อิทธิพลของความเค็มจากเกลือสินเธาว์ที่มีต่อการเลี้ยงปลานิล (จิตรลดา 3)

Influences of Rock Salt Salinity on Culture of Nile tilapia (Jitlada 3)

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บทคัดย่อ

การศึกษาการเจริญเติบโต อัตราการรอด อัตราการเปลี่ยนอาหารเป็นเนื้อและองค์ประกอบซากของปลานิล จิตรลดา 3 ในห้องปฏิบัติการ ผลการศึกษาการเจริญเติบโตของปลาพบว่าระดับความเค็มจากเกลือสินเธาว์มีผลต่อน้ำหนักที่เพิ่มขึ้นเฉลี่ย น้ำหนักที่เพิ่มขึ้นเทียบกับน้ำหนักเริ่มต้น และอัตราการเพิ่มน้ำหนักของปลาที่ใช้ทดลอง ($p<0.01$) โดยการเจริญเติบโตของปลามีแนวโน้มจะลดลงเมื่อระดับความเค็มของน้ำสูงกว่า 10ppt นอกจากนี้ระดับความเค็มยังมีผลต่ออัตราการเปลี่ยนอาหารเป็นเนื้อของปลาที่ใช้ทดลอง ($P<0.01$) อัตราการเปลี่ยนอาหารเป็นเนื้อของปลาที่เลี้ยงในระดับความเค็ม 10ppt มีค่าต่ำที่สุด ยิ่งไปกว่านั้นระดับความเค็มยังมีผลต่ออัตราการรอด ($P<0.05$) โดยปลาที่ใช้ในการทดลองมีอัตราการรอดสูงที่สุด ณ ระดับความเค็มประมาณ 5ppt จากการวิเคราะห์องค์ประกอบซากของปลาที่เลี้ยงในน้ำที่มีระดับความเค็มต่างๆ พบว่ามีองค์ประกอบของโปรตีนและไขมันแตกต่างกันอย่างมีนัยสำคัญยิ่งทางสถิติ ($P<0.01$) โดยปลานิลที่เลี้ยงในน้ำจืดมีระดับโปรตีนสูงที่สุดคือ 53.1±0.87% แตกต่างจากไขมันซึ่งพบว่าปลาที่เลี้ยงในน้ำที่มีความเค็ม 10ppt มีองค์ประกอบของไขมันสูงที่สุดคือ 19.5±0.75% อย่างไรก็ตามจากผลการศึกษาไม่พบผลกระทบระดับของความเค็มต่อปริมาณเถ้าในองค์ประกอบซากของปลาที่เลี้ยงในระดับความเค็มต่างๆ ($P>0.05$)

Abstract

Growth, survival rate, feed conversion ratio and carcass compositions of Jitlada 3, Nile tilapia reared under different rock salt salinity levels were investigated in laboratory experiment. The results of growth performance indicated the effects of rock salt salinity levels on mean weight gain, relative weight gain and specific growth rate of experimental fishes ($p<0.01$). Consequently, growth of experimental fishes tended to reduce as salinity was beyond 10ppt. Besides this, salinity levels showed the effect on feed conversion ratio of experimental fishes ($P<0.01$). The lowest feed conversion ratio of experimental fishes occurred at salinity of about 10 ppt. Furthermore, the levels of salinity also affected survival rate of experimental fishes ($P<0.05$). The highest survival rate of experimental fishes occurred at salinity of about 5ppt. Carcass analysis showed that crude protein and fat compositions of experimental fishes from different saline conditions were significantly different ($P<0.01$). Crude protein content in carcass of fishes reared under freshwater condition was highest, 53.1±0.87%. Differently, fat content was highest in fishes reared under 10 ppt salinity level, 19.5±0.75 %. However, the result of this study did not show the effect of salinity level on ash content of experimental fish carcasses ($P>0.05$).

คำสำคัญ : เกลือสินเธาว์ ความเค็ม ปลานิล

Key words : Rock salt; Salinity; Nile tilapia

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INTRODUCITION

Tilapias are practically cultured in both freshwater and saline water. One and important characteristic of tilapias is an ability in adaptation to various environment conditions. Generally, tilapias are freshwater fish, but due to their ability in adaptation to environment so many species of tilapias are cultured in saline water. The adaptation of tilapia to saline water involves structural and functional changes in the gills of saltwater-acclimated fish, resulting in increased rate of branchial Na^+ and Cl^- fluxes, increased Na^+, K^+-ATPase activity in gill tissues and increased number of chloride cells on gill lamellae (Murray and Mitsui, 1982; Liao and Chang, 1983; Watanabe, 1985). From this point of view lead to conducting many researches in trying to culture tilapias in saline water. Most of experiments relative to salinity tolerance focus on the effect on survival and growth of fishes. Chervinski and Hering (1973) found that *Tilapia zilli* could grow in salinity level of 40 ppt, while Osborne (1979) reported that this species could not tolerate salinity 30 ppt without acclimation. Lotan (1960) reported that *Oreochromis niloticus* could not tolerate salinity level of 21 ppt in case of directly transferred. Non salinity-acclimated *T. zillii* could tolerate salinity level of 27.3 ppt, while salinity-acclimated one could tolerate salinity level up to 35 ppt (Chervinski and Hering, 1973). Generally, many species in this group could tolerate salinity upto 18 ppt by directly transferring (Al-amoudi, 1987a; Perschbacher and McGeachin, 1988).

The acclimation of fish to high salinity level plays an important role in improving salinity tolerance of *Oreochromis niloticus* by gradually increasing salinity up to 51.8 ppt. Al-amoudi (1987a) has conducted comparative experiment on tolerance limit to salinity of five tilapias, *O. aureus*, *O. spilurus*, *O. niloticus*, *O. mossambicus* and hybrid *O. aureus x O. niloticus*. The results of the experiment showed that the gradually increasing of salinity in culture unit or transferring experimental fish from low salinity to high salinity tended to improve survival rate of experimental fishes. Hopkins *et al.* (1989) reported that an increasing salinity of 5 ppt/day was an efficient method in acclimation of *O. spilurus* to saline condition. Besides a gradually increasing salinity, Al-amoudi (1987b) has conducted feeding experiment of hybrid *O. mossambicus x O. spilurus* using feeds contained 36.5 % protein, 10 % NaCl with feeding rate at 5% body weight 3 times/day for 4 weeks. The results indicated that feeds mixed with NaCl increased salinity tolerance of experimental fish. However, this method showed less efficiency as compared to a gradually increasing salinity in culture units.

The development of salinity tolerance in tilapias closely related to size not age of fishes (Villegas, 1990). Watanabe *et al.* (1985b) reported that early hatched *O. niloticus* to 45 days had low salinity tolerance. Furthermore, tolerance limit of both *O. niloticus* and *O. aureus* tend to increase and maximize at 150 days, while Florida red tilapia started to develop salinity tolerance after hatching for 40 days (Watanabe *et al.*, 1990). However, the salinity tolerance of tilapias would not increase without limitation; e.g. *O. niloticus* had highest salinity tolerance limit at 51.7 mm in length and would not be improved further (Watanabe *et al.*, 1985b). Chervinski (1961) found that growth of *O. niloticus* reared in freshwater and salinity level of 50 ppt were not significant different and growth of fishes reared in 25 ppt were better than

fishes reared in freshwater. Chervinski and Yashouv (1971) reported that growth of *O. aureus* reared in 40 to 45 ppt was similar to fish reared in freshwater. Besides this, Liao and Chang (1983) reported that growth of hybrid red tilapia (*O. mossambicus x O. niloticus*) reared in 17 ppt saline water was better than fish reared in freshwater.

However, most of researches were conducted in brackishwater or seawater. But, there are less information concerning rock salt salinity in inland areas. The present study try to observe the effect of rock salt salinity on survival rate, growth rate, feed conversion ratio and even carcass compositions of Jitlada 3, Nile tilapia.

MATERIALS AND METHODS

Laboratory experiment was conducted using 12, (9 x 18 x 11.5 inches) glass aquariums. Each of aquarium was filled with 20 litters of water. 20 Jitlada 3, Nile tilapias with average weight of 0.07 g were stocked in each experimental aquarium. Four levels of salinity with triplicates, 0, 5, 10, 15 ppt were tested. Each salinity level was made up by addition of rock salt at a rate of 5 ppt/day until reaching designed level as indicated early. Salinity level in each experimental unit was measured using refractometer weekly. Experimental fishes were fed with commercial pelleted feed contained 42 % protein ad libitum 2 times/day for 1 month. Experimental units were continuous aerated and kept clean of feces. All experimental fishes were measured for weight and total length at the end of experiment. Growth performance of experimental fishes were evaluated through mean weight gain, relative weight gain and specific growth rate.

The experiment on carcass evaluation was conducted in 200 liters fiberglass tanks in triplicates. Salinity-acclimated Jitlada 3, Nile tilapia to salinity level of 0, 5, 10 and 15 ppt for 1 month were used as experimental fish in this experiment. 40 fishes with size of 0.63 to 0.47 g from each salinity level were stocked in experimental tank according to salinity level. Experimental fishes were fed with pelleted feed contained 32 % protein ad libitum 2 times/day for 3 month. 10 fishes from experimental tank were killed and oven-dried. Carcass compositions of experimental fishes were analyzed for crude protein, fat and ash according to AOAC (1980).

RESULTS AND DISCUSSION

Growth performances of the experiment were summarized in Table 1. Mean weight gain, relative weight gains and specific growth rate of experimental fishes reared in various saline conditions were significantly different ($P < 0.01$). Specific growth rate of experimental fishes were decreased as salinity is higher than 10 ppt (Fig. 1). The regression analysis indicated the relationship between specific growth rate and salinity from 10 to 20 ppt ($r2 = 0.844$, $p < 0.01$) (Fig. 2). The result in the present study can be supported by growth of Florida red tilapia that increased with salinity up to 36 ppt (Watanabe *et al.*, 1988). Liao and Chang (1983) reported that hybrid red tilapia (*O. mossambicus* x *O. niloticus*) grew better in 17 ppt than in freshwater.

Survival rate of fishes reared under various salinity were significantly different ($P < 0.05$) and reduce as salinity is higher than 5 ppt (Fig. 3). The regression analysis indicated the relationship between survival rate and salinity from 10 to 20 ppt ($r2 = 0.448$, $p < 0.05$) (Fig. 4). The result of the present study indicate that salinity up to 10 ppt may be not the main effect on survival rate of salinity-acclimated Nile tilapia. The result also

supported by Osborne (1979), the acclimation of fish to high salinity level plays an important role as seen in *Oreochromis niloticus* that improve its tolerance limit up to salinity of 51.8 ppt by gradually increasing salinity. A strongly recommendation on gradually increasing of salinity can improve salinity tolerance of tilapias may utilize the result of present study and of Hopkins *et al.* (1989) which reported that an increasing salinity of 5 ppt/day was an efficient method in acclimation of *O. spilurus* to saline condition.

Feed conversion ratio of fishes cultured under various salinity levels were significantly different ($P < 0.01$). Feed conversion ratio tend to vary according to salinity level and tend to be increased as salinity was higher than 10 ppt (Fig.5). The highest feed conversion ratio found in fishes cultured under salinity of 20 ppt in this study, while feed conversion ratio of experimental fishes reared under salinity level of 10 ppt was lowest at 1.69. The regression analysis indicated the relationship between feed conversion ratio and salinity from 10 to 20 ppt ($r2 = 0.725$, $p < 0.01$) (Fig. 6). The higher feed conversion indicated that experimental fishes may utilize part of energy in osmoregulation. Furthermore, metabolic rate of fish increased with increasing of salinity of growth medium (Bashamohideen and Parvatheeswararao, 1976). Febry and Lutz (1987) reported that osmoregulation energy cost of a hybrid tilapia (*O. mossambicus* x *O. urolepis* x *O. hornorum*) was higher in freshwater than in seawater (35 ppt). The salinity ranges in the present study may not clearly describe this situation, but may indicate that the salinity higher than 10 ppt may affect the culture of some tilapias fishes as same as occurred in this experiment. However, Watanabe *et al.* (1988) reported that with increasing of salinity up to 36 ppt tended to increase food consumption and lower food conversion ratio in Florida red tilapia.

Carcass compositions of Nile tilapia reared under various rock salt salinities were summarized in Table 2. The compositions of crude protein and fat of experimental fishes reared under various salinity levels were significantly different ($P < 0.05$). Range of crude protein and fat were 44.5 ± 1.51 to 53.1 ± 0.87 % and 14.2 ± 0.6 to 19.5 ± 0.75 %, respectively. Crude protein content in carcass of fishes reared under freshwater condition was highest, 53.1 ± 0.87%. Differently, fat content was highest in fishes reared under 10 ppt salinity level with an average of 19.5 ± 0.75 %. The higher fat deposition in fish carcass may result from less energy cost for osmoregulation in isosmotic media of tilapia which is about 10.6 ppt (Zale and Gregory, 1989). Ash content of experimental fish carcasses reared under various salinity were not significantly different ($P > 0.05$) and ranged from 26.9 ± 1.07 to 28.9 ± 0.59 %. Finally, the results of this study can confirm many articles on tilapias culture in saline conditions. Suresh and Lin (1992) have concluded that salinity range of 10 to 20 ppt is optimal for growth of tilapia from previous studies. The addition information from this study is the optimal salinity for growth of some tilapias is around 10 ppt, even source of salinity is rock salt.

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Table 1 Growth performances of Jitlada 3, Nile tilapia reared in various rock salt salinity levels (Mean ± SE)

Growth parameters	Salinity level (ppt)				
	0	5	10	15	20
Initial weight (g/fish)	0.072 ± 0.03	0.072 ± 0.03	0.072 ± 0.03	0.072 ± 0.03	0.072 ± 0.03
Final weight (g/fish)	0.63 ± 0.04^{bc}	0.62 ± 0.01^{bc}	0.68 ± 0.01^{c}	0.55 ± 0.02^{b}	0.47 ± 0.04^{a}
Mean Weight Gains (g/fish)	0.56 ± 0.04^{bc}	0.55 ± 0.01^{bc}	0.61 ± 0.01^{c}	0.48 ± 0.02^{b}	0.40 ± 0.04^{a}
Weight Gains (%)	770 ± 59^{bc}	765 ± 17^{bc}	846 ± 12.2^{c}	659 ± 33.6^{b}	552 ± 49.7^{a}
Specific growth rate(%/day)	7..2 ± 0.23^{b}	7.19 ± 0.07^{b}	7.49 ± 0.04^{b}	6.75 ± 0.15^{b}	6.23 ± 0.25^{a}
Survival rate (%)	90 ± 5^{bc}	95 ± 2.89^{c}	88.3 ± 3.33^{bc}	81.7 ± 8.82^{ab}	65 ± 10^{a}
Feed Convesion Ratio (FCR)	2.1 ± 0.21^{b}	1.8 ± 0.1^{b}	1.69 ± 0.1^{b}	2.34 ± 0.27^{b}	3.98 ± 0.61^{a}

Means in rows followed by the same letter are not significantly different at P = 0.05 according to DMRT

Table 2 Carcass compositions of Jitlada 3, Nile tilapia reared in various rock salt salinity levels (Mean ± SE)

Salinity level	Nutrient compositions (dry weight basis)		
(ppt.)	Crude Protein (%)	Fat (%)	Ash (%)
0	53.1 ± 0.87c	14.2 ± 0.6a	26.9 ± 1.07
5	44.5 ± 1.51a	17.2 ± 1.34b	27.4 ± 0.59
10	48 ± 0.50ab	19.5 ± 0.75b	27.3 ± 0.48
15	51.6 ± 1.56bc	14.7 ± 0.66a	28.9 ± 0.59

Means in columns followed by the same letter are not significantly different at P = 0.05 according to DMRT

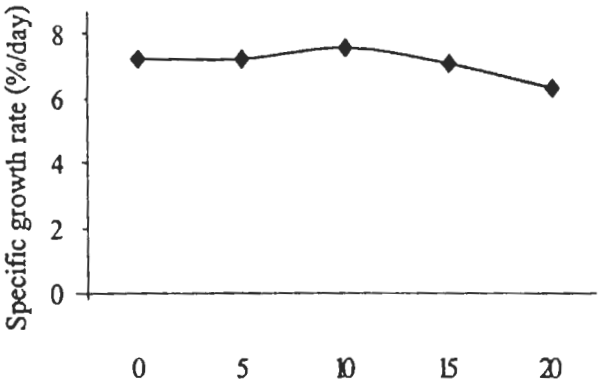

Fig.1 Specific growth rate of Jitlada 3, Nile tilapia reared under various rock salt salinity levels

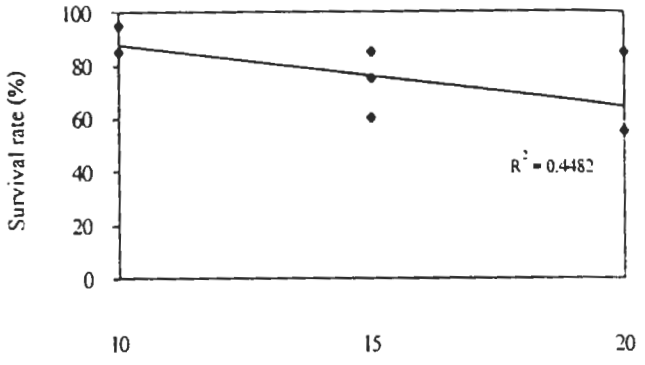

Fig.4 Regression line of survival rate of Jitlada 3, Nile tilapia and rock salt salinity levels

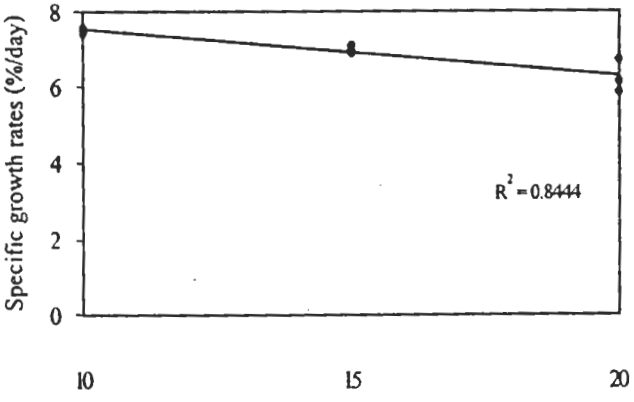

Fig.2 Regression line of specific growth rate of Jitlada 3, Nile tilapia and rock salt salinity levels

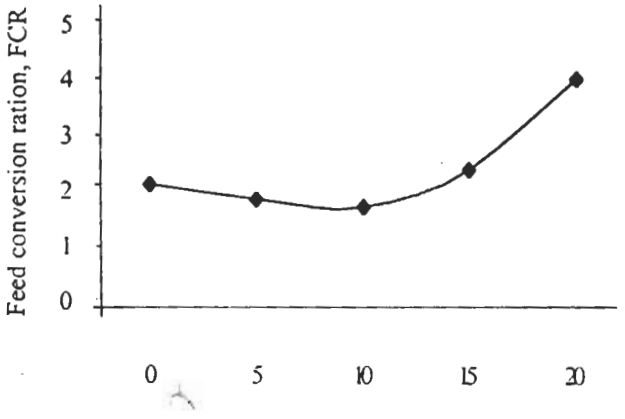

Fig.5 Feed conversion satio of Jitrada 3, Nile tilapia reared under various rock salt salinity levels

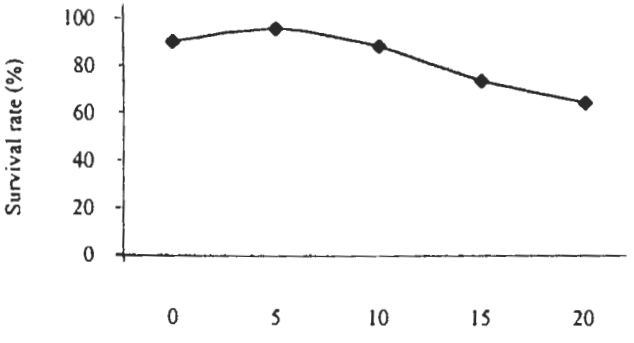

Fig.3 Survival rate of Jitlada 3, Nile tilapia reared under various rock salt salinity levels

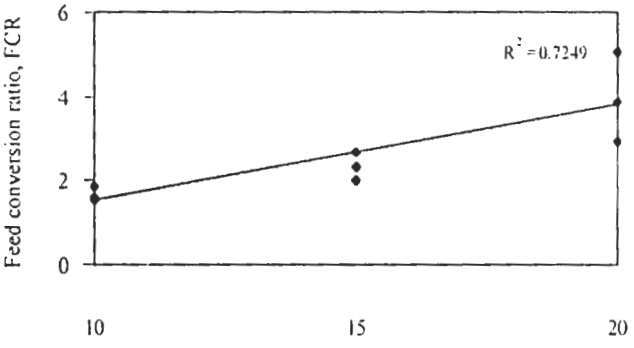

Fig.6 Regression line of feed conversion ratio of Jitlada 3, Nile tilapia and rock salt salinity levels