A STUDY OF GROWTH PERFORMANCE OF AFRICAN CATFISH, *Clarias gariepinus* IN HAPA SYSTEM

SITI AYUSAH BINTI MOHD ZAIB

A report submitted in fulfilment of the requirements for the degree of

Bachelor of Applied Science (Animal Husbandry Science) with Honours

Faculty of Agro Based Industry

UNIVERSITI MALAYSIA KELANTAN

2019

DECLARATION

I hereby declare that the work embodied in this report is the result of the original research and has not been submitted for a higher degree to any universities or institutions.

____

Student

Name : Siti Ayusah Binti Mohd Zaib

Date :

I certify that report of this final year project entitled "A Study of Growth Performance of African catfish, *Clarias gariepinus* in hapa system" by Siti Ayusah Binti Mohd Zaib, matric number F15A0208 has been examined and all the correction recommended by examiners have been done for the degree of Barchelor of Applied Science (Animal Husbandry Science), Faculty of Agro-Based Industry, University Malaysia Kelantan.

Approved by:

____

Supervisor

Name : Dr Lee Seong Wei

Date :

ACKNOWLEDGEMENT

Alhamdullilah. Thank to Allah SWT, with His willingness give me the great oppurtunity to complete this Final Year Project which entitle A Study of Growth Performance of African catfish, *Clarias gariepinus* in hapa system. This final year project was prepared for the Faculty Of Agro-Based Industry, University Malaysia Kelantan in fullfilment of the requirement of the degree of Barchelor of Applied Science (Animal Husbandry Science).

I would like to express sincerely my gratitude towards my supervisor Dr. Lee Seong Wei lecturer of Faculty of Agro-Based Industry for his kind support, academic advise Madam Halimatun Sa'adiah, as well as her understanding, expertise and help in completing this research throughout this semester session 2018/2019. I am very grateful to my fellow friends whose friendship and support have helped me for their assistances and constructive opinions in preparing this thesis when I facing difficulties.

A bunch of thanks to the lecturer and laboratory assistance of the Faculty of Agro-Based Industry for the cooperation and giving the information for my thesis. Next, I would like to express appreciation and thanks from bottom of my heart to my lovely family for their constant support, help, encouragement, patience and care of me during my program.

Last but not least, my sincere appreciation also extends to everyone that helping me in this project. This thesis would not have been possible without them.

LIST OF TABLES

No		Pages
1	Result for Weight Gain (WG), Average Body Weight, Feed Given, Specific Growth Rate (SGR) and Feed Conversion Ratio (FCR) of African catfish	20
2	Average water parameter using hapa system of African catfish	23

LIST OF ABBREVIATIONS

DO	Dissolved oxygen
DOA	Development Authority of Malaysia
F_1	Final body weight of fish
F_2	Initial body weight of fish
FAO	Food Of Agriculture Organization
FCR	Feed conversion ratio
pH	Hydrogen ion concentration
SGR	Specific growth rate
USAID	United States Agency for International Development
WG	Weight gain

LIST OF SYMBOLS

am	Ante meridiam (morning)
℃	degree Celsius
cm	centimetre
g	gram
kg	kilogram
L	litre
m	meter
mg	milligram
pm	Post meridiem (evening)
SD	Standard deviation
t	time

LIST OF FIGURES

NO		PAGE
1	Hapa system	8

TABLE OF CONTENTS

	PAGE
DECLARATION	ii
ACKNOWLEDGEMENT	iii
LIST OF TABLES	iv
LIST OF ABBREVIATIONS	v
LIST OF SYMBOLS	vi
ABSTRACT	x
ABSTRAK	xi
CHAPTER 1	1
INTRODUCTION	1
1.0 Research Background	1
1.1 Problem Statement	3
1.2 Hypothesis	3
1.3 Objective	3
1.4 Significance of Study	3
LITERATURE REVIEW	4
2.1 Introduction of African Catfish	4
2.2 Feeding Behaviour of African Catfish	6
2.4 Factors Affecting The Growth Performance Of African Catfish	10
2.6 Specific Growth Rate (SGR) Of African Catfish	14
2.7 Survival Rate Of African Catfish	15

CHAPTER 3 METHODOLOGY 16

3.1 Materials 16

3.2 Experimental design 16

3.3 Data analysis 17

CHAPTER 4 19

RESULT AND DISCUSSION 19

4.1 Growth Performance of African catfish (*Clarias gariepinus*) using hapa system 19

CHAPTER 5 CONCLUSION AND RECOMMENDATION 25

5.1 Conclusion 25

5.2 Recommendation 25

REFERENCES 27

APPENDIX 31

A Study of Growth Performance of African catfish, *Clarias gariepinus* in hapa system

ABSTRACT

Hapa is a rectangular or square shape like cage placed in earthen pond is a type of a culture system that used for holding fish various reasons. It is rarely practice in fish farming compare to other culture system. Hapa system usually use for hatchery phase of the fish before transfer it into pond or other system for the grow out until achieve marketable size. Objective of present study is determined the viability of using hapa in African catfish farming. In the present study, African catfish (*Clarias gariepinus)* fingerling with initial body weight of 8.05 g ± 0.08 and the size was 5 cm were used to know the growth performance of African catfish where 2 000 fingerlings were stocked in the hapa system. The growth performance of the experimental fish was evaluated for eight weeks. The final body weight of catfish on week eight was 7.31 g ± 0.33. The best value of feed conversion ratio (FCR) was 2.64 ± 0.81 on week two which the least value compared to other weeks. For specific growth rate (SGR) the highest value was 0.26 ± 0.06 which on week two. The water quality including temperature and pH in hapa were within acceptable range except the dissolved oxygen. The finding of the present study was needed for further research by husbandry students to make it worth, thus it can be evidance for the farmers to use it in fish farming.

Keywords: Hapa system, *Clarius gariepinus*, Feed Conversion Ratio (FCR), Specific Growth Rate (SGR)

Kajian tentang Prestasi Pertumbuhan ikan Keli Afrika *Clarias gariepinus* dalam hapa sistem

ABSTRAK

Hapa adalah bentuk segi empat tepat atau segi empat sama seperti sangkar yang diletakkan di dalam kolam tanah di mana ia adalah sejenis sistem penternakan ikan yang digunakan untuk pelbagai sebab. Ia jarang dipraktikkan dalam penternakan ikan berbanding dengan sistem lain. Sistem hapa biasanya digunakan untuk fasa penetasan ikan sebelum memindahknya ke kolam atau sistem lain untuk tumbesaran sehingga mencapai saiz yang boleh dipasarkan. Objektif untuk kajian ini untuk menentukan daya maju menggunakan hapa dalam penternakan ikan keli Afrika. Dalam kajian ini, ikan keli Afrika (*Clarias gariepinus*) dengan berat badan awal 8.05 ± 0.08 dan saiznya 5 cm digunakan untuk mengetahui prestasi pertumbuhan ikan keli Afrika di mana 2 000 ikan keli dipelihara menggunakan sistem hapa. Prestasi pertumbuhan ikan eksperimen telah dijalankan selama lapan minggu. Berat badan akhir ikan keli pada minggu ke lapan adalah 7.31 ± 0.33. Nisbah penukaran makanan (NPN) terbaik adalah 2.64 ± 0.81 pada minggu kedua yang paling rendah berbanding minggu-minggu lain. Bagi pertumbuhan nilai tertentu (PNT) nilai tertinggi ialah 0.26 ± 0.06 dimana di minggu kedua. Kualiti air termasuk suhu dan pH di dalam hapa berada dalam nilai yang boleh diterima kecuali oksigen terlarut. Penemuan kajian ini diperlukan kajian lanjut oleh pelajar sains penternakan untuk menjadikannya bernilai, oleh itu ia boleh menjadi bukti untuk penternak ikan menggunakannya dalam penternakan ikan.

Kata kunci: Sistem hapa, *Clarius gariepinus*, Nisbah penukaran makanan (NPN), Pertumbuhan nilai tertentu (PNT)

CHAPTER 1

INTRODUCTION

1.0 Research Background

African catfish, *Clarias gariepinus* are being cultured in worldwide due to their beneficial characteristics which fast growth, attain a large size and high market demand. This species can stand the wide range of environmental condition which in seasonal drying (Rashid, 2009). They can withstand with this condition due to possess of the special accessory breathing organ comprising of modified gill arches (Okpako, 2010). Graaf and Janssen (1996) stated that even there are more than 100 species exist in African waters but only two catfish species which are *C. gariepinus* and *C. anguillaris* become most farmed in Africa.

The Fisheries Development Authority of Malaysia (DOA) state the retail price of catfish ranges in March 2018 are from RM 6.99/kg to RM 7.26/kg while for the wholesale price ranges from RM 5.12/kg to RM 5.04/kg.

Food Agriculture and Organization, FAO (2018) reported that, the top producing African catfish countries are South African, Nigeria, Netherland, Brazil, Hungary, Kenya, Syria, Arab Republic Cameroon and Mali while some Asian countries such as China, Indonesia, Malaysia and Thailand also produce significant amounts of African catfish, but statistics are unavailable by FAO. Through the traditional selective breeding such as selection, crossbreeding and hybridisation can offers the opportunity in improved the production and also the characteristics of current strains.

The increasing demand from growing human population, lead to the insufficient fish supply to the consumers. Therefore, other alternative is needed in production system for increase the African catfish aquaculture production. For example, the hapa system.

In Malaysia, many fish farmers usually used the earthen ponds because it is relatively simple management to take care of it. But they may lack of knowledge in aquaculture management which resulted in high mortality of the fish in earthen pond. Hence, hapa system can be useful because it has many advantages compared to other aquaculture systems which is important for the farmers especially in rural area and landless people.

This study was conducted to determine the growth performance of African catfish by using the hapa system which can be the evidence to the farmers in using this aquaculture system. They also can increase the production of fishes which proved it is an innovative system. Hapa system may be a new application in catfish farming but the exposure of many advantages will teach farmers on how to manage this system properly. The primary objective of the study was to determine the growth performance of catfish by using hapa system.

1.1 Problem Statement

In Malaysia, hapa system rarely applied in culture system. Nowadays, concrete tank culture system is widely used in fish farming system as it uses recirculating system which can remove the waste from culture system and also can maintain the water condition in concrete tank. In the present study, hapa system was used in order to know the growth performance through feed conversion ratio and specific growth rate of African catfish.

1.2 Hypothesis

H_o: Hapa system may not suitable for growth performance of African catfish.

H_a: Hapa system may suitable for growth performance of African catfish.

1.3 Objective

1. To determine the growth performance of African catfish using hapa system

1.4 Significance of Study

The study of this topic was important to gain more knowledge about the suitability of African catfish farming using hapa system. The importance of the study is to know whether hapa system are effective or not for the growth of the African catfish. This finding may be useful for the farmers in which they can be apply in their farm.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of African Catfish

There are several strains species features predominantly in African aquatic ecology where more than 100 species of African catfish in African have been identified. These are the *Clarias gariepinus, Clarias anguillaris*, *Clarias pachynema*, *Clarias macromystax, Clarias agbonyiensis, Clarias buthupogon*, *Clarias lazera*, *Clarias macracanthus* and *Clarias tsanensis* (Graaf et al. 1995 and Idodo-Umeh, 2003: Okpako, 2010). These are the taxonomic hierarchy of African catfish from Okpako (2010),

Kingdom : Animalia

Phylum : Chordata

Class : Actinopterygii

Order : Siluriformes

Family : Clariidae

Genus : *Clarias*

Species : *Clarias gariepinus*

The distinguish features of African catfish are elongated body with large head. The head is depressed and bony with small eyes. It is a scale less fish with smooth skin and soft ray fin and dorsal-ventrally flattened body.

There is some differences morphology of adult and young fish which on the head. In adults there is a dark longitudinal lines on either side of head though absent in young fish. Adult heads are granulated compared to young, the head is smooth.

According to the Okpako (2010), the gills of the African catfish are widely open and possessed four pair of barbels present, short dorsal and anal fins. It has dorsal fin and anal fin with 61-80 rays and 50-65 ray respectively. The body depth of this species is about 6-8 times in standard length. Its teeth are arranged in row which vomerine, granular and next is fine. This fish usually can found in freshwater bodies where in lakes, rivers, swamp and others (Rashid, 2009).

African catfish is a hardy fish which can tolerate adverse water conditions (Palm, Babmann & Branner, 2017). The remarkable growth rate of this fish coupled with its high survival rate, disease resistance and easy to culture has made this species one of the most promising food fish in this country, Malaysia (Farahiyah, Ahmad, Thayalini & Yong, 2016).

2.2 Feeding Behaviour of African Catfish

Fish has a complex feeding behaviour. Lall and Tibbets (2009) mentioned about factors of feeding response in fish which are modes of feeding and feeding habit, mechanism of feed detection, frequency of feeding and preferences of feed provided or found in pond. Fish are unique among vertebrates in their ability to absorb minerals not only their diets but also from water through their gills and skin (Lall & Tibbetts, 2009).

African catfish is scavenger species which they can eat small fish, plant, insects or other small organism if there is insufficient of feed (Musa, Aura, Ngugi and Kundu, 2012). For that reason, the cannibalism rate may increase in hapa. Some of fish behaviour is dormant type which it will stay at one spot at feed source and some of it is sub-dormant which will away from one spot or source of feed or aggressive areas and some are also sub-ordinate feeder in behaviour (Maynard, Desmond, Barry, Thomas & Conrad, 2001). This kind of fish can stay out of feeding spot. Normally catfish are bottom feeders, but their feeding habits are adaptable and they occasionally filter feed in groups at the water surface (FAO, 2018).

In feeding behaviour, numeurous combination factors of abiotic and biotic factors influence the behaviour of the fish. For instance, high level of dissolved oxygen in water can cause the feeding activities to be higher and vice versa (Mallya, 2007). Other than that, concentration of ammonia also can affect the dissolved oxygen where the low level of ammonia will cause the dissolved oxygen in water to be higher. The different response to fish feeding behaviour are due to three factors that have been identified which are environmental factors, fish physiologycal factors and feeds factors that affected the feeding behaviour of fish.

2.3 Hapa System

Fish farming system are varied which can be operated on land-based systems such as earthen ponds and raceways or water-based which are cages and pens. Fish cage known locally as 'hapa' where farmers grow their fish. It usually applied in river, ocean, lake, pond and estuary. Hapa system can be used for both marine and freshwater aquaculture. This farming system can categorised as intensive system which the diet of fish is provided through nutritionally complete pelleted feed with little or no productivity of water bodies where fish being culture (Lazard & Dabbadie, n.d).

Usually in freshwater aquaculture, they used for nursery or hatchery phase in hapa before transferred it in the pond for the grow-out. Hapa is cages in small size which made from fine mesh and have rectengular shape and ranges from several meter cubic depend on the stocking density of fish. The netting or fine-mesh netting depend on the size of the fish thus fish inside can not escape (Nagoli & Subramaniam, 2008). In pond, hapa is installed in shallow area where less than 1.6 m (Aocayayo, 2011) and the ideal size of hapa is 3 m long, 3 m wide and 1.5 m deep (Tower, 2015). The shallow area must be low water flow and level flactuation.

Figure 2: Hapa system

Clarias gariepinus is know as a bottom feeders, but their feeding habits are adaptable and occasionally filter feed in group in the water surface (FAO, 2018). Since hapa is have limited area size, the movement is also restricted which fish does not use the a lot of energy for swimming to search the feed instead instead fish will spend energy on growth and other activity (Blakely and Hrusa, 1989; Mokenye, 2004) therefore can enhance the productivity of African catfish production.

The most recommmend in making netting is using fine mesh because the mesh size does not allow for *C. gariepinus* to dig into sediments which can minimise the turbidity problem (Blakely and Hrusa, 1987; Mokenye, 2004). Stocking density referred to weight of fish per unit or per unit volume in unit time of water flow through the holding environment (Ashley, 2007; Gizaw, 2017). When using hapa system, the stocking density for the fish must be optimum which allow the fish live in normal behaviour, reduce stress, better growth performance and survival.

Different size of hapa consist of different stocking density of the fish. According to Abiodun (2016), the volume of the water must be known before the calculation for the stocking density. Then, assume the target size at harvest and also the rate of mortality where ranges in 5 to 10 percent. The fingerlings of African catfish will be stocked with 100 to 150 kg of fish per cubic meter (Janssen, 1987). Stocking density consists of 3 types which are maximum, minimum and optimum where 100 per meter cubic, 25 per meter cubic and 50 per meter cubic respectively. To know the stocking density, it can be calculate using following formula (Nagoli & Balasubramaniam, 2008),

$$\text{Stocking density} = \frac{\text{Total biomass (kg)}}{\text{Hapa area} \times \text{volume}}$$

Where the total biomass (kg) using following formula (Nagoli & Subramaniam, 2008),

$$\text{Total biomass} = \text{Number of fish} \times \text{average weight (kg)}$$

Nagoli and Subramaniam (2008) stated that the hapa must be shaken regularly to avoid clogging or replenish oxygen using either flushing or adding genorous amount of water to the hapa using buckets. Since the African catfish are cannibalism when they grow larger, sorting or graded out the fish according to the size is necessary where it can improve the survival rate and less competitive.

When using hapa system in fish production, volume of water or surface area per fish is related to the stoking density which an important factors (Nagoli & Subramaniam, 2008). In World Fish Centre, (2009) mentioned that the higher stocking density can cause stress to fish which leads to reduction in food utilization and growth rate.

2.4 Factors Affecting The Growth Performance Of African Catfish

Water quality must be considered since water plays the role key in fish habitat. Previous study by Ernest (n.d) mentioned the temperature and dissolved oxygen had a combined effect on the fish survival and growth rate. Therefore, it may affect the fish's health and feed efficiency. In monitoring the water quality, the common parameter in aquaculture industry are temperature, pH, turbidity, dissolved oxygen, salinity and ammonia (Cline, 2012).

In pond, water quality are always fluctuate depending on the photosynthesis of aquatic plants, weather conditions, fish waste in water and others (Steven, 2009). Since fish are cold blooded animal, therefore their rate of metabolism effect directly from the water. Oxygen demand, food requirement, growth and food conversion effeiciency are the factors which have direct effect from temperature. It also affects the solubility of the dissolved oxygen. For *C. gariepinus*, the temperature ranges are 25℃ to 31℃ (Adeniji & Ovie, 1982; Gizaw, 2017). When temperature is low, organic matter and other waste will breakdown at slower rate which cause high risk of eutrophication (Wagner & Erickson, 2017).

Next, the level of dissolved oxygen is important to the fish as it obtains the oxygen from the water. Other than fish, bacteria in pond needs oxygen for their metabolism which can help in tranforming wastes into less toxic products (Svobodova, Lloyd, Machova & Vykusova, 1993). Since *C. gariepinus* have special organs, they can get the oxygen by the gulping to the water surface when there is low concentration of dissolved oxygen in water. When dissolved oxygen is low than the ranges value, it can reduce the feed intake, higher feed conversion ration (FCR), slow growth and disease outbreak will occurs.

Fingerlings of African catfish will used more available dissolved oxygen when their metabolic activity and growth are increased (Nagoli & Balasubramaniam, 2008).

pH can be defined as the negative logarithm concentration of hydrogen ion . If the pH is rapidly changing or too extreme, it can cause mortality to the fishes (Ernest, n.d.). In terms of water quality, it can be toxic because it affect the solubility and chemical form of various compaund contain in water. Since *C. gariepinus* are freshwater fish, the optimal pH value are 6.5 to 8.0 (Gaunder, 2005; Njoku, Obialo & Ogochukwu, 2007). If the pH value are below an above 8.5 or 6.5, it will reduced the feed intake, result in slow growth and higher FCR of the fish.

Stocking density is not static parameter where it is the biomass of the fish stocked at initial density increases as the fish grows (Lee & Wee, 2010). As the fish grow larger, there will be cramp in the pond which overcrowding. From previous study by Orisasona, Oni & A, (2015), they mentioned about the stocking density and growth in fish are link where in obtaining the highest possible fish yield are depend on the amount and quality of food availability.

Clarias gariepinus can tolerate in harsh environmental condition and also can adapt to culture environment but when they are keep crowded in high stocking density, it will be susceptible to disease attack (Orisasona et al., 2015). Due to the overcrowded, there are competition for food and space available. From previous survey by Daudpota, Kalharo, Shah, Kalharo and Abbas (2014), stocking density had a significant effect on growth and survival rates.

2.5 Feed Conversion Ratio (FCR) Of African Catfish

In fish farming, it is important for the fish farmers to know the FCR of the fish because it can reflect on effectiveness on an animal to converts the feed given within their body and it determined by dividing the weight of feed given by live weight gain over time interval (Edwin & Menghe, 2015). The FCR will be obtained by using the following equation (Edwin & Menghe, 2015),

$$\text{Feed conversion ratio} = \frac{\text{weight of feed given (g)}}{\text{fish weight gain (g)}}$$

Feed conversion ratio defines as the feed requirement in kg per kg body weight gain (Wenk, Pfirter and Bickel, 1980). This is crucial indicator in fish farming because it can determine the the level performance of the fish.

Feed given refers to the input of the feed has been fed while animal weight gain is the weight gain of a population (Group Techna, n.d). There is no specific unit measurement of FCR. If the FCR is lower, the weight gain obtained from the feed is higher (Group Techna, n.d.). For that reason, the feed that are given to the fish influenced the value of FCR in the fishes. By using the FCR, it is easier to compare between the initial input of feed and final output of the fish that are produced.

According to the Group Techna (n.d.), there are some limitation in using FCR such as population of the fish, amount of feed distributed and actual consumption of feed. Before the feed is given to the fish, the exact population number must be known by the farmer. The amount of feed is needed to help in the FCR calculation. Next, the amount of feed distributed must be balance with the population of fish. If feed given is less than the population, it will cause cannibalism between African catfish since it is omnivorous type while overfeeding can affect the water quality. In the meantime, actual consumption also can be a challenge to calculate FCR. This is due the information can be hard to obtain since the farmers need to know the exact amount of feed that has been consumed from the initial feed distribution until it is time to harvest per each fish.

According to the FOA (2018), *Clarias gariepinus* has a relatively high dietry protien requirement which 40 to 50 percent of crude protien. Therefore the feed must contain high in protien but it quite expensive. FCR can gets smaller when the amount of protien in diet are increase where it takes less feed to produce a kilogram of fish (USAID, 2011). FCR of fish can be alter by water quality, environment, genetics, pond management and also the health of the fish itself (Teodorowicz, 2013). According to USAID (2011), fish can eat both natural feed and commercial feed which can grow better where the value of FCR is possible to get less than one.

2.6 Specific Growth Rate (SGR) Of African Catfish

The SGR can be obtained by using the following formula (Okpako, 2010),

$$\text{Specific growth rate (SGR)} = \frac{F1 - F2}{t}$$

Where:

F_1= final body weight of fish (g)

F_2= initial body weight of fish (g)

t = time (days) between F_1 and F_2

Feed availability and intake, genetics, age and size, environment and nutrition are the factors that influence the fish growth (Asuwaju, Onyeche, Ogbuebunu, Moradun & Robert, 2014). To address fish growth, specific growth rate is used when the FCR is known. SGR is a numerical representation of growth in fish which assume a specific relationship between size and time (Hopkin, 1992).

2.7 Survival Rate Of African Catfish

Using hapa system, knowing the survival rate of fish is necessary since there are limited space, food, dissolved oxyen and other factors which can affect the survival of the fish. From previous research by Daudpota et al. (2014) mentioned that, the over-stocking of fish can create the food shortage. Therefore, the rate of cannibalism will be increased which result in low survival rate. The survival rate can be obtained by using the following formula (Daudpota et al., 2014),

$$\text{Survival rate} = \frac{\text{Final number of fish}}{\text{Initial number of fish}} \text{ x } 100$$

Other than that, the survival of the fish also causes by the predator such as birds, snakes and other organism. Gizaw (2017) found that the cannibalism are mostly in early life stage of fish. For example, there are negative effects of increasing density result in the growth performance of African catfish larvae are decreased and the cannibalism rate is increased (Hecht & Appelbaum, 1988; Hossain et al., 1998; Gizaw, 2017;). Then in juveniles, positive effect are shown in increasing density, in which it result by the growth performance are increased and the cannibalism decreased (Hecht & Appelbaum, 1988; Kaiser, Weyl & Hecht, 1995; Hect & Uys, 1997; Almazan-Rueda, 2004; Gizaw, 2017).

CHAPTER 3

METHODOLOGY

3.1 Materials

This experiment was carried out using two ready made hapa measuring 4.57 m × 3.04 m × 1.83 m. Other materials used included YSI Pro Multi-Parameter, Australia, Xiangshan electronic scale from China, fishing net and basket.

3.2 Experimental design

The experiment was carried out from April 2018 to May 2018 at Agro Techno Park, Universiti of Malaysia Kelantan, Jeli Campus, Kelantan. The experiment was carried out using previous method using hapa system published by Mabroke, Tahoun, Soluma & El-Harun, (2013). Hapa size is 4.57 m × 3.04 m × 1.83 m was tied tightly to the bamboo stick in pond. The experimental fish was fed two times a day which on 8 am and 6 pm with commercial feed. There were two hapa replicates.

Fingerlings of African catfish, *C. gariepinus* were used in the study which purchased from the local farm in Kelantan. Two thousand fingerlings which the size was 5 cm with mean initial body weight was 8.96 g of *C. gariepinus* were randomly divided into two treatment groups with one thousand of fish per hapa which the size of hapa is 4.57 m × 3.04 m ×1.83 m.

Water quality was measured four times a week which on Sunday (8.30 am and 4.30 pm) and Wednesday (8.30 am and 4.30 pm). Water quality which were dissolved oxygen, pH and temperature using muti-parameter (YSI Pro Multi-Parameter, Australia) were measured.

3.3 Data analysis

For growth parameter, every once a week, fish sample in hapa were randomly sampled to get fish weight. This step were repeated three times to get the average weight of the fish sample and weighed using Xiangshan electronic scale, China. The feed conversion ration were calculated using formula as below (Edwin & Menghe, 2015),

$$\text{Feed conversion ratio} = \frac{\text{weight of feed given (g)}}{\text{fish weight gain (g)}}$$

The specific growth rate will be calculated as below (Okpako, 2010),

$$\text{Specific growth rate (SGR)} = \frac{\text{F1} - \text{F2}}{\text{t}}$$

Where:

F_1= final body weight of fish (g)

F_2= initial body weight of fish (g)

t = time (days) between F_1 and F_2

The survival rate can be obtained by using the following formula by Daudpota et al., (2014) as below:

$$\text{Survival rate} = \frac{\text{Final number of fish}}{\text{Initial number of fish}} \text{ x } 100$$

CHAPTER 4

RESULT AND DISCUSSION

4.1 Growth Performance of African catfish (*Clarias gariepinus*) using hapa system

Data on the growth performance of African catfish (*Clarias gariepinus*) which are Weight gain (WG), Average Body Weight, Feed Given, Specific Growth Rate (SGR) and Feed Conversion Ratio (FCR) after eight weeks of experiment, were shown in Table 4.1 while data for average of water quality in Table 4.2.

Table 4.1: Result for Weight Gain (WG), Average Body Weight, Feed Given, Specific Growth Rate (SGR) and Feed Conversion Ratio (FCR) of African catfish

WEEK	WEIGHT GAIN (MEAN ± SD)	AVERAGE BODY WEIGHT (g) (MEAN ± SD)	FEED GIVEN (g) (MEAN ± SD)	SPECIFIC GROWTH RATE (MEAN ± SD)	FEED CONVERSION RATIO (MEAN ± SD)
1	0.08 ± 0.10	8.02 ± 0.23	0.40 ± 0.1	-0.13 ± 0.01	-2.73 ± 3.28
2	0.85 ± 0.93	8.87 ± 1.16	0.44 ± 0.06	0.26 ± 0.06	2.64 ± 0.81
3	-0.4 ± 1.47	8.81 ± 0.28	0.44 ± 0.01	-0.04 ± 0.16	-1.76 ± 3.15
4	-0.68 ± 0.64	8.13 ± 0.36	0.41 ± 0.02	-0.41 ± 0.01	-9.46 ± 12.89
5	0.14 ± 0.79	8.28 ± 0.36	0.41 ± 0.02	0.01 ± 0.10	-4.5 ± 7.23
6	-0.78 ± 0.36	7.50 ± 0.06	0.32 ± 0.07	-0.06 ± 0.03	-3.71 ± 4.87
7	-0.12 ± 0.35	7.31 ± 0.22	0.40 ± 0.02	0.06 ± 0.05	14.38 ± 10.17
8	-0.11 ± 0.77	7.31 ± 0.33	0.39 ± 0. 01	-0.30 ± 0.45	36.54 ± 25.84

After eight weeks of experiment, Table 4.1 showed the growth performance of African catfish is fluctuated every week. Specific growth rate (SGR) mean value were -0.13 (W1), 0.26 (W2), -0.04 (W3), -0.41 (W4), -0.06 (W6) and -0.30 (W8) while on week 5 and week 7 were 0.01 and 0.06 respectively. This showed that fish undergoes abnormal slow growth.

The mean of initial weight of African catfish is 8.81 g. The mean body of weight gained was -0.78 g (W6), -0.68 g (W4), -0.4 g (W3), -0.12 g (W7), -0.11 g (W8), 0.08 g (W1), 0.14 g (W5) and 0.85 g (W2). The weight gain of the fish is fluctuated for every week where its only gained on weight in week 1, week 2 and week 5 where the rest was losing weight. Instead of gaining weight, African catfish had lost approximately 1 g in the period of reared. This led to the specific growth rate and feed conversion ratio to be negative. Based on observation, it happened because the growth of African catfish was stunted. In can be seen through the fish which is randomly sampled in hapa 1 and hapa 2, there are some of the fish is small as the initial size even in week 8 and only a few of it grown bigger around 7 cm of size. Final body weight for each weeks was 8.02 g, 8.87 g, 8.81 g, 8.13 g, 8.28 g, 7.50 g and constant for week 7 and week 8 where 7.31 g.

Feed conversion ratio value for eight weeks were negative value might be due to improper feed and nutrient supply toward fish. Since the objective for this experiment is to determine the growth performance of African catfish using hapa, poor management of hapa resulted in low appetite of fish which affect the conversion of feed to flesh.

Because of the unusual result, there are several factors that can affect the feed conversion ratio of fish such as pond management, water quality, genetics, environment and the health of the fish (USAID,2011). Jamabo, Fubara and Dienye (2015) mentioned to get maximum growth, fish can be fed four times a day because it showed the highest feed consumption but the feed conversion ratio recorded the lowest when fed for two time per days. Therefore, feeding frequency also one of the factors that affect the growth performance and feed conversion ratio of the African catfish. Thus, this discussion will focus on the problems occur during experiments.

Based on the observation, the major problem occurred was the hapa system. The hapa that used in this experiment was torn and worn out due to not properly sewn and repaired before the fingerling of African catfish was placed. It is not strong enough to sustain the fingerlings. Due to torn hapa, fingerlings escaped from hapa which reduced the amount of fingerlings present in hapa. Other than that, the fish in pond such as tilapia and other small fish were managed to enter in the hapa where it caused overcrowded where Orisasona et al. (2015) mentioned that when African catfish were in high stocking density, disease outbreak occurred, competition of feed and limited space. Daudpota et al. (2014) proved that stocking density can affect the growth performance of the fish. Therefore, fingerling cannot get enough feed and unable to grow well which caused loss weight. Compared to the African catfish fingerling that escaped from the hapa, it showed that the size of fish was difference than the fish lived in hapa. This can relate from the previous study by USAID (2011) where fish can grow better when they eat both commercial feed and natural feed such as aquatic plant, worms, snail and others that present in pond which result in the FCR may get lower. Apart from that, there were heavy rain when doing sampling which it postponed to the next day. It resulted that hapa was sink and fish in hapa became lesser and also mixed with the African catfish which already gained more weight when it grows outside from hapa. From previous study by Olanrewaju, Kareem and Ajani (2016) mentioned when the attainment of fast growth is considered in rearing of fingerlings in hapa, the feed production must also be considered.

Since the fish was reared in open condition which used hapa system, it can caused stress to fish during cold condition like in the rainy days due to fluctuation of dissolved oxygen and water temperature. Charo-Karisa (2006) mentioned that low temperature caused low survival of small fingerlings as their immune system is weak and more susceptibled toward cold stress. When water temperature increase or decreases beyond the temperature 25ºC to 31ºC, fish in all age would eat lesser than ususal or stop taking feed (Srijaya, Pradeep, Mithun, Shaharom & Chatterji, 2011).

Table 4.2: Average water parameter using hapa-in-pond system of African catfish

Water parameter	**Data recorded**
Dissolved oxygen (mg/L)	3.44 to 5.64
Temperature (ºC)	28.1 to 33.57
pH	6.85 to 7.9

African catfish are able to tolerate in harsh environment such as temperature, dissolved oxygen and pH (Farahiyah, Ahmad, Thylani & Yong, 2016). The quality of water in which are raised seems to be directly related to the health and subsequent growth of fish (Viadero, 2005; Ajiboye, Awogbade & Bababola, 2015). Based on the Table 2, the ranges level of dissolved oxygen was 3.44mg/L to 5.64 mg/L therefore it does not meet the optimum condition. From previous study by Tower (2014) mentioned that the level of dissolved oxygen must maintain which between 4 mg/L. If it lower than the ranges, the growth performance was reduced and the rate mortality also increased (Sriyasak, Chitmanat, Whangchai, Promya & Lebel, 2015).

During experimental period, water temperature ranged 28.1°C to 33.57 °C. These water temperature were in the preferred range of temperature recorded by Tunde, Oluwagbemiga, Babatunde and Oluseyi, 2016. Since water in pond influenced by the water temperature, the optimum ranges for African catfish was between 25°C to 31°C (Adenji & Ovie, 1962; Gizaw,2017). If it increases than 32°C, the growth rate reduced.

Based on the data recorded for pH, it ranges 6.85 to 7.9. It was agreement with the acceptable pH value was 6.5 to 8.0 stated by Njoku, Obialo and Ogochukwu (2007) in order to obtain optimum growth performance. If it above than 6.5 and below than 8.5, it caused retardation of fish growth (Stevens, 2009).

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, the growth performance of African catfish was flactuated and showed stunted growth from week 1 until week 8. However, there were some error occured that lead to the failure in weight gain, feed conversion ratio and specific growth rate of African catfish. Factors that affect the growth performance were feeding frequency, the condition of hapa, environmental conditions, stocking density, pond management and health of fish should be considered.

5.2 Recommendation

Before experiment is going to be conducted, the hapa should be checked thoroughly to prevent the leak of African catfish fingerlings. If there any torn on hapa, we can fix it which to prevent more bigger damage. If the hapa was too worn out, replacement of new hapa should be considered. To improve the growth performance and feed efficiency of African catfish, feeding frequency should be twice a day as Jamabo, Fubara and Dienye (2015) proved that feed conversion ratio was low when the fish was fed twice a day meanwhile feeding four times a day can gave maximum growth of the fish. Other than that, to get an accurate data, do the sampling 3 times a week where it can get average weight of fish while monitoring the condition of the fish and also hapa.

Due to some circumstances occurs during experiments, it is failed to prove that hapa system was a good culture system for growing the African catfish. Therefore, further research was needed by husbandry students to make it worth, thus it can be evidance for the farmers to use for fish farming.

Even it was failed to prove, there are several advsntages and disadvantages using hapa system. The advantages using hapa is easy to construct and manage since the size of hapa is not big as the pond. Thus it is easy to monitor the growth performance of the fish and the sampling is easy to do because sample can take by using scoop net. This farming system is actually the best choice for the farmers that do not have land to rear the fish. They can grow it either in lakes, rivers or ponds.

Meanwhile, there also disadvantages in using hapa which is the management of hapa is more inconvenience compare to other methods. If the hapa is damage, the fish may easily escape which already happened in recent study. Other than that, hapa material will degrade after a long period in sunlight. Then, it need replacing it with new to avoid more damage and it also can be destroyed during stormy weather.

REFERENCES

Abiodun, E. (2016). Effect of Cold Weather on African Catfish and Solutions. *Profitable Fish Farming*.

Ajiboye, O. A., Awogbade, A. A. & Babalola, O. A. (2015). Effects of water exchange on water quality parameters, nutrient utilization and growth of African catfish (*Claries gariepinus*). *International Journal of Livestock Production*, 6(5), 57-60.

Asuwaju, F. P., Onyeche, V. O., Ogbuebunu, K. E., Moradun, H. F., & Robert, E. A. (2014). Effect of Feeding Frequency on Growth and Survival Rate of *Clarias gariepinus* Fingerlings Reared in Plastic Bowls. *Journal of Fisheries and Aquatic Science*, *9*(5), 425–429.

Boyd, C. E. & Hanson, T. (2010). Dissolved-oxygen concentration in pond aquaculture. *Global Aquaculture Alliance*, 40-41.

Celine, D. (2012). Water quality in aquaculture. Report prepared for Alabama Cooperative Extension System, Auburn University.

Charo-Karisa, H. (2006). Selection for Growth of Nile Tilapia (*Oreochromis niloticus L.*) in low-input environment. PhD Thesis. Wageningen University, Netherland.

Daudpota, A. M., Kalhoro, I. B., Shah, S. A., Kalhoro, H. & Abbas, G. (2014). Effect of stocking densities on growth, production and survival rate of red tilapia in hapa at fish hatchery Chilya Thatta, Sindh, Pakistan. *Journal of Fisheries*. 2(3), 180-186.

Ernest, N. A. (n.d). The effect of water exchange and water quality on growth and survival of *Clarias gariepinus* (Fingerlings) along the Mount Cameroon region. 1-21.

Fry, J. P., Mailloux, N. A., Love, D. C., Milli, M. C. & Cao, L. (2017). Feed conversion efficiency in aquaculture: do we measure it correctly?. *Environmental Research Letters.* 13.

Janssen, J. A. L. (1987). Seed production: Mass prodution of fry and fingerlings of African catfish *Clarias gariepinus*. *Food and Agriculture Organization (FAO)*.

Dural, M., Tepe, Turkmen, M. & Mustafa. (1986). *Clarias gariepinus. Food and Agriculture Organization (FAO)*. 314-316.

Edwin, H. R. & Menghe, H. L. (2015). Feed Conversion Ration for Pond-Raised Catfish. *Mississippi Agriculture & Forestry Experiment Station*. 1-4.

Farahiyah, I. J., Zainal. A. A. R., Ahmad, A., Mardhati, M., Thayalani, K. & Yong, S. T. (2016). Evaluation of Local Feed Ingredients Based Diets on Growth Performance of African Catfish, *Clarias gariepinnus. Journal Animal Science*, 19(2), 39-46.

FAO (2018).North African catfish-Natural food and feeding habits.

Francis, N. O. and Esa, Y. B. (2016). A Review of Production Protocols Used in Producing Economically Viable Monosex Tilapia. *Journal of Fisheries and Aquatic Science*, 11(1), 1-12.

Gizaw, Y. D. (2017). Survival rate, feed utiliztion and growth performance of fingerlings of African catfish, *Clarias gariepinus* (Burchell, 1822), at different stocking densities under dark condition. M. Sc. Thesis. Addis Ababa University and Bahir Dar University, Ethiopia

Graaf, D. & Janssen, H. (1996). A handbook of Artificial reproduction and pond rearing of the African catfish *Clarias gariepinus* in sub-Saharan Africa. Netherland: Nefisco Foundation

Hopkins, K. D. (1992). Reporting Fish Growth: A Review of the Basics. J*ournal of the World Aquaculture Society*, 23(3), 173-179.

Jamabo, N. A., Fubara, R. I. & Dienya, H. E. (2015). Feeding Frequency on Growth and Feed Conversion of *Clarias gariepinus* (Burchell, 1822) Fingerlings. *International Journal of Fisheries and Aquatic Studies.* 3(1), 353-356.

Kaiser, H., Weyl, O. & Hecht, T. (1995). Observation on agonistic behavior of *Clarias gariepinus* larvae and juvenils under different densities and feeding frequencies in a controlled environmment. *Journal of Applied Ichthyology*, 11, 25-36.

Lall, S. P. & Tibbbets, S. M. (2009). Nutrition, Feeding and Behaviour of Fish. *Veterinary Clinics of North America: Exotic Animal Practice*, 12(2), 361-372.

Lazard, J. & Dabbbadie, L. (n.d). Freshwater aquaculture and polyculture. 1-9.

Little, D., Nick, I. T., Turongruang, D. & Sollows, J. (n.d). Fry nursing in rice-fish systems. *Food Agriculture and Organization (FAO).*

Mabroke, R. S., Tahoun, A. M., Suloma, A. & El-Harun, E. R. (2013). Evaluation of meat and bone meal and mono-sodium phosphate as supplemental dietary phosphorus sources for broodstock Nile Tilapia (*Oreochromis niloticus*) under the conditions of hapa-in-pond system, *Turkish Journal of Fisheries and Aquatic Sciences*, 13(1).

Mallya, Y. J. (2007). The effect of dissolved oxygen on fish growth in aquaculture. *Fisheries Training Program*. The United Nation University, Reykjavik, Iceland.

Maynard, D. J., Barry, A. B., Thomas, A. F. & Conrad, V. W. M. (2001). Development of a Natural Rearing System to Improve Supplemental Fish Quality.*1996-1998 Progress Report Project No. 199105500*. 174

Mensah, E. T-D., Attipoe, F. K. & Atsakpo, K. (2014). Comparative growth study of *Oreochromis niloticus* and *Sarotherodon galilaeus* under two different culture regimes (Hapa-In-Pond and cage system). *International Journal of Fisheries and Aquatic Studies*, 1(15), 53-59.

M. O. A., Ministry of Agriculture & Agro-Based Industry Malaysia (2018). Weekly price reports. *Fisheries Development Authority of Malaysia.*

Mokenye, J. (2004). Enhanced growth of Cage Cultured African catfish (*Clarias gariepinus*) through Polyculture with Nile tilapia (*Oreochromis niloticu*s) in Chepkoilel fish ponds. 1-38.

Musa, S. M., Aura, C. M., Ngugi, C. C. & Kundu, R. (2012). The effect of three different feed types on growth performance and survival of African catfish fry (*Clarias gariepinus*) reared in a hatchery. *International Scholary Research Notices Zoology*. 12. 1-6

Ndwiga, J. (2015). Effect of stocking densities on growth and survival of juvenil Nile Tilapia *Oreochromis niloticus* (Lin, 1758) in hapa nets. M. Sc. Thesis. University of Eldoret, Kenya.

Njoku, I., Obiola, B. & Ogochukwu, O. (2007). Effect of pH on the Growth Performance of *Heterobranchus bidorsalis* X *Clarias gariepinus* hybrid juvenils. *Animal Research International*, 4(1), 639-642.

Nwachi, O. and Y. E. (2016). A Review of Production Protocols Used in Producing Economically Viable Monosex Tilapia. *Journal of Fisheries and Aquatic Science*, *11*(1), 1–11.

Okpako, B. A. (2010). The Effect of Feeding Time on the Performance of Juvenile African catfish (*Clarias gariepinus*, Burchell 1822). M. Sc. Thesis. University of Nigeria, Nsukka.

Olanrewaju, A. N., Kareem, O. K. & Ajani, E. K. (2016). Comparative study of growth performance and survival of African catfish *(Clarias gariepinus*, Burchell 1822) fry in indoor and outdoor concrete and hapa culture system. *Journal of FisheriesScience.com*. 10(1), 27-30.

Orisasona, O., A. E., Oni A, J., & A, J.-O. (2015). Growth and Economic Performance of *Clarias gariepinus* Fry Reared at Various Stocking Densities. *Journal of Fisheries & Livestock Production*, *3*(2), 1–3.

Palm, H. W., Babmann, B. & Brenner, M. (2017). Stress and welfare of African catfish (*Clarias gariepinus* Burchell, 1822) in a coupled aquaponic system. *Water*, 9(504).

Putra, I., Rusliadi, R., Fauzi, M., Tang, U. M., Muchlisin & Zainal, A. (2017). Growth performance and feed utilization of African catfish *Clarias gariepinus* fed a commercial diet and reared in the biofloc system enhanced with probiotic. *F1000 Research*, 6(1545), 1-9.

Rashid, A. O. (2009). Some aspect of the biology of the catfish in Chekoilel river.(A degree's dissertation). Moi University, Eldoret, Kenya.

Srijaya, T. C., Pradeep, P. J., Mithun, S., Shaharom, F. & Chatterji, A. (2011). General Biology of Tilapia: Aquaculture Technique & Potential. Selangor: Reka Cetak Sdn. Bhd.

Sriyasak, P., Chitmanat, C., Whangchai, N., Promya, J. & Lebel, L. (2015). Effect of water de-stratification on dissolved oxygen and ammonia in tilapia ponds in Northen Thailand. *International Aquatic Research.* 7(4), 287-299.

Steven, R. (2009). Fish Pond Water Quality: As Simple as Chemistry 101. Noble Research Institute

Svobodova, Z., Lloyd, R., Machova, J. & Vykusova, B. (1993). Water quality and fish health: Causes and effects of pollution on fish. Italy: FAO. 67

Teodorowicz, M. (2013). Surface water quality and intensive fish culture. *Archives Polish Fisheries*. 21, 65-111.

Tower, L. (2015). Hatchery management and tilapia fingerlings production. *The Fish Site*.

Tower, L. (2014). Water Quality Monitoring and Management for Catfish Ponds. *The Fish Site*.

Tunde, A. O., Oluwagbemiga, O. S., Babatunde, A. & Oluseyi, O. O. (2016). The Growth Performance of African Catfish (*Clarias gariepinus*) Fed Commercially Prepared Imported Fish Feeds. *International Journal of Agricultural Economics*, 1(3), 57-61

United States Agency for International Development. (2011). Feed conversion ratio. *Technical bulletin #07*. 1-2

Wagner, T. & Erickson, L. E. (2017). Sustainable Management of Eutrophic Lakes and Reserviours. *Journal of Environmental Protection*, 8(4).

Wenk, C., Pfirter, H. P. & Bickel, H. (1980). Energetic aspects of feed conversion in growing pigs. *Livestock Production Scien*ce, 7(5), 483-495.

Wilson, P. C. (n.d). Water Quality Notes: Dissolved Oxygen.

APPENDIX

Figure 1: Multi-parameter (YSI Pro Multi-Parameter, Australia)

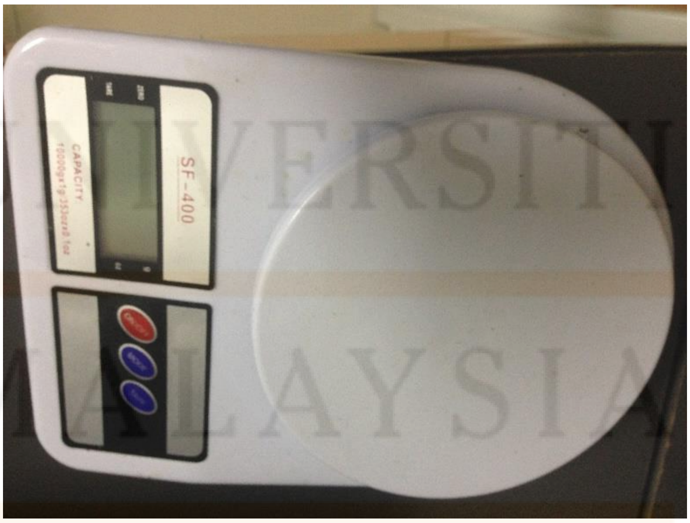

Figure 2: Electronic scale (Xiangshan, China)

Figure 3: African catfish fingerling

Figure 4: Weight measurement of sample

Figure 5: Sampling process