



**UNIVERSITI PUTRA MALAYSIA**

***DEVELOPMENT OF OPTIMAL FEEDING MANAGEMENT OF EARLY  
NURSERY CULTURE OF JADE PERCH (*Scortum barcoo* McCulloch &  
Waite, 1917) IN A RECIRCULATING SYSTEM***

**FIRAS MAHDI ABDALRODA**

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NURSERY CULTURE OF JADE PERCH (*Scortum barcoo* McCulloch &  
Waite, 1917) IN A RECIRCULATING SYSTEM**

By

**FIRAS MAHDI ABDALRODA**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfillment of the Requirements for the Degree of Master of Science**

**December 2017**

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## **DEDICATION**

*To my lovely country **Iraq** and Al-Qasim Green University*

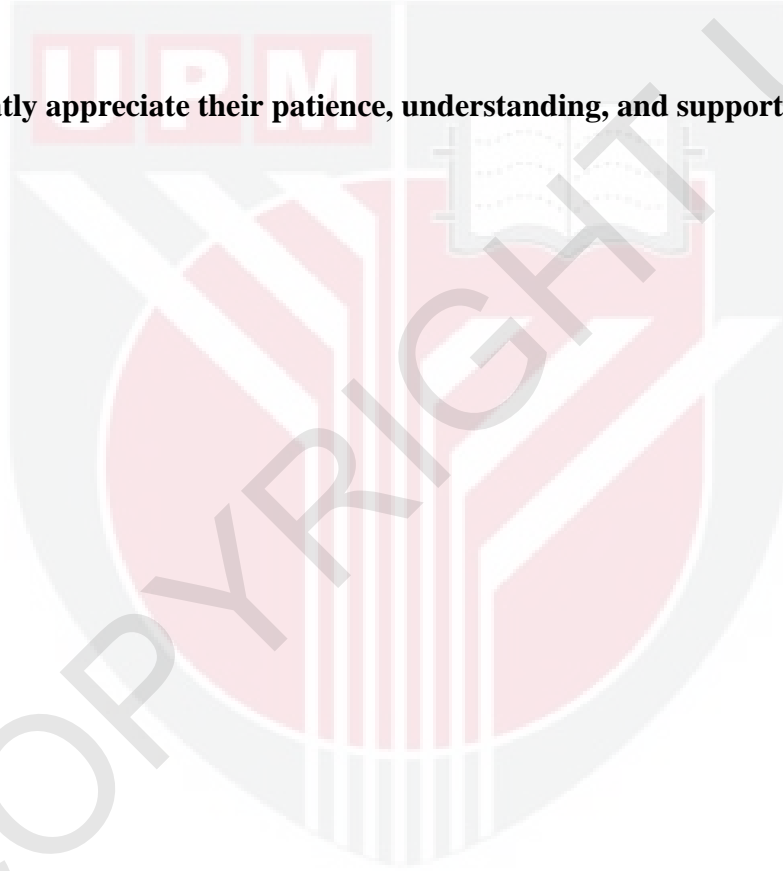
*To my beloved mother who always support of all of my endeavors, regardless of how seemingly outlandish, throughout my life and kept praying for me day and night to be what I am now and memory of my father*

*To sun of my life my wife, brothers, sister, daughter and son whose encourage, true love, constant trust and give me the power to achieve my goal*

*and*

*To roses that fill my world uncle Majed and my friends who always underpin me*

**I greatly appreciate their patience, understanding, and support over the years.**



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

**DEVELOPMENT OF OPTIMAL FEEDING MANAGEMENT OF EARLY NURSERY CULTURE OF JADE PERCH (*Scortum barcoo* McCulloch & Waite, 1917) IN A RECIRCULATING SYSTEM**

By

**FIRAS MAHDI ABDALRODA**

**December 2017**

**Chairman : S. M. Nurul Amin, PhD**  
**Faculty : Agriculture**

Over and underfeeding have negative effects on growth and survival rates. So, optimum feeding management strategy is critical to achieving optimal fish growth, with reducing wastage. Two experiments were carried out in this study to investigate the optimal feeding frequency and rates of juvenile Jade Perch *Scortum barcoo* reared in a recirculating system (RAS). Each experiment was designed in a completely randomized design in triplicate and a fish were fed the same floating diets (contained 43% crude protein and 6% crude fat). For the first experiment, Jade Perch mean weight  $\pm$  SE of  $7.28 \pm 0.13$  g were fed different frequencies that included once, twice, three, or four meals a day at 5% body weight per day for 72 days. Each replicate contained 65 fish. After 72 d, the survival, growth, feeding efficiencies, body indices, plasma biochemistry, whole-body proximate composition, and muscle cholesterol were measured while histological sections of the liver were stained for glycogen with Periodic-acid Schiff (PAS). Results showed that growth was best when fish were fed three times a day, which was significantly higher than those fed one, two or four times a day. Feeding efficiencies were significantly better for fish fed two or three times a day. Plasma glucose, plasma cholesterol, PAS staining intensity of the liver, and hepatosomatic index were significantly higher for fish fed three times a day compared with once a day. Whole-body crude protein was significantly lower for fish fed once a day compared with treatments of two or four times a day. Muscle cholesterol tended to increase with increasing feeding frequencies, but the results were not significant. No significant treatment effect was detected on the plasma mineral content. Based on a feeding rate of 5% body weight/d, it is recommended that feedings are divided into three meals a day to increase available energy for optimal growth. The second experiment was conducted to investigate the optimal feeding rates of 2%, 4%, 6%, or 8% body weight per day for juvenile Jade Perch (average initial weight  $7.45 \pm 0.09$  g). Each replicate

contained 50 fish and the experimental duration was 100 days. The results indicated that weight gain and feed conversion ratio increased significantly ( $P < 0.05$ ) as the rates of feeding were increased. Feeding rates had no effect on whole-body moisture, ash and protein, but crude lipid was significantly ( $P < 0.05$ ) higher in fish fed 8% per day. Although higher growth is achieved at 8% body weight per day, feeding efficiencies were reduced, which needs to be considered by the farmer depending on market demands and prices.



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

**PEMBANGUNAN PENGURUSAN PEMAKANAN OPTIMUM BAGI KULTUR AWAL SEMAIAN JADE PERCH (*Scortum barcoo* McCulloch & Waite, 1917) DALAM SISTEM EDARAN SEMULA**

Oleh

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Lebih dan kurang pemakanan mempunyai kesan negatif ke atas perkembangan dan kadar survival. Oleh itu, strategi pengurusan pemakanan yang optima adalah kritikal untuk mencapai pertumbuhan optima ikan, dan secara tidak langsung ia dapat mengurangkan sisa. Dua buah eksperimen telah dijalankan untuk mengkaji kekerapan dan kadar makan yang optimum bagi Jade Perch, *Scortum barcoo*, juvenil yang diternak dalam sistem berputaran semula (RAS). Setiap eksperimen telah dirancang dalam rekabentuk penuh rawak dengan tiga replikasi. Jade Perch telah diberi makan dengan diet terapong yang sama (mengandungi 43% protein mentah dan 6% lemak mentah). Bagi eksperimen pertama, berat purata Jade Perch  $\pm$  SE adalah pada  $7.28 \pm 0.13$  g dan telah diberi makan dengan kekerapan yang berbeza termasuklah satu, dua, tiga atau empat kali makan sehari pada kadar 5% berat badan sehari selama 72 hari. Setiap satu replikasi mengandungi 65ekor ikan. Selepas 72 hari, parameter bilangan yang hidup, tumbesaran, kecekapan makan, indeks badan, biokimia plasma, kandungan keseluruhan badan dan kolestrol otot telah diukur sementara keratan histologi hati telah diwanakan bagi glikogen dengan Periodic-acid Schiff (PAS). Keputusan menunjukkan bahawa tumbesaran terbaik didapati pada Jade Perch yang diberi makan tiga kali sehari. Ini memberi perbezaan yang ketara berbanding dengan yang diberi makan dengan satu, dua atau empat kali sehari. Kecekapan makan adalah lebih ketara bagi ikan yang diberi makan dua atau tiga kali sehari. Glukosa plasma, kolestrol plasma, intensiti pewarna PAS pada hati, indeks hepatosomatik didapati tinggi dengan ketara pada ikan yang diberi makan tiga kali sehari berbanding dengan sekali dalam sehari. Protin mentah keseluruhan badan adalah rendah dengan ketara bagi ikan yang diberi makan sekali dalam sehari berbanding rawatan dua atau empat kali sehari. Kolestrol otot meningkat dengan peningkatan kekerapan makan, tetapi keputusan adalah tidak signifikan. Tiada kesan rawatan yang ketara diperolehi atas kandungan mineral plasma. Berdasarkan kepada

kadar 5% berat badan/hari, adalah disyorkan makanan dibagikan kepada tiga kali makan sehari untuk meningkatkan kedapatan tenaga bagi tumbesaran yang optimum. Eksperimen kedua telah dijalankan untuk mengkaji kadar makan optimum 2%, 4%, 6%, atau 8% berat badan sehari bagi Jade Perch juvenil (purata berat permulaan  $7.45 \pm 0.09$  g). Setiap replikasi mengandungi 50 ekor ikan dan jangkamasa eksperimen adalah 100 hari. Keputusan menunjukkan bahawa peningkatan berat dan nisbah pertukaran makan meningkat dengan ketara ( $P < 0.05$ ) apabila kadar kekerapan makan bertambah. Kadar makan tidak memberi kesan keatas kelembapan badan keseluruhan, ash dan protin, tetapi lipid mentah meninggi dengan ketara ( $P < 0.05$ ) bagi ikan yng diberi makan 8% setiap hari. Walaupun kadar tumbesaran tercapai pada 8% berat badan sehari, kecekapan makan didapati mengurang dan ini perlu dipertimbangkan oleh peternak bergantung kepada permintaan pasaran dan harga.





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***Firas Mahdi Abdalroda Al-Khafaji, 2017***

I certify that a Thesis Examination Committee has met on 29 December 2017 to conduct the final examination of Firas Mahdi Abdalroda on his thesis entitled "Development of Optimal Feeding Management of Early Nursery Culture of Jade Perch (*Scortum barcoo* McCulloch & Waite, 1917) in a Recirculating System" 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 Master of Science.

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## TABLE OF CONTENTS

	<b>Page</b>
<b>ABSTRACT</b>	i
<b>ABSTRAK</b>	iii
<b>ACKNOWLEDGEMENTS</b>	v
<b>APPROVAL</b>	vi
<b>DECLARATION</b>	viii
<b>LIST OF TABLES</b>	xiii
<b>LIST OF FIGURES</b>	xiv
<b>LIST OF ABBREVIATIONS</b>	xv
<b>CHAPTER</b>	
<b>1 INTRODUCTION</b>	<b>1</b>
1.1 Objectives of the study	3
<b>2 LITERATURE REVIEW</b>	<b>4</b>
2.1 Taxonomy of Jade Perch	4
2.2 Distribution of Jade Perch	4
2.3 Identification Characteristics of Jade Perch	5
2.4 Reproduction of Jade Perch	6
2.5 Nutritional Value of Jade Perch	7
2.6 Jade Perch Culture	8
2.7 Feeding Requirement of Jade Perch	9
2.8 Feeding Management	9
2.9 Feeding Frequency	10
2.10 Feeding Rate	11
2.11 Recirculation Aquaculture Systems (RAS)	12
2.12 Automatic Feeders	13
<b>3 GENERAL METHODOLOGY</b>	<b>14</b>
3.1 Materials and Methods	14
3.1.1 Source of Experimental Fish and Set-up	14
3.1.2 Tank Set Up	15
3.1.3 Recirculation Aquaculture System (RAS)	16
3.1.3.1 Mechanical Belt Filter	17
3.1.3.2 Self-suction Pump	17
3.1.3.3 Two Foam Fractionator (Protein Skimmer)	17
3.1.3.4 CO <sub>2</sub> Degassing (Decomposition Filter)	17
3.1.3.5 Biological Trickling Filter Bed	17
3.1.3.6 Blower	17
3.1.3.7 Sub-flow Biological Filter Bed	17
3.1.3.8 High-intensity UV Disinfection Device	18
3.1.3.9 Sedimentation Tank	18

3.1.4	Water Quality	18
3.1.5	Data Collection	19
3.1.6	Plasma Biochemistry	19
3.1.7	Body Indices	20
3.1.8	Whole-Body Proximate Composition	20
3.1.9	Muscle Cholesterol Measurement	20
3.1.10	Chemical Analysis	21
3.1.10.1	Determination of Moisture	21
3.1.10.2	Determination of Ash	21
3.1.10.3	Determination of Lipid	21
3.1.10.4	Determination of Crude Protein	22
3.1.11	Statistical Analysis	22
<b>4</b>	<b>EFFECTS OF FEEDING FREQUENCIES ON THE GROWTH, PLASMA BIOCHEMISTRY, AND LIVER GLYCOGEN OF JADE PERCH <i>SCORTUM BARCOO</i> IN A RECIRCULATING SYSTEM</b>	<b>23</b>
4.1	Introduction	23
4.2	Materials and Methods	24
4.2.1	Liver Periodic Acid Schiff Staining	24
4.3	Results	25
4.3.1	Survival, Growth, and Feeding Efficiencies	25
4.3.2	Body Indices and Whole-Body Proximate Composition	27
4.3.3	Plasma Biochemistry	27
4.3.4	Liver PAS Staining	28
4.4	Discussion	30
4.5	Conclusion	32
<b>5</b>	<b>EVALUATE DIFFERENT FEEDING RATIOS ON THE GROWTH, PLASMA BIOCHEMISTRY, INTESTINAL SHORT-CHAIN FATTY ACIDS, FATTY ACIDS AND BODY COMPOSITION OF EARLY JUVENILE JADE PERCH (<i>SCORTUM BARCOO</i>) IN A RAS</b>	<b>33</b>
5.1	Introduction	33
5.2	Materials and Methods	33
5.2.1	Intestinal Short-Chain Fatty Acids (SCFA)	34
5.2.2	Fatty Acid Analysis	34
5.2.3	Lipid Peroxidation	35
5.3	Results	35
5.3.1	Survival, Growth and Feeding Efficiencies	35
5.3.2	Body Indices and Whole-Body Proximate Composition	38
5.3.3	Plasma Biochemistry	38
5.3.4	Fatty Acids	40
5.3.5	Intestinal Short-Chain Fatty Acids (SCFA)	42
5.4	Discussion	42
<b>6</b>	<b>SUMMARY, GENERAL CONCLUSION AND RECOMMENDATION</b>	<b>46</b>
6.1	Summary	46
6.2	Conclusions	46

6.3 Recommendation

47

**REFERENCES**

48

**BIODATA OF STUDENT**

64

**PUBLICATION**

65





## LIST OF TABLES

<b>Table</b>	<b>Page</b>
2.1 Fatty acids in different species	8
2.2 Feeding frequencies of different species	11
2.3 Feeding rations of different species	12
4.1 Mean ( $\pm$ SE) growth performance, feeding efficiencies and survival (%) of early juvenile Jade Perch ( <i>Scortum barcoo</i> ) fed at different frequencies for 72 days	26
4.2 Mean ( $\pm$ SE) whole-body proximate composition (% wet weight), muscle cholesterol ( $\mu$ g/ml), hepatosomatic index (HSI), viscerosomatic index (VSI), and condition factor ( <i>K</i> ) of early juvenile Jade Perch ( <i>Scortum barcoo</i> ) fed at different frequencies for 72 days	27
4.3 Mean ( $\pm$ SE) enzymes (U/L), lipid and glucose (mmol/l) and mineral content (mmol/l) in Jade Perch ( <i>Scortum barcoo</i> ) early juveniles when fed at different frequencies for 72 days	28
5.1 Mean ( $\pm$ SE) growth performance, feeding efficiencies and survival (%) of early juvenile Jade Perch ( <i>Scortum barcoo</i> ) fed at different Rates body weight per day after 100 days	37
5.2 Mean ( $\pm$ SE) whole-body proximate composition (% wet weight), muscle cholesterol ( $\mu$ g ml <sup>-1</sup> ), hepatosomatic index (HSI), viscerosomatic index (VSI) and condition factor ( <i>K</i> ) of early juvenile Jade Perch ( <i>Scortum barcoo</i> ) fed at different Rates body weight per day after 100 days	38
5.3 Mean ( $\pm$ SE) enzymes (U/L), lipid and glucose (mmol/l) and mineral content (mmol/l) in Jade Perch ( <i>Scortum barcoo</i> ) early juveniles when fed at different Rates per day after 100 days	39
5.4 Mean ( $\pm$ SE) fatty acids composition of the diet provided to early juvenile Jade Perch	40
5.5 Mean ( $\pm$ SE) fatty acids composition of early juvenile Jade Perch ( <i>Scortum barcoo</i> ) fed at different rates per day after 100 days	41
5.6 Mean ( $\pm$ SE) intestinal short-chain fatty acids (mmol) of early juvenile Jade Perch ( <i>Scortum barcoo</i> ) fed at different rates per day after 100 days	42

## LIST OF FIGURES

<b>Figure</b>	<b>Page</b>	
2.1	Jade Perch <i>Scortum barcoo</i> with two ellipse black patches	5
2.2	Jade perch <i>Scrotum barcoo</i> the other side no patches	5
2.3	The Y-shape of Jade Perch stomach	6
2.4	The fate inside Jade Perch	6
2.5	The eggs inside Jade Perch	7
2.6	An automatic feeder	13
3.1	Jade Perch fingerlings used for experiment	15
3.2	Set-up of the tanks used for the experiments	16
3.3	The recirculating system used in experiments	16
3.4	The biofilter in RAS used in experments	18
	Collecting blood sample from fish	19
4.1	Periodic acid Schiff staining of the liver of early juvenile Jade Perch ( <i>Scortum barcoo</i> ) fed (a) once, (b) twice, (c) three times, or (d) four times per day for 72 days. Fish fed three times a day tended to have more PAS-positive staining. Magnification 40×	29
4.2	Mean ( $\pm$ SE) area (%) stained by PAS in the liver of early juvenile Jade Perch ( <i>Scortum barcoo</i> ) fed at different frequencies for 72 days. Different letters indicate significant differences ( $P < 0.05$ )	29
5.1	Mean ( $\pm$ SE) intestinal short chain fatty acids (mmol) from Jade Perch <i>Scortum barcoo</i> early juveniles when fed at different rates body weight per day after 100 days	45

## LIST OF ABBREVIATIONS

%	Percentage
<	Less than
>	More than
<sup>o</sup> C	Degree Celsius
ALT	Alanine aminotransferase
ANOVA	Analysis of Variance
AST	Aspartate aminotransferase
cm	centimetre
CRD	Completely Randomize Design
CV	Coefficient of Variation
d	days
DO	Dissolved Oxygen
EDTA	Ethylenediaminetetraacetic acid
FCR	Food Conversion Ratio
g	gram
H	Hour
H <sub>2</sub> SO <sub>4</sub>	Sulfuric acid
HSI	Hepatosomatic Index
IU	International Union
<i>K</i>	Condition factor
Kg	kilogram
L	Liter
<i>L</i>	Length
m	meter
MDA	Malondialdehyde Assay
mg	milligram
Mg/L	Milligram per liter
mL	milliliter
mm	millimeter
MUFA	Monounsaturated Fatty Acid

N	Sample size
n-3	Omega-3
n-6	Omega-6
NaOH	Sodium hydroxide
p.a.	per annum
PAS	Periodic-acid Schiff
PER	Protein Efficiency Ratio
ppm	part per million
PUFA	Polyunsaturated Fatty Acid
RAS	Recirculating Aquaculture System
rpm	round per minut
SD	Standard Division
SE	Standard Error
SFA	Saturated Fatty Acid
SGR	Specific Growth Rate
SPSS	Statistical Package for Social Science
TL	Total Length
UPM	Universiti Putra Malaysia
USFA	Unsaturated fatty acid
VSI	Viscerosomatic Index
W	Weight

## CHAPTER 1

### INTRODUCTION

Worldwide, fisheries and aquaculture industry is very important source of food, nutrition, benefits and commercial income for hundreds of millions of people. According to FAO, (2016) report in 2014, each person around the world got 20 kg of fish, a high level as a result of the robust expansion in aquaculture, which supplies 50% of all fish consumed by the world's population. It is also responsible for a small, but significant increase of some fish stocks because of enhanced management of the fisheries industry. Moreover, fish has become one of the most significant traded food commodities with 50% in terms of value exported from developing countries around the world. Various organizations worldwide have emphasized the significance of the seas, oceans and inland waters and their potential in contributing to global food security and the required nutrition for a rapidly increasing world population that is projected to touch 9.7 billion by 2050 (FAO, 2016).

Fish consumption is increasing at the rate of 2.4% p.a. while population growth is projected to be 2% p.a. (FAO, 2006). Therefore, the population growth has exceeded that of fish as food since 1980, generating increasing consumption needs. As a result capture fisheries, have been overexploited by way of overcapacity and over fishing. As such, it is urgent to develop improved techniques to produce fish to adequately meet their market demands. Towards this, there has been a recent trend to diversify fish species in efforts to achieve the sustainability of aquaculture.

The Australian Jade Perch (*Scortum barcoo*) has been identified as an ideal species for fresh and brackish water aquaculture. Its suitability is based on the fact that it exhibits fast growth and are able to survive high density stocking in typical recirculating aquaculture systems (RAS). It is also known to feed on grow-out diets with very low fishmeal and fish oil content (Van Hoestenberghé *et al.*, 2013). In addition, Jade Perch could well become an important fishery resource due to many propitious characteristics: besides its rapid growth, it is also resistant to diseases, has high feed conversion, and excellent palatability (Chen *et al.*, 2011).

Environmental and economic concerns have prompted aquaculture production to move from open pond and cage culture systems to the more closely controlled recirculating systems (RAS). Despite the fact that RAS in aquaculture incur higher capital investment and operating overheads, in comparison with the more traditional cage culture and raceway or pond culture systems, RAS offers many advantages that make it commercially more viable. These advantages include a higher control over water quality to optimize productivity, ease of harvesting and flexibility in site selection (FAO, 2016).

A primary objective of today's intensive fish farms is higher productivity at low cost. Quality nutrition in animal production systems is crucial for the economic production of a healthy and top quality product. It is no different in fish farming, where proper nutrition is critically needed as feed constitutes a high 40-50% of the production costs. For this industry, the good news is the availability of new balanced commercial fish diets that facilitate optimal fish growth and health. Diets that are species-specific have been formulated to support the aquaculture industry in its efforts to meet the market demand for affordable, safe, and high-quality fish and seafood products (Craig and Helfrich, 2009). Diet cost could constitute as much as 70% of the overall cost of production of an aquaculture entry price, and this could increase with greater intensification of the administration (Webster *et al.*, 2001). One of the ways to reduce feeding costs is through proper feeding management, and this includes the optimal feed frequency and ration. Moreover, this can also minimize water quality deterioration. High-density systems cannot afford to make mistakes in managing their feeding regime as the results could lead to poor quality product, reduced performance and performance negative economic outcomes (Conte *et al.*, 2008). The predetermined rate and other efficient programming strategies are crucial to the culture system. In light of the above, it can be concluded that feeding and the many aspects of this activity emerge as one of the most important elements in commercial aquaculture.

Feeding frequency is necessary to ensure optimal growth performance and food conversion ratios of cultured organisms (De Silva and Anderson, 1994). Higher feeding frequencies reduce aggressive behaviour, which could encourage more rapid growth and uniformity in size. Additionally, feeding frequency can also have an affect survival, body composition (Zhou Z *et al.*, 2003) and water quality (Zakes *et al.*, 2006). Feeding frequencies, especially during the nursery culture of fish, are well acknowledged to affect productivity with younger fish oftentimes requiring more frequent feeding to support their relatively faster growth (Lee *et al.*, 2000a). However, overfeeding may lead to higher incidences of unconsumed feeds as well as potentially increased swimming activity, in anticipation of the next meal, that leads to excessive energy being spent ( Johansen and Jobling, 1998).

The optimal feeding rates have been determined for various fish species and sizes, and some of the influences to these can include the nutritional content of the feeds, water temperature, stocking density, and rearing system (Collins, 1971; Andrews and Page, 1975 ; Minton, 1978 ; Hung and Lutes, 1987; Hung *et al.*, 1989; 1993; 1995; Li and Lovell, 1992a; 1992b; Cho *et al.*, 2003). The most commonly used criteria for assessing the optimal feeding rates include growth performance, feed efficiencies, viscerosomatic index/hepatosomatic index, and body proximate composition (Cho *et al.*, 2006; 2007; Kim *et al.*, 2007; Okorie *et al.*, 2013). A few studies have also investigated histological changes and/or serological features in fish (Okorie *et al.*, 2014).

Currently, no information is available for Jade Perch fingerlings despite being of great interest to consumers as well as scientists. Although Jade Perch has been successfully cultured, there are many knowledge gaps regarding how to optimize their production though proper feeding management. Acquiring important information on the rates and frequency of feed will lead to optimal fish growth at minimal cost.

### **1.1 Objectives of the study**

The following are the objectives of the study:

- 1) To investigate the effect of varying feeding frequencies on growth performance and survival of Jade Perch in a recirculating aquaculture system (RAS).
- 2) To evaluate the impact of varying feeding rations on growth performance and body composition for the improvement of fingerlings rearing management of Jade Perch in a RAS.

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