TILAPIA GIFT PRODUCTION PERFORMANCE AND QUALITY CULTURED UNDER DIFFERENT CULTURE SYSTEMS

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27th March 2017

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ABSTRACT

The growth performance, feed utilization, sensory evaluation, proximate and fatty acid composition of Genetically Improved Farmed Tilapia (GIFT) reared in different culture systems were examined in 126 days of feeding trials. Throughout the feeding trial, fish were fed commercial tilapia feed twice a day at 3 % of their body weight. In the present study, there was a higher range of temperature, pH, salinity and nitrite of cage culture system compared to the tank culture system. However, only ammonium content of water was significantly affected by the culture systems. It was found that significantly higher viscerosomatic and hepatosomatic indices, weight gain, daily growth rate, specific growth rate, gross yield and better feed conversion ratio were yielded in GIFT cultured in cage (9.16 %, 2.50 %, 267.06 g, 2.67 g fish^{-}1 day-1, 3.90 % day-1, 24.43 g fish-1 day-1 and 1.06, respectively) than in tank (5.38 %, 1.26 %, 172.55 g, 1.50 g fish-1 day-1, 2.07 % day-1, 18.84 g fish-1 day-1 and 1.41, respectively). In contrast, GIFT cultured in tank showed significantly higher survival rate (100.00±0.00 %) and ash content (1.45±0.66 %) than GIFT cultured in cage (94.00±1.15 %; 1.05±0.56 %, respectively). Length-weight relationship showed both GIFT reared in either tank or cage culture systems have strong positive relationship. GIFT reared in cage showed a heavier and bigger size (b=3.07) compared to tank culture system (b=2.58). There were significant different ($P<0.05$) in mean total weight of GIFT between both culture systems. In the present study the values of relative condition factor (K) of GIFT from tank and cage culture systems; showed ideal growth (0.8605 and 1.2285, respectively). The daily feed consumption varied considerably for both culture systems, but there was an upward trend in consumption at the beginning of trials and the maximum feeding rates for the whole system in the tank and cage were approximately 2,500 g/day and 2,300 g/day, respectively. Apart from that, higher positive scores obtained in sensory evaluation test indicated that the acceptance of consumers toward GIFT fillets cultured in both systems. Nevertheless, panels claimed to like or most prefer fillets of GIFT cultured in tank more than GIFT cultured in cage to be chosen as a food product. A higher contents of 20:5n-3 (0.29±0.09 %) and 22:6n-3 (14.59±0.23 %) of GIFT fillets cultured in tank culture systems proposed that GIFT cultured in tank culture systems richer of EPA and DHA omega-3 which widely recognized to be beneficial for human health and nutrition. In our study, suggested that a higher proportions of UFAs of GIFT fillets cultured in tank culture system than those cultured in cage were mainly influenced by significantly different size of fish and maturity factor in the two culture systems during harvest. Growth performance of GIFT in this study shows various possibilities of manipulation of culture systems in aquaculture industry. It can be concluded that both systems have their own advantages and disadvantages in terms of growth, survival and fillet quality of GIFT. Therefore, findings from the present study indicated that both culture systems are feasible to be practiced in Malaysia depending on the farm's objective and availability of culture facility.

ABSTRAK

PRESTASI PRODUKSI GIFT DAN KUALITI KULTUR DALAM SISTEM KULTUR YANG BERBEZA

Prestasi pertumbuhan, utilisi makanan, penilaian deria rasa, komposisi anggaran dan kandungan asid lemak GIFT (*Genetically Improved Farmed Tilapia*) yang diternak dalam sistem kultur berbeza selama 126 hari menggunakan percubaan pemakanan telah dikaji. Sepanjang tempoh percubaan pemakanan, ikan telah diberi makan menggunakan makanan tilapia komersil pada 3 % daripada berat badan mereka. Dalam kajian ini, terdapat julat yang lebih tinggi pada suhu, pH, kemasinan dan nitrit dalam sistem ternakan sangkar berbanding dengan sistem ternakan tangki. Walau bagaimanapun, hanya kandungan ammonium yang terjejas dengan ketara oleh sistem kultur. Telah didapati bahawa viscerasomatik, hapatosomatik, peningkatan berat, kadar pertumbuhan seharian, kadar pertumbuhan spesifik, hasil kasar dan nisbah penukaran makanan yang lebih baik pada GIFT yang diternak dalam sistem kultur sangkar (9.16 %, 2.50 %, 267.06 g, 2.67 g ikan^{-1} hari^{-1}, 3.90 % hari^{-1}, 24.43 g ikan^{-1} hari^{-1} dan 1.06, masing-masing) berbanding di tangki (5.38 %, 1.26 %, 172.55 g, 1.50 g ikan^{-1} hari^{-1}, 2.07 % hari^{-1}, 18.84 g ikan^{-1} hari^{-1} dan 1.41, masing-masing). Walau bagaimanapun, GIFT yang dikultur di dalam sistem tangki menunjukkan kadar kemandirian (100.00 ± 0.00%) dan kandungan abu (1.45±0.66%) lebih tinggi berbanding GIFT yang diternak dalam sistem sangkar (94.00±1.15%; 1.05±0.56%, masing-masing). Hubungan panjang-berat menunjukkan kedua-dua GIFT yang dipelihara sama ada dalam sistem ternakan tangki atau sangkar mempunyai hubungan positif yang kukuh. GIFT diternak dalam sangkar menunjukkan saiz yang lebih berat dan lebih besar (b = 3.07) berbanding dengan sistem ternakan tangki (b = 2.58). Terdapat perbezaan yang signifikan (P <0.05) dalam jumlah berat purata GIFT antara kedua-dua sistem kultur. Dalam kajian ini nilai-nilai keadaan relatif faktor (K) GIFT daripada sistem tangki dan sangkar; menunjukkan pertumbuhan ideal (masing-masing 0.8605 dan 1.2285). Pengambilan makanan harian jauh berbeza untuk kedua-dua sistem kultur, tetapi ada pola peningkatan dalam pengambilan makanan pada awal percubaan dan kadar makan maksimum untuk keseluruhan sistem dalam tangki dan sangkar adalaah masing-masing 2,500 g/hari dan 2,300 g/hari. Selain itu, skor positif yang lebih tinggi diperoleh dalam penilaian deria rasa menunjukkan penerimaan pengguna terhadap filet GIFT dalam kedua-dua sistem kultur. Walau bagaimanapun, para panel mengaku lebih menyukai dan memilih filet GIFT dalam tangki berbanding yang dikultur dalam sangkar sebagai produk. Nilai kandungan asid lemak yang tinggi 20:5n-3 (0.29±0.09%) dan 22:6n-3 (14.59±0.23 %) daripada filet GIFT kultur tangki mencadangkan ikan yang diternak dalam sistem kultur tangki kaya dengan lemak EPA dan DHA omega-3 yang diiktiraf secara

meluas dalam memberi manfaat kepada kesihatan manusia dan nutrisi pemakanan. Dalam kajian kami, mencadangkan bahawa perkadaran lebih tinggi asid lemak UFAs dalam sistem kultur tangki berbanding sangkar adalah disebabkan oleh saiz berbeza dan faktor kematangan ikan dalam kedua-dua sistem kultur. Dapat disimpulkan bahawa kedua-dua sistem mempunyai kelebihan dan kekurangan masing-masing dari segi tumbesaran, kadar kemandirian dan kualiti filet GIFT. Oleh yang demikian, hasil kajian ini menunjukkan bahawa kedua-dua sistem kultur GIFT dapat dipraktikkan di Malaysia bergantung kepada objektif dan ketersediaan kemudahan sistem kultur di ladang tersebut.

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LIST OF SYMBOLS

g	-	Grams
kg	-	Kilograms
lbs	-	Pound
m	-	Metres
km	-	Kilometres
mm	-	Millimetres
cm	-	Centimetres
ºC	-	Degree Celsius
mg	-	Milligrams
mL	-	Millilitres
µ	-	Microns
MT	-	Metric tonnes
L	-	Litres
ha	-	Hectares
mg/L	-	Milligrams per litres
ppm	-	Parts per million
ppt	-	Parts per thousand
%	-	Percentage

LIST OF ABBREVIATIONS

GIFT	-	Genetically Improved Farmed Tilapia
AOAC	-	Association of Official Analytical Chemists
MAO	-	Ministry of Agriculture and Agro-based Industry
FAO	-	Food and Agriculture Organization of United Nations
NRC	-	National Research Council
WWF	-	World Wide Fund for Nature
NABARD	-	The National Bank for Agriculture & Rural Development
HSI	-	Hepatosomatic index
VSI	-	Viscerosomatic index
FCR	-	Feed conversion ratio
DO	-	Dissolved oxygen
MIB	-	2-methyl-isoborneol
SCD	-	Stearoyl-CoA desaturase
DHA	-	Docosahexaenoic acid
EPA	-	Eicosapentaenoic acid
ALA	-	Alpha-linolenic acid
UFA	-	Unsaturated fatty acid
HUFA	-	Highly unsaturated fatty acid
SFA	-	Saturated fatty acid
MUFA	-	Monounsaturated fatty acid
PUFA	-	Polyunsaturated fatty acid

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CHAPTER 1

GENERAL INTRODUCTION

1.1 Research Background

Aquaculture in Malaysia is currently expanding rapidly as a result of the increasing need of fish supply as a source of protein. This sector has been growing more rapidly than any other animal food-producing sector in the world. It is estimated that by 2030, the aquaculture production will grow by 40 % to fulfil global fish demand (WorldFish, 2015). As stated in an overview of National Aquaculture Sector Malaysia, aquaculture has become a priority area in the government's most recent policy programme for 1998-2010 along with Ministry of Agriculture and Agro-based Industry (MOA)'s objective to further expand aquaculture industry in the country (FAO, 2014). Demand for consumable fish was expected to increase annually from 1.31 million metric tonnes (MT) to 1.59 MT in 2015 (WWF Malaysia, 2014). Therefore, efforts need to be geared towards achieving higher production intensities. There have been several efforts to increase the aquaculture production including introduction of new species, improvement of culturing techniques and also intensifying research and development (R&D) projects related to mass production of aquaculture species.

Freshwater aquaculture in Malaysia is predominated by pond culture practice which comprises mainly the tilapia and catfish and climbing perch (FAO, 2014). Traditionally, tilapia has been cultured in earthen ponds under extensive and semi-intensive systems (El-Sayed, 2006). One of the advantages using pond culture system is tilapia can be culture at high density and released water from this culture systems can be used in the agricultural land, and it is also good source of fertilizer

(Rahman *et al.,* 2012). In general, GIFT was reported to perform well across common farming (pond) conditions and culture (cage) environments (Herathm *et al.,* 2012). This species is known for its rapid growth rate, high fillet yield and good disease resistance capability (Dey & Gupta, 2000; Qiang *et al.,* 2012). However, mixed-sex population's breed in pond culture will compete for food, cause reduction in fish growth, and the population becomes stunted which indirectly caused variations in size of fish (DeLong *et al.,* 2009).

1.2 Problem Statements

Even though freshwater aquaculture in Sabah is not growing as rapid as the mariculture sector, it is still considered a very important sector especially in tackling the issue with food security. With the frequent occurrence of harmful algae bloom in the West Coast of Sabah, the local people have to turn to other protein sources which include the freshwater fishes. Therefore, boosting the freshwater aquaculture sector in the West Coast of Sabah is seen as an agenda to be considered seriously by the government. Yet, the expansion of aquaculture in Malaysia is being increasingly constrained by problems closely linked to the large expanse of land required for intensive aquaculture in pond. Therefore, urban aquaculture system such as using tanks is becoming more popular these days.

Many researchers agreed with the ideas of practising urban aquaculture in order to minimize the impact on degradation of land. In the past, studies related to GIFT strain reported the findings on the effects of culture systems basically on tank shape and volumes in relation to growth performance of fish (Kolkovski *et al.,* 1995), evaluation of lipid and fatty acid of GIFT strain in a semi-intensive systems (Al-Souti & Claereboudt, 2014), performance of GIFT strains in fresh and seawater (Ridha, 2014) and evaluation on GIFT reared in cages and grown under natural conditions in reservoir (De Silva *et al.,* 2015). However, the performances of the fish in both culture systems have not been adequately investigated to provide a better understanding on the current practices, particularly in Sabah, Malaysia. Thus, this study aimed at comparing the performances of GIFT in different culture systems including their growth, survival rate and post-harvest quality and fatty acids composition.

1.3 Significance of Study

This study is important for several reasons, firstly to observe the effects of culture systems on GIFT growth performance. Researchers have concluded that the GIFT strain has several advantages compared to the Nile tilapia. Yet, the manipulation of culture systems toward their carcass, taste of fillets and nutritional composition which are way more important in providing nutritional food source to the consumers have not been deeply understand. The findings from the present study will be able to provide more knowledge on the efficiency of difference culture systems in producing GIFT.

Furthermore, by evaluating the proximate, sensory and fatty acids composition of GIFT strains cultured in different systems, will provide additional input to the freshwater aquaculturists in promoting their product value. A consistent effort and systematic management of culture systems study is needed in culturing tilapia GIFT, which then will increase the production of tilapia in freshwater aquaculture industry. Thus, by diligently study the differences in culture system's management, feeding materials, time supervision and the product value of cultured GIFT, this will give significant information to the farmers in order to support sustainable growth of the industry.

1.4 Objectives

There are three main objectives of this study:

1. To determine the growth performance of GIFT cultured in tank and cage culture systems.

2. To determine the post-harvest quality of GIFT cultured in tank and cage culture systems.

3. To determine the GIFT production performance and quality cultured under different culture systems of tank and cage culture systems.

CHAPTER 2

LITERATURE REVIEW

2.1 Genetically Improved Farmed Tilapia (GIFT)

In Malaysia, red tilapia (*Oreochromis sp.*) is the dominant freshwater species that have been cultured and highly favoured by consumers due to its attractive red colour which raises a higher price in the market (Josupiet, 2005; Liping & Fitzsimmons, 2011). The rapid increase in global tilapia production is due to the successfully introduction of improved strains of Nile tilapia. One of the most globally well-known strains of Nile tilapia is Genetically Improved Farmed Tilapia (GIFT) strain developed by the WorldFish Center (See Figure 2.1). The origin of the GIFT strain of Nile tilapia *Oreochromis niloticus* was described in detail by Ponzoni *et al.*, (2005) and Nguyen *et al.*, (2007). A fully pedigreed population based on the sixth generation of GIFT was established in Malaysia in 2002. The GIFT was introduced from Philippines in 2001 and stocked in Jitra and Penang. Since then, WorldFish and the Department of Fisheries, Malaysia jointly collaborating on further research and development of GIFT (WorldFish Center, 2010).

Figure 2.1: Genetically Improved Farmed Tilapia (GIFT) used in present study