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

Milad Maniat[1], Negar Ghotbeddin[1*], Ebrahim Rajabzadeh Ghatrami[2]

[1]*Department of Fisheries, College of Agriculture and Natural Resources, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran*

[2]*Department of Fisheries, Faculty of Marine Natural Resources, Khorramshahr University of Marine Science and Technology, Khorramshahr, Iran*

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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.

* **Corresponding Author:** Negar Ghotbeddin ✉ ghotbeddiny2005@gmail.com

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,theuse ofantibiotics as a growth promoters in diets of animal and fish is restricted by thegovernmentbecause of theharmful effects on human health(Botsoglu 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 basedimmunostimulants (Sahu *et al*., 2007). In addition, the global demand for safe food has prompted the search for natural alternative growthpromoters to be used in aquatic feeds. There has been heightened research in developingnew dietary supplementation strategies in which various health and growth promotingcompounds as probiotics, prebiotics, synbiotics, phytobiotics and other functionaldietary 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 (diallythiosulfinate) is the most abundant compound representing about 70% of all thiosulfinates 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 (*Mesopotamichthyssharpeyi*) 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 trail. 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℃ 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 proteincontent was determined using the Kjeldahl methodusing an Auto Kjeldahl System.Crude lipid was analyzed by ether extraction,moisture content by a dry oven dryingat 105℃ for 24 h and ash by a furnace muffler (550℃ for 4h).

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 ($p \leq 0/05$) 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 Table2. 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 Table3. The resultsshowed thehighest amount ofproteinin 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 ofgarlicinthe diet of all treatmentsleads to reduced significantly body fatcompared withcontrol 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 theeffects ofgarlic powder on growth performance and feed efficiency of different fish species.

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

	Experimental Diets				
	0%	0.5%	1%	2%	3%
Dietary composition					
Kilka fish meal[a]	24.5	24.5	24.5	24.5	24.5
Wheat flour	26.3	26.3	26.3	26.3	26.3
Soybean meal	10	10	10	10	10
Corn gluten meal	15	15	15	15	15
Wheat bran	10	10	10	10	10
Fish Oil [b]	3	3	3	3	3
Soybean oil	3	3	3	3	3
Molasses	1	1	1	1	1
Vitamin premix[c]	2	2	2	2	2
Mineral premix[d]	2	2	2	2	2
Antioxidants[e]	0.2	0.2	0.2	0.2	0.2
Filler	3	2.5	2	1	0
Garlic powder	0	0.5	1	2	3
Proximate Analyses (DM)					
Moisture	10.7	10.8	10	10.7	10.9
Crude protein (%)	35.8	35.7	35.6	35.9	35.8
Crude fat (%)	10.9	10.6	10.8	10.9	10.7
Energy(kcal/100gr)	360	360	360	360	360

[a]Clopeonella meal, Iran

[b] Kilka oil, Mazandaran Co, Iran

[c]Vitamin premix (composition per 1kg): A=1600000 IU, D3=400000 IU, E=40000 mg, K3=2000 mg, B1=6000 mg, B2=8000 mg, B3=12000 mg, B5=40000 mg, B6=4000 mg, B9=2000 mg, B12=8 mg, H2=40 mg, C=60000 mg, Inositol=20000 mg

[d]Mineral premix (composition per 1kg): Iron:6000 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)confirmthe positive effectsof garlic powderon growth performanceof 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(Megbowon*et al*., 2013) on cichlid fish demonstratetheuse ofgarlicherbimproves growthperformancein different fishspecies.

Generally, improvedgrowth performanceintreatments containing garlic powder canbeattributed tocontainingsulfurcompoundsin garlic, such as allicin, which secretesdigestive enzymes,stimulatesappetite andbalancingintestinalbacterialflora.Soleads toincrease food intake and improvesdigestion. (Khalil *et al*., 2001; Platel and Srinivasan, 2004; Samadi, 2012; Talpur and Ikhwanuddin, 2012). On the other hand, higher levels of garlic powder in diet of different fish species induce to decline growth, due to pungent smellof 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 inweight of fish with high levels of garlic powder is related to negative effect of smell andpungent tasteof garlic that leads to reduce fishfeed 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.

	Diets				
	Con	0.5%	1%	2%	3%
Initial average weight (gfish^{-1})	11.31±0.16^{ns}	11.30±0.09	11.31±0.08	11.33±0.12	11.28±0.12
Final average weight (g fish $^{-1}$)	16.81±0.17^{a}	17.49±0.09^{b}	17.61±0.25^{b}	17.30±0.20^{ab}	17.28±0.29^{ab}
[1]Weight gain (g fish^{-1})	5.50±0.03^{a}	6.19±0.11^{b}	6.30±0.17^{b}	5.97±0.08^{ab}	6±0.17^{ab}
[2]Weight gain percent	48.61±0.63^{a}	54.85±1.34^{b}	55.70±1.11^{b}	52.67±0.21^{ab}	53.19±1.11^{ab}
[3]Specific growth rate[1] (%)	0.70±0.01^{a}	0.78±0.03^{b}	0.79±0.02^{b}	0.75±0.01^{ab}	0.77±0.02^{b}
[4]Food conversion ratio	2.84±0.03^{a}	2.48±0.07^{b}	2.34±0.06^{b}	2.43±0.08^{b}	2.56±0.07^{b}
[5]Survival	97.76±2.23^{ns}	97.76±2.23	97.76±2.23	100	95.56±4.43

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

ns= not significant ($P > 0.05$).

[1]Weight gain= final weight-initial weight

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

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

[4]Food conversion ration= weight gain/ feed intake

[5]Survival= (final fish number / initial fish number) × 100.

The result of experiment showed that using different levels of garlic powder induce higher protein and lower fat content in body of Benni fish. Farahi*et al*, (2010) reportedthat the use ofgarlicwithlevels of 1, 2and3%in diets of therainbow troutfor 60 dayscaused asignificant differencein thepercentage ofcrude protein, crude fatand ash content inthe carcassesoffish compared with control group. Shalaby*et al*, (2006)reported thehighest crudeprotein content of Niletilapia because of 30 gr kg^{-1} garlic in diet.Also,it was observed the lowest fatcontentinfish fed30 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 thatthe presence ofnitrogen reserves in thebody is a key indicator ofprotein contentin the body. Also, they said thatcompounds ingarlic, havepositive effects

onnitrogen balancein the body of fish through effectonthe proteolytic activity ofbacteria inthe digestive tractof tested animals. AlsoWanapat*et al.*,2008reported thatgarliccausesdigestion,absorption andretention ofnitrogen inthemammals (Samadi, 2012). On the other hand, BanerjeeandMaulik (2002)demonstrated thatcompounds ingarlic lower the activityof lipogenic and cholestrogenic enzymessuch asmalicenzyme, Fatty AcidSynthaseinLiver. Also, Compounds ingarlicincrease theexcretion ofacidic and neutralsteroids that cause theexcretion ofcholesterolfromthe body content. Water-solublesulfur compoundssuch asS-alLyl Sulfur Said cysteine (SAC)and Diallyl-di-sulfide (DADS)ofgarlic extractinhibitthesynthesis ofcholesterol (Yeh and Liu, 2001; Gebhardt and Beck, 1996). As well asallicin ofgarliccausesinhibition 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.

	Diets				
	Con	0.5%	1%	2%	3%
Crude protein	14.33±0.14^{a}	14.70±0.20^{ab}	15.04±0.18^{b}	14.96±0.09^{ab}	14.89±0.39^{ab}
Crude lipid	8.34±0.09^{a}	7.71±0.09^{b}	7.32±0.12^{b}	7.38±0.10^{b}	7.37±.16^{b}
Moisture	71.33±0.22^{ns}	71.40±0.19	72.23±0.23	71.91±0.10	71.80±0.31
Ash	3.41±0.18^{ns}	3.67±0.14	3.73±0.14	3.74±0.13	3.81±0.05

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

The differencesbetween thevarious experimentscan berelated by thedifferenceintheamount ofsulfur compoundsinthe extracts andessential oils, speciesdifference, type of food, theperiodof thetrial and method of lipid analysis (Yeh and Liu, 2001; Silagy and Neil, 1994; Warshafsky *et al.*, 1993). Also, increasingofbody ash is related tothe constantaccessto foodand absorbingminerals andnutrientsbyaquatic 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 growthpromoters in diet of juveniles (*Mesopotamichthys sharpeyi*).

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