THE EFFECT OF THE SALINITY CHANGE ON THE SURVIVAL AND GROWTH OF NILE TILAPIA (*Oreochromis niloticus)*

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Abstract

The research is conducted on May to June of 2012 at Fishery Laboratory of University 45 Makassar. It is aimed at understanding the effect of salinity change on the survival and growth of Nile Tilapia O. niloticus. Research involves five treatments in which each treatment includes the salinity rates of 11, 17, 23, 29 and 35 ppt. Research is initiated by adapting Nile Tilapia O. niloticus juvenile to salinity 5 ppt for 10 days. The salinity of media water is then increased slowly to 11, 17, 23, 29, and 35 ppt until the day 20. At the day 21 to the day 31, the salinity of media water is decreased until it reaches 5 ppt. Result of research indicates that the highest level of survival and growth of Nile Tilapia O. niloticus is found at salinity 17 ppt, while the lowest is salinity 35 ppt. It seems that Nile Tilapia O. niloticus has the high adaptation rate at salinity 17 ppt (82.23 %) and provides the best growth rate (6.43 %/ day).

Keywords: salinity, nile tilapia, survival, growth

1. INTRODUCTION

Nile tilapia *O.niloticus* is an important commodity of fresh water fishery from Africa (Khairuman and Amri, 2006), characterized by high tolerance to many environmental conditions, easy reproduction, and omnivorous character (Pullin, 1997; FAO, 2004).

A successful cultivation of Nile tilapia *O.niloticus* is shown by the high level of survival and growth at short term. It is evident if the energy is surplus. There is much energy to consume after reduction by the energy demand. The environmental change may influence the consumption of energy and those used by osmoregulative process. Nile tilapia *O.niloticus* is *euryhaline* (0-35 ppt) (Watanabe et al, 1997), but the salinity to support the growth is lower than salinity to maintain the survival.

Salinity, indeed, represents an influential environmental factor on the survival and growth of aquatic organism (FAO, 2005) because it is *masking factor* to modify the water physical and chemical variables in developing an osmotic impact in the osmoregualtion and bioenergetic of aquatic organism (Fitzsimmons., 2001). In this matter, salinity will influence the internal ion management which is directly requiring energy to actively transport ions to keep on the internal environment. The survival and growth of Nile tilapia *O.niloticus* are only reached if the salinity of medium is able to support the physiological processes.

The effect of salinity on survival and growth of Nile tilapia *O.niloticus* and the determination which salinity is producing maximum survival and growth will be reviewed in the research entitled "The Effect of Salinity Change on Survival and Growth of Nile tilapia *O.niloticus*", which is aimed at understanding the effect of salinity change and at determining the optimum salinity which produces a maximum survival and growth.

2. RESEARCH METHOD

Research Material

Research is conducted on May and June of 2012 at Fishery Laboratory of University 45 Makassar. The materials used are: the juvenile of Nile tilapia *O.niloticus* with 20 days of age, ± 3 cm length, and 1.5 g weight; artificial food; sea water; and fresh water.

Research Procedure

Sea water is diluted based on the treatment salinities such as 5, 17, 23, 29 and 35 ppt. It is disinfected using ultraviolet (UV). The research batches are filled with media water at salinity 5 ppt. Each batch is then containing 30 liters water and poured with 20 juveniles of Nile tilapia *O.niloticus*. The treatment is changing salinity 5 ppt of maintenance media into the expected salinity for 10 days. At day 21, the salinity is reduced to initial salinity and maintained for 10 days. During the research, the parameter of water quality and the clearance of precipitated manure and dirt are observed daily.

Experimental Plan

Research design is Complete Random Planning (RAL). There are 5 treatments and 3 replications. The salinity change treatment is shown in Table 1.

Table 1. Salinity Change Treatment at Nile tilapia *O.niloticus*

Treatment	Salinity on day		
	1-10	11-20	21-30
A	5	11	5
B	5	17	5
C	5	23	5
D	5	29	5
E	5	35	5

Observed Parameters

The survival of Nile tilapia *O.niloticus* is determined by Effendie (1997) equation as follows:

$$SR = \frac{N_t}{N_o} \times 100\ \%$$

Information :

SR = Survival rate of Nile tilapia *O.niloticus* (%)

N_t = The number of Nile Tilapia *O. niloticus* who lived at the end of the study (tail)

N_o = The number of Nile Tilapia O. niloticus at baseline (tail)

Growth rate of Nile tilapia *O.niloticus* is counted by Changboo et.al (2004) as follows:

$$SGR = \frac{\ln \overline{Wt} - \overline{Wo}}{t} \times 100$$

Information :

SGR = The growth rate (% / day)

$\overline{Wt}$ = Average weight of Nile tilapia *O.niloticus* at the end of the study (g)

$\overline{Wo}$ = Average weight of Nile tilapia *O.niloticus* at baseline (g)

t = Long maintenance (days)

Water Quality

The supporting data are obtained from the measurement of some water quality parameters such as temperature, pH, dissolved oxygen and ammonia. Temperature is

measured by hard water thermometer with 0.1^0C carefulness, while pH by pH meter, dissolved oxygen by DO meter, salinity by hand refractometer, and ammonia by spectrophotometer.

The measurement of temperature, pH and dissolved oxygen is made twice a day, precisely at 6 and 18 pm. The ammonia is measured three times during a research, which are at the beginning, middle and end of research.

Data Analysis

Data are analyzed by analysis of variance (ANOVA) and then examined by W-Tukey Test (Steel and Torrie, 1993) using SPSS Program version 17.0. The water quality parameter is analyzed descriptively based on the life reliability of Nile tilapia *O.niloticus*.

3. RESULT AND DISCUSSION

Survival

The survival of Nile tilapia O.niloticus before and after the increase and decrease of salinity and average rate is shown at Table 2.

Table 2. The Survival Average of Nile tilapia *O.niloticus* Before and After The Increase and Decrease of Salinity

Treatment	Survival (%) prior to Improvement (Days 1 – 10)	After Improvement (Days 10 – 20)	Decrease in Salinity (Days 20 – 30)
A	97,78 ± 3,85[a]	73,67 ± 7,74[a]	71,13 ± 13,89[a]
B	100 ± 0,00[a]	82,23 ± 3,87[a]	71,10 ± 3,81[a]
C	95,56 ± 7,70[a]	68,90 ± 3,81[a]	66,67 ± 6,65[a]
D	95,56 ± 3,85[a]	48,87 ± 7,68[b]	31,10 ± 3,81[b]
E	100 ± 0,00[a]	31,1 ± 3,81[c]	15,61 ± 13,82[b]

Note: different letter in the similar column shows the obvious difference between treatments at 5 % rate ($p < 0.05$)

Result of analysis of variance shows that the salinity 5 ppt of maintenance media before the increase is not having obvious effect ($p > 0.05$) on the survival of Nila Fish *O. niloticus*. After the increase, the salinity has very obvious effect ($p < 0.01$) on the survival of Nile tilapia *O.niloticus*. Result of W-Tukey Test indicates that the survival of Nile tilapia *O.niloticus* in the increased maintenance media salinity to 11, 17 and 23 ppt is not obviously different ($p > 0.05$), but the increased salinity to 29 and 35 ppt has very obvious difference ($p < 0.05$) especially at Treatment A, B and C. Nile tilapia *O.niloticus* in the media salinities of 11, 17 and 23 ppt which are decreased to 5 ppt is not experiencing obvious difference ($p > 0.05$). The decrease of maintenance media salinity from 29 and 35 ppt to 5 ppt is showing obvious difference in Treatment A, B and C, while Treatment D and E do not show obvious difference.

Table 2 shows that Nile tilapia *O.niloticus* cultivated for 10 days in Treatment A, B, C, D and E is producing similar survival rate. It is apparent because the maintenance media salinity in all treatments is 5 ppt. The increase of maintenance media salinity to 11, 17, 23, 29 and 35 ppt has produced different survival rate. The survival rate of Nile tilapia *O.niloticus* is affected by the environmental factors such as salinity and food supply. The supply of adequate and qualified food and the environmental supportability will increase the efficiency of energy for the growth. According to Kamal, *at al.*, (2005),the lower survival of organism due to salinity change is showing a reflection of organism capacity loss during osmotic change.

The survival of Nile tilapia *O.niloticus* is highest at salinity 11-23 ppt with 68.90-82.23 % and lowest at salinity 35 ppt by 31.10 %. The highest survival at salinity 11-23 ppt means that Nila Fish has better life capability at this salinity than higher salinity. The lower

survival rate in the high salinity may be due to the excessive use of energy in adapting to the salinity change, thus reducing body energy. According to Lemarie, *et al.*,(2004), the fluctuation of high salinity can cause the death because of osmolarity symptom between media and body liquid (internal and external). Sahoo, *et al.*,(2003) proposes that the salinity change will result in the different osmotic pressure between body liquid and media water which is then causing the change of activity and metabolism. This change increases the use of energy and then influences the survival rate.

The re-decrease to salinity 5 ppt at all treatments will also reduce the survival rate between 15.61 – 17.13 %. Nile tilapia may be stress due to the changing salinity and drastic physiological change. Such change forces Nile tilapia *O.niloticus* to adapt to the lower salinity change. However, the lack of adaptation to the environmental change may cause a death, thus reducing the survival rate.

Growth

The growth rate of Nile tilapia *O.niloticus* before and after the increase and decrease of salinity is indicated at Table 3 and 4.

Table 3. The Average of Growth Rate of Nile tilapia *O.niloticus* Before and After The Increase and Decrease of Salinity

Treatment	Specific Weight of Daily Growth Rate (% / day)		
	prior to Improvement (Days 1 – 10)	After Improvement (Days 10 – 20)	Decrease in Salinity (Days 20 – 30)
A	6,69 ± 0,37a	4,57 ± 0,34b	2,91 ± 0,32ab
B	6,66 ± 0,17a	6,43 ± 0,04a	3,05 ± 0,18a
C	6,50 ± 0,17a	4,58 ± 0,48b	2,82 ± 0,39ab
D	6,64 ± 0,08a	1,65 ± 0,52c	2,33 ± 0,30ab
E	6,73 ± 0,18a	0,66 ± 0,93c	2,13 ± 0,33b

Note: different letter in the similar column shows the obvious difference between treatments at 5 % rate (p < 0.05)

Result of analysis of variance indicates that maintenance media salinity 5 ppt does not have obvious effect (p > 0.05) on the growth of Nile tilapia *O.niloticus*. After the increase and decrease, the salinity has very obvious effect (p < 0.01) on the growth rate. Result of W-Tukey Test shows that the growth rate of Nile tilapia *O.niloticus* in the increased maintenance media salinity to 11 ppt and 23 ppt is not obviously different (p > 0.05), but the increased salinity to 29 and 35 ppt has very obvious difference (p < 0.05) at all treatments. The growth rate of Nile tilapia in the re-decrease of salinity from 11 ppt and 35 ppt is obviously different (p < 0.05) at all treatments. The increased salinity from both these salinities does not show obvious difference.

Table 4. The Growth Average of Nile tilapia *O.niloticus* Before and After The Increase and Decrease of Salinity

Treatment	Absolute growth (g)		
	prior to Improvement (Days 1 – 10)	After Improvement (Days 10 – 20)	Decrease in Salinity (Days 20 – 30)
A	0,95 ± 0,07^{a}	0,92 ± 0,08^{b}	0,85 ± 0,11^{ab}
B	0,95 ± 0,03^{a}	1,38 ± 0,03^{a}	1,04 ± 0,06^{a}
C	0,92 ± 0,03^{a}	0,91 ± 0,10^{b}	0,81 ± 0,10^{b}
D	0,94 ± 0,01^{a}	0,29 ± 0,10^{c}	0,49 ± 0,05^{c}
E	0,96 ± 0,04^{a}	0,11 ± 0,16^{c}	0,40 ± 0,05^{c}

Note: different letter in the similar column shows the obvious difference between treatments at 5 % rate (p < 0.05)

Result of analysis of variance shows that maintenance media salinity 5 ppt before the increase is not having obvious effect ($p > 0.05$) on growth rate of the specific weight of Nile tilapia *O.niloticus.* After the increase and re-decrease, very obvious effect is found ($p < 0.01$) on the growth of absolute weight. Result of W-Tukey Test indicates that the growth of absolute weight of Nile tilapia *O.niloticus* in the increased maintenance media salinity to 11 ppt and 23 ppt is not obviously different ($p > 0.05$). The growth in the salinity increased to 17 ppt is obviously different for all treatments. However, the increased salinity to 29 and 35 ppt does not show obvious difference. The growth of absolute weight of Nile tilapia *O.niloticus* in the maintenance salinity 11, 17 and 23 ppt but re-decreased to 5 ppt is not showing obvious difference ($p < 0.05$). The absolute weight growth of Nile tilapia *O.niloticus* at maintenance media salinity 29 ppt is not obviously different from that at 35 ppt. The absolute weight growth at decreased salinity from 17 ppt seems obviously different from that at salinity 23, 29 and 35 ppt. However, the absolute weight growth of Nile tilapia at the decreased maintenance media salinity from 29 and 35 ppt is showing the obvious difference.

Table 3 and 4 show that Nile tilapia *O.niloticus* is maintained at salinity 5 ppt for 10 days and producing growth rate between 6.50 and 6.73 % per day. This growth rate is similar for all treatments and is classified as relatively high. Setyawati and Suprayudi (2003) admit that the daily growth rate of Nile tilapia *O.niloticus* is 2.61% / day. The increase of maintenance media salinity to 11 until 35 ppt has produced various growth rates.

High growth rate of Nile tilapia *O.niloticus* from salinity 17 ppt is related to the lower osmotic rate of Nila Fish. Fitzsimmons., 2001). assert that the growth will be efficient if the organism is living in the media not far away from its iso-osmotic rate. Jobling (1994) adds that the use of energy for osmoregulation can be suppressed if the organism is living in the iso-osmotic media such that the use of food is efficient and the growth is increasing. Fitzsimmons., 2001). determine that salinity which is suitable to the physiological condition and fish osmoregulation system can increase the growth.

In the cultivation media, salinity can control habitat reliability and influence organism organ activity. The interaction between habitat reliability, food supply, and organism organ activity may determine organism growth. Such growth happens if energy excess is used for many body activities including osmoregulation. Nile tilapia from salinity 17 ppt is related to the lower osmotic rate of Nile tilapia et obtains energy from the food which is consumed and used for many activities such as osmoregulation. Higher growth rate of daily specific weight of Nile tilapia at salinity 17 ppt provides a description that this salinity is giving the most ideal condition for the growth Nile tilapia *O.niloticus*. At this condition, media salinity approaches isoomotic when body cells remain in the ideal condition. Physiological processes in Nile tilapia body are normal with smooth metabolism and increased growth. The lower osmotic burden at salinity 17 ppt will reduce the burden of enzyme Na^+-K^+ATPase and the active transportation Na^+-K^+ and Cl^-. Consequently, the energy (ATP) used for osmoregulation is lowered such that the energy portion for growth is available.

The lowest growth rate of Nile tilapia *O.niloticus* is attained at salinity 35 ppt. It is estimated that high osmotic rate is shown due to the increased maintenance media salinity. According to Sahoo, *et al.,*(2003), too higher salinity can influence the growth because the salinity will influence the metabolism and change the function of epithel chloride cell in the gill and the activity of Na^+-K^+ATPase.

Table 4 and 5 indicates that Nile tilapia maintained at re-decreased salinity has produced similar growth rate at all treatments. Highest growth rate is obtained at salinity 17 ppt, which is 3.05 %/day or 1.04 g. The lowest growth rate is attained at salinity 35 ppt, which is 2.13%/day or 0.40 g. The high growth rate of Nile tilapia *O.niloticus* at salinity 17 ppt is assumed as the best salinity for Nile tilapia *O.niloticus*. Meanwhile, Ath-thar dan Gustiano (2010) find the highest growth rate of Nile tilapia *O.niloticus* at salinity 15 ppt.

Water Quality

Some parameters of water quality are measured such as temperature, pH, dissolved oxygen and ammonia. These water quality parameters are shown in Table 6.

Table 6. The Water Quality Parameters in the Research Media of Nile tilapia *O.niloticus*

parameters	The range of values
Temperature (^oC)	25 – 30
pH	7,2 – 7,8
Dissolved oxygen (ppm)	4 – 7
Amoniak (ppm)	0,05 – 0,08

The maintenance media temperature during the research is in the range from 27 to 30^0C. This temperature range is reliable for Nile tilapia. Setyo (2006) declares that the ideal temperature for the cultivation of Nile tilapia *O.niloticus* is between 25 and 33^0C. Prihatman (2000) adds that the optimal temperature for the cultivation of Nile tilapia *O.niloticus* is between 25 and 30^0C.

Indeed, maintenance media pH during the research is in the range of 0.05 and 0.08 ppm. This pH range is reliable for the living of Nile tilapia *O.niloticus*. According to Setyo (2006), the ideal pH for the maintenance of Nile tilapia *O.niloticus* is between 7 and 8.

The dissolved oxygen found in this research is in the range 4 to 7. This range is reliable for the living of Nile tilapia *O.niloticus*. Boyd (1990) asserts that the dissolved oxygen which is supporting the growth and production of Nila Fish *O. niloticus* is greater than 3 ppm.

Ammonia rate in the maintenance media is in the range between 0.05 and 0.08. This ammonia rate is reliable to the living of Nile tilapia *O.niloticus*. According to Setyo (2006), the ammonia toxicity is deadly in the range between 0.1 to 0.3 ppm.

4. CONCLUSION

The survival rate of Nile tilapia *O.niloticus* after the increased salinity is highest at salinity 17 ppt by 82.23 % and lowest at 35 ppt by 31.1 %. At re-decreased salinity treatment, both survival rates also decrease by 71.13 % and 15.61 %. The growth rate of Nile tilapia *O.niloticus* after the increased salinity is highest at salinity 17 ppt by 6.43 %/day and lowest at salinity 35 ppt by 0.66 %/day. At re-decreased salinity, both growth rates are 3.05 %/day and 2.13%/day. The weight growth of Nile tilapia *O.niloticus* after increased salinity is highest at salinity 17 ppt by 1.38 g, and lowest at salinity 35 ppt by 0.11 g. At re-decreased salinity, both weights are 1.04 g and 0.40g

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REFERENCES

Changbo, Z., D. Shuanglin, W. Fang and H. Guoqiang, 2004. Effects of Na/K ratio in seawater on growth and energy budget of juvenile *Litopenaeus vannamei*. Aquaculture, 234: 485-496.

Chowdhury. ,YangYi., C K Lin & E R El-Haroun (2006).Effect of salinity on carrying capacity of adult Nile tilapia *Oreochromis niloticus* L. in recirculating systems

Aquaculture and Aquatic Resource Management Program, Asian Institute of Technology

Effendie, M. I, 1997. Fisheries Biology. Nusantara Foundation Library, Yogjakarta.

FAO, 2004. Tilapia as Alien Aquatics in Asia the Pacific: A Review. FAO Fisheries Technical Papers-T453. ISBN: 9251052271: 74 pp.

FAO (2005) FAO *Fishery information*, Data and Statistics Unit (FIDI). Fishery Statistical Collections. FIGIS Data Collection. FAO-FIGIS.

http://www.fao.org:80//gis/servlet/static?dom=collection&xml= g Lobal-aquaculture-production.xml [Accessed Tue Jan1718:35:34 CET 20 6].

Fitzsimmons K. (2001) Polyculture of tilapia and penaeid shrimp. Global Aquaculture Advocate 4,43-44.

Kamal A.H.M.M. & Mair G.C. (2005) Salinity tolerance in superior genotypes of Tilapia, *Oreochromis niloticus*, *Oreochromis mossambicus* and their hybrids. Aquaculture 247, 189-201.

Khairuman dan K. Amri, 2002. Tilapia Aquaculture. Publisher Agromedia Library, Jakarta.

Lemarie G., Baroiller J.F., Clota F., Lazard J. & Dosdat A. (2004) A simple test to estimate the salinity resistance of fish with specific application to *O. niloticus* and *S. melanotheron*. Aquaculture 240,575-587.

Prihatman, K. 2000. Aquaculture Tilapia (Oreochromis niloticus). Rural Community Economic Development Project -BAPPENAS, Jakarta.

Pullin, R. S. V. and J. Maclean, 1992. Analysis of Research for the Dvelopment of Tilapia Farming An Interdisciplinary is Lacking. Netherlands Journal of Zoology: 512-522.

Sahoo S.K., Giri S.S.,Maharathi C. & Sahu.A.K. (2003) Efect of salinity on survival, feed intake and growth of Clarius batrachus (Linn.) fingerlings. Indian Journal of Fisheries 50, 119-123.

Setyawati, M. dan A. M. Suprayudi. 2003. Growth and Feed Efficiency of Tilapia (*Oreochromis sp*.) Maintained in Bersalinitas Media. Journal of Aquaculture Indonesia, 2 (1): 27-30.

Setyo, B. P., 2006. Concentration effect of Chromium (Cr^{+3}) and Utilization Efficiency Of Different Salinity for growth in Tilapia Feed (*Oreochromis niloticus*). Thesis. Graduate Program, University Dipanegoro, Semarang. (Not Published).

Steel, R. G. D. dan J. H. Torrie, 1993. Prinsip dan Prosedur Statistika. PT. Gramedia Pustaka Utama, Jakarta. 748 hal.

Watanabe, W.O., D.H. Ernst, B.L. Olla and R.I. Wicklund, 1997. Saltwater Culture of The Florida and Other Saline Tolerant Tilapias, in Tilapia Aquaculture in Americas. American Aquaculture Society. pp: 55 - 141.

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