Faculty of Resource Science and Technology

GROWTH PERFORMANCE OF TILAPIA USING SAGO (*Metroxylon sagu*) AS DIET

Florida Easter Anak Juat (23511)

Bachelor of Science with Honours
(Aquatic Resource Science and Management)
2012

Growth Performance of Tilapia Using Sago (*Metroxylon sagu*) as Diet

Florida Easter Anak Juat (23511)

This project is submitted in partial fulfilment of the requirements for the degree of
Bachelor of Science with Honours
(Aquatic Resource Science and Management)

Department of Aquatic Science
Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK
2012

DECLARATION

I hereby declare that no portion of the work referred in this project has been submitted in support of an application for another degree qualification of this or any other university or institution of higher learning.

Florida Easter Anak Juat

Department of Aquatic Science
Faculty of Resource Science and Technology
Universiti Malaysia Sarawak

Acknowledgement

I would like to express special thank to Dr. Khairul A. Rahim as my supervisor for his effort, guidance and support during this study. His knowledge and also experience during his study was tremendously important to assist me to conduct this experiment. Guidance and advised from my supervisor was helpful for me to complete my final year project.

Thanks to all contribution from my family and all my friends that help me a lot for the preparation of this final year project. My parents always keep their moral supports to ensure my success during my studies. My friends also always accompany me during the laboratory session in the Unimas External Laboratory.

My sincere thank also for the Science Officer of Faculty of Resource Science that always gave the approval for application of the laboratory during the experiment was conducted. Thank also to all the laboratory assistants especially Mr. Zulkifli Ahmad and Mr. Zaidi Ibrahim for their contribution in the laboratory management of my study in the external laboratory, Faculty of Resource Science and Technology.

Table of Contents

List of Tables

List of Figures

Growth Performance of Tilapia using Sago (*Metroxylon sagu*) as Diet

Florida Easter Ak Juat

Department of Aquatic Science
Faculty of Resource Science and Technology
Universiti Malaysia Sarawak

ABSTRACT

This experiment was conducted to test the formulated diets enhanced using different percentage of *Metroxylon sagu* (*M.sagu*) in order to observe the growth performance of *Oreochromis mossambicus* (*O. mossambicus*).Main objectives of this study were to determine the best percentage quantity of *M. sagu* for growth performance of *O. mossambicus* and to identify the suitability of diets formulated using *M. sagu*. Effects of formulated diets enhanced with *M. sagu* were evaluated for a period of 9 weeks. Fifteen individual fry were stock in each treatment and were feed daily with 30%, 50%, 70% of *M. sagu* and commercial diets which defined as Treatment A, Treatment B, Treatment C and Treatment D respectively. The length and weight of ten individual fry of each treatment was measured weekly while water quality parameter such as pH and Temperature were measured every two week. There was no significance different of mean weight and mean total length for all treatment at early experiment. However, there was significance different among treatment at end of experiment. Treatment D had shown the highest mean weight, mean total length and also specific growth rate. Treatment C had shown the highest survival rate among treatment. Further study on diet formulated enhance using plant based protein was recommended.

Key words : *Metroxylon sagu* , *Oreochromis mossambicus* , Growth performance

ABSTRAK

Eksperimen ini dijalankan untuk mengkaji diet yang diformulasikan dengan penambahan peratusan Metroxylon sagu (M. sagu) *untuk menilai kadar tumbesaran* Oreochromis mossambicus (O. mossambicus). *Obejktif utama eksperimen ini adalah untuk menentukan kadar peratusan kuantiti* M. sagu *yang optimum untuk tumbesaran* O. mossambicus *dan juga untuk mengenal pasti kesesuian diet yang diformulasi mengunakan pertambahan* M. sagu*. Kesan diet yang di formulasi dengan pentambahan* M. sagu *telah di nilai selama 9 minggu. Lima belas ekor anak benih ikan diletakkan di setiap rawatan dan diberi makanan setiap hari dengan 30%, 50%, 70% daripada* M. sagu *dan diet komersial untuk rawatan A,B,C dan D. Panjang dan berat daripada sepuluh anak benih ikan dalam setiap rawatan diukur setiap minggu manakala kualiti air seperti suhu dan pH diukur setiap dua minggu. Kajian mendapati bahawa tiada perbezaan yang signifikan di awal eksperimen untuk semua rawatan. Walau bagaimana pun, terdapat perbezaan yang signifikan di akhir eksperimen. Rawatan D menunjukan min panjang, min berat dan kadar tumbesaran spesifik yang paling tinggi. Rawatan C mempunyai kadar kemandirian yang paling tinggi berbanding rawatan yang lain. Kajian yang terperinci di masa depan dengan pertambahan tumbuhan beasaskan protein ke atas diet formulasi yang baru amatlah digalakkan.*

Kata Kunci : Metroxylon sagu , Oreochromis mossambicus , *kadar pembesaran.*

1.0 Introduction

Aquaculture of tilapia fish have great economic important and it is the most cultured fish in Malaysia. Tilapia is ranked the third in terms of production after carps and salmonids among the popular cultured fish in the World (El-Sayed, 2006). According to El-Sayed (2006), Nile tilapia currently dominates tilapia culture in Asia, with a production of 1001302 Metric tonnes in 2002 which representing 84% of total tilapia production in the continent.

High cost of feeds is the most recent issue of aquaculture in Malaysia. Feeding represents the largest part of expenses in intensive and semi-intensive aquaculture, so fish feed must be of good quality to assure high utilization, high growth rates within shorter periods and good health, as well as to prevent water pollution to the environment (Stankovic *et al*., 2010).

In order to reduce feeding costs while obtaining high fish production, study on diet formulation of fish made with plant sources need to improve to fulfill nutrient and energy requirements of fish in aquaculture. According to Gonzales *et al.* (2007), ingredients of formulated diet will be required modification which ingredients may shift from animals based ingredients to plant-based feedstuffs. To increase production of Tilapia in food industry, low cost and effective diets using plant sources such as sago (*Metroxylon sagu*) should be carried out.

Metroxylon sagu, famous in Sarawak are found throughout the coastal belt of Sarawak mainly in the river area of Mukah District. Karim *et al.* (2008) found that sago starch is the only example of commercial starch derived from the stem of palm (Sago Palm). McClathey *et al.* (2006) reported that *Mextroxylon* is of extreme importance to over a million people who use the palms as their primary dietary starch source. More research studies on *M. sagu* are still needed. The properties and nutrition of *M. sagu* have highly potential as food source for both humans and animals which also gain income in terms of economy for food industry. *Metroxylon sagu* is one of the important economic species and presently grown commercially in Malaysia, Indonesia, the Philippines and New Guinea for production of sago starch and conversion to animal food or fuel ethanol (McClathey *et al.*, 2006).

In aquaculture, *M. sagu* starch may be a good alternative food source especially in feeding of *Oreochromis mossambicus*. The main objectives of this study are to determine the best percentage quantity of *M. sagu* for growth performance of *O.mossambicus* and to identify the suitability of diet formulated using *M. sagu*.

2.0 Literature Review

2.1 The Nature of Tilapia

The name of ‘tilapia’ was derived from the African Bushman word meaning ‘fish’ (Trewavas, 1982 as cited by El-Sayed, 2006). According to El-Sayed (2006), tilapia will represent a large number of freshwater fish species within the family Cichlidae. Tilapia in are macrophyte-feeders in which the adult feed mainly on filamentous algae and higher aquatic plants. The genus *Oreochromis* are microphagous where their feeding regime consists principally of phytoplankton, zooplankton, detritus and benthic organisms (Lim *et al*., 2006). However, Lim *et al.* (2006) found that several species of this genus, such as *Oreochromis aureus*, *Oreochromis niloticus* and *Oreochromis mossambicus*, are primarily omnivores. Despite the diversity of food resources consumed by adult tilapia and *Oreochromis* spp., they are commonly regarded as opportunistic omnivores with a strong tendency towards herbivory. In aquaculture industry, Lovell (1987) found that tilapia consumed a variety of feed, in meal form and in moist, sinking and floating pallets.

Tilapia can tolerate with various environmental conditions. Lim *et al.* (2006) reported that tilapia can tolerate with temperature ranged between 20^{o}C to 35^{o}C and the reproduction will take place at 25^{o}C to 36^{o}C. Halver (1989) found that tilapia are tropical fish and do not survive below 10^{o}C.

This fish have desirable qualities for culture in the tropics in that they grow fast, use natural aquatic food effectively, accept a variety of supplemental feeds, reproduce readily under managed conditions and are tolerant to a range of water-quality conditions. The unique characteristics of tilapia are thermophilic fish and known to tolerate a wide range of water temperatures (El-Sayed, 2006).

In aquaculture, El-Sayed (2006) found that Asia is the largest producer in the world, accounting for 79% of the production of global farmed tilapia in 2002. Apart from the great economic important of tilapia for aquaculture and fisheries, they play a significant role in tropical aquatic ecosystems.

2.2 Nutrition for Diet Requirements of Tilapia

De Silva *et al*. (1995) found that diets which are expected to provide the organisms with all of its energy requirements, gross major nutrient requirements as well as micronutrients requirements. However, an ‘economic diets’ is expected to produce a kilogram of healthy fish at the least cost under normal growing conditions. Stankovic *et al*. (2010) found that feed is formulated to fulfill the requirements of fish in nutrients and energy. This supported by Halver (1989) where a diet is formulated to give maximum growth and yet be economically available to commercial operators. In addition, the fish diets must be locally available feed ingredients preferably those unsuitable for direct human consumption due to the economic and also practical reasons (Al- Ruqaie, 2007).

Then formulating a fish feed involves selecting a combination of ingredients which will produce a mixture containing levels of essential nutrients at or above the minimum requirements of the fish. This also supported by Bhosale *et al.*(2010) suggest that formulation of low-cost balanced diet using available agroindustry byproducts is needed. Nguyen *et al*. (2009) state that non fish meal protein sources for tilapia in the development of practical diets has the potential to reduce feed cost and encourage the development of organic product to satisfy the growing demand in the market.

Since the feed covers 40% to 60% of the total expenses in production, the prices per Kg present a very important factor in formulating of fish diets (Stankovic *et al*., 2010). Therefore, the selection of proper quantity and quality of dietary protein is a necessary tool for successfully tilapia culture practices. The major challenge facing tilapia nutritionists in developing countries is the development of commercial, cost effective tilapia feed using locally available, cheap and unconventional resources (El-Sayed, 2006).

De Silva *et al.* (1995) examined that a study evaluating the least-cost dietary protein level using the available data on dietary protein requirements of four species of tilapia (*Oreochromis mossambicus*, *Oreochromis niloticus*, *Oreochromis aureus* and *Tilapia zilii*) showed that the dietary protein level of 34 to 36% provided maximum growth of young tilapia (1 to 5 g), but the most cost-effective protein level was 25 to 28%.

Furthermore, Lim *et al.* (2006) reported that larvae and fry of tilapia have been reared successfully using diets containing 25 to 45% crude protein. It is suggested, that larval or starter feeds for tilapia reared intensively in hatcheries, such as in tanks or “hapas”, should contain about 45% to 59% crude protein and 8% to 10% fats. Halver (1989) found that digestible carbon as an energy source in tilapia diets.

2.3 Effects of Feeding and Fish Growth Performance.

Feeding rates of tilapia are influence by species, water temperatures, feeding frequency and the availability of natural foods (Lovell, 1987). According to Lim *et al*. (2006) and Lovell (1987) reported that frequency of feeding varies with fish sizes or life stage and will decreases as the fish grow. However, due to continuous feeding behavior and smaller stomach capacity of tilapia, they respond better to more frequent feeding than do channel catfish and salmoids. Furthermore, the time of day to feed the fish is also of critical importance. Tilapia also show high feeding activities at dawn and dusk (Lim *et al*. 2006). Kubaryk (1980) as cited by Lovell(1987) found that *O.niloticus* grew faster when feed 4 times daily then when feed 2 times daily, but did not grow faster when fed 8 times daily.

2.4 *Metroxylon sagu* Nutrition and Properties.

Laufa *et al.* (2009) reported that sago palm (*Metroxylon* spp.) is a palm species and belongs to order Arecales, family Palmae, subfamily Calameae, subtribe Metroxylinae and genus *Metroxylon* and had generally been classified into 2 species, based on morphological characters which namely non-spiny type (*Metroxylon sagu* Rottb) and spiny type (*Metroxylon rumphii* mart). However this agronomic view had change after the 8th ISS in Jayapura, Indonesia (2005) and presently, Sago palm is only one species.

McClatchey *et al*. (2006) found that sago palm is presently used as a source of edible starch, with the possible exception of *Metroxylon vitiense. Metroxylon sagu* is considerably more productive for starch production compared to other *Metroxylon* sp. It is two primary uses are for production of edible starch and durable leaf thatch.

In addition, D. Kasi *et al*. (2007) reported that the most efficient starch-producing crops is Sago palm. Furthermore, Karim *et al*. (2008) as cited by Flores (2009) reported that Sago components such as ash (0.06 - 0.43%), fat (0.10 - 0.13%), fiber (0.26 - 0.32%) where their studies focused on obtaining sago starch of highest purity.

In addition, the herbivorous species consume more plant material with a high content of carbohydrate. Carbohydrate is the least expensive source of energy. It is therefore economically advantageous to use as much as carbohydrate as possible in fish diet (Halver, 1989).

In modern starch industry, the starches can be modified to quite an extent. In addition, there is an easy supply of cheap, clean and non-corroded starch which sago will be clearly competitive to all other starches and for some purposes (Flach, 1997). Flores (2009) found that they are preferable for food consumption because of their beneficial properties as anticarcinogernic, antioxidative and other health benefits although these are classified as non-nutrients.

3.0 Material and Methods

3.1 Experimental Design

The experiment was conducted at the External Laboratory of Faculty of Resource Science and Technology (FRST), UNIMAS. A completely randomized design (CRD) were applied where there are three treatment with different percentage (30%, 50% and 70%) of *M. sagu* and one control (commercial diet). Each treatment and control had given triplicate and was stocked at fifteen individual fry per tank. Each treatment for 30%, 50% and 70% of *M.sagu* were defined as treatment-A (TA), treatment-B (TB) and treatment-C (TC) respectively.

Twelve glass aquariums with respective labels were used in this experiment (Figure 1). Each aquarium was equipped with 24 hour aeration system to remove chlorine content and provides oxygen. Clear water from rainwater or dichloride tap water was used. Each aquarium had the same size are 45cm x 60cm x 45cm (121500cm^3) and three quarters of clear water will be filled in. The initial weight (g) and total length (mm) of fry were selected randomly for each treatment which average range of 1.636 ± 0.531 g and 44.105 ± 3.05 mm. The stocks fries of *O.mossambicus* were provided from the PM Aquaculture Sdn. Bhd and cost RM0.30 per fish fry.

Treatment A (TA)

30% of *M.sagu*

Treatment B (TB)

50% of *M.sagu*

Treatment C (TC)

70% of *M.sagu*

Treatment D (TD)

Control (commercial diet)

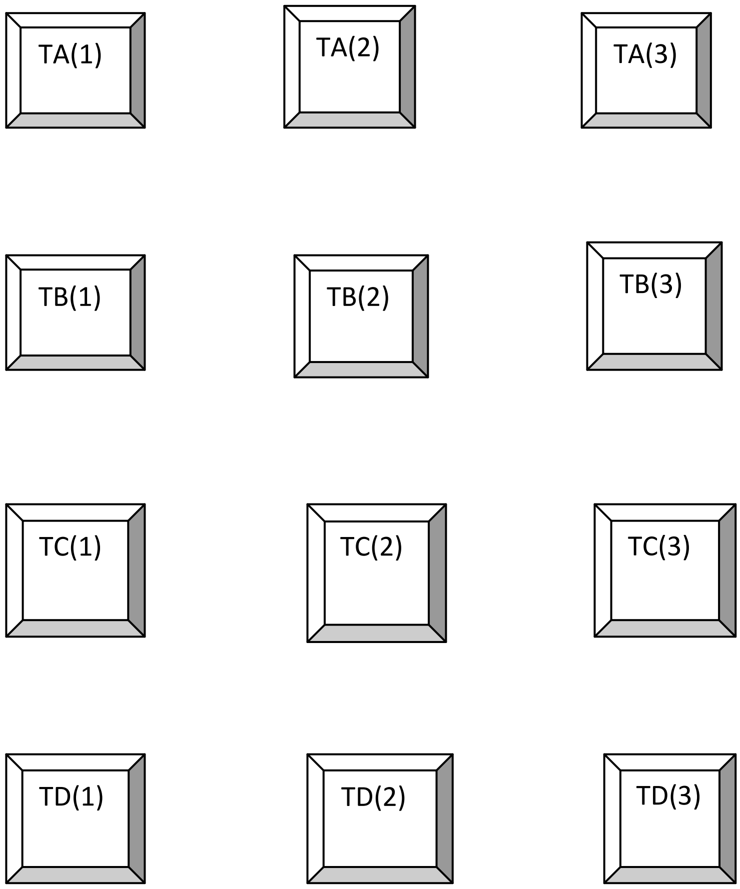

Figure 1 : Experimental design of *Oreochromis mossambicus*

3.2 Diet Formulation of *Oreochromis mossambicus*.

Metroxylon sagu was the main ingredient in the diet preparation for *O. mossambicus*. The diet products were in pellet form. The percentage of diets were produced and prepared as in the experimental design which were 30%, 50% and 70% of *M. sagu*. Houlihan *et al*. (2001); Lim *et al.* (2006); Halver (1989) and Silva (1995) found that expended techniques and extrusion techniques have been used in diet manufacture of fish feed.

Expended techniques refer to feed mixture with highly pressure conditioning within an angular expander while extrusion technique refer to fish feed production in an attempt to increase the digestible energy content of the feeds via increased lipid corporation (Houlihan *et al*, 2001). Therefore, manufacturing of formulated diet processes were using extrusion technique (Figure 2). Binding, mixing, pelleting, cooling (freezing) and storing were the basic step in the diets manufacturing (Halver, 1989).

The concept of extrusion technique by Houlihan *et al.* (2001) but have been modified to be done manually was applied in this experiment. The raw materials of the formulated diets were *Metroxylon sagu*, corn meal, soy bean meal, fish meal and also fish oils. The raw materials were weighed using analytical balance (Shimadzu ELB200). The fish oils were boiled for 5 minutes. The others ingredients such as *Metroxylon sagu*, corn meal, soy bean meal and fish meal were grounded. The homogeneous ingredients were produced and the fish oils ware added to the mixture.

Then the mixture was heated in the oven (Brand ESCO) at temperature 90°C for 20 minutes. After removed from the oven, it was cooled at room temperature for 5 minutes, then the mixture was squeezed using squeezer (Zhenzhong) and further cooled at room temperature for 15 minutes. The ingredients were crushed into small pellet. The pellets were heated again in the oven for overnight at temperature 70°C. The pellets were cooled and dried, then followed by packing and were labeled for each treatment. Lastly, the pellets for immediate use were stored at room temperature while stocks of pellets were stored in refrigerator (20°C to 25°C) for long terms. Formulated diets for tilapia were produced. In total there were 250 g of diets were prepared for each treatment.

The new formulated diets were produced according to the percentage of *M.sagu* and the other raw material was constant as following:

$$\text{Percentage of } \textit{M. sagu} \text{ added} = \frac{\textit{M. sagu} \text{ (g)}}{\text{Total weight (g)}} \times 100\%$$

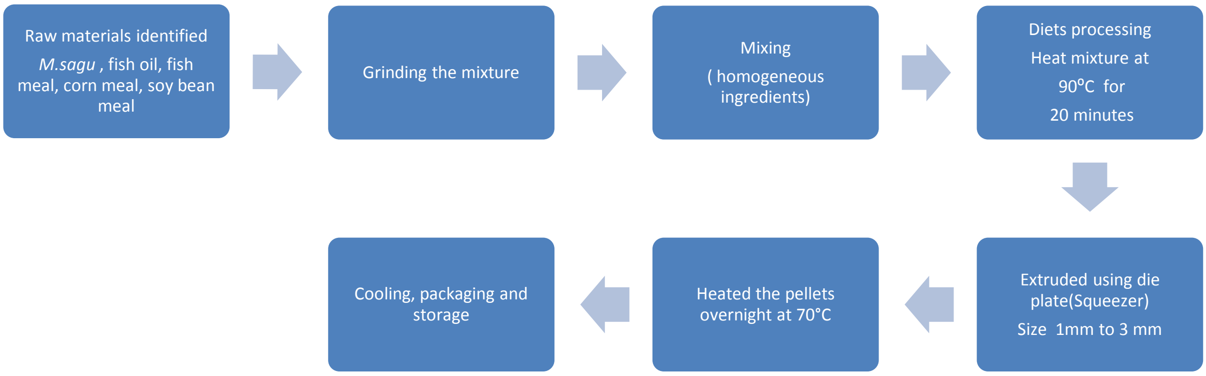

Figure 2: The process involve in extrusion techniques (Houlihan *et al*., 2001)

3.3 Feeding Quantity for *Oreochromis mossambicus*.

The fingerlings of *O.mossambicus* were fed three times per daily for all treatments and also control (0800am, 1200pm and 1700pm). All the fry were monitored within 9 weeks of experiments. Hand-feeding was applied to distribute the fish feed. The quantities of feeding were different between each treatment (Table 1). Each tank will be given 1.0 g of the formulated diet per meal.

Table 1: Feeding and diets formulation of *Oreochromis mossambicus* for treatament A,B.C and D.

Feeding Quantity	Label of aquariums	Diets formulations(g)
1.0 g each tank	TA(1) TA(2) TA(3)	10 g *M.sagu* + 5 g fish meal + 5 g fish oil + 5 g corn meal + 5 g soy bean meal (30% of *M. sagu*)
1.0 g each tank	TB(1) TB(2) TB(3)	20 g *M.sagu* + 5 g fish meal + 5 g fish oil + 5 g corn meal + 5 g soy bean meal (50% of *M. sagu*)
1.0 g each tank	TC(1) TC(2) TC(3)	50 g *M.sagu* + 5 g fish meal + 5 g fish oil + 5 g corn meal + 5 g soy bean meal (70% of *M. sagu*)
Control 1.0 g each tank	TD(1) TD(2) TD(3)	Commercial diets

3.4 Water Quality Monitoring.

In order to maintain water quality, 70% exchange of water in the aquarium was replaced every week to maintain water quality and the uneaten feed that accumulated at the bottom of the aquarium were removed. Parameters of water quality was record and been monitored daily including temperature (^{o}C), and pH are measure using MARTINI instrument (Mi 105).

3.5 Estimation of Growth and Survival.

The growth was measured weekly. Ten individual fish from each aquarium were selected randomly and measured in terms of their total length (mm) and also fish weight (g) using vernier clipper (Mitutoyo SC3671) and analytical balance (Shimadzu ELB200). The specific growth rate (SGR) was estimated.

The length (mm) and weight gain (g) were calculated, final values of experiment will deduct the initial values of experiment. Mean weight gain and mean total length were calculated at the end of experiment. Mortality of fish was observed daily. Total fish at the end of experiment were counted to estimate survival rate.

$$\text{Specific Growth Rate (SGR) (g/day)} = \frac{\text{ln final weight (g)} - \text{ln initial weight (g)}}{\text{Time (Days)}}$$

$$\text{Survival rate (\%)} = \frac{[\text{ final fish number }]}{[\text{ initial fish number }]} \times 100$$

3.6 Data Analysis

The growth and survival data were recorded and all treatments need to be compared the results to determine any significant different. To test any significant differences among treatments, One-Way analysis of variance (ANOVA) was applied using SPSS 15.0 for Window Evaluation Version.

4.0 Results

4.1 Growth Rate of *Oreochromis mossambicus*.

Table 2 had shown the mean weight gain of *O. mossambicus* after nine weeks of experiment. Treatment D was the highest mean weight gain which was treated with commercial diets over duration of nine week experiment. This was followed by Treatment A which feed on 30% *M.sagu*, Treatment B which fed with 50% of *M.sagu* and Treatment C (70% of *M.sagu*) was the lowest among all the treatment.

Table 2: Mean weight gain of *Oreochromis mossambicus* after 9 week rearing; mean ± S.E with range in parentheses

Treatment	Initial Weight (g)	Final Weight (g)	Weight gain end of experiment (g)	Weight gain per day (g / day)
TA	1.00 ± 0.12 (0.88 - 1.12)	2.44 ± 0.31 (2.12 - 2.75)	1.437	0.022^{a}
TB	1.03 ± 0.04 (0.99 - 1.07)	2.29 ± 0.25 (2.04 - 2.54)	1.258	0.019^{a}
TC	1.08 ± 0.05 (1.03 - 1.16)	2.21 ± 0.26 (1.95 - 2.46)	1.128	0.018^{a}
TD	1.12 ± 0.04 (1.08 - 1.16)	4.33 ± 0.68 (3.65 - 5.01)	3.207	0.051^{b}

Figure in the same column having same superscript are not significantly different ($P > 0.05$)