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Effects of oyster mushroom as a feed addictive in juvenile cherry salmon

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ABSTRACT: Our research on juvenile *Oncorhynchus masou masou* in oyster mushroom supplemented diet was studied to investigate the effect of feeding. Mixing of feed ingredients for dried oyster mushrooms, 3.5, 7.0, 10.5, 14.0 (%) was added to the amount of oyster mushroom dietary beta-glucan content of the more abundant. After the weight of feed given to salmon survey oyster mushrooms diet for 3.5 to 7.0% was similar to the formula feed and the weight of the fish ate oyster mushroom feed over 10.5% were reduced. The oyster mushroom of the experimental diets containing 3.5 to 7.0 percent hepatosomatic index and feed coefficient figure was similar to those of the formulated diets. Therefore we have juvenile cherry salmon fed diets containing 3.5 to 7.0% was considered good to eat and additional research on the immune response will be carried out was necessary.

KEYWORDS: Beta-glucan, Cherry salmon, Fishmeal, *Pleurotus ostreatus*

INTRODUCTION

The farmhouses of Oyster mushroom are 926 houses in the whole country as of 2017, and the production amount runs to 53,532M/T, and it occupies about 35.7% of the total production amount of mushroom (Ministry of Agriculture, 2018). The non-product mushrooms of about 10% of the cultivation structural product amount of the oyster mushroom occurs are occurred, but these non-product mushrooms are discarded along with the medium after harvesting in the state without the marketability. The fish feed generally contains a lot of protein, and the study for new vegetable protein source which can replace fish meal due to the various problems according to currently the supply fluctuations of the fish meal and the price rise, etc. have been made (Dabrowski *et al*, 1979; Jackson *et al*, 1982; Kim *et al*, 2000; Robinson *et al*, 1985; Wilson *et al*, 1985). Kim *et al.* (2009) have reported that it is important to reduce the addition rate of the fish meal of the feed for the economical stable supply of feed, and for this reason, it is necessary to develop the cheap protein source which can substitute the fish meal and the stable supply is possible. Mostak *et al.* (2013) have reported that the crude protein of the dried oyster mushroom was 28.4% and the content of such protein showed the possibility that can be used as the protein feed source. If the non-product mushroom of the oyster mushroom can be used, it is expected that the manufacturing cost of the fish feed for aquaculture can be reduced. In addition, there was the report for the effect of β-glucan as the additive that increases the defense ability against the disease of fish, and it has been reported that the experimental results after breeding for six weeks by mainly the feed of the juvenile olive flounder, good effect in the growth rate, the feed efficiency, the non-specific immune response and the disease resistance was shown (Kim *et al*, 2006). As a result that investigates the anti-bacteria, antioxidant activity and anticancer activity for the fish disease bacteria by using the mixed culture medium of the *Coriolus versicolor* and *Phellinus linteus* mycelium,

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Table 1. Composition of the experimental diets for the juvenile cherry salmon (%, dry matter)

Treatment		Fish meal (%)	Wheat flour (%)	Soybean oil (%)	Fish oil (%)
Control	0	15.0	34.5	2.25	2.25
Oyster mushroom meal level (%)	3.5	13.5	32.4	2.25	2.35
	7.0	12.0	30.2	2.35	2.45
	10.5	10.5	28.0	2.40	2.60
	14.0	9.0	25.9	2.35	2.75

※The others (%) : Soybean meal 12.5, Squid liver oil 12, Squid meal 3.5, Meat meal 5.0, Corn gluten meal 12, Vitamin premix 0.5, Mineral premix 0.5

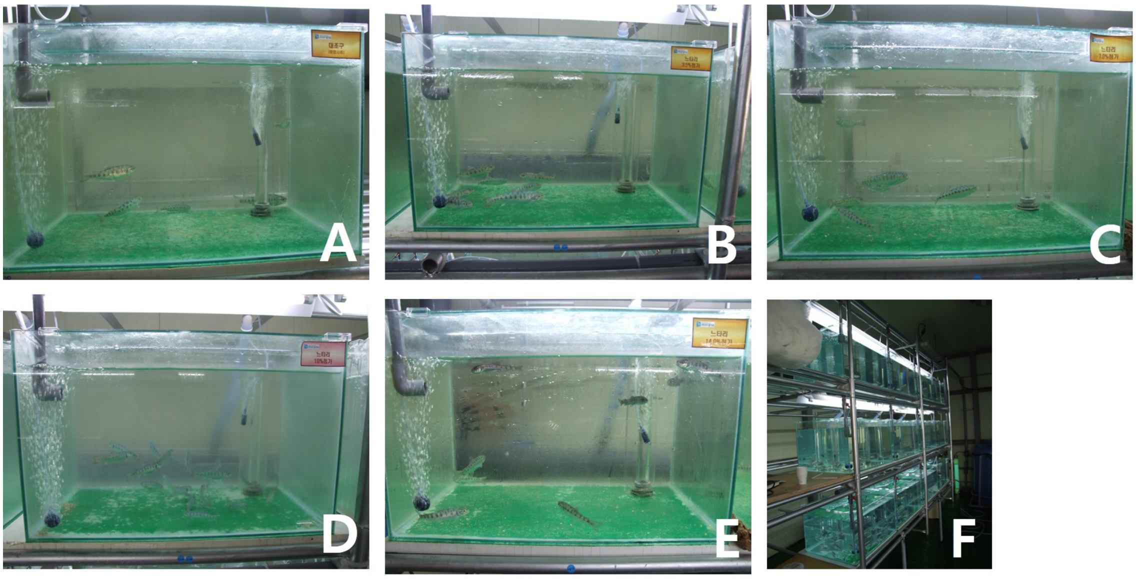

Fig. 1. The photography of experiment equipment
A: Control (0%), B: 3.5%, C: 7.0%, D: 10.0%, E: 14.0%, F: Full equipment

all results showed high values (Kim *et al*, 2008) Jang has reported that as a result that investigates the β-glucan by the megazyme method, the fruit body of oyster mushroom was about 26.8% (Jang, 2011). It is expected that this β-glucan will be able to be used for the improvement of immunity of fish by being added into the fish feed. Thus, this study was performed so that the mushroom farm family creates the new source of income and the aquaculture fishery household can derives the stable production of high quality by developing the fish feed using the non-product area of the oyster mushroom which is the typical edible mushrooms in Korea, and the possibility for the alternative sources of the fish meal protein targeting the cherry salmon which is the main cultured species of freshwater fishes was reviewed.

MATERIALS AND METHODS

The examination varieties of the oyster mushroom by-product used in this experiment are Chunchu 2, and the oyster mushroom classified as the non-product after the bottle cultivation in Mushroom Research Institute were used. And in order to make the experimental diets, fish meal, soybean meal, corn gluten meal, squid liver powder, meat scrap, fish oil, soybean oil and oyster mushroom by-product were used (Table 1). The experimental diets were made by adding the content of 3.5%, 7.0%, 10.5%, 14.0%, respectively, of the oyster mushroom by-product as the substitute feed of fish meal protein, including the control hole of oyster mushroom. The experimental diets was used while storing in -20°C freezer after being made by using a pellet making machine.

The juvenile cherry salmon parceled out from Gyeonggi-

Table 2. Nutrients composition of the experiment diets

Treatment		Water content (%)	Crude protein (%)	Crude fat (%)	Crude Ash (%)	Crude fiber (%)
Control	0	14.7	43.3	9.6	7.8	1.58
Oyster mushroom meal level (%)	3.5	15.4	42.1	9.5	7.9	1.88
	7.0	14.4	43.5	9.7	7.7	2.06
	10.5	15.1	41.4	9.6	8.1	2.23
	14.0	14.8	43.3	9.3	7.9	2.31

do Maritime Resources Institute were preliminarily bred at 250L water tank for 14 days as the fishes for experiment. The juvenile cherry salmon which the average weight is 5.0 ± 0.1g after preliminary breeding were randomly placed in three iterations by 20 fishes per each experimental hole into 40L square water tank (Fig 1). Each experimental water tank was a recirculating system and the water flow was controlled to 1L/min, and the water temperature was 13 ± 1°C, and pH was 7.0~7.5. The feed was supplied daily across two times at 09:00 and 21:00 by 3~4% of the weight of the juvenile cherry salmon. Total breeding period was four weeks.

The measurements of the fish body for the experiment were performed before the experiment and after the end of the experiment, and the total length of the fish was measured by using a digital vernier calipers, and the weight was measured up to 0.1 g by an electronic balance. These values were used for the analysis and investigation about total length, weight gain, feed efficiency, condition factor and feed conversion rate, and the hepatosomatic index was calculated by extracting the liver, and the calculating formula for the investigation contents were as follows:

- Feed efficiency = Total weight gain / Total feed intake × 100

Hepatosomatic index = Liver weight / fish weight×100,
Condition factor = (fish weight / fish length^3) × 100,
Feed conversion ratio = dry feed intake / fish weight × 100

According to AOAC(2000) methods for the experimental diets and fish body, the moisture was analyzed by the drying method (atmospheric heating, 80°C, 48hours), and the crude protein, by the kjeldahl nitrogen determination method, and the crude ash, by the direct ash method. The crude fat was analyzed by the soxhlet extraction method, using soxtec system 1046 (Tacator AB, Sweden) after freeze-drying the sample for 12 hours.

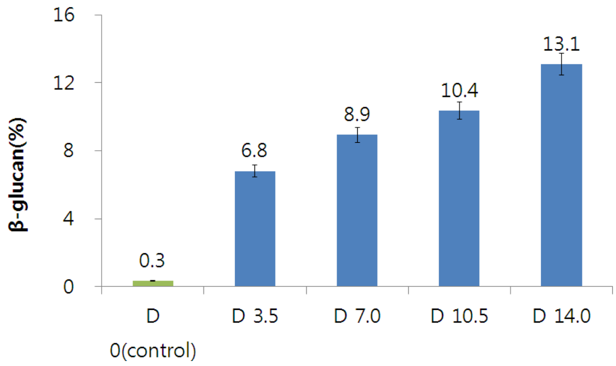

Fig. 2. β-glucan content (%) of the experiment diets. D, control; D 3.5, Oyster mushroom meal level 3.5%; D 7.0, Oyster mushroom meal level 7.0%; D 10.5, Oyster mushroom meal level 10.5%; D 14.0, Oyster mushroom meal level 14.0%.

RESULTS AND DISCUSSION

As a result that produces the feed by adding the oyster mushroom by-product, the general components are the same as shown in Table 2. Most of the components were equal to the control, and it showed the tendency that the more the addition amount of the by-product was increased, the more the crude was increased. It showed the tendency that the more the addition amount of the by-product was increased, the more the content of β-glucan was increased (Fig 2). It has been known that β-glucan increases the defense ability of fish body against the infection of the strongylida and bacteria when the feed of fish is supplied (Nikl *et al*., 1993; Raa *et al*., 1992; Robertsen *et al*., 1990; Siwicki *et al*, 1994; Yoshida *et al*., 1995). However, it has been reported that the fish which was supplied the diets containing β-1,3/1,6 glucan showed the non-specific immune response such as the lysozyme activity and the chemical luminescent reactions but if a suitable amount of the glucan was exceeded, the fish showed the negative effects (Kim *et al*., 2006; Won *et al*., 2004; Yoo *et al*., 2007). In the present experiment,

Table 3. Increment of total length and weight gain for cherry salmon fed experimental diet during 4 weeks

Treatment		Total length (mm)	Weight gain (g)
Control	0	106.7a[a]	13.29a
Oyster mushroom meal level (%)	3.5	106.9a	13.21a
	7.0	106.7a	12.03ab
	10.5	108.3a	11.99b
	14.0	102.3b	10.11c

[a] Values followed by the same letter do not differ significantly at p>0.05 according to Duncan's multiple range test.

the more the added amount of the oyster mushroom was much, the more the content of β-glucan became high, and the results that the more the content of the by-product was high, the more the total length or the weight of fish become lower was represented as shown in Table 3. Thus, the oyster mushroom by-product should be prepared adjusting the level of the suitable content when developing the fish feed. In addition, it has been reported that the *Oncorhynchus mykiss* (rainbow trout) which has eaten the β-glucan derived from Shiitake mushroom showed an immune reaction results for a bacterially caused disease (Brankica *et al*., 2008) and in future, it needs to investigate the suitable content which can augment the immune via the further studies on that β-glucan presented in oyster mushroom has any impact on the cherry salmon (*Oncorhynchus masou masou*). (Seong and Kim, 2008) have reported that the number of feeding of the optimal feed in the juvenile period of cherry salmon was twice a day, and also in this experiment, the cherry salmon was fed the feed twice a day. The growth form on 4 weeks after the incubation of the juvenile cherry salmon showed the tendency that the more the oyster mushroom by-product was much, the more the total length became small, and the fish's weight showed the tendency getting lower (Table 3). It has been reported that as a result that feeds during 12 weeks to flatfishes by adding the culture medium of mushroom mycelia (*P. linteus*, *C. versicolor*) into the diets, the fish's weight was increased about 12~20% in comparison with the control hole, and the average full-length was generally increased (Kim *et al*., 2006; Kim *et al*., 2000) have reported that if the soybean meal above-optimum level was added in the diets, the result that the growth of fish was generally reduced was represented, and also the oyster mushroom by-product showed the same trend. Thus, in this experiment, the fish's weight was not increased according to oyster mushroom by-product but showed the same results to the control hole, and it is considered that this results from the target fishing species, breeding period and the differences by mushroom. In addition, because the addition rate of fish meal whithin the assorted feed is very important factor in the unit price of feed (Kim *et al*., 2009), it is considered that if non-product oyster mushroom can be replaced to a certain portion of fish meal, the economic feasibility of the assorted feed will be able to be secured. In addition, it is expected that it will be able to be used as the increasing agent of the level of immunity in addition to the substitution of the protein source, and it needs to clear up it through the further study for the bacterial pathogenicity experiment of the cherry salmon. As a result that investigates the growth characteristics of the cherry salmon according to the addition amount of the oyster mushroom by-product, the feed efficiency, hepatosomatic index, condition factor and feed conversion rate were shown the tendency that the more the addition amount was increased, the more their values became lower. The feed efficiency showed the same results to the control hole when the addition of oyster mushroom by-product was 7% or less, and the hepatosomatic index and the condition factor, in 10.5%

Table 4. Growth properties of cherry salmon fed experimental diet during 4 weeks

Treatment		FE (%)	HIS (%)	CF (%)	FCR (%)
Control	0	0.87a[a]	1.86a	0.96a	0.87a
Oyster mushroom meal level (%)	3.5	0.89a	2.01a	0.95a	0.89a
	7.0	0.80ab	1.89a	0.94a	0.80ab
	10.5	0.67bc	1.90a	0.89ab	0.67bc
	14.0	0.53cd	1.62b	0.82b	0.53cd

[a] Values followed by the same letter do not differ significantly at p>0.05 according to Duncan's multiple range test.
※FE; Feed efficiency, HSI; Hepatosomatic index , CF; Condition factor, FCR; Feed conversion ratio

Table 5. Nutrients composition of cherry salmon by the experiment diets fed

Treatment		Crude protein (%)	Crude fat (%)	Crude Ash (%)
Control	0	21.7	5.8	1.4
Oyster mushroom meal level (%)	3.5	22.0	3.5	1.8
	7.0	21.9	3.7	1.6
	10.5	20.9	3.3	2.0
	14.0	21.5	2.1	2.3

or less, and the feed conversion rate, in 7.0% or less. Thus, it was determined that the optimum addition of oyster mushroom by-product was 7.0% or less. As a result that investigates the general components for the fish body of the cherry salmon after that the experiments have been completed, the crude protein was smaller than the control hole and showed the tendency getting lower as the addition amount of oyster mushroom by-product was increased, and it showed the tendency that the more the addition amount of the by-product was much, the more the crude ash became high (Table 5).

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