*Plant Archives* Volume 20 No. 2, 2020 pp. 7321-7326 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

# INFLUENCE OF DIFFERENT LEVELS OF GARLIC *ALLIUM SATIVUM* POWDER ADDITIONS ON GROWTH PROMOTER AND BIOCHEMICAL COMPOSITION OF COMMON CARP *CYPRINUS CARPIO* L.

**Mahmoud Ahmad Mohammad**

Department of Animal production, College of Agriculture and Forestry, Mosul University, Mosul, Iraq.

## Abstract

The aim of the current research is to know the effect of adding three different levels of garlic powder *Allium sativum* on the performance of the common carp *Cyprinus carpio* L. The first diet was free of garlic (control diet), while the second, third and fourth feeds contained garlic powder in a ratio of 1, 1.5 and 1.75%, respectively on growth, food utilization of food and the main nutrients deposited in edible part of common carp. 120 fish were used with initial weight of 9±1 g/fish, which were randomly distributed in four experimental diets with three replications each. The growth experiment took 56 days, preceded by a three-week adaptation period, to adapt the fish to the aquarium environment. The results of the statistical analysis of the growth criteria showed a significant effect ($P \leq 0.05$) due to the addition of garlic powder on the final weight criteria, weight gain, relative and specific growth (except for the third treatment) and feed conversion ratio compared to control (first treatment). Adding garlic powder with a positive effect in improving the quality of the edible part by adding this type of spices by 1.75%, which led to a significant decrease ($P \leq 0.05$) in the percentage of fats compared to the control diet. It can be seen from the aforementioned that the growth and qualitative characteristics of fish meat can be enhanced through the use of this type of medicinal herb.

***Key words:*** garlic, growth performance, body chemicalcomposition, carp.

## Introduction

Common carp belongs to carp family, which contributes greatly to inland fish production in fresh water and comes third in the world for most important species cultured in freshwater and in Eastern Europe (Ljubojevi *et al.,* 2016). Aquaculture in floating ponds and floating cages are most common culture systems for fish farming in Iraq, where fish production reached 24 thousand tons in 2014 (AOAD, 2016). Iraq's production from the aquaculture sector is estimated about 24,000 tons in 24 thousand tons (AOAD, 2016). While Saleh, (2019) indicated that Iraq's production of fish amounted to 390 thousand tons, which is produced in floating cages and earthen ponds, which are the common methods of fish production in central region of Iraq. Many factors influence fish growth. Perhaps the foremost of these factors is food, nutrition, environmental conditions, ability of fish to resist diseases and other factors that affect the survival rate and all of which affect the final return and profits of the farm, for this type of economic activity. There is now more concern about food safety as a result of the use of chemicals and antibiotics, which have led to many negative effects on fish and the consumer of these products, which necessitated the ban on the use of these additives. Where the percentage of loss reaches 50% of fish farmed due to diseases before it reaches the appropriate size for marketing. Therefore, prebiotic supplementation is the alternative for growth and health improvement (Ganguly *et al*., 2015; Mohammad *et al*., 2015). Recent increase of intensive aquaculture practices has led to the appearance of several anxieties like those regarding biological material safety or growth performance. Regrettably, the intensive culture of fish produces a worrying environment leading to the devastation of immune system and increasing of the defenselessness of fish to infectious diseases (Harikrishnan *et al*., 2011). Widespread use of antibiotics has resulted in drug remainder and pathogens sturdy in treated fish. Drug residue not only pollutes the environment, but also impends human consumers. On contrary, garlic is considered an antibiotic, friendly to the aquatic environment and it does not cause harm to

***Author for correspondence :** E-mail: dr.mahmoud@uomosul.edu.iq

consumed neighborhoods, whether it is side or physical effects, as garlic has verified its effectiveness in treating many diseases of consuming organisms as a result of its antimicrobial properties and contains many It is a natural antioxidant.

Garlic contains Allicin, di-calcium sulfate, which are due to most pharmacological possessions of this type of medicinal herb (Amagase *et al.,* 2001). Garlic powder contains many biologically active organic compounds, such as di-thiosulfinate, antioxidants (Wu *et al.,* 2001), immune-promoting (Kang *et al.,* 2001), decreasing fat levels (Lawson *et al.,* 2001) and depressing blood pressure (Ali *et al.,* 2000). The aim of the present research is to study the effect of adding different levels of garlic powder *Allium sativum* on growth criteria, utilization of food and main nutrients in edible portion of common carp *Cyprinus carpio* L.

## Maerial and Methods

### Experimental diets

Four experimental rations were prepared to contain different levels of garlic *Allium sativum* powder with 1, 1.5, 1.75% (diet 2, diet 3 and diet 4 respectively), which isonitrogenous and isocaloric. Control diet was free from garlic (diet 1). Feed ingredients were ground and milled intopellets, provided 3-5% of live body weight of fish. After being dried, the pellets were relocated to in a freezer until instantaneously prior to feeding (Table 1).

### Fish and experimental condition

This experiment was carried out at the Fish Laboratory, Depart. of Animal Production College of Agriculture and Forestry, University of Mosul. Fish under study were adapted for three weeks to acclimate to aquarium environment (72 liters), which contained 10 fish. Growth experiment lasted fifty-six days. Fish were randomly distributed on experimental diet. Average primary weight of fish was 9±1g/fish. Each experimental group was fed with three replicates was fed on one of the experimental diets. Fish were fed 3-5% of the total body weight, twice a day.Glass aquaria are provided with an air pump for each aquaria. 25% of aquariawater are replaced daily to eliminate waste. The temperature in the breeding water is controlled by air conditioners, where the average temperature between 24-28°C., pH is 7.3-7.6 and dissolved oxygen is 6.6-7.8 mg /l. Amount of feed provided to fish was increased depending on the increase in fish weight during the trial period, as it is weighed every two weeks.

### Growth parameters

The Following criteria were used to assess the effect of the supplemented of garlic on fish growth was calculated according to Recker, (1975) and Castell and Tiews, (1980). feed utilizationwas calculated according to Stuart and Hung, (1989). Protein retention parameters was calculated according to Zehra and Khan, (2012).

### Analytical methods

Body components and experimental diets of moisture, crude protein, crude fats and ash were analyzed according to standard methods (AOAC, 2000).

**Table 1:** Ingredients and chemical composition (% DM) of theexperimental diets containing different percentages of garlic powder.

| Diets / Ingredients | Control (1) | Garlic powder 1% (2) | Garlic powder 1.5% (3) | Garlic powder 1.75% (4) |
|---|---|---|---|---|
| Garlic powder | - | 0.75 | 1 | 1.75 |
| Fish meal | 10 | 10 | 10 | 10 |
| Soybean meal | 30 | 30 | 30 | 30 |
| Local barley | 20 | 20 | 20 | 20 |
| Yellow corn | 18.5 | 18.5 | 18.5 | 18.5 |
| Wheat bran | 19 | 19 | 19 | 19 |
| Salt | 1 | 1 | 1 | 1 |
| Vita. & Miner. Mix. | 0.5 | 0.5 | 0.5 | 0.5 |
| Lime stone | 0.5 | 0.5 | 0.5 | 0.5 |
| Binder (bentonite) | 0.5 | 0.5 | 0.5 | 0.5 |

| Chemical composition | | | | | |
|---|---|---|---|---|---|
| Crude protein | Ether extract | Ash | Crude fiber | Nitrogen free extract | ME (MJ/Kg) |
| 25.45 | 3.54 | 6.97 | 4.75 | 52.2 | 13.17 |

*Calculated according to Smith's (1971) equation:
ME (MJ/Kg) = Protein × 18.8 + Fat × 33.5 + NFE × 13.8.

### Statistical analysis

Complete Randomized Design (CRD) used in data analysis by the Statistical Package for Social Science (SPSS, 2017) in analyzing the effect of experimental coefficients on the studied criteria and the significant differences between the mean characteristics of the characters examined by the multiple-ranged Duncan's test (Duncan multiple range test, 1955).

## Results and Discussion

### Growth criteria

#### 1. Criteria of final weight, weight gain and daily weight gain:

Results of statistical analysis of the fish growth performance 56 days after the trial period recorded in table 2 that indicated there were no significant differences ($P \leq 0.05$) in primary weight,

**Table 2:** Effect of garlic powder supplementation on final weight, weight gain and daily growth rate criteria of common carp (Mean ± SE).

| Criteria / Diets | Initial body weight (gm) | Final body weight (gm) | Total weight Gain (gm\fish) | Weight gain (gm/fish /day) |
|---|---|---|---|---|
| Control | 9.18±0.82 a | 15.31±0.97 a | 6.37±0.47 b | 0.114±0.008 b |
| Garlic powder 1% | 8.44±0.17 a | 16.01±0.128 a | 7.57±0.11 a | 0.135±0.002 a |
| Garlic powder 1.50% | 9.29±0.27 a | 16.59±0.499 a | 7.30±0.31 ab | 0.130±0.005 ab |
| Garlic powder 1.75% | 9.17±0.21 a | 16.98±0.398 a | 7.81±0.30 a | 0.144±0.004 a |
| *Rates with vertically similar letters do not differ significantly (P≤0.05). | | | | |

**Table 3:** Effect of garlic powder supplementation on RGR, SGR and survival rate criteria of common carp (Mean ± SE).

| Criteria / Diets | Relative growth rate | Specific growth rate | Survival rate % |
|---|---|---|---|
| Control | 71.29±2.67 c | 0.91±0.03 b | 100 |
| Garlic powder 1% | 89.84±2.75 a | 1.10±0.05 a | 100 |
| Garlic powder 1.50% | 78.60±3.09 bc | 1.07±0.02 a | 100 |
| Garlic powder 1.75% | 83.98±2.45ab | 1.11±0.03 a | 100 |
| *Rates with vertically similar letters do not differ significantly (P≤0.05). | | | |

which was 9 g / fish. Significant differences were not found between fish fed on experimental diets containing different levels of garlic powder in final body weight criteria (g / fish) which were 15.31 for control diet, 16.01, 16.59 and 16.98 for fish fed on diets containing 1 and 1.5 and 1.75% garlic powder respectively. Fish group fed on diets with 1% and 1.75% had higher total weight gain (7.75, 7.81 g\fish) as well as daily weight gain (0.135, 0.144g\fish) criteria than fish fed on control diet that reached about 15.31 and 0.114 g\ fish respectively. Allicin is the most vital compound of which induces increase in feed intake. Zeng, (1996) found adding allicin to tilapia diet increased its weight gain. These results are consistent with result of Farahi *et al.,* (2010) in rainbow trout and Diab *et al.,* (2008). in Nile tilapia..

**2. Survival, RGR and SGR rate:**

Survival rate was 100% in all fish groups fed on different experimental diets, meaning that they adapts well to aquaria environment and test diets. Data in table 3 showed that fish fed on garlic powder was significantly (P≤0.05) compared to control group (0% garlic-free). Fish fed on diets containing garlic powder increased by 1% and 1.75 significantly in relative growth rate (89.84% and 83.98% and specific growth 1.10 and 1.11, criteria respectively, while the value of these two criteria reached 71.29% and 0.91, respectively paralleled to control diet.

These results were consisted with many researchers who found that adding garlic to fish diets had positive results in improving growth characteristics of Nile tilapia *Oreochromisniloticus* (Soltan and El-Laithy, 2008, Shalaby *et al*., 2006, Abou-Zeid, 2008 and Metwally, 2009) and rainbow trout (Farahi *et al.*, 010).

**3. Food intake and feed conversion ratio:**

Results of statistical analysis of food intake showed that there was no significant effect due to the addition of garlic powder to different experimental diets on amount of food intake compared to control diet (Table 4). Meanwhile feed conversion ratio improved significantly (P≤0.05) for fish fed on diet contained 1, 1.5 and 1.75% which reached to 1.91, 2.16 and 1.90 for fish fed at diet 2nd, 3rd and 4th diet respectively and 2.35 for control diet.

Likewise, feed efficiency ratioimproved with increasing garlic powder amounts up to 52.24% and 52.24% of the 2nd and 4th diet respectively, while fish fed on control diet reached to 47.11%. However, when dietary garlic powder was increased utilization of food groupsincreased significantly (P≤0.05) compared to control (except fish fed at 1.50% garlic, 3rd treatment). These results agreed with Shalaby *et al*., (2006), Mehrim *et al*., (2014) in *Oreochromisniloticus* and Nya, (2009) in Rainbow trout fed with garlic supplemented diets.

**4. Protein intake and protein efficiency ratio:**

Results recorded in table indicated that there was no significant effect on the protein intake of fish fed on different levels of garlic powder compared to the control diet. Results showed that dietary additive with garlic powder 1% and 1.75% had a positive effect on PER which reached 2.05 (diet 2) and 2.06 among fish fed on control diet (1.73). This positive effect of addition of this type of medicinal herbs by 1, 1.5 and 1.75% had been demonstrated values of protein deposited (Table 5), where deposited protein rates of fish fed at 2nd, 3rd and 4th diets which

**Table 4:** Effect of garlic powder supplementation on food intake, feed conversion ratio of common carp (Mean ± SE).

| Criteria / Diets | Food intake (gm/fish) | Food intake (gm/fish/day) | Feed conversion ratio | Feed efficiency Ratio (%) |
|---|---|---|---|---|
| Control | 14.89±0.83 a | 0.266±0.015a | 2.35±0.06 a | 47.11±1.68 b |
| Garlic powder 1% | 14.50±0.11 a | 0.259±0.002a | 1.91±0.03 c | 52.24±0.78a |
| Garlic powder 1.50% | 15.72±0.40a | 0.281±0.007a | 2.16±0.056b | 46.42±1.25b |
| Garlic powder 1.75% | 14.92±0.96a | 0.266±0.012a | 1.90±0.061c | 52.45±1.59a |
| *Rates with vertically similar letters do not differ significantly (P≤0.05). | | | | |

**Table 5:** Effect of garlic powder supplementation on protein intake, protein efficiency ratio, protein retention and protein productive value criteria of common carp (mean± SE).

| Criteria / Diets | Protein consumption (gm/fish) | Protein efficiency ratio (PER) | Protein retention (gm/ fish) | Protein Productive Value (PPV) |
|---|---|---|---|---|
| Control | 3.79±0.21 a | 1.73±0.08 b | 1.09±0.09 b | 28.66±0.87 c |
| Garlic powder 1% | 3.69±0.03 a | 2.05±0.03 a | 1.52±0.02 a | 41.13±0.50 ab |
| Garlic powder 1.50% | 4.00±0.10 a | 1.82±0.05 b | 1.51±0.07 a | 37.71±1.14 b |
| Garlic powder 1.75% | 3.80±0.18 a | 2.06±0.06 a | 1.62±0.05 a | 45.08±3.93 a |
| *Rates with vertically similar letters do not differ significantly (P≤0.05). | | | | |

amounting to 1.52, 1.51 and 1.62 respectively caused in appear significant differences (P≤0.05) compared to fish fed on control diet (1.09 g \ fish).

Our current study of the protein productive value criterion where fish recorded in table 5 fed garlic powder at different levels was different significantly (P≤0.05) than the control diet which was 41.13%, 27.33%, 37.71 45.08 and 28.66% for diet 1, 2, 3 and 4 respectively. This results agree with Mehrim *et al.,* (2014) who obtain significant differences in PER, PPV and EU criterion by addition of 1% dry garlic lob.

This results are consistent with the results obtained by many researchers in enhancing the nutritional value of experimental diets as a result of adding garlic which reflected positively on growth performance and food utilization, within this context Gabor *et al*., (2012); Abdel-Hakim *et al*., (2010); Aly and Mohamed, (2010) and Ndong and Fall, (2007) in Nile tilapia and Jahanjoo *et al*., (2018), in Sobaity sea bream *(Sparidentex hasta*). The effects of bioactive components as diallylsulphides in garlic had positive effect on growth and feed utilization (Amagase and Milner, 1993), Moreover, garlic-containing allicin has a strong stimulating effect on olfactory sensation in most aquatic animals (Freeman and Kkodera, 1995 ), including *Pelodiscussinensis*, grass carp, common carp, golden fish and Nile tilapia (Lee and Gao, 2012). Allicin composes approximately 70% of all sulfur compounds (Han Yukheron, 1995). The containment of garlic with allicin improves intestinal microflora, which is reflected positively in improving digestion of nutrients, utilization of food energy (Khalil, Nadia and Soliman, 2001) and promoting immunity (EL-Afify, 1997), which positively boosted growth.This improvement in fish performance is due to the properties contained in this medicinal herb contains antioxidant and antimicrobial compounds (Sivam, 2001).

Pashaki, (2018) who found lower FCR when fed common carp on diet contained garlic extract, also Manoppo, Kolopita and Malatundah, (2016), mentioned additive garlic on common carp increased weight rate and SGR than control group.

**5. Protein, fat and ashretention:**

At the end of the trial period, the chemical components of edible portion of common carp fish body were recorded in table 5. Biochemical parameters of fish fed diets contained different level of garlic powder showed that protein and ether extract were significantly (P≤0.05) different compared with control diet. Data recorded in table 5 indicate that percentage of protein deposited directly with percentage additive of garlic which reached 17.89, 17.97 and 18.10% for fish fed on 2nd, 3rd and 4th respectively, meanwhile 16.04% for control diet. Results of statistical analysis of fat criteria in table 5 showed percentage of fat deposited in edible portion decreased with increasing the percentage of garlic but not significantly until to the percentage reached to 1.75%, which amounted to 7.65%, which differed significantly (P≤0.05) with control diet (8.81%). Table 5 shows that there were no significant differences in the moisture and ash criteria as a result of adding different levels of garlic powder to experimental diets.

These results are agreement with Mehrim *et al.,* (2014) who shows the addition of 1% garlic increased significantlyprotein content in their whole body, whereas total lipid and ash was decreased significantly compared with control. Many researchers have found that enhancing nutritional value of experimental feeds by adding garlic is an improvement in improvement of fish body component of Nile tilapia ( Khattab *et al*., 2004; Shalaby *et al*., 2006; Aly *et al*., 2008; Metwally, 2009; Mehrim, 2009). Likewise, in grass carp (Luo *et al*., 2008. On the other hand, addition of different levels of garlic did not affectedon chemical body composition (Diab *et al*., 2002). Abdel-Hakim *et al*., (2010) found no significant differences for the total body content of moisture, dry matter and

**Table 6:** Chemical composition (%) of the edible portion of common carp fed to different percentages of garlic is calculated based on wet weight (mean ± SE).

| Criteria / Diets | Dry weight | Total protein | Ether extract | Ash |
|---|---|---|---|---|
| Control | 27.68±0.48 a | 16.04±0.06 b | 8.81±07 a | 3.43±0.04 a |
| Garlic powder 1% | 28.36±0.50 a | 17.89±0.20 a | 8.16±0.25 ab | 3.46±0.03 a |
| Garlic powder 1.50% | 28.17±0.18 a | 17.97±0.15 a | 7.78±0.20 ab | 3.48±0.02 a |
| Garlic powder 1.75% | 28.02±0.12 a | 18.1±0.07 a | 7.65±0.06 b | 3.50±0.02 a |
| *Rates with vertically similar letters do not differ significantly (P≤0.05). | | | | |

ash, while the differences were significant for protein and fat when adding garlic to Nile tilapia diets.

Our findings in our study showed that there is an improvement in the chemical composition of common carp due to nutritional supplementation. Garlic powder can enhance the total plasma protein, which was reflected positively in improving growth performance, PER and PPV (Mehrim *et al*., 2014).

The valuable effects of garlic can be related to antioxidants such as vitamin C and selenium as well as other phytochemicals such as organosulpher compounds (Balasethil *et al*., 2000 and Songk, 2001), by their its ability to eliminate free radicals, prevents formation of lipid peroxides, promote of endogenous cellular antioxidant defenses like GSH (Boik, 2001). Allicin is an influence on feed intake and weight gain (Zeng, 1996).

## Conclusion

Results of oursearch showed supplemented diet with garlic powder improves productive performance, feed conversion ratio, protein retention and PPV parameters. While percentage of fat decreased significantly ($P \leq 0.05$), when fish fed on diet contained 1.75% garlic powder compared with control diet.

## Acknowledgment

The author are very grateful to university of Mosul, College of Agriculture and Forestry "for their provided facilities, which helped to improve quality for this work.

## References

Abdel-Hakim, N.F., M.M.E. Lashin, A.A.M. Al-Azab and A.M. Ashry (2010). Effect of fresh or dried garlic as a natural feed supplement on growth performance and nutrients utilization of the Nile tilapia *Oreochromisniloticus*. *Egypt J. Aquat. Biol. Fish*., **14:** 19-38.

Abou-Zeid, S.M. (2002). The Effect of Some Medical Plant on Reproductive and Productive Performance of Nile tilapia Fish. Ph.D. Thesis. Cairo University, Faculty of Agriculture, Cairo, Egypt.

Ali, M., K.K. Al-Qattan, F. Al-Enezi, R.M. Khanafer and T. Mustafa (2000). Effect of allicin from garlic powder on serum lipids and blood pressure in rats fed with a high cholesterol diet. *Prostaglandins Leukotrienes and Essential Fatty Acids*, **62:** 253-259.

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

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

Amagase, H., B.L. Petesch, H. Matsuura, S. Kasuga and Y. Itakura (2001). Intake of garlic and its bioactive components. *J. Nutr*., **131:** 955S-962S.

AOAD (2018). The Arab Organization for Agricultural Development, *Arab Fishery Statistics Yearbooks*, **11:** 155.

Association of Official Analytical Chemists (AOAC) (2000). 17th (ed). Vll, Washington, DC. USA. 125-291.

Balasethil, S., S. Arivazhagan and S. Nagini (2000). Garlic enhances circulatory antioxidants during 7,12- dimethyl benz (a) anthracence induced hamster buccal ponds carcinogenesis. *J. Ethnopharincol*, **72:** 429-433.

Boik, C. (2001). Antioxidant health effect of aged garlic extract. *J. Nutr*., **131:** 10105- 10155.

Castell, J.D. and K. Tiewes (1980). Report of the EIFAC, IUNS and ICES working group on the standardization of methodology in fish research, Hamburg, FRG, 21-23 March 1979. IFAC tech. Pap., **3(24)**.

Diab, A.S., S.M. Aly, John, G. Abde-Hadi and Yasser (2008). Effect of garlic, black seed and Biogen as immunostimulants on the growth and survival of Nile tilapia, *Oreochromisniloticus* (Teleostei: Cichlidae) and their response to artificial infection with *Pseudomonas fluorescens*. *African J. of Aquatic Science*, **33(1):** 63-68.

Diab, A.S., G.O. El-Nagar and Y.M. Abd-El-Hady (2002). Evaluation of *Nigella sativa* L. (black seeds; baraka), *Allium sativum* (garlic) and BIOGEN as feed additives on growth performance and immunostimulants of *O. niloticus* fingerlings. *Suez Canal Vet Me. J*., 745-775.

Duncan, C.B. (1955). Multiple rang and multiple " F " test. *Biometric*, **11:** 1-12.

FAO (2018). The State of World Fisheries and Aquaculture (2018): Meeting the sustainable development goals. Rome, License: CC BY-NC-SA 3.0 IGO: 210.

Farahi, A., M. Kasiri, M. Sudagar, M.S. Iraei and M.D. Shahkolaei (2010). Effect of garlic (*Allium sativum*) on growth factors, some hematological parameters and body compositions in rainbow trout *Oncorhynchusmykiss*. *AACL Bioflux,* **3(4):** 317-323.

Freeman, F. and Y. Kkodera (1995). Garlic chemistry: stability of S-(2-propenyl)-2-propene-1- sulphinothioate (Allicin) in blood, solvents and simulated physiological fluids, *J. Agric. Food Chem.*, **43:** 2332-2338.

Gabor, Erol-Florian, AurelŞara, M. Benţea, CălinaCreţa and AncaBaciu (2012). The effect of phytoadditive combinations on growth and consumption indices and resistance to *Aeromonashydrophila* in common carp *Cyprinus carpio* juveniles. *Animal Science and Biotechnologies*, **45(2):** 48-52.

Ganguly, S., K.C. Dora, S. Sarkar and S. Chowdhury (2013). Supplementation of prebiotics in fish feed: a review. *Reviews in Fish Biology and Fisheries,* **23:** 195-199.

Gowsala P. Sivam (2001). Protection against *Helicobacter pylori* and other bacterial infections by garlic. *American Society for Nutritional Sciences*., 1106S-1106S.

Han, J., L. Lawson, G. Han and P.A. Han (1995). Spectrophotometric method for quantitative determination of allicin and total garlic thiosulfinates. *Analytical Biochemistry*, **225:** 157-160.

Jahanjoo, V., M. Yahyavi, R. Akrami and A.H. Bahri (2018). Influence of adding Garlic (*Allium sativum*), Ginger (*Zingiberofficinale*), Thyme (*Thymus vulgaris*) and their combination on the growth performance, haemato Immunological parameters and disease resistance to *Photobacteriumdamselae* in sobaity sea bream (*Sparidentex hasta*) fry. *Turkish Journal of Fisheries and Aquatic Sciences*, **18:** 633-645.

Jassim, A.A.R., M.A. Almaktar, A.A. Jabir and K.H. Hasoni (2013). Field study of fish farming status in Basrah governorate. *Iraqi J. Aquacult*., **10(1):** 63-74. (In Arabic).

Kang, N.S., E.Y. Moon, C.G. Cho and S. Pyo (2001). Immunomodulating effect of garlic component, allicin, on murine peritoneal macrophages. *Nutrition Research*, **21:** 617-626.

Khalil, R.H., B.M. Nadia and M.K. Soliman (2001). Effects of Biogen and Levamisol Hcl on the immune response of cultured Oreochromisniloticus to Aeromonashydrophila vaccine. *Beni-Suef Vet. Med. J., Egypt,* **XI(2):** 381-392.

Khan, M.N., K. Shahzad, A. Chatta, M. Sohail, M. Piria and T. Treer (2016). A review of introduction of common carp *Cyprinus carpio* in Pakistan: Origin, purpose, impact and management. *Croat. J. Fish*., **74:** 71-80.

Khattab, Y.A.R., M. Abdel-Tawwab and M.H. Ahmad (2004). Effect of protein level and stocking density on growth performance, survival rate, feed utilization and body composition of Nile tilapia fry *Oreochromisniloticus* L.. In: Bolivar, R, Mair, G. and Fitzsimmons, K. (eds). Proceedings of the Sixth International Symposium on Tilapia in Aquaculture, Manila, Philippines, BFAR, Philippines, 264-276.

Lawson, L.D., Z.J. Wang and D. Papadimitriou (2001). Allicin release under simulated gastrointestinal conditions from garlic powder tablets employed in clinical trials on serum cholesterol. *Planta. Medica.*, **67:** 13-18.

Lee, Jeong-Yeol and Gao, Yang (2012). Review of the Application of Garlic, *Allium sativum*, in Aquaculture. *Journal of The World Aquaculture Society*, **43(4):** 447-458.

Ljubojevi, D.,V. Radosavljevi, M. Peli, V. Orevi, B.M. Živkov and M. Irkovi (2016). Fatty acid composition, chemical composition and processing yield of traditional hot smoked common carp (*Cyprinus carpio* L). *Iran. J. Fish. Sci*., **15(4):** 1293-1306.

Manoppo, H., M.E.F. Kolopita and R. Malatundah (2016). Growth promoter effects of Garlic (Allium sativum) on carp (*Cyprinus carpio* L.). *International Journal of Pharmtech. Research*, **9(4):** 283-288.

Metwally, M.A.A. (2009). Effects of garlic (*Allium sativum*) on some antioxidant activities in tilapia Nilotica (*Oreochromisniloticus*). *World J. Fish Mar. Sci*., **1(1):** 56-64.

Mehrim, A.I., F.F. Khalil and M.M. Refaey (2014). Evaluation of dietary addition of garlic *Allium sativum* L. lobes on growth performance, feeding utilization and physiological responses of *Oreochromisniloticus*, fingerlings.*Abbassa Int. J. Aqua*., **7(2):** 342-361.

Ndong, D. and J. Fall (2011). The effect of garlic (Allium sativum) on growth and immune responses of hybrid tilapia (*Oreochromisniloticus x Oreochromisaureus*). *Journal of Clinical Immnunology and Immunopathology Research*, **3(1):** 1-9.

Nya, E.J. and B. Austin (2009). Use of garlic *Allium sativum* to control *Aeromonashydrophila*infection in rainbow trout, *Oncorhynchusmykiss* (Walbaum). *J. Fish Dis*., **32:** 963-970.

Pashaki, A. Karimi, S.M.J. Zorriehzahra, M. Ghasemi, M. Sharif Rohani and S.M. Hosseini (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(2):** 28-39.

Recker, W.E. (1975). Computation and interpretation of biological statistics of fish population. *Fish Res. Borard Can. Bull*., 191.

Saleh, K.I. (2019). Statistics of Iraqi Association of Fish Producers, International Conference of Soybean Producers Association 28-29 September, 2019, Dubai, United Arab Emirates.

Shalaby, A.M., Y.A. Khattab and A.M. Abdel Rahman (2006). Effects of garlic (*Allium sativum*) and chloramphenicol on growth performance, physiological parameters and survival of Nile tilapia *Oreochromisniloticus*. *J. Venom. Anim. Toxins*., **12(2):** 172-201.

Smith, R.G. (1971). A method for measuring digestibility and metabolizable of energy of feeds. Progressive Fish-Culturist., **33:** 132 -134.

Soltan, M.A. and S.M. El-Laithy (2008). Effect of probiotics and some spices as feed additives on the performance and behavior of the Nile tilapia, *Oreochromisniloticus*. *Egypt J. Aquat. Biol. Fish*., **12:** 63-80.

Songk, M. (2001). The influence of heating on the anticancer properties of garlic. *J. Nutr*., **131:** 10545-10575.

SPSS (2017). Statistical package for the social sciences. Ver. 25.

Stuart, J.S. and S.S.O. Hung (1989). Growth of juvenile white sturgeon (acipensertransmontanus) fed different proteins. *J. Aquaculture*. **76:** 303-316.

Wu, C.C., L.Y. Sheen, H.W. Chen, S.J. Tsai and C.K. Lii (2001). Effects of organosulfur compounds from garlic oil on the antioxidation system in rat liver and red blood cells. *Food and Chemical Toxicology*, **39:** 563-569.

Zehra, S. and M.A. Khan (2012). Dietary protein requirement for fingerling Channapunctatus (Bloch), based on growth, feed conversion, protein retention and biochemical composition. *Aquaculture International*, **20(2):** 383-395.

Zeng, H., Z.L. Ren and Q. Guo (1996). Application of allicin in tilapia feed, *China Feed*, **21:** 29-30.