International Journal of Agricultural Technology 2019 Vol. 15(4): 637-644
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Effect of garlic (*Allium sativum*) supplemented diets on growth, feed utilization and survival of red tilapia (*Oreochromis* sp.)

Samson, J. S. [1, 2*]

[1]College of Fisheries, Central Luzon State University, Science City of Muñoz 3120, Nueva Ecija, Philippines; [2] Freshwater Aquaculture Center, Central Luzon State University, Science City of Muñoz 3120, Nueva Ecija, Philippines.

Samson, J. S. (2019). Effect of garlic (*Allium sativum*) supplemented diets on growth, feed utilization and survival of red tilapia (*Oreochromis* sp.). International Journal of Agricultural Technology 15(4): 637-644.

Abstract The present study evaluated the effect of varying levels of garlic (*Allium sativum*) inclusion on the growth, feed utilization and survival of red tilapia (*Oreochromis* sp.). One hundred twenty red tilapias with initial average body weight of 7.36 ± 0.75 g were randomly introduced into 12 aquaria in 4 groups with 10 fish per aquarium. Treatments were fed with experimental diets for six weeks. The various levels of garlic powder (0, 1%, 1.5% and 2%) was added to commercial diet. At the end of the experiment, growth, survival rates, and feed utilization were evaluated. There was no significant difference in the growth of the fish. The highest survival rate was recorded from 1.5% garlic supplementation that showed significant difference compared to the control diet ($P < 0.05$). In terms of feed utilization, lowest feed conversion ratio (FCR) was recorded from 1% garlic inclusion that showed significant difference compared to the control diet ($P < 0.05$). This study showed that addition of 1% to 1.5% garlic powder in the diet improved the feed utilization and survival rate of red tilapia.

Keywords: Aquaculture, Feed additive, Growth promotant, Immunostimulant

Introduction

Plants are indigenous and natural sources of safe and inexpensive chemicals (Lee *et al*., 2012, 2014). There have been reports on the positive effects of plants as feed additives in promoting growth, appetite stimulation, anti-stress activities and disease resistance of the cultured organisms (Citarasu *et al*., 2001, 2002; Sivaram *et al*., 2004). Garlic (*Allium sativum*) is one of the good examples of these plant source-feed additives that has been reported to have beneficial effect on growth promotion, digestion and flesh quality of the cultured organism (Vampires *et al*., 2005; Tatara *et al*., 2008).

Garlic is a plant belonging family Liliaceae, that has been used as spice, traditional medicine, and a functional food to enhance physical and mental

* **Corresponding Author:** Samson, J. S.; **Email:** samsonjaypee@clsu.edu.ph

health (Lee *et al*., 2012, 2014; Saleh *et al*., 2015; Labrador *et al*., 2016). It contains several minerals such as iron, magnesium, selenium, zinc, germanium, copper and potassium. It is also found to be rich in phosphorus, carbohydrates, calcium and generally, has a high nutritional significance (Saleh *et al*., 2015; Labrador *et al*., 2016; Saghaei *et al*., 2015). Moreover, garlic contains several important compounds including silicates, iodine and sulfur salts that has positive influence in the skeletal and circulatory system, cholesterol and as well as in the control of liver diseases (Labrador *et al*., 2016).

Antibiotics, hormones and other chemicals has been widely used to enhance the resistance and growth of the cultured species by administering them into the feeds given to the animals (Rico *et al*., 2013). However, the practice of using these chemicals have been constrained because of their side-effects in the environment and health safety concerns (Reverter *et al*., 2014). Therefore, the use of plants such as garlic as replacement for these synthetic chemicals for the promotion of growth, appetite stimulation and immunostimulation in cultured species is one possible alternative as these products are safer, cheap, effective, can be easily prepared and are environmentally friendly (Syahidah *et al*., 2015).

In previous studies, garlic and other plants extracts have been found to improve the growth performance, survival rate and immune response of aquatic animals such as *Litopenaeus vannamei* (Javadzadeh *et al*., 2002; *Zare et al*., 2014; Gol Aghaei *et al*., 2016), *Lates calcarifer* (Talpur and Ikhwanuddin, 2012), *Poecilia sphenops* (Pour *et al*., 2014), *Clarias gariepinus* (Nwabueze, 2012), *Oreochromis niloticus* (Aly *et al*., 2008), *Acipenser ruthenus* (Lee *et al*., 2012, 2014), *Huso huso* (Tangestani *et al*., 2011; Nobahar *et al*., 2014; Akrami *et al*., 2015), *Mugil cephalus* (Akbary *et al*., 2016) *Cyprinus carpio haematopterus* (Chesti and Chauhan, 2018) *Oncorhynchus mykiss* (Büyükdeveci *et al*., 2018).

In this study, the effect of different levels of garlic powder in the growth, feed utilization and survival of the red tilapia were evaluated. It is important to know the optimum level of garlic inclusion in the diet of red tilapia since it differs from species to species.

Materials and Methods

Red tilapia with an initial average body weight (ABW) of 7.36 ± 0.75 g were used in the experiment, with stocking rate of 10 fish per aquarium. All fish were fed with experimental diets for 6 weeks with initial feeding rate of 5% of their body weight. Sampling was done once every two weeks to measure their weight and adjust the feeding rate.

This study was randomly designed using four treatments with three replications. Commercially-available diet (35% protein, 4% fat) was used as the control for the experiment. Commercial diet was added with 0 (Control) 1, 1.5 and 2% garlic powder and water (200 mL kg^{-1}) (Cho and Lee, 2012). Mixtures were mixed thoroughly and dried at room temperature before storing at -20 ℃.

Growth, survival and feed utilization parameters such as specific growth rate (SGR) and relative growth rate (RGR), weight gain (WG), survival rate, and feed conversion ratio (FCR) were calculated are as follows:

$$\text{SGR (\%/day)} = \frac{\ln [\text{final weight}] - \ln [\text{initial weight}])}{(\text{time interval in days})} \times 100$$

$$\text{RGR (\%)} = \frac{\text{Final weight of fish - Initial weight of fish}}{\text{Initial weight of fish}} \times 100$$

$$\text{Weight gain (g)} = \text{Final weight} - \text{Initial weight}$$

$$\text{Survival rate (\%)} = \frac{\text{No. of individuals at the end of the experiment}}{\text{No of individuals at the beginning of the study}} \times 100$$

$$\text{FCR} = \frac{\text{Amount of feed given (g)}}{\text{Weight gain (g)}}$$

All data were subjected to one-way analysis of variance (ANOVA) followed by Duncan's test at a significant level of $P < 0.05$.

Results

The ABW, SGR, RGR, WG and FCR of the experimental fish were computed after the feeding experiment and are shown in Table 1. No Significant differences were observed in the ABW, SGR, RGR and WG among the treatments. On the other hand, groups fed with 1% garlic inclusion showed significantly lower ($P < 0.05$) FCR of 1.19 ± 0.16 compared to 2% inclusion and Control with 1.81 ± 0.05 and 1.92 ± 0.24%, respectively.

The survival rate of each treatment was computed at the end experiment. Garlic inclusion of 1.5% has the highest recorded survival rate among the treatments with 60.00 ± 10.00 %, which is significantly different compared to the Control that has the lowest survival of 20.00 ± 0.00 %.

Table 1. Growth indices, feed utilization and survival rate (Mean ± SD) (n=3) of the experimental fish

	Treatments			
	Control	**1%**	**1.5%**	**2%**
ABW (g)	15.42 ± 2.54[c]	16.97 ± 0.95[c]	15.21 ± 2.59[c]	14.99 ± 2.78[c]
SGR (%)	1.35 ± 0.16[a]	1.72 ± 0.24[a]	1.52 ± 0.36[a]	1.49 ± 0.14[a]
RGR (%)	96.96 ± 16.01[a]	137.02 ± 29.31[a]	116.16 ± 41.11[a]	110.78 ± 14.61[a]
WG (g)	7.62 ± 1.81[a]	9.77 ±1.40[a]	7.88 ± 0.45[a]	7.87 ± 1.72[a]
FCR	1.92 ± 0.24[a]	1.19 ± 0.16[b]	1.38 ± 0.33[ab]	1.81 ± 0.05[a]
SR%	20.00 ± 0.00[b]	46.67 ± 15.28[ab]	60.00 ± 10.00[a]	43.33 ± 20.82[ab]

Means in rows with the same letter are not significantly different at $P < 0.05$.

Discussion

Due to the emergence of antibiotic resistance pathogens in aquaculture, the use of plant origin growth enhancers and immunostimulants has been in an increasing trend (Citarasu *et al*., 1998). Several studies noted the positive effect of garlic inclusion in the diet of aquatic animals including; *Litopenaeus vannamei* (Javadzadeh *et al*., 2002; *Zare et al*., 2014; Gol Aghaei *et al*., 2016), *Lates calcarifer* (Talpur and Ikhwanuddin, 2012), *Poecilia sphenops* (Pour *et al*., 2014), *Clarias gariepinus* (Nwabueze, 2012), *Oreochromis niloticus* (Aly *et al.*, 2008), *Acipenser ruthenus* (Lee *et al*., 2012, 2014), *Huso huso* (Tangestani *et al*., 2011; Nobahar *et al*., 2014; Akrami *et al*., 2015), *Mugil cephalus* (Akbary *et al*., 2016) *Cyprinus carpio haematopterus* (Chesti and Chauhan, 2018) *Oncorhynchus mykiss* (Büyükdeveci *et al*., 2018).

In the present study, there are no significant effects noted in the growth performance of the red tilapia with the inclusion of different concentrations of garlic in their diet. The final length and weight of the experimental fish were not improved by garlic supplementation in feeds. The result concurs with the report of Fall and Ndong (2007), where they observe no significant increase in the growth of hybrid tilapia (*Oreochromis niloticus* × *Oreochromis aureus*) fed with garlic supplemented feed for 4 weeks. In addition, Sahu *et al*. (2007), Thanikachalam *et al*. (2010), Nobahar *et al*. (2014) and Pashaki *et al*. (2018) also observed no significant effects on growth parameters of *Labeo rohita*, *Clarias gariepinus*, *Huso huso* and *Cyprinus carpio* after adding different levels of garlic in their diets. Furthemore, Aly *et al*. (2008) and Aly and Mohamed (2010), also studied the growth performance of Nile tilapia by adding different concentrations of garlic in their diet (10 and 20 g kg^{-1}), and found no significant increase in the growth of the fish after 1 or 2 months of application, but after 8 months significant increase in the growth parameters were observed. The period of application and administration of garlic to the fish

is a possible factor to consider why there are no significant effects in growth were observe. In this study, the duration of the administration may not be enough to observe the possible effect of the garlic in the growth of the red tilapia.

In this study, significant result was observed in the feed utilization of the experimental fish. Significantly lower FCR was observed from 1% garlic inclusion. The result coincides with the report of Pashaki *et al*. (2018) where they observed significantly better FCR while no significant effect observed from the growth from *Cyprinus carpio* fingerlings fed with garlic extract-supplemented diet. Better feed utilization of the experimental fish fed with 1% garlic powder can be attributed to the presence of allicin in garlic, which stimulates intestinal flora, leading to better digestion and utilization of energy that can result to improved growth (Khalil *et al*., 2001). Furthermore, it was observed in this study that increasing garlic inclusion in the diet also result to increasing FCR values. The increasing values of FCR can be a result of lower feed intake, due to the pungent smell of garlic which can affect the palatability of the feeds especially at high rates of inclusions. In addition, high amounts of garlic inclusions may not improve fish growth; instead, it can be harmful to the health of the fish due to excessive amount of alkyl sulfide that enters the intestine, interfering with metabolism and suppressing mitosis, resulting in poor growth or even mortality (Erguig *et al*., 2015).

The survival rates obtained in all treatments are noticeably low. Mortalities of the experimental fish started during the third and fourth week of the experiment. As an observation, some experimental fish are gliding their bodies along the sides and bottom of the aquarium. It is possible that during the experiment, the fish acquired bacterial disease which is one possible reason why the survival rates in all treatments are low. Aside from that, the level of oxygen throughout the experiment ranged only from 2.4 to 3 mg/L which is lower than the required dissolved oxygen level of at least 5 mg/L. Given those circumstances, higher survival rates were observed in treatments with garlic inclusions. Treatment with 1.5% garlic powder showed significantly higher survival rate compared to the Control group. Several studies reported that the inclusion of garlic in the diet of the cultured animals including *Penaeus monodon* (Citarasu *et al*., 2002), *Oreochromis niloticus* (Aly *et al*., 2008), *Clarias gariepinu*s (Thanikachalam *et al*., 2010), *P. vannamei* (Zare *et al*., 2014) and *Carassius auratus* (Dadgar *et al*., 2019). Higher survival rates of garlic powder-supplemented treatments may be a result of the the stimulatory effect of garlic on the immune system, which enhances the immune response of the fish (Aly *et al*., 2008). Consumption of garlic results to immune stimulation and

increase in fish resistance due to the presence of compounds such as vitamin A, vitamin C, and allicin (Khodadadi *et al*., 2013).

It was concluded that based on the results obtained from the study, inclusion of garlic powder in the diet of red tilapia at 1-1.5%, improved the feed utilization and the survival of the fish. Therefore, addition of garlic in the diet of red tilapia is a possible alternative rather than using synthetic or chemical supplements to improve the growth, feed utilization and survival of the fish.

Acknowledgement

The author would like to acknowledge the assistance of the College of Fisheries and the Freshwater Aquaculture Center where the study was conducted. Also, the author would like to extend his appreciation to the Department of Science and Technology – Accelerated Science and Technology Human Resource Development Program (DOST-ASTHRDP) for the financial assistance during the experiment.

References

Akbary, P., Negahdari, J. and Sondakzehi A. (2016). Effects of garlic (*Allium sativum* L) extract on growth, feed utilization and carcass composition in *Mugil cephalus* (Linnaeus, 1758) larvae. Iranian Journal of Fisheries Sciences, 15:552-557.

Akrami, R., Gharaei, A., Razeghi, M. and Galeshi, A. (2015). Effects of dietary onion (*Allium cepa*) powder on growth, innate immune response and hematoebiochemical parameters of beluga (*Huso huso* Linnaeus, 1754) juvenile. Fish and Shellfish Immunology, 45:828-834.

Aly, S. M, Atti N. M. A. and Mohamed M. F. (2008). Effect of garlic on survival, growth, resistance and quality of *Oreochromis niloticus*. International Symposium on Tilapia in Aquaculture, 277-296.

Aly, S. M. and Mohamed, M. F. (2010). *Echinacea purpurea* and *Allium sativum* as immunostimulants in fish culture using Nile tilapia (*Oreochromis niloticus*). Journal of Animal Physiology and Animal Nutrition, 94:31-39.

Büyükdeveci, M. E., Balcázar J. L., Demirkale İ. and Dikel S. (2018). Effects of garlic-supplemented diet on growth performance and intestinal microbiota of rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 486:170-174.

Chesti, A. and Chauhan, R. S. (2018). Effect of inclusion of garlic (*Allium sativum*) on feed utilization and growth in Amur carp, *Cyprinus carpio haematopterus*. The Pharma Innovation Journal, 7:249-252.

Cho, S. H. and Lee, S. M. (2012). Onion powder in the diet of the olive flounder, *Paralichthys olivaceus*: effects on the growth, body composition, and lysozyme activity. Journal of World Aquaculture Society, 43:30-38.

Citarasu, T., Immanuel, G. and Marian, M. P. (1998). Effect of feeding Artemia enriched with stresstol and cod liver oil on growth and stress resistance in the Indian white shrimp *Penaeus indicus* postlarvae. Asian Fisheries Science, 12:1-7.

Citarasu, T., Babu, M. M., Punitha, S. M. J., Venket, R. K. and Marian, M. P. (2001). Control of pathogenic bacteria using herbal medicinal products in the larviculture system of

Penaeus monodon. International Conference on Advanced Technologies in Fisheries and Marine Sciences, MS University, India.

Citarasu, T., Sekar R. R., Babu M. M. and Marian M. P. (2002). Developing Artemia enriched herbal diet for producing quality larvae in *Penaeus monodon*. Asian Fisheries Science, 15:21-32.

Dadgar, S., Seidgar M., Nekuiefard, A., Valipour, A. R., Sharifian, M. and Hafezieh, M. (2019). Oral administration of garlic powder (*Allium sativum)* on growth performance and survival rate of *Carassius auratus* fingerlings. Iranian Journal of Fisheries Sciences, 18:71-82.

Fall, J. and Ndong, D. (2007). The effect of garlic (*Allium sativum*) on growth and immune responses of hybrid tilapia (*Oreochromis niloticus*×*Oreochromis aureus*). Journal of Clinical Immnunology and Immunopathology Research, 3:1-9.

Gol Aghaei, M., Adel, M. and Hafezieh, M. (2016). The effect of row garlic powder (*Allium sativum*) on growth, survival and body composition of *Litopenaeus vannamei* cultured with Caspian Sea water. Iranian Journal of Fisheries Science Research, 25:143-150.

Javadzadeh, M., Salarzadeh, A., Yahyavi, M., Hafezieh, M. and Darvishpour, H. (2002). The effects of garlic extract on growth factors and survival of *Litopenaeus vannamei* post larvae. Iranian Journal of Fisheries Science Research, 21:39-46.

Khalil, R. H., Nadia, B. M. and Soliman, M. K. (2001). Effects of Biogen and Levamisol Hcl on the immune response of cultured *Oreochromis niloticus* to *Aeromonas hydrophila* vaccine. The Journal of Veterinary Medical Research, 10:381-392.

Khodadadi, M., Peyghan, R. and Hamidavi, A. (2013). The evaluation of garlic powder feed additive and its effect on growth rate of common carp, *Cyprinus carpio*. Iranian Journal of Veterinary and Animal Sciences, 6:17-26.

Labrador, J. P., Guiñares, R. C. and Hontiveros, G. S. (2016). Effect of garlic powder-supplemented diets on the growth and survival of Pacific white leg shrimp (*Litopenaeus vannamei*). Cogent Food and Agriculture, 2:1210066.

Lee, D. H., Ra, C. S., Song, Y. H., Sung, K. I. and Kim J. D. (2012). Effect of dietary garlic extracts on growth, feed utilization and whole body composition of juvenile starlet sturgeon (*Acipenser ruthenus*). Asian-Australasian Journal of Animal Sciences, 25:577-583.

Lee, D. H., Lim, S. R., Han, J. J., Lee, S. W., Ra, C. S. and Kim, J. D. (2014). Effects of dietary garlic powder on growth, feed utilization and whole body composition changes in fingerling sterlet sturgeon. Acipenser ruthenus. Asian- Australasian Journal of Animal Sciences, 27:1303-1310.

Nwabueze, A. A. (2012). The Effect of Garlic (*Allium sativum*) on Growth and Haematological Parameters of *Clarias gariepinus* (Burchell, 1822). Sustainable Agriculture Research, 1:222-228.

Nobahar, Z., Gholipour-Kanani, H., Kakoolaki, Sh. and Jafaryan, H. (2014). Effect of garlic (*Allium sativum*) and nettle (*Urtica dioica*) on growth performance and hematological parameters of beluga (*Huso huso*). Iranian Journal of Aquatic Animal Health, 1:63-69.

Pashaki, A. K., Zorriehzahra S. M. J., Ghasemi M., Rohani M. S. and Hosseini S. M. (2018). Effects of dietary Garlic extract on some blood, immunity and growth parameters of Common Carp fingerlings (*Cyprinus carpio*). Iranian Journal of Aquatic Animal Health, 4:28-39.

Pour, F., Maniat M., Vahedas A. and Ghayem S. (2014). Enhancement of growth performance and body composition in molly fish (*Poecilia sphenops*) associated with dietary intake of garlic (*Allium sativum*). International Journal of Biosciences, 5:115-121.

Rico, A., Phu T. M., Satapornvanit, K., Min, J. and Shahabuddin, A. M. (2013). Use of veterinary medicines, feed additives and probiotics in four major internationally traded aquaculture species farmed in Asia. Aquaculture, 412:231-243.

Reverter, M., Bontemps, N., Lecchini, D., Banaigs, B. and Sasal, P. (2014). Use of plant extracts in fish aquaculture as an alternative to chemotherapy: current status and future perspectives. Aquaculture, 433:50-61.

Saghaei, A., Ghotbeddin, N. and Ghatrami, E. R. (2015). Evaluation of growth performance and body composition of Oscar fish (*Astronotus ocellatus*) in response to the consumption of dietary intake of garlic (*Allium sativum*). aquaculture, aquarium, conservation and legislation. International Journal of the Bioflux Society, 8:485-490.

Saleh, N. E., Michael, F. R. and Toutou, M. M. (2015). Evaluation of garlic and onion powder as phyto-additives in the diet of sea bass (*Dicentrarcus labrax*). Egyptian Journal of Aquatic Research, 41:211-217.

Sivaram, V., Babu, M. M., Citarasu, T., Immanuel, G., Murugadass, S. and Marian, M. P. (2004). Growth and immune response of juvenile greasy groupers (*Epinephelus tauvina*) fed with herbal antibacterial active principle supplemented diets against *Vibrio harveyi* infections. Aquaculture, 237:9-20.

Syahidah, A., Saad, C. R., Daud, H. M. and Abdelhadi, Y. M. (2015). Status and potential of herbal applications in aquaculture: A review. Iranian Journal of Fisheries Sciences, 14:27-44.

Talpur, A. D. and Ikhwanuddin, M. (2012). Dietary effects of garlic (*Allium sativum*) on haematoimmunological parameters, survival, growth and disease resistance against *Vibrio harveyi* infection in Asian sea bass, *Latescal carifer* (Bloch). Journal of Aquaculture, 364:6-12.

Tangestani, R., Alizadeh Doghikoloei, A., Ebrahimi, A. and Zarae, P. (2011). The effect of garlic issuance on heamatologic parameters of cultured young *Huso huso*. Journal of Veterinary Research, Tehran University, 66:209-216.

Tatara, M. R., Sliwa E., Dudek, K., Gawron, A. and Piersiak, T. (2008). Aged garlic extract and allicin improve performance and gastrointestinal tract development of piglets reared in artificial sow. Annals of Agricultural and Environmental Medicine, 15:63-69.

Thanikachalam, K., Kasi, M. and Rathinam, X. (2010). Effect of garlic peel on growth, hematological parameters and disease resistance against *Aeromonas hydrophila* in African catfish *Clarias gariepinus* (Bloch) fingerlings. Asian Pacific Journal of Tropical Medicine, 3(8):614–618.

Vampires, V. S., Christodoulou, V., Christaki, E., Florou-Paneri, P. and Spais, A. B. (2005). Effect of dietary garlic bulb and garlic husk supplementation on performance and carcass characteristics of growing lambs. Animal Feed Science and Technology, 121:273-283.

Zare, H., Hosseini, S. A., Sodagar, M. and Zendebodi, A. (2014). The effects of garlic extract on growth factors and resistance of *Litopenaeus vannamei* post larvae and tolerance against salinity and pH stress. Aquatic Animal's Culture and Exploitation, 3:1-16.

(Received: 2 April 2019, accepted: 30 June 2019)