ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)
'A Bridge Between Laboratory and Reader'

www.ijbpas.com

STUDY OF EFFECT OF DIFFERENT LEVELS OF BETA-GLUCAN ON THE PERFORMANCE AND SURVIVAL OF GROWER'S RAINBOW TROUT

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ABSTRACT

Beta-glucans are a Non-starch polysaccharide molecule that's composed of glucose chains which are classified as soluble fibers. The effects of beta-glucans as immune triggers affecting immunity increase and resistance against illnesses have been proved. Therefore, in order to evaluate the effect of different amounts of beta-glucans on the function and survival of rainbow trout, 408 of the mentioned fish weighing 150±5 g were divided into one control group and three treatment groups (N = 102 in each group) with three replications. 0.1%, 0.5%, 1% beta-glucan was administrated in treatment groups 1, 2, 3 respectively for 40 days. The fish maintenance conditions in terms of water physiological quality and the kind of base dietary were identical. At the end of the growing period the absolute growth rate, FCR, the rate of feed consumption and survival rate of any treatment group were calculated. The results of the present study revealed that there is a meaningful statistical difference among different groups in terms of feed consumption, FCR, absolute growth rate, and survival rate ($P<0.05$); such that the feed consumption, absolute growth rate, and survival rate of the beta-glucan consumed groups were decreased, and the FCR was increased compared with the control group. So, the administrated amounts of beta-glucan in the present study can decrease performance and survival rates of farming rainbow trout.

Keywords: Betaglucan, Performance, Survival, Rainbow Trout

INTRODUCTION

The cost of aquatic feed production is high. Its high cost is due to the high dependency of the dietary to the fish powder and other costly elements such as protein resources **(Ayoleke, *et al* 2006)**. Beta-glucans which contained glucose units linked to β-1, 3 and β-1-6 of gulicoside bond are the most polysaccharide structures of bacteria, fungi and plants **(Robertsen, *et al*. 1990)**. Beta-glucans were used at first for stimulation of fighting systems against tumors as well as increase the resistance of the host against a varied spectrum of microbial pathogens in rats **(DI-Luzio, 1985)**.

Recently it has been proven that beta-glucans stimulating immune stimulants affect the increase of immunity and resistance against diseases in fish **(Bagni, et al. 2005 & Cook, et al. 2001)**. Many studies have evaluated the effect of beta-glucan on fish immunity. Most of researches have been concentrated on in-vivo experiments. Many other researches use intra-peritoneal injection due to its efficiency and rapidity **(Jørgensen, *et al*., 1993 & Robertsen, *et al*., 1990)**. But the use of the method in aquatics is time consuming, so it is not practical. The oral consumption of Beta-glucans has been proved as an effective method **(Siwicki, *et al*. 1994)**. Some studies have demonstrated that oral administration of Beta-glucan increase nonspecific immune system and resistance against diseases in fish **(Ortuno, *et al*. 2002 & Sahoo and Mukherjee, 2001)**. By the way, the rate of its increase depends on the rate of Beta-glucan dietary and the type of that. Considering that the most conducted studies are about fish immune system, and the consumed Beta-glucan is one of the effective factors on its function; hence, it will be tried, in the present study, to evaluate the effect of different amounts of beta-glucan on the function and survival of farming rainbow trout.

MATERIALS AND METHODS

12 circular concrete fish ponds with 2 m diagonal and 1.5 m depth of water and constant water flow, which were in a covered saloon, were selected. The ponds were divided into four groups with three replications (one control group and three treatment groups), then they were marked. In order to insure the identical condition during the experiment stages, the water temperature, dissolved oxygen and pH were measured and recorded every morning. The results of water physical and chemical factors have been demonstrated in table 1-2. The amount of dissolved oxygen, pH, and water temperature were measured using an oxygen-meter kit made by Karizab Co., pH-meter made by

Karizab Co., and mercurial thermometer, respectively **(Table 1)**.

Input water of ponds was collected using a scaled large pan for one minute to determine the input water to the pond in liter per minute, which was 23 L/m. The process was necessary to determine the appropriate number of fish in the ponds. The fish were obtained from the fish culturing farm where the experiment was conducted. Then, 102 rainbow trout (from each treatment group with three replications) weighing 150±5 were added to the pond. Then, the commercial base diet available in the farm was given to all treatment groups to remove tension caused by sorting and transferring the fish.

The experimental groups consisted of the followings:

Treatment 1: control (the commercial base diet without beta-glucan)

Treatment 2: base diet + 0.1% beta-glucan

Treatment 3: base diet + 0.5% beta-glucan

Treatment 4: base diet + 1% beta-glucan **(El-Boshy, *et al*. 2010)**.

The basal diet was identical for all groups and it was used from the diets of Faradaneh Co as GFT2 according to the manufacturer suggestions until the end of the period. The used beta-glucan in this study was the extract of Yeast Saccharomyces cell wall riched of Mannan oligosaccharides (MOS) and beta 1-3- glucan of a German company (Biochem). During the present study, the considered amounts of beta-glucan was mixed with sunflower liquid oil (30cc per kg feed) and sprayed uniformly onto the pellets. It must be mentioned that sunflower oil was added to the control group diet in order to create an identical experimental condition for all groups. During each Biometry of the experiment, the fish were weighted using a digital scale with an accuracy of 0.01 g. This process was repeated four times for any experimental unit and their mean was recorded as the mean weight of fish.

The recorded parameters during the experiment and after killing consisted of feed, absolute growth rate, FCR, and fish survival rate.

One of the important factors in rainbow trout culturing is the measuring and determining the consumed feed, such that their diet was weighted truly every day before administrating.

The amount of consuming feed was calculated using the following formula:

$$\textbf{Consumed feed} = \frac{\textbf{Fish number} \times \textbf{weight mean} \times \textbf{the amount of given feed (biomass percentage)}}{\textbf{100}}$$

The adjustment of consuming feed is based on water temperature, fish weight, and consumed feed quality. Accordingly, the water temperature was measured after obtaining the fish mean weight in any experimental unit and then the considered number was obtained from the manufacturer feed table (Faradaneh Co).

Recording the absolute growth in aquatic industry can be conducted based on absolute changes in aquatic weight. The absolute growth rate is one of the criteria for measuring the weight gain in fish that evaluate the growth rate during the culturing period. It is calculated by the following formula:

TWG = Wb – Wa

Where, Wb is the fish weight on the day b and Wa is the fish weight on the day a.

Calculating the FCR based on the study type in aquatic culturing industry may be different slightly compared with other experiments. In the present study like other researches, FCR will be obtained using absolute growth data as dividing the amount of consumed feed into absolute growth.

In order to calculate the percentage of survival rate, the amounts of losses were recorded daily for each experimental unit.

The experimental period was 40 days. The recording was conducted on day 0, 10, 20, 30, and 40. **RESULTS**

After the implementation of the experimental stages, the obtained records of the mentioned criteria were analyzed statistically using the ANOVA method, and the obtained results were evaluated.

Wight gain (absolute growth) in the experiment period:

One of the rainbow trout evaluation criteria is the growth rate or weight gain. The obtained results of the present study demonstrated that there is a significant difference in absolute growth among treatment and control groups; such that the highest absolute growth rate in control group was 54 g in each fish, and the lowest rate was 47g in each fish which was in 1% beta-glucan treatment group during the experiment ($p<0.05$) (**Table 2**).

The amount of consuming feed

The amount of consuming feed is one of the efficient criteria for FCR calculation, and can reflect the concentration of dietary energy. The results of the present study demonstrated that there is a meaningful difference in terms of consuming feed amount between control and 0.1% betaglucan treatment group, and other treatment groups ($p<0.05$). The highest consumed feed was in the control group and the lowest was in 0.5% beta-glucan treatment group (**Table 2**).

FCR

FCR is considered as an economical criteria that the amount of consumed feed and weight gain lie in which. It is also considered as a criteria to determine the favorable diet and aquatics; such that the cost of per kg weight gain in aquatic industry is calculated using multiplying FCR in the price of per kg diet.

The results of the present study demonstrated that there is a meaningful difference in terms of FCR between control and 0.5% betaglucan treatment group, and other treatment groups ($p<0.05$). The lowest FCR was in the control group and the highest was in 1% beta-glucan treatment group (**Table 2**).

Survival rate

Since, today the ecosystem of the aquatic digestive tract is considered as the protection system, the evaluation of survival rate using beta-glucans is considerd an important issue due to a direct relationship with the fish digestive tract. The results of the present study showed that there is a meaningful difference between control and treatment groups ($p<0.05$) **(Figure 1)**. The lowest losses amount was in the control group and the highest was in 0.5% beta-glucan treatment group.

Table 1: the mean of physical and chemical characteristics of rainbow trout culturing water

Temperature (O^C)	Dissolved oxygen (mg/l)	PH
12±0.5	7±0.3	7.5±0.23

Table 2: comparison of the TWG, feed consumption, and FCR of farming rainbow trout among treatment groups

Group / Factor	control	T1	T2	T3
TWG	54±00 [a]	51.3±00 [b]	50±1.25 [c]	47±0.50 [d]
Feed consumption	5407±20.42 [a]	5389±12.66 [a]	5228±16.16 [b]	5254±13.07 [b]
FCR	1.00±0.006 [a]	1.07±0.005 [b]	1.00±0.004 [a]	1.11±0.005 [c]

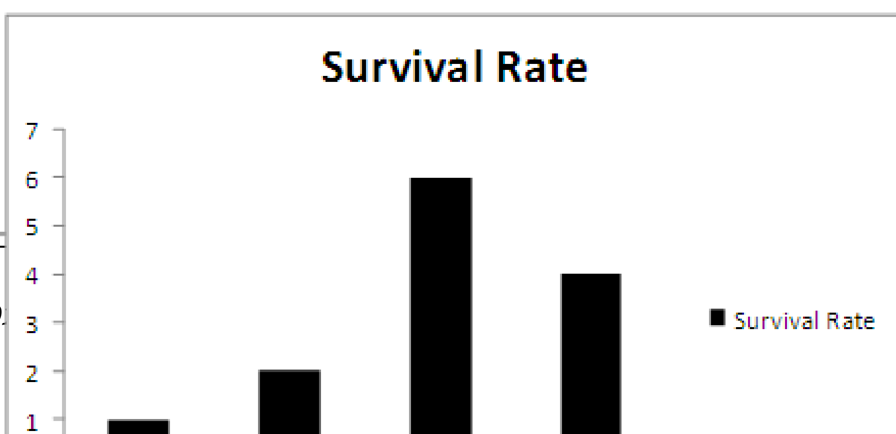

Figure 1: comparison of the mean survival rate of farming rainbow trout among treatments

DISCUSSION

Oral consumption of beta-glucans can improve grow rate in farmed fish **(Cook *et al*., 2003; Misra *et al*., 2006)**, but this issue doesn't apply to all aquatics. In the present study no positive effects of using different amounts of beta-glucans was observed and the growth rate was lower in all treatment groups compared with the control group.

This result was similar to the results obtained by **Ye *et al* in 2001** about Carp **(Ye, *et al*, 2001)**, Efthimiou about English sole **(Efthimiou, 1996)**, Kumari about Asian Catfish **(Kumari and Sahoo, 2006)**, Bagni about Perch **(Bagni *et al*., 2005)**، Welker about Channel Catfish **(Welker *et al*., 2007)**, and Sealey about rainbow trout **(Sealey *et al*., 2008)**. It seems that the rate of growth improvement depends on the consumption amount and the consuming duration of beta-glucan **(Ye, *et al*, 2001)**. In large Tigertooth croaker fed with diet contained low amounts of beta-glucan (0.09%) for 8 weeks caused increased growth rate compared with the control group, but the group which was fed with high amount of beta-glucan (0.18%) has a low growth rate **(Ai *et al*., 2007)**. The apparent decrease in the growth of Tilapia fed with diet contained 0.01% and 0.02% beta-glucan for 70 days was observed **(Whittington *et al*., 2005)**.

In the study conducted by **Kanta Misra, *et al* in 2006** on the effects of long-term consumption of beta-glucan on immunity, growth, and survival of Indian Carp, the different amounts of beta-glucans (0 control group), 100, 250, and 500 mg beta-glucan per kg feed) were administrated to finger-size Labeo Rohita for 56 days. Then, blood and biochemical parameters as well as immunity parameters were tested with a two weeks interval. After 56 days, the specific growth rate (SGR) and food conversion ratio (FCR) were calculated. In that study the immunity parameters such as white blood cells, phagocytes ratio, phagocytic index, lysosome activity, serum antibacterial complement and activity reached to the highest level on the day of 42 following the feeding with 250 mg beta-glucan per kg food. Furthermore, this amount of beta-glucan caused the highest level of protection against bacteria. The amounts of 250 and 500 mg beta-glucan in diet caused improved SGR and FCR. The amount of 250 mg beta-glucan has been suggested by the researches to enhance immunity, growth, and survival rate of finger-size Labeo Rohita **(Kanta Misra, *et al*. 2006)**. In the present study the amount of consumed feed as well as fish growth in the treatment groups in which beta-glucan was administrated decreased in the control group and the FCR increased. The results of that study on trout were not conformed with the results of the first and second experiments of the present study.

The use of beta-glucans as immunity stimulants caused an increased protection against different pathogenic factors in different species of fish such as *Aeromonas hydrophila* in *Cyprinus carpio* **(Gopalakannan and Arul, 2010)**, *Oreochromis niloticus* **(El-Boshy, *et al*. 2010)**, Daniorerio **(Rodriguez, *et al*. 2009)**, *Aeromonas Salmonicida* in *L. rohita* , channel catfish **(Chen and Ainsworth, 1992)**, and virus causing bleeding in Grass Carp **(Kim, *et al*. 2009)**, and *Ichthyophthirius multifiliis* in rainbow trout **(Kim, *et al*. 2009)**. Beta-glucans can have different effects on immunity parameters of some fish such as lysosome activity increase **(Gopalakannan and Arul, 2010; Jeney, *et al*. 1997; Lauridsen and Buchmann, 2010; Misra, *et al*. 2006)**, phagocytic activities **(Chen and Ainsworth, 1992; El-Boshy, *et al*. 2010; Jeney, *et al*. 1997; Sahoo and Mukherjee, 2001)**, and granulocyte number **(Misra, *et al*. 2006; Rodriguez, *et al*. 2009; Sahoo and Mukherjee, 2001)**. Also, it has been demonstrated that beta-glucans can affect complementary system **(Misra, *et al*. 2006; Yano, *et al* 1991)**. By the way, the beneficial effects of beta-glucans depend on the amount of their consumption and the duration of treatment. For example, the low dosage of beta-glucans (0.1%) in fish feed can have a decreasing effect on the fish stress. Its high dosage (1%) can have reverse results such as the loss rate during pathogenic diseases **(Jeney, *et al*. 1997)**. Furthermore, the long-term administration of beta-glucan in diet can affect negatively on fish survival rate when an infection in Common Carp by *Aeromonas salmonicida* **(Ye, *et al.* 2011)**. Considering the low survival percentage in betaglucan-administered treatment groups compared with the control group, it can be concluded that the observed results are the results of the high dosage or long-term administration of beta-glucan in rainbow trout. The results of the present study demonstrated that the administration of 0.1%, 0.5%, 1% beta-glucan in farming rainbow trout diet during 40 days can cause increased performance and survival rate.

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