EFFECT OF DIETARY INCLUSION OF THE VARIOUS SOURCES OF ADDITIVES ON GROWTH, BODY COMPOSITION AND CHALLENGE TEST OF JUVENILE ROCKFISH (*SEBASTES SCHLEGELI)*

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EFEKAT UKLJUČIVANJA U HRANLJIVE SMEŠE ADITIVA RAZLIČITOG POREKLA NA RAST, TELESNI SASTAV I OTPORNOST MLAĐI CRNOG MORSKOG GRGEČA (*SEBASTES SCHLEGELI*)

Apstrakt

U radu je tvrđen efekat uključivanja u hranljive smeše aditiva različitog porekla [đumbir (CG), fermentisana sojina pasta (CJ), borovnica (BB), japanska jabuka (PM), paradajz (TT), brokoli (BC) i jakon (YC)] na rast, telesni sastav i otpornost mlađi crnog morskog grgeča. Hiljadu šesto osamdeset riba je nasumično raspoređeno u 24 protočna tanka zapremine 200 L. Pripremljeno je osam oglednih smeša za ishranu: kontrolna bez dodataka (Con) i smeše sa dodatkom GG, CJ, BB, PM, TT, BC i YC. Svaka od smeša korišćena je u tri tanka, a ribe su 7 nedelja ručno hranjene do sitosti. Posle isteka ovog perioda, dvadeset riba iz svakog tanka inficirano je sa *Streptococcus parauberis* i praćeno narednih 10 dana. Prirast i specifična stopa rasta (SGR) bili su veći kod riba koje su u hrani dobijale jakon (YC) nego kod onih koje su hranjene drugim smešama. Kumulativni mortalitet do 5. dana posle infekcije bio je niži kod riba koje su hranjene smešama sa dodatkom GG, BB i YC nego kod ostalih jedinki. U zaključku, smeša sa dodatkom YC pokazala se kao najbolja u smislu poboljšanja prirasta i SGR kod crnog morskog grgeča. Osim toga, dodatak GG, BB i YC u smeše bio je najefikasniji u smanjivanju mortaliteta crnog morskog grgeča usled infekcije sa *S. parauberis*

Ključne reči: crni morski grgeč (Sebastes schlegeli), aditivi, prirast, specifična stopa rasta, kumulativni mortalitet
Keywords: rockfish (Sebastes schlegeli), additives, weight gain, specific growth rate, cumulative mortality

INTRODUCTION

Annual aquaculture production of rockfish, *Sebastes schlegeli* has been highly ranked (MFAFF, 2014). Many feeding trials to determine dietary nutrient requirements (Lee et al., 2002), digestibility of various feed ingredients (Lee, 2002), alternative animal and/or plant protein sources for fishmeal in the diet (Lee et al., 1996), optimum feeding rate (Mizanur et al., 2014), optimum feeding frequency (Lee et al., 2000) and dietary additives to improve lysozyme activity and stress recovery (Hwang et al., 2013) for rockfish have been reported.

However, since high mortality of fish commonly occurs at fish farm every year due to outbreak of disease throughout year-round culture and dietary administration of the certain synthetic chemicals such as antioxidant to fish which can be used for human consumption is prohibited in some countries (Tang et al., 2001), development of the natural resource of new dietary additive to improve growth performance and/or immune response and to lower mortality of fish at the event of disease occurrence keeps being highly needed.

Ginger (GG), *Zingiber officinale* Roscoe, containing the gingerols and shogaols, was known to have an antioxidant activity and used for treatments of the several diseases (Ali et al., 2008) and its dietary administration improved the antioxidant effect on animals (Kota et al., 2008). Cheongkukjang (CJ) containing isoflavone and anthocyanin, traditional fermented soyfood, had the antioxidant and free radical scavenging activities (Kim et al., 2009). Blueberry (BB), *Vaccinium ashei*, containing anthocyanin had an antioxidant activity and showed the antioxidant effect on animals (Papandreou et al., 2009). Persimmon (PM), *Diospyros kaki* L., containing polyphenols was known to have an antioxidant activity and its dietary supplementation improved the antioxidant effects on animals (Kim et al., 2003). Tomato (TT), *Solanum lycopersicum*, containing lycopene was reported to have an antioxidant activity and its dietary inclusion improved the antioxidant effects on animals (Moreira et al., 2005). Broccoli (BC), *Brassica oleracea*, containing gluconsinolate showed an antioxidant activity and its dietary administration improved the antioxidant effects on animals (Muller et al., 2012). Yacon (YC), *Polymnia sonchifolia*, containing polyphenols also had an antioxidant activity and its dietary supplementation increased the antioxidant effect on animals (Kim, 2013).

Therefore, dietary inclusion of the various sources of additives on growth, body composition and challenge test of juvenile rockfish was determined in this study.

MATERIALS AND METHODS

One thousand six hundred and eighty fish averaging 3.0 g were randomly distributed into 24 of 200 L flow-through tanks. The water source was the sand-filtered natural seawater, while constant aeration was supplied to the each tank. Water flow rate into the tanks was 4.6 L/min. Water temperature was ranged from 15.8 to 23.1° C (mean ± SD: 20.5 ± 2.64° C).

Eight experimental diets were prepared; the control diet (Con) with no additive, GG, CJ, BB, PM, TT, BC and YC. One percent of each additive was included in the each experimental diet at the expense of wheat flour except for the Con diet. The Con diet was prepared to satisfy dietary nutrient requirements for rockfish (Kim et al., 2001; Kim et al., 2004).

Twenty externally normal fish shown to be free from bacterial infection were selected from each tank and stocked into 24 static 200 L tanks at the end of the 7-week feeding trial. Fish was used for the *Streptococcus parauberis* challenge and water was not exchanged throughout the challenge test. The bacteria used for the challenge were reference pathogenic strainof gram positive-*S. parauberis* (KCTC11980BP) isolated from rockfish.

SAS version 9.3 (SAS Institute, Cary, NC, USA) was used to conduct a one-way ANOVA. Tukey's honestly significant difference (HSD) test was used to determine the significance ($P< 0.05$) of the differences among the means responses to dietary treatments.

RESULTS AND DISCUSSION

Survival of the juvenile rockfish ranging above 98% was not significantly ($P > 0.05$) affected by the various sources of dietary additives. However, weight gain (g/fish) and SGR (%/day) of fish fed the YC diet was significantly ($P < 0.05$) higher than that of fish fed the all other diets, followed by the GG, BB and Con diets. Weight gain and SGR of fish fed the CJ, PM and BC diets was significantly ($P< 0.05$) lower than those of fish fed the Con diet. The poorest weight gain and SGR was observed in fish fed the BC diet. Similarly, the oral administration of CJ containing polyphenols containing isoflavone and anthocyanin into the diets lowered weight gain of rats fed the high cholesterol diet (Kim et al. 2009). However, weight gain of rats fed the high cholesterol diet was not affected regardless of oral administration PM leaf extract (Kim et al., 2003). Dietary inclusion of BC extract did not affect either weight gain or feed consumption of broilers compared to the control diet without additive (Mueller et al., 2012).

Feed conversion ratio (FCR) and protein efficiency ratio (PER) of fish fed the TT and YC diets were significantly ($P< 0.05$) higher than those of fish fed the all other diets. FCR and PER of fish fed the Con and GG diets were significantly ($P< 0.05$) higher than those of fish fed the CJ, BB, PM and BC diets. The poorest FCR and PER were observed in fish fed the BC diet. Less feed consumption, but comparable weight gain of fish fed the TT diet led to the improved FCR and PER compared to those of fish fed the Con diet in this study. The poorest PR was obtained in fish fed the BC diet. Improved weight gain, FCR and PER of rockfish fed the YC diet could be resulted from the increased feed consumption compared to those of fish fed the Con diet in this study. Weight gain of rats fed the high fat-high cholesterol diet supplemented with 10% YC powder was lower than that of rats fed the high fat-high cholesterol diet without YC powder although food intake in the former was slightly, but not significantly, increased (Kim et al., 2010). Weight gain, feed intake and feed conversion of broiler chicken not affected by dietary inclusion of YC when 0.5, 1 and 2% YC byproduct was included and fed for 5 weeks (Kim, 2013).

A cumulative mortality of rockfish fed the Con diet was significantly ($P< 0.05$) higher than that of fish fed the all other diets since 36-hr after infection throughout the 10-day observation (Figure 1). This indicated that all dietary additives used in this study were effective to lower mortality of rockfish at occurrence of *S. parauberis*. The cumulative morality of fish fed the GG and BB diets was significantly ($P< 0.05$) lower than that of fish fed the BC diet in 60 hr after infection, but not significantly ($P> 0.05$) different from that of fish fed the CJ, PM, TT and YC diets.

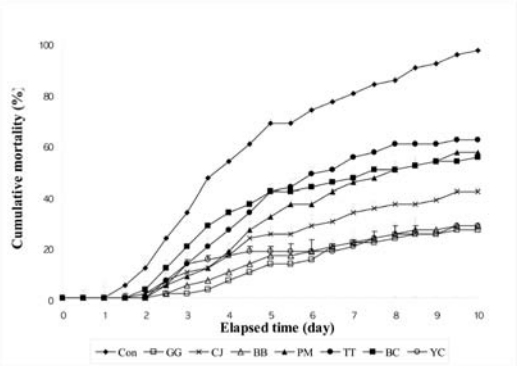

Figure 1. Cumulative mortality (%) of juvenile rockfish, *Sebastes schlegeli*, fed the experimental diets containing the various sources of additives for 7 weeks and then infected by *Strepcococcus parauberis*(means of triplicates ± SE).

The cumulative mortality of fish fed the GG, BB and YC diets was significantly ($P<$ 0.05) lower than that of fish fed the all other diets in 5-day after infection, but no significant difference was found among fish fed the GG, BB and YC diets throughout 10-day observation. At 10-day, the lowest cumulative mortality was observed in fish fed the GG diet, followed by the BB, YC, CJ, BC, PM, TT and Con diets in order. This indicated that GG, BB and YC would be the good dietary additive to lower mortality of rockfish at occurrence of *S. parauberis*. An oral administration of aloe at 0.5% lowered cumulative mortality of rockfish infected by *Vibrio alginlyticus*.

CONCLUSION

YC was the best dietary additive to improve weight gain and SGR of rockfish. In addition, YC and TT was the most effective to obtain improved FCR and PER of fish. However, dietary inclusion of GG, BB and YC were the most effective to lower mortality of rockfish at infection of *S. parauberis*.

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