and feed for zooplankton (D).

2.2.5 Types of feed

Three types of feed were used in the experiment. These are as follows

Type-1: Commercial feed

Type-2: *Moina macrocopa* (Zooplankton)

Type-3: Handmade feed

2.3 Physico-chemical parameters of water

It can be described as physical, chemical and biological factors that influence the condition of water. Temperature, dissolve oxygen (DO), light intensity, pH, conductivity, total dissolve substance (TDS) are physical parameters of water. Physico-chemical parameters of water were done twice in a week with relevant instrument.

Temperature

The temperature of aquarium water was measured with a thermometer at the time of sampling.

Dissolve oxygen

The amount of dissolve oxygen in water was determined by dissolve oxygen meter (HI-9146).

Light intensity

Appropriate amount of sunlight is required for the growth of fish. Light intensity was measured by digital lux meter (LX1010B).

Conductivity and TDS

The amount of TDS and conductivity of water was measured by conductivity meter (4510 Conductivity meter).

pH

It is essential to maintain optimum pH level for fish culture. The pH value was determined by pH meter (HANNA, HI- 8424 pH meter).

2.4 Study of growth performances of fish

The following parameters were used to evaluate the growth.

2.4.1 Fish sampling procedure

Sampling was accomplished at the 14^{th}, 28^{th}, 42th, and 56^{th} day of the experimental period. Prior of weighing, the fishes were caught with a fine mesh scoop net and their individual length and weight were recorded to the nearest centimeter and nearest gram

respectively. At the end of the experimental period the final length (cm) and weight (g) of the individual fish were carefully recorded. A steel measuring scale was used for measuring the lengths. The total body weight of individual fish was determined by a sensitive electronic balance.

2.4.2 Condition factor (K %)

This is the factor through which condition of the fish is expressed in numerical terms. It was calculated by the following formula as suggested by Hile (1936).

$K = (W/L^3) \times 100$

Where,

K= Condition factor

W= Body weight in grams

L= Body length in centimeters

2.4.3 Average Daily Gain (ADG, g/day)

Average daily gain means the increase of body weight per day. It was calculated by the following formula as suggested by Jones (1967)

$$ADG = \frac{\text{Mean final fish weight (g)} - \text{mean initial fish weight(g)}}{T_2 - T_1}$$

Where,

T2= Final time

T1= Initial time

2.4.4 Specific Growth Rate (SGR %)

SGR mean the percentage of body weight increase per day. Specific growth rate was calculated by the following formula as suggested by Hopkins (1992)

$$\text{Specific Growth Rate (\% day)} = \frac{\text{Loge W2} - \text{Loge W1}}{T_2 - T_1} \times 100$$

Where,

W_1 = the initial wet body weight (g) at time T_1 (day)

W_2 = the final wet body weight (g) at time of T_2 (day).

2.4.5 Feed Conversion Ratio (FCR)

The FCR is mainly the amount of feed it takes to grow a kilogram of fish. Feed conversion ratio was determined by the following formula as suggested by Payne (1987).

FCR= $\frac{Feed\ (g) consumed\ by\ the\ fish}{Weight(g) gaing\ of\ the\ fish\ (W2-W1)}$

Where,

W2= Final weight, W1= Initial weight

2.4.6 Survival rate

The survival rate of fish catch treatment was examined on basis of number fish harvested at the end of the experiment. The survival rate was calculated by counting the actual number of fishes survived, divided by the initial number stocked and multiplying by 100

Survival rate (%) = $\frac{\text{No.of fishes harvested}}{\text{No.of fish stocked}} \times 100$

2.5 Biochemical analysis of fish

2.5.1 Sample preparation

At the end of the experiment period the samples were collected, measured and weighted. Then the samples were taken for laboratory analysis to estimate the whole body percentage of moisture, protein, fat, and ash. The sample were then weighted and minced. Required amount of samples in duplicate were taken for the determination of moisture. Rest of the minced samples was collected as completely as possible. Wet weight was recorded and dried in an oven at 100ºC. Weight of the dry sample was recorded. Proximate analysis was accomplished in dry sample and the values were later readjusted for wet weight.

2.5.2 Estimation of moisture

a) Moisture

Moisture content is express as the amount of water as a percentage (%) and the remaining portion is the dry mater content. The following method (Air Oven method) is applicable to all food products except those that may contain volatile compounds (e.g Volatile lipids) other than water or those liable to be decomposed at 100 degree Celsius.

b) Principle

The sample is dried to constant weight in the air oven.

c) Apparatus

1. Oven (100-105℃)
2. Aluminum foil
3. Petri dish
4. Desiccators
5. Electronic balance

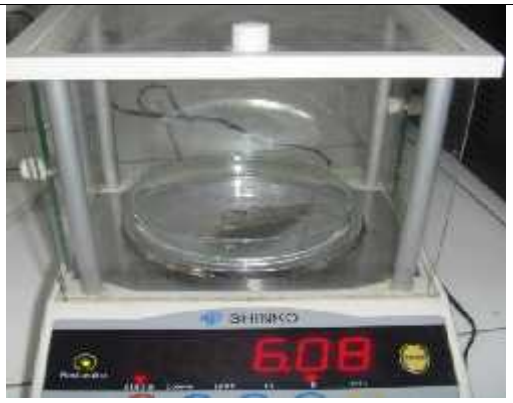
d) Procedure

About 5 gram of previously prepared fairly minced samples were taken into each known weight basin and weighed in a digital balance (Toledo, Switzerland). The samples were allowed to dry into the oven (Memmet 854 Schwabach) at 105C for 24 hours in order to remove the moisture until constant weight. After that, the basins are taken out of the oven, cooled in a desiccators and were weighed in a digital balance. The loss of weight was calculated as percent moisture content.

$$\textbf{Moisture } (\%) = \frac{\text{Original sample weight (g)} - \text{Dried sample weight (g)}}{\text{Original sample weight (g)}} \times 100$$

$$\textbf{Moisture factor} = \frac{100 - \textit{Moisture content}}{100}$$

A: Digital microscope



B Electric balance.

C: Cultured Species

D: Collection of musscle

Plate 5: Showing Digital microscope (A), Electric balance (B), Cultured species (C), Collection of muscle (D)**.**

2.5.3 Estimation of Ash

a) Principle

The ash content of a sample is the inorganic residue left over after the organic matter has been burnt away at 600-700℃

b) Materials and Equipments

1. Muffle furnace
2. Desiccators
3. Electronic balance
4. Porcelain crucibles

c) Procedure

About 4-5 g fish sample was weighed into a pre-weighed crucible. The crucible with the contents was heated first over a long flame till all the material was completely churned. Then it was transferred in the Muffle Furnace held at dark red at a rate of 600ºC for 5 hours until the residue become white. The crucible were cooled in desiccators and weighed. Finally the ash content was calculated and expressed as percentage of the original sample.

Calculation

$$\% \text{ of Ash} = \frac{Final\ weight(g) - Crucible\ weight(g)}{Sample\ weight(g)} \times 100 \times Moisture\ factor$$

2.5.4 Estimation of protein

a) Principle

Crude protein in the sample fish fillets were quantified method following the procedure of AOAC (1998) by Kjeldahl methods. 0.5 g of powdered fish fillet was weighed into Kjeldahl digestion flask and then digested by heating at 370 ℃ for four hours in the presence of 6 mL Sulfuric acid, 3.5 mL H_2O_2, 3 g of catalyst Copper Sulfate ($CuSO_4$) and Potassium sulfate (H_2SO_4). After digestion was completed, formed clear solution was cooled for 30 minutes and neutralized by addition of 25 mL NaOH (40 %) and diluted using 25mL distilled water. 25 mL of distilled water, 25 mL of Boric acid and 3 drops of Methyl blue was added to receiving flask 250 mL capacity connected to the distiller by tube. The distillation process was terminated when the volume of receiving

flask reached between 200 to 250 mL. Note: all reagents were added to the blank except the sample. The nitrogen content was estimated by titration of the borate anion formed with N/70 H_2SO_4. The Nitrogen value is then multiplied by 6.25 to get the value of crude protein. Calculation

b) Materials: Dry sample of fish

c) Reagent

1. N/70 H_2SO_4
2. Concentrated Sulphuric acid
3. 2%Boric acid
4. 40%Sodium hydroxide(aqua)
5. Phenolphthalein indicator

d) Apparatus

1. Kjeldahl flask
2. Filter paper
3. Distillation chamber
4. Digestion chamber
5. Burette with stand
6. Pipette
7. Electronic balance

e) Procedure

The Kjeldhal method consists of following steps:
1. Digestion of the sample
2. Distillation
3. Titration

Calculation

The percentage of nitrogen in the sample was calculated by the following equation:

$$\textbf{\% of nitrogen} = \frac{(S-B)\times A\times C\times Factor}{Weight\ of\ sample}\times 100$$

Where,
S= Titration reading for sample
B = Titration reading for blank
A= Strength of N/70 H_2SO_4
C= Digestion taken for distillation

A. Digestion chamber

B. Distillation chamber

Plate 6: Showing digestion chamber (A), Distillation chamber (B**)**

2.5.5 Estimation of fat

Principle: Fat content was determined according to the modified method described by Folch *et al*. (1957). : The fat content was determined quantitatively by extraction with a mixture of chloroform methanol(2:1).the mixture was allowed to stand overnight and lower lipid protein was transferred to a pretreated and weighted flask was heated to dryness. The differences in the two weights of the round joint flask give the weight of the fat.

Reagents

1. Chloroform
2. Methanol

Apparatus

1. Round joint flask
2. Filter paper
3. Oven at 105℃
4. Conical flask

Procedure

About 5 g of the homogenous sample was taken into conical flasks and 10 ml of folch reagent (Chloroform: Methanol = 2:1) was added into the sample and homogenized properly and kept in airtight condition for 24 hours. Fat contents of the fish muscle react with that solvent and remains in the solution. After 24 hours the solution of the flask was filtered in another weighed conical flask through a filter paper. Then these flasks were given in a hot water bath to dry up and removed the solvent. After that the flasks were kept into an oven for an hour to get the actual fat content. Then the flasks were weighed in an electronic balance to get the amount of fat content. Calculation

$$\textbf{(\%) of Fat}=\frac{Final\ weight(g)-Flask\ weight(g)}{Sample\ weight(g)}\times 100\times Misture\ factor$$

2.6 Data Analysis

Data were analyzed by using ANOVA followed by Tukey's HDS post hoc for multiple comparisons. The data were presented as mean ± SEM and analyzed by using the statistical program IBM SPSS statistics version 20.0 with the level of significance at $p<0.05$ All statistical analyses were carried out by MS EXCEL 2000 (version 7.0).

Chapter 3
Results

3.1 Condition Factor (K)

The highest (K=1.93) condition factor was found in rearing of Tilapia fry at treatment T_2 (commercial feed) and the lowest (K=1.66) was at treatment T_3 (live feed). The K value (K=1.82) of T_1 (handmade feed) was higher than T_3 and lower than T_2 (Fig 1).

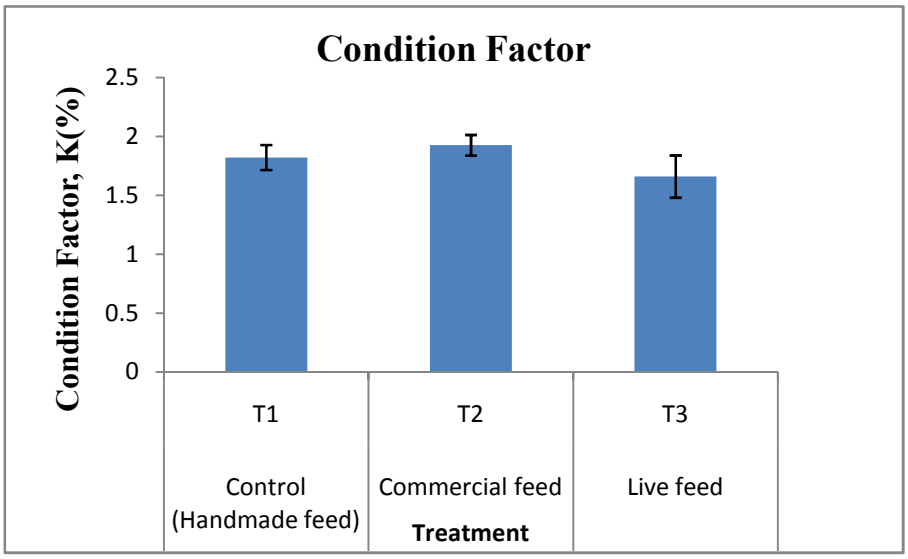


Fig 1: Condition Factor, K (%), (Mean ± SEM) of Tilapia fry cultured for 56 days with three different feed

Table1: Condition Factor, K (Mean ± SEM) at 56 days rearing period

Condition Factor					
Treatment	0 days	14 days	28 days	42 days	56 days
T1	1.784±0.109	1.730±0.072	2.069±0.138	2.043±0.132	1.492±0.097
T2	2.145±0.187	1.779±0.041	1.727±0.043	2.122±0.223	1.856±0.112
T3	1.958±0.159	1.797±0.040	1.852±0.085	1.585±0.087	1.733±0.052

Values are mean ± SEM of duplicate groups of 10 fish. Mean in the same column with different superscripts are significantly difference at $P<0.05$

3.2 Average Daily Gain (ADR g/day)

The highest (ADG = 0.09 ± 0.13) Average Daily Gain of Tilapia fry at rearing period was found at T3 and the lowest was (ADG = 0.04 ± 0.01) at T1. And then the ADG value (ADG = 0.06 ± 0.01) of T2 was higher thanT1 and lower than T3. The ADG value of treatment T3 is significantly higher than treatment T1 at 5% level (p =0.014) (Fig 2).

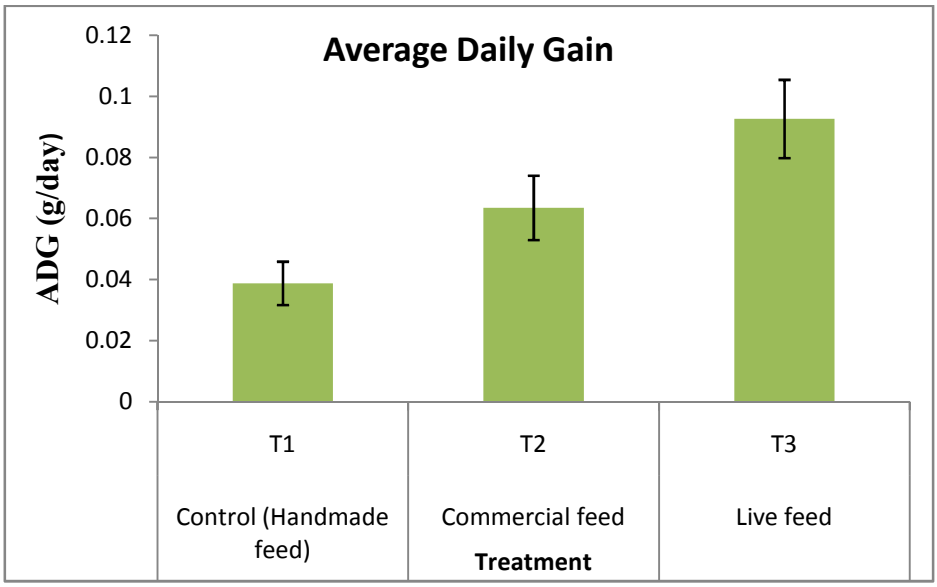


Fig 2: Average daily Gain, ADG (%), (Mean ± SEM) of Tilapia fry cultured for 56 days With three different feed

Table 2: Average Daily Gain, ADG (Mean ± SEM) at 56 days culture period

Average Daily Gain (g/day)				
Treatment	14 days	28 days	42 days	56 days
T1	0.06 ± 0.00^{b}	0.03 ± 0.01^{b}	0.01 ± 0.01	0.04 ± 0.02^{a}
T2	0.05 ± 0.00^{b}	0.03 ± 0.01^{b}	0.01 ± 0.02	0.08 ± 0.01^{ab}
T3	0.09 ± 0.00^{a}	0.08 ± 0.01^{a}	0.07 ± 0.01	0.13 ± 0.016^{b}

Values are mean ± SEM of duplicate groups of 10 fish. Mean in the same column with different superscripts are significantly difference at $P<0.05$

3.3 Feed Conversion Ratio, FCR (%)

The highest (FCR =3.08) Feed Conversion Ratio of Tilapia fry at rearing period was found treatment T1 and the lowest was (FCR =1.43) at treatment T3. And then the FCR value (FCR = 1.53) of treatment T2 was higher than treatment T3 and lower than treatment T1. Fig (3)

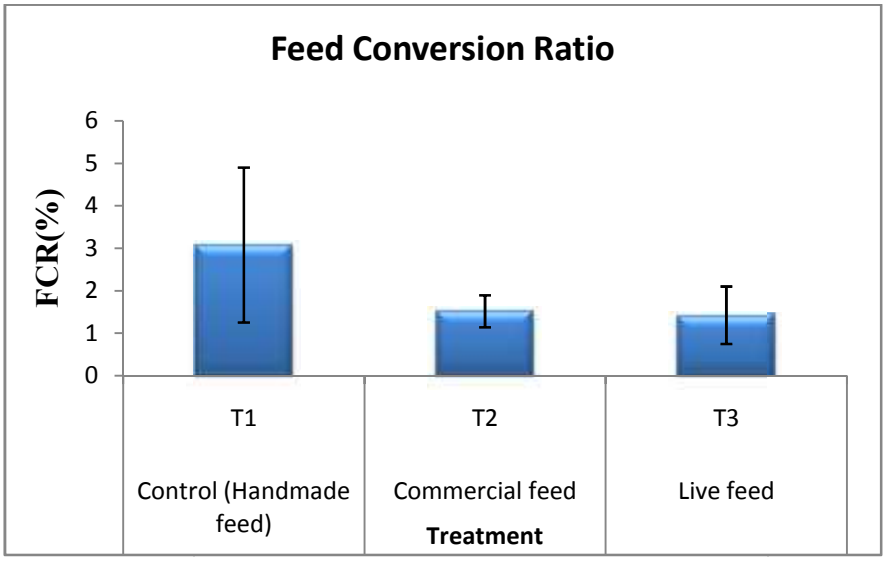


Fig 3: Feed conversion Ratio, FCR, (Mean ± SEM) of Tilapia fry cultured for 56 days With three different feed

Table 3: Feed Conversion Ratio, FCR (Mean ± SEM) at 56 days rearing period

Feed Conversion Ratio (%)				
Treatment	14 days	28 days	42 days	56 days
T1	0.82 ± 0.13	8.15 ± 3.87^{a}	0.79± 2.51	0.69 ± 0.41
T2	0.64 ± 0.04	1.16 ± 0.01^{ab}	2.05 ± 0.61	2.23 ± 0.54
T3	0.61 ± 0.06	0.15 ± 0.03^{b}	3.18 ± 0.49	1.76 ± 0.24

Values are mean ± SEM of duplicate groups of 10 fish. Mean in the same column with different superscripts are significantly difference at $P<0.05$

3.4 Specific Growth Rate (SGR)

The highest (SGR =3.90) Specific Growth Rate was found of Tilapia fry at treatment T3 and the lowest was (SGR =3.32) at treatment T1. And then the SGR value (SGR = 3.62) of treatment T2 was higher than treatment T1 and lower than treatment T3. There is no significant difference among the treatments at 5% level (Fig 4).

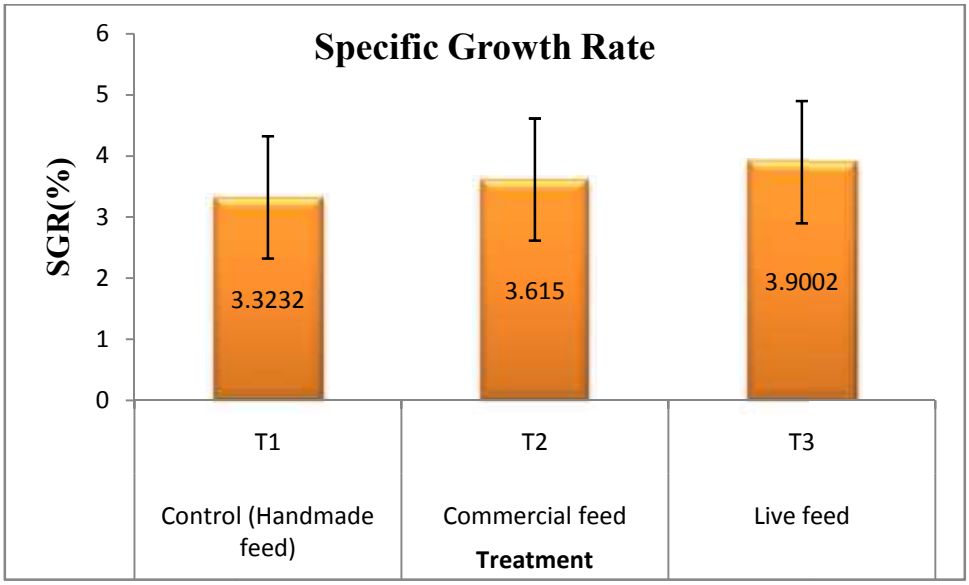


Fig 4: Specific growth Rate, SGR (%), (Mean ± SEM) of Tilapia fry cultured for 56 days With three different feed

Table 4: **Specific Growth Rate, SGR (Mean ± SEM) at 56 days rearing period**

Specific Growth Rate (%)				
Treatment	14 days	28 days	42 days	56 days
T1	7.62 ± 0.53	2.33 ± 0.41	1.97 ± 0.51	1.72 ± 0.82
T2	8.84 ± 0.43	2.63 ± 0.29	2.61 ± 0.58	2.51 ± 0.32
T3	6.12± 0.42	3.49 ± 0.31	2.08 ± 0.34	2.77 ± 0.36

Values are mean ± SEM of duplicate groups of 10 fish. Mean in the same column with different superscripts are significantly difference at $P<0.05$.

3.5 Survival rate (%)

After rearing period of 56 days the average survival rates of tilapia fry in the treatment T1, T2 and T3 were 88.5%, 91.5% and 91.5% respectively. The survival rate of tilapia fry was not significantly different among the treatments.

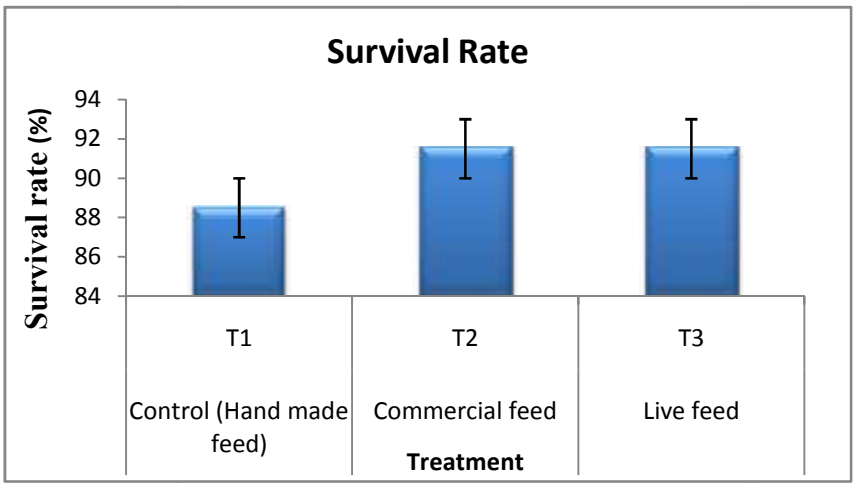


Fig 5: Survival Rate (%) of Tilapia fry cultured for 56 days with three different feed

3.6 Proximate analysis of fish samples

3.6.1 Moisture content in fish

Fig 5 depicted the percentage of moisture in tilapia species fed with various kinds of feed. Moisture content was found to be range of 82.48 to78.62%. From this it was observed that moisture content in tilapia fry fed with hand made feed was highest 82.76% than the fry fed with commercial feed 81.48% and live feed 78.62%. From this, we observed that the lowest percentage of moisture was found in tilapia fry fed with live feed and highest percentage of moisture was found fed with hand made feed.

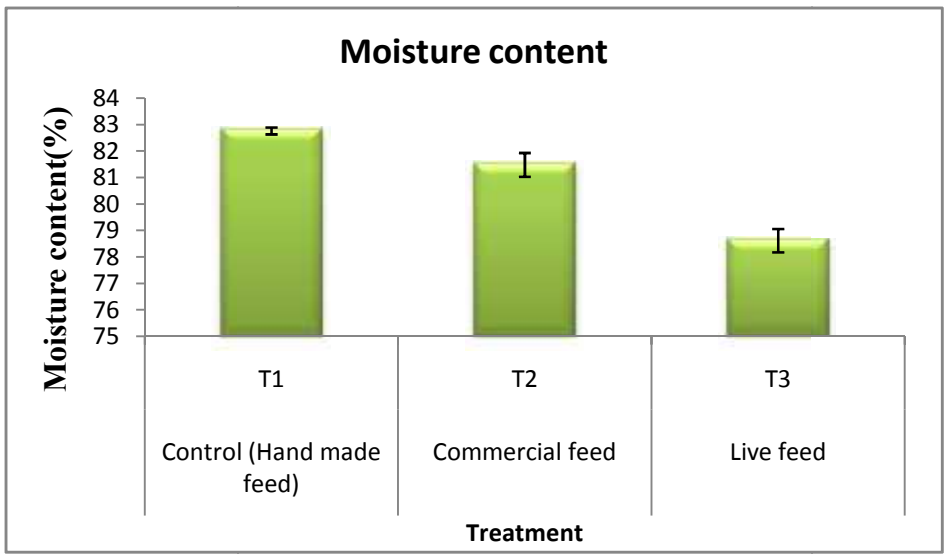


Fig 6: Moisture content (%), (Mean ± SEM) in tilapia fry cultured for 56 days with three different feed.

3.6.2 Protein content in fish

In this study protein content was found to be in the range 10.96-15.91%, the highest content of protein was found fed with live feed (15.91%), while the lowest was being found in hand made feed (10.96%) and commercial feed (11.88%).

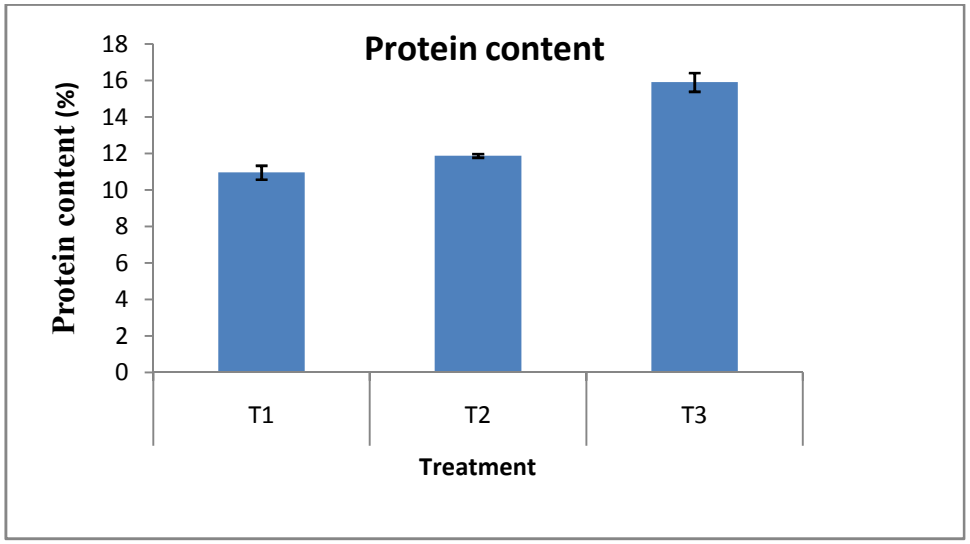


Fig 7: Protein content (%), (Mean ± SEM) in tilapia fry cultured for 56 days with three different feed.

3.6.3 Fat (Lipid) content in fish

The laboratory analyzed crude lipid contents of tilapia fry fed with hand made feed, commercial feed and live feed were 3.89%, 4.12% and 3.46% respectively. The highest content of lipid was found fed with commercial feed (4.12%), while the lowest was being found in live feed (3.46%) and hand made feed (3.89%). There was no significant different was found among various treatments at ($p < 0.05$) level.

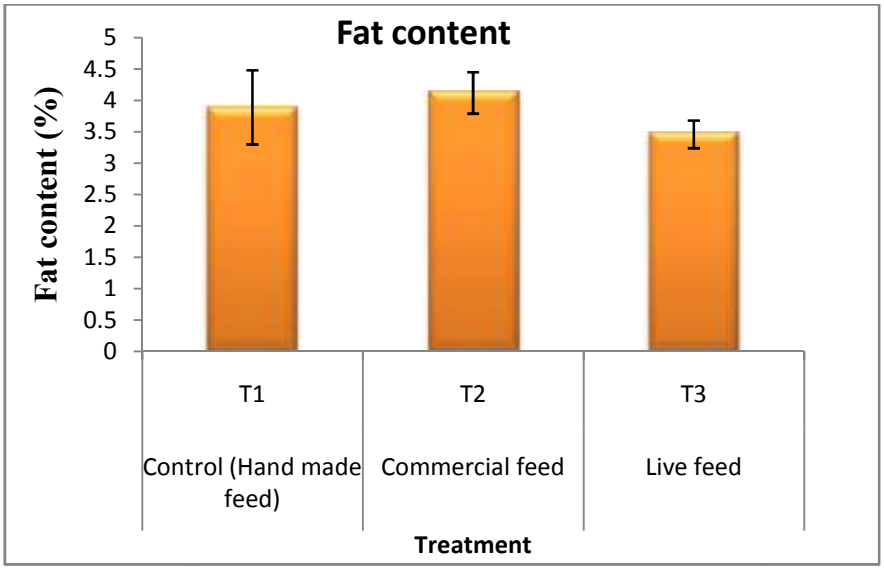


Fig 8: Fat content (%), (Mean ± SEM) in tilapia fry cultured for 56 days with three different feed

3.6.4 Ash content in fish

Fig: showed the percentage of ash in tilapia fry fed with different feed. The laboratory analyzed ash contents of tilapia fry fed with hand made feed, commercial feed and live feed were 2.24%, 2.24% and 2% respectively. The highest content of ash was found fed with commercial feed and hand made feed (2.24%), while the lowest was being found in live feed (2%).

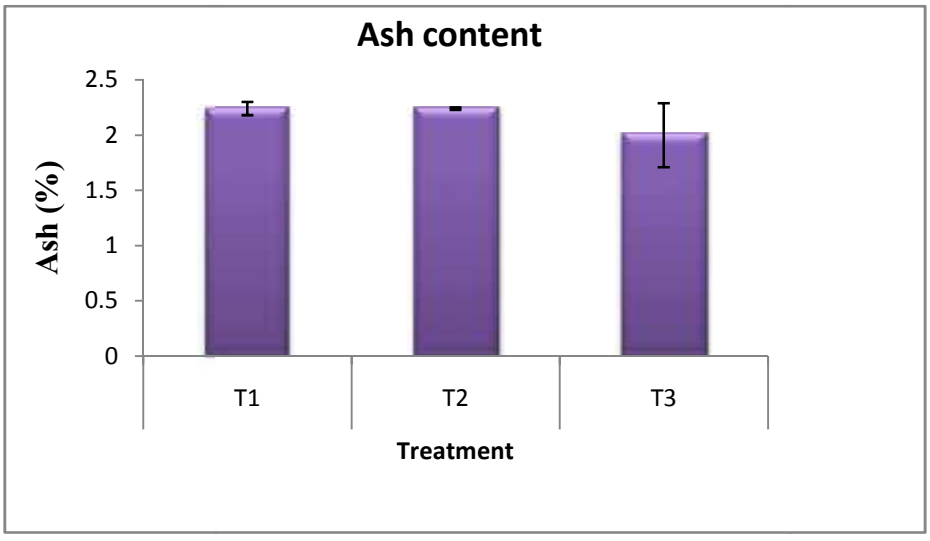


Fig 9: Ash content (%), (Mean ± SEM) in tilapia fry cultured for 56 days with three different feed

3.7 The effect of period of growth on population density of *Moina macrocopa* treated with four different type of feed

The results of the period of growth of *Moina macrocopa* in this experiment are presented in figure 10, figure11, figure 12 appendix…respectively. Result show that *M. macrocopa* increased population from day 3 to day 13 except handmade feed. In the four treatments *M. macrocopa* increased its population 20individual/L of water to 7100 individuals/L of water was obsersed in day 13 in the period of growth in spirulina. Then growth rate of *M. macrocopa* decline was observed from day 14 to day 24 in spirulina. After that the growth rate increased was observed in spirulina. In yeast *M.macrocopa* increased 10 individuals/ L of water to 6000 individuals/ L of water was observed in day 13 in the period of growth. Then growth rate of *M. macrocopa* decline was observed from day 14 to day 21. After that the growth rate increased was observed. In handmade feed after 9 days no individuals was found in the random sample water. In cabbage leafs maximum growth was found at 13 day 1900 individuals/ L of water. Then population decline up to 27days.

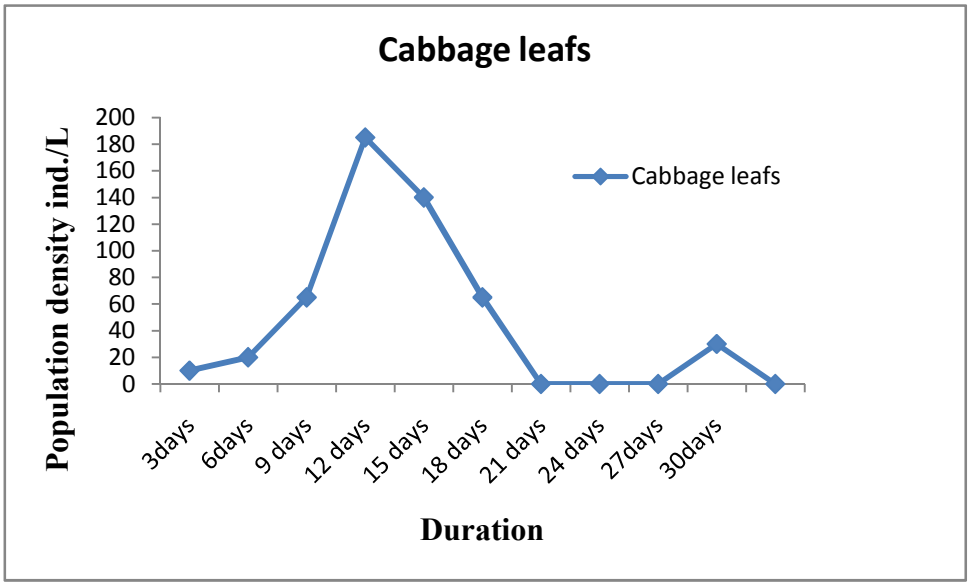


Figure 10: Effect of Period of Growth on Population Density of *Moina macrocopa* treated with cabbage leafs

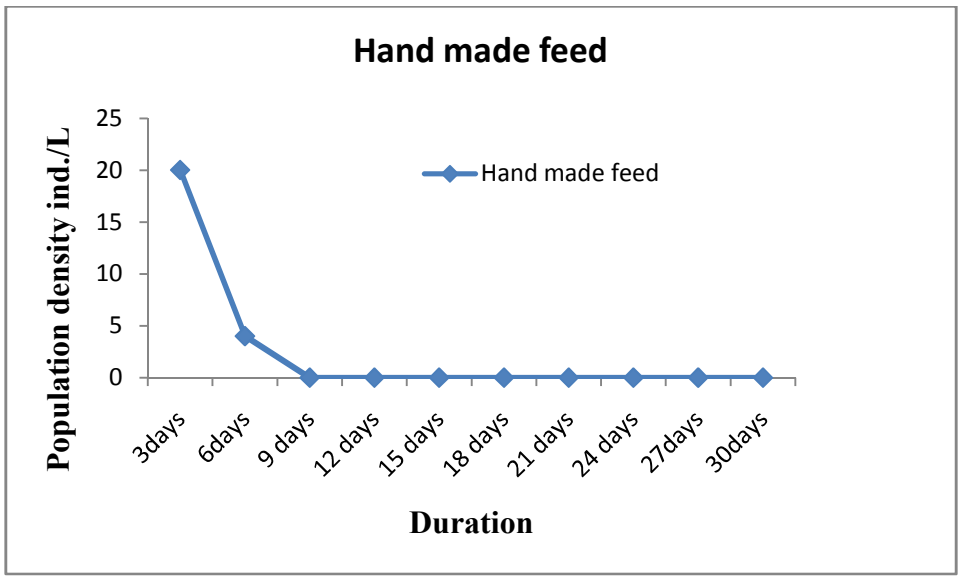


Figure 11: Effect of Period of Growth on Population Density of *Moina macrocopa* treated with hand made feed.

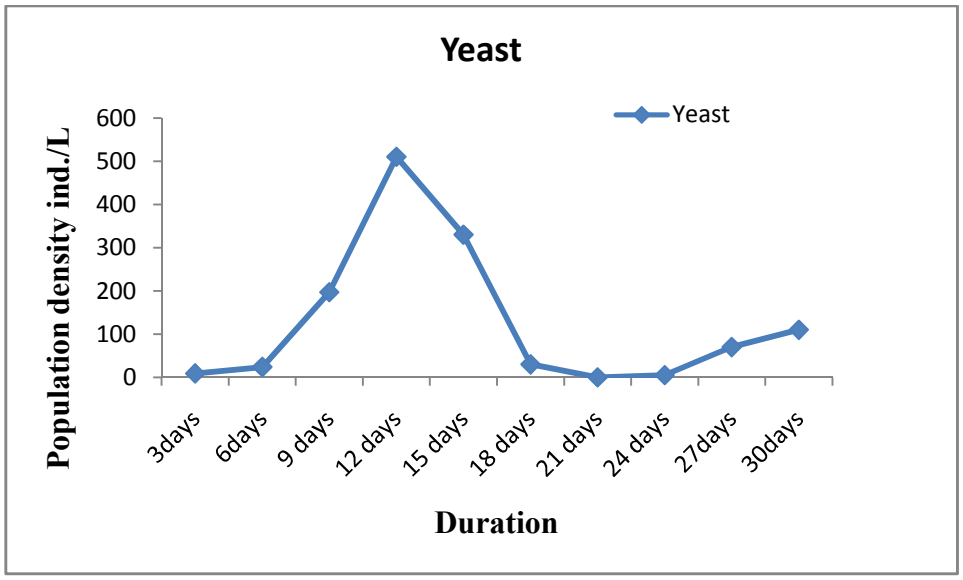


Figure 12: Effect of Period of Growth on Population Density of *Moina macrocopa* treated with yeast.

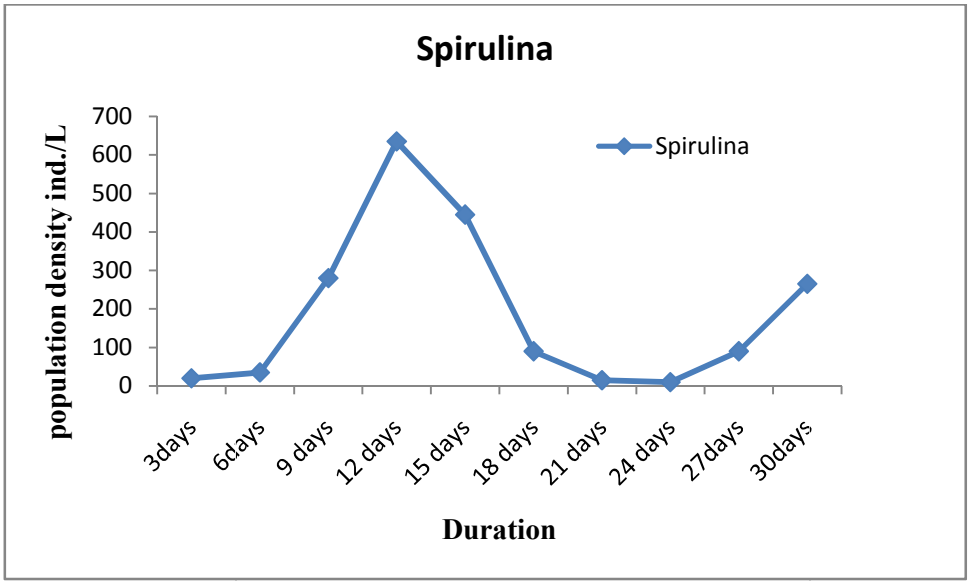


Figure 13: Effect of Period of Growth on Population Density of *Moina macrocopa* treated with spirulina.

3.8 Proximate composition of *Moina macrocopa*

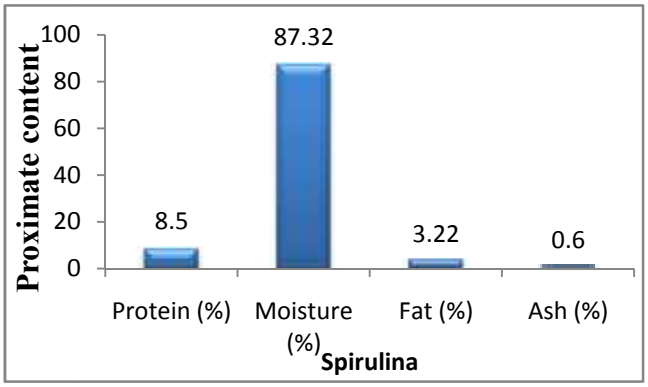


Fig14: Proximate composition in *M. macrocopa* cultured for 30 days in treatment spirulina.

3.9 Water quality parameter for culturing of *M. macrocopa* in each treatment

Water quality parameters were monitored in the each treatment over the culture period of *M. macrocopa* in this study shown in the table 5. The temperature for each of the treatment were not significantly different ($p<0.05$) from each other.

In this investigation results recorded for Dissolved oxygen, pH, Conductivity, light intensity through the period of the experiment were not significant different ($p<0.05$) in

the various treatment. Throughout the period of this experiment the lowest value was 5.39±0.7 in handmade feed while the highest value 6.06±0.14 in yeast. The pH values ranged from 7.9±.06 to 8.28±0.29 throughout the period of experiment. In this investigation results recorded for Total dissolved substance through the period of the experiment was significant different ($p<0.05$) found in cabbage leafs with other treatment.

Table 5 Water quality parameter for culturing of *M. macrocopa* in 30 days culture period

Treatment	Temperature º C	DO mg/L	pH mg/L	TDS mg/L	Conductivity	Light intensity Klux
Cabbage leafs	28.2±1.02	5.57±0.7	7.9±0.06	4.94±0.3	6.99±0.05	2.68±2.08
Hand made feed	28.2±1.15	5.39±0.3	8.28±0.29	6.02±0.08	6.91±0.08	3.06±2.48
Yeast	28.08±1.63	6.06±0.14	8.2±0.29	6.14±0.2	6.87±0.06	2.4±1.89
Spirulina	27.48±.73	5.94±0.12	7.94±0.07	6.09±0.08	6.95±0.06	2.42±1.89

3.10 Water quality parameter for culturing of *M. macrocopa* in each treatment

Water quality parameters were monitored in the each treatment 7days interval.

Table 6 Water quality parameter for culturing of *Oreochromis niloticus* in 56 days culture period

Treatment	Temperature º C	DO mg/L	pH mg/L	TDS mg/L	Conductivity	Light intensity Klux
Hand made feed	25.92±0.94	5.53±0.28	8.16±0.11	4.430.07	7.04±0.08	0.39±0.1
Commercial feed	25.82±0.91	5.57±0.27	8.0±0.16	4.420.08	7.0±0.1	0.39±0.1
Live feed	25.75±0.81	5.73±0.17	7.86±0.17	4.450.03	7.06±0.08	0.39±0.1

Chapter 4

Discussion

The present work described the growth performance and the proximate composition (moisture, protein, fat and ash) in Tilapia fry fed with live feed and other kinds of feed. It is well known that fish constituents the major share of animal foods in Bangladeshi diet. In our country Tilapia has great acceptance among poor peoples because of its availability and easy culture. For this reason, in the present study tilapia was selected for analysis. As tilapia is omnivorous fish, different kinds of feeds are supplied to determine the growth performance and proximate composition of fish.

4.1 Growth performance

Growth performance parameters of fish are illustrated in table 1, table 2, table 3 and table 4 respectively. The condition factor of Nile tilapia fry fed by zooplankton, handmade feed and commercial feed were found 1.66± 0.18, 1.82 ± 0.11 and 1.93± 0.09 respectively. There was no significant difference among different feed at 5% level. On 56^{th} day significantly higher value (1.86 ± 0.11) was found in commercial feed than handmade feed (1.47±0.09) at 5% level. Condition factor (K) of the present study showed the less variation and good performance at T2.

Rahman *et al*. (1997) in a study on the survival and growth of cat fish giving selected supplemental feeds got the values of condition factor between o.51-0.87.

The average daily gain of Nile tilapia fry fed by zooplankton (*Moina macrocopa*), handmade feed and commercial feed were found 0.09 ± 0.01, 0.04 ± 0.01 and 0.06 ± 0.01 respectively. The average daily gain of tilapia fry fed by live feed was found significantly higher value (0.09± 0.01) than handmade feed (0.04 ± 0.01) at 5% level ($p=0.014$). On 14^{th} and 28^{th} days average daily gain of fish fed by live feed was found highly significant value with handmade feed and commercial feed at 5% level ($p= 0.000$). On 56^{th} day significantly higher ADG was found in live feed than commercial feed at 5% level ($p =0.007$).

ADG value depends on several climatic factors including temperature, DO, pH, light intensity and other different factors such as availability of feed, stocking density,

predatory fish etc. Moreover average daily gain varies on size of the fish, sex, age, physiological condition and so on.

Significantly higher weight (2.98± 0.26 g) of fry was found in treatment T3 feed with *M. macrocopa* than that of others while lower weight 1.84±0.19 g and 1.58±0.12 g were found in treatment T2 and T1 respectively ($p<0.05$)

Significantly higher Feed Conversion Ratio was found on 28^{th} day in handmade feed (8.15 ± 3.89) than live feed (0.15 ± 0.03) at 5% level ($p = 0.04$). But there was no significant difference found on 56^{th} day at 5% level.

Specific growth Rate of Nile tilapia was found 3.32 ± 1.44, 3.62± 1.65, 3.90 ± 0.88 at handmade feed, commercial feed and live feed respectively. The highest SGR value was found at live feed and lowest at handmade feed. Fermin *et al*. (1991) showed that the specific growth rate of sea bass was 18.82% fed by *M.macrocopa*. In the present study specific growth rate of tilapia fry was found 3.90% fed by *M. macrocopa*. Due to the culture

The average survival rates of tilapia fry in the handmade feed, commercial feed and live feed were 88.5%, 91.5% and 91.5% respectively. Pena et al. (2001) showed that the survival rate of sea bass larvae was 92.4-96.9% fed by *Diaphanosoma celebensis*. In the present study the survival rate was 91.5% fed by *Moina macrocopa* which is very similar.

4.2 Proximate analysis

Significantly higher value of moisture was found (82.76%) at handmade feed than live feed (78.62%) at 5% level ($p=0.009$). The lowest value of moisture was found at live feed.

Desrosier *et al*. (1977) showed in a study the amount of moisture, fat and protein in fish reported that general fish contain 70-80% moisture. Mohsin *et al*. (1994) worked on *Cirrhimus mrigala* (Hamilton) and observed that larger fish contain lower amount of moisture than those of the smaller ones. Rubbi *et al*. (1987) investigate the moisture content of twenty seven species of fresh water fish, where moisture content was found to be in the range of 72.18-83.65% which is also nearly similar to the present study. Thus,

moisture content in the present study is in a good agreement with the values reported in the previous studies.

Significantly higher value of protein content was found at live feed (15.91%) and lowest value at handmade feed (10.96%) at 5% level (p=0.005).The

Desrosier *et al*. (1977) showed in a study the amount protein in fish was reported to be in a range of 13-20%. In another experiment (INFS, 1980) protein content of fresh water fish was reported to be in range 15-18%. Govindan *et al*. (1985) also reported to be a range 9-25% protein freshwater and marine fish. All the above studies suggest a wide range for protein to present in general fish. In the present study the protein content in treatment T3 is in good agreement with the valued reported in these previous studies.

In the present study, lipid content was found to be in the range of 3.46-4.12%. No significance difference was found in fat content using live feed and other feed. The highest (4.12%) content of fat was found in hand made feed while the lowest (3.46%) content was found in live feed.

Ash contains different kinds of minerals which play an important role in body structure such as calcium, iron, magnesium, zinc and so on. In the present study there was no significant different found in ash content among various treatment.

4.3 Water quality parameters

Rottmann *et al.* (2003) showed that the temperature for culturing *M. micrura* ranges from 24-310C and average water temperature (26.380C ± 0.410C) .In the present study the temperature for culturing *M. macrocopa* ranges from 24-32ºC and the average temperature (27.99± 0.48) . This is very similar to that value.

Rottmann *et al.* (2003) showed the average pH of water (6.80 ± 0.20), dissolved oxygen (6.29 ± 0.35mg/L) was optimum for culturing *M. micrura*. In the present study for culturing *M. macrocopa* the pH of water was (8.09±0.11) and dissolved oxygen was (5.74±0.12). For culturing *Moina macrocopa* ammonia and nitrite contents in water was measured by using ammonia kits and nitrite kits respectively. Nitrite content was found 0.656 mg/L to 3.28 mg/L and ammonia 2.0 mg/L to 2.5 mg/L on the culture period.

In the present study for rearing tilapia fry Dissolved oxygen, temperature, pH, Conductivity, Total dissolved substance were found 5.61 ± o.13, 25.82± 0.81, 8.01± 0.09, 7.03±0.04, 4.41±0.03, 0.3±0.1respectively.

Lakshmana *et al*. (1967) reported that the dissolved oxygen content of water ranging from 6.7-8.3ppm were satisfactory level for fish production. He also got the values of dissolved oxygen between 4.7-8.7mg/L which has similar with the present study. Coche *et al*. (1982) recommended DO levels of 3mg/L and above have been satisfactory for fish culture.

Rahman *et al.* (1982) reported that the water temperature ranged from 26.06- 31.97ºC was suitable for fish culture. In the present study the temperature range was found 24.2-29.3ºC which is suitable for fish culture

Ali *et al*. (1991) recorded pH value range 7.5 to 9.5 from a fresh water pond. Hossain *et al*. (1997) found pH value range 6.7 to 8.3 in pond. Katule and Mwaugulumba (2002) recorded the average pH 7.2 value as which is within the optimum range for fish production. In the present study the pH value was 8.01±0.09 which is suitable for *O. niloticus* culture.

Chapter 5

Conclusion and Recommendations

5.1 Conclusion

The current study showed the difference of growth performance and proximate composition of *Oreochromis niloticus* between live feed as *Moina macrocopa* and commercial feed. Best growth perfoemance and protein content was found in tilapia fry fed with *moina macrocopa*. There is a significantly positive effect was found by using moina macrocopa as live feed on the growth and proximate composition of tilapia fry. On the other hand, tilapia fish fed with hand made feed showed the poorest growth performance and proximate composition. In a comparison between commercial feed and live feed on proximate, live feed showed better performance. The average daily gain, specific growth rate, survival rate, protein content was more live feed treatment tilapia than other treatments.

5.2 Recommendations

On the basis of the observation made during the rearing of *Oreochromis niloticus* and statistical analysis *M macrocopa* is excellent feed for tilapia fry rearing**.** *M macrocopa* is good feed for fry because it body is soft structure and contain high level of protein which digestible rate is high. *Moina macrocopa* can be used as alternative of commercial feed for tilapia fry rearing in hatchery level.

LITERATURE CITED

AOAC. 1995. *Official Methods of Analysis of the AOAC International*, 16th ed., Association of official analytical chemists, Washington DC 1285 pp.

BOYD, C.E. and LICHTKOPPLER, F. 1979. Water quality management in pond fish culture. (R.andD. Series; 22) Auburn University Alabama, Department of Fisheries and Allied Aquacultures. 30pp.

BRYANT, P.L. and MATTY, A.J. 1980. Optimisation of Artemia feeding rate for carp(*Cyprinus carpio* L.). *Aquaculture.* **21**: 203-212.

BANG, H.O., DYERBERG, J. 1980. The composition of the Eskimo food in northwestern Greenland. *Am. J. Ciln. Nutr*. **29**: 2657.

CHIMITS, P. 1957. The tilapia and their culture. FAO Fish Bulletin in: Tiews K, Halver JE. (eds). *Finfish. Nutri. Fish. Feed. Techno*. **2**: 191 – 218.

CLUCAS, I.J. and WARD, A.R. 1996. *Post Harvest Fisheries Development: a guide to handling, preservation, processing and quality*. Natural Resources Institute. United Kingdom. pp. 384-389.

CORPEI. 2001. Alternative dietary protein for farmed tilapia *Oreochromis* spp. *Aquaculture*. **179**: 149-168.

CRAIG, J.F. 1977. The body composition of adult perch*, perca fluvitalis* in windermere, with reference to seasonal changes andreproduction. *J.Animal. Ecology***. 46**: 617-632.

COCHE, A.G. 1982. Cage culture of tilapias. In:the biology and cultura of tilapias.pp 205-246.

COWARD, K. and BROMAGE, N.R. 2000. Reproductive physiology of female tilapia brood stocks. *Rev. Fish Biol. Fisheries*. **40**: 1-25.

DAN, N. C., LITTLE, D. C. 2000. Overwintering performance of Nile tilapia Oreochromis niloticus (L.) brood fish and seed at ambient temperature in Northern Vietnam. *Aquaculture Research*, **31**: 485 – 493.

DABROWSKI, K. and RUSIECKI, M. 1983. Content of total and free amino acids in zooplanktonic food of fish larvae. *Aquaculture.* **30***:* 31-42.

DRESOSIER, N.W. 1977. Element of food technology. The Avi. Pub. Co. Inc. pp 384.

EL-SAYED, A. F. M. 2006. Tilapia Culture. CABI Publishing, Wallingford, GB. 256 pp.

EMST. 1985. Nutritional properties of fish oils. World Rev. Diet. 11-46.

FAO. 2006. Food and Agriculture Organization. State of world aquaculture. FAO Fisheries Technical Paper, vol. 500.FAO, Rome. 134.

FERMIN, A.C. 1991. Freshwater cladoceran *moina macrocopa* (strauss) as an alternative live food for rearing sea bass *Lates calcarifer* (Bloch) fry. *J. Appl. Ichthyol*. **7**: 8-14.

FAO. 2013. Food and Agriculture Organization. The state of food insecurity in the world. The multiple dimensions of food security. Rome. 56.

FERNANDO, C.H. 1994. *Zooplankton*, fish and fisheries in the tropical freshwater. *Hydrobiologia,* **272***:* 105-123GOVINDAN,T.K. 1985. Fish prossing technology. Oxford and IBH publishing Co. New Delhi, Bombay and Calcutta. 47-48: pp-180-198.

GOODNIGHT, S.H.J.R. and HARRIS, W.S. 1982. Polyunsaturated fatty acids hyperlipidemia, thrombosis. *Arterioclerosis* **2**: 87.

GRUNDY, S.M., BILHEIMER, D.BLACKBURN, H. 1982. Rationale of the diet/ heart statement of the American heart association, circulation 65: 839A- 854A.

HOSSAIN, M.A. and SHIKHA, F.H. 1997. Apparent protein digestibility co efficient of some low protein ingredients for African cat fish, *Clarias gariepinus*. *Bangladesh. J. Zool.* **25**(1): 77-82.

HILE, K. J. 1936. Systematic sources of bias in a bioenergetics model: examples for age 0 striped bass. *Transac. American Fish. Soc*. **122**: 912-926.

HOPKINS, S. W. 1992. Consumption, growth and allometry: a comment on Boisclair and Leggett (1989). *Canadian J. Fish. Aquat. Sci*. **48:** 1334-1337.

HOLMAN, S., ET. AL. 1982. Fatty acids composition of fish oils. Academic press New York.

HUSS, H.H. 1988. Fresh fish quality changes. Food and Agriculture Organization of the United Nations Danish International Development Agency, Rome.

HUSSAIN. 2004. Replecement of fishmeal with maggot meal in the diet of Nile Tilapia, Oreochromis niloticus. *World Aquaculture*. **35**: 52-54.

H, G.E. 1967. Atreatise of limnology. Vol-2 International to the lake biology and the limnoplankton. John Wiley and Sons, New York. Pp 1115.

JOBLING, M. 1980. Effect of starvation on proximate chemical composition and energy utilization for plaice, pleuronectus platessa L. *J.Fish. Bio*. **17**: 39-41.

JAQUOT, R. 1961. Organic constituent of fish and other aquatic animals. In: *Fish as Food* (Ed. Borgstrom, G.), Academic Press, New York and London. pp. 145-209.

LOKMAN, H.S. 1994. Lipid and fatty acid composition of indigenous zooplankton from Terengganu Waters of the South China, *J. Aquacult. Trop.* **9**: 291.

LAKSMANN, M.A.V., MURTHY, D.F., PILLAY, K.K. and BANERJEE, S.C. 1967. On a new artificial feed for carp fry. *FAO Fish Rept*. **43**: 275-531.

LANNSO, R.P., HICKIE, B.E. and DIXON, D.G. 1989. Feeding and nutritional considerations in aquatic toxicology. *Hydrobiol*. **188**: 525-531.

KENNETH, M.M. 1990. Ecology and role of zooplankton in the fishery of lake Naivasha. *Hydrobiol*. **208**: 1-2.

KHADKA, B.R. and T.R. RAO. 1986. Prey size selection by common carp larvae in relation to age and prey density. *Aquaculture*. **54**(1): 89-96.

MUNILLA – MORA, R., STARK, J.R. and BARBOUR, A. 1990. The role of exogenous enzymes in digestion in cultured larvae (*Scophthalmus maximus*) *Aquaculture.* **88**: 337-350.

RAHMAN, M.A., BHADRA,A., BEGUM, N. and HUSSAIN, M.G. 1997. Effects of some selective supplemental feeds on the survival and growth of cat fish (Clarias batrachus Lin) fry. *Bangladesh J. Fish*. Res. **1**(2): 39-45.

MOHSIN, A.S. 1994. Nutrition today: March-April. Vol. 10.

MURRY, J. and BURT, J.R. 1992. The composition of fish. Ministry of Agriculture, Fisheries and Food, Torry Research Station.

MIMS, S.D., WEBSTER, C.D., TIDWELL, J.H. and YANCEY, D.H. 1991. Fatty acid Composition of *Daphnia pulex* cultured by two different methods. *J. Aquacult. Soc.* **22** (2*)*: 53-156.

NANDINA, S. AND S.S.S. SHARMA. 2003. Population growth of some genera of cladocerans (cladocera) in relation to algal food (*Chlorella vulgaris*) levels. *Hydroboil*. **491**: 211-219.

NETTLETON, A. 1985. Nutrients and substances in fresh sea food. In: Seafood nutrition facts. Issues and marketing of nutrition of fish and selfish. Van Nostrand Reinold, New York.pp. 25-64.

NILSON. 1946.The value of fish and selfish. *Food Research*. **30**: 177.

NURULLAH, M., KAMAL. M., WAHAB. M.A., ISLAM. M.N., AHASAN. C.T. and THILSTED. S.H. 2003. *Nutritional quality of some small indigenous fish species of Bangladesh*.pp. 151-158.

OLOJO, E.A.A., OLURIN, K.B. and Osikoya, O.J. (2003). Food and feeding habits of *Synodontis nigrita* from the Osun River, South West, Nigeria. *NAGA World fish Centre Quarterly* volume **26**(4) Oct.-Dec. 2003. pp. 21-24.

PILLAY, T.V.R. 1990. Aquaculture*: Principal and practices*. Fishing news book. Blackwell scientific publication, Ltd. Oxford, UK. Pp 575.

PAYNE, C.T. 1987. A generalized bioenergetic model of fish growth for microcomputers, version 2.0. Technical report WIS-SG-92-250. Madison, WI: University of Wisconsin,Sea Grant Institute.

ROTTMANN, R.W., GRAVES, S. J., WATSON, C. and YANONG, R. P.E. 2003. CULTURE Techniques of Moina. Circular 1054, Department of Fisheries and Aquatic Sciences, Florida Cooperative Extension Service. Institute of Food and Agricultural Sciences, University of Florida. 1-9pp.

RAHMAN, M.M., CHOI, J., LEE, S. 2013. Use of distillers dried grain as partial replacement of wheat flour and corn gluten meal in the diet of juvenile Black Seabream (Acanthopagrus schlegeli) *Turkish J. Fish. Aquat. Sci.* **13**: 699 – 706.

RASMUSEEN, R.S. 2001. Quality of farm salmonids with emphasis on proximate composition, yield and sensory characteristics. *Aquaculture Research* **32**: 767-786.

RAHMAN. 1982. Limnological studies for four ponds . *Bangladesh J. Fish*. Res. **1**(2): 55-58.

RUBBI, S.F., RAHMA, M.M. and JAHAN, S.S. 1987. Studies on the proximate composition and quality of some commercial species in fresh water fish.

SANTIAGO, C. B., LARON, M. 2002. Growth and fry production of Nile tilapia Oreochromis niloticus (L) on different feeding schedules. *Aquaculture Research*. **33**: 129 – 136.

SIPAUBA-TAVARES, L. H. and BACHION, M. A. (2002). Population growth and development of two species of Cladocera, *Moina micrura* and *Diaphanosoma birgei*, in laboratory *Braz. J.Bio.,* **62**(4): 20pp.

SOSA, I.D.L.A.B., ADILLO. M.D.L.J, IBANEZ, A.L. and FIGUEROA, J.L.I.A. 2005. Variability of tilapia (Oreochromis spp) introduced in mexico: Morphometric, meristic and genetic characters. *J. Appl. Ichthol*. **20**: 7-10.

SRIVASTAVA, C.V.L. 1985. *A textbook of Fishery and Indian Fisheries*, Kitab Mohal, Allahbad, India. pp. 47-86.

SPENELLI, J. 1979. Preparation of Salmonid diets containing zooplankton and their effect or organoleptic properties of pen-reared salmonids. *In:* J.E. Halver and K. Tiews (Eds) *Proceedings of the World Symposium on finfish Nutrition and fishfeed Technology,* Hamburg 20-23 June 1978, Berlin **2**: 383-392.

TACON, A.G.J. 1990. *Standard methods for the nutrition and feeding of farmed fish and shrimp,* Washington DC, Argent Laboratories Press, 454 pp.

TITUS, B.G., KULMACZ, R.J. AND LANDS, W.E.M. 1982. Selective destruction and removal of heme from posttaglandin H. Syntase. *Arch. biochem. Biophys. Demic*. **214**: 824.

WATANABE, T. and KIRON, V. 1994. Prospects in larval fish dietetics. *Aquaculture* **124**:223-251.

YURKOWSKI, M. and TABACHEK, J.L. 1979. Proximate and amino acid composition of some natural fish foods. In J.E. Halver and K. Tiews (Eds). *Proceeding of World Symposium on Finfish Nutrition and Fish Feed Technology.* **2**: 435-448.

Appendices

Condition factor, K

Mean

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T3	5	1.659760
T1	5	1.822060
T2	5	1.925800
Sig.		.352

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Zero day

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T1	10	1.7842672
T3	10	1.9581020
T2	10	2.1451206
Sig.		.245

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Fourteen days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T1	10	1.7303793
T2	10	1.7792772
T3	10	1.7977315
Sig.		.652

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Twenty eight days

Tukey HSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T2	10	1.7271465	
T3	10	1.8522663	1.8522663
T1	10		2.0699283
Sig.		.637	.268

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Forty two days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T3	10	1.5857589
T1	10	2.0349612
T2	10	2.1220283
Sig.		.106

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Fifty six days

Tukey HSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T1	10	1.4910	
T3	10	1.7332	1.7332
T2	10		1.8557
Sig.		.161	.611

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Condition factor, K

ANOVA

		Sum of Squares	DF	Mean Square	F	Sig.
Zero day	Between Groups	.651	2	.326	1.352	.276
	Within Groups	6.506	27	.241		
	Total	7.157	29			
Fourteen days	Between Groups	.024	2	.012	.421	.660
	Within Groups	.776	27	.029		
	Total	.800	29			
Twenty eight days	Between Groups	.602	2	.301	3.201	.057
	Within Groups	2.538	27	.094		
	Total	3.140	29			
Forty two days	Between Groups	1.656	2	.828	2.574	.095
	Within Groups	8.686	27	.322		
	Total	10.343	29			
Fifty six days	Between Groups	.689	2	.344	4.191	.026
	Within Groups	2.219	27	.082		
	Total	2.907	29			

Condition factor, K

Case Summaries[a]

				Zero day	Fourteen days	Twenty eight days	Forty two days	Fifty six days
		1		1.82899	1.75323	3.11926	1.74953	1.60
		2		1.86771	1.54703	2.06120	1.31171	2.12
		3		1.84509	1.54733	1.68800	1.55041	1.71
		4		1.91327	2.29338	2.05213	3.15922	1.12
		5		1.59908	1.60992	1.91091	1.25171	1.28
		6		1.39407	1.64669	1.99982	2.88787	1.19
	T1	7		1.40741	1.91524	2.51494	2.21993	1.39
		8		1.87976	1.53785	1.82216	2.21875	1.72
		9		1.52416	1.75000	1.78601	1.92188	1.24
		10		2.58313	1.70313	1.74486	2.07861	1.53
Treatment			Mean	1.7842672	1.7303793	2.0699283	2.0349612	1.4910
		Total	Std. Error of Mean	.10918049	.07291551	.13837469	.19796007	.09711
			N	10	10	10	10	10
		1		2.31481	1.76089	1.55672	1.78745	1.45
		2		2.72352	1.71875	1.43832	2.01316	1.63
		3		2.53183	1.85720	1.74486	1.82870	1.77
		4		2.25394	1.79654	1.78437	1.45430	2.20
	T2	5		1.40800	1.60373	1.77263	1.81680	2.38
		6		3.04101	1.66894	1.86147	2.36800	2.28
		7		2.38350	2.07905	1.85720	1.72707	1.82
		8		1.13885	1.81628	1.69796	3.46774	2.06

		9		1.77818	1.79654	1.84375	1.49246	1.58
		10		1.87756	1.69485	1.71418	3.26461	1.39
			Mean	2.1451206	1.7792772	1.7271465	2.1220283	1.8557
		Total	Std. Error of Mean	.18697386	.04109840	.04316594	.22306298	.11204
			N	10	10	10	10	10
		1		1.45748	1.78400	1.64574	.95763	1.40
		2		1.67847	1.87654	1.66841	1.56465	1.67
		3		2.29630	1.97451	1.64008	1.74889	1.70
		4		2.25512	1.85954	1.82785	1.63450	1.95
		5		1.68109	1.91091	1.82899	1.85534	1.86
		6		2.13211	1.84362	1.56019	1.57783	1.63
	T3	7		2.99315	1.83967	2.49108	1.35819	1.64
		8		1.37625	1.66434	1.96290	1.58333	1.75
		9		1.52588	1.59242	1.93741	1.94760	1.85
		10		2.18519	1.63176	1.96000	1.62963	1.89
			Mean	1.9581020	1.7977315	1.8522663	1.5857589	1.7332
		Total	Std. Error of Mean	.15939784	.04022672	.08479465	.08700970	.05164
			N	10	10	10	10	10
		Mean		1.9624966	1.7691293	1.8831137	1.9142495	1.6933
	Total	Std. Error of Mean		.09070110	.03033114	.06007523	.10903406	.05781
		N		30	30	30	30	30

a. Limited to first 100 cases.

Average Daily Gain

Mean

TukeyHSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T1	4	.038892	
T2	4	.060350	.060350
T3	4		.092600
Sig.		.357	.128

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Fourteen days

Tukey HSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T2	10	.0527143	
T1	10	.0560714	
T3	10		.0875000
Sig.		.843	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Twenty eight days

Tukey HSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T2	10	.0341429	
T1	10	.0342857	
T3	10		.0800714
Sig.		1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Forty two days

Tukey HSD

Treatment	N	Subset for alpha = 0.05

		1
T1	10	.0407857
T3	10	.0727143
T2	10	.0782857
Sig.		.181

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Fifty six days

Tukey HSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T1	10	.0432857	
T2	10	.0764286	.0764286
T3	10		.1302857
Sig.		.404	.104

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Average Daily Gain

ANOVA

		Sum of Squares	DF	Mean Square	F	Sig.
Fourteen days	Between Groups	.007	2	.004	20.392	.000
	Within Groups	.005	27	.000		
	Total	.012	29			
Twenty eight days	Between Groups	.014	2	.007	15.793	.000
	Within Groups	.012	27	.000		
	Total	.026	29			
Fort _two days	Between Groups	.008	2	.004	1.934	.164
	Within Groups	.057	27	.002		
	Total	.065	29			
Fifty six days	Between Groups	.039	2	.019	5.995	.007
	Within Groups	.087	27	.003		
	Total	.125	29			

Average Daily Gain

Case Summaries[a]

				Fourteen days	Twenty eight days	Forty two days	Fifty six days
	T1	1		.04857	.03857	.11857	.04071
		2		.05857	.06500	.04286	.09929
		3		.06857	.05000	.00500	.15000
		4		.04643	.05714	.10071	-.10071
		5		.06357	.04143	.01429	.01786
		6		.06286	.02643	.06214	.02214
		7		.06714	.00429	.02714	.00643
		8		.05357	.00286	.00500	.05214
		9		.05857	.02143	.01000	.03000
		10		.03286	.03571	.02214	.11500
Treatment			Mean	.0560714	.0342857	.0407857	.0432857
		Total	Std. Error of Mean	.00347692	.00658194	.01284411	.02188773
			N	10	10	10	10
	T2	1		.08429	.07786	.11929	.13357
		2		.05786	.02143	.12643	.15571
		3		.06643	.02214	.16857	.03357
		4		.04786	.04357	.05500	.11286
		5		.04714	.04500	.06429	.09571
		6		.04429	.03500	.10571	.03071
		7		.04857	.02214	.04500	.05857
		8		.04786	.03071	.07429	.05714

	9		.04000	.01929	.01286	.04357
	10		.04286	.02429	.01143	.04286
		Mean	.0527143	.0341429	.0782857	.0764286
	Total	Std. Error of Mean	.00426423	.00567426	.01616426	.01417137
		N	10	10	10	10
	1		.11071	.08214	.04714	.22214
	2		.08286	.08714	.15786	.11500
	3		.10214	.08214	.14714	.09786
	4		.09000	.10000	.03571	.19143
	5		.10357	.07286	.05286	.16000
	6		.08286	.12071	.04786	.09357
T3	7		.08429	.02571	.02714	.17857
	8		.08643	.08143	.04714	.09857
	9		.07500	.07286	.08786	.07500
	10		.05714	.07571	.07643	.07071
		Mean	.0875000	.0800714	.0727143	.1302857
	Total	Std. Error of Mean	.00488792	.00759180	.01445213	.01687697
		N	10	10	10	10
	Mean		.0654286	.0495000	.0639286	.0833333
Total	Std. Error of Mean		.00375061	.00546706	.00866687	.01200508
	N		30	30	30	30

a. Limited to first 100 cases.

Feed Conversion Ratio

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T3	4	1.426225
T2	4	1.518300
T1	4	3.078350
Sig.		.583

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Fourteen days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T2	10	.6358640
T3	10	.6559188
T1	10	.8197311
Sig.		.307

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Twenty eight days

Tukey HSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T3	10	.1503311	
T2	10	1.1580142	1.1580142
T1	10		8.1532514
Sig.		.945	.087

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Forty two days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T2	10	2.0466827
T3	10	3.1816510
T1	10	6.7440163
Sig.		.092

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Fifty six days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T3	10	1.7589762
T2	10	2.2328365
T1	10	3.2710038
Sig.		.428

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Feed Conversion Ratio

ANOVA

		Sum of Squares	DF	Mean Square	F	Sig.
Fourteen days	Between Groups	.203	2	.102	1.353	.275
	Within Groups	2.031	27	.075		
	Total	2.234	29			
Twenty eight days	Between Groups	379.985	2	189.993	3.813	.035
	Within Groups	1345.358	27	49.828		
	Total	1725.343	29			
Forty two days	Between Groups	120.145	2	60.073	2.602	.093
	Within Groups	623.374	27	23.088		
	Total	743.519	29			
Fifty six days	Between Groups	11.962	2	5.981	.833	.446
	Within Groups	193.869	27	7.180		
	Total	205.831	29			

Feed Conversion Ratio

Case Summaries[a]

				Fourteen days	Twenty eight days	Forty two days	Fifty six days
		1		.74118	2.15704	.79952	3.97895
		2		.70000	1.51385	2.99600	1.37986
		3		.65625	2.25600	25.32000	.72667
		4		.90462	1.49800	1.11404	-1.62837
		5		.61348	2.47172	6.55200	4.92800
		6		.54091	3.69297	1.53517	5.55484
	T1	7		.56596	24.64000	3.05053	13.68889
		8		1.04533	36.68000	16.20000	1.36164
		9		.51220	4.18133	6.54000	2.05000
		10		1.91739	2.44160	3.33290	.66957
Treatment			Mean	.8197311	8.1532514	6.7440163	3.2710038
		Total	Std. Error of Mean	.13289308	3.86618881	2.51230792	1.34558118
			N	10	10	10	10
		1		.37966	1.18132	1.30275	1.59465
		2		.55309	1.14225	.66441	1.01789
		3		.48172	1.13972	.56593	5.88298
		4		.66866	1.17632	1.65818	1.01456
	T2	5		.67879	1.18036	1.40933	1.25896
		6		.72258	1.16105	.84000	4.81860
		7		.65882	1.14616	1.70667	1.63049
		8		.66866	1.15868	1.09038	2.09125

	9		.80000	1.14425	5.50667	1.56066
	10		.74667	1.15003	5.72250	1.45833
		Mean	.6358640	1.1580142	2.0466827	2.2328365
	Total	Std. Error of Mean	.04048461	.00512511	.60720861	.53500064
		N	10	10	10	10
	1		.61419	.15513	4.30182	.90932
	2		.66379	.11213	1.11367	2.23478
	3		.60699	.14261	1.30485	2.68759
	4		.61111	.10343	5.39280	.96903
	5		.39586	.14588	3.26919	1.13125
	6		.62759	.07953	4.22507	2.15878
T3	7		.86610	.42444	5.01789	.74200
	8		.47438	.11368	3.51273	1.73478
	9		.66667	.12157	1.75512	2.53333
	10		1.03250	.10491	1.92336	2.48889
		Mean	.6559188	.1503311	3.1816510	1.7589762
	Total	Std. Error of Mean	.05712547	.03129549	.49597215	.23934517
		N	10	10	10	10
	Mean		.7038380	3.1538655	3.9907833	2.4209388
Total	Std. Error of Mean		.05067521	1.40824458	.92445666	.48640237
	N		30	30	30	30

a. Limited to first 100 cases.

Specific Growth Rate

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T1	4	3.323250
T3	4	3.615000
T2	4	3.900275
Sig.		.952

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.000.

Fourteen days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T1	10	7.6167472
T3	10	8.3700754
T2	10	8.8428567
Sig.		.164

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Twenty eight days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T1	10	2.3295622
T2	10	2.6367882
T3	10	3.4884910
Sig.		.060

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Forty two days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T1	10	1.9687751
T3	10	2.0820245
T2	10	3.6040900
Sig.		.063

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Fifty six days

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T1	10	1.7219067
T2	10	2.5076457
T3	10	2.7687764
Sig.		.383

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 10.000.

Specific Growth Rate

		Sum of Squares	DF	Mean Square	F	Sig.
Fourteen days	Between Groups	7.648	2	3.824	1.797	.185
	Within Groups	57.445	27	2.128		
	Total	65.093	29			
Twenty eight days	Between Groups	7.210	2	3.605	3.077	.063
	Within Groups	31.636	27	1.172		
	Total	38.846	29			
Forty two days	Between Groups	16.679	2	8.340	3.499	.045
	Within Groups	64.347	27	2.383		
	Total	81.026	29			
Fifty six days	Between Groups	5.938	2	2.969	.981	.388
	Within Groups	81.718	27	3.027		
	Total	87.656	29			

Specific Growth Rate

Case Summaries[a]

				Fourteen days	Twenty eight days	Forty two days	Fifty six days
		1		7.57766	2.98717	5.12963	1.15754
		2		7.84723	3.95565	1.76537	2.93085
		3		8.15784	2.87927	.23312	4.81877
		4		6.67971	3.98771	4.01361	-4.01361
		5		8.48906	2.66940	.86163	.94872
		6		9.12615	1.89202	3.11734	.84776
	T1	7		8.89440	.31751	1.73736	.35623
		8		6.07033	.21484	.36109	2.96294
		9		9.40930	1.69520	.86312	2.09829
		10		3.91581	2.69683	1.60549	5.11157
			Mean	7.6167472	2.3295622	1.9687751	1.7219067
		Total	Std. Error of Mean	.52913644	.41490165	.51385105	.82101183
			N	10	10	10	10
		1		11.03500	3.90138	3.55437	2.59947
		2		9.52275	1.72259	5.83757	3.73832
Treatment		3		9.26202	1.54910	6.49987	.80303
		4		9.52004	3.66444	2.92744	3.74788
		5		9.90210	3.85674	3.33941	3.15806
		6		7.03001	2.87209	4.95105	.96886
	T2	7		8.62439	1.98085	2.85888	2.55142
		8		9.30652	2.73919	4.07992	2.06234
		9		6.82508	1.85589	1.01407	2.64678
		10		7.40066	2.22563	.97833	2.80030
			Mean	8.8428567	2.6367882	3.6040900	2.5076457
		Total	Std. Error of Mean	.43107698	.28746601	.57834254	.31733266
			N	10	10	10	10
		1		8.48331	2.97053	1.27406	4.07763
		2		8.10236	3.84649	4.01465	1.94635
	T3	3		8.54197	3.18079	3.54986	1.65338
		4		8.50831	4.09246	1.03401	3.88359
		5		10.80125	3.12296	1.63346	3.44054

		6		8.37657	4.97228	1.29523	2.00608
		7		6.87010	1.23340	1.10557	4.74598
		8		9.81446	3.80575	1.53150	2.42125
		9		8.08144	3.61179	2.79354	1.74270
		10		6.12097	4.04846	2.58838	1.77026
			Mean	8.3700754	3.4884910	2.0820245	2.7687764
		Total	Std. Error of Mean	.41528735	.31101946	.34124215	.36498582
			N	10	10	10	10
		Mean		8.2765598	2.8182805	2.5516299	2.3327762
	Total	Std. Error of Mean		.27353112	.21130644	.30517837	.31741798
		N		30	30	30	30

a. Limited to first 100 cases.

Proximate composition

Moisture content

Tukey HSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T3	2	78.6200	
T2	2		81.4800
T1	2		82.7600
Sig.		1.000	.177

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 2.000.

Protein content

Tukey HSD

Treatment	N	Subset for alpha = 0.05	
		1	2
T1	2	10.9600	
T2	2	11.8850	
T3	2		15.9100
Sig.		.322	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 2.000.

Fat content

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T3	2	3.4650
T1	2	3.8950
T2	2	4.1200
Sig.		.567

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 2.000.

Ash content

Tukey HSD

Treatment	N	Subset for alpha = 0.05
		1
T3	2	2.0050
T1	2	2.2400
T2	2	2.2450
Sig.		.638

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 2.000.

Proximate Analysis

ANOVA

		Sum of Squares	DF	Mean Square	F	Sig.
Moisture	Between Groups	17.972	2	8.986	32.636	.009
	Within Groups	.826	3	.275		
	Total	18.798	5			
Protein	Between Groups	27.706	2	13.853	50.008	.005
	Within Groups	.831	3	.277		
	Total	28.537	5			
Fat	Between Groups	.443	2	.222	.647	.584
	Within Groups	1.027	3	.342		
	Total	1.470	5			
Ash	Between Groups	.075	2	.038	.621	.595
	Within Groups	.182	3	.061		
	Total	.257	5			

Physiological parameters of Fish culture water

Case Summaries[a]

				Temperature	DO	pH	Conductivity	TDS	Light intensity
Treatment	T1	1		29.30	5.82	7.86	6.81	4.35	.79
		2		26.50	5.65	8.35	7.25	4.60	.30
		3		25.30	5.50	8.45	7.10	4.29	.30
		4		24.40	4.50	8.25	7.15	4.40	.40
		5		24.10	6.20	7.90	6.90	4.15	.20
			Mean	25.9200	5.5340	8.1620	7.0420	4.3580	.3980
		Total	Std. Error of Mean	.94255	.28365	.11956	.08133	.07358	.10298
			N	5	5	5	5	5	5
	T2	1		29.00	5.75	7.48	6.75	4.45	.79
		2		26.60	5.40	8.40	7.30	4.50	.30
		3		25.20	4.60	8.20	7.15	4.10	.30
		4		24.10	6.20	7.90	6.80	4.60	.40
		5		24.20	5.90	8.30	7.00	4.45	.20
			Mean	25.8200	5.5700	8.0560	7.0000	4.4200	.3980
		Total	Std. Error of Mean	.91345	.27459	.16654	.10368	.08456	.10298
			N	5	5	5	5	5	5
	T3	1		28.70	5.85	7.90	6.98	4.46	.80
		2		26.30	5.90	7.60	7.25	4.55	.40
		3		25.10	5.10	8.25	7.10	4.35	.40
		4		244.00	5.70	8.10	6.80	4.40	.30

		5		24.20	6.10	7.30	7.20	4.50	.20
			Mean	69.6600	5.7300	7.8300	7.0660	4.4520	.4200
		Total	Std. Error of Mean	43.59154	.17000	.17146	.08097	.03541	.10198
			N	5	5	5	5	5	5
		Mean		40.4667	5.6113	8.0160	7.0360	4.4100	.4053
	Total	Std. Error of Mean		14.54563	.13459	.09040	.04828	.03775	.05494
		N		15	15	15	15	15	15

a. Limited to first 100 cases.

DO = Dissolved Oxygen

TDS = Total Dissolved Substance

pH = Power of Hydrogen

Physiological parameters of *Moina macrocopa* culture water

Case Summaries[a]

				Temperature	DO	pH	TDS	Conductivity	Light intensity
Treatment	Cabbage leafs	1		29.20	4.82	7.94	4.33	6.78	.90
		2		26.60	4.85	7.85	4.55	7.09	.40
		3		25.40	5.86	7.83	5.25	7.03	.40
		4		31.30	6.36	7.75	6.00	7.10	11.00
		5		28.50	6.00	8.15	4.60	6.95	.70
			Mean	28.2000	5.5780	7.9040	4.9460	6.9900	2.6800
		Total	Std. Error of Mean	1.02713	.31414	.06853	.30490	.05891	2.08216
			N	5	5	5	5	5	5
	Hand made feed	1		28.70	5.15	7.59	6.19	7.10	.76
		2		26.40	6.08	7.68	5.85	6.85	.39
		3		25.30	6.10	8.17	6.10	6.80	.40
		4		32.00	4.56	8.90	5.80	6.70	13.00
		5		28.60	5.09	9.10	6.19	7.10	.76
		Total	Mean	28.2000	5.3960	8.2880	6.0260	6.9100	3.0620

		Std. Error of Mean	1.15109	.30137	.30860	.08406	.08124	2.48584
		N	5	5	5	5	5	5
	1		28.70	6.40	8.50	5.80	7.00	.73
	2		26.30	5.85	7.60	6.50	6.72	.40
	3		25.40	5.67	8.50	6.70	6.74	.35
	4		32.40	6.09	9.10	5.60	7.00	10.00
Yeast	5		27.60	6.29	7.60	6.10	6.90	.56
		Mean	28.0800	6.0600	8.2600	6.1400	6.8720	2.4080
	Total	Std. Error of Mean	1.21713	.13520	.29086	.20640	.06086	1.89917
		N	5	5	5	5	5	5
	1		28.50	5.75	8.15	5.85	6.93	.74
	2		26.20	6.17	7.85	5.96	7.05	.45
	3		25.50	5.95	7.80	6.14	7.12	.36
	4		29.50	6.25	8.10	6.35	6.95	10.00
Spiruluna	5		27.70	5.62	7.80	6.19	6.74	.57
		Mean	27.4800	5.9480	7.9400	6.0980	6.9580	2.4240
	Total	Std. Error of Mean	.73239	.11985	.07649	.08783	.06445	1.89507
		N	5	5	5	5	5	5
	Mean		27.9900	5.7455	8.0980	5.8025	6.9325	2.6435
Total	Std. Error of Mean		.48596	.12454	.10800	.14447	.03241	.96744
	N		20	20	20	20	20	20

a. Limited to first 100 cases.

DO = Dissolved Oxygen
pH = Power of Hydrogen
TDS = Total Dissolved Substance

Water quality parameters for *M. macrocopa* culturing treatment water

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Temperature	Cabbage leafs	5	28.2000	2.29674	1.02713	25.3482	31.0518	25.40	31.30
	Hand made feed	5	28.2000	2.57391	1.15109	25.0041	31.3959	25.30	32.00
	Yeast	5	28.0800	2.72158	1.21713	24.7007	31.4593	25.40	32.40
	Spiruluna	5	27.4800	1.63768	.73239	25.4466	29.5134	25.50	29.50
	Total	20	27.9900	2.17326	.48596	26.9729	29.0071	25.30	32.40
DO	Cabbage leafs	5	5.5780	.70244	.31414	4.7058	6.4502	4.82	6.36
	Hand made feed	5	5.3960	.67389	.30137	4.5593	6.2327	4.56	6.10
	Yeast	5	6.0600	.30232	.13520	5.6846	6.4354	5.67	6.40
	Spiruluna	5	5.9480	.26799	.11985	5.6152	6.2808	5.62	6.25
	Total	20	5.7455	.55695	.12454	5.4848	6.0062	4.56	6.40
pH	Cabbage leafs	5	7.9040	.15323	.06853	7.7137	8.0943	7.75	8.15
	Hand made feed	5	8.2880	.69005	.30860	7.4312	9.1448	7.59	9.10
	Yeast	5	8.2600	.65038	.29086	7.4524	9.0676	7.60	9.10
	Spiruluna	5	7.9400	.17103	.07649	7.7276	8.1524	7.80	8.15
	Total	20	8.0980	.48299	.10800	7.8720	8.3240	7.59	9.10
TDS	Cabbage leafs	5	4.9460	.68178	.30490	4.0995	5.7925	4.33	6.00
	Hand made feed	5	6.0260	.18796	.08406	5.7926	6.2594	5.80	6.19
	Yeast	5	6.1400	.46152	.20640	5.5669	6.7131	5.60	6.70
	Spiruluna	5	6.0980	.19639	.08783	5.8541	6.3419	5.85	6.35
	Total	20	5.8025	.64607	.14447	5.5001	6.1049	4.33	6.70
Conductivity	Cabbage leafs	5	6.9900	.13172	.05891	6.8264	7.1536	6.78	7.10
	Hand made feed	5	6.9100	.18166	.08124	6.6844	7.1356	6.70	7.10

	Yeast	5	6.8720	.13609	.06086	6.7030	7.0410	6.72	7.00
	Spirulina	5	6.9580	.14412	.06445	6.7791	7.1369	6.74	7.12
	Total	20	6.9325	.14495	.03241	6.8647	7.0003	6.70	7.12
	Cabbage leafs	5	2.6800	4.65586	2.08216	-3.1010	8.4610	.40	11.00
	Hand made feed	5	3.0620	5.55851	2.48584	-3.8398	9.9638	.39	13.00
Light intensity	Yeast	5	2.4080	4.24667	1.89917	-2.8649	7.6809	.35	10.00
	Spirulina	5	2.4240	4.23750	1.89507	-2.8376	7.6856	.36	10.00
	Total	20	2.6435	4.32653	.96744	.6186	4.6684	.35	13.00

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Temperature	T1	5	25.9200	2.10761	.94255	23.3031	28.5369	24.10	29.30
	T2	5	25.8200	2.04255	.91345	23.2838	28.3562	24.10	29.00
	T3	5	25.7600	1.82975	.81829	23.4881	28.0319	24.20	28.70
	Total	15	25.8333	1.84997	.47766	24.8089	26.8578	24.10	29.30
DO	T1	5	5.5340	.63426	.28365	4.7465	6.3215	4.50	6.20
	T2	5	5.5700	.61400	.27459	4.8076	6.3324	4.60	6.20
	T3	5	5.7300	.38013	.17000	5.2580	6.2020	5.10	6.10
	Total	15	5.6113	.52126	.13459	5.3227	5.9000	4.50	6.20
Ph	T1	5	8.1620	.26734	.11956	7.8301	8.4939	7.86	8.45
	T2	5	8.0560	.37240	.16654	7.5936	8.5184	7.48	8.40
	T3	5	7.8300	.38341	.17146	7.3539	8.3061	7.30	8.25

TDS	Total	15	8.0160	.35012	.09040	7.8221	8.2099	7.30	8.45
	T1	5	4.3580	.16453	.07358	4.1537	4.5623	4.15	4.60
	T2	5	4.4200	.18908	.08456	4.1852	4.6548	4.10	4.60
	T3	5	4.4520	.07918	.03541	4.3537	4.5503	4.35	4.55
	Total	15	4.4100	.14619	.03775	4.3290	4.4910	4.10	4.60
Conductivity	T1	5	7.0420	.18185	.08133	6.8162	7.2678	6.81	7.25
	T2	5	7.0000	.23184	.10368	6.7121	7.2879	6.75	7.30
	T3	5	7.0660	.18105	.08097	6.8412	7.2908	6.80	7.25
	Total	15	7.0360	.18700	.04828	6.9324	7.1396	6.75	7.30
Light intensity	T1	5	.3980	.23026	.10298	.1121	.6839	.20	.79
	T2	5	.3980	.23026	.10298	.1121	.6839	.20	.79
	T3	5	.4200	.22804	.10198	.1369	.7031	.20	.80
	Total	15	.4053	.21277	.05494	.2875	.5232	.20	.80