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FULL LENGTH ARTICLE

Evaluation of garlic and onion powder as phyto-additives in the diet of sea bass (*Dicentrarcus labrax*)

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Abstract The present study is a preliminary work which was conducted to evaluate the impact of adding 3 levels of garlic (10, 20 and 30 g/kg diet) as well as onion powder (5, 10 and 20 g/kg diet) in a basal diet of sea bass (*Dicentrarcus labrax*) fry (initial weight = 0.4 ± 0.05 g/fish) on growth performance, feed utilization, body composition, survival rate and some hematological parameters. The present results suggested that dietary garlic or onion powder administrated separately at levels of 30 or 10 g/kg respectively could improve survival, growth and feed utilization of sea bass fry. Administration of garlic and onion indicates a slide edge for garlic to onion in growth, feed utilization and fish protein content. It will also induce a significant increase in some blood variables (hemoglobin content, hematocrit value, mean corpuscular volume, mean corpuscular hemoglobin and leukocytes count) in treated fish when compared to the control fish group.

Introduction

Incorporation of feed additives in diets of aquacultured fish aims to enhance fish performance, immunity and quality of flesh. Searching for new feed additives is still a very important point for aquaculture researchers (Cho and Lee, 2012). Garlic (*Allium sativum*) is one of members of family *Liliaceae* used as a spice and in traditional medicine. It is rich in calcium, phosphorus, carbohydrates and generally, has a high nutritive value. Garlic also contains many valuable compounds such as iodine salts which have positive effects on the circulatory system, silicates which have a positive effect on the skeletal and circulatory system and sulfur salts with positive effects on cholesterolemia, skeletal system and control liver diseases. Garlic also contains many vitamins such as vitamins A, C and B complex as well as linoleic acid (Drăgan et al., 2008). Allicin is one of the important constituents of garlic which has an anthelmintic effect (Iqbal et al., 2001). Garlic has several benefits for humans and animals where it is considered to be an antimicrobial (Kumar and Berwal, 1998), an antioxidant and an antihypertensive agent (Konjufca et al., 1997). Garlic plays a role in the control of pathogens, especially bacteria and fungi. It also increases the welfare of fish (Corzo-Martínez et al., 2007).

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Another member of the *Liliaceae* family is onion (*Allium cepa*) which contains small quantities of fat, sugar and vitamins A, C and B complex; it is rich in magnesium, potassium and copper (Gabor et al., 2010). In addition, onion is used as a vegetable, spice and a medicinal plant where it is an antibiotic, antiseptic, anti-infectious, antibacterial and antifungal agent (Benkeblia, 2004). It is also an antioxidant and has anticancer properties (Ramos et al., 2006; Bello et al., 2012a,b).

Several studies were conducted to evaluate the effects of supplemental garlic on the performance of farmed fish including; African catfish (Agbebi et al., 2013), rainbow trout (Gabor et al., 2012), Nile tilapia (Aly and Mohamed, 2010) and sword fish (Kalyankar et al., 2013). However, only few studies have considered the effects of supplemental onion on farmed fish including African cat fish (Bello et al., 2012a,b); brown-marbled grouper (Apines-Amar et al., 2012) and olive flounder (Cho and Lee, 2012). As far as the authors know, little information is available on the efficacy of using dietary phyto-additives in sea bass feeds. The present study is the first work to evaluate the effect of garlic and onion powder inclusion in the feeds of sea bass; on their growth, feed utilization, proximate composition and hematological parameters as an indicator of fish health without negatively affecting fish ambient environment.

Materials and methods

Experimental design and diet preparation

Seven diets were formulated to contain approximately 45% crude protein, 13% crude lipid and 23.32 kJ/g gross energy which fulfill the requirement for sea bass fry. Diets were formulated as control diet (CTR) along with 6 other diets, they included three levels of garlic; 10 g/kg (G1); 20 g/kg (G2), and 30 g/kg (G3) and three levels of onion powder; 5 g/kg (O1); 10 g/kg (O2), 20 g/kg (O3) to partially replace wheat flour. Diets' formulation and proximate composition are shown in Table 1. All dry dietary ingredients were blended together thoroughly then oil was added to them. The mixture was moistened, minced and then dried at 40 °C for 24 h. Diets were stored at −20 °C until use.

Experimental fish and rearing conditions

Five hundred sea bass (*Dicentrarcus labrax*) fry were obtained from El-Anfoushy Hatchery, National Institute of Oceanography and Fisheries (NIOF). A feeding experiment was conducted in the Fish Nutrition Laboratory, (NIOF), Alexandria, Egypt.

After acclimation for a week on the control diet (without garlic or onion powder) the fish were divided into seven triplicated groups of 15 fish per replication, with an average weight of 0.4 ± 0.05 g/fish. They were then randomly stocked in 21 glass aquaria (80 × 30 × 40 cm) (length × width × height) with continuous aeration. The aquaria were daily cleaned before the first feeding and excreta were siphoned. Ambient water temperature, dissolved oxygen and pH through the experimental period were 24.0 ± 1.0 °C, 7.6 ± 1.0 mg l^{-1} and 8.0 ± 0.2, respectively. The test diets were fed twice daily, at 09.00 and 17.00 h, for apparent satiation rate for 7 days a week, for 8 weeks and fish were weighed biweekly. During the study period, the total amount of feeds consumed by the fish in each aquarium was determined and the feed consumed for each individual fish was calculated accordingly.

Proximate analyses

Five fish were netted from each aquarium at the end of the feeding trial. They were then pooled together and homogenized for proximate composition (total of 15 fish per treatment). Moisture, total protein, lipid and ash contents were all determined by Standard Association of Official Analytical Chemist (AOAC, 1995) methodology. Triplicates of diet samples were used for proximate analyses (Table 1).

Evaluation of growth performance and feed utilization efficiency

Growth performance and feed utilization including weight gain (WG, g), percent weight gain (%WG), specific growth rate (SGR, %/day), feed conversion ratio (FCR), protein efficiency ratio (PER) and protein productive value (PPV) were determined as follows:

$$\mathrm{WG} = \mathrm{FW} - \mathrm{IW}\ (\mathrm{g/fish})$$

$$\%\mathrm{WG} = 100 \times [(\text{final fish weight (g)} - \text{initial fish weight (g)})/\text{initial fish weight}]$$

$$\mathrm{SGR} = 100 \times [(\ln \text{final fish weight}) - (\ln \text{initial fish weight})]/\text{experimental days}$$

$$\mathrm{FCR} = \text{feed fed (g)(dry weight)/weight gain (g)}$$

$$\mathrm{PER} = \text{weight gain (g)/protein fed (g)}$$

$$\mathrm{PPV} = 100[\text{protein gain (g)/protein fed (g)}]$$

Hematological analyses

At the end of the experiment, blood was collected from the fish. They were cut at the caudal peduncle and their blood was collected in coded 1.5 mL heparinized plastic tubes. The blood samples were analyzed within half an hour of the collection. The Complete Blood Count (CBC) of each of the blood samples was determined by ERMA-Inc. Full Automatic Blood Counter model PCE210 N to assess Red Blood Cell Count (RBC, $10^6/\mu l$), Hemoglobin concentration (Hb, g/dl), Hematocrit value (PCV,%), Mean Corpuscular Volume (MCV, femtoliters "fl"), Mean Corpuscular Hemoglobin (MCH, picogram "pg"), Mean Corpuscular Hemoglobin Concentration (MCHC) and White Blood Cell Count (WBC, $10^3/\mu l$).

Statistical analysis

The results of the study were subjected to statistical verification using a one-way analysis of variance (package super ANOVA 1.11; Abacus Concepts, Berkeley, CA, USA). Before statistical analyses, survival data were normalized by an arc-sine transformation method (Sokal and Rohlf, 1981). Significant differences between means were evaluated by

Table 1 Dietary ingredients and proximate composition of the test diets.

Ingredients (g/kg)	Control	Tested Fish Groups					
		G1 (10 g/kg diet)	G2 (20 g/kg diet)	G3 (30 g/kg diet)	O1 (5 g/kg diet)	O2 (10 g/kg diet)	O3 (20 g/kg diet)
Fish meal[1]	550	550	550	550	550	550	550
Soybean meal	240	240	240	240	240	240	240
Corn gluten	60	60	60	60	60	60	60
Yellow Corn	40	40	40	40	40	40	40
Wheat flour	40	30	30	10	35	30	20
Sardine Oil	50	50	50	50	50	50	50
Vit./min. Premix[2]	20	20	20	20	20	20	20
Onion powder	0	10	20	30	-	-	-
Garlic powder	0	-	-	-	5	10	20
Total	1000	1000	1000	1000	1000	1000	1000
Chemical composition (%):							
Dry matter (DM)	97.3	96.9	97.5	97.3	97.2	96.6	97.1
Crude protein (CP)	45.7	44.9	45.8	45	45.7	46.8	46.2
Total lipid (TL)	13	13.3	13.1	13.3	12.9	12.7	13.4
Ash	12.6	11.9	11.8	12.4	12.5	13.4	11.6
Fiber	3.0	2.8	3.2	2.7	2.6	2.9	96.9
NFE[3]	25.7	27.1	26.1	26.6	26.3	24.8	24.7
Gross energy (GE)[4]	20.34	20.51	20.47	20.45	20.40	20.33	20.45

[1] Danish 999 LT (68.9% protein & 8.1% lipid).
[2] Vit./min. Premix (mg kg^{-1}); p-amino benzoic acid (9.48); D-Biotin (0.38); Inositol (379.20); Niacin (37.92); Ca-pantothenate (56.88); Pyridoxine-HCl (11.38); Riboflavin (7.58); Thiamine-HCl (3.79); L-ascorbyl-2-phosphate Mg (APM) (296.00); Folic acid (0.76); Cyanocobalamine (0.08); Menadione (3.80), Vitamin A-palmitate (17.85); α-tocopherol (18.96); Calciferol (1.14). K_2PO_4 (2.011); $Ca_3(PO_4)_2$ (2.736); Mg SO_4 $7H_2O$ (3.058); NaH_2PO_4 $2H_2O$ (0.795).
[3] Nitrogen-free extracts (NFE) = 100 − [% Ash + % lipid + % protein + % Fiber].
[4] GE (kJ/g) = (protein content × 23.6) + (Lipid content × 39.5) + (carbohydrate content × 17.2).

Tukey–Kramer test following an ANOVA (Kramer, 1956). Probabilities of less than 0.05 were considered significant.

Results

Survival (%), growth and feed utilization indices of sea bass (*Dicentrarcus labrax*) that were fed on the test diets that contain three concentrations of garlic powder and three concentrations of onion powder for 8 weeks are presented in Table 2. Both garlic and onion fed fish groups were compared separately against one control fish group that had received neither garlic nor onion. The survival rate of fish was over 95% for all experimental diets and it was significantly improved in the fish fed on G3 and O2 diets (97.5% & 98%, respectively) when compared with the CTR group. Percentage weight gain (%WG) of the CTR group was significantly lower (655.1%) compared to G2 (716.3%) and G3 (719.6%) fish groups. The lowest SGR (3.36) was also recorded for the CTR group in relation to all other fish groups which have received garlic powder at all inclusion levels. It shall be noted that, G2 and G3 groups showed significantly ($P < 0.05$) higher SGR values when compared with the G1 group (3.75, 3.76 & 3.62, respectively).

Results illustrated in Table 2 also demonstrate a pronounced decrease in FCR values in G2 and G3 fish groups (1.4 & 1.37, respectively) relative to G1 and CTR groups (1.75 & 1.73, respectively). Values of PER and PPV at all garlic inclusion levels were also elevated and the highest PER and PPV (1.47 & 26.83, respectively) were recorded in the G2 fish group. In general, growth rates and feed efficiency at G3 were not significantly different than those at G2.

Gradual improvement in growth performance indices was recorded coinciding with increasing onion powder inclusion level in sea bass diets and values of %WG and SGR in fish fed O2 and O3 diets were relatively similar and insignificantly different comparing with each other but significantly different with the CTR group (Table 2).

Onion powder inclusion in fish diets led to mend in all feed utilization indices. Values of FCR and PER of O1 and O2 groups were similar and significantly better when compared with either the O3 or the CTR groups ($P < 0.05$). Values of PPV at all onion inclusion levels were significantly higher when compared with the CTR group ($P < 0.05$) as presented in Table 2.

The biochemical composition of the whole body of sea bass at the end of the feeding trial is shown in Table 3. Biochemical measurements of the whole body for all fish groups fed by garlic or onion as feed additive at all addition levels revealed that moisture, total lipid and ash contents were not significantly ($P > 0.05$) different in comparison with each other or with CTR. Only the crude protein (CP) content showed significant variations among treatments ($P < 0.05$). Fish fed G2 and G3 diets showed significant elevations (16.33 & 16.78%, respectively) in crude protein contents when compared to the CTR fish group (14.88%).

Table 2 Growth and Feed utilization parameters of sea bass fed on different levels of Garlic and Onion powder as phyto-additives.

Parameters	Tested Fish Groups						
	Control	G1 (10 g/kg diet)	G2 (20 g/kg diet)	G3 (30 g/kg diet)	O1 (5 g/kg diet)	O2 (10 g/kg diet)	O3 (20 g/kg diet)
Survival (%)	95.2 ± 1.30^{a}	96.3 ± 1.20^{ab}	96.8 ± 2.00^{ab}	97.5 ± 2.20^{b}	95.7 ± 1.50^{a}	98.0 ± 3.80^{b}	96.2 ± 2.40^{ab}
Initial weight	0.49 ± 0.01	0.50 ± 0.02	0.49 ± 0.09	0.51 ± 0.06	0.52 ± 0.06	0.51 ± 0.05	0.48 ± 0.02
Final weight	3.71 ± 0.32^{a}	3.80 ± 0.09^{a}	4.01 ± 0.14^{b}	4.18 ± 0.11^{b}	4.12 ± 0.23^{b}	4.15 ± 0.28^{b}	3.90 ± 0.38^{ab}
WG (g/fish)	3.21 ± 0.15^{a}	3.30 ± 0.12^{a}	3.51 ± 0.13^{b}	3.67 ± 0.14^{b}	3.58 ± 0.31^{b}	3.64 ± 0.41^{b}	3.62 ± 0.22^{b}
WG (%)	655.10 ± 7.10^{a}	660.0 ± 4.20^{a}	716.3 ± 7.80^{b}	719.61 ± 12.40^{b}	688.4 ± 8.70^{ab}	713.6 ± 9.80^{b}	712.5 ± 6.90^{b}
SGR (%/day)	3.36 ± 0.04^{a}	3.62 ± 0.08^{b}	3.75 ± 0.05^{c}	3.76 ± 0.03^{c}	3.68 ± 0.09^{b}	3.74 ± 0.15^{c}	3.73 ± 0.03^{c}
FI (g/fish)	5.91 ± 0.13^{b}	5.79 ± 0.07^{b}	5.20 ± 0.28^{a}	5.84 ± 0.27^{b}	5.01 ± 0.21^{a}	5.06 ± 0.25^{a}	5.32 ± 0.28^{a}
FCR	1.73 ± 0.05^{b}	1.75 ± 0.16^{b}	1.40 ± 0.11^{a}	1.37 ± 0.09^{a}	1.40 ± 0.18^{a}	1.39 ± 0.22^{a}	1.56 ± 0.06^{b}
PER	1.19 ± 0.02^{a}	1.27 ± 0.09^{b}	1.47 ± 0.08^{b}	1.40 ± 0.03^{b}	1.56 ± 0.09^{c}	1.56 ± 0.12^{c}	1.37 ± 0.11^{b}
PPV	21.57 ± 0.62^{a}	23.19 ± 1.41^{a}	26.83 ± 0.72^{b}	25.60 ± 1.20^{b}	27.07 ± 1.40^{b}	25.82 ± 0.94^{b}	26.75 ± 0.83^{b}

Fish fed Garlic or onion powder were separately compared with fish fed control diet.
Different letters within the same row indicate significant differences ($P < 0.05$).

Table 3 Carcass composition of sea bass fed on different levels of Garlic and Onion powder as phyto-additives.

	Tested Fish Groups						
Carcass Composition%	Control	G1 (10 g/kg diet)	G2 (20 g/kg diet)	G3 (30 g/kg diet)	O1 (5 g/kg diet)	O2 (10 g/kg diet)	O3 (20 g/kg diet)
Moisture	73.91 ± 2.50	73.75 ± 3.11	73.95 ± 3.42	74.59 ± 3.69	74.16 ± 2.45	73.97 ± 3.12	74.85 ± 2.99
CP	14.88 ± 0.54^{a}	15.65 ± 0.91^{a}	16.33 ± 0.12^{b}	16.78 ± 0.89^{b}	15.79 ± 0.95^{b}	15.81 ± 0.83^{b}	15.54 ± 0.14^{b}
EE	5.18 ± 0.52	5.24 ± 0.41	5.03 ± 0.67	4.49 ± 0.32	5.06 ± 0.15	5.01 ± 0.19	4.98 ± 0.22
Ash	4.55 ± 1.25	4.40 ± 0.88	4.16 ± 1.82	4.27 ± 1.69	4.00 ± 0.98	3.89 ± 1.55	3.80 ± 1.83

Fish fed Garlic or onion powder were separately compared with fish fed control diet.
Different letters within the same row indicate significant differences ($P < 0.05$).

Table 4 Blood parameters of sea bass fed on different levels of Garlic and Onion powder as phyto-additives.

Parameters	Tested Fish Groups						
	Control	G1 (10 g/kg diet)	G2 (20 g/kg diet)	G3 (30 g/kg diet)	O1 (5 g/kg diet)	O2 (10 g/kg diet)	O3 (20 g/kg diet)
RBC($\times 10^{6}$/μl)	2.75 ± 0.32	2.61 ± 0.43	2.72 ± 0.20	2.74 ± 0.21	2.64 ± 0.30	2.67 ± 0.28	2.59 ± 0.21
Hb (g/dl)	10.02 ± 0.41^{a}	10.51 ± 0.62^{ab}	10.80 ± 0.16^{b}	11.10 ± 0.61^{b}	10.20 ± 0.19^{a}	10.90 ± 0.60^{b}	10.60 ± 0.40^{ab}
PCV (%)	33.10 ± 1.11	32.12 ± 1.99	33.91 ± 2.70	32.89 ± 2.32	31.93 ± 0.81	33.64 ± 3.35	33.11 ± 1.80
MCV (fl)	120.36 ± 3.54^{a}	123.07 ± 4.21^{ab}	124.67 ± 2.89^{b}	120.04 ± 2.78^{a}	120.95 ± 3.22^{a}	125.99 ± 4.56^{ab}	127.84 ± 2.95^{b}
MCH (pg)	36.44 ± 0.99^{a}	40.27 ± 1.14^{b}	39.72 ± 1.30^{b}	40.51 ± 2.99^{b}	38.64 ± 1.01^{ab}	40.82 ± 2.33^{b}	40.93 ± 2.11^{b}
MCHC	30.27 ± 1.58	$32.72 \pm .1.11$	31.85 ± 1.97	30.10 ± 1.98	31.95 ± 2.39	32.40 ± 1.82	32.01 ± 2.91
WBC($\times 10^{3}$/μl)	28.5 ± 1.11^{a}	29.9 ± 1.60^{ab}	30.3 ± 1.77^{ab}	31.8 ± 1.95^{b}	31.3 ± 1.60^{b}	32.6 ± 1.40^{b}	32.1 ± 1.70^{b}

Fish fed Garlic or onion powder were separately compared with fish fed control diet.
Different letters within the same row indicate significant differences ($P < 0.05$).

Data in Table 3 reveal how the supplementation of onion power to sea bass diets at all inclusion levels has significantly raised protein contents when compared to the CTR group ($P < 0.05$).

The hematological parameters of sea bass (*Dicentrarcus labrax*) fed different levels of garlic or onion powders are summarized in Table 4. Results showed no significant variations ($P < 0.05$) in RBCs, PCV and MCHC values among all inclusion levels or in relation to the CTR group either in fish fed garlic or onion powder as feed additives.

Results in Table 4 show a gradual elevation in Hb content accompanying the increment in garlic inclusion level. The values were found to be significantly higher in G1 and G2 (10.80 & 11.10, respectively) when compared to the CTR group (10.02). Fish fed garlic at all supplementation levels show a significant ($P < 0.05$) increase in MCH values comparing with the CTR group. An elevation in WBC values in all fish groups that had received garlic was apparent when compared with the control but it was significantly higher only in fish fed the G3 diet.

Fish fed the O2 diet significantly showed the highest Hb content (10.90) in relation either to the O1 (10.20) or CTR (10.02) group and results also showed that the values of MCH in O2 and O3 groups were significantly higher when compared to the CTR group. Addition of onion powder to fish diets, at all inclusion levels, significantly raised the count of WBCs in relation to CTR.

Discussion

Values of growth performance and feed utilization indices, in the present work, indicate an enhancement in growth and feed utilization for all fish groups fed garlic or onion powder at all inclusion levels compared to the control fish group.

Many authors recorded the positive effects of administrating garlic in diets on growth and feed utilization of many fishes including; African catfish, *Clarias gariepinus* (Agbebi et al., 2013); rainbow trout, *Oncorhynchus mykiss* (Gabor et al., 2012; Nya and Austin, 2009); Swordtail, *Xiphophorus helleri* (Kalyankar et al., 2013) and Nile tilapia, *Oreochromis niloticus* (Shalaby et al., 2006; Mesalhy et al., 2008; Metwally, 2009; Aly and Mohamed, 2010). In the present study, enhancement in fish growth performance and feed utilization can be interpreted according to Khalil et al. (2001) who mentioned that garlic contains allicin, which promotes the performance of the intestinal flora, thereby improving digestion, and enhancing the utilization of energy. This would then lead to improved fish growth.

Parallel to the present results, growth enhancing properties of an onion bulb based diet showed an increase in body weight gain as recorded by Bello et al. (2012a,b) in African catfish (*C. gariepinus*) juveniles and also by Apines-Amar et al. (2012) in the brown-marbled grouper, *Epinephelus fuscoguttatus*. Most of the positive effects of onions can be attributed to the presence of cysteine sulfoxide (CSO) with S-propenyl-CSO as the predominant S compound (Keusgen et al., 2002; Ostrowska et al., 2004). Sulfur-containing compounds such as methyl sulfonate methane (MSM) have immunomodulation properties (Amar and Faisan, 2011) which are attributed to S being a component of the antioxidant enzyme Glutathione peroxidase. Additionally, the varied components of onion may exert further biological effects on enhancing growth through different mechanisms either separately or synergistically (Apines-Amar et al., 2012). Contrary to the previous results, growth performance of Olive Flounder, *Paralichthys olivaceus* was not affected by the use of onion powder (Cho and Lee, 2012).

The present study shows that the survival rate significantly improved when G3 or O2 diets were used. Survival rate in many fishes was improved when garlic or onion was added to their diets as Asian sea bass *Lates calcarifer* (Talpur and Ikhwanuddin, 2012), Swordtail, *X. helleri* (Kalyankar et al., 2013), African catfish, *C. gariepinus* (Thanikachalam et al., 2010), rainbow trout, *O. mykiss* (Farahi et al., 2010) and brown-marbled grouper, *E. fuscoguttatus* (Apines-Amar et al., 2012). Beneficial health properties of garlic are attributed to organosulphur compounds, particularly to thiosulfinates (Block, 1992). Furthermore, the health-enhancing properties of onions have been attributed to the flavonoids particularly quercetin and also the organosulfur compounds (Price and Rhodes, 1997; Griffiths et al., 2002).

The present work shows a significant increase in the whole-body protein content in fish fed G2, G3 and onion powder at all inclusion levels. This increase can be interpreted by that administration of garlic or onion powder in diets may cause a rise in muscle free amino-acid contents which lead to an enhancement in protein synthesis. Increment in crude protein contents was recorded in *O. mykiss's* body when fed with diets that included 3% garlic (Gabor et al., 2010). In contrast, Cho and Lee (2012) used onion powder at different inclusion levels in the diet of Olive Flounder, *P. olivaceus* and did not record any significant differences in fish protein content between fish groups.

The contradictory between results of the present study and some previous studies on the effects of dietary garlic or onion on fish growth, body composition and survival rates may be attributed to the variations in fish species, salinity of ambient water, sort and dietary inclusion level of the feed additive, fish physiology and variant rearing conditions.

Evaluation of hematologic and blood chemistry analyses will enhance the culture of fish by facilitating early detection of infectious diseases and identification of sublethal conditions that may affect the production performance. The present study demonstrated that administration of garlic or onion powder induced a considerable increase in some measured blood parameters (Hb, MCV, MCH and WBCs) in treated fish and this result coincided with Kalyankar et al. (2013) who revealed that administration of 1.5% garlic in Swordtail, *X. Helleri* diet induced significant increases in all blood parameters (RBCs, WBCs, Hb and PCV). Ndong and Fall (2011) recorded that total leukocyte count (WBCs) increased significantly by 23.62% and 43.67% for hybrid tilapia (*O. niloticus x Oreochromis aureus*) fed with 1% garlic supplemented diet after 2 and 4 weeks, respectively. Similar findings were reported by Talpur and Ikhwanuddin (2012) whom verified that the addition of garlic to Asian sea bass, *L. calcarifer* (Bloch) diets increased RBCs, Hb, MCV, WBCs and thrombocytes. Thanikachalam et al. (2010) indicated that garlic peel enhanced the hematological parameters of African catfish, *C. gariepinus*. This elevation in some blood constituents may be due to some constituents of garlic and onion that may play a role in the immune system stimulation and in the function of organs related to blood cell formation such as thymus, spleen and bone marrow.

Conclusion

Results of the present study showed an enhancement in growth, feed utilization, fish protein content and some hematological parameters when garlic or onion powder was added in sea bass diets. The results suggested that the recommended levels for supplementation of dietary garlic and onion in fish diets are 30 and 10 g/kg respectively. Results also showed a slight edge for garlic over onion.

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