UNIVERSITI PUTRA MALAYSIA

PERFORMANCE OF AN AUTOMATIC TEMPERATURE AND SALINITY CONTROL SYSTEM FOR FISH REARING

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the Degree of Master of Science

PERFORMANCE OF AN AUTOMATIC TEMPERATURE AND SALINITY CONTROL SYSTEM FOR FISH REARING

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October 2014

Chairman : Professor Wan Ishak Wan Ismail, PhD, IR
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Water temperature and salinity has significant effect in fish growth. Inappropriate temperature and salinity in the fish tank can develop disease for the fish and influence the profit gained by the fish farmers. It is important to develop a system that is able to control and monitor temperature and salinity in a fish tank. However, fish farmers prefer to use manual method. This is because manual method is easy and is available at lower cost. But by using man power, there is some limitation that appears like the data taken is not accurate and the data is not collected at the same time during the experiment. The objective of this research was to develop an automatic control system for temperature and salinity in the fish tank. Arduino Uno control board that is equipped with Atmega328 microcontroller is used to control and monitor temperature and salinity inside the fish tank. WZP-191 temperature sensor and Vernier salinity sensor is connected to the control board to measure temperature and salinity. The developed system was tested at FRI Pulau Sayak, Kota Kuala Muda, Kedah for 4 consecutive weeks to see the performance of the developed system. Besides that, the effect of temperature (at 25^{O}C and room temperature) and salinity (at 25 ppt and 30 ppt) on the *Lates calcarifer's* growth was also studied. Total of 150 *L. calcarifer*'s juveniles were used in this experiment. All the fishes were weighted and the lengths were measured every week to see the effect of different temperature and salinity combination to the fish. Data were analyzed by SPSS to determine the best temperature and salinity to grow *L. calcarifer* in tanks. Compared with another temperature and salinity combination in this study, result showed that Treatment 1 tanks (Temperature: 25^{O}C, Sa

linity: 25 ppt) was suitable to rear juvenile *L.calcarifer* as weight gain, SGR and PER were showing significant differences in the 2-way ANOVA test conducted. The mean weight gain ± standard error for the weight gain, SGR and PER for Treatment 1 tanks are as follows 17.02 ± 1.08 g, 2.25 ± 0.22 and 1.49 ± 0.14 correspondingly. It can be concluded that the developed system was able to control and monitor temperature and salinity in a fish tank. It is suggested that the fish farmers use the developed system in their fish tank to gain more profit.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PRESTASI SISTEM KAWALAN AUTOMATIK BAGI SUHU DAN KEMASINAN UNTUK PENTERNAKAN IKAN

Oleh

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Suhu dan kemasinan akan mempengaruhi pertumbuhan ikan. Suhu dan kadar kemasinan yang tidak sesuai boleh menyebabkan penyakit dan mempengaruhi keuntungan yang diperolehi oleh penternak. Oleh itu, adalah penting untuk membina satu sistem automatik yang mampu memantau dan mengawal suhu dan kemasinan air di dalam tangki ikan. Walaubagaimanapun, penternak lebih gemar menggunakan kaedah manual kerana kaedah ini lebih mudah dan mempunyai kos yang lebih rendah. Tetapi kaedah manual adalah tidak tepat dan data tidak diambil pada waktu yang konsisten. Objektif kajian ini adalah untuk membina sebuah sistem kawalan automatik untuk penternakan ikan di dalam tangki. Papan kawalan Arduino Uno yang dilengkapi pengawal mikro Atmega328 digunakan untuk mengawal dan memantau suhu dan kemasinan di dalam tangki ikan.Pengesan suhu WZP-191 dan pengesan kemasinan Vernier disambungkan kepada papan kawalan untuk mengukur suhu dan kemasinan. Sistem yang dibangunkan telah diuji di Pulau FRI Sayak, Kota KualaMuda, Kedah bagi tempoh 4 minggu berturut-turut untuk melihat prestasi sistem yang dibangunkan. Selain itu , kesan suhu (pada 25^{O}C dan suhu bilik) dan kemasinan (pada 25 ppt dan 30 ppt) terhadap pertumbuhan ikan siakap juga dikaji. Sejumlah 150 ekor juvenil *L. calcarifer* telah digunakan dalam eksperimen ini. Semua ikan ditimbang dan panjangnya diukur setiap minggu untuk melihat kesan gabungan suhu dan kemasinan yang berbeza terhadap pertumbuhan ikan. Keputusan eksperimen menunjukkan tangki dengan Rawatan1 (Suhu: 25^{O}C, Kemasinan: 25 ppt) paling sesuai untuk memelihara juvenil ikan siakap di mana pertambahan berat, SGR dan PER menunjukkan perbezaan yang signifikan berdasarkan analisis ANOVA yang telah dijalankan.Nilai purata ± ralat bagi pertambahan berat, SGR dan PER untuk ikan dalam tangki Rawatan 1 adalah seperti berikut 17.02 ± 1.08 g, 2.25 ± 0.22 and 1.49 ± 0.14. Kesimpulannya, sistem yang telah dibina mampu untuk mengawal suhu dan kemasinan di dalam tangki ikan dengan baik.

Adalah dicadangkan agar penternak ikan menggunakan sistem kawalan yang telah dibina bagi membantu meningkatkan hasil.

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I certify that a Thesis Examination Committee has met on the date of viva to conduct the final examination of Nur Lailina Makhtar on her thesis entitled **"PERFORMANCE OF AN AUTOMATIC TEMPERATURE AND SALINITY CONTROL SYSTEM FOR FISH REARING"** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Degree of Master Science

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AI	Analog Input
DAC	Digital Analog Converter
DO	Dissolved Oxygen
D/O	Digital Output
FCR	Food Conversion Ratio
I/O	Input/Output
PER	Protein Efficiency Ratio
ppt	part per thousand
SGR	Specific Growth Rate

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Aquaculture is a branch of agriculture that has less attention from public. This situation happens because agricultural sectors are focusing their interest and efforts to develop plants and inland animal technology. This is due to the difficulties in understanding the behavior and aquatic environment itself. During Seventh Malaysia Plan (1996-2000), aquaculture has been recognized as one of the important industry to supply food to the country. Due to its importance to the nation, aquaculture was notified as the third engine growth in the Eighth Malaysian Plan (2001-2005). Aquaculture was recognized as one of the most prolific sector when income per hectare per annum and return to investment was taken into account when comparing with another agricultural sector such as oil palm, rubber, paddy, fruits and vegetables. Besides that, this sector also acknowledged as a prospective essential export earner after oil palm and rubber (FAO, 2010).

Looking at the importance of aquaculture in increasing food supply, the third National Agriculture Policy (NAP 3) during 1998 to 2010 focused on expansion of sustainable aquaculture. The target during this period was to enhance aquaculture production to 600 000 tonnes by 2010. The expected growth was about 200% from the existing production of 200 000 tonnes.

In Malaysia, Department of Fisheries is one of the agencies that seriously doing research and contributes to the development of aquaculture industry. The interest are on breeding highly commercial valued fishes, finding the best method and technology to help fishermen increase their income and also train potential and interested parties to work in aquaculture sector.

Aquaculture development involves large land and water supply. Government identifies more than 400 000 ha of land and inland water resources that are suitable for aquaculture activity. However, other agriculture sector and other economic activities are also creating competition for the land requirement. To ensure food security and minimize the food import bill, agriculture industry, comprises with aquaculture received top priority by the government. By introducing Aquaculture Industrial Zone (AIZ), aquaculture industry receives about 40 000 ha land for development.

Malaysia had been successful in the breeding technology of different fish species through Department of Fisheries' research and training programme. However, there are

only a few or nearly no studies focusing on the development of the equipment for the better environment for the fish growth. Usually, after the breeding process was successful, the juvenile would be placed in a rearing tank before transferred to the sea. Mostly, the monitoring and controlling of the environment inside the tank was done manually by the workers. This would influence the accuracy of the treatment.

Therefore, this study is very important to increase the treatment efficiency after successful breeding process. Besides, it is important to make sure the fish fry are in good condition before getting ready to grow for the next stage. Simple and easy installation equipment needs to be developed to ease the unskilled labors' work. It is hoped that the proposed system will help to increase the aquaculture production for future development.

Optimum temperature and salinity plays an important role in ensuring fish growth. They not only directly effects the fish productivity but other water quality parameters are also depending on temperature and salinity content. For example, temperature is related to the Dissolved Oxygen (DO) content in the water, photosynthesis and decomposition rate, ammonia ionization and fish metabolic rate (Wedemeyer, 2001). Salinity on the other hand is associated with pH value. Any changes in salinity will give reverse effect on pH value of the water. Moreover, it is important to control water temperature and salinity because it effects fish growth. Automatic monitoring and control of water temperature and salinity in the fish tank can ensure maximum yield attained at the fish farm.

Usually, aquaculture research revolved around breeding technology and manual preparation of desired parameters such as pH, salinity and dissolved oxygen content in the tank. There is not many research published in the technology of automatically controlled environment inside fish tanks although it is known that water quality has a great significant effect on fish productivity. Besides that, it was found out that most of the research focused on using sensors to detect water quality parameters. However, the sensors were only used to monitor the environment inside the fish tank but not to communicate with a control system that would be able to automatically maintain the desired water quality.

Lates calcarifer or locally known as 'ikan siakap' was chosen in this experiment because it is a high economic value fish. The demand is high across countries in South-East Asia such as Singapore, Malaysia, Taiwan, Hong Kong and South Korea. Because of the sweet taste, it is usually served as cuisine in restaurants, hotels and caterings. In 2002, Malaysian *L.calcarifer*'s production from aquaculture project was 4004 metric tonnes with value of RM 46.2 million. National Economic Action Council (NEAC) has acknowledged *L.calcarifer* as a major species for cultivation besides giant freshwater prawn, tilapia and tiger prawn (MOA, 2014).

1.2 Statement of Problems

Simbeye et. al (2014) raised the issue of inefficient monitoring in the fish ponds in terms of water quality monitoring. Water quality monitoring is important because fish consume water during respiratory process. Unsuitable water quality can cause disease spread among the fishes. Huge losses was reported in several places such as salmon farm in Chile, oyster in Europe and marine shrimp farming in Asia, South America and Africa. These incidents were caused by disease spread that resulted from poor monitoring of water quality at the fish pond. As mentioned previously, current water quality monitoring is done manually by the workers. The workers will measure desired parameters such as temperature, pH, salinity, dissolved oxygen and others by using manual equipment like thermometers, refractometer (to measure salinity), pH meter and DO meter. The reading is then written in the monitoring book. However, the measurement is not taken at consistent time and depending on the availability of the worker.

In addition, manual measurements are time consuming, laborious and resulting in fewer measurements. The worker is not available during weekend, holidays and at night. This result in fewer measurements recorded and no real time monitoring in the fish tank. It will affect the accuracy of the data later on. The constraint on workers and working time make the manual procedure of controlling temperature and salinity difficult at certain time. So, it is important to develop a system that is able to automatically detect and correct the temperature and salinity inside the fish tank at any time changes occurs. The automatic monitoring system can measure and record the parameters in real time.

On the other hand, Harris et al. (1991) mentioned the gap between the latest technology and the user capability. The suppliers are not interested to deal with small, low price and custom setting up equipment. Thus, it is suggested that the ideal system must offer conveniences for the workers. The system must have simple procedures for instrument maintenance, offering consistent and correct monitoring of parameters and easy installation of the sensors into the system.

1.3 Objective of Study

The objective of this project is to develop an automatic monitoring and control system for temperature and salinity in the fish tank. Without this control system, the environment inside the fish tanks will be influenced by weather changes outside the fish tank. Hot season tends to make the temperature and salinity inside the fish tank higher while raining season making the temperature and salinity lower.

The aims of the study are as follows;

i. To investigate the effect of different temperature and salinity on *L.calcarifer*'s juvenile growth
ii. To determine the developed system's ability to maintain water temperature and salinity for duration of fish life

1.4 Scope of Study

The study was conducted on juvenile L.calcarifer reared in tanks at FRI Pulau Sayak, Kota Kuala Muda, Kedah. The parameters controlled and monitored were limited to temperature and salinity.

1.5 Significance of Study

Environment inside a fish tank will influence fish growth and effects on the yield gained by the fish farmers. However, the importance of maintaining optimum environment for fish rearing is always neglected because fish farmers prefer to use manual method.

This study is useful to the aquaculture industry because it introduces new equipment to control temperature and salinity in a fish tank. The developed system is suggested to overcome the problems caused by using manual method. It is hoped that the developed system can help to improve production in the fish farm. Besides that, the developed system would be user friendly and could be operated easily by the workers.

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