Original Research Article

Growth performance of Tilapia fingerlings fed with phytoadditives from fruit wastes (pineapple, citrus and banana) for aquaculture

ABSTRACT

Aims: This study determines the effects of the different fruit wastes (banana, citrus and pineapple peel) on the zootechnical parameters (weight gain (WG), increased in length, specific growth rate (SGR), feed conversion ratio (FCR) and survival) of juvenile tilapia and in which feed additives is suitable for tilapia fingerlings.
Study design: Feeding study was conducted and growth in terms of weight gain and length were analyzed.
Place and Duration of Study: College of Fisheries and Aquatic Science Hatchery Laboratory from March 2019 to May 2021.
Methodology: Fingerling Tilapia were used in this study. The treatments used for the two experiments were consists of commercial feeds (control), 2% pineapple, 5% pineapple, 10% pineapple, 2% citrus, 5% citrus, 10% citrus, 2% banana, 5% banana and 10% banana.
Results: Results shows that weight gain and FCR was significantly affected by the treatments and that treatment containing 2% pineapple, 2% citrus and 2% banana exhibited superior growth and FCR than other treatments. Fish length and survival did not show any significant difference.
Conclusion: The weight gain was significantly affected by the treatments but not the length of tilapia fingerlings when fed with fruit waste. Better FCR and survival rate were when fingerlings were fed with 2% banana peel but without significant difference with 2% citrus or pineapple. Water parameters were at a normal level (temperature, dissolve oxygen (DO), and pH) and did not significantly affect the treatments.

Keywords: Weight gain, FCR, feeds, feed additives

1. INTRODUCTION

The quality and healthfulness of the food products are reported to be some of the crucial factors that influence the choice of consumers when purchasing the food items. As consumers are getting more health-conscious, they select food that has positive health benefits.

Interest in the use of plants and various phytochemicals as dietary additives for poultry and livestock has increased in recent years due to the potential health benefits to these farmed animals that result in better and healthier meat quality. However, the plants that are being used as feed ingredients for farmed animal production are the same plants that are being consumed by human beings, hence, a potential conflict in addressing food security issues. As such, novel sources of animal feeds have to be explored to avoid competition with providing sources of food for the human population [1]. An example of a novel alternative source of animal feed is fruit waste and by-products. Currently, approximately 1.3 billion tons of food is lost and wasted annually, and fruits form a substantial part of this loss [2].

There is a change in the cropping pattern from cereals to more lucrative fruit and vegetable crops in several developing countries [2]. This shift in the farming system will potentially generate huge quantities of fruit and vegetable wastes in the future. These wastes and by-products have the potential to be recycled and brought back to the food chain by converting them to aquaculture feeds [1]. In addition, some of these waste products could be sources of some beneficial bioactive compounds that are added to aquaculture feeds to improve the health and growth performance of the aquacultured species (Table 1).

Table 1. Commonly used fruit wastes and by-products as feed additives or ingredients in the animal feed industry.

Common Name	Scientific Name	Parts Utilized
Banana	*Musa acuminata*/*Musa paradisiaca*	Peels
Cinnamon	*Cinnamomum* spp.	Bark
Citrus	*Citrus* spp.	Peels and pulp/rind
Papaya	*Carica papaya*	Peels
Passion fruit	*Passiflora edulis*	peels and rind
Pineapple	*Ananas comosus*	peels and core

Olusola et al. [3] and Steiner & Syed [4].

On a global scale, there is an increasing demand for food including fruits and vegetables [5].However, approximately 1.3 billion tons of food is lost and wasted annually, and fruits and vegetables form a substantial part of this loss. The annual fruit and vegetable wastes that are generated in India is 1.81 million tons, The Philippines 6.53 million tons, China 32.0 million tons, and USA with 15.0 million tons [2]. The feed cost can be as high as 70% of the total cost in producing fish and livestock, and through the use of these wastes, it is likely to reduce the cost of feeding, resulting in a higher profit to the fish and livestock producers.

Plants are being utilized by the food industry as sources of spices, condiments, and culinary herbs. Plant-based additives are also used as preservatives for some food preparations because they have antimicrobial properties [6].Further, the food additives upon addition to food result in preservation of flavor and enhancement of taste and appearance [7]. Because of these benefits, plants have been used to develop healthy and safe food for humans as well as feeds for livestock, and also these are potential alternatives to the use of synthetic antimicrobials in animal feeds [8, 9].

The content of processed fruit waste is highly dependent on the type of fruit and the part of the fruit that forms the main mass of the waste [10]. Some of the bioactive compounds that are present in fruit and plant wastes and by-products that has beneficial effects to the host when used as feed additives (Table 2). The presence of these bioactive compounds from fruit wastes results in the stimulation of immune responses of the fish [1, 11] and at the same time contributes to the quality of the carcass. A good quality fish flesh will also contribute to a healthier source of food for the consumers.

2. MATERIAL AND METHODS

2.1 Study site

The study was conducted at the Aquatic Science Laboratory of the College of Fisheries and Aquatic Sciences of the Western Philippines University – Puerto Princesa. Freshwater tilapia was used as a model species to test this proof of concept. Tilapias were chosen because they are readily available, easy to maintain, and relatively cheap to obtain.

2.2 Feed preparation and treatments

An experiment using Tilapia fingerlings (1-2 g) fed with fruit waste (banana, citrus, and pineapple peel) was gathered from the fruit vendor in a market was conducted in this study. The treatments used for the experiment were consists of commercial feeds (control), 2% pineapple, 5% pineapple, 10% pineapple, 2% citrus, 5% citrus, 10% citrus, 2% banana, 5% banana and 10% banana. The commercial feeds were used as a control for this experiment. The pineapple, citrus, and banana were sundried for seven days. The sundried fruit waste samples were ground into fine pieces using a mortar and pestle and were added to the feeds at 2, 5, and 10% of the total feed weight. The feeds added with fruit waste were fed to the fingerling Tilapia at the initial rate of 5% body weight for 30 days. Adjustments in the feeding rate was calculated every 15 days.

2.3 Experimental setup

A randomized design was used in setting twelve tanks that were used for this experiment. Prior to the experiment, tanks, water containers, air stones, and hoses were washed with a detergent and disinfected using chlorine. All treatments in this study were replicated three times. Tanks and water containers were filled with 3 L of water and stocked with 6 fish in experiment 1 and 10 fish in experiment 2.

2.4 Sampling and monitoring

Fifty percent (50%) volume of water change was conducted every 15 days. Siphoning of feces was daily and lost water during siphoning was replaced with the filtered one immediately. The water parameters such as pH, ammonia, and temperature were monitored using a kit and thermometer.

A sampling of fish was also conducted every 15 days. Weight gain (WG), length, feed conversion ratio (FCR), and survival were some of the biological performance of Tilapia that was recorded and analyzed in the two experiments.

The following formula was used in computing the biological performance of fish in this experiments:

$$Survival\ rate\ (\%) = Total\ fish \frac{survived}{number\ of\ fish\ stocked} x\ 100$$

$$FCR = \frac{Amount\ of\ feed\ fed}{Fish\ weight\ gain}$$

$$SGR = (Final\ weight - initial\ weight) x \frac{100}{Number\ of\ days}$$

2.5 Statistical analysis

The WG of the fish, length, FCR, SGR, and survival were subjected to a non-parametric one-way ANOVA with multiple comparisons. Differences among means were identified Tukey's test with $P < 0.05$.

3. RESULTS AND DISCUSSION

Results show that weight gain was significantly affected by the treatments but not the length of tilapia fingerlings when fed with fruit waste incorporated diets. Better FCR and survival rate were when fingerlings were fed with 2% banana peel.

The WG showed a significant difference but not the length (Table 2). The WG was highly significant in treatment with 10% banana (7.40±0.57). The treatment containing 10% pineapple had significantly high FCR while the lowest FCR was observed in treatment containing 2% banana. Significantly high SGR (0.29±0.01) was observed in treatment containing 2% banana. No significant difference was observed for the survival rate of fish.

The DO rages from 10-15 in all treatments and no sudden fluctuation was observed in all treatments. The temperature was at 24°C in all treatments throughout the experiment. The pH was maintained at 7.5 in all treatments throughout the experimental trial.

Table 2. Biological performance of fingerling Tilapia in fed with different inclusion of fruit waste in the diet for 30 days. (n=3)

Treatment	Initial	WG (g)	Length (inch)	FCR	SGR	Survival (%)
Control 1	2.13±0.19	5.99±0.27[a]	1.87±0.36	1.06±0.05[a]	0.20±0.01[a]	90±0.33
2% pineapple	1.46±0.12	7.02±0.57[a]	2.37±0.2 0	0.91±0.07[a]	0.24±0.02[a]	100±0.00
5% pineapple	1.70±0.12	6.24±0.38[a]	2.27±0.2 4	1.02±0.06[a]	0.23±0.01[a]	100±0.00
10% pineapple	1.48±0.10	5.78±0.28[a]	2.17±0.19	1.08±0.05[ab]	0.21±0.00[a]	90±0.33
2% citrus	1.65±0.10	7.10±0.53[a]	1.60±0.2 0	0.89±0.07[a]	0.25±0.01[a]	100±0.00
5% citrus	1.77±0.18	7.01±0.54[a] b	1.73±0.32	0.92±0.07[a]	0.26±0.01[a]	100±0.00
10% citrus	1.81±0.12	6.80±0.35[a]	1.80±0.3 6	0.94±0.05[a]	0.24±0.00[a]	100±0.00
2% banana	1.87±0.2 4	8.70±0.25[a]	2.07±0.33	0.73±0.02[a]	0.29±0.01[b]	90±0.33
5% banana	1.37±0.0 9	7.06±0.35[a] c	1.87±0.12	0.89±0.05[a]	0.25±0.00[a]	100±0.00
10% banana	1.68±0.0 9	7.40±0.57[a] c	2.27±0.43	0.86±0.07[a]	0.26±0.01[a]	100±0.00

Factors such as the size of fish, water quality, and the nutrient content of the formulated feeds affect the growth of fingerlings tilapia in this experiment [12, 13]. Although some of the parameters in this experiment such as the proximate analysis of feeds, and fish body, nutrient content of feeds and another important water parameter such as ammonia were not analyzed due to the limitation of resources, time, and situation.

The phytogenic are plant-derived products that are added to the feed to improve the health and growth performance of the animal. These are widely tested as additives in the manufacture of feeds for livestock, and recently these are being evaluated in the diets for fish and crustaceans in aquaculture [8, 14]. The mode of action of most phytogenics is still not fully elucidated [15], but these plant-based products possess antioxidant, antimicrobial, anticarcinogenic, analgesic, insecticidal, antiparasitic properties, growth promoters, appetite enhancement, stimulant of bile secretion and digestive enzyme activity [16, 17].

Different size of tilapia requires a different amount of protein for growth. A fingerling tilapia of 0.02 to 10 g in weight requires 35-40% protein in their diet [18, 19]. Although protein content in the diet was not analyzed, the protein content of the pineapple peel ranges from 5.11 to 8.8% [20, 21], banana peels vary whether they are ripe or unripe and the protein content ranges from 6.86% to 8.51% [22], and the citrus peel (Citrus maxima) at 0.42% [23].

In pineapple peel, the level of anti-nutritional factors such as oxalates, hydrogen cyanides, alkaloids, and phytates, and total phenolics contents were 129.06 mg %, 71.50 mg %, 16.19 mg %, 1.99 mg %, and 1.42 mg % respectively [20]. Citrus peel has a high amount of Alkaloids (3498.37 mg/100g) and has also a high amount of antinutritional factor in the form of phytic acid (444.11 mg/100g) [23]. In general, the oxalates level of banana peel is 280.88 mg %, 116.26 mg % of hydrogen cyanides, 6.88 mg % alkaloids, 6.02 mg % of phytates, and total phenolics of 7.40 mg % [20]. The presence of antinutritional factors in fish feeds results in poor palatability, poor food intake, interference with feed utilization, alteration of gut morphology, high FCR, and slow growth of fish [24, 25].

The unripe banana peel has a higher content of anti-nutritional factors present than the ripe banana peel [22, 26]. In their study, an increased in the incorporation of banana peel from 5-15% in the diet decreased the weight gain of Tilapia which was similar to the result of this study. Banana peel has a high fiber load, and when fed to fish could accumulate to increase cell wall materials and non-soluble polysaccharides which limits the digestion and absorption of nutrients resulting to a decline in the growth of fish [22, 27].

It was observed that smaller size of fish grow faster and exhibit uniform growth than bigger sizes of fish which was also observed in the present experiment [28]. The water parameters including salinity, DO, temperature, pH, and ammonia also affect the growth and survival of Tilapia [13, 29, 30].

The poor quality of water especially the nitrite concentration can affect the growth of tilapia, and it was observed the wide range tolerance of tilapia in high acidity should not affect by their growth and survival rate [31, 32], however hence, the maintaining of good quality of water the physical and chemical property, should be kept within the certain safe level as well as the biological properties [33]. Culturing of fish in the culture tank it demonstrates a heterogeneous growth but the FCR and SGR were not affected by their stocking densities [34].

The optimal range temperature of the water is 25°-30°C for growth of juvenile tilapia and who noted 21°-28°C for food conversion [35], however according to [36], prove and observe the fish in the 35°-40°C lived for two weeks are hardly ate, were very stressed, and presented red eyes, very smooth skin and blood spills, and temperatures above 32°C may significantly decrease the survival and growth rate of tilapia and reduced growth performance that could be attributed to the low food intake and high rate of gastric evacuation [37]. However, dissolved oxygen was proved of researchers and preferred for growth of tilapia is 5mg/l and tolerate with the high of 40mg/l and 3mg/l should be minimum the optimum concentration for growth of tilapia [38], the present experiment was to observe the pH concentration and score of 7.0- 7.5, it is an optimal growth of tilapia that did not affect their survival rate [33].

4. CONCLUSION

The weight gain was significantly affected by the treatments but not the length of tilapia fingerlings when fed with fruit waste. Better FCR and survival rate were when fingerlings were fed with 2% banana peel but without significant difference with 2% citrus or pineapple. Water parameters were at a normal level (temperature, DO, and pH) and did not significantly affect the treatments. Conduct a similar study and longer 3-4 months of culture using a 0.15 g of tilapia and used culture tank size 30”Lx30”W; examine the flesh and carcass of fish to prove that fruit waste is effective using alternative feeds. A trial using other levels of incorporation of feed phytoadditives is also recommended.

CONSENT (WHERE EVER APPLICABLE)

All authors declare that ‘written informed consent was obtained from other approved parties for publication of this research. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

All authors hereby declare that "Principles of laboratory animal care were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

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