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Effects of Black Soldier Larvae (BSFL) and Earthworm Feeding To The Growth Performance of Betta Fish (*Betta Splenders*)

By

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A report submitted in fulfillment of the requirements for the degree of Bachelor of Applied Science (Animal Husbandry) with Honors

Faculty of Agro Based Industry

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DECLARATION

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

_____

Student

Name: Muhamad Farid Bin Mohd Zin

Date: 04/03/2022

I certify that the report of this final year project entitled "Effects of Black Soldier Larvae (BSFL) and earthworm feeding to the growth performance of betta fish (*Betta Splenders*) by Muhamad Farid Bin Mohd Zin, matric number F18A0073 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Animal Husbandry) with Honours,

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LIST OF ABBREVIATION AND SYMBOLS

BSFL	Black Soldier Fly Larvae
BSF	Black Soldier Fly
CM	Centimeter
MM	Millimeter
SGR	Specific Growth Rate
FCR	Feed Conversion Rate
PWG	Percentage Weight Gain
g	Gram
Kg	Kilogram
%	Percentage

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ABSTRACT

Effects of Black Soldier Larvae (BSFL) and earthworm feeding to the growth performance of betta fish (*Betta Splenders*)

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A study was conducted to determine the effect of earthworm feed and Black Soldier Fly Larvae (BSFL) feed as an alternative to Fish Meal on growth performance and nutritional content of feed formulation of betta fish. Earthworm is known as a soil-dwelling burrowing annelid worm that aids in aeration, drainage, and the burial of organic materials. It is also known for its good quality of crude protein. While BSFL is commonly referred as Black soldier fly larvae, it is an insect that contains a high concentration of crude protein and a various amount of amino acids. The diets were formulated into 9 different types of inclusions treatments. From 9 treatments, 1 of them is a constant treatment which given fish meal and the other 8 treatments were Earthworm and BSFL each given 4 inclusion which is 25%, 50%, 75% and 100%. 54 different fishes were observed throughout the research period, 35 days. Each treatment received 3 replicates. Proximate analysis was conducted to determine the nutrient content of fish meal, earthworm and BSFL. Weight Gain, Specific Growth Rate, Feed Conversion rate were collected. The results showed that 50% of Earthworm has the highest percentage weight gain at 19.46% and the lower feed conversion rate for the 5 weeks. However, 75% BSFL showed a positive result in percentage weight gain and feed conversion ratio. In term of growth performance, overall 50% of Earthworm showed excellent result in dry matter and crude fat content in fish feed. To conclude, the maximum performance is achieved from 50% Earthworm inclusion. 50% of Earthworm has the greatest result in growth performance and nutritional content without any adverse effect so that it can replace the fish meal as a protein source with that particular inclusion other than BSFL.

Keywords: Earthworm, Black Soldier Fly Larvae, Growth Performance, Specific Growth Rate, Feed Conversion Rate, Betta Fish

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ABSTRAK

Kesan Larva Terbang Askar Hitam (BSFL) dan pemberian cacing tanah pada prestasi pertumbuhan ikan betta (Betta Splenders)

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Kajian telah dijalankan untuk menentukan kesan makanan cacing tanah dan makanan Larva Terbang Askar Hitam (BSFL) sebagai alternatif makanan ikan terhadap prestasi pertumbuhan dan kandungan nutrisi formulasi makanan ikan betta. Cacing tanah dikenali sebagai cacing annelid yang tinggal dalam tanah yang membantu dalam pengudaraan, saliran, dan pengebumian bahan organik. Ia juga terkenal dengan kualiti protein mentah yang baik. Manakala, BSFL dikenali sebagai larva terbang askar hitam dikenali sebagai serangga yang mengandungi kualiti protein mentah yang baik dan pelbagai jumlah asid amino. Diet telah dirumuskan kepada 9 jenis rawatan kemasukan yang berbeza. Daripada 9 rawatan, 1 daripadanya adalah rawatan berterusan yang diberi tepung ikan dan 9 lagi rawatan adalah Cacing Tanah dan BSFL masing-masing diberi 4 inklusi iaitu 25%, 50%, 75% dan 100%. 54 ikan berbeza telah diperhatikan sepanjang tempoh penyelidikan selama 35 hari. Setiap rawatan menerima 3 ulangan. Analisis proksimat dijalankan untuk menentukan kandungan nutrien tepung ikan, cacing tanah dan BSFL. Pertambahan Berat, Kadar Pertumbuhan Tertentu, Kadar Penukaran Suapan telah dikumpulkan. Keputusan menunjukkan bahawa inklusi 50% daripada Cacing Tanah mempunyai peratusan pertambahan berat yang paling tinggi pada 19.46% dan kadar penukaran makanan yang lebih rendah untuk 5 minggu. Walau bagaimanapun, inklusi 75% BSFL menunjukkan keputusan positif dalam peratusan penambahan berat badan dan nisbah penukaran makanan. Dari segi prestasi pertumbuhan, secara keseluruhan inklusi 50% Cacing Tanah menunjukkan hasil yang sangat baik dalam bahan kering dan kandungan lemak mentah dalam makanan ikan. Sebagai kesimpulan, prestasi maksimum dicapai daripada inklusi 50% kemasukan cacing tanah. Inklusi 50% daripada Cacing Tanah mempunyai hasil terbaik dalam prestasi pertumbuhan dan kandungan nutrisi tanpa sebarang kesan buruk supaya ia boleh menggantikan tepung ikan sebagai sumber protein dengan kemasukan tertentu termasuk BSFL.

Kata kunci: Cacing Tanah, Larva Lalat Askar Hitam, Prestasi Pertumbuhan, Kadar Pertumbuhan Tertentu, Kadar Penukaran Makanan, Ikan Betta

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Ornamental fish keeping was first enjoyed in ancient times by the Chinese, Japanese, Egyptians and Romans (Swann, 1992). Favourable Ornamental Fish that attract Malaysian people is Betta Fish. Malaysia is the country that the nearest to Singapore. Both countries do not really have different weather or climate because of the near of location. Then, Singapore become the good example to breed the Betta Fish. According to the Aqueon.com, said that there are about 73 different tail types that are recognised and different colour pattern that are raised and ordinarily available for trade. With these differences make Malaysia one of the suitable countries to breed the betta fish because in Malaysia betta fish is currently one of the most interesting ornamental fish to be put in the aquarium. By breeding the betta fish, can make Malaysia one of the best places to breed the betta because of the widespread of betta fish breeding in the country itself.

This research was carried out in order to get insight into the relationship between different fish feeding practises and the growth performance of the fish that were

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housed in an aquarium. When it comes to investigating growth performance, fish are fed with two distinct types of feed to see which one performs better than the other.

The Black Soldier Fly which is known as Hermetia illucens, and earthworm that are commonly used as a supplement for fish meal. BSFL is a BSF juvenile grub that is enjoyed by both fish and chicken. Hi protein is a form of premium protein that will be extracted from the BSFL. Hi protein is said to have a high crude protein content and an amino acid profile that is well-balanced. BSFL is a natural, long-lasting, and environmentally friendly product. It is said to contain around 40 to 50 percent crude protein, making it a high protein source for animal feed. The BSFL are also said to have a higher calcium content but a lower phosphorus content than fish meal, with fish meal containing 8 to 10% dry matter and 0.6 to 1.5 percent dry matter, respectively. However, the calcium phosphorus ratio is unsuitable for fish feed, although it can be increased by adding phosphorus.

Different species of earthworm are said to contain 50–60 percent crude protein (CP) in dry matter (DM) and have a low ash content, which is a desirable characteristic for a fish feed ingredient. Earthworms (*Perionyx Excavates*) have been found to be a good source of protein, according to the references. It is also a high-protein ingredient that's used as a dietary supplement for some fish species. This tropical earthworm species' high reproductive rate and biomass production make it suitable for worm meal production. The nutritional value of this earthworm is a key factor in its ability to replace fishmeal in feed production. Because of their high protein content, both Black Soldier Fly Larvae (BSFL) and earthworm can be used as a fish meal substitute.

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1.2 Problem Statement

For the past few years, the market for aquaculture feed has risen to the point that it has outpaced the availability of some feeds used in the industry. The aim of this research was to find a way to replace the fish meal as a feed ingredient. The problem was that there was a limited supply of fish meal. The limited amount of fishmeal available and the rising price of this commodity have been studied for over a decade in order to reduce the fish meal's dependence.

Next, the growth performance among the breeder of ornamental fish breeder had become a problem when they wanted to breed the fishes. Ornamental fish is said to be very sensitive towards the temperature as well as the Ph level whereby it can affect the health of the fish. If the feed that is given to the fish low in protein and low-intensity production, it can cause growth performance problem which can hinder the growth rate level for the betta fish.

Since year 2000, the price of fish meal continues to increase over the month whereby the price is about two or three times the price of soybean meal. Due to the high cost of fish meal, the price of fish feed that consist of fish meal also increase which made it harder for the small holder farmer to buy it.

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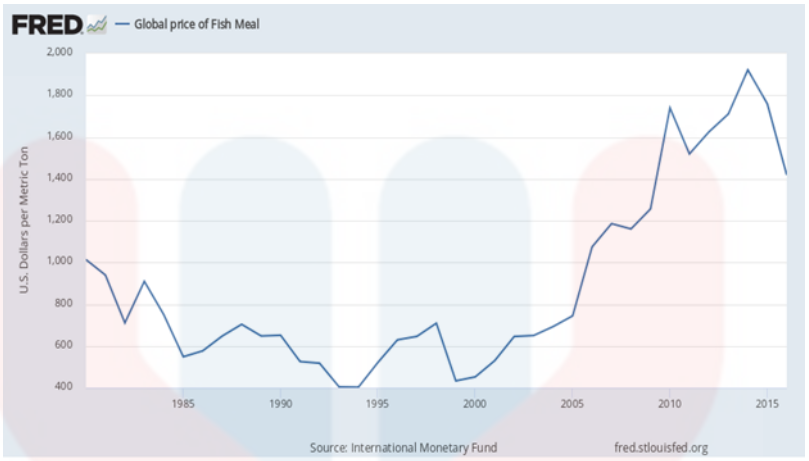

Figure 1.1: Fish meal yearly price (source:International Monetary Fund)

1.3 Objectives

1) To investigate the growth performance for the feeding trial of earthworm and Black Soldier Larvae (BSFL)
2) To analyze the factor that can affect the growth performance of Betta Fish.

1.4 Hypothesis

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H_0: There is no difference in the mean body weight of betta when comparing with BSFL as feed and Earthworm as feed (mean body weight on BSFL as feed = mean body weight Earthworm as feed).

H_a: There is significant difference in the mean body weight of betta when comparing with BSFL as feed and Earthworm as feed (mean body weight on BSFL as feed = mean body weight Earthworm as feed).

1.5 Scope Of Study

The study of the effect on growth by different ingredient as fish feed. The most significant factors to control in feeding storage to prevent excessive deterioration in quality and feed losses. Comparison occur when measure their body weight using digital scale in over 8 weeks period.

1.6 Significance of study

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The aim of this research is to find the best ingredient for feeding betta fish and to determine their growth potential. By using a variety of materials to make fish feed, it can enhance the aquaculture industry's ability. The data gathered can be used as a source of knowledge for future studies. Since the material used is inexpensive and not artificial, this approach would yield a higher profit. It is critical to increase profits by using high-nutrient feed that is also affordable. Furthermore, in our country, the use of materials such as larvae and egg yolk as fish feed is restricted, and the potential to expand the use of the material as fish feed will be realized.

1.7 Research Question

1) Will the fish consume the feed that was formulated using earthworm powder and Black Soldier Fly Larvae (BSFL) meal?
2) Which feed will have better growth performance which is suitable for the betta fish?
3) Can earthworm meal or Black Soldier Fly Larvae (BSFL) meal compete with the fish meal regarding the nutrition content?

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CHAPTER 2

LITERATURE REVIEW

2.1 Ornamental Fish

Ornamental fish are fish that are kept in a home aquarium or are kept for decorative purposes. There are several different types of ornamental fish, all with different shapes, sizes, and colours. Water quality is very important in ornamental fish management because it ensures the survival of the fish. There are over 30,000 fish species recorded around the world, with around 800 of them being ornamental fishes. Anabantidae, Characidae, Callichthyidae, Cobitidae, Cichlidae, Cyprinidae, Cyprinodontidae, and Poeciliidae are among the eight closely related families. The egg layers (oviparous) and live bearers are the two types of aquarium fish. Furthermore, aquarium species are egg layers, and they normally require external fertilisation. Egg carriers, nest builders, mouth incubators, egg buriers, egg scatter laying adhesive eggs, and egg scatter laying non-adhesive eggs will be divided into six classes for egg layers.

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2.2 Betta Fish

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Betta Splendens are colourful fish that are bred and exported by ornamental fish groups to different countries. The species was found in the early 19th century. The Siamese fighting fish (*Betta splendens,* also known as the betta) is well known in aquarium markets, and also presents an exciting new research model for studying parental care, aggressive behavior, and cryptically diverse pigmentation (Srikulnath et all., 2021)

Betta splendens is found in ditches, rice fields, small pools, and slow-moving streams in Thailand, Cambodia, Laos, and Vietnam. They have a peculiar labyrinth organ that allows them to breathe air above the water surface to survive in these warm, oxygen-depleted environments, while they also have gills like other fish. Air-breathing fish of the Anabantoidei group meet their metabolic requirements for oxygen through both aerial and aquatic gas exchange (Alton et all., 2013)

Betta splendens are likely the most well-known livebearer among both aquarium owners and advanced breeders. These fish are for the most part vigorous and tolerant of an extensive variety of aquarium conditions hence they are regularly prescribed for amateurs. However, because of intense selective breeding, fancy betta can be harder to maintain than their wild ancestors. Ornamental fish and particularly live breeders are the most popular pet fish and breed effectively. Siamese fighting fish or bettas are highly favoured for their aesthetical value and kept as ornamental fish. They are widely bred to satisfy the market demands (Chua et all., 2017)

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Most ornamental fish culture still depends on the supply of live food and formulated diets, both of which crucial for lowering production costs and sustaining commercial activity. Although live food is believed to be the best protein source, but production is costly and sometimes unreliable. Optimal feeding frequency in aquaculture is vital for the sustainable and economical production of healthy, high-quality fish (Hakim et all., 2020)

2.3 Protein Sources for Animal Nutrient

2.3.1 Fish Meal

Fish meal (FM) has been traditionally used as the main protein source in the aquafeed industry, due to its high protein content and balanced EAA profile (Abdel-Fattah, 2020). Fish meal is known as an excellent source of a highly digestible protein, essential vitamins and minerals, long chain omega-3 fatty acids (EPA and DHA) (IFOMA, 2001). For centuries, it was used as a part of animal feeds, but in the last 50 years, fish meal processing has become a global enterprise. Fish meals are typically made from species of fish that aren't intended for human consumption or from by-products of

the seafood processing industry. The annual global production of fish meal has risen steadily over the last few decades, from a low of 5.5 to a high of 7.5 tonnes (Mt). Over 65 percent of the fish meal produced was traded globally, affecting global supplies and prices. Fish meal was most often used in poultry feed. Until 1990, less than 10% of annual fish meal production was used for aquaculture feeds, but it has increased by more than 10% every year for the past two decades. Because of the current usage trend of fish meal, it is predicted that demand will surpass annual production sooner or later.

For the past 15 years or more, a few research centres have performed a number of tests in order to identify alternative protein sources that can be used to supplement fish meal in farmed fish diets. The others that was not a part of the research to find an alternative for the fish meal had embrace the issue for a couple of reason int he aquaculture industry and the awareness had been expended over the segment of the scientific community that need to face the issues every day (Naylor et al., 2000). The rise in popularity of fish meal has resulted in a market for high-quality protein sources. Fish meal had become the main protein source in the feed diets of poultry, fish, and swine, which needed a higher quality of protein than sheep and cattle (FAO, 1975). Between 1964 and 1997, total aquaculture output increased from 10 Mt to more than 30 Mt. (FAO, 1999). In 1998, the harvest of fish totalled nearly 19 Mt, with cyprinids such as various species of carp accounting for more than 70% of the total (FAO, 2000).

2.3.1.1 Nutritional Content of Fish Meal

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The addition of fish meal to fish diets can help to improve feed efficiency and development, as well as nutrient uptake, absorption, and digestion. Fish meal contains a balanced amino acid composition that can have synergistic effects with other animal and vegetable protein in the diet, promoting rapid development. The use of fish meal in the diet of aquatic animals will help to mitigate contamination caused by wastewater effluent by improving nutrient digestibility. A high-quality fish meal will typically contain more than 66 percent crude protein, 8 to 11 percent fat, and less than 12 percent ash. Another fishery by-product would be a high-protein fish protein concentrate with a protein content of more than 70%. (Kaushik, 2010). Other nutrients found in fish meal include essential fatty acids, cholesterol, minerals, phospholipids, and vitamins (Tacon et al.,2009)

2.3.2 Black Soldier Fly (BSF)

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The Black Soldier Fly, *Hermetia illucens Linnaeus* 1758, is a type of fly (Diptera) that belongs to the Stratiomyidae family. The cycle of the black soldier fly (BSF) will run parallel to the flow of the organic waste transformation for the development of BSF larvae (Dortmans et al, 2017). The adult fly is black in colour, has a wasp-like appearance, and measures 15-20 mm in length (Hardouin et al., 2003). The larvae will grow to be 27 mm long, 6 mm wide, and weigh up to 220 mg at the end of their larval stage. The larvae have a bland, whitish appearance (Diclaro et al., 2009). At the end of

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the larval stage, which is prepupa, the larva will empty its digestive tract while also ceasing to breed and travel (Hardouin et al., 2011). It takes about 14 days for the pupal stage to complete, but it can last up to 5 months depending on the circumstances (Hardouin et al., 2003). The female will mate and oviposit into dry cracks and crevices adjacent to a feed source two days after emerging (Diener et al., 2011). Furthermore, the fat that was accumulated during the larval stage would not be consumed by the adults (Diclaro et al., 2009). Since the 1990s, it has been suggested that rearing the *Hermetia illucens* is an effective way to dispose of organic waste by converting it into a protein- and fat-rich biomass that is ideal for a variety of applications, including animal feed for all livestock species, chitin production, and biodiesel production (Van Huis et al., 2013 Diener et al., 2011). The black soldier fly is a hardy species that can withstand harsh environmental conditions such as a lack of food, drought, or oxygen deficiency (Diener et al., 2011). Farmers were able to open additional marketing possibilities by using feed based on black soldier fly larvae in aquaculture, where some consumers were required to use fish meal in their feeds (Tiu, 2012).

Table 2.1: nutrient composition of 100g of dried BSFL

Nutrient	Amount (%)
Protein	50
Magnesium	1
phosphorus	1.2
Calcium	6

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sodium	0.3
Fat	35

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2.3.2.1 Nutritional Content of BSFL

BSFLs are high in protein, fat, calcium, and phosphorus, among other nutrients. The 100g of dried BSFL contains up to 50% protein, 6% calcium, 35% fat, 1% magnesium, 1.2 % phosphorus, and 0.3 % sodium. The amino acid composition of the fat contained in BSFL was similar to that of fish meal. Pigs, poultry, fish, and shrimp have all been known to consume BSFL as an alternative protein source. The nutrient composition of the BSFL larvae may be affected if they are fed with various sources. When the BSFL is fed manure, the amount of protein in the fly larvae increases, and the protein content ranges from 31.2 % to 45.7 %. When compared to other widely consumed insects, BSFL has about 80 times the amount of calcium. The BSFL is also high in fat, with the fat contained being of higher quality than that found in other conventional feed fats. This is due to the fact that 53 % of the fat in the BSFL is known as lauric acid, which is a healthy substance that aids in the absorption of nutrients by pets.

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2.3.3 Earthworm

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Earthworms are known for their efficiency in transforming plant and animal waste into biomass, allowing them to be used as a feed ingredient in animal production. From a ton of animal waste, 100 kg of worms can be created (Edwards, 1985). Earthworm is a high-quality protein that is used in livestock feeds, but the practical use of earthworm meal is influenced by economics. Vermicomposting produces protein-rich earthworms as a by-product. It is said that growing earthworms is easier than raising insects, both economically and environmentally, since many earthworm species are adapted to a wider temperature range than insects (Tedesco et al., 2019).

2.3.3.1 Nutritional Content of Earthworm

The protein content and amino acid composition of earthworm is better than the fish meal and soybean milk. For dry matter, earthworm contains 60-70% protein, 2-3% minerals, 6-11% fat, 5-21% carbohydrates and a range of vitamins including niacin. Earthworm is known to be higher in essential amino acids such as methionine, lysine and either meat or fish meat. The earthworm is also high in the essential long chain of fatty acids. The earthworm is also high in the essential long chain of fatty acids. In many

contexts earthworm meal is already considered an alternative source of protein in human and animal nutrition and is used in feed supplements for poultry, fish and swine, under certain conditions (Tedesco et all., 2020)

2.4 Life Cycle of Betta Fish

The Betta life cycle starts with male and female mating, which may result in injury or death for the female fish in many instances. The male Betta builds a bubble nest and once complete the female Betta will lay her eggs onto the male Betta's tail where he then fertilises them. Fish that build and guard bubble nests are gourami (Jaroensutasinee, 2005). Bubble nest building is the first step of the fish reproductive cycle (Hall, 1968). Males create bubble nests by blowing bubbles around a floating foundation, also known as a foam nest. Female spawn under the nest, where the male waits to fertilize the eggs and typically 400-500 eggs are spawn by female fish (Sterba, 1983; Sakurai *et al*., 1992).

The life cycle of betta fish begins with the larvae which is very sensitive to the environment and small in size. Fighter fish larvae are usually very small, extremely fragile, and generally not physiologically fully developed (SS Herath et all, 2012) (Laven and Sorgeloos, 1996).

Betta eggs are laid at the water's surface in large clusters, which are primarily cared for by male Betta fish. Betta fish eggs require oxygen to develop, which is why

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they must be laid near the surface. The eggs will hatch in 24 to 48 hours after the spawning process is completed. The number of Betta fry that will hatch is unpredictable and can range from one to 300. When the Betta fish hatch, they will feed on their eggs for the first 24 hours and then remain close to them for another 24 hours. To stop some battle with the fry, the male parent should be removed after they have fully eaten their yolk bag, which may take up to five days for certain fry.

Young Betta fish grow labyrinth organs, which enable them to breathe at the water's surface, between three and six weeks of age. Bettas do not begin to display their distinctive colour until week 8 or 9 of their lives. Due to sexual maturation and attempts to battle other siblings, most of your Betta fish will have to be separated at this time. The Betta fish has reached adulthood at three months of age and cannot be housed in the same tank as another Betta fish or several other species of fish.

2.5 Feed Conversion Rate (FCR) of Betta Fish

This term was used in aquaculture industry to determine the level of performance acquired from an additive or a feed**.** FCR allows for an estimation of the feed that will be needed in the growing cycle of fish. Knowing quantity feed will be needed then lets a farmer to determine the profitability. It takes less feed to produce one kilogram of fish when a feed

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has low FCR. A low FCR is a good indication of a great quality feed (December,2011). FCR was calculated according to Okpako, 2010 :

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Total feed intake (g)}}{\text{Total wet weight gain (g)}}$$

2.6 Specific Growth Rate (SGR) of Betta Fish

This term was used in aquaculture industry to estimate the production of fish after acertain period by using the following formulae (Okpako, 2010):

$$\text{SGR} = Final\ body\ weight\ of\ fish - Initial\ body\ weight\ of\ fish\ /\ No\ of\ days\ reared$$

2.7 Percentage weight gain (PWG) of Betta Fish

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This term was used in aquaculture industry to determine the percentage weight gain by the cultured fish. Fish that receive pelleted feeds usually have higher performances in terms of weight gain and lower feed conversion compared with mash feeds as according to various authors (Sun et al 2007; Shiu et al 2015; Kabir et al 2015; Sharawy et al 2016; Hasan et al 2018; Huang & Nitin 2019). Percentage weight gain can be calculated by using formula below:

Weight gain (%) = 100* (final weight-initial weight) / initial weight)

2.8 Growth of Betta Fish

The rate of growth was well known due to the fact that the body size, length, and weight of fish are all highly changeable characteristics. For fish breeding and cultivation, it is critical to address genetic regulation of development within the fish. Fish growth was linked to the activity ratio of trypsin to chymotrypsin, which was lower in females than in males. White muscle levels of RNA decreased during development, with females having higher levels than males, while the protein levels increased with no difference between sexes (K Thongprajukaew et all, 2013). Diverse feed items can influence body length at different ages, which was assessed as a growth marker using a scale written on the aquarium. It takes one to two months for young fry to mature.

Every week, the fish in each batch's tank will be weighed and counted. This was removed in order to keep track of survival and adjust the food diet based on each

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individual's growth rate after the weekly decision. At the end of the experiment, all of the fish in the aquarium are separated into males and females and can be weighed separately. This was done to compare the consequences of the treatments on growth and survival as because the coincident of variance (CV) in the fish growth for both sexes (Harpaz et all., 2005). Body measure in angle is a to a great degree variable character. In most fish species there are impressive contrasts between the mean sizes of various populations and in addition between the sizes of people having a place with the same population (Ryman, 1973). The overall development can be deceiving, as females grow faster and larger.

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CHAPTER 3

METHODOLOGY

3.1 Preparation of betta fish feed

In this study, Betta Fish (*Betta splendens*) used as the main material in this experiment. The body growth weighed under the period of conducted the experiment which are over 35 days or around 5 weeks. The ways to weigh the fish are using the small beaker with the water and record the weigh. Then put the betta fish inside the beaker and weighed again and record. The body weigh was weighted by weeks, betta fish was weighed using digital balanced and recorded the weight of betta fish. The formulation is:

Where, betta fish weight

= (Total weight of betta fish + beaker + water) – (total weight of beaker + water)

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After that, two betta fish were tested in each aquarium by giving different feed to accomplish the experiment. Each treatment has 3 aquarium with 2 fishes each with a total of 6 fishes for each treatment, The betta fish are well known for its sensitivity to the feed, so it was given three different feeds in each beaker. The first feed as the feed is Fish Meal as the control feed was obtained from the animal lab in UMK Jeli. The second feed is Black Soldier Fly Larvae (BSFL) meal was obtained from local supplier. The third feed is Earthworm is collected from masjid UMK Jeli and was breed for about 3 months before the experiment was started. The feed is formulated and weighed for about 0.01gram and was given directly to the betta fish and the observation when feeding is observed around 30 minutes to records any unwanted behaviour to the fish.

The management of water condition need to be cared to make sure that the mortality of betta fish does not occurs because the Earthworm make the water condition become cloudy and odour to betta fish.

3.2 Observation Growth Performance (Body Weight)

The growth performances which is the weight of the fish need to be measured every week on the same day before cleaning the aquarium. For treatment 1 that has been label as constant was given Fish Meal as the fish feed, while for the treatment 2 was given

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Black Soldier Fly Larvae (BSFL) meal as the fish feed and for the treatment 3 is given Earthworm as the fish feed.

To measure the weight of the betta fish, digital balanced was used. Betta fish was taken out of the aquarium for a short period of time and put in a beaker. The beaker that contains the fish then will be put on the digital balanced scale to take the accurate weight at that time. This action must be done quickly to prevent the fish from getting stressed and the death of the fish could be prevented.

3.3. Proximate Analysis

Proximate composition analyses of the experimental diets were performed according to AOAC (1997). The ingredients and approximate makeup of the diets that are provided. All experimental diets were analysed for amino acidscomposition using HPLC (High Performance Liquid Chromatography) system (Breeze,Water Corporation, Milford, MA, USA) according to the manufacturer instructions. The table determine the feed's approximate composition. Table 1 shows the approximate content of feed manufactured using Black Soldier Fly Larvae (BSFL), while table 2 shows the approximate composition of feed created with earthworm.

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Table 3.1: Results of Proximate Analysis and Nutritional Content of Fish Meal and Earthworm

Ingredients (g/kg)	Feeds				
	0% earthworm (EW 1)	25% earthworm (EW 2)	50% earthworm (EW 3)	75% earthworm (EW 4)	100% earthworm (EW 5)
Fish meal	26	19.5	13	6.5	0
Earthworm	0	6.5	13	19.5	26
Soybean meal	30	30	30	30	30
Wheat flour	10	10	10	10	10
Vitamin mineral premix	2	2	2	2	2
Molasses	4	4	4	4	4
Rice bran	28	28	28	28	28
Total	100	100	100	100	100
Proximate analysis (%)					
Crude fibre	1.59	1.78	2.03	1.82	2.1
Crude fat	2.67	2.87	3.57	3.00	2.63
Crude protein	35.17	36.47	37.4	37.17	32.7
Moisture	4.62	7.53	7.47	8.1	10.57
Ash	6.63	9.97	7.73	7.5	11.33
Total carbohydrate	60.33	58.1	58.87	61.4	55.57
Energy value (kcal/100g)	367.88	363.59	372.69	380.38	350.96

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Table 3.2: Results of Proximate Analysis and Nutritional Content of Fish Meal and BSFL

Ingredients (g/kg)	Feeds				
	0% Black Soldier Fly Larvae (BSFL 1)	25% Black Soldier Fly Larvae (BSFL 2)	50% Black Soldier Fly Larvae (BSFL 3)	75% Black Soldier Fly Larvae (BSFL 4)	100% Black Soldier Fly Larvae (BSFL 5)
Fish meal	26	19.5	13	6.5	0
Earthworm	0	6.5	13	19.5	26
Soybean meal	30	30	30	30	30
Wheat flour	10	10	10	10	10
Vitamin mineral premix	2	2	2	2	2
Molasses	4	4	4	4	4
Rice bran	28	28	28	28	28
Total	100	100	100	100	100
Proximate analysis (%)					
Crude fibre	2.1	2	1.9	2	2.07
Crude fat	3.63	3.17	5.03	5	8.67
Crude protein	32.73	32.47	33.27	33.7	33.5
Moisture	4.43	8.27	6.77	6.83	7.77
Ash	6.67	6.4	7.1	7.1	6.97
Total carbohydrate	58.4	51.13	58.77	61.77	61.03
Energy value (kcal/100g)	361.42	327.03	358.44	389.58	416.66

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3.4 Statistical analysis

The data were obtained from the body weight of betta fish that were recorded weekly over the period 5 weeks from each of the two-betta fish sample from 9 replicate in the 3 treatments. The data were analyses one-way ANOVA using Software Statistical Package for the Social Sciences (spss).

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CHAPTER 4

RESULTS AND DISCUSSION

4.1 Body Weight of Betta Fish.

The 5 weeks of determining betta fish (Betta Splenders) body weight were studied. For treatment 1 that has been labelled as constant was given fish meal as the fish feed. The fish diet for treatments 2, 3, 4, and 5 was earthworm at a percentage of 25%, 50%, 75%, and 100%, whereas treatments 6, 7, 8, and 9 were Black Soldier Fly Larvae (BSFL) at a percentage of 25%, 50%, 75%, and 100%.Designed for treatment 1 which given Fish Meal as the feed, the body weight that has been weight constantly given almost slightly decrease every week compare to other beakers. The treatment 2 which was given 25% of the Earthworm as feed give increase some increase of body weight but also give some decrease in value for body weight. For treatment 3 which was given 50% of Earthworm show an increasing value in weight almost every week compared to other earthworm feed. Treatment 4 was given 75% of Earthworm recorded slightly decrease in weight value almost every week. Treatment 5 which is 100% of Earthworm show a slightly increase in body weight weekly and come second to the Treatment 3 in the value of body weight.

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Table 4.1: Mean and Standard error values of different parameters in betta fish in different percentage type of feed for Fish Meal and Earthworm.

Parameter	0% (EW/BSFL)	25% EW	50% EW	75% EW	100% EW
Initial weight	1.22 ± 0.16	1.06± 0.16	1.15 ± 0.20	1.16 ± 0.23	0.97 ± 0.26
Final weight	1.27 ± 0.20	1.10 ± 0.19	1.18 ± 0.20	1.18 ± 0.23	1.00 ± 0.25
Specific growth rate	0.003 ±0.001	0.005±0.007	0.006±0.006	0.005±0.003	0.003±0.002
Percentage specific growth rate (%)	0.25±0.15	0.46±0.67	0.63±0.56	0.49±0.32	0.25±0.21
Feed conversion rate	1.60±1.03	10.87 ±14.15	0.94±0.81	0.88±0.60	4.70±6.23
Percentage weight gain (%)	7.01±3.66	6.77±12.84	19.46±17.38	14.55±8.49	9.77±9.23

Table 4.2: Mean and Standard error values of different parameters in betta fish in different percentage type of feed for Fish Meal and BSFL.

Parameter	25% BSFL	50% BSFL	75% BSFL	100% BSFL
Initial weight	1.15 ± 0.25	1.10 ± 0.13	1.13 ± 0.19	1.09 ± 0.19
Final weight	1.14 ± 0.24	1.12 ± 0.13	1.13 ± 0.20	1.10 ± 0.11
Specific growth rate	0.004±0.005	0.003±0.003	0.004±0.001	0.004±0.003
Percentage specific growth rate (%)	0.37±0.48	0.27±0.29	0.40±0.09	0.38±0.27
Feed conversion rate	15.30±27.62	4.89±6.48	0.76±0.20	2.58±4.38
Percentage weight gain (%)	5.27±8.31	9.51±11.49	12.71±4.21	12.28±8.43

A one-way analysis of variance was conducted to evaluate the null hypothesis that there are no significant differences between different feed to betta fish (N=6). The independent variable, the different feed to betta fish included nine treatment: Fish Meal (M=7.01; SD=3.66; n=6), 25% Earthworm (M=6.77; SD=12.84; n=6), 50% Earthworm (M=19.46; SD=17.39; n=6), 75% Earthworm (M=14.55; SD=8.49; n=6), 100% Earthworm (M=9.77; SD=9.23; n=6), 25% BSFL (M=5.27; SD=8.31; n=6), 50% BSFL (M=9.52; SD=11.49; n=6) , 75% BSFL (M=12.71; SD=4.21; n=6), 100% BSFL (M=12.28; SD=8.43; n=6). This is the result for the percentage weight gain of all the treatment. The ANOVA was not significant, $p > 0.05$, n=6. Thus, there is no significant evidence to reject the null hypothesis and conclude there is no significant different of different feed to betta fish.

Post hoc comparisons to evaluate differences between treatments means were conducted with the use of Tukey HSD test since equal variance were enable. Test revealed no significance differences between the mean score of body weight of betta fish of Earthworm as the betta fish and the body weight of betta fish of BSFL as the betta fish feed, $p > .05$. Body weight of 0%, 25%, 75% and 100% of Earthworm do not significantly differ from 0%, 25%, 75% and 100% of BSFL treatment, $p > .05$

In this research it was said that the result can be shown through the appendix for the raw data. From the treatment 1 the betta fish was given Fish meal as the feed as the control treatment that give effect of body weight for 5 weeks in open environment. 6 betta fish in Treatment 1 was weighed separately. The record for body weight the first fish in beaker 1 is 1.36g in first week and for the second week increase to 1.46. For the next three week it was constantly recorded the increase in body weight until 1.49g, 1.51g and 1.53g in the weeks 5. The initial record of body weight in second fish is 1.33g and also recorded slightly increase in body weight until weeks 5 where resulted 1.43g. It also

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happens to the third fish by the initial body weight of betta fish which recorded initial weight by 1.34g and constantly increase until it become 1.38g in weeks 3. But unexpectedly the third fish was dead after weight of weeks 3 was recorded due to several environmental factor. The fourth fish in the treatment was initially weighed at 1.34g and increase each week until weeks 3 at 1.36g, 1.38g each. However, fourth fish also dead after weeks 3 dues to environmental factor. Fifth and sixth fish also recorded an increase in weight which initial weight at 1.26g and 1.02g each. And it increases until week 5 and the final weight for each of it is 1.36g and 1.1g each.

For the treatment 2 betta fish consume 25% of Earthworm as the feed that give effect of body weight for 5 weeks. The record for body weight for each fish in the treatment 2 can be summarize that overall, it gains weight but there also happened loss of weight occur for the betta fish. There are 3 betta fish that loss weight at week 2 while there are 2 betta fish recorded for the losses of weight in week 3. There is one fish from the treatment 2 which was initially weight at 0.87g and constantly increasing at lower value until week 2 at 0.87 and decrease slightly to 0.7893 at week 3 but then took a boost of value of weight in week 4 at 1.46g and gain a slightly decrease in final weight in week 5 at 1.44g.

From the treatment 3 the betta fish consumes 50% Earthworm as the feed that gives the effect of mean 19.46 and the standard deviation of 7.10. In this treatment, there are also 6 fishes and one of the fishes has the highest weight gain that is 0.4993. The initial weight of this fish is 1.4307 and the final weight is 1.93. Unfortunately, there are 4 fishes that died. Among the fish that had died, the increase of weight is about the same. In addition, one of the fish had a slight decrease of 0.0141 g on the third week and increase again on the following which has produce a total weight gain of the fish that is 1.3132.

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Next, fish in treatment 4 survived until the end of the experiment with a total weight gain of 1.0241. Treatment 4 which is the 75% earthworm has a mean weight gain 14.55 and standard deviation 3.46. This treatment can be said to the second highest mean weight gain than the other treatment. For the fish in treatment 5, one fish died with the final weight of 1.391 and a initial weight of 1.3179. The total weight gain for this treatment is 0.529. In addition, treatment 5 is known as 100% earthworm feed. There is one fish among all the fish that has the highest weight gain of 0.1915 than the other fish. This is the first fish in the data which its initial weight is 1.2072 and the final weight is 1.3987.

For treatment 6 that is 25% BSFL, all of the fish survived throughout the research. 3 fish losses weight at week 2 and during week 3, 2 of the fish increases in weight while the other one continues to decrease until week 4. The overall body weight for this treatment is 0.3885. From the spss analysis, the mean value that was obtain is 5.27 while the standard deviation is 3.39. The highest weight gain from all the fish is 0.2923 and the lowest is 0.0014. 50% BSFL is known as treatment 7 that has the mean of 9.52 and standard deviation 4.69. 4 of the fish continue to increase until week 5 but only 1 fish decrease in weight at week 2. The weight of the fish decreases from 1.156 to 1.1375 on week 2 and continue to increase that result in 1.1621 for the final weight.

For treatment 8, there is no dead fish until the end of the research. This treatment has the mean of 12.71 and standard deviation 1.72. Based on the raw data, treatment have the highest total weight gain of all fish than the other BSFL feed based. All of the fish increase in in weight from week 1 until week 5. For the first fish, weight for week 1 is 1.0951, week 2 is 1.0383, week 3 is 1.134, week 4 is 1.1069 that had a slight decrease but then continue to increase to 1.1852 for its final weight. Treatment 8 that is 100% BSFL has 1 dead fish on the third week of the experiment. For the mean weight gain of

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treatment 9 is 12.28 and the standard deviation is 3.44. The initial weight for the fish that had died is 1.1201, week 2 is 1.089 and the final weight is 1.205. the fish that has the low weight gain in the raw data is the fish that has body weight in week 1 is 1.1201, week 2 is 1.0829, week 3 is 1.0096, week 4 is 1.1455 and the final weight is 1.1288.

For overall result for the initial weight, fish meal feed results in the highest amount of mean 1.22 with a standard deviation of 0.16. 25 % earthworm has mean of 1.06 with standard deviation of 0.16, 50% earthworm has 1.15 for mean and 0.20 standard deviation, 75% earthworm has 1.16 mean and 0.23 standard deviation and 100% earthworm has 0.97 mean with 0.26 standard deviation. For BSFL, 25% mean is 1.15 with standard deviation of 0.25, 50% mean is 1.10 with standard deviation 0.13, 75% mean is 1.13 with standard deviation 0.19, and 100% BSFL mean is 1.09 with standard deviation 0.19. The final weight of all treatment shows that the fish meal feed has the highest mean of 1.27 and standard deviation of 0.20.

4.2 Specific Growth Rate

Based on all of the treatment, specific growth rate has the lowest value than the other parameters. It can be proven from all of the result that was shown by each types of feed. For mean, fish meal has 0.003, 25% earthworm has 0.005, 50% earthworm has 0.006, 75% earthworm has 0.005, 100% earthworm has 0.003, 25% BSFL has0.004, 50% BSFL has 0.003, 75% BSFL has 0.004, and 100% BSFL has 0.003. From this result, it

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shows that the lowest mean of the specific growth rate is 0.003 whereby 4 treatments have the same amount that is fish meal, 50% BSFL, 100% earthworm, and 100% BSFL. Percentage of specific growth rate shows that fish meal and 100% earthworm have the same amount of mean that is 0.25. 75% earthworm shows that it has the highest amount of specific growth rate with a mean of o.63 and standard deviation 0.56. 75% BSFL also has the highest percentage growth rate among the BSFL feed than other BSFL feed with a mean of 0.40 and 0.09 for standard deviation.

4.3 Feed Conversion Rate

For the feed conversion rate, 25% BSFL is the highest with a mean of 15.30 and a standard deviation of 27.62 while the lowest is 75% BSFL with a mean of 0.76 and a standard deviation of 0.20. 25% earthworm has mean of 10.87 with standard deviation of 14.15, 50% earthworm has 0.94 mean with 0.81 for the standard deviation, 75% earthworm has mean of 0.88 with standard deviation 0.60. 100% earthworm has 4.70 mean with standard deviation 6.23. it can be said that 75% mean has lower mean value of feed conversion rate that 50% earthworm. Next, when compare the feed conversion rate of 100% BSFL and earthworm, it shows that earthworm is higher than BSFL. The percentage weight gain of all the feed shows that 50% earthworm has the highest mean of 19.46 and 25% BSFL has the lowest mean of 5.27.

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From the research, it can be concluded that the best fish feed that can be considered as the best most consumed by the betta fish is 50% Earthworm based on the positive effect toward body weight in the indirectly that supply the most nutrition toward betta fish. While the worst fish feed for the betta fish is 25% BSFL. It is not said that 25% BSFL is not edible to be feed for the betta fish but it does not give the suitable nutrition due to lack of protein percentage in it. The 25% BSFL is the best food to be given if there is a planning for the betta fish to diet or loss the weight. However, mostly betta fish will eat whatever we give as the feed but either the negative effect happen, we need to consider to not make the rate or mortality to increase.

Based on the result, it can be conclude that it follows the hypothesis which is carried out in the early of the experiment where stated that the Earthworm feed to betta fish will be the best fish feed to betta fish because compared to other feed , fish meal and BSFL it has higher nutritional content in protein. It is easy to find the earthworm and make it easy to feed the fish that act as a non-chemical composition to not harm the betta fish.

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4.4 Data for proximate Analysis

Table 4.3: Nutritional Content for different percentage of Earthworm Feed

	Feeds				
Ingredients (g/kg)	0% earthworm (EW 1)	25% earthworm (EW 2)	50% earthworm (EW 3)	75% earthworm (EW 4)	100% earthworm (EW 5)

Crude fibre	1.59	1.78	2.03	1.82	2.1
Crude fat	2.67	2.87	3.57	3	2.63
Crude protein	35.17	36.47	37.4	37.17	32.7
Moisture	4.62	7.53	7.47	8.1	10.57
Ash	6.63	9.97	7.73	7.5	11.33
Total carbohydrate	60.33	58.1	58.87	61.4	55.57
Energy value (kcal/100g)	367.88	363.59	372.69	380.38	350.96

Table 4.4: Nutritional Content for different percentage of BSFL Feed

	Feeds				
Ingredients (g/kg)	0% Black Soldier Fly Larvae (BSFL 1)	25% Black Soldier Fly Larvae (BSFL 2)	50% Black Soldier Fly Larvae (BSFL 3)	75% Black Soldier Fly Larvae (BSFL 4)	100% Black Soldier Fly Larvae (BSFL 5)

Crude fibre	2.1	2	1.9	2	2.07
Crude fat	3.63	3.17	5.03	5	8.67
Crude protein	32.73	32.47	33.27	33.7	33.5
Moisture	4.43	8.27	6.77	6.83	7.77
Ash	6.67	6.4	7.1	7.1	6.97
Total carbohydrate	58.4	51.13	58.77	61.77	61.03
Energy value (kcal/100g)	361.42	327.03	358.44	389.58	416.66

The findings of proximate analysis of both experimental diets, BSFL-based pellet and earthworm-based pellet, with 0, 25, 50, 75, and 100% inclusions, were shown in Tables 4.3 and 4.4. Earthworm-based pellets have a higher crude protein content than BSFL-based pellets, with 50% and 75%earthworm inclusions resulting in 37.4 percent and 37.17 percent crude protein content, respectively. Meanwhile, BSFL-pellets had the greatest crude

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protein level of 33.7 percent, with 75% inclusion. All of the inclusions in both experimental diets, on the other hand, have higher crude protein levels than the control diet, which is fish meal.

The moisture percentage of 100% earthworm inclusion is the greatest among all other inclusions at 10.5%, whereas the lowest moisture level other than 0% inclusion is 6.77% in 50% BSFL inclusion. 0% inclusion from both pellets, on the other hand, results in the lowest moisture content compared to other inclusions. Furthermore, there is no significant difference between 25% and 50% inclusions of both experimental diets, however there is a significant difference between 75% and 100% inclusions of both diets. This illustrates that as the number of inclusions increases, so does the moisture level, which is ideal for betta fish, as they only require 6-10% of the pellet's moisture content. The rate of food absorption and assimilation in the consumer is determined by the amount of moisture in the food. It also determines the keeping quality of food which means that the determined values indicated that both experimental diets except control diet may not be stored at room temperature for a long period of time (Sodamade, Bolaji et al. 2013).

The amount of mineral stuff that is likely to be detected on food substance is indicated by ash on food. Except for 25% and 100% earthworm inclusion, which are 9.97% and 11.3% respectively, there is no significant variation in ash concentration in both experimental diets. Furthermore, the trend has indicated that when inclusion increases, the ash content increases as well. As ash level increases, digestibility decreases, resulting in more fish waste in the water. The majority of the ash content in this scenario does not exceed the maximum specified ash percentage for fish pellets, which is 8%.

The crude fat content of 50% inclusion in earthworm-based pellets is the highest, but it is not statistically different from other inclusions. Meanwhile, with BSFL-based

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pellets, 50%, 75%, and 100% inclusions provide a substantial difference when compared to 0% and 25% inclusions. Furthermore, betta fish only require a minimum of 7% crude fat for sustenance. In this scenario, only a 100% BSFL-based pellet provided the betta fish with the appropriate amount of fat. The betta fish, on the other hand, only require a maximum of 7% crude fibre as a nutrition. All of the inclusions in both diets met the required amount of crude fibre for the betta fish's nutrition, as shown in the table above. There are no significant differences in all of the items between the BSFL and earthworm diets. Furthermore, in both experimental diets, the greatest crude fibre is 0% BSFL and 100% earthworm, while the lowest is 50% BSFL and 0% earthworm.

The protein and energy levels of a diet are intimately connected, and there are few studies on the impact of both on betta fish growth and feed consumption. When the nutritional energy level of a food is insufficient to meet a fish's energy demand, the amino acids that make up the protein will be used as a source of energy, resulting in the expulsion of a large amount of nitrogen by excessive deamination of the amino acids. A low energy to protein ratio, on the other hand, may diminish fish development rates by increasing metabolic energy need to excrete nitrogen, as well as lowering water quality, which is the most significant aspect of ornamental fish in aquaria. On the other hand, large energy to protein ratio could lead to lipid accumulation deposition on body carcass and reduce the nutrient intake leading to lack of nutrients and reduced disease resistance of fish (Lemos, Arantes et al. 2014).

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CHAPTER 5

CONCLUSION AND RECOMMENDATION

Betta Fish (betta splenders) has become one of the most important ornamental fish production industries in recent years. Because of their color, form, and activity, ornamental fish are frequently referred to as living diamonds. They are calm, often small, brightly colored, and can fit into a small space. Furthermore, rather than the way of life of edible fish, there is a scarcity of information on the dietary needs and feeding of ornamental fish. Different live feeds have been used for fish raising since nutrition has a significant impact on the development and reproductive potential of aquarium fish.

There is limited information on the nutritional needs for freshwater ornamental fish production to cover reproductive requirements. However, the effects of different live feeds and diets on betta fish growth and reproduction must be explored at that moment. The majority of benthic green growth and aquatic insect larvae were found in the digestive tracts of wild guppies. Males ate more each peck and were fed at lower densities than females of same weight.

Future research is needed to support the recommendation, which should include comparisons of populations from high and low predation areas, as well as male and female kinematics correlations. Male bettas have been seen to emigrate from their original pool more frequently than females, and the likelihood of emigration is skewed

toward upstream development. As a result, it's possible that jumping is more obvious in men from high-predation areas than in other groups.

Furthermore, there is a need to conduct additional research on betta. The behaviour of betta fish has not been well studied, and there is a scarcity of information as compared to other species. There are many studies on the behaviour of betta fish, however most of them are not from our nation. It should be broadened to other areas since, in the future, our country will be a better breeder, similar to Indonesia, despite the fact that we have a lesser geographical region to cover. It can also be done with other decorative fish that are usually significant in aquaculture life, which may be due to a lack of awareness among people as well as a lack of understanding and interest in them.

From this research, I would like to recommend that when doing research about betta fish, the same gender of the fish should not be put together into the same aquarium because it will lead to the competition of the same gender. This can be shown throught the weight gain result that was collected which the aquarium that has the same gender of fish had a decrease in body weight of one of the fish.

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APPENDIX A

Table A 1: Raw Data For Weight of Betta Fish for 5 weeks for Earthworm Feeding

VARIABLES	Treatment	Replicate	Weight	Weight	Weight	Weight	Weight
			WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5
FISH MEAL (CONTROL) (0% EARTHWORM)	1	1	1.2362	1.255	1.251	DEAD	DEAD
		1	1.3024	1.257	1.2342	1.2105	1.2396
		2	1.991	1.276	1.3143	DEAD	DEAD
		2	0.8712	0.867	0.7893	1.4581	1.4393
		3	1.037	0.9306	0.9602	1.0158	1.011
		3	0.9734	0.9956	1.0717	0.9729	0.9331
25% EARTHWORM	2	1	1.2312	1.0695	1.0575	DEAD	DEAD
		1	1.2754	1.281	1.3172	DEAD	DEAD
		2	0.9281	0.9131	0.899	1.4358	1.3615
		2	0.9464	1.0031	1.0921	DEAD	DEAD
		3	1.4307	1.4748	1.4619	0.854	1.293
		3	1.0974	1.1324	1.1796	DEAD	DEAD
50% EARTHWORM	3	1	1.2601	1.4007	1.4452	1.3515	1.3579
		1	0.9982	0.9978	0.8835	DEAD	DEAD
		2	1.3252	1.3697	1.3093	1.0527	1.2261
		2	1.3619	1.3209	1.3194	DEAD	DEAD
		3	1.0291	1.0408	1.0462	0.944	0.917
		3	1.2489	1.1455	1.1346	1.0555	1.0308
75% EARTHWORM	4	1	1.2804	1.3138	1.404	1.4515	1.1611
		1	1.3264	1.2333	1.2223	1.0548	1.4199
		2	0.689	0.7076	0.7264	0.3569	0.7772
		2	1.2425	1.2805	1.2298	1.2636	1.2958
		3	1.2425	1.1897	1.1971	1.1826	1.1483
		3	1.2077	1.2487	1.3152	1.3759	1.3804
100% EARTHWORM	5	1	1.2072	1.2365	1.2668	1.1821	1.1987
		1	0.756	0.7895	0.8585	0.811	0.8384
		2	0.64	0.7177	0.7789	0.7851	0.7962
		2	0.954	0.929	0.8932	0.9146	0.8384
		3	0.933	0.9409	0.93	0.8627	0.9443
		3	1.3179	1.3691	1.391	DEAD	DEAD

Table B 2: Raw Data For Weight of Betta Fish for 5 weeks for BSFL Feeding

VARIABLES	Treatment	Replicate	Weight	Weight	Weight	Weight	Weight
			WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5
25% BSFL	6	1	1.1051	1.0383	1.334	1.0069	0.9855
		1	1.3101	1.3713	1.45	1.4737	1.4831
		2	1.275	1.3203	1.3239	0.8919	0.881
		2	1.2565	1.225	1.241	0.8812	0.8552
		3	0.95	0.9527	0.8881	1.1463	1.118
		3	0.8671	0.8781	0.9145	1.0133	1.497
50% BSFL	7	1	0.8998	0.9062	0.9033	0.9985	1.184
		1	1.0967	1.1613	1.2053	1.2137	1.2096
		2	1.0086	1.0194	1.07	1.1215	1.0656
		2	1.2573	1.2469	1.2188	1.1527	1.1174
		3	1.1181	1.1375	1.1488	1.8121	1.139
		3	1.203	1.3318	1.228	1.2252	1.0656
75% BSFL	8	1	0.9622	0.9536	0.8697	0.8703	0.892
		1	1.032	1.152	1.265	0.9978	1.058
		2	0.9961	0.9814	0.8348	0.8197	0.8402
		2	1.326	1.2258	1.1188	1.5317	1.6183
		3	0.9821	0.9706	0.915	0.7271	0.6605
		3	1.5802	1.5704	1.5421	1.0917	1.0723
100% BSFL	9	1	1.107	1.2435	1.3565	1.3262	1.3565
		1	1.126	1.0304	0.906	0.7313	0.6716
		2	1.182	1.2066	1.2833	1.4136	1.4154
		2	1.1201	1.0028	0.9051	DEAD	DEAD
		3	0.879	0.9514	1.1088	1.0415	1.0191
		3	1.1201	1.0829	1.0096	1.1455	1.1288

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APPENDIX B

Figure B 1: Treatment for Betta Fish

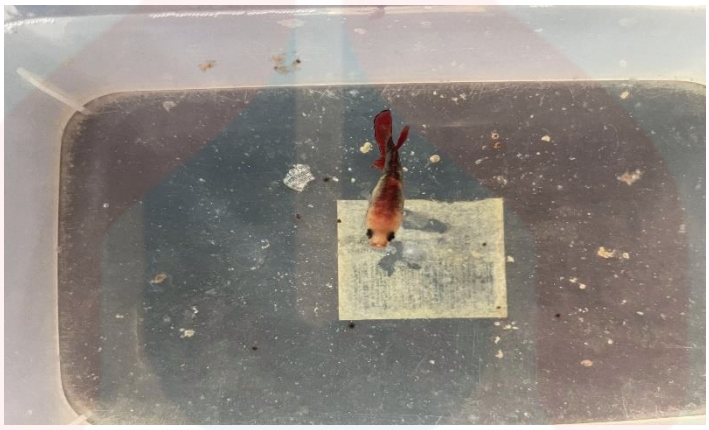

Figure B 2: Betta Fish eat Earthworm feed

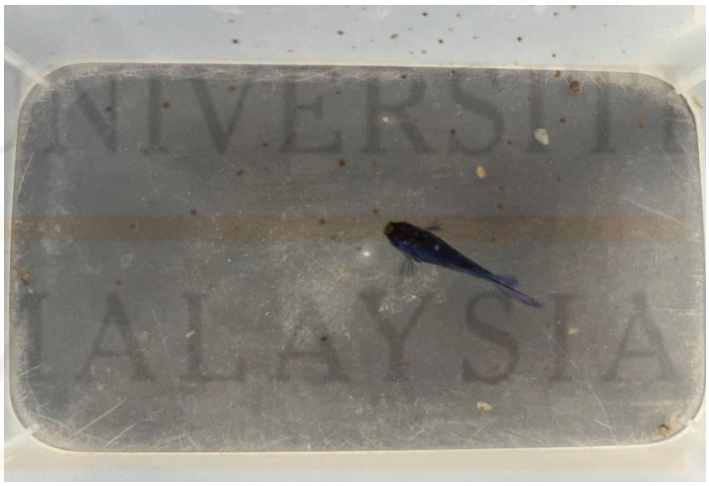

Figure B 3: Betta Fish eat BSFL feed

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Figure B 4: Betta Fish Died

Figure B 5: Earthworm

Figure B 6: Formulated BSFL feed

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