STUDY OF GAMMA IRRADIATED CHITOSAN AS A DIETARY SUPPLEMENT FOR TILAPIA

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ABSTRACT

This study was conducted to evaluate the influence of irradiated chitosan added to the commercial food pellet on growth performance and feed digestibility of tilapia. Chitosan obtained from deacetylation of chitin is irradiated under gamma irradiation (25 kGy) to produce low molecular weight oligo chitosan as a dietary supplement in tilapia tank. The study consisted of 4 treatments (control, 0.025 % oligo chitosan, 0.05 % oligo chitosan and 0.075 % oligo chitosan) and fed three times daily to the tilapia. The water parameters such as pH, temperature, nitrate, nitrite, ammonia and dissolved oxygen were recorded to maintain the suitable condition in water tank. The addition of oligo chitosan (0.05%) showed the best result on final weight, growth rate, feed conversion ratio, protein efficiency ratio and survival rate.

Key words: Gamma irradiation, chitosan, dietary supplement.

INTRODUCTION

Tilapia stand the world's most important group of aquaculture species in terms of production. In Malaysia, Red tilapia is the second largest fish produced after catfish. However, the production of tilapia has been found to decrease each year, from 51,554 mt in 2012 to 35,996 mt in 2016. The decrease in tilapia production has recalled actions to improve fish management strategies and

tilapia culture practices (FRI, 2018). Several methods have been applied in intensive aquaculture system to improve feed digestibvility, fish growth, water quality (Putra, 2020) and dietary supplement (Cheng *et al.*, 2017).

In aquaculture, chitosan has been found to be useful as an immunostimulant to enhance protection of fish (Anderson and Siwicki, 1994; Siwicki *et al*., 1994; Paramá *et al*., 2005; Cha *et al*., 2008) and shrimp (Wang and Chen, 2005) against bacterial disease. There are several criteria that should be taken into account when including any additive to fish diets to avoid any undesirable effects on fish. The low toxicity profile of chitosan compared with other natural polysaccharides is one of its various attractive advantages (Abdel-Ghaney and Salem, 2020). In fact, chitosan safety in terms of inertness and low or no toxicity has been proved (Fouad, 2008). The use of chitosan nanoparticles (5.0 g kg-1 of diet) certainly improved the final weight, differences in final weight, feed conversion ratio and the contents of crude fat and inosinic acid of tilapia, in tanks as reported by Wang and Li (2011). Thus, chitosan nanoparticles acted as feed additive has appeared to improve the growth and meat quality status of tilapia in fish farms. Although having many advantages, chitosan reveal several drawbacks including poor solubility. Radiation degradation of chitosan has been studied to produce low molecular weight chitosan (Duy *et al.*, 2015). Therefore, the aim of the study is to investigate the using of low molecular weight chitosan (oligochitosan) from radiation irradiation of gamma ray as a food supplement for tilapia.

MATERIALS AND METHODS

Preparation of radiation degraded chitosan

Chitosan powder with molecular weight of 176 kDa and degree of deacetylation of >85% was obtained from USA. The chitosan powder was mixed with distilled water. The prepared mixture (chitosan powder swells in water) was irradiated under gamma irradiation (SINAGAMA) at 25 kGy to produced low molecular weight oligo chitosan. The irradiated solution was then dissolved with lactic acid and homogenized for 24 hours. The molecular weight was measured by Size Exclusion Chromatoghraphy (SEC) equipped with MALLS (multi angle laser light scattering) detector brand Wyatt.

Preparation of tilapia feed

Commersial tilapia feed comprise of 32 % protein was used in this study. Low molecular weight chitosan (oligochitosan) derived from degradation of chitosan by gamma irradiation was further used as a dietary food supplement. The commercial food pellet was mixed with 0.025 %, 0.05 % and 0.075 % oligochitosan. The ingredients were well mixed and dried at 50° C in oven for 2 hours. The prepared food diets were then stored in plastic container at ambient temperature until use.

Experimental procedure and conditions

Juvenile tilapias were obtained from local supplier, which were then transferred into 140 L tank. The tank was connected to aerator and filter system to support the required condition. After acclimation for two weeks, the weight of each fish was taken and randomly distributed to 4 cylinder tanks with diameter of 60 cm and 50 cm height. The fish in tank with label A were fed with conventional food pellet as a control parameter. The fish in tank B, C and D were fed with 0.025%, 0.050% and 0.075% oligo chitosan mix with commercial food pellet respectively. The fish were fed at the rate of 5% of their body weight thrice per day. The basic parameter of water such as pH, temperature, dissolved oxygen and ammonia were check regularly to maintain the optimal level. The fish were reared for 30 days and weighed every ten days.

Growth performance

The weight of each individual specimen of fish with 4 different oligochitosan intakes was recorded at the beginning and every 10 days during the experiment. Based on the weight of each fish the weight gain was calculated as follows (Lin *et al*., 2011);

Weight Gain (WG) = Final weight (g) – Initial weight (g)

The feed conversion ratio (FCR) was calculated according to the fed intake and weight gain.

Feed conversion ratio (FCR) = Diet fed (g) / Weight gain (g)

The protein efficiency ratio (PER) was calculated by using the relationship between the increase in the body weight of fish and protein consumed according to the method of Zeitoun *et al.* (1976);

Protein efficiency ratio PER = Weight gain (g) / crude protein in diet

The survival rate (SR) was recorded daily and calculated as follows;

Survival rate (%) (SR) = (Final number of tilapia/Initial number of tilapia) X 100%

RESULTS AND DISCUSSION

1. Weight gain

The influence of different levels of oligochitosan on the weight gain is presented in Figure 1. There were significant differences in weight gain of tilapia between diets containing oligochitosan and without oligochitosan during 30 days of experiment. A general tendency of increasing weight gain was observed in all treatmeats with the addition of oligochitosan in the diets. The young tilapia with a starting average weight of about 40 g showed the best growth with 0.05% oligochitosan, followed by 0.075 % and 0.025 %. Minimum growth was observed in tilapia fed with commercial feed without oligichitosan.

The obtained result clearly showed that the dietary with 0.05% oligochitosan enhanced the growth performance of tilapia to optimum level compared to 0.025 and 0.075% oligochitosan. The effect of chitosan on growth performance of fish has been reported by Niu *et al.* (2011), which concluded that chitosan is an active growth promoter and can be considered as an essential element for the growth of aquatic animals. Improvement in the morphological structure of small intestine can be the main effect of chitosan, which may improve nutrients absorption and growth performance as revealed by Zaki *et al*. (2015)

Figure 1. Weight gain of the tilapia fed with oligochitosan

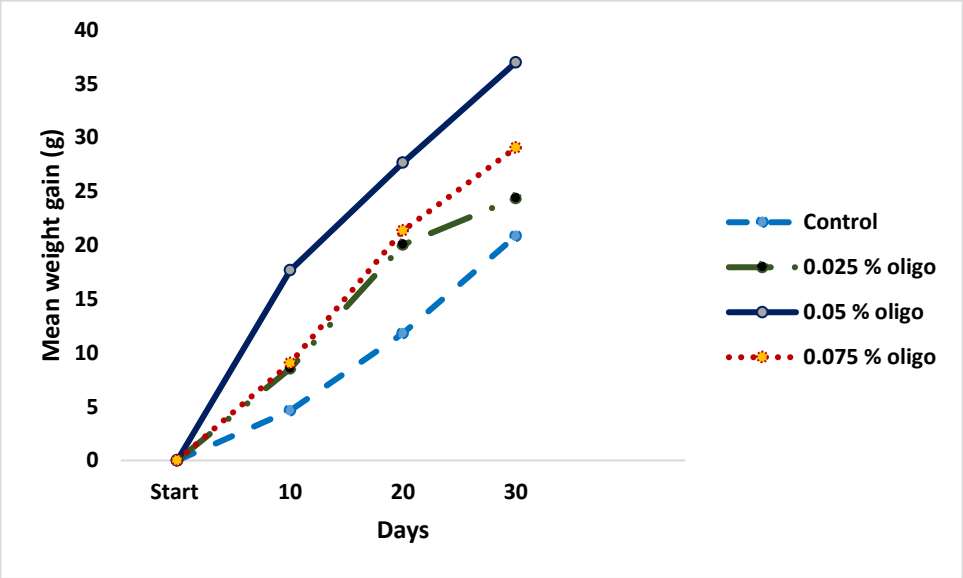
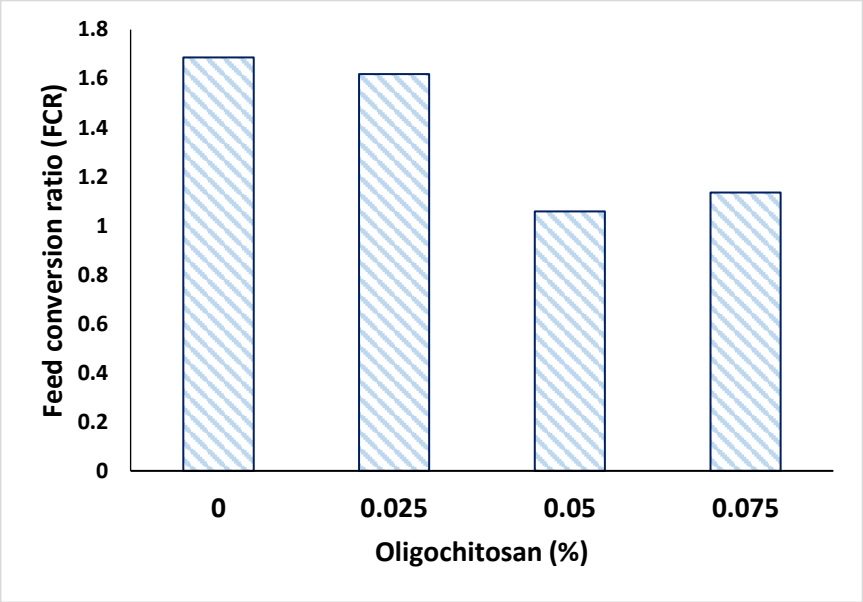


Figure 2. FCR of the tilapia fed with oligochitosan



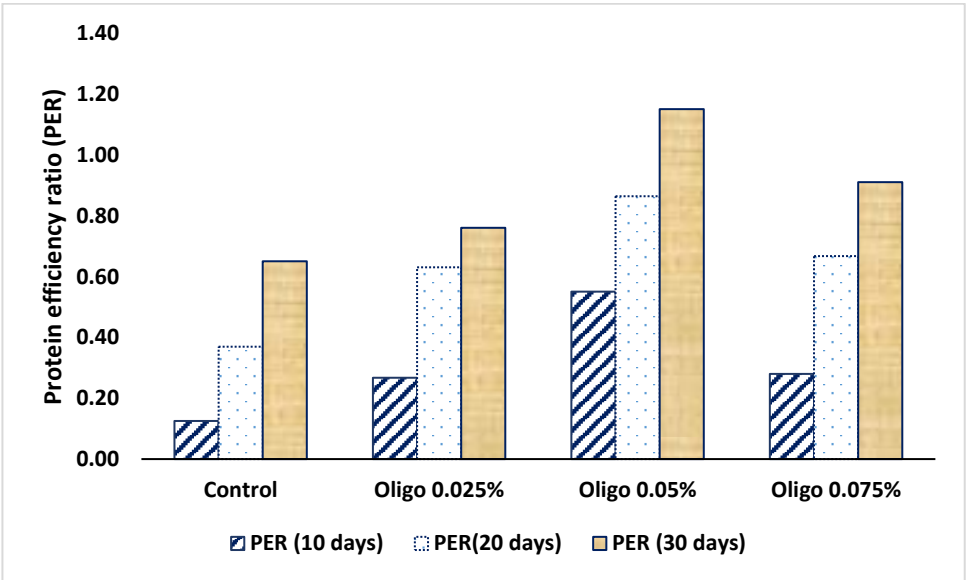
2. Feed conversion ratio (FCR)

Feed conversion ratio (FCR) of a tilapia cage culture feed with 32 % protein is 1.7 as reported by (Boyd USA). This FCR result was in accordance with our results, however, the best feed conversion ratio (FCR) obtained in our study is at the concentration of 0.05 % oligochitosan and the poorest feed conversion ratio are of normal feed diet without oligochitosan. The diet of 0.075 % oligochitosan gave better feed conversion ratio than diet with 0.025 % oligochitosan. The value of FCR (Figure 2) revealed that tilapia fed with 0.05% oligochitosan took less food (1.06 g) to produce 1.00 g of fish compared to the tilapia fed with commercial fish pellet, 0.025 % and 0.075 % oligochitosan.

3. Protein efficiency ratio (PER)

Protein efficiency ratio (PER) is a widely used method for evaluating the quality of protein in food. In this study, the increases of percentage of oligochitosan lead to the increasing of protein efficiency ratio (PER) of tilapia. The study conducted in 30 days revealed that PER of tilapia fed with 0.05 % oligochitosan (Figure 3) has positive correlation with the weight gain and feed conversion ratio (FCR). The best PER value for tilapia fed experimental and control diets was from diet of 0.05% oligochitosan. This result revealed that the addition of 0.05 % oligochitosan in the diet significantly improve the protein efficiency ratio (PER) hence optimizing the protein consumed.

Figure 3. Protein efficiency ratio (PER) of the tilapia fed with oligochitosan



4. Survival rate (SR)

The survival rate of feeding trial in control and 0.075 % oligochitosan showed more than 50 % mortality, whereas 100 % survival rate was recorded for 0.025 % and 0.05 % oligochitosan. This result indicated that the optimum level of oligochitosan to be added in commercial tilapia food pellet is less than 0.05 % to avoid mortality and preserved suitable condition in the tank.

CONCLUSION

This study concluded that the addition of 0.05 % oligochitosan obtained from 25 kGy gamma irradiated chitosan offers a promising solution as food supplement for tilapia. However, the potential application of research data into the real tilapia farming should be further study to fill this gap.

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