Effect of garlic on growth performance and body composition of benni fish (*Mesopotamichthys sharpeyi*)

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**Abstract**

A feeding trial was conducted to evaluate the effect of garlic powder on the growth performance and body composition of Benni fish (*Mesopotamichthys sharpeyi*). Five isonitrogenic and isolipidic diets were prepared with levels of 0 (control), 5, 10, 20 and 30 g kg⁻¹ Garlic powder. Triplicate groups (15 fish per tank) of Benni fish with initial weight of 11.30±0.04 g were hand-fed to visual satiation at two meals per day for 8 weeks. The result of experiment showed, growth performance and feed efficiency were improved in all treatments compared with control group. But according to the results, the best final weight, weight gain rate (WGR%), specific growth rate (SGR) and food conservation ratio (FCR) were observed in the fish fed 10 g kg⁻¹ garlic powder in diet. The highest protein content was obtained in the fish fed with dietary with 10 g kg⁻¹ garlic powder. Also fat tissue of fish had significantly decreasing trend compared with control group. Moisture and ash contents were no significantly affected by garlic powder. Based on the results of growth performance and body composition of fish, it can be concluded that 10 g kg⁻¹ of garlic powder have good effect on growth performance and body composition of Benni fish.

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Introduction

Good nutrition in animal production systems is essential to economically produce a healthy, high quality product. In fish farming, nutrition is critical because feed represents 40-50% of the production costs. Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health. The development of new species-specific diet formulations supports the aquaculture (fish farming) industry as it expands to satisfy increasing demand for affordable, safe, and high-quality fish and seafood products (Craig and Helfrich, 2002).

More recently, the use of antibiotics as a growth promoters in diets of animal and fish is restricted by the government because of the harmful effects on human health (Botsoglou and Fletouris, 2001; Williams and Losa, 2001; McCartney, 2002). So, because of negative impact of it, researchers try on alternatives to antibiotics that may keep fish healthy such as probiotics and plant based immunostimulants (Sahu et al., 2007). In addition, the global demand for safe food has prompted the search for natural alternative growth promoters to be used in aquatic feeds. There has been heightened research in developing new dietary supplementation strategies in which various health and growth promoting compounds as probiotics, prebiotics, synbiotics, phytobiotics and other functional dietary supplements have been used (Denev, 2008). In concerning evaluation of phytobiotics in aquaculture is a relatively new area of research showing promising results (Cristea et al., 2012).

A member of the Liliaceae family, garlic was used for centuries as a spice and also in popular medicine. It is a rich source of calcium and phosphorus; it has a high content of carbohydrates and as a consequence a high nutritive value. Garlic also contains iodine salts which have positive effects on the circulatory system and rheumatism, silicates which have a positive effect on the skeletal and circulatory system and sulfur salts with positive effects on the skeletal system, cholesterolemia and liver diseases. Another substance with a major role is aliicin, which has anthelmintic effects (Gabor et al., 2012).

The fresh bulb contains alliin, allicin and volatile oils. When the garlic clove is crushed, the odorless compound alliin is converted to allicin, via the enzyme allinase. Allicin gives garlic its characteristic pungent smell (Williamson, 2003). Also, it contains vitamins and minerals (Gruenwald, 2004) and trace elements (selenium & germanium) (Skidmore-Roth, 2003). Allicin (diallylthiosulfinate) is the most abundant compound representing about 70% of all thiosulfonates present, or formed in crushed garlic (Block, 1992; Han et al., 1995).

Benni fish (Mesopotamichthys sharpeyi) is the one of the aquaculture species in Iran and Iraq. Mesopotamichthys sharpeyi which is locally known as Benni. It is one of 300 Barbus species in the world and 15 known Barbus species in Iran. There is an increasing interest in this species for aquaculture purposes. It also contains 23% of the total fish production in Iraq (Abdoli, 1999).

Until now, no trial has been conducted to study the effect of dietary garlic powder on growth of Benni fish (Mesopotamichthys sharpeyi). Therefore, this study was designed to investigate the optimal level of dietary garlic powder on growth performance and body composition of Benni fish.

Materials and methods

Diet preparation

Fresh garlic bulbs were purchased from a local market (Abadan, Khouzestan, Iran). After peeling garlic was cut into small pieces and dried in air for five days. Ingredients and nutrient contents of the experimental diets are presented in Table 1. Five diets were formulated to contain 0, 5, 10, 20 and 30 g kg⁻¹ Garlic powder as the Control, T1, T2, T3 and T4. All ingredients were thoroughly mixed with 300 g kg⁻¹ distilled water, and pellets were prepared using a moist pelleting machine. The pellets were dried at room temperature for 24 h and ground into desirable particle sizes. The dried diet was packaged into plastic...
bag and stored frozen at -20°C until use.

**Growth experiment**

Juveniles of Benni (*Mesopotamichthys sharpeyi*) were obtained from a local farm (Shoushtar, Khouzestan, Iran). The fish were acclimated to laboratory condition for 2 weeks before starting the feeding trial. Juveniles fish (initial mean weight, 11.30±0.04 g) were allocated randomly into 150 L circular plastic tanks with 15 fish per each tank for the feeding trial after being collectively weighed. Three replicate groups of fish were hand-fed to apparent satiation two times a day (9:00 and 16:00) for 8 weeks. During the experimental period, mean water temperature was 25.49±0.78°C, dissolved oxygen was 7.69±0.55 mg L⁻¹ and the pH was 7.13±0.19. The photoperiod was left under natural conditions during the feeding trial. At the end of experiment, juvenile Benni fish in each tank were collectively weighed after anesthetizing with Carnation powder at a concentration of 30 mg L⁻¹ after starvation for 24 h.

**Diets and whole body chemical analysis**

Five fish from each tank were randomly sampled and stored at -20°C in freezer for proximate composition at the end of experiment. Proximate analysis of diets and fish were determined according to the method of AOAC (1995). Crude protein content was determined using the Kjeldahl method using an Auto Kjeldahl System. Crude lipid was analyzed by ether extraction, moisture content by a dry oven drying at 105°C for 24 h and ash by a furnace muffler (550°C for 4 h).

**Statistical analysis**

In outline, this study was planned and executed entirely by accident. All data are collected normal distribution using the Shapiro-Wilk test was performed, and significant differences between treatments at different levels (p ≤ 0.05) using ANOVA (One-way ANOVA) and post- Duncan test was examined. Analysis of all the data and the operations were performed by SPSS 19 software.

**Results**

The result of growth performance of Benni fish fed the experimental diets were presented in Table 2. The result of experiment showed, the use of garlic in diet of fish induces to increase growth performance in all treatments compared with control group. But a group of fish fed with 10 g kg⁻¹ garlic powder in diet had significantly higher growth performance compared with control group (p<0.05). Furthermore using 2% and 3% garlic in diet of fish induced lower growth performance than 1% garlic powder in diet but was not significantly different (p>0.05). Also, 10 g kg⁻¹ garlic powder in diet of fish induced higher weight gain (gr, %) and SGR than other groups that was significantly different compared with control group (p<0.05). FCR of all fish fed garlic powder were significantly lower than control group (p<0.05). But fish fed 10 g kg⁻¹ garlic powder had the lowest FCR among treatments. Also, the results of the body composition of Benni fish fed the experimental diets were presented in Table 3. The results showed the highest amount of protein in treatment 2 that was significantly different compared with control group (p>0.05). But It was not observed significant difference among other treatments (p>0.05). The use of garlic in the diet of all treatments leads to reduced significantly body fat compared with control group (p<0.05). Ash content of fish had increasing trend but was not significantly different compared with control group (p>0.05). Also, the moisture content of fish was not significantly different compared with control group (p>0.05).

**Discussion**

Garlic (*Allium sativum*) is probably one of the earliest known medicinal plants and has been used to improve growth and resistance of a number of livestock and fish (Megbowon *et al.*, 2013). Garlic is an important vegetable extensively cultivated in many countries. It is used as food for humans, animals and as remedy for several diseases in folk medicine (Shalaby *et al.*, 2006). Now days antibiotics are largely used for treatment and control or reduce harmful bacterial contamination, so need to replace...
them with natural substances to avoid from bad effects of them (Farahi et al., 2010).

The result of our experiment showed that 5-30 g kg\(^{-1}\) garlic powder in diets has beneficial effect on growth performance and body composition of Benni fish. The final weight, weight gain and SGR increased significantly in all groups fed on garlic. But the highest growth performance was observed in fish fed 10 g kg\(^{-1}\) garlic in diet. Different Studies were conducted on the effects of garlic powder on growth performance and feed efficiency of different fish species.

Table 1. Formulation and proximate composition of experimental diets (%).

<table>
<thead>
<tr>
<th></th>
<th>Experimental Diets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
</tr>
<tr>
<td><strong>Dietary composition</strong></td>
<td></td>
</tr>
<tr>
<td>Kilka fish meal(^a)</td>
<td>24.5</td>
</tr>
<tr>
<td>Wheat flour</td>
<td>26.3</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>10.0</td>
</tr>
<tr>
<td>Corn gluten meal</td>
<td>15.0</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>10.0</td>
</tr>
<tr>
<td>Fish Oil(^b)</td>
<td>3.0</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>3.0</td>
</tr>
<tr>
<td>Molasses</td>
<td>1.0</td>
</tr>
<tr>
<td>Vitamin premix(^c)</td>
<td>2.0</td>
</tr>
<tr>
<td>Mineral premix(^d)</td>
<td>2.0</td>
</tr>
<tr>
<td>Antioxidants(^e)</td>
<td>0.2</td>
</tr>
<tr>
<td>Filler</td>
<td>3.0</td>
</tr>
<tr>
<td>Garlic powder</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Proximate Analyses (DM)</strong></td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td>10.7</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>35.8</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>10.9</td>
</tr>
<tr>
<td>Energy(kcal/100gr)</td>
<td>360</td>
</tr>
</tbody>
</table>

\(^a\) Clopeonella meal, Iran
\(^b\) Kilka oil, Mazandaran Co, Iran
\(^c\) Vitamin premix (composition per 1 kg): A=1600000 IU, D\(_3\)=400000 IU, E=40000 mg, K\(_3\)=2000 mg, B\(_1\)=6000 mg, B\(_2\)=8000 mg, B\(_3\)=12000 mg, B\(_5\)=40000 mg, B\(_6\)=4000 mg, B\(_9\)=2000 mg, B\(_12\)=8 mg, H\(_2\)=40 mg, C=60000 mg, Inositol=20000 mg
\(^d\) Mineral premix (composition per 1 kg): Iron:60000 mg, Zinc:10000 mg, Selenium:20 mg, Cobalt:100 mg, Copper:6000 mg, Manganese:5000 mg, Iodine:600 mg, CoCl\(_2\):6000 mg
\(^e\) Antioxidant: Butylated hydroxytoluene (BHT)

DM, dry matter.

Khalil et al., (2001) reported that allicin in garlic through improving digestion and performance of intestinal flora leads to enhance the utilization of energy and better growth in Nile tilapia (Oreochromis niloticus). Also, Diab et al (2002) reported that feeding fish with 2.5% garlic resulted highest growth performance in the Nile tilapia (Oreochromis niloticus). This is in agreement with Shalaby et al. (2006) who reported significant increased weight gain and specific growth rate (SGR) in the Nile tilapia (Oreochromis niloticus) when fed diet containing 30g kg\(^{-1}\) garlic powder in diet. Furthermore, the results of (Mesalhy Aly et al., 2008) confirm the positive effect of garlic powder on growth performance of Niletilapia. Also other studies conducted by Nya and Austin (2009) on Onchorhynchus mykiss, (Farahi et al., 2010) on rainbow trout (Oncorhynchus mykiss), (Lee et al., 2012) on Sterlet Sturgeon (Acipenser...
ruthenus), (Guo et al., 2012) on (Epinephelus coioides), (Nwabueze et al., 2012) on (Clarias gariepinus) and (Mebowon et al., 2013) on cichlid fish demonstrate that the use of garlic in improving growth performance in different fish species.

Generally, improved growth performance in treatments containing garlic powder can be attributed to containing sulfur compounds in garlic, such as allicin, which secretes digestive enzymes, stimulates appetite and balances intestinal bacterial flora. So, leads to increase food intake and improves digestion. (Khalil et al., 2001; Platel and Srinivasan, 2004; Samadi, 2012; Talpur and Ikhwanuddin, 2012). On the other hand, higher levels of garlic powder in the diet of different fish species induce a decline in growth, due to the pungent smell of garlic. Metwally (2009) reported that although growth is enhanced with garlic supplementation but high dose of garlic in fish may reduce feed intake as a result of its unpleasant odour. It was announced that reduction in weight of fish with high levels of garlic powder is related to the negative effect of smell and pungent taste of garlic that leads to reduce fish feed intake (Mesalhy Aly et al., 2008; Platel and Srinivasan, 2004).

Table 2. Growth performance of juvenile Benni fish fed the experimental diets for 8 weeks.

<table>
<thead>
<tr>
<th>Diets</th>
<th>Con</th>
<th>0.5%</th>
<th>1%</th>
<th>2%</th>
<th>3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial average weight (g fish^-1)</td>
<td>11.31±0.16\textsuperscript{ab}</td>
<td>11.30±0.09</td>
<td>11.31±0.08</td>
<td>11.33±0.12</td>
<td>11.28±0.12</td>
</tr>
<tr>
<td>Final average weight (g fish^-1)</td>
<td>16.81±0.17\textsuperscript{a}</td>
<td>17.49±0.09\textsuperscript{b}</td>
<td>17.61±0.25\textsuperscript{b}</td>
<td>17.30±0.20\textsuperscript{ab}</td>
<td>17.28±0.29\textsuperscript{ab}</td>
</tr>
<tr>
<td>Weight gain (g fish^{-1})</td>
<td>5.50±0.03\textsuperscript{a}</td>
<td>6.19±0.11\textsuperscript{b}</td>
<td>6.30±0.17\textsuperscript{b}</td>
<td>5.97±0.08\textsuperscript{ab}</td>
<td>6.0±0.17\textsuperscript{ab}</td>
</tr>
<tr>
<td>Weight gain percent</td>
<td>48.61±0.63\textsuperscript{a}</td>
<td>54.84±1.34\textsuperscript{b}</td>
<td>55.70±1.11\textsuperscript{b}</td>
<td>52.67±0.21\textsuperscript{ab}</td>
<td>53.19±1.11\textsuperscript{ab}</td>
</tr>
<tr>
<td>Specific growth rate (%)</td>
<td>0.70±0.01\textsuperscript{a}</td>
<td>0.78±0.03\textsuperscript{b}</td>
<td>0.79±0.02\textsuperscript{b}</td>
<td>0.75±0.01\textsuperscript{ab}</td>
<td>0.77±0.02\textsuperscript{ab}</td>
</tr>
<tr>
<td>Food conversion ratio</td>
<td>2.84±0.03\textsuperscript{a}</td>
<td>2.48±0.07\textsuperscript{b}</td>
<td>2.34±0.06\textsuperscript{b}</td>
<td>2.43±0.08\textsuperscript{ab}</td>
<td>2.56±0.07\textsuperscript{b}</td>
</tr>
<tr>
<td>Survival</td>
<td>97.76±2.23\textsuperscript{ab}</td>
<td>97.76±2.23</td>
<td>97.76±2.23</td>
<td>100</td>
<td>95.56±4.43</td>
</tr>
</tbody>
</table>

Values (means ± SE of three replication) in the same row not sharing a common superscript are significantly different (P < 0.05).

ns = not significant (P > 0.05).

\textsuperscript{1}Weight gain = final weight-initial weight

\textsuperscript{2}Weight gain percent = [(final weight-initial weight)/initial weight] × 100

\textsuperscript{3}Specific growth rate (%) = [ln (final fish wt.) - ln (initial fish wt.)] × 100/days of feeding.

\textsuperscript{4}Food conversion ratio = weight gain/ feed intake

\textsuperscript{5}Survival = (final fish number / initial fish number) × 100.

The result of the experiment showed that using different levels of garlic powder induce higher protein and lower fat content in body of Benni fish. Farahiet al., (2010) reported that the use of garlic with levels of 1, 2 and 3% in diets of rainbow trout for 60 days caused a significant difference in percentage of crude protein, crude fat and ash content in the carcasses of fish compared with the control group. Shalaby et al., (2006) reported the highest crude protein content of Nile tilapia because of 30 gr kg^{-1} garlic in diet. Also, it was observed the lowest fat content in fish fed 30 gr kg^{-1} garlic in diet. Furthermore, Talpur and Ikhwanuddin, 2012, announced lower fat content in body of sea bass fed garlic in diet. Generally, the result of body composition of Benni fish is in agreement with these studies.

Kamruzzaman et al., (2011) demonstrated that the presence of nitrogen reserves in the body is a key indicator of protein content in the body. Also, they said that compounds in garlic, have positive effects.
On nitrogen balance in the body of fish through effect on the proteolytic activity of bacteria in the digestive tract of tested animals. Also, Wanapat et al., 2008 reported that garlic causes digestion, absorption, and retention of nitrogen in the mammals (Samadi, 2012). On the other hand, Banerjee and Maulik (2002) demonstrated that compounds in garlic lower the activity of lipogenic and cholesterogenic enzymes such as malic enzyme, Fatty Acid Synthase in Liver. Also, compounds in garlic increase the excretion of acidic and neutral steroids that cause the excretion of cholesterol from the body content. Water-soluble sulfur compounds such as S-allyl Sulfur Sait cysteine (SAC) and Diallyl-di-sulfide (DADS) of garlic extract inhibit synthesis of cholesterol (Yeh and Liu, 2001; Gebhardt and Beck, 1996). As well as allicin of garlic causes inhibition of accumulation of fat in body (Elkayam et al., 2003).

Table 3. Proximate composition (%) of the whole body of Benni fish fed the experimental diet for 8 wee.

<table>
<thead>
<tr>
<th>Diets</th>
<th>Crude protein</th>
<th>Crude lipid</th>
<th>Moisture</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Con</td>
<td>14.33±0.14 a</td>
<td>8.34±0.09 a</td>
<td>71.33±0.22 a</td>
<td>3.41±0.18 ns</td>
</tr>
<tr>
<td>0.5%</td>
<td>14.70±0.20 ab</td>
<td>7.71±0.09 b</td>
<td>71.40±0.19 b</td>
<td>3.67±0.14</td>
</tr>
<tr>
<td>1%</td>
<td>15.04±0.18 b</td>
<td>7.32±0.12 b</td>
<td>72.23±0.23 b</td>
<td>3.73±0.14</td>
</tr>
<tr>
<td>2%</td>
<td>14.96±0.09 ab</td>
<td>7.38±0.10 b</td>
<td>71.91±0.10</td>
<td>3.74±0.13</td>
</tr>
<tr>
<td>3%</td>
<td>14.89±0.39 ab</td>
<td>7.37±0.16 b</td>
<td>71.80±0.31</td>
<td>3.81±0.05</td>
</tr>
</tbody>
</table>

Values (mean ± SE of three replication) in the same row not sharing a common superscript are significantly different (P < 0.05).

The differences between the various experiments can be related to the differences in the amount of sulfur compounds in the extracts and essential oils, species difference, type of food, the period of the trial, and the method of lipid analysis (Yeh and Liu, 2001; Silagy and Neil, 1994; Warshafsky et al., 1993). Also, increasing of body ash is related to the constant access to food and absorbing minerals and nutrients by aquatic organisms (Tacon et al., 2002; Samadi, 2012).

Generally based on the result of growth performance and body composition it can be recommended 10 gr kg⁻¹ garlic powder as a natural alternative growth promoters in diet of juveniles (Mesopotamichthys sharpeyi).

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