Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2017 14(4):1175-1181. **OPEN ACCESS**

Effect of *Saccharomyces cerevisiae* on seed production and fry performance of *Oreochromis niloticus* broodstock

Hanan Aly Abo-State[1*] and Al-Azab Mohamed Tahoun[2]

[1]Fish Nutrition Lab, Animal Production Department, National Research Centre, P.O. Box 12622 Dokki, Giza, **Egypt.**
[2]Department of Aquaculture, Faculty of Fish Resources, Suez University, Suez, **Egypt.**

***Correspondence:** hanan_abostate@yahoo.com **Accepted:** 03 Dec. 2017 **Published online:** 30 Dec. 2017

Yeast *(Saccharomyces cerevisiae* L.) can be applied in different fish species for improving growth performance, survival rate and nutrient utilization. Studies on yeast as dietary supplements rarely focused on the effect of seed production and reproductive performance. This study aimed to investigate the effect of yeast on seed production and fry performance of Nile tilapia *(Oreochromis niloticus*) brood stock. 48 females and 24 males Nile tilapia broodstock were fed with commercial pelleted diet (35% crude protein, 4586 $kcal^{-1}$Gross energy/kg^{1} diet supplemented with different concentrations of yeast (0.0, 10 and 20 gkg^{-1}diet) for 105 days, in 6 breeding hapas (2x2x1 m^3) with feeding rate 2% then offsprings collected to study reproductive performance. Forfry feeding in nursery hapas a commercial powder diet (40.50 % CP and 4897 $Kcalkg^{-1}$ GE) were fed for 60 days. With feeding rate 10% of the total fry biomass at the first 30 days then decreased to 5 % in the 2nd growth interval which extended for 30 days. Results indicated that there were significant improvement in seeds production and reproductive performance parameters for female broodstock supplemented with $20gkg^{-1}$ yeast in diet. The data also indicated that the inclusion of yeast in tilapia broodstock diets have positive effect on fry growth performance, nutrient utilization with no significant effect on body chemical composition at the same level.

Keywords: Tilapia, *Saccharomyces cerevisiae* L., seeds production, broodstock, fry growth performance.

INTRODUCTION

Broodstock diets have been gained a great attention to the level of different nutrients. Limited studies on broodstock nutrition have been conducted and these studies were relatively expensive. In many cultured fish. Species, reproductive performance is variable and unpredictable (Izquierdo et al, 2001). This is the limiting factor for the mass production success of Juveniles. Improving broodstock nutrition and feeding influencing egg, sperm quality and seed production (Sarmento et al, 2018). Larval and juvenile quality depending greatly on quality of broodstock diet and nutritional composition (Chung et al, 2011) because, during ovarian development, mobilization and transformation of dietary and maternal reserves have been conducted into the oocytes. These processes provide nutritional requirements and energy for development of the embryo and larval yolk sac till exogenous feeding start (Sarmento et al, 2018). A recent development in research studies about the nutrients requirements for broodstock fish must be conducted due to lack of information for fish (Lupatsch et al, 2010 and Sousa et al, 2013). In sustainable aquaculture industry, Yeast considered as one of the important probiotics (Yousefian and Amiri, 2009). Yeast cells improve the immune response and growth performance as well as metabolism in fish and shrimp due to

presences of β-glucan, polyamins, nucleic acid, protein and oligosaccharides in yeast cells. (Gatesoupe,2007). It was used as dietary supplement in shrimp and fish feeds to increase disease resistance, feed intake, survival and growth performance (Dawood et al, 2017 and Deng et al, 2013). Yeast cells also used as an alternative protein sources for fishmeal (Hauptman et al, 2014).

Brewer's yeast *(Saccharomyces cerevisiae)* has been identified as an ingredient with several positive factors) in both whole cell or extract forms (Paryad and Mahmoudi, 2008 and Sonmez, 2017).The efficient use of *S. cerevisiae* symbiotic forms as feed additives in cultured *O. niloticus* would have tremendous beneficial effects on both immune status as well as growth performance and increased economic outcome (Mohammadi et al, 2016 and Sonmez, 2017). Due to its rapid growth and easy accommodation to environmental conditions, tilapia is one of the most commercially important species grown all over the world in tropical and subtropical regions (El-Sayed et al, 2005). Although the growth promoter effect of *S. cerevisiae* on many aquatic animals are well established, but the detailed supplemental effects on *O. niloticus* are still not documented, and its effect on seeds production of broodstock are not fully evaluated. Therefore, the aim of the present work was to verify the effect of *S. cereviace* as a feed additive supplement on some reproductive performance parameters of female Nile tilapia broodstock and their fry performance, feed utilization and body chemical composition.

MATERIALS AND METHODS

Fish and culture facilities

An over-wintered Nile tilapia (*Oreochromis niloticus*) broodstock were obtained from a commercial tilapia farm located in Kafr El-Sheikh Governorate. Broodstock were netted from earthen ponds, manually selected, sexed and transferred to conditioning hapas, where they were held and kept separately for 20 days for acclimatization to the new environment.

A total number of 48 females and 24 males were counted, batch weight and stocked in each hapa at a rate of 2 ♂: 4 ♀ fish/ m^3. Body weight was recorded at the beginning, subsequent spawning and at the end of experiment (105 days). Natural mating was practiced by placing the broodstock in six breeding hapas (2X2X1m^3). Before mating, the breeders were conditioned and given better space and feed, to improve and increase sexual maturation. Every hapa was inspected once every week for seed. Seed out were recorded and representative sample swim-up fry from the third clutch were collected from each hapa and transferred to nursery hapas at a stocking density of 100 fry (One nursing hapa for each group of fry). Different water quality parameters including water temperature (T), dissolved oxygen (DO), ammonia (NH4–N), nitrites (NO_2–N), pH and total alkalinity (TA, $CaCO_3$) were monitored weekly using Hanna Instrument, Inc., Jud-Cluj Romania. The average values of these parameters throughout the study were; T = 27.5 ±1 °C, DO = 7.6±1.2 mg l^{-1}, NH_4–N = 1.14 mg l^{-1}, NO_2–N = 1.14 ± 0.14 mg l^{-1} pH = 7.75 ± 0.20 and total alkalinity 144.6 mg l^{-1}. They were in the tolerable ranges for Nile tilapia (*Oreochromis niloticus*) culture in all treatments.

Test diets and feeding regime.

Commercial diet were used for tilapia broodstock (35 % crude protein and 4586 Kcal GE kg^{-1}diet) in pelted form with graded level of feed additive yeast at three treatments (T_1: 0.0, T_2: 10 and T_3: 20 g kg^{-1}, respectively).

Broodstock fed the experimental diets at a feeding rate of 2% from the total broodstock biomass in each hapa daily (6 days/week) for 105 days. The feed was introduced to broodstock in spawning hapas at 9.00 am) six days per week with amounts adjusted at approximately 15 days interval in response to their new weight gain.

For fry feeding in nursery experiment a commercial diet (40.50 % crude protein and 4897 Kcal kg^{-1}diet). The diet was in powder form and rate of feeding was 10 % of the total fry biomass at the first 30 days started from the 2nd day of collecting fry from the broodstock (spawning) hapas and decreased to 5 % in the 2nd growth interval which extended for 30 days with a whole experimental period of 60 days. In the fry growth trial, feed was introduced to fry at a feeding frequency of 5 times daily with amounts adjusted every week interval in response to fry weight gain each nursing hapa.

Body composition analysis.

At the end of the fry growth trail, fry in each hapa were netted, weighed and finally frozen for final body composition analysis. Representative samples of the experimental fish were randomly taken at the end of the experiment Fish samples were killed and kept frozen (-18°C) until performing the body chemical analysis according to AOAC (2006) methods.

Spawning performance and seed output.
Variables were estimated according to Mair et al. (2004) from the data included:-
Mean weight = (final weight for female brood stock-Initial weight of brood stock)/2
Total seed number/female= summation of seeds for four clutches.
Seeds/female (g) = total seed number for each female/mean weight (g).
Seeds/female/day = total seed number/days of the experiment (105 day).
Seeds/m^3/day = total seed number for all females in m^3/days of the experiment.

Calculations of fish performance for fry tilapia.
The growth performance and feed utilization efficiency were calculated as following:
Weight gain (WG) = final weight (g) – initial weight (g).
Specific growth rate (SGR) % = 100 (ln W_2 – ln W_1)/T
Where W_1 and W_2 are the initial and final weight, respectively, ln is represent Natural logarithm and T is the number of days in the feeding period.
Survival rate (SR) %= (No. of fish survived at the end of the experiment/ whole number of fish at the beginning) ×100.
Feed conversion ratio (FCR) = feed intake (g)/fish weight gain (g).
Protein efficiency ratio (PER) = weight gain (g)/protein intake (g)
Protein productive value (PPV) % = 100 [protein gain (g)/protein fed (g)].
Energy utilization (EU) % = Retained energy in carcass (Kcal)/energy intake (Kcal) ×100.

Statistical analysis
All data were subjected to one-way analysis of variance (ANOVA) at a 95% confidence limit, using SPSS software, version 16 (2007). Differences among means were tested using Duncan's Multiple Range (Duncan, 1955).

RESULTS AND DISCUSSION

Reproductive performance of broodstock.
The reproductive performance of female Nile tilapia broodstock fed tested diet for 105 days are indicated in Table (1). There were significant differences ($p<0.05$) observed among all treatments in mean weight of female broodstock, indicated that althoughT_3 (84.04 g) have the lowest weight than T_1 and T_2 (87.94, 88.31g) respectively. But this treatment supplemented with 20gkg^{-1}diet Yeast showed superiority in all reproductive performance parameters in Total seed number, seeds/g female, seeds/female/day and seeds/m^2/ day (1455,17.14,13.86 and 55.43) respectively. Compared with the T_2 which supplemented with 10gkg^{-1} yeast (1187, 13.45, 11.30 and 45.22) for the same parameters. The lowest values were recorded in T_1 with no yeast supplementation (1033, 11.76, 9.85 and 39.38) respectively. In the present study, improved seeds production and female reproductive performance of Nile tilapia may be related with tested *S. cereviacie* component , where its component enhance broodstock nutrition. Also, related with the improved immune statue which reflect on female reproductive performance. The improved immune statue which reflects on female reproductive performance (Izquierdo et al, 2001) may relate to the yeast components (carotenoids, vitamins C and E, proteins, lipids and fatty acids). So, probiotics are used to explore their effect on growth performance and prevent infections. In this respect, Abasali and Mohamad (2010) with fresh water fish *Xiphophorus helleri* using probiotic containing *Bifidobacteriurn thenmaphilum, L. casei, Entenococcus fizecium*, and *Lactabacillus acidophilus.* The results revealed that the total production of *helleri* female and the relative fecundity showed significant increase in fry production and fecundity of female group fed on probiotic compared with the other groups.

Table 1: Effect of dietary levels of *S. cerevisiae* on seed production of Nile tilapia female brood stock.

Treatments	Mean weight (g)	Total seed number	Seed/ female (g)	Seed/female/day	Seeds/m^3/day
T_1	87.94±0.03^a	1033±1.23^c	11.76±0.14^c	9.85±0.12^c	39.38±0.47^c
T_2	88.31±0.76^a	1187±2.86^b	13.45±0.44^b	11.30±0.27^b	45.22±1.09^b
T_3	84.04±0.59^b	1455±1.30^a	17.14±0.14^a	13.86±0.14^a	55.43±0.50^a

Values in the same column with different superscripts are significantly different at $P<0.05$.

Growth performance of Nile tilapia.

Growth performance and survival rate of Nile tilapia fry fed test diet for 60 days are shown in Table (2). Growth performance of fish in all groups increased during the trail. No significant differences ($p>0.05$) have been found in initial weight in all treatment groups, which reflect homogeneity in all treatment groups. The final weight (FW), weight gain (WG) and specific growth rate (SGR) were significantly higher in fish fed diets supplemented with *S. cerevisiae* T_2 and T_3 (11.70, 11.58, 7.63g) and (11.60, 11.49, 7.84g) respectively. However T_1 showed the lowest values of FW and WG and SGR (8.50, 8.39, 7.32g) respectively.For survival rate, significant differences ($p>0.05$).Were found among all treatments. The highest survival rate observed in T_3 97% followed by T_2 95% with no significant differences ($p<0.05$) between T_1 and T_2. The treatment T_1 showed the lowest survival rate 94%. Similar results were reported for *S. cerevisiae* for Common carp, *Cyprinus carpio* (Dehghan et al, 2011) in three spots Chilidi (Mohammadi et al, 2016). Higher growth performance and detectable increase in nutrient utilization have been reported in T_2 and T_3 treatment as compared to the control (T_1) after feeding for 60 days. The results are in a good agreement with results of other studies which indicated that the application of *S. cerevisiae* improves growth rates and feed utilization of *Oreochromis niloticus* (Abdel-Tawwab et al, 2008 and Asadi Rad et al, 2012). On the other hand, Nile tilapia fed with 20 gkg^{-1} of Brewer's yeast has no significant difference in weight gain, survival rate and feed intake (Vechklang et al, 2012). This discrepancy of the results may be due to different yeasts types or digestibility. The effects may depend on the concentration of β-glucan in the diet, its solubility.

It is also depend on length of feeding period, fish species and temperature of water as suggested by Dalmo and Bogwald (2008) investigated that, enhancing of growth occurred due to β-glucans (the main component yeast) which induce the intestinal immune response that increasing the resistance reduction in weight gain and probably diseases. An essential growth factors (polyamines) secreted by Yeast *S. cereviace* such as putrescine and spermidine (Buts et al, 1994).These growth factors also play a great role in rapid growth, fundamental role in proliferation and tissues regeneration (Taoka et al, 2006). Wache et al. (2006) explained that improvement by yeast application in fish growth and feed utilization may be due to improvement in digestion of nutrients.

Feed utilization parameters.

The data of feed intake (FI), feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV) and energy utilization (EU) were illustrated in Table (3). Feed intake (FI) was higher in T_2 and T_3 than T_1. The best FCR was reordered in T_3 followed by T_2 and T_1 with no significant differences between them. The same trend of PER which indicated the highest PER was recorded significantly ($p>0.05$) in T_3 when compared with T_2 and T_1 with no significant differences between them. On the other hand no significant differences were recorded in PPV% and EU% values in all treatments although there were numerical differences between treatments. Generally, lowest growth performance and nutrient utilization have been determined in the control group. The better FCR and PER in fish diet supplemented with *S. cerevisiae* 20gkg^{-1} in this study in agreement with Dawood et al. (2017) found the improved absorption and digestion (as shown by feed efficiency ratio and protein gain), may be due to higher performances of β-glucan (main component in *S. cerevisiae*) that have been fed to fish. An explanation of that Protein retention efficiency (PRE) not significantly different in study by (Halver and Hardy, 2002) may be due to PRE was determined by a number of factors dietary protein levels, final and initial weight and feed intake of animals as well as the final and initial protein content of animals. In contrast with our study Qiu and Davis (2016) in Pacific white shrimp, they found significant reduction of PRE caused by the decreases weight gain of shrimp fed on flash dried yeast.

Effects on body composition.

Concerning to body composition in (Table 4), the statistical analysis of all treatments showed that there were no significant difference ($p<0.05$) in Dry matter (DM), Ash, Crude protein (CP) and Ether extract (EE) have been found among all the studied treatments. In agreement with our study, Vechlang et al. (2012) found that, tilapia fed with diets contained 10 and 20 gkg^{-1} Brewer's yeast had no significance on the whole body proximate composition. In contrast with our results (Mohammadi et al, 2016) found significant differences ($p<0.05$) in crude protein in different treatment in three spot chilide fed on *S. cerevisiae*.

Table 2: Growth performance parameters of Nile tilapia fed test diets

Treatments	IW (g)	FW (g)	WG (g)	SGR	SR %
T_1	0.11±0.01[a]	8.50±0.50[b]	8.39±0.50[b]	7.32±0.02[c]	94.00±1.00[b]
T_2	0.12±0.00[a]	11.70±0.20[a]	11.58±0.20[a]	7.63±0.03[b]	95.00±0.00[ab]
T_3	0.11±0.01[a]	11.60±0.40[a]	11.49±0.40[a]	7.84±0.02[a]	97.00±0.00[a]

Values in the same column with different superscripts are significantly different at P<0.05.

Table 3: Feed intake and Feed utilization parameters of Nile tilapia fed test diets.

Treatments	Feed intake (g)	FCR ratio	PER ratio	PPV %	EU %
T_1	11.05±0.78[b]	1.32±0.02[a]	1.88±0.02[b]	24.50±1.31[a]	20.03±1.21[a]
T_2	15.16±0.29[a]	1.31±0.00[a]	1.89±0.01[b]	23.83±0.14[a]	19.64±0.45[a]
T_3	14.11±0.35[a]	1.23±0.01[b]	2.01±0.01[a]	26.08±1.31[a]	20.48±0.52[a]

Values in the same column with different superscripts are significantly different at P<0.05.

Table 4: Body composition (%) on dry matter basis of Nile tilapia fed the test diets at the end of the experiment.

Treatments	Dry matter	Crude protein	Ether extract	Ash
T_1	24.40±1.41[a]	53.40±0.90[a]	23.92±0.04[a]	22.50±0.75[a]
T_2	23.93±0.12[a]	52.75±0.45[a]	24.09±1.38[a]	23.00±1.03[a]
T_3	23.58±0.33[a]	54.90±1.45[a]	22.41±0.77[a]	22.65±0.25[a]

Values in the same column with different superscripts are significantly different at P<0.05.

Abdel-Tawwab et al. (2008) reported that, yeast supplementation plays a role in enhancing feed intake which reflected on improved fish body composition. The enhanced feed intake may be due to increasing in feed uptake. Changes in protein and lipid content of fish body may be due to changes in their synthesis, deposition rate in muscle and/or different growth rate as suggested by Abdel-Tawwab et al. (2006).

CONCLUSION

Supplementation of aqua feeds with *Saccharomyces cerevisiae* have a beneficial effect on seed production of Nile tilapia broodstock, enhancing growth performance of fry and increase their nutrient utilization. However, there is no effect on chemical body composition.

.

CONFLICT OF INTEREST

The present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

The author would thank all participants and their parents.

AUTHOR CONTRIBUTIONS

Dr. Hanan: participated in designed the experiments, Laboratory analysis, statistical analysis and wrote the manuscript of the paper. Dr. AL-Azab: participated in practical work in field experiment. All authors read and approved the final version.

REFERENCES

Abasali, H., Mohamad, S. 2010**.** Effect of dietary supplementation with probiotic in reproductive Performance of female live bearing ornamental Fish. Research Journal of Animal Sciences, 4 (4): 103-107.

Abdel-Tawwab ,M., E., Khattab, Y.A., Ahmad M.H. Shalaby, A.M.E. 2006. Compensatory growth, feed utilization, whole-body composition and hematological changes in starved juvenile Nile tilapia, *Oreochromis niloticus* (L.). Journal of Applied Aquaculture, 18: 17–36.

Abdel-Tawwab, M., Abdel-Rahman, A. M. Ismael, N. E. M. 0 2008. Evaluation of commercial live bakers' yeast, *Saccharomyces cerevisiae* as a growth and immunity promoter for fry Nile tilapia, *Oreochromis niloticus* (L.) challenged *in situ* with *Aeromonas hydrophila*. Aquaculture, 280:185–189.

AOAC, Official Methods of Analysis, Association of Official Analytical Chemists International, Arlington, Va, USA, 18th edition, 2006.

Asadi Rad, M., Zakeri , M., Yavari V., Mousavi , S.M. 2012. Effect of different levels of dietary supplementation of *Saccharomyces cerevisiae* on growth performance, feed utilization and body biochemical composition of Nile tilapia (*Oreochromis niloticus*) fingerlings. Journal of Persian Gulf, 3(9):15-24.

Buts J. P., De Keyser, N., DeRaedemaeker, L.1994. *Saccharomyces boulardii* enhances rat intestinal enzyme expression by endoluminal release of polyamines. Pediatric Research 36:522-527.

Chung, M.Y., Liu, C. Chen, Y.N., Cheng, W. 2011. Enhancing the reproductive performance of tiger shrimp, *Penaues monodon,* by incorporating sodium alginate in the brood stock and larval diets, Aquaculture, 312, 180-184.

Dalmo, R.A, Bogwal,J. 2008. B-glucans as conductors of immune symphonies, Fish and Shellfish Immunology., 25, 384-396.

Dawood,M.A.O., Koshio, S., Ishikawa, M., Yokoyama, S.,ElBasuni, M.S., Hossain, M.F., Nhu, T.H., Moss, A.S., Dossou ,S. Wei, H. 2017. Dietary supplementation of β-glucan improves growth performance, the innate immune response and stress resistance of red Sea bream, Pagrus major, Aquaculture Nutrition, 23, 148-159.

Dehghan, M., Jafaryan , H., Jamali ,H. , Sahandi ,H. , Adineh ,H. ,Faramarzi, M. 2011. Evaluation of growth and survival rate of *Artemia parthenogenetica* feed with micro algae *(Isochrysis galbana* and *Chlorella vulgaris*) and bakery yeast *(Saccharomyces cerevisiae).* AACL Bioflux, 4(4),463-468.

Deng, D., Mei, C. , Mai, K. , Tan,B.P., Ai ,Q., Ma,H. 2013. Effects of a yeast-based additive on growth and immune responses of white shrimp, *Litopenaeus vannamei* (Boone, 1931), and aquaculture environment. Aquaculture Research, 44, 1348–1357.

Duncan, D. 1955. Multiple range tests and multiple F tests. Biometrics, 11, 1-42.

El-Sayed, A. M., Mansour , C.R., Ezzat,A.A. 2005. Effects of dietary lipid source on spawning performance of Nile tilapia (*Oreochromis niloticus*) brood stock reared at different water salinities. Aquaculture, 248, 187-196.

Gatesoupe, F. J., 2007. Live yeasts in the gut: Natural occurrence, dietary introduction, and their effect on fish health and development. Aquaculture , 267,20–30.

Halver,J.E.,Hardy,R.W.2002. Fish nutrition. San Diego, CA, USA, Academic press.

Hauptman, B. S., Barrows,F.T., Block, S. S., Gaylord,T.G., Paterson,J.A., S.D. Rawles ,S.D., Sealey, W.M. 2014. Evaluation of grain distillers dried yeast as a fish meal substitute in practical-type diets of juvenile rainbow trout, *Oncorhynchus mykiss*. Aquaculture, 432, 7–14.

Izquierdo, M.S., Fernandez-Palacios ,H., Tacon,A.G.J. 2001. Effect of brood stock nutrition on reproductive performance of fish. Aquaculture, 197, 25-42.

Lupatsch, I., deshev ,R. magen,I. 2010. Energy and protein demands for optimal egg production including maintenance requirements of female tilapia (*Oreochromis niloticus*). Aquaculture Research, 41, 763-769.2010.

Mair, G.C., Lakapunrat ,S., Jere ,W.L., Bart ,A. 2004. Comparison of reproductive parameters among improved strains of Nile tilapia *Oreochromius niloticus* .In:Bolivar,R.B.; Mair GC and Fitzsimmons K (Editors). New dimensions in farmed tilapia.pro 6thInter.Sympos.Tilapia in aquaculture, Roxas Boulevard, Manila,

Philippines, Sept.12-16.

Mohammadi F., Mousavi,S.M., Zakeri ,M. , Ahmadmoradi, E. 2016. Effect of dietary probiotic, *Saccharomyces cerevisiae* on growth performance, survival rate and body biochemical composition of three spot cichlid (*Cichlasoma trimaculatum*). AACL Bioflux 9(3):451-457.

Paryad, A., Mahmoudi,A. 2008. Effect of different levels of supplemental yeast *Saccharomyces cerevisiae* on performance, blood constituents and carcass characteristics of broiler chicks. African Journal of Agricultural Research, 3(12) 835–842.

Qiu, X., Davis, D.A. 2017. Evaluation of flash dried yeast as a nutritional supplement in plant-based practical diets for Pacific white shrimp *Litopenaeus vannamei*. Aquacultre Nutrition, 23(5):942-951.

Sarmento, N. L.A.F, Martins, E. F.F., Costa, D. C., Mattioli, C.C. , Da Costa Julio, G. S., Figueiredo, L. G. , Luz, M. R., Luz, R. K., 2018. Reproductive efficiency and egg and larvae quality of Nile tilapia fed different levels of vitamin C. Aquaculture, 482 :96-102.

Sönmez, A.Y. 2017.Evaluating Two Different Additive Levels of Fully Autolyzed Yeast, Saccharomyces cerevisiae, on Rainbow Trout (*Oncorhynchus mykiss*) Growth Performance, Liver Histology and Fatty Acid Composition .Turkish Journal of Fisheries and Aquatic Sciences 17: 379-385.

Sousa, S.M., Freccia, A., Santos,L., Meurer,F., Tessaro, L., Bombardelli,R.A. 2013. Growth of Nile tilapia post-larvae from broodstock fed diet with different levels of digestible protein and digestible energy. Revista Brasileira De Zootechia. 42(8), 535-540.

SPSS, 2007.Statistical Package for Social Science (for Windows). Release 16 copyright, SpssInc, Chicago, USA.

Taoka, Y., Maeda,H., Jo,J., M.J. Jeon,M.J., S.C. Bai,S.C., W.J. Lee,W.J., K.Yuge ,K., Koshio ,S. 2006. Growth, stress tolerance and non-specific immune response of Japanese flounder *Paralichthys olivaceus* to probiotics in a closed recirculating system. Fisheries Science, 72, 310-321.

Vechklang, K., Lim,C. Boonanuntanasarn, S. , Welker,T., Ponchunchuwong,S., Klesius P.H., Wanapu,C. 2012. Growth Performance and Resistance to Streptococcus iniae of Juvenile Nile Tilapia (*Oreochromis niloticus*) Fed Diets Supplemented with GroBiotic-A and Brewtech Dried Brewer's Yeast, Journal of Applied Aquaculture, 24 (3): 183-198.

Waché, Y., Auffray,F., Gatesoupe, F.J., Zambonino,J., Gayet,V., L. Labbé ,L. , Quentel, C. 2006.Cross effects of the strain of dietary *Saccharomyces cerevisiae* and rearing conditions on the onset of intestinal microbiota and digestive enzymes in rainbow trout, *Onchorhynchus mykiss* fry. Aquaculture 258:470-478.

Yousefian, M., Amiri, M.S. 2009.A review of the use of prebiotics in aquaculture for fish and shrimp. African Journal of Biotechnology, 8: 7313–7318.