TECHNOLOGY IMPROVEMENT ON ARTIFICIAL INCUBATOR SYSTEM FOR TILAPIA (*Oreochromis niloticus*) EGG

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DECLARATION

I hereby declare that the work embodied in here is the result of my own research except for the excerpt as cited in the references.

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ABSTRACT

Malaysia has gained demand in Nile Tilapia fish raw material. Incubation system is a established artificial incubation system for intensive fry production of Nile Tilapia (*Oreochromis niloticus*). This study was carried out to create the new system by creating smart incubation system as an alternative incubation system for small-scale hatchery operators. Two incubation systems are used ie Smart Artificial system were compared with normal. Results showed that the amount of water used was significantly lower in Smart Artificial system with 70L of water compared to normal incubation system control with 15 000L of water at Aquaculture Extension Centre in Jitra, Kedah. The eggs hatching percentage was significantly higher in Smart Artificial system 89.17% compared to normal incubation system control 74.4%. Hatching tended to occur slightly earlier in the Smart Artificial system than normal incubation system control. After 10 days of rearing, the mean fry survival rate was highest in Smart Artificial 82.53% compared to the normal incubator system control 67.30%. The dissolved oxygen was significantly higher in Smart Artificial system 5.96 mg/l. The mean for the water temperature was lowest in Smart Artificial system 29.17ºC compared to normal incubation system control 30.02ºC recorded a high value. Further experiments indicated that 3000 eggs can be successfully hatched with a hatching rate of 89.17% and reared to swim-up fry in 70L size of Smart Artificial system with no water exchange. Smart Artificial system is best suited for incubation of late stage eggs and rearing of newly hatched larvae up to free swimming stage that called fry stage. The results indicate that the Smart Artificial system can be used as an alternative of artificial incubator system for Nile Tilapia eggs.

Keywords: Nile Tilapia, Smart Artificial, normal incubation, egg hatching rate,s urvival rate of fry

ABSTRAK

Malaysia telah mendapat permintaan dalam bahan mentah ikan Nile Tilapia.Sistem inkubasi ialah sistem inkubasi buatan yang dibina untuk pengeluaran benih ikan nila secara intensif (*Oreochromis niloticus*). Kajian ini dijalankan untuk mencipta sistem baharu dengan mewujudkan sistem pengeraman pintar sebagai sistem pengeraman alternatif untuk pengusaha penetasan berskala kecil. Dua sistem inkubasi digunakan iaitu sistem Smart Artificial dibandingkan dengan sistem Kawalan. Keputusan menunjukkan bahawa jumlah air yang digunakan adalah jauh lebih rendah dalam sistem Smart Artificial dengan 70L air berbanding kawalan sistem Inkubasi Kawalan dengan 15 000L air di Pusat Pengembangan Akuakultur di Jitra, Kedah. Peratusan penetasan telur adalah lebih tinggi dengan ketara dalam sistem Smart Artificial 89.17% berbanding kawalan sistem Inkubasi Kawalan 74.4%. Penetasan cenderung berlaku lebih awal sedikit dalam sistem Smart Artificial daripada kawalan sistem Inkubasi Kawalan. Selepas 10 hari pemeliharaan, purata kadar survival anak ikan adalah tertinggi dalam Smart Artificial 82.53% berbanding kawalan sistem Inkubator kawalan 67.30%. Oksigen terlarut adalah jauh lebih tinggi dalam sistem Smart Artificial 5.96 mg/l. Purata bagi suhu air adalah paling rendah dalam sistem Smart Artificial 29.17ºC berbanding kawalan sistem inkubasi biasa 30.02ºC mencatatkan nilai yang tinggi. Eksperimen lanjut menunjukkan bahawa 3000 biji telur boleh berjaya ditetaskan dengan kadar penetasan 89.17% dan dipelihara untuk anak ikan berenang dalam saiz 70L sistem Smart Artificial tanpa pertukaran air. Sistem Smart Artificial paling sesuai untuk pengeraman telur peringkat akhir dan pembesaran larva yang baru menetas sehingga peringkat berenang bebas yang dipanggil peringkat goreng. Hasilnya menunjukkan bahawa sistem Smart Artificial boleh digunakan sebagai alternatif sistem inkubator buatan untuk telur tilapia..

Kata kunci:Tilapia Nil,Tiruan Pintar,Pengeraman biasa,kadar penetasan telur,kadar kemandirian anak ikan

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% - Percentage

cm - Centimeter

ºc- Celcius

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CHAPTER 1

INTRODUCTION

1.1 Research Background

For Malaysia's population, the fisheries sector has been a key source of animal protein. Overall, the country's fishery output in 2017 was 1.7 million tonnes, with almost 1.5 million tonnes coming from catch and 0.2 million tonnes coming from aquaculture (excluding seaweeds) (DOF, 2017). Malaysia placed third in tropical carrageenin seaweed farming and was the world's seventh largest producer of farmed seaweeds, with 0.2 million tonnes cultivated. The coastal and offshore sub-sector of marine capture fisheries are subdivided (DOF, 2017). In 2017, the three sub-sector statistics in aquaculture produced 49 001 tons for marine, 72 451 tons for brackish water, and 105 096 tons for freshwater (FAO, 2017). However the Nile Tilapia (*Oreochromis niloticus*) is a freshwater also found in Central and North Africa, as well as the Middle East (Boyd, 2004).

The Nile Tilapia is another common species that widely cultivated around the world. In 2015, global Tilapia production reached 6.4 million tons (MT), with a market value of USD 9.8 billion (FAO 2017). China (1.8 MT) and Indonesia are the main producers of *Oreochromis niloticus* (1.1 MT).). One of the major challenges confronting the Tilapia aquaculture industry is obtaining a enough supply of high-quality seed when seed is cultivated in Hapa, concrete tanks, fibreglass tanks, and earthen ponds using the natural incubator. Many fish species need the incubation and hatching of their embryos (eggs) in open water. Floating or sinking eggs are dropped into the water column. Adhesive eggs may stick to both plants and hard surfaces (rock or gravel). Other fish eggs are laid in a nest, and the parents fan their fins to keep the water flowing. Some fish incubate eggs in their mouths, where gentle tumbling and water circulation is provided by the action of the gill plates.

These natural processes are mimicked by artificial incubation and hatching of fish embryos. In the wild, eggs are prey for predators and are easily destroyed by the natural world's constant changes.. Man-made hatcheries have the advantage of being able to control and manipulate the environment. Developing embryos and freshly hatched larvae are the most vulnerable and delicate stages in a fish's existence (fry). As a result, it's crucial to make sure they're in the right incubating and hatching environments. Temperature, light, water quality, water flow, shock protection, and egg shape and size are all important considerations.

Artificial incubation of fish eggs is a hatchery procedure that improves a commercial fish culture operation's economic efficiency. Egg hatching rate and survival rates of fry may increase with artificial incubation. Additionally, removing the eggs from the parents can increase egg production by reducing the time between spawnings. Traditional hatcheries find it almost hard to produce and supply a large amount of fry using traditional methods. Artificial egg incubation can increase fry output and profitability at a commercial hatchery. In Malaysia Technology based on the artificial incubator in aquaculture industry such as for Tilapia eggs cannot be used by breeders due to price factors that are too expensive to build. As a result, breeders can use natural incubators stored in the fish's mouth. Due to uncontrollable factors in the fish's mouth, such as temperature, egg hatching and high fry survival rates are common.

All breeders in Malaysia who want to use the Smart Artificial Incubator were constructed using materials that are readily available and low in cost. This technology would also be checked using *Oreochromis niloticus* tilapia eggs to see if the egg hatching rate and fry survival rate are satisfactory. This study was conducted to produce a new system by creating a smart incubation system as an alternative incubation system for the use of small-scaled hatcheries and use in the laboratory. The technology was tested through egg hatching percentage and survival rate of fry for *Orecochromis niloticus*.

1.2 Problem Statements

Nowadays, artificial incubators provide a very important technology in the aquaculture industry by fish breeders. In addition, this system also requires high costs to build. Breeders also have problems with low egg hatching rate and survival rate of fry due to not using the artificial incubator method which has problems with damage to eggs due to changes in environmental factors on uncontrollable fish.

1.3 Hypothesis

H_0 : Improved technology of smart artificial incubator does not give any positive impact to Tilapia fry

Ha :Improved the technology smart artificial incubator system promotes Tilapia fry with improved and better qualities

1.4 Scope of Study

This research focuses on new technology improvement in aquaculture about the artificial incubator for Tilapia. This is due to the fact that this experiment would include test on the egg hatching rate and survival rate for eggs Tilapia species. This is a new technology improvement designed is suitable for aquaculture and this project just focuses for Tilapia because to solve problems faced by breeders in terms of the high cost to build a hatchery for incubator. In addition it can increase the survival rate and eggs hatching rate and also to solve the problems that faced by researchers in the laboratory where the size of the technology produced is suitable for laboratory use.

Apart from focusing in the technology improvement, this project also heavily leans on the functionality of this technology whether it works perfectly or not. This due to fact that both the functionality for this technology and rate of eggs hatching and survival rate are significantly related to both.Through research for this technology by study the rate of eggs hatching and survival rate of fry for technology improvement to aquaculture industry that focus on the eggs Tilapia and find out whether this technology gives good results or not by producing high eggs hatching rate and survival rate of fry or not because this result is very important for this technology whether it is successful or not

1.5 Significant of the Study

It is undeniable that the aquaculture in Malaysia is very expensive and became a burden every breeder will have to endure, primarily to build a hatchery for an artificial incubator system. The aftermath of expensive technology led to the increase the production and operation cost of a farm thus leading to the rise of the aquaculture product price itself. This is due to the fact that, these technology uses expensive equipment to create and build the technology where the material used is a very durable and high quality.

In this new technology improvement for egg Tilapia, this can certainly be a lifesaver to the aquaculture industries especially breeders hence reducing the cost of production become much more affordable as well as reducing of the aquaculture product itself. In this technology and experiment, the egg hatching rate and survival rate of fry will be tested by using a real incubator system to identify this technology improvement can give the good result and to know it is safe for human use or not

1.6 Objectives

1. To design a portable smart artificial incubator technology for Tilapia (*Oreochromis niloticus*) egg

2. To determine the survival rate of fry and hatching eggs of *Orechromis niloticus* using the smart artificial incubator

CHAPTER 2

LITERATURE REVIEW

2.1 History of Aquaculture

Aquaculture refers to the farming of aquatic organisms such as fish, mollusks, and aquatic plants in fresh, marine, or brackish water (Pillay and Kutty, 2005). Aquaculture has been practised in ancient China and Egypt since 4000 to 5000 years ago (Ackefors et al., 1994; Pillay and Kutty, 2005). However, it is thought that the Egyptians were the first to cultivate tilapia in clay ponds circa 2500 B.C. (Pillay and Kutty, 2005; Shelton and Popma, 2006). Commercially significant Nile tilapia species include *Oreochromis niloticus, Oreochromis aureus*, and different red hybrids of the former two species (Stickney, 2005; Shelton and Popma, 2006).These tilapias have a number of traits that make them ideal for aquaculture, including a short culture period (about 6 months), a high tolerance for poor water quality, high stocking density, and high productivity rates. Malaysians were initially introduced to Mozambique tilapia during World War II (*Oreochomis mossambicus*).

They looked at tilapia strains from various commercial breeders in the area (Chitralda, Philippines, Taiwan strains, and *Oreochromis mossambicus*). *Oreochromis niloticus* and *Oreochromis mossambicus*, or a cross-breed of both, were recognised as the farmed species in Malaysia (*Oreochromis sp*.)

2.2 Taxonomy of *Oreochromis niloticus*

Cichlids are freshwater fish native to the Nile River basin in the south-western Middle East, which includes the rivers Niger, Benue, Volta, and Senegal, as well as the lakes Chad, Tanganyika, Albert, Edward, and Kivu (Trewavas, 1983; Daget et al., 1991). It has been introduced to more than 50 countries on every continent except Antarctica (Pullin et al., 1997), and is now found in almost every tropical region (Pullin et al., 1997). Table 2.2 shows the taxonomy of *Oreochromis niloticus.*

TABLE 2.2: Taxonomy of *Orechromis niloticus*

Kingdom	**Animalia**
Phylum	Chordata
Class	Actinopterygii
Order	Perciformes
Family	Cichlidae
Genus	*Oreochromis*
Species	*niloticus* (Linnaeus, 1758)
Infraspecific	subsp. niloticus

Tilapia is the common name for a group of African cichlids. *Oreochromis, Sarotherodon*, and tilapia are the three general that important in aquaculture. There are many characteristics that differentiate these three general, but the most important is their reproductive activity. The eggs are fertilized in the nest, but the parents pick them up in their mouths and hold them through incubation and for several days after hatching in both *Sarotherodon* and *Oreochromis* species. In *Oreochromis* species, only females practice mouth brooding, while in Sarotherodon species, males or both male and females practice mouth brooding.

Tilapia farming has become common in the tropical and semi-tropical world over the last half-century. Outside of Africa, the genus *Oreochromis* now encompasses all commercially important tilapia, with Nile tilapia accounting for over 90% of all commercially farmed tilapia. Tilapia (*O. aureus*), Mozambique tilapia (*O. Mossambicus*), and Zanzibar tilapia are less commonly farmed species (*O. urolepis hornorum*).

2.3 Physical Characteristics

Tilapia resembles sunfish or crappie in appearance, but they have an interrupted lateral line that is only found in the Cichlid family of fish. They have long dorsal fins and a deep-bodied, laterally compressed body. The dorsal fin's forward portion is heavily spined. The pelvis and anal fins have spines as well. The sides of fry, fingerlings, and sometimes adults have wide vertical bars running down them.

2.4 Water Parameter

Water quality for aquaculturist refers to the quality of water that enables successful the propagation of the desired organisms. These parameters provide important information about the health of a water body. The quality of the aquatic environment depends on four kinds of factors, such as physical, chemical, biological and meteorological factors.

2.4.1 Water Temperature

In a hatchery system, temperature is critical for egg production and fry growth. For several species of fish, the effects of water temperature on growth and development have been thoroughly studied (El-Sayed et al., 1996). Beamish (1970) found that the ideal temperature for Nile Tilapia development and reproduction was 22°C to 30°C, and 28°C for fry. Temperature is also known to explain most of the variance in planktonic egg development stages (Pauly and Pullin, 1988). *Oreochromis niloticus*, hatching period decreased from 7 to 3.3 days with increase in temperature from 24°C to 27°C (El-Naggar et al., 1998).

2.4.2 pH

In general, a pH range of 6.5 to 9.0 is suitable for aquaculture (Boyd, Tucker, & Somridhivej, 2016). Some fish species, such as the tambaqui, *Colossoma macropomum* (Cuvier) (Aride, Roubach, & Val, 2007), prefer acidic waters, although others, such as the Mozambique Tilapia, *Oreochromis mossambicus*, are acidic-tolerant (Furukawa, Watanabe, Inokuchi, & Kaneko, 2011). According to El-Sherif and El-Feky (2009), the optimal water pH for the culture of Nile Tilapia, is 7 - 8. The pH of the incubation has a strong influence on the activity of hatching, which present highest activity over rainbow trout eggs at pH 8.5 (Hagenmaier, 1974)

2.4.3 Dissolved Oxygen

In the morning, DO concentrations of less than 0.3 mg/L can be tolerated by Tilapia. Normally, aerators were used to keep morning DO concentrations between 0.7 and 0.8 mg/L, Nile Tilapia grew better in research studies(Lucy, 2005). Additional aeration did not improve growth when DO concentrations were held above 2.0 to 2.5 mg/L. It is widely known that as water temperatures rise, the amount of dissolved oxygen in the water decreases (El-Sayed, 2006). Tilapia, on the other hand, are known for their ability to survive in conditions with low oxygen levels (Kutty, 1996). According to Riche and Garling (2003), the preferred DO for optimum growth of tilapia is above 5 mg/L.

2.5 Artificial Incubator

The survival of eggs and fry in species of Nile Tilapia is intrinsically tied to the mouth-brooding mode of clutch protection. Simulating the natural pattern of parental rearing is beneficial in developing an efficient artificial rearing system for the mass production of eggs and fry. A temporary pair-bond forms between the ripe female and the nesting male in natural breeding conditions. The female releases eggs in batches of 20-50 during spawning, which can take anywhere from 45 minutes to 2 hours, and the male sheds his sperms over the location (Trewavas, 1983). She places the eggs in her buccal cavity as quickly as they are laid, which might be before, during, or after fertilisation. The pair-bond is broken once spawning is completed, and the female departs to incubate her clutch. The eggs or developing fry are rolled over in the buccal cavity by the brooding female's respiratory movements and by periodic backflushing during the maternal rearing period, which can last anywhere from 10 to 21 days in *Oreochromis* species (Van Roon, 1950;).

The reasons for rolling or churning the eggs in the buccal cavity are yet understood. Fishelson (1966), provided another view in suggesting that if the yolky eggs remain stationary, the heavy lipids sink to the lower pole. The embryo's internal organisation is disrupted, and it fails to develop.To simulate this rolling action of naturally reared eggs, eggs have been agitated with air and water by various methods. Researches have used conical containers (Valenti, 1975; Rothbard and Hulata,1980) and shaking tables (Rothbard and Pruginin, 1975; Lee, 1979) for the incubation of tilapia eggs.

Understanding the response of these eggs and fry to various environmental factors will become more crucial in providing optimal rearing conditions as tilapia culture, particularly that of mouth-brooders (Aronson, 1949), expands outside its native bio geographical range. These factors have been generally disregarded in the past due to the mouth-brooding behaviour and the general challenges connected with artificially raising eggs and producing fry. As a result, effective artificial incubation systems are required to establish the best egg and fry raising conditions, as well as to fulfil the recent trend of frequent seed harvesting on farms, which can result in vast amounts of eggs being gathered.

2.5.1 Artificial Incubator System

Artificial incubation of fish eggs is a hatchery procedure that improves a commercial fish culture operation's economic efficiency. Artificial incubation will improve hatching rates and survival. Additionally, removing the eggs from the parents may improve egg production by reducing the period between spawnings Based on the journal of Establishment and efficiency evaluation of a simple mini hatchery for production of *Oreochromis niloticus* seeds, a simple mini hatchery was built to compare the hatchability, survival, and total production of seeds in the mini hatchery with those in a breeding hapa installed in an earthen pond, and to compare the hatchability, survival, and total production of seeds in the mini hatchery with those in a breeding hapa installed in an earthen pond.

Countries like the Philippines, Thailand, Indonesia, India, and Bangladesh are well-suited to artificial incubation systems in large-scale tilapia fry production, generating millions of fry fingerling to meet those countries' seed demands, this study was to create a simple small hatchery (Green, 2006). Many countries lack of large-scale or small-scale artificial hatchery facilities for tilapia. Farmers must pay high transportation fees in addition to the cost of seeds purchased from government hatcheries. As a result, constructing an artificial incubator system for the production of tilapia fry is a viable method for tilapia aquaculture expansion.

The study site is in a fish farming area near to Kattakaduwa perennial reservoir in Hambantota District. The mini hatchery created as an artificial incubator is close to the fish farmer pond. The design created for the mini hatchery as an artificial incubator system is using a plastic jar system. Water recirculation was mechanised utilising a floating valve fixed in the above tank, which is among the basic knowledge about this design. The eggs were incubated in twelve 4 L clear round plastic bottles with concave bottoms. The yolk-sac larvae were reared in plastic trays (3 L) measuring 40 cm (L) x 28 cm (W) x 4 cm (H).

Down-welling pipes (1.25 cm diameter) provided water to the hatchery jars and larval rearing containers, which are widely employed by hatchery operators (Bhujel, 2008). A 1.25 cm diameter PVC pipe was used to supply inflow water to the bottom of each bottle and the sides (28 cm width) of the trays. Water is removed from the bottle's top via a 2.5 cm pipe and a series of holes punctured and covered with 1.5 mm nylon net on the trays' 40 cm sides. The results obtained based on this study after this artificial incubator was tested were to ensure consistent hatching and survival rates of Nile Tilapia eggs and fry, many trials were conducted to determine the appropriate flow rate and stocking densities for incubation bottles (hatchery jars) and larval rearing. trays. For egg incubation, the optimal flow rate was 2.70 0.18 L.min-1, and for yolk-sac larvae rearing, it was 5.40 0.14 L.min-1. Flow rates resulted in an average of 90 % survival for yolk-sac larvae and over 90 % hatchability for eggs.

The number of eggs and yolk-sac larvae that survived the best at these flow rates was 500. Senaarachchi and De Silva (Senaarachchi & De Silva, 2014). The hatchability and survival rates of yolk-sac larvae in artificial plastic incubators with optimal flow rates were over 80% and 90%, respectively (Senaarachchi & De Silva, 2014). Down-welling round bottom incubators with a capacity of 2-3 L produced 17 to 22 % hatchability and a percent survival rate of yolk-sac larvae, according to Rana (1986) and Macintosh and Little (1995).In the current investigation, however, the hatchability of eggs was over 90%. The micro hatchery yield (24,000 fry) was substantially different (P 0.05) from the hapa technique (4,879 fry), indicating that this well-established tiny hatchery might serve as a useful model for small-scale farmers interested in *Oreochromis niloticus* seed production.

CHAPTER 3

3.1 Material and Equipment

The raw material used as the material to study this system was *Oreochromis niloticus* eggs. In addition, other materials used to create the system are water pump, pipe, glue, plastic tray, plastic jar, rod, aluminum rod, net, span, plate and adjuster stopper. Finally, the apparatus used to take the water quality parameter reading pH meter, ammonia calorimeter and DO meter

3.1.1 Smart Artificial Incubator system

Smart Artificial Incubator for Tilapia eggs was designed using plastic tray with a length of 80 cm, a width of 50 cm and a height of 15cm. Another tray with a width of 80 cm, 13 cm was used to make a water filtration place for this system before being re -pumped for reuse because this smart artificial used a recycled water system. For the water filtration part, a sponge was used as a filter device to filter the dirt before it was re -pumped through the piping system. The pipe used was a type of PVC pipe with a size of 20MM (3/4 "). The pipe system was built with a height of 30 cm with a length of 75 cm where it were placed with a frame made using aluminum rods.

In addition, the pump used an aquarium pump that SOBO brand with model WP-205K, frequency 50/60Hz and 5 Watts of power. This technology used a jar incubation system by using 1.5L plastic jars and perforated plastic incubation tray with size 17cm x 25 cm. The total number of jars and trays used in this system were 3, where the jars were placed on aluminum sheets to keep the jars in a stable condition with a width of 15cm x length 70 cm. Plastic rod was used as a place for water to come out of the piping system and into the plastic jar. The length of the plastic rod was 25cm and was placed in the center of the jar. This technology system was created at the Aquaculture Workshop, University Malaysia Kelantan, Jeli Campus and was tested at Extension Center in Jitra, Kedah

The technology had taken 4 weeks to create and full functional and were tested on Tilapia fish eggs. This technology design with a small size compared to the real artificial incubator system used in the hatchery or house for the incubator system. The technology was designed to be used in laboratories for studies involving fish eggs and incubator systems with the appropriate size of technology for laboratory use.

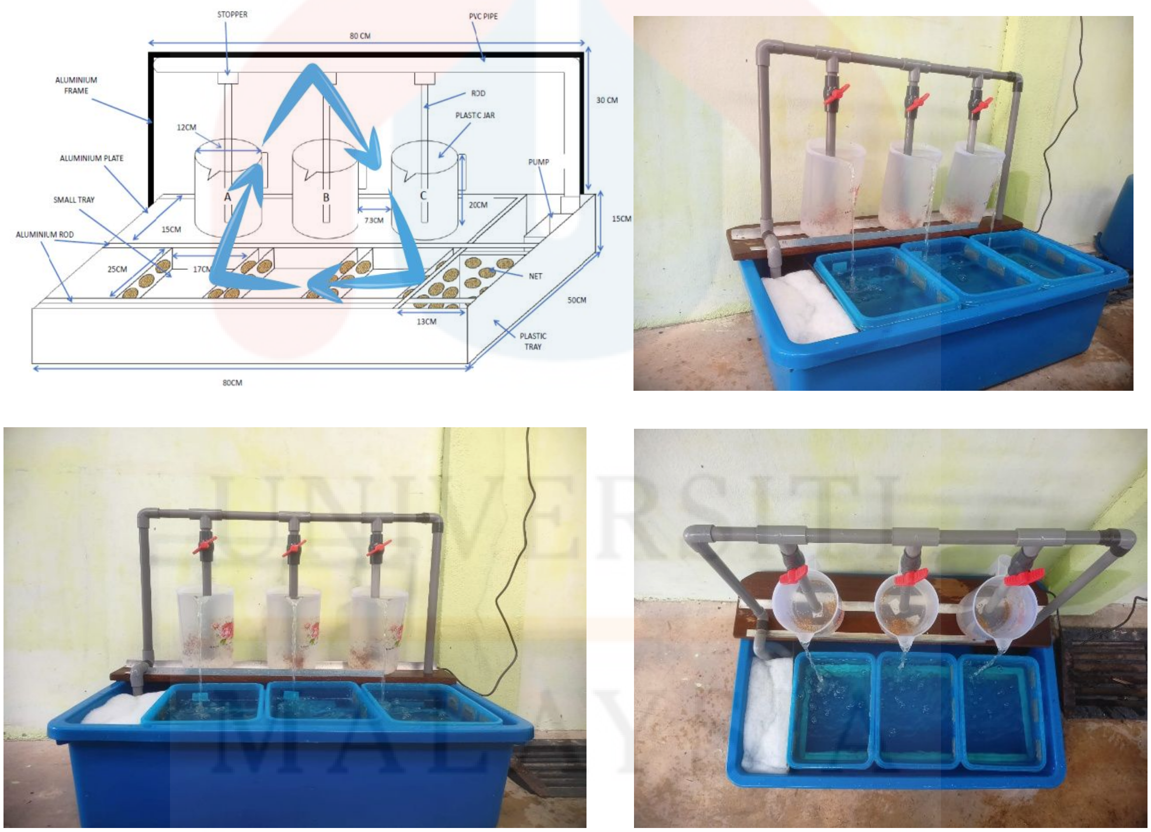


Figure 3.1.1:Smart Artificial Incubator Design

3.1.2 Cost of Smart Incubation System

Table 3.2.1 below shows a list of materials and equipment used to create this technology for example pipes, pumps, glue and others

Table 3.1.2: Total cost of the materials used to create the smart incubation system

EQUIPMENT	PRICE(RM/UNIT)	QUANTITY	TOTAL
WATER PUMP	30	1	30
PIPE	20	-	20
GLUE	5	1	5
PLASTIC TRAY	12	5	50
PLASTIC JAR	10	4	40
ROD	5	4	20
ALUMMINIUM BOARD	10	1	10
NET	10	1	10
SPAN	30	1	30
PLATE	20	1	20
	TOTAL PRICE		235

Table 3.1.2 Showed total cost of raw materials used in this study of smart incubation system.

3.2 Methods

3.2.1 Artificial Incubator Trial

Firstly, 6000 *Oreochrimis niloticus* eggs were used and reared from the first day the eggs were placed in the incubator until the 11th day which was the fry stage. Artificial incubator was tested at the aquaculture Extension Center in Jitra, Kedah. The egg experiment was performed on 1 treatment, namely Smart Artificial Incubator and 1 normal incubation (Incubator system in hatchery). Each treatment consisted of 3 labelled with A, B, and C (Smart Artificial Incubator and normal incubation) where each jar had been filled with 1000 eggs. Next, Nile Tilapia eggs were put into each jar at 8.00 am after the robbing process was done. Eggs in jars for treatment and control were monitored 2 times a day at 8.30 am and 5.00 pm. The monitoring process was conducted for 11 days. Water quality parameters such as water pH, water temperature, ammonia and dissolved oxygen were monitored during this study to avoid affecting the rate of egg yolk pressure and survival rate of fry in the incubator system.

3.2.2 Eggs Hatching Sampling

Eggs in the incubation system were monitored twice a day at 8.30 a.m. and 5.00 p.m. for 4 days because the time taken to complete the hatching process was 48 hours to 96 hours or 2 to 4 days. During the monitoring of the eggs, the damaged eggs were removed and the total of all damaged eggs during the monitoring were recorded in the daily data. The total number of hatching eggs were calculated after all hatching was completed in each jar on the 4th day for Smart Artificial Incubator and the Real Artificial Incubator System. The resulting hatching eggs in each jar was calculated then the egg hatching rate calculation was calculated to find out the percentage for the hatching rate of eggs for each jar.

3.2.3 Survival Rate of Fry Sampling

The starting data for the sampling of survival rate of fry was taken from the data generated for the egg hatching rate for each jar which were 3 jars for treatment 1(Smart Incubator) and 3 jars from control (Control Incubator System). The data was taken starting on the 5th day after the stage of egg hatching occurs completely on the 4th day, where on the 5th day they were called as larvae. In the process of sampling the life rate of larvae to reach the fry stage, each jar was monitored twice a day at 8.30 a.m. and 5.00 p.m. for the 6 days. During the 6 days of larvae monitoring, the total number of dead larvae were recorded in the daily data for each jar. The percentage of survival rate of fry was calculated on the 11th day to determine the percentage of life rate produced for each jar.

3.2.4 Others Parameter

Dissolved oxygen, pH, and temperature were monitored and tested twice a day, at 8.30 a.m. and 5.00 p.m., in the Smart Artificial Incubator and Real Artificial Incubator Systems, using a tool to check water quality which was DO meter, ammonia calorimeter, and pH meter

3.2.5 Volume of Water in the Incubator System

Water was filled into the tank until it reached the water level, 70L for the Treatment Incubator system tank and 15000L for the Control Incubator system and no water exchange needed..

3.2.6 Data Analysis

Data were analyzed with One -Way Anova Test for statistical data analysis. Data calculation based on the percentage of hatching egg and survival rate of fry for Tilapia. Duncan Multiple Test was used in order to compare the data collected and analysed.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Eggs Hatching of *Oreochromis niloticus*

One of the major factors that has a direct impact on the sustainability and productivity of any aquaculture system is the economics of seed production. Artificial incubation systems' practical and economic benefits are dependent on efficient water consumption and high rates of survival during incubation, both of which need be adjusted and standardized before commercial systems are established.Many types of artificial incubation systems are designed to be used but the jar incubation system is a good artificial incubation system to use and it is also widely used for the production of *Oreochromis niloticus.* Although artificial hatching systems that use jars are cheap, easy to create, more transparent and easy to operate. The Nile Tilapia egg hatching system requires a special structure to hatch and a sufficient amount of water for the circulation of eggs in the jar. The system is recirculating water system.

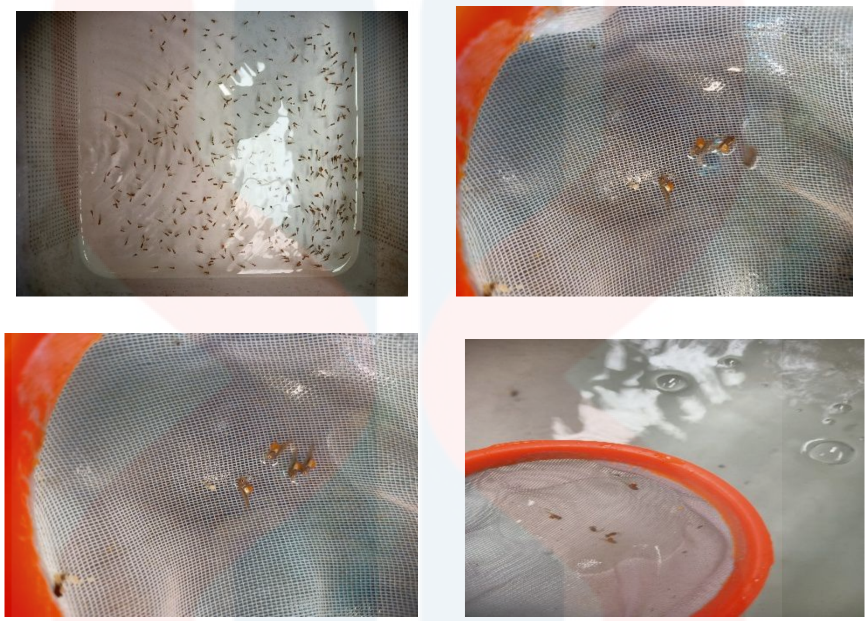
The results of this study show that the water consumption for Control Incubation system is 15 000 L of water compared with Incubator Treatment system is 70 L of water required to work well. For each systems have 3 jars, the amount of water used for each jar is 1.5 L with an incubation capacity of 1000 eggs. In this experiment, two incubation systems were tested, namely Control Incubation and Incubator Treatment systems as an alternative to jar incubation system. Control incubation systems are commonly used and built by the government for the incubation of Nile Tilapia eggs using high cost, difficult to operate, difficult to build and others.This system is best suited for types of eggs that are completely submerged and not sticky such as catfish eggs. The results of this experiment showed that Control Incubation requires a large amount of water that is 15 000L compared to the Incubator Treatment which uses 70L water for this system to work. This result suggests that there is Incubator Treatment has the advantage in terms of low water consumption compared to the Control Incubation system used to incubate Nile Tilapia eggs.

The hatching rate for Control incubation and Incubator Treatment of this system takes four days for the hatching process to take place completely. In another study on *O. niloticus*,4th day where the day that all hatching should take place completely between 70-90 hours (Courtesy: DG Mackean, 2011).The result in Table 4.1 showed the percentage of eggs hatching of Nile Tilapia that applied on Control Incubation system and Incubator Treatment system.It was found that there was difference percentage of eggs hatching In Control Incubation compared to the Incubator Treatment (Table 4.1) as shown in graph above where Incubator Treatment took 4 days for the Nile Tilapia eggs to hatch completely by 89.17% meanwhile Control Incubation also took 4 days for the Nile Tilapia eggs to hatch completely by 74.40%. The percentage of eggs hatched for the Control Incubation system and Incubator Treatment system is not the same due to the water quality parameter readings are not the same. In Table 4.1 shows the uneven hatching of eggs due to different water quality factors for each Treatment. In Table 4.1, shows the percentage of different egg hatching due to different water quality factors for each Treatment. The temperature factor is a very important factor in hatching.

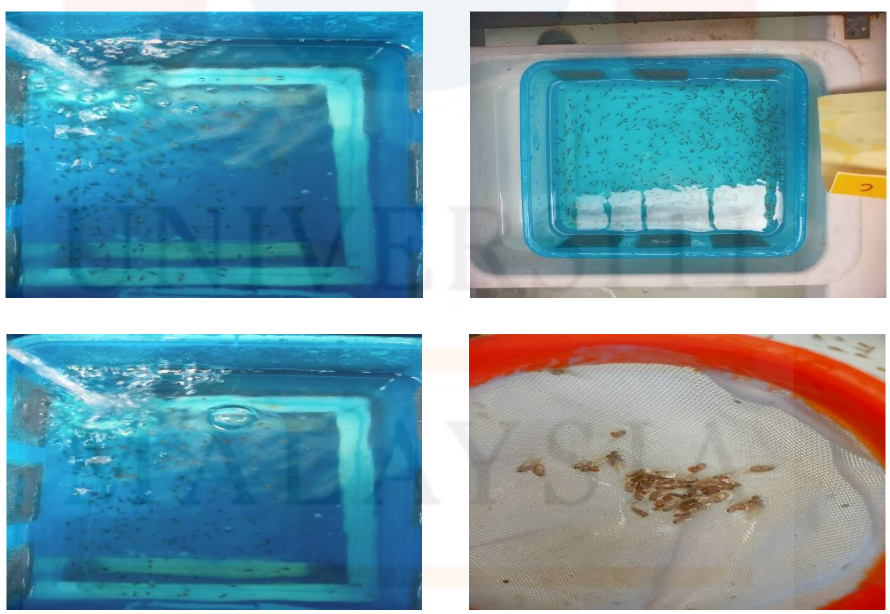
In appendix A shows the water temperature readings in each system that give different percentages of Nile Tilapia eggs hatched. These findings back with previous research that suggests temperature has an impact on egg and larval development by influencing metabolic rate (Blaxter, 1992; Kamler, 2008) and cellular function (Somero and Hofmann, 1997). Environmental parameters such as pH, temperature, salinity, and others have a significant impact on development (Sawant et al., 2001). Changes in pH can have a significant impact on egg production, fertilisation, hatching, proper embryo and larval growth, and survival.

Table 4.1:Percentage of egg hatching for Control system and Incubator Treatment system

Treatment	Number of eggs per jar		Day 0	Day 1	Day 2	Day3	Day 4	Total
Control Incubation	1000	Total Hatching	0	338	979	829	86	2232
		Percentage (%)	0	11.27	32.63	27.63	2.87	74.4
Incubator Treatment	1000	Total Hatching	0	397	1102	906	270	2675
		Percentage (%)	0	13.23	36.73	30.2	9	89.17



a) Control Incubation on 4th day



b) Incubator Treatment on 4th day

Figure 4.1Control Incubation and Incubator Treatment for the Egg Hatching

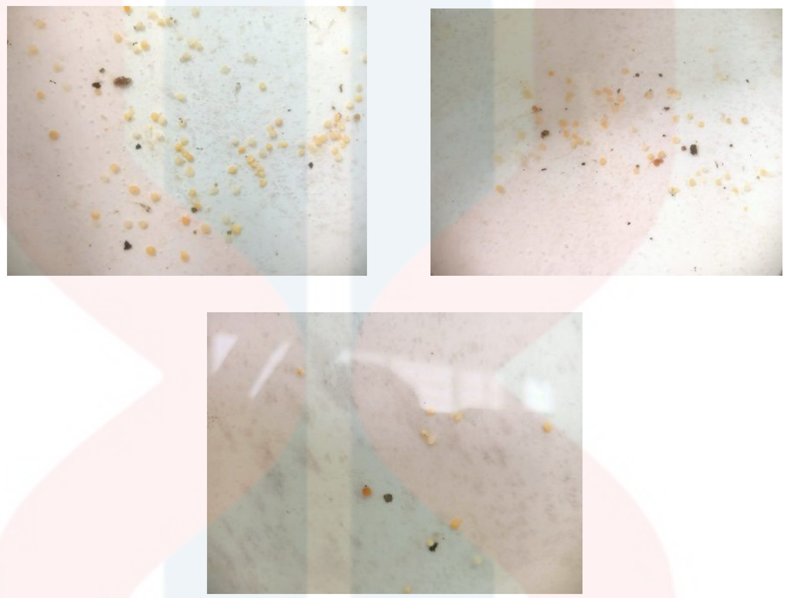
4.2 Eggs Damaged of *Oreochromis niloticus*

Table 4.2 shown the Percentage of eggs damaged during the egg hatching process for Control Incubation and Incubator Treatment. In less than 24 hours for Control Incubation and Incubator Treatment there is 0% number of damaged eggs as shown in the Table 4.2. After 24 hours on day 1, there the percentage of total damaged eggs for Control Incubation is 15.3% and for Incubator Treatment is 6.83%.On the 2nd day the percentage of damaged eggs for Control Incubation is 6.83% while for Incubator Treatment 2.5%.Next is on the 3rd day, the percentage of damaged eggs for Control Incubation is 3.47% and for Incubator Treatment is 1.86%.On day 4, the percentage of damaged eggs for Control Incubation and Incubator Treatment was 0%. The total percentage of damaged eggs for Control Incubation was 25.6% where the percentage of completely hatched eggs was 74.4% only. For Incubator Treatment, the total percentage of damaged eggs was 10.83% and completely hatched eggs was 89.17%. The percentage of damaged eggs for each treatment is due to the different water temperature factors for each treatment.

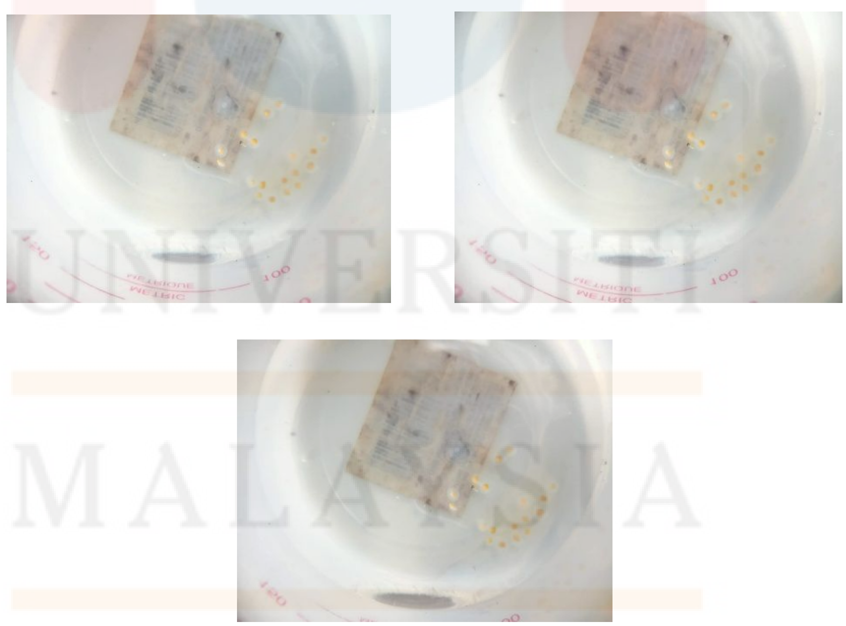
Table 4.2: Percentage of eggs damaged during the egg hatching process for Control Incubation and Incubator Treatment

Control Incubation	Total spoiled	0	459	205	104	0	768
	Percentage(%)	0	15.3	6.83	3.47	0	25.6
Incubator Treatment	Total spoiled	0	194	75	56	0	325
	Percentage(%)	0	6.47	2.5	1.86	0	10.83

Despite differences in dissolved oxygen and pH, ammonia levels were less than 0.01 mg/L, which was below acceptable limits for Tilapia egg development (Beveridge and McAndrew, 2000). In Appendix A shows the water temperature readings for each treatment. Factors of high water temperature above 30 ºC or water temperature readings approaching (30 ºC) cause damage to Nile Tilapia fish eggs. These findings back up previous research that suggests temperature has an impact on egg and larval development by influencing metabolic rate (Blaxter, 1992; Kamler, 2008) and cellular function (Somero and Hofmann, 1997). Temperature increases are known to speed up metabolism via biochemical activity triggered by heat energy (Beveridge and McAndrew, 2000), resulting in improved fish egg development. This process also resulted in a larger hatchability rate at higher temperatures and a lower hatchability rate at lower temperatures, as El-Gamal reported in *C. carpio* between 27 and 30°C (2009)



a) Control Incubation



b) Incubator Treatment

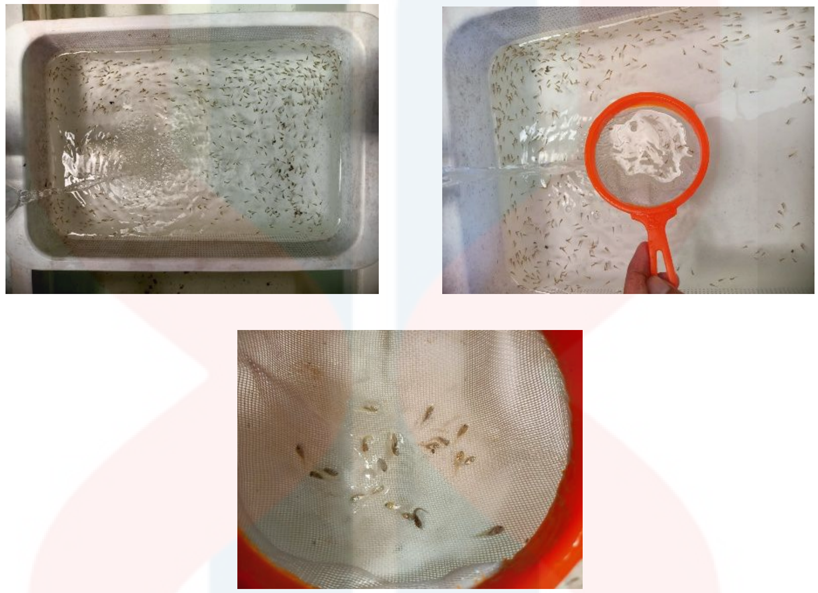
Figure 4.2 Control Incubation and Incubator Treatment for the Damaged Egg

4.3 Survival Rate of Fry (*Oreochromis niloticus*)

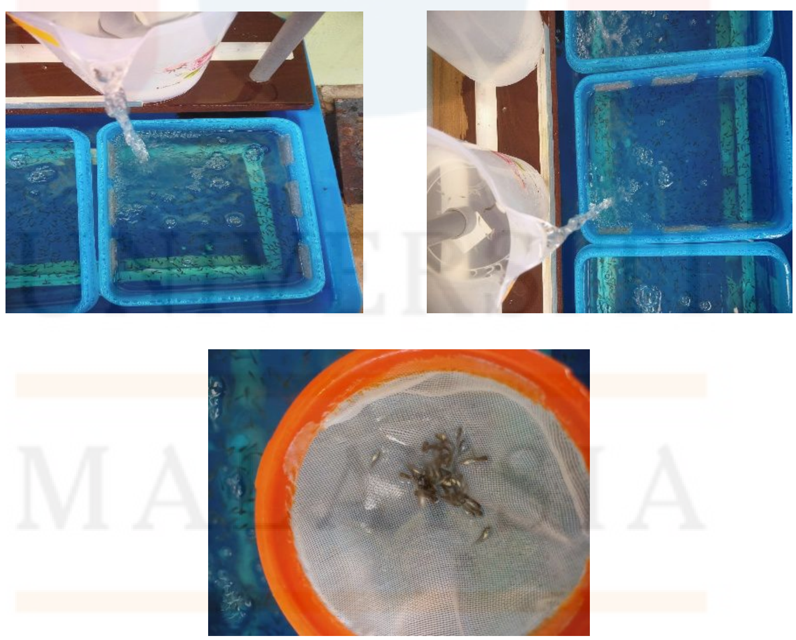
The result in Table 4.3 showed the survival rate of fry Nile Tilapia after 10days in each treatment tested using Control Incubation systems and Incubator system.It was found that there were differences survival rate of fry in Control Incubation system compared Incubator Treatment system. On the 10th day of this study tested on each system, Incubator Treatment system produced a high survival rate of fry on the 10th day which is 82.53% compared to the Control Incubation system which is 67.30%.

Table 4.3:Mean incubation period,eggs hatching rate and fry survival rate of *Oreochromis niloticus* in different systems.

Parameters	Smart Fin-Tech Incubation	Control Incubation
Number of egg incubated	3000	3000
Number of egg per jar	1000	1000
Incubation period (days)	10	10
Hatching rate (%)	89.17	74.4
Fry survival rate at 10-days (%)	82.53	67.3



a) Control Incubation



b) Incubator Treatment

Figure 4.3 Control Incubation and Incubator Treatment for the Survival rate of fry Nile Tilapia

4.4 Mortality of Fry *(Oreochromis niloticus)*

The result in table 4.4 showed the mortality of fry for each treatment caused by water quality parameter.From the table 4.4, percentage mortality of fry Nile Tilapia for Control Incubation system is 7.10% compared Incubator Treatment is 6.63%. Mortality of fry for each system is due to water quality parameters. Mortality of fry is due to high water temperature. In Appendix A shows the temperature readings for each system. Water temperature readings for each system recorded a temperature reading of 28ºC and above, this causes the death of fry Nile Tilapia occurs. Water temperature is one of the most important environmental factors affecting fish physiological responses of growth and feed utilization.

Table 4.4: Percentage of Fry (*Oreochromis niloticus)* Mortality for Control system and Incubator System

Treatment		Total Mortality
Control Incubation	Mortality	213
	Percentage(%)	7.10%
Incubator Treatment	Mortality	199
	Percentage (%)	6.63%

The ideal temperature for Nile Tilapia growth and reproduction was found to be between 22 to 32 C. (Beamish 1970; Caulton 1982; El Gamal 1988), with a temperature of 28°C. for fry..In the present study the water temperature for Control Incubation system and Incubator Treatment system is between 28.40ºC -30.55ºC with the mean of 30.01ºC for the Control Incubation system and 29.17 ºC for the Incubator Treatment system. In appendix A the pH reading is stable which is between 6.98 -6.97 for each system. The mortality factor of fry is unaffected by this pH measurement. Nile Tilapia, despite the fact that pH is the most important element determining water quality. Extreme pH has been shown to have a severe impact on fish development and reproduction (Zweig et al., 1999), as well as causing significant death in fish (Zweig et al., 1999). According to El-Sherif and El-Feky (2009), the optimal range of water pH for rearing Nile Tilapia, *Oreochromis niloticus*, is between 7 and 8.

According to Nobre, Lima, and Magalhes (2014), the best pH range for farming Nile Tilapia juveniles is between 5 and 8, with the species adapting and growing well in mildly acidic waters. Similarly, Oreochromis niloticus juveniles maintained in acidic waters as low as pH 4 showed higher growth performance, high survival, and low mortality rates, according to Rebouças et al. (2015) and Wangead, Geater, and Tansakul (1988). Tilapia can survive in a pH range of 5 to 10, although they thrive in a pH range of 6 to 9.. During the experiment, there were only minor changes in the levels of dissolved oxygen.

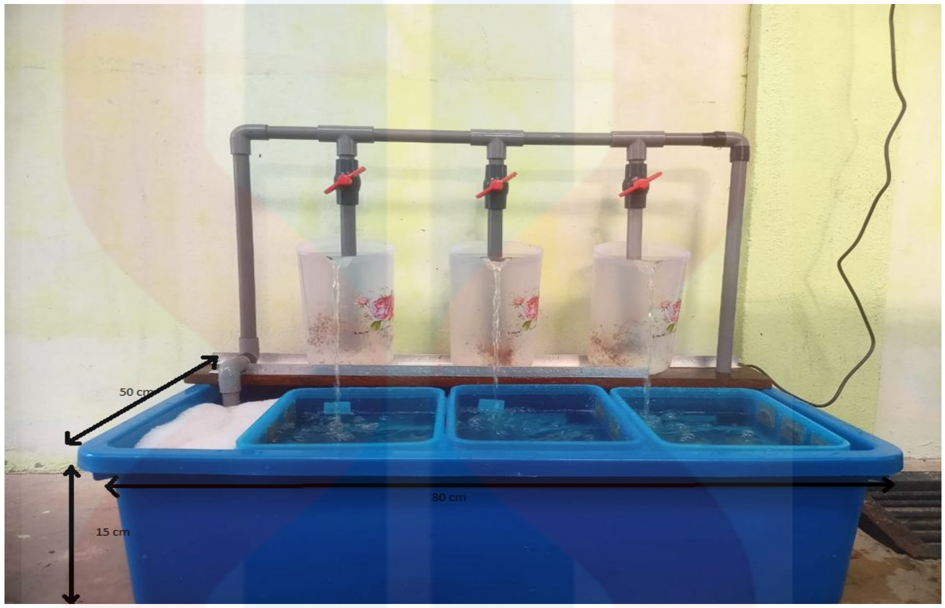
In Appendix A shows the dissolved oxygen readings during this study performed for each treatment. The values of dissolved oxygen ranged for Control Incubation system between 3.88 mg/l to 4.68mg/l compared to Incubator Treatment system between 4.42 mg /l to 6.86 mg/l. The lowest value of dissolved oxygen was 3.88 mg/l in the Control Incubation system and the highest value was 6.86 mg/l was observed in the Incubator Treatment system.

Whereas, the mean values of dissolved oxygen were noticed lowest (4.27 mg/l) in Control Incubation system and highest (5.96 mg/l) in Incubator Treatment system respectively (Appendix A) .Dissolved oxygen concentration in water, plays a vital role during fish culture. Tilapia survives dissolved oxygen (DO) concentrations of less than 0.3 mg/l, considerably below the tolerance limits for most other cultured fish. In research studies by Trewavas (1983). Nile Tilapia grew better when aerators were used to prevent morning DO concentrations from falling below 0.7 to 0.8 mg/l compared with unaerated control ponds (Trewavas, 1983). The ideal DO for Nile Tilapia growth is over 5 mg/L, according to Riche and Garling (2003). Other researchers, on the other hand, have demonstrated that Nile Tilapia can endure high oxygen super saturation levels of up to 40 mg/L. (Tsadik and Kutty, 1987). Ross (2002) stated that a DO concentration of 3 mg/L should be the absolute minimum for Tilapia growth. In this study, ammonia did not affect the mortality of fry Nile Tilapia due to the low ammonia value for each treatment.

In appendix A the average value of ammonia recorded for the Control Incubation system was 0.01 mg/L and for the Incubator Treatment system was 0.16 mg/L. Burkhalter and Kaya (1977) found that at concentrations of un-ionized ammonia ranging from 0.05 to 0.37 mg/L, the effects of ammonia on fertilised eggs and the ensuing sac fry of rainbow trout (Salmo gairdneri) were excellent. The recommended level of nitrite for fish farming was <0.3 mg L-1 (Boyd, 1998). Alim (2005) recorded nitrite concentration ranging from 0.00 to 1.021 mg/L

4.5 Size of the Incubation System

Figure 4.5 shows the size of the incubation system for the Treatment Incubator System and Control Incubation system at the Aquaculture Extension Center in Jitra, Kedah. The tray size used for Treatment Incubator system with a length of 80 cm, a width of 50 cm and a height of 15cm compared to the Control Incubation System with a length of 800 cm, a width of 100 cm and a height of 60 cm. Due to its small measurement the treatment incubator system is more suitable to be used in laboratory compared to the control incubation system which where was way bigger.



a) Treatment Incubation System

b) Control Incubation System

Figure 4.5 Control Incubation and Treatment Incubator for the Size of Incubation System

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The results of this study showed the effect from the treatment of artificial incubation to Nile Tilapia (*Oreochromis niloticus*). The parameters of egg hatching percentage and survival rate of fry for Smart Artificial incubator system show a higher percentage compared Control Incubation. Thus, this study proved that the maximum egg hatching and survival rate of fry for *Oreochrimis niloticu*s were succesfully achieved when the Smart Artificial incubator was used as another means as the *Oreochromis niloticus* egg hatching system. Even though the control incubation system show similar effect to egg hatching and survival rate of fry, the Smart Artificial incubator system exhibit more higher percentage value in egg hatching and survival rate of fry for *Oreochromis niloticus*.

The best suitable technology selected as an alternative technology for the use of breeders is Smart Artificial incubator system due to few factors. First is the percentage of hatching of Nile Tilapia eggs is better shown by this treatment through several parameters recorded and has significant differences compared to Control.In addition, Smart Artificial incubator recorded the highest survival rate of fry Nile Tilapia which is 82.53% compared to Control Incubator which is 67.3%. Aside from that, the material cost (Table 3.1.2) to create Smart Artificial incubator was cheaper that Control Incubator. Therefore Smart Artificial incubator is considered as an efficient and effective system technology for use in breeding field especially once in the breeding of Nile Tilapia (*Oreochromis niloticus*) because it can help in overcoming the problem of high cost to create artificial incubators and can overcome the problems faced by farmers regarding the low production of Nile Tilapia fish seeds for small holder farmers.

To conclude, the overall results of the study indicate that the Smart Artificial incubator system can be applied and used to ensure the egg hatching and survival rate of fry can be produced with a high percentage rate and that this established Smart Artificial incubator system could serve as a productive model to support small scale farmers in Nile Tilapia (*Orechromis niloticus*) seed production.

5.2 Recommendation

Further research is needed to look at the experimental materials used to create this system to achieve the optimum level for egg hatching and survival rate of fry Nile Tilapia. The study on different type of technology artificial incubator for Nile Tilapia species were beneficial as well to help in improving the lacking information from this study. Next is the suggestion to farmer when to use this system in terms of water quality parameters that need to be controlled for example water pH, water temperature, dissolved oxygen and ammonia. Firstly is the water temperature, the best water temperature for smart incubation system is an average value of 29.17ºC. While for the average value of dissolved oxygen is 5.96 mg/l and the average pH value is between 6.97-6.98. Finally the average value of ammonia recommended when using this system is 0.16 mg/L. The above water quality values as in Table 5.2 must be followed to obtain the effectiveness of this system to function and obtain the best results.

Table 5.2 : Water quality parameter for smart incubation system

Parameter	Incubator Treatment
Dissolved Oxygen	5.96 mg/l
pH	6.97-6.98
Ammonia	0.16 mg/L
Water Temperature	29.17ºC

5.2.1 Advantages of Smart Artificial Incubator system

Among the advantages of using this Smart Artificial Incubator system is that embryonic development can easily be observed and monitored because this system is a system that can be observed from the outside, not the same as in the mouth of a fish that cannot be observed. In addition, the higher in egg hatching rate and survival rate of fry is due to the lack of environmental factors that can cause by egg damage and mortality of fry. Next advantage is cost, this system uses a low cost to design compared to the cost required to design in the hatchery. Finally, this system can be easily moved from one place to another place because this system is portable with a small size

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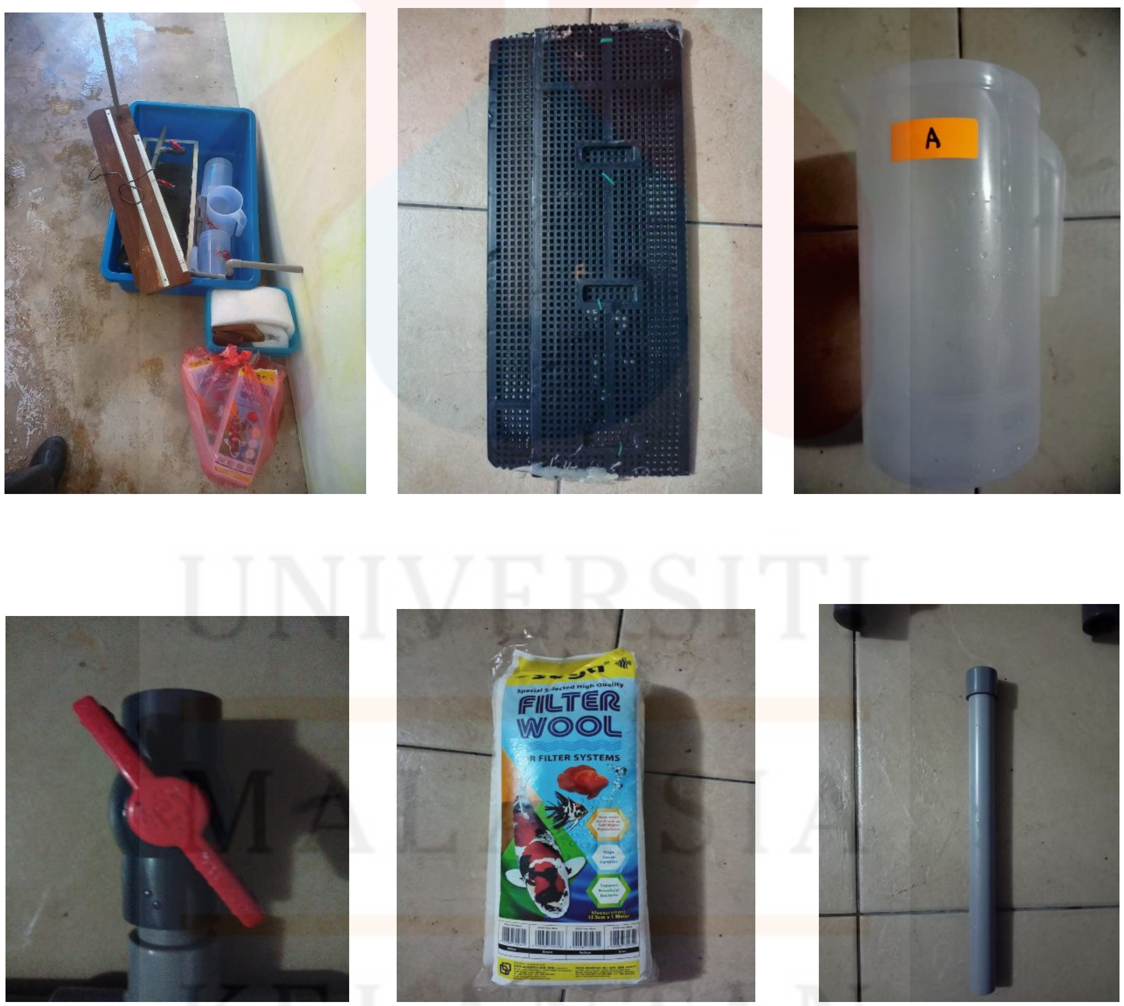
APPENDIX H

FIGURE H: EQUIPMENT AND MATERIAL




SOBO
aquarium
submersible pump
水陆两用潜水泵
WP-5000

APPENDIX I

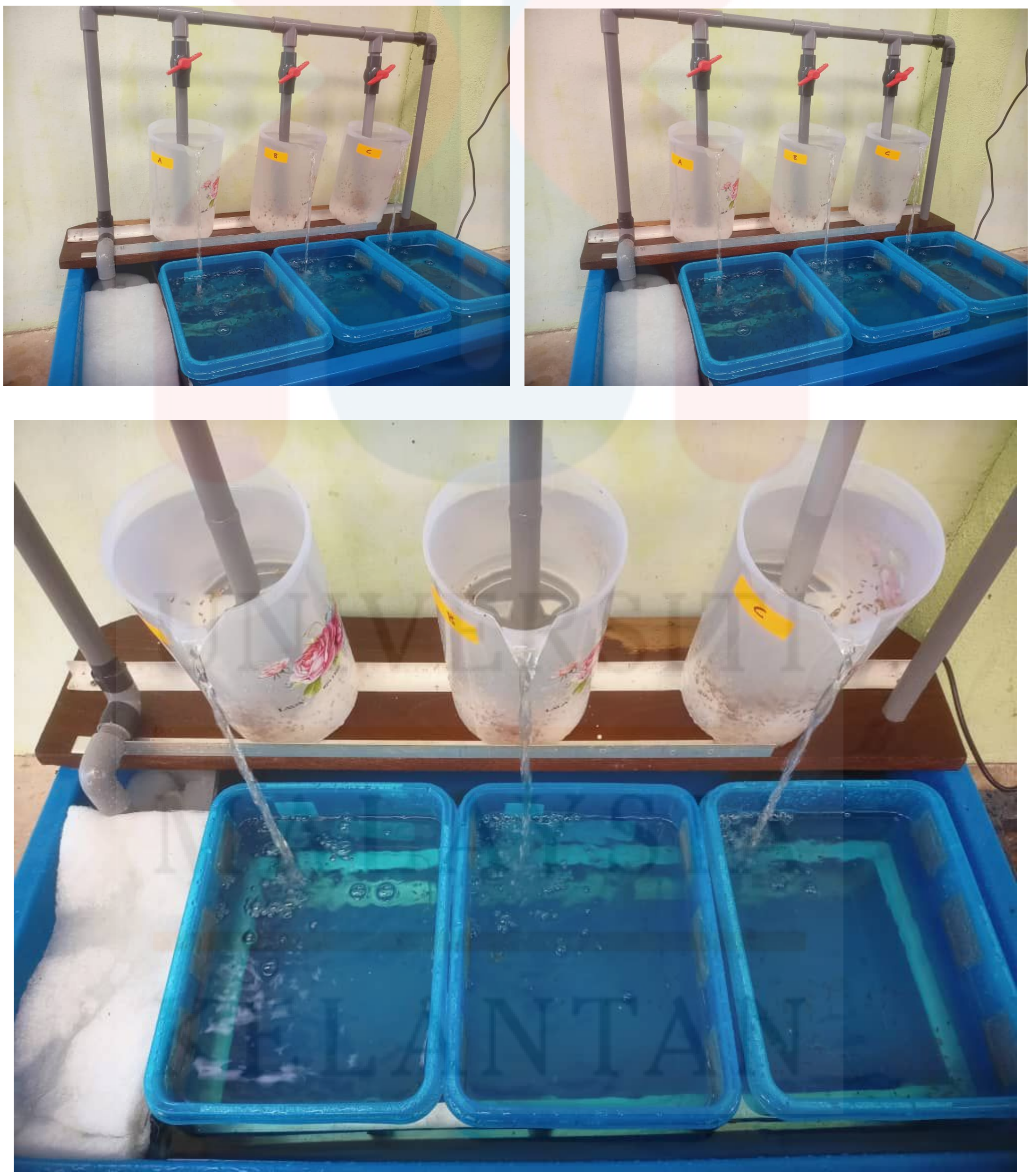
FIGURE I: APPERATUS

APPENDIX J

FIGURE J: Experimental of smart incubation system

APPENDIX K

FIGURE K : The smart incubation system



APPENDIX L

FIGURE L:Control Incubation system in PPA Jitra