Effects of *Saccharomyces cerevisiae* on survival rate and growth performance of Convict Cichlid (*Amatitlania nigrofasciata*)

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(Received 26 Nov 2012; revised version 9 Jun 2014; accepted 21 Jul 2014)

Summary

Using probiotics can control pathogens by a variety of mechanisms. Probiotics can promote growth performance and have, therefore, become increasingly important in the aquaculture industry. Convict Cichlid belongs to the family of Cichlidae and is known for its rapid development in laboratory conditions and is suitable for behavioral examinations. The aim of this study was to evaluate the effects of *Saccharomyces cerevisiae* on growth performance, survival rate and body composition of Convict Cichlids (*Amatitlania nigrofasciata*). One hundred sixty eight Convict Cichlids (mean weight: 2.1 ± 0.12 g and mean length: 2.2 ± 0.05 cm) were fed by commercial diets with different concentrations of *S. cerevisiae* (0, 0.5%, 1%, 2%). At the end of the experiment, survival rate and growth indices were measured. Based on the results, growth performance significantly increased with probiotic, *S. cerevisiae*, specially, at the 2% probiotic level of concentration. In the present study, the best FCR (feed conversion rate), SGR (specific growth rate), CF (condition factor) and BWG (body weight gain) values were observed in a 2% concentration of *S. cerevisiae*. The results suggest that this yeast could improve feed utilization in this fish species.

Key words: Probiotic, *Saccharomyces cerevisiae*, Growth performance, Convict Cichlid, *Amatitlania nigrofasciata*

Introduction

Aquaculture is an important industry with a significant role in food production (Verschuere *et al*., 2000). In this industry, effective management is vital for improving survival rates and growth rates. Probiotics can control pathogens by a variety of mechanisms and have, therefore, become increasingly important as alternatives to antibiotic treatment (Verschuere *et al*., 2000). Fuller (1989) described probiotics as live microbial food supplements that can beneficially affect the host animal by improving intestinal microbial balance.

Lactobacillus acidophilus, *L. bulgaricus*, *L. plantarium*, *Streptococcus latis* and *Sacharomyces cerevisae* are some of the common proibiotic strains used as in aquaculture (FAO, 2004). Probiotics are sometimes expected to have direct growth promoting effects on fish, either by directly involving nutrient uptake or by providing nutrients or vitamins (Ringo and Gatesoupe, 1999). Using yeast as a probiotic was studied by Andlid *et al*. (1995), Li and Gatlin (2005), and Czerucka *et al*. (2007). Pooramini *et al*. (2009) reported positive effects of yeast (*Saccharomyces cerevisiae*) as a probiotic on growth parameters, survival and carcass quality in fry rainbow trout (*Oncorhynchus mykiss*).

Convict Cichlid belongs to the family of Cichlidae. It is known for its rapid development in laboratory conditions and is suitable for behavioral examinations. Also, the acclimatization of this species to new environments is very easy since it is constantly active (Spence *et al*., 2008).

The aim of this study was to evaluate the effects of *S. cerevisiae* on growth performance, survival rate and body composition of Convict Cichlid (*Amatitlania nigrofasciata*).

Materials and Methods

One hundred sixty eight Convict Cichlids (*Amatitlania nigrofasciata*) (mean weight: 2.1 ± 0.12 g and mean length: 2.2 ± 0.05 cm) were obtained from an ornamental fish culture center located in the south of Iran and transferred to fiberglass tanks at the fishery laboratory, Faculty of Marine Natural Resources, Khorramshahr University of Marine Sciences and Technology, Khorramshahr, Iran. Fourteen days before the beginning of the experiment, the fish were distributed randomly among twelve aquariums (with 20 L capacity). During the adaptation period, all fish were fed a commercial diet (Table 1) 3% of their body weight twice daily, at 9:00 and 17:00 for 56 days (from mid March to mid May). The experiment included 4 diet treatments supplemented with different levels of *S. cerevisiae* (including 0, 0.5%, 1%, 2% probiotic concentrations). To prepare experimental diets, probiotic and basic commercial diets were mixed for 45 min and mechanically extruded to obtain pellets. The pellets were dried in a convection oven at 25°C to obtain a moisture level of approximately 100 g kg^{-1} and stored in airtight plastic bags until use. The experiment was carried out in triplicates. Water quality parameters (water temperature, dissolved oxygen concentration, and pH) were recorded daily. Temperature was 27 ± 1°C during the experimental period. Average values for dissolved oxygen and pH were 6 ± 0.5 g/L and 7 ± 0.3, respectively.

Table 1: Composition of the commercial diet (Biomar, Incio plus 801)

Food composition	rate
Crude proteins (%)	54
Crude lipids (%)	18
Nitrogen free extract (%)	11
Crude cellulose (%)	1
Ashes (%)	10
Total phosphorus (%)	1.6
Gross energy (MJ/kg)	22
Digestible energy (MJ/kg)*	20
Digestible proteins/Digestible energy (g/MJ)	25.4
Vitamin A - added (IU/kg)	7500
Vitamin D3 - added (IU/kg)	1500
Vitamin E - added (mg/kg)	260
Vitamin C - added (mg/kg)	500
Number of pellets per kg - indicative	260000

* Biomar digestible energy calculated on proteins, lipids and starch only

At the end of the experiment, biometry was performed for all fish and survival rates and growth indices were measured. Five fish from each replicate were euthanized for the analysis of proximate body composition. Proximate composition of experimental diets and whole body proximate compositions were analyzed using standard methods (AOAC, 1997). Each analysis was conducted in triplicates. Moisture was determined by drying the samples in an oven at 105°C for 24 h to a constant weight. Ash was determined by incinerating the samples in a muffle furnace at 550°C for 12 h. Crude protein (N: 6.25) was measured by Auto kjeldahl units (Buchi, German; model B-414, K-438, K-371 and K-370). Total lipid was extracted from samples by homogenization in chloroform and methanol (2:1, v/v) (Bligh and Dyer, 1959), methylated and transesterified with boron trifluoride in methanol (AOAC, 1997). Growth performance and feed utilization were calculated as follows:

(1) Body weight gain (BWG, %) = [(final body weight (g) - initial body weight (g))/initial body weight (g)] × 100

(2) Specific growth rate (SGR, % day - 1) = [(Ln final weight - Ln initial weight) × 100]/duration in days

(3) Condition factor (CF) = (fish mass/fish total length 3) × 100

(4) Feed conversion ratio (FCR) = [feed dry weight (g)/wet weight gain (g)]

(5) Daily feed intake (FI, g d - 1 fish - 1) = diet consumed × 100/duration in days/fish number per tank

The results were analyzed by running a one way ANOVA, using SPSS Software version 11.5. Duncan's procedure was applied for multiple comparisons. Results were considered significant at the level of 0.05.

Results

Growth performance and survival rates of Convict Cichlid (*Amatitlania nigrofasciata*) fed with different concentrations of *S. cerevisiae* are shown in Table 2. Based on the results, growth performance at the 2% probiotic concentration level was found to be significantly better than the other groups. Whereas, the final body weight of all groups fed with different levels of probiotic was significantly (P<0.05) higher than the control group. In addition, the group receiving the 2% concentration diet was significantly different from other groups for body weight gain parameter (P<0.05). Weight gain analysis also showed the same trend among different groups. On the other hand, diets with 0.5% and 1% *S. cerevisiae* concentrations had no significant differences with the control group for SGR (P>0.05). However, the third group with the 2% probiotic concentration was significantly higher than the control group in case of SGR (P<0.05).

Feed utilization results including FCR and CF are presented in Table 2. The average feed conversion ratio (FCR) in treatments fed by the 1% and 2% diets significantly improved in comparison with the other groups (P<0.05). These results indicate that the best FCR values were obtained in treatments 3, 2, 1 and the control group, respectively. Condition factor was not

Table 2: Growth performance, feed utilization and survival rates of Convict Cichlid fed with three concentration levels of probiotic *Saccharomyces cerevisiae* (0.5, 1 and 2%)

Parameters	Experimental diets			
	Control (0%)	Group 1 (0.5%)	Group 2 (1%)	Group 3 (2%)
Initial average weight (g)	0.22 ± 0.1^{a}	0.23 ± 0.1^{a}	0.22 ± 0.005^{a}	0.23 ± 0.005^{a}
Final average weight (g)	0.63 ± 0.08^{a}	0.79 ± 0.02^{b}	0.89 ± 0.09^{c}	0.92 ± 0.08^{d}
BWG (%)	180 ± 11^{a}	240 ± 11^{ab}	301 ± 47^{ab}	380 ± 50^{b}
SGR (%)	0.01 ± 0.006^{a}	0.01 ± 0.005^{a}	0.01 ± 0.002^{a}	0.02 ± 0.004^{b}
FCR	0.29 ± 0.05^{c}	0.21 ± 0.01^{b}	0.18 ± 0.01^{a}	0.17 ± 0.02^{a}
CF (%)	0.06 ± 0.01^{a}	0.06 ± 0.02^{a}	0.07 ± 0.01^{a}	0.09 ± 0.03^{a}
Survival rate (%)	98 ± 2.8^{a}	99 ± 1.1^{a}	100^{a}	100^{a}

Values in the same row with a common superscript are not significantly different (P<0.05). All data were presented as mean±SE

Table 3: Whole body biochemical composition fed with different concentrations of *Saccharomyces cerevisiae*

Chemical composition	Initial	Experimental diets			
		(Control)	1	2	3
Crude protein (%)	49.45	51.63	51.08	48.98	51.97
Fat (%)	28.87	30.88	31.62	32.6	28.66
Ash (%)	12.43	13.42	13.24	13.68	15.3

significantly different among different groups and the control (P>0.05). The third group's CF, with a 2% concentration level of *S. cerevisiae* was higher than the other groups; however, this difference was not statistically significant (P>0.05). In this study, *S. cerevisiae* as a probiotic, significantly enhanced food efficiency (P<0.05).

At the end of the experiment, mortality rate was low and in groups 2 and 3, a 100% survival rate was observed. These differences between these groups and the others, however, were not statistically significant (P>0.05).

Table 3 shows the results of the whole body composition analysis including crude protein, fat and ash. No significant differences were observed in whole body crude protein, fat, and ash among the groups.

Discussion

Brewer's yeast, *S. cerevisiae* has been recognized as having the potential to substitute live food in fish culture (Nayar *et al*., 1998) or replace fish meal (Oliva-Teles and Gonçalves, 2001). Researchers have evaluated the nutritional value of brewer's yeast, *S. cerevisiae*, in Nile tilapia (Korkmaz and Cakirogullari, 2011), Rohu (Tewary and Patra, 2011), lake trout (Rumsey *et al*., 1990), rainbow trout (Rumsey *et al*., 1991) and sea bass (Olive-Teles and Goncalves, 2001) by comparing growth performance and feed utilization.

Based on the results of the present study, growth performance significantly increased by using probiotic *S. cerevisiae*, specially, at the 2% concentration level. These results agree with those of Mehrim (2001), and Diab *et al*. (2002) for tilapia. Khattab *et al*. (2004), and Mohamed *et al*. (2007) reported that Nile tilapia (*O. niloticus*) fingerlings fed on diets supplemented by probiotics exhibited greater growth than those fed with control diets. Essa *et al*. (2010) reported that the probiotic supplementation of experimental diets resulted in higher growth and feed utilization as compared with control diets. Similar results have been reported for *S. cerevisiae* used in diets for carp (Noh *et al*., 1994), and Nile tilapia (Lara-Flores *et al*., 2003). Fuller (1989) reported diet to be the only factor among several others which may influence the results obtained by probiotics. Probiotics may improve digestion by stimulating and producing digestive enzymes or by causing other alterations in the gut environment, all leading to improved growth performance. The gut microbial population is also important in fish nutrition, because it increases nutrient uptake and utilization, affects the production of enzymes, amino acids, short chain fatty acids and vitamins and improves digestion (Welker and Lim, 2011).

Based on the results from this study, the best FCR values observed with yeast supplemented diets suggest that adding yeast (*Saccharomyces cerevisiae*) improves feed utilization. Commercial diets supplemented with *Streptococcus faecium* and a mixture of bacteria and yeast have been shown to improve growth and food conversion efficiency of *Cyprinus carpio* (Bogut *et al*., 1998) and *Catla catla* (Mohanty *et al*., 1996). Similar results have been reported for tilapia fingerlings by Khattab *et al*. (2004) and Mohamed *et al*. (2007). Probiotics can improve digestive activity by synthesizing vitamins and cofactors or enhancing enzymatic activity (Fuller, 1989; Gatesoupe, 1999). These properties could cause weight increase by improving digestion or nutrient absorption. Yeast has been used either as a live or a processed feed ingredient to improve fish growth performance (Stones and Mills, 2004).

Similar to the results reported for *S. cerevisiae* in diets for trout, *Oncorhynchus mykiss* (Waché *et al*., 2006), in the present study, mortality rates were low and not statistically significant. Moreover, no significant differences were observed in whole body crude protein, fat and ash between the groups. These results are in close agreement with those obtained by Diab *et al*. (2002), Lara-Flores *et al*. (2003), and Mohamed *et al*. (2007). Nevertheless, Abdelhamid *et al*. (2004) found that probiotics (Betafin and Biopolym) not only increased body weight, growth rates and total productivity of African cat fish fingerlings, but also improved the percentage of muscular protein. In the present study, the best FCR, SGR, CF and BWG values were observed in the *S. cerevisiae* 2% concentration, suggesting that this yeast has improved feed utilization. In practical terms, this means that using probiotics can reduce the amount of food necessary for animal growth and decrease production costs.

Acknowledgement

The authors wish to express their appreciation to the research council of the Khorramshahr University of Marine Science and Technology for their financial support of this research project.

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