

Chapter 1

1.0 INTRODUCTION

1.1 Background of the Study

Fish nutrition science, since its foundation in 1935 (Belal, 2005), had contributed nearly 77 years to developments in commercial aquaculture. In fish farming, nutrition is the most crucial factor to be taken into account due to its contribution of up to 70% of the production costs. The increasing price of fish feed is considered as the main obstacle limiting the profitability and production of aquaculture industry, mainly due to the over dependence on the sole main protein source, fish meal (Mc Coy, 1990). As a result, there are several attempts and continuous research conducted in searching for the best and also superior alternative protein source in aquaculture diet. Therefore, it is important that the principles underlying fish nutrition are well understood. Nowadays, fish nutritionists and feed formulators are more focused on new protein sources that have similar amino acid content to fish meal to promote optimum fish growth. Thus, the main aim in fish nutrition is to use the knowledge of nutrient requirements, locally available feed ingredients and digestive capacity of the aquatic organism for the development of a nutritionally balanced mixture of feedstuff and acceptable cost. Proper nutrition is one of the most important factors influencing the ability of cultured organism to attain its genetic potential for growth, reproduction and longevity. In addition, although many new alternative proteins have been introduced in fish feeds, many of them need to undergo nutritional evaluation to determine their nutritive values and appropriate levels before being incorporated in the respective diets (Glencross *et al.*, 2007).

FAO (1990) has defined aquaculture as the farming of aquatic organisms with some intervention through the rearing system to increase the production such as stocking, feeding management, predatory protections and disease outbreak administration. Since aquaculture has been practiced previously and as times goes by, this practice has gradually spread all over the world changing the conventional mode into the modern practice of aquaculture operation. In fact, aquaculture is probably the fastest growing food-producing sector in the world with an average growth rate of 8.8% per year since 1970, compared with only 1.2% of capture fisheries and 2.8% for terrestrial farmed meat production system (FAO, 2007). World aquaculture production achieved high in 2010 with an estimated total value of USD\$119 billion. Asia accounted for 89% of world aquaculture production by volume and this was dominated by the contribution of China (FAO, 2012). Increasing production capacity of aquaculture through intensifications seems to be the good choice to meet the increasing demand. Therefore, development of cost effective and sustainable dietary formulations is deemed as one of the best solutions to support the expansion of aquaculture production. Otherwise this sector could face major problem in terms of low production due to its inability to feed the cultured fish with good quality feed.

Currently, the reliance on fish meal has decreased and several efforts are made to replace it with other alternative protein sources in order to reduce the overall production cost without affecting the growth performance of fish. The question raised is on how much portion of fish meal could be replaced by other potential protein sources in order to achieve optimum growth and harvestable size of cultured fish particularly red tilapia. Thus, it is essential to know the growth performance of fish fed with insect-based diet with different proportion of fish meal replacement in laboratory scale before it can be implemented in much larger scale commercially. It is also essential to know the nutrient evaluation including chemical composition and digestibility measurement,

efficiency of diets containing the insect meal in terms of palatability and acceptability and the way to develop the complete set of diet by adding some added value properties such as supplementation of amino acid as well as prebiotic compounds.

1.2 Statement of the Problems

Aquaculture in Malaysia has immense potential and kept expanding throughout the years. By the year 2010, the aquaculture production has recorded approximately 155,398.63 metric tonnes with estimated value of RM 760 million (Department of Fisheries Malaysia, 2010). It is worth to mention the previous record of freshwater aquaculture has increased in production from 95,846.16 metric tonnes in 2008 valued at RM 471 million to 152,628.09 metric tonnes in 2009 with estimated value of RM 704 million (Ministry of Agriculture Malaysia, 2010). Recent statistics given by the Department of Fisheries (DOF) expected the aquaculture industry to contribute almost USD 400 million (RM 1.39 billion) of income annually (Ahmad Faiz *et al.*, 2010). Besides, the productivity of the aquaculture industry will reduce the gap between fish supply and demand, which can generate the country's economic development (Department of Fisheries Malaysia, 2007a). Together with this development more job opportunities can be created.

In Malaysia, about 29,013 metric tonnes of red tilapia was produced in 2010 with a value of RM 192.991 million (Department of Fisheries Malaysia, 2010). The potential of tilapia production is increasing. It is also a highly popular freshwater fish due to its desirable qualities as a food fish such as its white flesh and firm texture, which has made them gain acceptance with different tastes and food preferences (Shiau, 2002). As the culture of tilapia continues to intensify, this species is heavily depended on prepared feeds. Thus, formulated feeds are used to either replace or supplement the natural feed in the diets of cultured fish rather than totally dependent on commercial feed (Goddard, 1996).

Since feeding can take up to 70% of the whole operation cost of aquaculture (El-Sayed, 2004), one way to increase the profitability and reduce dependence on imported fish meal is to replace it with other locally available alternative protein sources that consequently can increase the profit margin by minimizing operation cost. Protein is commonly the most expensive in the dietary component due to shortage of FM production coupled with great competition from other livestock feed industry. Therefore, finding less expensive and more sustainable sources, which provide better fish growth is advantageous to feed manufacturers and aquaculture playmakers (Coyle *et al.*, 2004).

Previously, the development of commercial aquafeed has been traditionally based on fish meal as the main protein source (El-Sayed, 1999). Continuous demand for sole protein source, fish meal has resulted in shortage in supply and increase in price (Hardy and Tacon, 2002). Although fish meal has remained stable in its production, its recent decline obviously cannot meet the commercial aquafeed demand in the future (Tacon *et al.*, 2006). Replacement of fish meal with available protein sources has been identified as an essential requirement for future of aquaculture development. The need to identify appropriate new sources of protein is therefore is imperative. It is highly desirable that selected protein sources do not conflict with human food security interests.

1.3 Significance of the Study

Malaysia is an importer of fish feedstuff particularly fish meal. Statistic of fishery commodities shows the import value of fish meal registered the highest increase of 73.7% from RM 23 million in the year 2005 to RM 40 million in the year 2006 (Department of Fisheries Malaysia, 2007b). As mentioned earlier, the aim is to reduce the dependence upon fish meal that is continually increasing in price. By 2010, 690 000 tonnes of formulated feed is needed to support the demand of the local aquaculture

industry (Che Musa and Nuruddin, 2005). Unfortunately, the country is limited in producing only up to three metric tonnes and the rest approximately 11 thousand metric tonnes with a value of RM 662,595 has to be imported from worldwide source (Department of Fisheries Malaysia, 2007). Almost 80% of the ingredients used in the aquafeeds that are produced locally such as maize, rice bran, meat meal, leaf meal, plant meal cakes are imported from Thailand, China, India, Indonesia, Burma, Australia, Chile and Peru (Hashim, 2006).

In this research, super worm (*Zophobas morio*) meal was tested as an alternative protein because it is abundantly available locally. It can be purchased at pet shop for reptile and fish. This research will use this highly protein content source in replacing fish meal as much as possible. Also, the use of mushroom stalks as an agriculture by-product for supplementary nutrient to reduce the dependency on imported ingredients is economically and environmentally friendly. Thus, addition of mushroom also is a new idea in prebiotic administration rather than using antibiotic that could be potentially harmful. The idea is to develop aquafeeds from insect meal that can be adapted easily to the digestive physiology of fish. It will be combined with other economical compound to develop the feed with the best potential which contained all the nutritional complete requirement packages against all the common problems faced by aquaculture practitioners. Based on its availability, biological value and nutritional value, super worm, *Zophobas morio* meal is said to be a viable alternative to fish meal in the diet of fish. It seems that the utilization of super worm meal offers a good opportunity for the development of low cost fish feeds, especially in developing countries where fish meal is imported very expensively and therefore not readily available. In the literature review made recently, little or limited research or reports regarding this insect, *Zophobas morio* has been made and utilized experimentally, as fish feed.

Thus, a systematic research on the possibility of partial and complete replacement of fish meal with insect meal especially super worm meal by upgrading feeds with amino acid supplementation will hopefully be similar to fish meal based diet. An easily available, nutritionally balanced diet and locally produced is therefore required to reduce the dependence of fish meal in fish culture in many developing countries including Malaysia.

1.4 General Objectives

The main objective of this research was to investigate the nutritional suitability and cost-effectiveness of super worm meal (SWM) as an alternative protein source to fish meal in the diet of red tilapia. In addition, the specific objectives were:

1. To evaluate the nutritional value of the super worm meal as an alternative to fish meal in the diet of red tilapia.
2. To study the effect of using different proportions of super worm meal incorporated in the diet on growth performances of red tilapia.
3. To investigate the effect of dietary amino acid supplementation of diets containing the mixtures of the super worm meal based diets on growth performance and feed utilization.
4. To evaluate the effect of mushroom stalk meal inclusion as a supplement in the super worm based diet on growth performance.