Addition of Pineapple Flesh in The Diets of Red Hybrid Tilapia (*Oreochromis niloticus X Oreochromis mossambicus*): Effect on Growth Performance and Survivability

By
Siti Alawiyah Binti Jamal Abdul Naser

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

Faculty of Agro Based Industry
UNIVERSITI MALAYSIA KELANTAN

2018

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: Siti Alawiyah Binti Jamal Abdul Naser

Date:

I certify that the report of this final year project entitle “Addition of Pineapple Flesh in The Diets of Red Hybrid Tilapia (*Oreochromis niloticus X Oreochromis mossambicus*): Effect on Growth Performance and Survivability” by Siti Alawiyah Binti Jamal Abdul Naser, matric number F14A0349 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Animal Husbandry Science) with Honours, Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

Approved by;

____

Supervisor

Name: Dr. Suniza Anis Binti Mohamad Sukri

Date:

ACKNOWLEDGEMENT

All praises to Allah for giving the chance to finish this study, by providing me with the strength and optimistic attitude regardless of any complications or doubts that may have arise during the research.

With affection and gratitude, I would like to express my deep appreciation to my supervisors, Dr Tan Sze Huey and Dr Suniza Anis Binti Mohamad Sukri, who provides me the guidance and knowledge during the running of the experiment. Not to forget for my family members especially to my parents Mr. Jamal Abdul Naser Bin Abu Bakar and Siti Aminah Binti Said who shared their time, expertise, assistance, guidance, moral support and inspiration throughout the experiment.

Besides, to my Final Year Project (FYP) partner, Zuraini Binti Zainalabidin and the others teammates (Nurul Farisya Hanis Binti Zakir, Amalia Binti Mohd Daud, Nurul Afizah Binti Muhammad Afiq Wong, Che Anis Farhana Binti Che Razali, Nurshahiza Binti Abd Kadir and Nur Raihan Binti Muharris) from whom I obtain technical knowledge regarding some techniques of doing experiment.

Next, to the entire lab assistant especially Mr. Wan Shamsul Amri Bin Wan Zainul Abidin and Mr. Abdul Khaliq Bin Zakaria who have been very supportive in providing the equipment such as tank, aerator and others to complete my project.

Lastly, I want to say thank you to my coursemate's friends because they also give me some ideas and moral support in making this report and explain everything that I cannot understand.

Addition of Pineapple Flesh in The Diets of Red Hybrid Tilapia (*Oreochromis niloticus X Oreochromis mossambicus*): Effect on Growth Performance and Survivability.

ABSTRACT

Red hybrid tilapias *(Oreochromis niloticus X Oreochromis mossambicus)* with an average weight of 2.50±0.29g were used to investigate the pineapple flesh effects in the diets of red hybrid tilapia on growth performance and survivability. The liquid sample from pineapple flesh was filtered and sprayed to the commercial feed at different volumes. The treatments consist of Control: no addition of liquid sample from pineapple flesh; Treatment 1: addition of 12.5 ml of liquid sample from pineapple flesh per 100 g of commercial feed; Treatment 2: addition of 31.25 ml of liquid sample from pineapple flesh per 100 g of commercial feed; Treatment 3: addition of 50 ml of liquid sample from pineapple flesh per 100 g of commercial feed. The feeding trial was conducted for six weeks of duration. The results showed that, Treatment 3 with addition of 50 ml of liquid sample from pineapple flesh per 100 g of commercial feed has higher in weight gain (WG) with 39.00 g per fish compared with Control (15.60 g), Treatment 1 (32.00 g) and treatment 2 (32.80 g). In specific growth rate (SGR) also Treatment 3 with 50 ml addition of liquid sample from pineapple flesh per 100 g of commercial feed was the highest with 1.62 % per day compared with Control (0.88 %), Treatment 1 (1.57 %) and treatment 2 (1.59 %). The better feed conversion ratio (FCR) was Treatment 3 (0.16) compared with Treatment 1 (0.20), Treatment 2 (0.22) and Control (0.35). Survivability rate for red hybrid tilapia fish was higher in Treatment 3 (93.3%) compared with Control (60%), Treatment 1 (75.5%) and Treatment 2 (80%). The finding provided economic alternative of feed enrich with pineapple to increase tilapia's growth and survivability through feed additive.

Keywords: Pineapple flesh, liquid sample, red hybrid tilapia, growth performance, survivability.

Penambahan Isi Nanas Dalam Diet Tilapia Hibrid Merah (*Oreochromis niloticus X Oreochromis mossambicus*): Kesan Ke Atas Tumbesaran dan Kadar Hidup.

ABSTRAK

Tilapia hibrid merah *(Oreochromis niloticus X Oreochromis mossambicus)* dengan purata berat 2.5±0.29 g telah digunakan untuk mengenalpasti kesan penggunaan isi nanas dalam diet tilapia hibrid merah keatas tumbesaran dan kadar hidup. Sampel cecair dari isi nanas ditapis dan disembur pada makanan komersial dengan isipadu yang berbeza. Rawatan-rawatan terdiri daripada Kawalan: tiada penambahan sampel cecair daripada isi nanas; Rawatan 1: penambahan 12.5 ml sampel cecair daripada isi nanas per 100 g makanan komersial; Rawatan 2: penambahan 31.25 ml sampel cecair daripada isi nanas per 100 g makanan komersial; Rawatan 3: penambahan 50 ml sampel cecair daripada isi nanas per 100 g makanan komersial. Kajian pemakanan ini mengambil masa enam minggu. Keputusan menunjukkan bahawa Rawatan 3 dengan penambahan 50 ml sampel cecair daripada isi nanas per 100 g makanan komersial mempunyai peningkatan berat yang lebih tinggi iaitu 39.00 g per ikan berbanding dengan Kawalan (15.60 g), Rawatan 1 (32.00 g) dan Rawatan 2 (32.80 g). Dalam kadar pertumbuhan tertentu juga Rawatan 3 dengan penambahan 50 ml sampel cecair daripada isi nanas per 100 g komersial feed mempunyai nilai yang paling tinggi iaitu 1.62 % per hari berbanding dengan Kawalan (0.88 %), Rawatan 1 (1.57 %) dan Rawatan 2 (1.59 %). Nisbah penukaran makanan yang paling baik adalah Rawatan 3 iaitu 0.16 berbanding dengan Rawatan 1 (0.20), Rawatan 2 (0.22) dan Kawalan (0.35). Kadar hidup untuk ikan tilapia hibrid merah mempunyai nilai yang paling tinggi pada Rawatan 3 (93.3%) berbanding dengan Kawalan (60%), Rawatan 1 (75.5%) dan Rawatan 2 (80%). Penemuan ini menyediakan alternatif ekonomi makanan ikan yang diperkaya dengan nanas untuk meningkatkan tumbesaran dan kadar hidup tilapia melalui makanan tambahan.

Kata kunci: Isi nanas, sampel cecair, tilapia hibrid merah, tumbesaran, Kadar hidup.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

FAO	Food and Agriculture Organization
DO	Dissolved Oxygen
WG	Weight Gain
SGR	Specific Growth Rate
FCR	Feed Conversion Ratio
SR%	Percentage of Survival Rate
TDS	Total Dissolved Solids
ANOVA	Analysis of Variance
PFR	Pineapple Fruit Residue
mg	Miligram
g	Gram
ppt	Part per thousand
mg/L	Miligram per litre
m	Milimetre
kg	Kilogram
L	Litre
°C	Degree celcius
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Research Background

Tilapia is the world's second most famous of farmed fish after carp. Tilapia has an excellent faster growth and tolerance even in bad environmental water condition (Berkeley, 2015). Apart from that, prepared feeds are often too expensive for the production of tilapia sold in domestic markets (Lucy, 2010).

Vitamin C is the body's primary water-soluble antioxidant, defending all areas of the body against free radicals that attack and damage normal cells. Free radicals have been shown to promote the artery plaque build-up of atherosclerosis and diabetic heart disease, cause the airway spasm that leads to asthma attacks, damage the cells of the colon so they become colon cancer cells, and contribute to the joint pain and disability seen in osteoarthritis and rheumatoid arthritis. This would explain why diets rich in vitamin C have been shown to be useful for preventing or reducing the severity of all of these conditions. In addition, vitamin C is vital for the proper function of the immune system, making it a nutrient to turn to for the prevention of recurrent ear infections, colds, and flu (Paul & Chen, 2010).

Ascorbic acid or vitamin C that contains in pineapple also can fights bacterial and viral infections and helps the body absorbs iron. This may increase the survivability of red hybrid tilapia (Joseph, 2015).

Pineapple is an excellent source of the trace mineral manganese, which is an essential cofactor in a number of enzymes important in energy production and antioxidant defenses. For example, the key oxidative enzyme superoxide dismutase, which disarms free radicals produced within the mitochondria, requires manganese. Just one cup of fresh pineapple supplies 128.0% of the DV for this very important trace mineral (Paul & Chen, 2010).

Manganese (Mn) is an essential nutrient for growth in several aquatic species, but it often has to be supplemented as insufficient levels are present in water. Mn also plays significant role in better survival, muscle composition, immune response, antioxidant defense and stress tolerance in some fish and crustaceans (Aerin, 2016).

According to Aerin (2016) the levels of manganese-oxide (Mn_3O_4) nano particles (NP) was derived from the fruit peelings as an ingredient in aqua feed. The present work proposed that 16mg/kg of Mn-oxide NPs could be supplemented for flexible enhanced survival, growth and production.

There were limited studies on addition of some vitamin C in the diets of red hybrid tilapia to enhance the growth performance and survivability. Thus, the aims of this study were to determine the effect of addition of pineapple flesh to the diet on the growth performance and survivability of red hybrid tilapia.

1.2 Problem Statement

Red hybrid tilapia is commonly recognized and favored by most of people worldwide due to its attributes such as its wealth of nutrients, minerals, and vitamins. Red hybrid tilapia is susceptible to various microbial infections throughout life cycle. So, this research is focusing on increasing fish immunity against infections through dietary strategy by addition of pineapple flesh in tilapia feed.

1.3 Hypothesis

H_0 = The pineapple flesh in the red hybrid tilapia's diet influence the growth and survivability.

H_a = The pineapple flesh in the red hybrid tilapia's diet statistically does not influence the growth and survivability.

If p-value<0.05, $H_0$was accepted
If p-value>0.05, H_a was rejected

1.4 Objectives

Objectives of this study were described as follow:

i. To determine the effects of pineapple flesh as supplement in fish diet towards growth performance of tilapia.
ii. To determine the effects of pineapple flesh as supplement in fish diet towards survivability of tilapia.

1.5 Scope of Study

The study was conducted in the aquaculture and animal laboratory of University Malaysia Kelantan (UMK) Jeli Campus. Red hybrid tilapias were subjected to feed that contain with liquid sample from pineapple flesh. Survivability and growth performance was determined and have been observed.

1.6 Significance of Study

This study was aimed to enhance the growth performance and survivability of tilapia as well as increasing its immunity. In this study, the fish diet was supplemented with pineapple flesh juice which may act as booster for growth and increase the survivability.

Pineapple (Ananas comosus (L.) Merr), with excellent quality, special flavor, and nutritional richness, is favored by consumers worldwide. It is known as the third most commercial tropical fruit. Pineapple contains considerable calcium, potassium, fibre, and vitamin C. it is low in fat and cholesterol. Vitamin C is the body's primary water soluble antioxidant, against free radicals that attack and damage normal cells (Paul & Chen, 2010).

Since feed is the major factor to be considered in tilapia farming to produce a good quality tilapia, this study was improving the feed with addition of supplement such as vitamin C. The contribution of this study was helps the farmers to apply the local fruit as a vitamin C supplement in the red hybrid tilapia's diet such as pineapple to increase the growth performance and survivability.

CHAPTER 2

LITERATURE REVIEW

2.1 Tilapia

There are several types of tilapia such as *Oreochromis urolepis hornorum, Oreochromis mossambicus, Oreochromis aureus and Oreochromis niloticus.* In addition, the other species of tilapia is red hybrid tilapia that comes from crossing of *O. niloticus* and *O. mossambicus*. Although all the species are different names and colors, the edible fillets or portions are very similar and more influenced by growing conditions and feeds than external colors (Irimia & Gottschling, 2016).

There are newly demonstrated that tilapia can be cultured in the moveable canvas tank system, with a slight alteration of added aeration and increased water exchange rate (Hashim et al., 2000). According to Irimia & Gottschling (2016), more than 80 nations produce farm-raised tilapia as well as the United States and China is the largest producer accounting for up to 50 percent of the world's production.

Tilapia culture is economically benefits landless people, and avoids the off-flavor problems because it has rapidly prolonged. Mass mortality is the most serious problem in the development of tilapia culture. This problem were caused by fish disease, including water-quality problems, bacterial infection, ectoparasite infestation and some diseases that are related to improper feeding, climate change and high stocking density (Amal & Zamri, 2011).

Tilapia is one of the species that are tough and can tolerate in a wide range of ecological conditions, including high temperatures, high salinity, low oxygen levels and high ammonia concentrations. That's why tilapia is very suitable for aqua farming. In the other hand, tilapias have been found to be defenseless to both parasitic and bacterial diseases (Amal & Zamri, 2011).

Popularity of red hybrid tilapia are gaining among culturists due to their similarity to some marine species such as sea bream (*Chrysophrys major*) and red snapper (*Lutjanus campechanus*) due to their feed conversion ratio and excellent growth with range 1:4:1 to 1:8:1 in freshwater (Abdul et al., 2014).

In Japan and the U.S. West Coast, an excellent potential for market development was exists for fresh product. In the other country such as Caribbean Islands which are Bahamas, Curacao and Martinique, a domestic market for red tilapias has been created by the incapability of marine catches to satisfy demand for fish. Commercial tilapia farming in the Caribbean is successfully established in Jamaica, where red hybrid strains are preferred by consumers. Production for 1987 is estimated at 2,600 mt from 720 ha of fresh and brackish water (0-10 ppt) ponds. Water supply is considered as an important constraint to further expansion of aquaculture as water resources are scarce (Watanabe et al., 1989).

The red hybrid tilapia was introduced in 1980s and since then there has been a gradually increase in the contribution of tilapia to freshwater aquaculture in Malaysia. According to Abdel (2016), the national fishery statistics was stated that, the production of Nile tilapia in 1992 was 3145 tons whereas the production of red tilapia amounted 1486 tons in the same year. As further development took place, tilapia production has been in favor of red tilapia as reflected in the fishery statistics whereas in 2011, red tilapia produced about 33,000 tons compared to about 9500 tons for normally pigmented tilapia. The market survey indicated that the average price of red tilapia is about 25% higher than normal tilapia.

The red tilapia's genetic heritages are not well documented because their derivation is attributed to cross-breeding of mutant reddish-orange *O. mossambicus* with other species including *O. aureus, O. niloticus*and *O. hornorum* (Irimia & Gottschling, 2016). Red hybrid tilapia culture for seawater and brackish is suggested by the salinity tolerance exhibited by these parental species, which are known to be moderately to highly euryhaline (Watanabe et al., 1989).

Feed conversion ratio (FCR) is an indicator that is usually used in all types of fish farming. The FCR provide a good indication of the efficiency of feed or a feeding strategy (Abdul et al., 2014).

It is also can be said that the FCR is the relationship of mathematical between the input of the feed that has been fed per fish and weight gain at the end of experiment. The lower of the FCR, showed that the higher in weight gain. When FCR applied to the aquatic animals, it is generally lower than land animals as shown in the table below:

Table 2.1: Average of FCR in different fish species and land animal.

Species	Average FCR
Tropical shrimps	1.6 – 2.0
Omnivorous fish	1.4 – 1.8
Domesticated carnivorous marine	1.3 – 1.6
Salmonids	1.0 – 1.2
Broiler	1.8 – 2.2

Source: (FAO, 2015).

2.2 Protein Requirements for Tilapia

According to Food and Agriculture Organization of the United Nations (FAO), requirements protein for optimum growth of fish are depends on the protein quality in dietary, age or size of fish and the energy contents of the diets. Based on the Stickney (1997), the best protein digestibility occurs at 25°C and the optimum dietary protein to energy ratio was estimated in the region of 110 to 120 mg per kcal digestible energy respectively for fry and fingerling. The fish broodstock need about 40-45% protein for optimum spawning efficiency, reproduction, survival and larval growth (FAO, 2015).

Table 2.2: Protein requirement for freshwater species.

Life stage	Weight (g)	Requirement (%)
First feeding larvae	-	45-50
Fry	0.02-1.0	40
Fingerlings	1.0-10.0	35-40
Juveniles	10.0-25.0	30-35
Adults	25-200	30-32
	>200	28-30
Broodstock	-	40-45

Source: (FAO,2015).

2.3 Water Quality

Based on the research from Southern Regional Aquaculture Centre (2016), Tilapias are more tolerant to low dissolved oxygen, high salinity, high ammonia concentrations and high water temperature.

2.3.1 Salinity

The Nile tilapia can only tolerate with salinity up to 25 ppt while the Mozambique tilapia can tolerate salinity up to 40 ppt. Red tilapia can survive in pure seawater up to 32 ppt (Jaspe and Caiping, 2011). Due to this, tilapia species are the best option because they are omnivorous and can be easily adapted on artificial feed, survive at low oxygen levels, tolerate a wide range of salinity and can be cultured on low volume with high densities (Ronald et al., 2014).

Based on the research from Southern Regional Aquaculture Centre (2016), some ranks were reportedly spawned of red hybrid tilapia in full strength seawater and shows that reproductive performance begins to decrease at salinities above 10 to 15 ppt. Besides that, Nile and Blue tilapias also can well develop in salinities up to 10 to 15 ppt but numbers of fry were decline significantly so they can perform better at salinities below 5 ppt.

2.3.2 Temperature

Commercial culture of tilapia in temperate regions, the intolerance to low temperatures is a serious constraint. The lower fatal temperature for most of the species is 10 to 11°C for a few days, but different in the Blue tilapia tolerates temperatures to about 8.8°C (Southern Regional Aquaculture Centre, 2016).

Generally, when temperature falls below 17.2°C tilapias was stop feeding. Temperature for disease-induced mortality which is after handling seriously constrains sampling, harvest and transport is below than 18.3°C. A temperature higher than 26.6°C is the best for reproduction and does not occur below 20°C. The number of fry produced in subtropical regions decreased when daily water temperature averages less than 23.8°C. Fry recovery was about 600 fry per female brooder at a water temperature of 27.7°Cafter 16 to 20 day spawning cycles with ½ pound Nile tilapia, but only 250 fry per female at 23.8°C (Southern Regional Aquaculture Centre, 2016).

The optimal temperature for tilapia growth is about 29.4 to 31.1°C which is typically three times greater than growth at 22.2°C (Southern Regional Aquaculture Centre, 2016).

According to Amal & Zamri (2011), the best temperatures for tilapia reproduction in Malaysia is above 27°C, but reproduction does not occur when the temperatures below than 20°C. However, temperature of 31°C or more can cause outbreaks of *Streptococcus agalactiae* infection in tilapia (Amal et al., 2008).

2.3.3 Dissolved Oxygen Concentration

Dissolved oxygen (DO) concentrations below the tolerance limits for most other cultured fish which is less than 0.3 mg/L is suitable for tilapia in routine dawn. Tilapia grew better when aerators were used to avoid morning dissolved oxygen concentrations from declining below 0.7 to 0.8 mg/L. Growth was not enhanced if additional aeration kept dissolved oxygen concentrations above 2.0 to 2.5 mg/L (Southern Regional Aquaculture Centre, 2016).

Tilapia also can survive acute low dissolved oxygen concentrations for several hours. To maintain dissolved oxygen concentrations above 1 mg/L, tilapia ponds should be managed well. Growth, disease resistance, and metabolism are depressed when dissolved oxygen concentrations falls below this level for prolonged periods.

2.3.4 pH

Generally, the pH range for tilapias from 5 to 10but according to Rakocy (2009), the optimum pH for tilapia range from 6 to 9. Tilapia can tolerate to lower pH to approximately 5 however it having best growth between pH 7 to 9 (Ross, 2000).In tilapia fingerlings and adults culture, the best pH range is from 2 to 8 (El-Sherif & El-Feky, 2009).Low water pH can lead to behavioral changes, damage of gill epithelial cells, and reduction in the efficiency of the nitrogenous excretion and increased mortality (Amal & Zamri, 2011).

2.3.5 Ammonia

High mortality of tilapia occurs within a few days when fish are abruptly transferred to water with unionized ammonia concentrations greater than 2 mg/L. Nevertheless, when it is acclimated to sub fatal levels, around half of the fish will survive 3 or 4 days at unionized ammonia concentrations as high as 3 mg/L. Prolonged disclosure to unionized ammonia concentration greater than 1 mg/L causes losses among fry and juveniles in water with low dissolved oxygen concentration. First mortalities from prolonged disclosure may begin at concentrations as low as 0.2 mg/L. Unionized ammonia begins to lower feed consumption at concentrations as low as 0.08 mg/L (Southern Regional Aquaculture Centre, 2016).

2.3.6 Nitrate

Nitrate makes the hemoglobin less ability of transporting oxygen and chloride ions to reduce the toxicity, so nitrate is considered as toxic to many fish. When dissolved oxygen concentration was high which is at 6 mg/L and chloride concentration was low which is at 22 mg/L, the nitrate concentration at which 50 percent of the fish died in 4 days was 89 mg/L as nitrate. Generally, for freshwater culture, the nitrate concentration should be fixed below 27 mg/L as nitrate. A defend against nitrate toxicity in recirculating systems, chloride concentrations are often maintained at 100 to 150 mg/L chloride (Southern Regional Aquaculture Centre, 2016).

2.4 Nutrient Composition of Pineapple

Pineapple (*Ananas cosmosus*) is one of the tropical fruit which is originated from Central and South America and it is located in the tropical and sub-tropical areas. Mostly pineapple grows on the ground and it is come from Bromeliaceae family. It can grow up to 1m in height and 1.5m wide. A production of pineapple is around 16 to 18 million tons and involves some countries such as Thailand, Brazil, India, Philippines and China (FAO, 2015).

Pineapple is also known as the queen of fruits due to its superb flavor and it is the significant marketable fruit crops in the world (Baruwa, 2013). Pineapples have a vibrant tropical flavor, large health benefits and extraordinary juiciness.

Pineapple can be used as additional nutritional fruit for excellent personal health and it is exposes high sugars, high moisture, low crude fiber and soluble solid content ascorbic acid (Hemalatha & Anbuselvi, 2013). It is also containing high content of vitamin C, amount of potassium, carbohydrates, calcium, crude fiber, water and different minerals that is good for the digestive system (Megan, 2017).

Table 2.3: Nutrients in 100 grams of pineapple.

Nutrients	Amount
Energy	52 calories
Dietary fiber	1.40 g
Carbohydrate	13.7 g
Protein	0.54 g
Iron	0.28 g
Magnesium	12 mg
Calcium	16 mg
Potassium	150 mg
Phosphorus	11 mg
Zinc	0.10 mg
Vitamin A	130 I.U
Vitamin B 1	0.079 mg
Vitamin B 2	0.031 mg
Vitamin B 3	0.489 mg
Vitamin B 6	0.110 mg
Vitamin C	24 mg

Source: (Olaleye, 2011)

Pineapple contains of ascorbic acid that helps the body absorbs iron and also fights viral and bacterial infections. Essential minerals that exist in pineapples such as trace mineral and manganese and involved to the formation of bone, and also the creation and activation of certain enzymes. According to Debnath et al. (2012), trace mineral and copper in pineapple helps in the absorption of iron and also regulates blood pressure and heart rate.

According to Yousefi et al. (2013), vitamin C acts as a biological reducing agent for hydrogen transport and also needed for the best growth and maintenance. Ascorbic acid is a crucial nutrient for fish because they cannot synthesize this nutrient due to the lack of certain enzyme which is L-gulonolactone oxidase. So, in this case, fish is depending on exogenous supply of ascorbic acid via a proper dietary source (Shiau & Lin, 2006).

Nutritional requirements of an animal are a basic aspect that depends on habitat, life cycle stage and species. Vitamins C are important essential nutrients for most animal species (Sargent et al., 1989). Vitamin C level in the trout diet is positively related to the disease resistance and also humoral antibody production in rainbow trout (Lall & Olivier, 1993).

2.5 Benefits of Pineapple

2.5.1 Benefit to Human

Nutritional composition for canned pineapple is different from raw pineapple (Szalay, 2014). According to the U.S. Department of Agriculture, there has 131 calories per cup and 31.88 grams of sugar of canned pineapple in light syrup and it is also containing fewer vitamins and minerals. But it is different for pineapple canned in Malaysia which is containing 109 calories per cup and 26 grams of sugar (Schaefer & Gotter, 2016).

Pineapple is only a major nutritional source of bromelain that is found in the greatest concentration within the core of the fruit and also found in the juice and throughout the sweet parts of pineapple. Pineapple can be helpful in the treatment of sports injuries, with the presence of anti-inflammatory properties of bromelain (Schaefer & Gotter, 2016).

Bromelain is a proteolytic enzyme, and functions in protein digestion. Proteolytic enzyme is anti-inflammatory properties include the decrease of swelling and bruising. Bromelain seems to work by triggering the body's production of substances that fight pain and reduce swelling, and it contains chemicals that avoid the blood from clotting (Schaefer & Gotter, 2016).

Study by Schaefer & Gotter (2016) shows a bromelain are probable to act as an efficient cancer-fighting agent. Particularly, it may work in concurrently with chemotherapy to restrict the growth of cancer cells from grow. It also contains beta carotene, which can protect against prostate cancer and perhaps colon cancer.

Pineapple juice that contains of vitamin C may help to protect against heart disease. Based on the study by Schaefer & Gotter (2016) from Finland and China, it is shows that higher vitamin C intake can causes a decrease in the risk of coronary heart disease. In addition, risk of cancer and heart disease also can reduce with a high-fiber diet.

In defensive vision, vitamin C plays a crucial role. A study by Megan (2017) shows the higher intake of vitamin C decreases the risk of cataracts, which cause cloudiness of the lens that, can obstruct vision. Vitamin C was suggested to apply as the major preventive method.

Pineapple contains some beneficial vitamins and minerals, as well as vitamin C, copper, beta carotene, foliate and zinc. Beta carotene in the pineapple was changed into active vitamin A during digestion and will reduce the risk of exercise-induced asthma (Megan, 2017).

Another benefit of drinking pineapple juice is the manganese content. A large percentage of the population is lacking in manganese. It is an essential nutrient that fights aging and disease by protecting our cells from free radicals, which cause cellular damage that can lead to both (Schaefer & Gotter, 2016).

Pineapple juice that contains bromelain which plays role in fasten the breakdown of the protein which may help in speed up digestion, reducing both bloating and constipation in the process (Schaefer & Gotter, 2016). Bromelain in pineapple has been used to treat symptoms of bowel conditions like ulcerative colitis, potentially reducing swelling and even ulcers. Diets in antioxidant-rich have been shown to increase fertility. The reproductive system can damage cause by free radicals, so foods with high antioxidant activity are recommend for those who trying to pregnant (Schaefer & Gotter, 2016). According to Megan (2017), the antioxidants in pineapple have properties that affect both male and female fertility.

According to Steven (2013), serving of pineapple has more than 130% of the daily requirement of vitamin C for human beings, making it one of the richest and most delicious sources of ascorbic acid. Ascorbic acid helps in boosting the immune system and decreasing illnesses by acting as an antioxidant and stimulating the activity of white blood cells to defend against the harmful effects of free radicals. Free radicals are known to be dangerous byproducts of cellular metabolism that can damage various organ systems and disrupt function, as well as cause healthy cells to mutate into cancerous ones (Megan, 2017).

2.5.2 Benefit to Livestock

Based on the National Institute of Animal Nutrition and Physiology (2016), a silage technology has developed in Bangalore to preserve pineapple fruit residue (PFR) and use it as silage for livestock. This silage was feeding along with other feed ingredients in dairy cattle has shown improved milk quality and milk production. By using this technology, the pineapple fruit residue which is wasted in processing factories can be utilized as a valuable silage resource.

Nutritive value of the PFR silage on dry matter basis (total sugars 52.0%, crude protein 7.50%, neutral detergent fibre 56.04%, acid detergent fibre 19.76%, total digestible nutrients 72%, calcium 0.61%, and phosphorus 0.30%) was better than the conventional maize green fodder. Evaluation and validation was done through feeding studies in sheep and dairy cows using PFR silage as fodder source. The rations were balanced for major nutrients with PFR silage and concentrate mixture, and fed as total mixed ration (TMR) (National Institute of Animal Nutrition and Physiology, 2016).

Feeding of PFR silage based TMR to sheep for 75 days did not show any adverse effects and supported a daily growth rate of 140 g, and the overall performance was similar to maize green fodder silage based TMR fed group of sheep. The dairy cows fed PFR silage based TMR replacing conventional hybrid Napier green fodder for 90 days showed an improvement of daily milk yield by about 20% and fat content by 0.6 units. No evidence of metabolic or health related disorders were noticed indicating that PFR silage was effectively utilized by the livestock (National Institute of Animal Nutrition and Physiology, 2016).

Now the dairy farmers in India have started obtaining the fruit residue from the nearby factories and make silage for feeding to dairy animals. Its feeding has been found very economical. Currently, the cost of PFR silage is half the price of conventional green fodder. This technology has a potential for adoption in Kerala, North-eastern parts of India and parts of East Asia and Africa where pineapple fruit is cultivated and processed (National Institute of Animal Nutrition and Physiology, 2016).

2.5.3 Benefit to Fish

The pineapple deserve attention among agro-industrial residues by being source of calcium and vitamins A, B, C and bromelain which is enzyme belonging to protease group. Bromelain enzyme occurs on stalk, leaves, roots and pineapple fruit (Franca-santos et al., 2009). In general, fruit pulp factories discard pineapple leaves, shells and the pressed bagasse that was made after obtaining the pulp. Besides, to feed monogastric animals it is advisable the using of pressed bagasse bran, due presents a lower fiber content, in relation to the one made of leaves, shells, and bagasse.

Based on the research by Steven (2017), the nutritional composition of pineapple residue bran, it is considered as an ingredient of energetic source, and Fialho et al. (2009)also stated that, the ingredient to be considered as an energetic one, it must presents a percentage average under 20% of crude protein and under 18% of crude fiber.

CHAPTER 3

MATERIALS AND METHOD

3.1 Preparation of Red Hybrid Tilapia

Fingerlings of tilapia with average weight 2.50±0.29 g were bought from supplier at Agrotechno park, UMK. All the fingerlings were placed into a big tank for two weeks for acclimatization period. After two weeks, fingerlings were transferred into four different small tanks with approximately 15 fingerlings per tank that have been aerated for 24 hours. The optimum water parameter was used to rearing the fingerlings to avoid the disease outbreaks due to high ammonia content in the water. Fish have been fed twice daily and the amount of feed is 3% from their body weight. Aquariums were cleaned once in two days to remove all the detritus and to prevent any infection from pathogens.

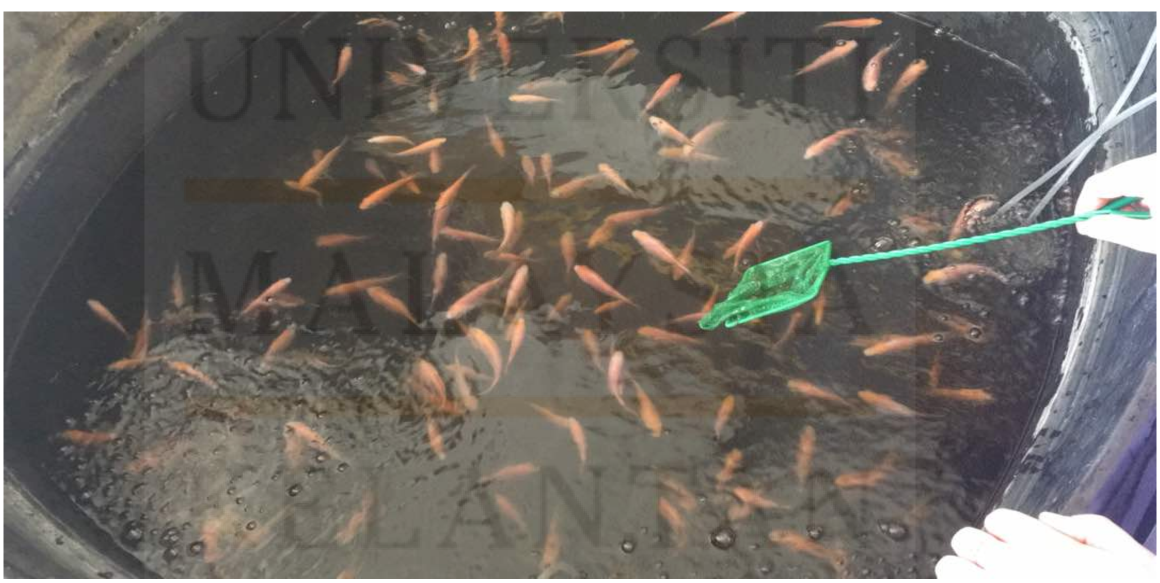

Figure 3.1: Tilapia fingerlings were placed in the big tank for two weeks of acclimatization period.

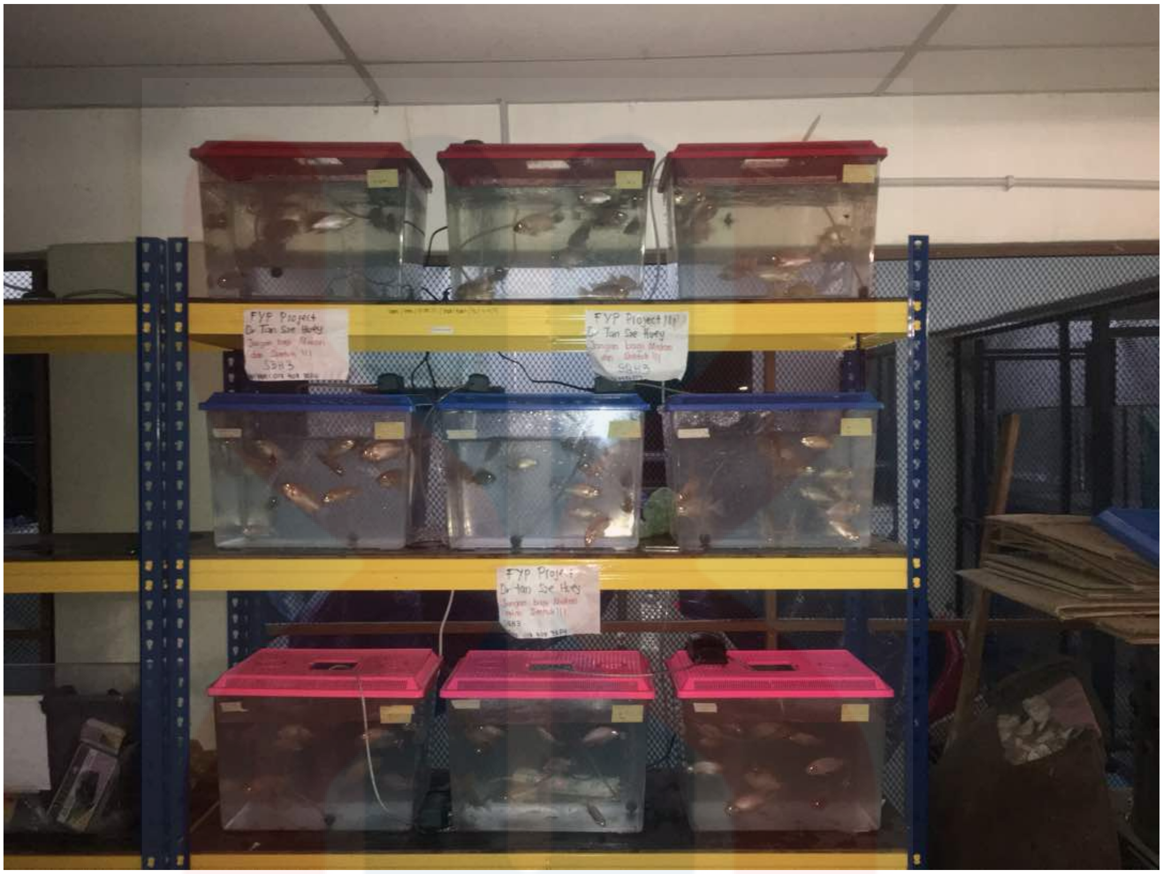

Figure 3.2: Tilapia fingerlings were transferred to small tank that have been aerated after two weeks of acclimatization period.

3.2 Preparation of Pineapple Flesh

Pineapple was bought from market around Jeli, Kelantan. Then, pineapple then was cleaned to remove the dirt and dust. The skins were peeled and separated from the flesh. Then, pineapple flesh was weighed using the digital weighing scale. Pineapple flesh was then milled by using electric blender. Then, paste was use to filtered using the muslin cloth to get the liquid sample of pineapple flesh. The liquid sample was filtered again using filter paper, filter funnel and conical flask to make sure liquid sample do not contain any paste left.

3.3 Preparation of Fish Feed

Liquid sample from pineapple flesh was sprayed in the commercial feed by using spray bottle for certain amount of each treatment.

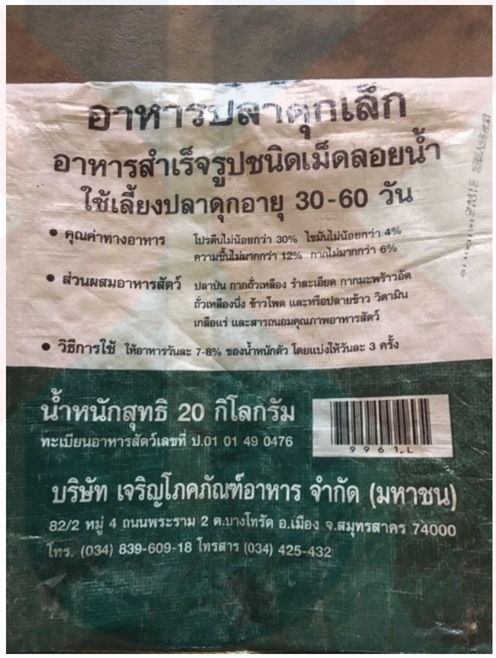

Figure 3.3: Commercial feed that has been used in the experiment.

Table 3.1: Feed formulations in each treatment.

Treatment	Feed formulation
Control	Commercial feed containing 30% of crude protein, 4% of crude lipid, 6% of crude fibre and 12% of moisture
Treatment 1	100 g commercial feed + 12.5 ml liquid sample from pineapple flesh
Treatment 2	100 g commercial feed + 31.25 ml liquid sample from pineapple flesh
Treatment 3	100 g commercial feed + 50 ml liquid sample from pineapple flesh

3.4 Feeding Trial

Feeding trials were held for six weeks and red hybrid tilapia fingerlings were fed twice per day. Growth rate and survivability rate was recorded.

3.5 Growth Performance

3.5.1 Weight Gain (WG)

Weight Gain (WG) = $(W_f - W_i)$

Where,

W_f = final weight (in gram) of fish at the end of experiment

W_i = initial weight (in gram) of fish at the beginning of experiment

3.5.2 Specific Growth Rate (SGR)

Specific Growth Rate (SGR) = $(\log W_f - \log W_i) \div T \times 100$

Where,

$\log W_f$ = Logarithm of the fish final weight

$\log W_i$ = logarithm of the fish initial weight

T = experimental period in days

3.5.3 Feed Conversion Ratio (FCR)

Feed Conversion Ratio (FCR) = Feed Intake (g) ÷ Weight Gain (g)

3.5.4 Survival Rate (SR%)

Survival rate (SR%) = $N_f \div N_i \times 100$

Where,

N_f = the number of fish stock at the end of experiment

N_i = the number of fish stock at the beginning of experiment

3.6 Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) software version 22. Statistical difference for the growth rate, specific growth rate, feed conversion ratio and survivability of the experimental fish (with the different percentage liquid sample of pineapple flesh) and the control fish was determined by One-way ANOVA and post-hoc Duncan multiple range tests at $P < 0.05$.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Environmental Conditions

Table 4.1 shown the optimum and recorded of physical parameter throughout the experimental period.

Table 4.1: Optimum and recorded of physical parameter.

Physical parameter	Optimum	Recorded
Temperature (°C)	22 – 29	28.17 – 28.25
pH	7 – 9	5.62 – 5.74
Dissolved oxygen (mg/L)	>3	3.82 – 4.30

Based on Table 4.1, water temperature for tilapia growth throughout the experiment was suitable because still in the range of optimum temperature that recorded by Magid (1975) with 22 – 29. According to Ross (2000), optimum pH for tilapia growth is 7 – 9. It was showed that the recorded pH in this experiment was in the range of 5.62 – 5.74. During the experimental period, dissolved oxygen was recorded with range of 3.82 – 4.30. This data was in the range of optimum value which was stated by Ross (2000) which is more than 3.

4.2 Effect of Pineapple Flesh on Growth Performance of Red Hybrid Tilapia

4.2.1 Weight Gain (WG)

Table 4.2 shown the initial weight, final weight and weight gain of red hybrid tilapia after six weeks of feeding trial based on different treatment.

Table 4.2: Initial weight, final weight and weight gain of red hybrid tilapia after six weeks of experiment.

Treatment	Initial Weight (g/fish) (Mean±SD)	Final Weight (g/fish) (Mean±SD)	Weight Gain/fish (g/fish) (Mean±SD)
Control	11.40±4.34	27.00±10.10	15.60±5.98[a]
Treatment 1	8.60±1.14	40.60±4.45	32.00±3.32[b]
Treatment 2	8.80±3.11	41.60±9.69	32.80±6.76[b]
Treatment 3	10.20±3.11	49.20±7.50	39.00±5.10[b]

[ab]Values in the same column with different superscripts differ significantly ($p<0.05$)
*Control: no addition of liquid sample from pineapple flesh; Treatment 1: addition of 12.5 ml of liquid sample from pineapple flesh per 100 g of commercial feed; Treatment 2: addition of 31.25 ml of liquid sample from pineapple flesh per 100 g of commercial feed; Treatment 3: addition of 50 ml of liquid sample from pineapple flesh per 100 g of commercial feed.

Based on the table above, there had significant different between Control and Treatment 1, Treatment 2 and Treatment 3 but no significant different between Treatment 1, Treatment 2 and Treatment 3. The highest weight gain was Treatment 3 with 39.00 g per fish and the lowest weight gain was Control with 15.60 g per fish.

Based on the Table 4.2, weight gain for treatment 3 have the highest value compared to others because the 50 ml of liquid sample from pineapple flesh provide more vitamin C for red hybrid tilapia for fastest growth compared to control that has the lowest value of weight gain because there did not contain vitamin C in their feed that can enhance the growth performance of tilapia.

This is due to fish required adaptation towards acceptance of pineapple flesh juice that has been added in the commercial feed. In previous study by Shiau& Lin (2006) has stated that, vitamin C levels generally contained79 mg AA/kg in tilapia feeds.

4.2.2 Specific Growth Rate (SGR)

Table 4.3 shown the specific growth rate of red hybrid tilapia after six weeks of feeding trial.

Table 4.3: Specific growth rate per day of red hybrid tilapia.

Treatment	Specific growth rate (%/day) (Mean±SD)
Control	0.88±0.087[a]
Treatment 1	1.57±0.027[b]
Treatment 2	1.59±0.13[b]
Treatment 3	1.62±0.20[b]

[ab]Values in the same column with different superscripts differ significantly ($p<0.05$)
*Control: no addition of liquid sample from pineapple flesh; Treatment 1: addition of 12.5 ml of liquid sample from pineapple flesh per 100 g of commercial feed; Treatment 2: addition of 31.25 ml of liquid sample from pineapple flesh per 100 g of commercial feed; Treatment 3: addition of 50 ml of liquid sample from pineapple flesh per 100 g of commercial feed.

Based on the table above, there had significant different between Control and Treatment 1, Treatment 2 and Treatment 3 but no significant different between Treatment 1, Treatment 2 and Treatment 3. The highest specific growth rate was Treatment 3 with 1.62 % per day and the lowest specific growth rate was Control with 0.88 % per day.

Based on the result in Table 4.3, Treatment 3 was the highest value in specific growth rate because growth rate of red hybrid tilapia in Treatment 3 tank was faster with the addition of some vitamin C which is pineapple. Pineapple also contain of manganese that act as essential nutrient for growth in several aquatic species (Irimia & Gottschiling, 2016).

Tilapia in the Treatment 3 tank was accepted to the feed that enriched with vitamin C from pineapple because specific growth rate was increase if the accepted of the feed was in good condition. This was supported by Amisah, Oteng & Ofori (2009), there was common problems encountered the acceptability of feed by fish when using alternative feed sources and this frequently related to palatability of the diets.

4.2.3 Feed Conversion Ratio (FCR)

Table 4.4 shown the feed conversion ratio of red hybrid tilapia from all the treatments.

Table 4.4: Feed conversion ratio of red hybrid tilapia.

Treatment	Feed conversion ratio (Mean±SD)
Control	0.35±0.12[b]
Treatment 1	0.20±0.022[a]
Treatment 2	0.22±0.041[a]
Treatment 3	0.16±0.025[a]

[ab]Values in the same column with different superscripts differ significantly ($p<0.05$)
* Control: no addition of liquid sample from pineapple flesh; Treatment 1: addition of 12.5 ml of liquid sample from pineapple flesh per 100 g of commercial feed; Treatment 2: addition of 31.25 ml of liquid sample from pineapple flesh per 100 g of commercial feed; Treatment 3: addition of 50 ml of liquid sample from pineapple flesh per 100 g of commercial feed.

Based on the table above, feed conversion ratio (FCR) of red hybrid tilapia at the end of the experimental period were 0.35, 0.20, 0.22 and 0.16 for Control, Treatment 1, Treatment 2 and Treatment 3 respectively. There were significant differences ($p<0.05$) in the feed conversion ratio at different treatment, but the difference was not significant ($p<0.05$) between Treatment 1, Treatment 2 and Treatment 3.

From the results in the Table 4.4, the best FCR was Treatment 3. It is showed that fish in the Treatment 3 tank were consumed less amount of feed but has better growth performance which is higher in weight gain compared to Control, Treatment 1 and Treatment 2. It means the liquid sample from pineapple flesh that had been added in the commercial feed is very effective for tilapia growth performance because lower in FCR allow for more fish to be grown in a pond because there was less waste polluting the water (Sangkat, 2011).

Feed conversion ratio values in all treatments were less than 1.50 might be due to improper feed and nutrient supply towards fish. In this study, red hybrid tilapia was fed with commercial feed with addition of pineapple flesh juice. Improper nutrient supply was due to loss of nutrients available in feeds when it was immersed in culture water (Genodepa et al., 2007).

4.3 Effect of Pineapple Flesh on Survivability of Red Hybrid Tilapia

Table 4.5 and show the percentage survival rate of red hybrid tilapia throughout six weeks of experiment was conducted. The highest survival rate is Treatment 3 with 93.3% and followed by Treatment 2 with 80% thirdly is Treatment 1 with 75.5% and lastly the lowest survival rate is Control with 60%.

Table 4.5: Percentage survival rate of red hybrid tilapia.

Treatment	**Survival rate (%)**
Control	60
Treatment 1	75.5
Treatment 2	80
Treatment 3	93.3

Based on the survivability results that have been recorded in this experiment, the survivability rate for Treatment 3 is the highest because there have 50 ml of liquid sample from pineapple flesh that contain vitamin C. Vitamin C level in the diet is positively related to the disease resistance and also humoral antibody production (Lall and Olivier, 1993).

According to Lucy (2010), vitamin C is the top of the list among natural immune boosters for fish body. Vitamin C has the immune-stimulating properties and compensates the immune-depression. It offers protection to fish immune system by encouraging the activity of immune system cells including neutrophils and phagocytes.

Vitamin C prevents bacteria from adhering to epithelial cells. High concentration of vitamin C in white blood cells enables the immune system to function properly by providing protection against oxidative damage from free radicals generated during their action against bacterial, viral or fungal infections.

Cruz & Mair (1994) mention that, mortality observed during the hormonal treatment may be explained by establishment of feed hierarchy among fish. Dominant individuals within the population may consume more food and grow faster leaving less food for submissive individuals who have less growth and become, consequently, vulnerable to cannibalism and death by starvation.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

As a conclusion, commercial feed that supplemented with 50 ml pineapple flesh juice (Treatment 3) showed better growth performance and survivability of red hybrid tilapia. As mention before, vitamin C that contain in pineapple is needed for the best growth and maintenance (Yousefi et al., 2013). In addition, according to Debnath (2012), ascorbic acid that contains in pineapple could fights bacterial and viral infections and helps iron absorption in the body. The feed that have been added with pineapple flesh also attract the fish with their smell and increase their appetite. Based on the finding on calculation of growth performance and survival rate, objectives to increase the growth and survivability of red hybrid tilapia through addition of pineapple flesh juice in feeds were achieved.

5.2 Recommendations

The recommendation from this study are further study such as determination the ferritin mRNA levelcan be done to the tilapia after feeding trial which related to the immune system by using Polymerase Chain Reaction (PCR). Besides that, to determine survivability rate red hybrid tilapia also can challenge with *Streptoccus sp.*at the end of the experiment.

REFERENCES

Abdel, R.E.G (2016). Development of tilapia aquaculture in Malaysia.Retrieved from http://fishconsult.org/?p=13670 accessed on 30 November 2017.

Abdel-fattah M. El-Sayed, Malcolm W. Dickson, Gamal O. El-Naggar (2015). Acta Medicine etSociologica, 7 (22-23), 48-79. Doi:10.19055/ams.2016.7/22-23/4

Abdul, M.D., Illahi, B.K., Sajjad, A.S., Hameedia K., Ghulam, A. (2014). Effect of stocking densities on growth, production and survival rate of red tilapia in hapa at fish hatchery ChilyaThatta, Sindh, Pakistan.Journal of Fisheries. 2:180-186.

Abdul, R., Robert, L., Laura, L., Arthur, C., Meritxell, C. (2014). Mechanistic Insights into Allosteric Structure-Function Relationships at the M1 Muscarinic Acetylcholine Receptor .doi:10.18411/a-2017-023

Amal, M.N.A. &Zamri-Saad, M. (2011).*Streptococcus* in Tilapia (*Oreochromisniloticus*): A Review Journal of fisheries, 34(2), 195-206.

Amal, A.M.N., Siti-Zahrah, A., Zulkafli, R., Misri, S., Ramley, A., &Zamri-Saad, M. (2008).The effect of water temperature on the incidence of *Streptococcus agalactiae* inflection in cage culture tilapia.*International Seminar on Management Strategies on Animal Health and Production Control in Anticipation of Global Warming*.48-51.

Baruwa, O.I. (2013). Profitability and constraints of pineapple production in Osun State, Nigeria. 2013. Journal of Horticultural Research.

Berkeley (2015). The Truth About Tilapia. Retrieved January 02, 2018, from http://www.berkeleywellness.com/healthy-eating/food/food-safety/article/truth-about-tilapia

Cruz, E. M. V.; MAIR, G. C. Conditions for effective androgen sex reversal in Oreochromisniloticus (L). Aquaculture, Amsterdam, v. 122, n. 2/3, p. 237-248, May 1994.

Debnath, S. B., Devshete N.G. &Kurkarni T.S. (2012). Sensory attributes of the squash made from bael and pineapple. doi:10.18411/a-2017-023

El-Sherif, M. S., & El-Feky, A. M. I., (2009). Performance of Nile Tilapia (*Oreochromis niloticus)*Fingerlings. I. Effect of Ph. *International Journal of Agriculture & Biology*, 11:297-300.

FAO (2015). Http://ljournal.ru/wp-content/uploads/2017/03/a-2017-023.pdf. Aquaculture Species .doi:10.18411/a-2017-023

Genodepa, J., Zeng, C., & Southgate, P. C. (2007). Influence of binder type on leaching rate and ingestion of microbound diets by mud crab, Scylla serrata (Forsskal), larvae. *Aquaculture Research,* 38, 1486-1494.

Irimia R. &Gottschling M. (2016) Taxonomic revision of Rochefortia Sw. (*EhretiaceaeBoraginales*). Biodiversity Data Journal 4: e7720. https://doi.org/10.3897/BDJ.4.e7720. (n.d). doi:10.3897/bdj.4.e7720.figure2f

Jaspe, C.J.C. and Caipang, M.A., 2011. Small-scale hatchery and larval rearing techniques for local strains of saline tolerant tilapia, *Oreochromis* spp. *ABAH Bioflux*, **3**: 71-77.

Kamol, S. I., Howlader, J., Sutra Dhar, G. C. &Aklimuzzaman, M. (2015). Effect of different stages of maturity and postharvest treatments on quality and storability of pineapple . Retrieved January 03, 2018, from https://pdfs.semanticscholar.org/085b/3fb80373b0a47c334f1eff9bf074a96f1519.pdf

Lall, S.P. and G. Olivier, (1993).Role of Micronutrients in Immune Response and Disease Resistance in Fish. In: Fish Nutrition in Practice, Kaushik, S.J. and P. Luquet (Eds.). INRA, Paris, pp: 101-18.

Lucy (2010). Value chain analysis of the aquaculture feed sector in Egypt. Retrieved January 03, 2018, from http://www.sciencedirect.com/science/article/pii/S0044848614006073

Magid, A., and M. M. Babiker.(1975). Oxygen consumption and respiratory behavior of three Nile fishes.Hydrobiologia 46: 359-367.

Megan, W. (2017). Pineapple: Health Benefits, Recipes, Health Risks. Retrieved from https://www.medicalnewstoday.com/articles/276903.php

Olaleye, W.I. (2011). Growth Performance and Digestibility of Nile Tilapia, *Oreochromisniloticus* Fed Pineapple (*Ananascomosus*) Peel Meal-based Diets.

Paul, R. E., & Chen, C. (2010).Postharvest physiology, handling and storage of pineapple. The pineapple: botany, production and uses, 253-279. doi:10.1079/9780851995038.0253

Ronald, N., Gladys, B. and Gasper, E., 2014. The effects of stocking density on the growth and survival of Nile Tilapia (*Oreochromisniloticus*) fry at Son Fish Farm, Uganda. *J. Aquacult. Res. Dev.,* **5**: 222. https://doi.org/10.4172/2155-9546.1000222

Ross, L. (2000). Environmental physiology and energetic. Dordrecht, The Nertherlands: Fish and Fisheries Series 25, Kluwer Academic Publishers.

Sangkat, B. K. K., (2011). Feed Conversion Ratio (FCR). Retrieved from https://pdf.usaid.gov/pdf_docs/PA00K8MQ.pdf on 1st December 2017

Sargent, J.R., R.J. Henderson and D.R. Tocher, (1989).The Lipids. In: Fish Nutrition, Halver, J.E. (Ed.)., Academic Press, New York, pp: 154-218.

Schaefer, A., &Gotter, A., (2016). The 9 Best Pineapple Juice Benefits. Retrieved November 17, 2017, from https://www.healthline.com/health/food-nutrition/pineapple-juice-benefits#1

Shamloo, M., Bakar, J., Hashim, M., &Khatib, A. (2012). Biochemical properties of red tilapia (Oreochromisniloticus) protein hydrolysates . International Food Research Journal , 19(1), 183-188.

Shiau, S., & Lin, Y. (2006).Vitamin Requirements of Tilapia – A Review.*Avances En NutriciónAcuícola VIII,* 129–138

Southern Regional Aquaculture Centre (2016).Nitrate in Fish Ponds. Retrieved January 03, 2018, from http://aqua.ucdavis.edu/DatabaseRoot/pdf/462FSR.PDF

Stickney, R.R. 1997. Tilapia update, 1995. World Aquaculture 27(1):45-50.

Szalay, J. (2014). Pineapple: Health Benefits, Risks & Nutrition Facts. Retrieved November 15, 2017 from https://www.livescience.com/45487-pineapple-nutrition.html

Watanabe, Y. M., Burroughs, A. M., Anand, S., Souza, R. F., &Aravind, L. (2017). Polyvalent Proteins, a Pervasive Theme in the Intergenomic Biological Conflicts of Bacteriophages and Conjugative Elements. Journal of Bacteriology, 199(15). doi:10.1128/jb.00245-17

Yousefi, P., Yavari, Vahid, Zakeri, Mohammad, Salati, Amir-parviz, Keyvanshokooh, Saeed.(2013). Effect of Dietary Supplementation of Vitamin C on Growth Performance, Feed Utilization and Carcass Composition of *Barbussharpeyi* Fingerlings. (pp. 23-31) Vol.

APPENDIX A

Table A.1: One-way ANOVA.

		Sum of Squares	df	Mean Square	F	Sig.
WeightGain	Between Groups	1500.550	3	500.183	16.884	.000
	Within Groups	474.000	16	29.625		
	Total	1974.550	19			
Mean Weight Gain	Between Groups	41.681	3	13.894	16.885	.000
	Within Groups	13.165	16	.823		
	Total	54.846	19			
SGR	Between Groups	1.942	3	.647	40.178	.000
	Within Groups	.258	16	.016		
	Total	2.200	19			
FCR	Between Groups	.104	3	.035	8.032	.002
	Within Groups	.069	16	.004		
	Total	.173	19			

Table A.2: Post Hoc Analysis using Duncan Multiple Test for Weight Gain (WG).

Duncan[a]

Treatment	N	Subset for alpha = 0.05	
		1	2
1	5	15.6000	
2	5		32.0000
3	5		32.8000
4	5		39.0000
Sig.		1.000	.071

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Table A.3: Post Hoc Analysis using Duncan Multiple Test for Mean Weight Gain (MWG).

Duncan[a]

Treatment	N	Subset for alpha = 0.05	
		1	2
1	5	2.6000	
2	5		5.3340
3	5		5.4660
4	5		6.5000
Sig.		1.000	.071

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Table A.4: Post Hoc Analysis using Duncan Multiple Test for Specific Growth Rate (SGR).

Duncan[a]

Treatment	N	Subset for alpha = 0.05	
		1	2
1	5	.8760	
2	5		1.5720
3	5		1.5940
4	5		1.6180
Sig.		1.000	.595

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

Table A.5: Post Hoc Analysis using Duncan Multiple Test for Feed Conversion Ratio (FCR).

Duncan[a]

Treatment	N	Subset for alpha = 0.05	
		1	2
4	5	.162460	
2	5	.196340	
3	5	.217160	
1	5		.352280
Sig.		.230	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.