

The Effect of Newly Developed Sustainable Soft Dry Fish Feed from Household Waste for Red Tilapia on Water Quality

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ABSTRACT

This paper reported on a new formulated fish feed pellet prepared by extrusion method and the effect towards water quality. The obtained pellets showed well combination of all ingredients using household waste such as fish waste, vegetables waste, chicken fats and used palm oil. As a result, the well-developed feed pellets exhibit remarkable improvement in preserving water quality compared to commercialize fish feed pellet. The new formulated fish feed pellet has low turbidity value and Biochemical Oxygen Demand (BOD) level which help in maintaining quality of water. Platinum-Cobalt unit has confirmed the low effect of new formulated fish feed pellet on water colour. It was found that the new pellet may slightly reduce the pH of the water at low composition of protein sources.

KEYWORDS

Fish feed, Household waste, Aquaculture, Waste water, Red tilapia.

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INTRODUCTION

Aquaculture industry has been drastically increasing due to high demand from various industry especially in food and cosmetic industry. Fish may be cultured in ponds, raceways, net cages or even in the tank in order to meet these industrial demands. Despite high demand for aquaculture products, these have lead concern on environmental issues mainly on water quality and eutrophication especially fish culturing in water sources (Wu et al., 1994). The production of fish especially using marine aquaculture sites lead to increase in amounts of effluent including nutrients, waste feed, faeces as well as medications and pesticides (Wu, 1995). There are several factors that contribute to these problems and it depend on culture method, species, stocking density, hydrography of the site, husbandry practices as well as feed type (Carroll et al., 2003 and Saalah et al., 2010). Generally, fish feed is important to ensure the growth of fish, but due to high dependent on chemicals to preserve the taste and nutrients in the formulation have leads to environmental problems. Making matter worse, some selection of the formulation could be harmful to the ecosystems which are not favourable to be used.

In Malaysia, fish are normally fed with trash feed, formulated feed, poultry industry waste and by-product of agriculture production due to costing issues (Yamashita et al., 2009). However, these types of feeds lack proteins, vitamins and other supplements which will not provide better growth and digestibility of the fish. In addition, some of the fish feed are not able to be fully digested by the fish and could end up settled down at the bottom of the tank (Karakassis et al., 2002, Barrow et al., 2003 and Craig et al., 2009). Besides, studies showed that some phosphorus, carbon and nitrogen from feed may lost into the environment through fish excretion, feed wastage, faeces production and respiration (Sørensen, 2012 and Blaszczyk et al., 2013). The environmental impact of dissolved nutrient and constituents depend on the rate assimilation of the product by ecosystem. However, there is a risk of high levels of nutrients accumulation which could cause hypernutrification, high sediment oxygen demand, anoxic sediments, production of toxic gases and reduce benthic diversity (Mmochi et al., 2002, Tacon et al., 2008, Saalah et al., 2010 and Hasan et al., 2013). Thus, sustainable development of fish feed will help to prevent these potential problems via circumspectly selecting the formulation and conclusively improved properties of the feed.

In this study, a new sustainable fish feed was developed using household waste for high density fish farming via extrusion process. Extrusion process is the easiest way to produce a hard-feed type pellet in a short time. It used a preconditioning chamber to expose the feed mixture into heat and steam moisture with higher temperature, 190 to 300°F (Sørensen, 2012). During extrusion process, fats are included together to reduce frictional force when the fish feed is being forced through the extruder barrel. The advantage is lipids will be the fat coater of the fish feed pellet and act as energy to the fish when consumed (Nya et al., 2009 and Barreto-Curiel at al., 2015). The feed pellet later than undergo characterization and water quality test conducted to investigate the effect of new developed fish feed on aquatic environment.

MATERIALS AND METHODOLOGY

Preparation of Fish Feed Pellet

The household wastes were collected according to nutrients needed and its function to develop the fish feed pellet. The feed pellets were prepared according to Table 1. The ingredients were then cleaned, grinded and extruded into pellets. The formulated fish feed pellet prepared were then used to study its effect to environment by comparing it with commercialize fish feed pellet.

Table 1: Composition of formulated fish feed pellet (wt%)

No	Fish scrap	Garlic clove	Peeled vegetables	Chicken fat	Rice water	Used palm oil
1 (Control)	100	-	-	-	-	-
2	80	7.5	2.5	1.25	7.5	1.25
3	60	14.0	7.0	2.5	14.0	2.5
4	50	15.0	10.0	5.0	15.0	5.0
5	40	19.5	14.0	3.5	19.5	3.5



Turbidity Test

The feed pellets were immersed in water with varies duration time of 1h, 2h and 3h. Then, the water from each pellet samples were collected in prepared turbidity bottle. The turbidity was then measured using Hach 21000N laboratory turbidity meter.

The pH Test.

Fish feed contains high composition of nutrients and organic compound. It will release the nutrient and organic contents immediately when immersed in water. In such situation, excess amount of organic contents may result

in low pH of water. As for this study, pH test was conducted in water containing commercial and formulated fish feed using Hanna HI5221pH meter.

Platinum-Cobalt Method

The turbidity from turbidity test was removed by filtration using 0.45 micron filter paper and Nessler tubes. The filtered samples were analysed using DR 6000 UV-VIS Spectrophotometer at 455nm wavelength and absorbance recorded in Pt-Co units.

Biochemical Oxygen Demand (BOD)

The samples were analysed and conditioned to ensure there are favourable growth conditions for bacteria, which may include adjustment for pH. The sample were then diluted, and the appropriate amount of seed bacteria added. The initial dissolved oxygen content was recorded, and the sample then incubated for 5 days at 20°C. After the 5 days period, the sample was removed from the incubator and the final dissolved oxygen reading was taken. BOD₅ is calculated by using Equation 1.

$$BOD_5 = \frac{[(D_0 - D_5) - (BS_0 - BS_5)(1/10)]}{(30\text{mL}/300\text{mL})} \quad (1)$$

RESULTS AND DISCUSSION

Fish Feed Production

The composition ratios in producing fish feed was based on the amount of percentage of fish wastes that was used. The total weight used for all compositions was 500g. Table 2 showed the observation result for each composition that has been produced. At 100% fish wastes composition, it can be observed that more crumble was formed. This composition does not contain any starch that acts as binding agent, such as rice water, that was used in other compositions. For composition consists of 80% fish wastes composition shows less formation of crumble and the shape was also flat. This composition has been included with small amount of starch. As for 40%, 50% and 60% fish wastes composition show a positive result with less crumble was formed and the shape was cylindrical. In this composition, amount of starch added was higher compared with 80% and 100% fish wastes composition. Starch added act as binder for the ingredients, hence less crumble was formed.

Table 2: Observation of formulated fish feed pellet

Composition (fish wastes wt%)	Observation
40	No crumble was formed and the shape was cylindrical.
50	No crumble was formed and the shape was cylindrical.
60	Less crumble was formed and the shape was cylindrical.
80	Less crumble was formed and the shape was flat.
100	More crumble was formed and the shape was flat.

Turbidity Test

Turbidity is the cloudiness of suspended solids that were invisible to the naked eye. Hence, this test is vital as it verified the quality of water that has been measured in Nephelometric Turbidity Units (NTU). Turbidity does increase with time due to break down of substances resulting from hydrolytic cleavage



that release undisclosed particles and change the clarity of water. Figure 1 showed that, after 3 hours, 40% and 80% formulations and commercialize fish feed pellet have higher turbidity value more than 5.00 NTU. While for fish feed at 50%, 60% and 100% composition showed low turbidity values below 5.00 NTU.

Commercialized fish feed contained most synthetic substances that were very harmful to the environment which are not easily degrade in water. This condition changed the appearance of water into cloudiness. On the other hand, formulated fish feed at certain formulation easily degraded when immersed in water due to natural occurrence of the ingredients used in the formulation. High value of turbidity in water will trigger the growth of microorganism such as bacteria and fungus due to low penetration of light to the bottom level of water bodies (Karakassis et al., 2002). Hence, it will restrain the aquatic life's ability to obtain dissolved oxygen in water.

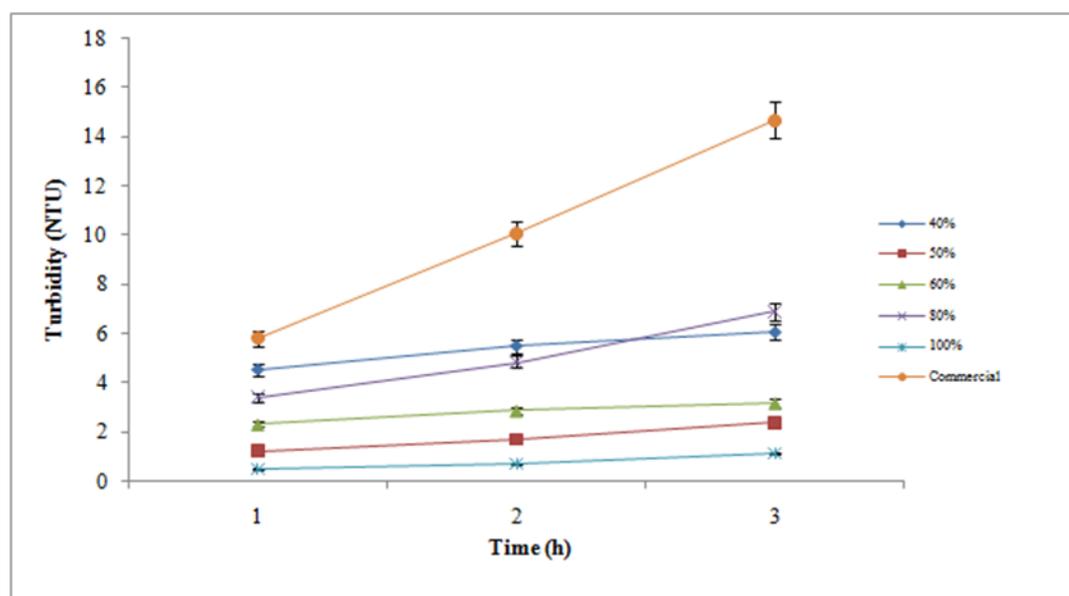


Figure 1: NTU level of water after introduced with fish feed pellet

The pH Testing

In this test, both types of fish feed show decreasing of pH value after been immersed in water for three hours as indicate in Figure 2. Commercial and 100% composition shows alkali value although has been immersed in water more than three hours. Commercial fish feed was manufactured mostly by synthetic ingredients that are chemically stable in water for long duration of time. While, 100% composition was made up only with one ingredient which was fish wastes only. Therefore, it does not leach any substances that reduced the pH value drastically when immersed in water.

As for other compositions, the pH value of water was reduced dramatically into acidic when formulated fish feeds were immersed. This was due to the pressure of other natural ingredients during production of fish feed, which were added with different ratios into each composition. These ingredients such as oil, chicken skins, peeled vegetables and rice water were proven to be chemically stable in water. Hence, when it was immersed in water, the ingredients were leached, since it was not fully bond, which depends on the amount of starch added as binder. Formulated fish feed with 100% fish wastes composition showed an alkali characteristic while other compositions exhibit acidic properties. Overall, the trend shows that, the fish feed pellet formulated affect the pH value of water.

Platinum-Cobalt Testing

The Platinum-Cobalt method is useful for measuring colour of water derived from naturally occurring materials. It is beneficial as it will measure the true colour of the water after it has been immersed with commercialized and formulated fish feed in a certain period of time. Colour measurement is one of the



parameter in determination of water quality. Colour in water was affected by the existence of natural metallic ions such as iron or manganese including plankton, weeds and industrial wastes.

Turbidity does affect the colour of water. Based on Figure 3, the turbidity increases as time increases. Composition of 40% and 80% has the higher value of unit Pt-Co after three hours of immersion. This was due to amount of ingredients that have been added in the fish feed formulation. Based on this method, it can be deduced that both compositions produced an immense haziness in water that may disturb the aquatic organisms.

However, other fish feed compositions including commercial fish feed, they have lower unit Pt-Co which was almost 600 units Pt-Co. On the other hand, the values may be considered desirable because haziness produced from these compositions was not too serious. Thus, Platinum-Cobalt result should be considered as a benchmark to indicate the turbidity of water as a primary screening for the water quality analysis.

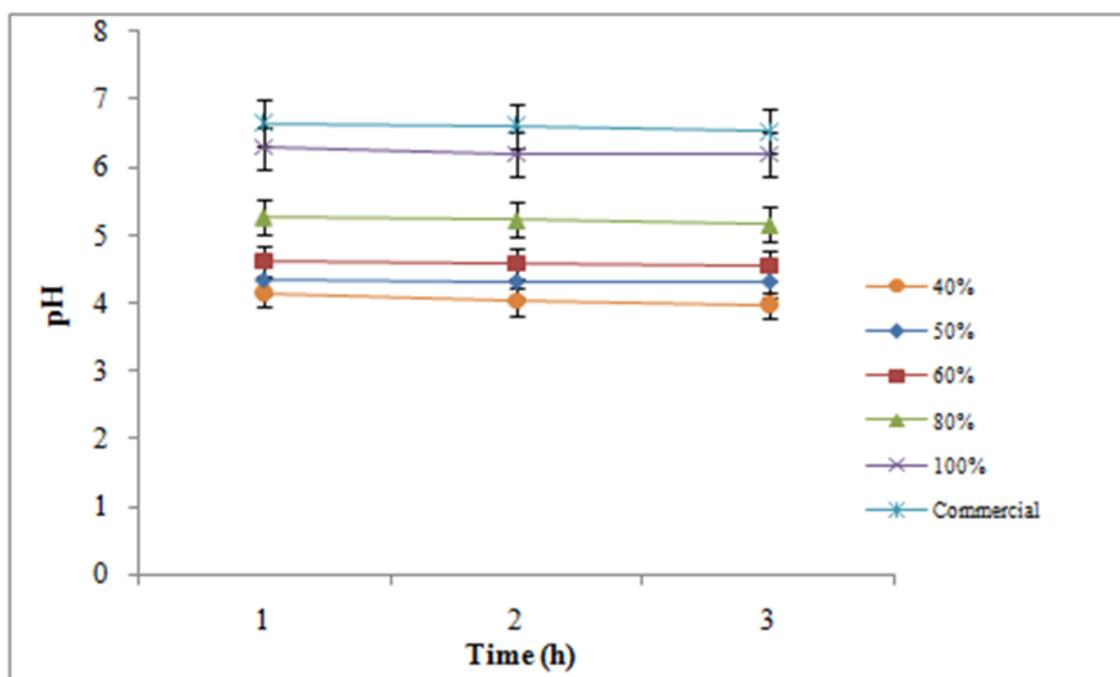


Figure 2: The pH value of water after introduced fish feed pellets

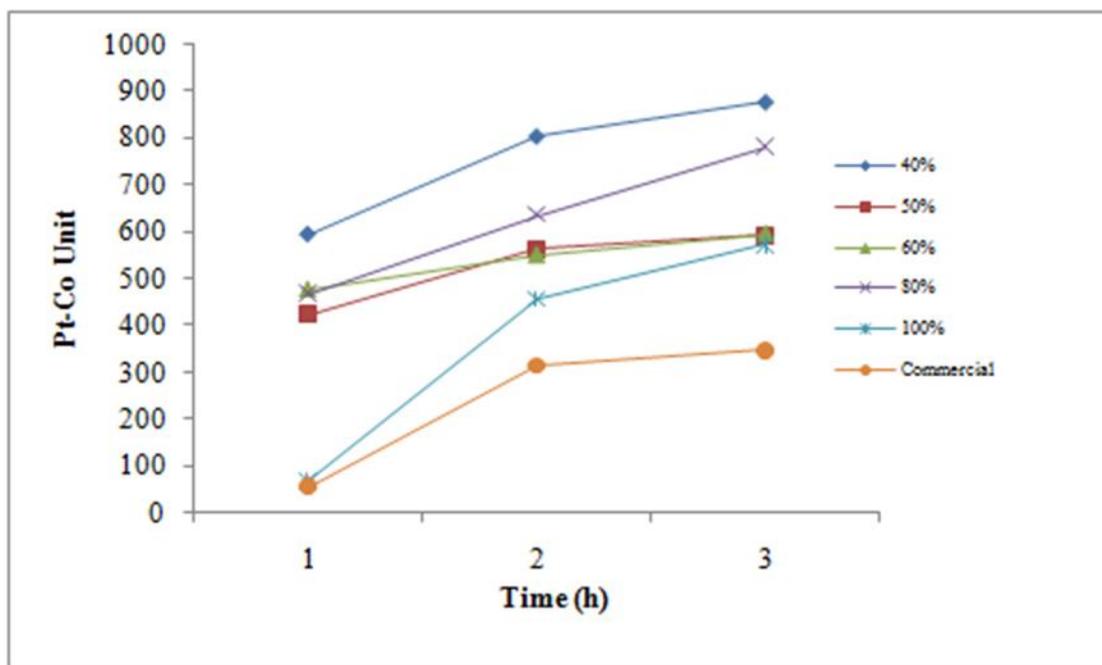


Figure 3: Platinum-Cobalt unit changes after introduced fish feed pellet

Biochemical Oxygen Demand (BOD)

In this experiment, the samples were immersed in water for three hours and seeded with 1mL of microorganisms and were left in incubator for five days after the dilution and the BOD₅ results were calculated for commercial and formulated fish feed as shown in Table 3.

Biochemical oxygen demand or commonly known as BOD is a chemical procedure to measure the amount of dissolved oxygen in water body. The dissolved oxygen (DO) is needed by aerobic organism such as bacteria as its source of energy to breakdown organic material present in water body. Biochemical Oxygen Demand is an important water quality parameter because it provides an index to assess the effect discharged wastewater will have on the receiving environment (Barreto-Curiel et al., 2015). If the rate of DO consumption by bacteria exceeds the supply of DO from aquatic plants, algae photosynthesis or diffusing from air, unfavourable conditions occur. Depletion of DO causes stress on aquatic organisms, making the environment unsuitable for life.

As can be seen from the results, DO was depleted drastically after all samples were incubated for five days. However, compositions of 40% and 80% shown great amount of DO losses compared with other compositions. It shows that there is a great amount of living microorganisms in the both samples. The higher the BOD value, the higher the amount of organic matter available for bacteria life. The consequences of high BOD are the same as those for low dissolved oxygen: aquatic organisms become stressed, suffocate, and die.

Table 3: BOD₅ Level of commercialize and new formulate fish feed pallets

Sample	Initial DO, mg/L	Final DO, mg/L	DO depletion, mg/L	BOD ₅ , mg/L
Blank	4.72	4.66	0.06	0.0002
Blank seeded	5.24	3.82	1.42	42.60
Commercial	4.41	1.50	2.91	27.68
40%	4.48	1.04	3.44	32.98
50%	4.58	2.12	2.46	23.18
60%	5.53	2.35	3.18	30.38
80%	5.78	0.76	5.02	48.78
100%	6.14	2.88	3.26	31.18



Consumers like fish and other aquatic animals eat some of the producers, and the nutrients move up the food chain. When these organisms die, bacteria decompose the organic compounds and release into the water inorganic nutrients such as nitrate, phosphate, calcium, and others. Some of these nutrients end up downstream or in sediments, but most of them recycle again and again (Yamashita et al., 2009). Most of the bacteria in the aquatic water column are aerobic. That means that they use oxygen to perform their metabolic activities of decomposition.

On top of that, dissolved oxygen exists in very low concentrations. Natural levels of oxygen in aquatic systems are always somewhat depleted by normal levels of aerobic bacterial activity. In most cases, if dissolved oxygen concentrations drop below 5 parts per million (ppm) or mg/L, fish will be unable to live for very long. All clean water species such as red tilapia will die well above this level.

CONCLUSIONS

In this paper, new formulated fish feed pellet was successfully synthesized by extrusion method. The feed pellets obtained showed well integration between all ingredients and have well-defined physical characteristic. The 40% and 50% formulation showed great combination which suitable for developing new type feed pellet. The effect of formulated fish feed pellet on to water quality has been studied on turbidity, pH, Platinum-Cobalt method and BOD level. Overall trend suggests that, the new formulated feed pellet was not give significant effect on water quality compared to commercialize fish feed. The 50% formulation showed low turbidity and BOD level as well as Platinum-Cobalt unit which can be used for further studies to improve aquaculture system. The optimization studies need to be done in future research works in order to optimize the fish feed pellet production especially in large scale production.

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