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Response of Nile Tilapia (*Oreochromis niloticus*) fingerlings to different replacement levels of fish meal with soybean meal using garlic and onion

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Abstract

Twelve experimental diets were formulated to contain 35% crude protein and 429.93 Kcal gross energy $100g^{-1}$ in order to study the effects of replacement levels of dietary fish meal with soybean meal using garlic and onion on growth performance, feed utilization and whole body composition of Nile tilapia (*Oreochromis niloticus*) mono-sex fingerlings. Three groups of diets according to replacement levels of fish meal with soybean meal were processed: group 1 (G_1) consists of: 25% fish meal (FM) + 75% soybean meal (SBM); group 2 (G_2): 50% FM + 50% SBM and group 3 (G_3): 75% FM + 25% SBM. Each group included four treatments according to garlic and onion level: a) three experimental treatments considered as negative control diets (without garlic or onion: D_1, D_5, D_9), b) three experimental treatments supplemented with 4% garlic (D_2, D_6, D_{10}) c) three experimental treatments supplemented with 6% onion (D_3, D_7, D_{11}) and d) three experimental treatments supplemented with 10% mixture (4% garlic and 6% onion: D_4, D_8, D_{12}). Fish were reared in thirty six glass aquaria for 84 days, triplicate per treatment. Ten fingerlings of tilapia were placed per each aquarium with an average initial weight of 3.12 ± 0.3 g/fish. The results showed that the best growth performance values and feed utilization were significantly ($P<0.05$) realized with fingerlings fed diets containing of 50% FM + 50% SBM (G_2). Addition of 10% mixture of garlic and onion (D_8) was significantly ($P<0.05$) increased growth performance and feed utilization rather than solitary addition. Fingerlings fed either D_8 diets realized the higher values for protein efficiency ratio (PER), protein productive value (PPV %), energy utilization (EU %) and the best feed conversion ratio (FCR). The results indicate that the diet contain of 50% FM + 50% SBM with 10% mixture of garlic and onion for 84 days had enhanced growth performance, diet utilization efficiency Nile tilapia mono-sex fingerlings**.**

Keywords: fish meal, soybean meal, garlic, onion, Nile tilapia, chemical composition.

1. Introduction

According to the proposed principles of organic aquaculture feeds, all fish meal (FM) incorporated must be derived from fishery resources certified to be sustainability managed (NOP, 2006), where FM is the protein source traditionally used in aquaculture diets, yet it is a limited resource and is expensive (FAO, 2006). Alternate protein sources can lower the cost of aquaculture diets to reduce the amount of wild fish used as protein, and potentially reduce the nutrient levels in effluent waste. However, for most species, there is a limit to how much FM can be replaced by alternative protein sources without any adverse effects on the fish.

Soybean meal (SBM) is lesser expensive than FM, readily available (Hardy, 2006) and considered to be one of the most suitable and stable supply of an alternative ingredient for replacing FM in commercial fish feed industries. In addition, SBM is one of the most promising ingredients because of its high protein content, very low carbohydrate and fiber, high digestibility and good amino acid profile (Gatlin *et al*., 2007). Moreover, SBM protein has produced encouraging results in diets for different fish species in spite of being limited technically for its amino acid profile and poor palatability (Tacon and Akiyama, 1997). Furthermore, SBM has significantly lesser phosphorous than FM (NRC, 1993).

Gabor *et al.* (2010) concluded that the use of phytoadditives in fish feeding stimulate the appetite as nutritional additive, improving the voluntary intake of a diet as a sensory additive, improve the nutritional value of a diet as a zootechnical additive and control the

health of fish through direct effects as a coccidiostats and histomonstats. However, phytoadditives have benefits for both fish welfare and environment.

Garlic (*Allium sativum*), member of the *Alliaceae* family, is one of the most popular herbs used worldwide to reduce various risk factors associated with several diseases. It is a rich source of Ca, P, Zn, Fe; has a high content of carbohydrates and as a consequence a high nutritive value; contains I, Si, S salts, B_1, B complex, A, C and F vitamins (Drăgan *et al*., 2008). It has long been considered that garlic (*Allium sativum*) has several beneficial effects for human and animals; exhibiting antimicrobial, antioxidant, and antihypertensive properties (Konjufca *et al*., 1997; Sivam, 2001), and has proved to be hypolipidemic (Sumiyoshi, 1997), antimicrobial (Kumar and Berwal 1998), antihypertensive (Suetsuna, 1998), hepatoprotective and insecticidal (Wang *et al*., 1998). Garlic extract has also been shown to reduce serum cholesterol levels (Bordia *et al*., 1975; Augusti, 1977). The antimicrobial effect of essential oil extracts of three types of onion (green, yellow and red) and garlic was studied by Benkeblia (2003) who found that the strongest antibacterial (inhibitory activity) effect was observed in garlic and red onion. It is also used as immunostimulants and growth promoters for Nile tilapia (Shalaby *et al.,* 2006; Ahmed *et al.*, 2008; Salah *et al*., 2008; Metwally, 2009).

Garlic bulbs (on DM basis) contain 6.1% CP, 0.65% EE, 0.86% CF, 1.48% crude ash and high concentrations of trace minerals (Se), glucosinolates and enzymes (Grela and Klebaniuk, 2007), 17 amino acids, which include lysine, arginine and cysteine (Adetumbi *et al*., 1986; Rees *et al*., 1993; Corzo-Martinez *et al.*, 2007). Garlic contains also 0.1–0.36% of a volatile sulfur containing compounds: *Allicin* (responsible for the distinctive odor), diallyl-disulfied, diallyl-trisulfied and others, which are responsible for most of the pharmacological properties of garlic (Silagy and Haw, 1994; Benkeblia, 2003). Moreover, onion (*Allium cepa*) is a member of family Alliaceae, used as a medicinal plant (antibiotic, antiseptic and anti-infectious) and has hipoglicemiant, antioxidant, anti-thrombotic, anti-cholestremia, anti-platelet activity and tonic effects. These pharmacological properties of onion can be ascribed to sulfur compounds which are responsible for the typical odor, flavor and to flavonoids, in particular quercetin which was well known for its anti-carcinogenic properties (Deschner *et al.,* 1991). Also, onion peel improve male sexual function (Junemann, 2003; Lines and Ono, 2006), where it contains small quantities of sugar, fats and A, C and B complex vitamins; high content of Mg, K and Cu (Drăgan *et al*., 2008). Simultaneously, it has been considered a digestive material and used to improve the appetite.

The objective of the present study is to investigate the effects of replacement levels of dietary fish meal with soybean meal using different garlic and onion levels on growth performance, feed utilization and whole body composition of Nile tilapia (*Oreochromis niloticus*) mono-sex fingerlings.

2. Material and methods

2.1. Experimental diets and design

Twelve experimental diets were formulated for containing 35% crude protein and 429.93 Kcal gross energy $100g^{-1}$ (Table 2). Three groups of diets according to replacement levels of fish meal with soybean meal are process: group 1 (G_1) consists of: 25% fish meal (FM) + 75% soybean meal (SBM); group 2 (G_2): 50% FM + 50% SBM and group 3 (G_3): 75% FM + 25% SBM. Each group included four treatments according to garlic and onion level: a) three experimental treatments considered as negative control diets (without garlic or onion: D_1, D_5, D_9), b) three experimental treatments supplemented with 4% garlic (D_2, D_6, D_{10}) c) three experimental treatments supplemented with 6% onion (D_3, D_7, D_{11}) and d) three experimental treatments supplemented with 10% mixture (4% garlic and 6% onion: D_4, D_8, D_{12}). Triplicate per treatment were used in this study. The experimental design and diets combinations are summarized as follow:

Groups	Diet No.	Garlic and onion additives
G_1	D_1	without garlic or onion (Control)
	D_2	With 4% garlic
	D_3	With 6 % onion
	D_4	with a mixture of 4 % garlic and 6 %onion
G_2	D_5	without garlic or onion (Control)
	D_6	With 4% garlic
	D_7	With 6 % onion
	D_8	with a mixture of 4 % garlic and 6 %onion
G_3	D_9	without garlic or onion (Control)
	D_{10}	With 4% garlic
	D_{11}	With 6 % onion
	D_{12}	with a mixture of 4 % garlic and 6 %onion

G_1: (25% FM + 75% SBM)
G_2: (50% FM + 50% SBM)
G_3: (75% FM + 25% SBM)

2.2. Fish culture facility

Fingerlings with an average initial body weight of 3.12 ± 0.3 g/fish were placed randomly in thirty six glass aquaria with dimensions of 100×40×30cm and 100 l water volume/aquarium in triplicate. Before starting the experiment, fingerlings were acclimated to the experimental system for 15 days. Each aquarium was stocked with ten fingerlings of Nile Tilapia, *O. niloticus*.

2.3. Experimental diets

The feed ingredients were ground in a homogenous mixture grinder (PHILIPS, Mode HL 1616ID, Philips India Limited. 7, Justice Chandra Medhab Road, Calcutta 700020), until passing through a 1.0 mm screen. The diets were processed by blending the dry ingredients into a homogenous mixture. Pellets of 2 mm were made in Sprout-Waldron laboratory pellet

mill (CPM, California Pellet Mill Co., San Francisco, California, CA, USA). The pelleting temperature did not exceed 60 ºC and all diets were air dried for 4 h (moisture content of about 10%). All diets was packed in cellophane bags and cooled at -4 ˚C prior to use. During the 84-days feeding period, every two weeks, in each net-pen, the total weight and number of fish were measured, to adjust the feed ration. Processed diet particle size was 0.6 mm in diameter and 2 mm - length. Fish in each aquarium were fed three times daily (six days a week) at a rate of 5 % of body weight for 84 days.

2.4. Water quality

Water quality parameters in the experimental glass aquaria were determined according to the methods of APHA (1992). The concentrations of ammonia, total alkalinity, nitrate, and nitrite were determined according to Boyd, (1979). Ammonia and nitrite were measured at weekly intervals, while water temperatures were recorded daily in each aquarium .Also, dissolved oxygen was measured daily by oxygen meter and pH using pH meter.

2.5. Measurement of growth

Total weight gain, average daily gain, specific growth rate, feed conversion ratio, protein and energy utilization were determined according to Recker (1975) and Castell and Tiews (1980).

Total gain (g/fish) = $(W_T - W_I)$

Where:

W_T: Final means weight of fish in grams and W_I: Initial means weight of fish in grams.

Average daily gain (ADG) (g/fish day^{-1}) = total gain / duration period

Specific growth rate (SGR, % day^{-1}) = $100 \times (\ln W_T - \ln W_I)$ / duration period. Where: (ln) is the natural log and (n) is the duration period.

2.6. Measurement of feed and nutrient utilization

Feed conversion ratio (FCR) = dry matter intake (g) / total gain (g).

Protein efficiency ratio (PER) = total gain (g) / protein intake (g)

Protein productive value (PPV %) = $(P_T - P_I) \times 100$ / protein intake (g)

Where: P_T: Protein content in fish carcass at the end and P_I: Protein content at the start.

Energy utilization (EU %) = $(E_T - E_I) \times 100$ / Energy intake (kcal)

Where: E_T: Energy in fish carcass (kcal) at end and E_I: Energy in fish carcass (kcal) at start.

2.7. Proximate Analysis of Diet and Fish

At the start of the experiment, 20 fish were taken and kept frozen for the chemical analysis. At the end of the experiment, the basal diet and fish samples from each treatment were chemically analyzed according to the standard methods of AOAC (2000). Gross energy (GE) and energy content (Eco) were calculated from (NRC, 1993) as 5.65, 9.45, and 4.11 kcal/g for protein, lipid, and carbohydrates, respectively.

2.8. Statistical Analysis

Statistical analyses of growth performance, feed utilization and whole body composition were done using F-test and analysis of variance for treatments difference was performed according to Steel and Torrie (1980). Statistical analysis was done by, ANOVA, F-test, and L.S.D procedures available within the SAS software package 9.0 (2004).

3. Results and Discussion

All water quality parameters tested throughout the experimental period revealed that all parameters were within the permissible levels for optimum Nile tilapia growth. Determined water quality parameters averages in the experimental glass aquaria were temperature (28 ± 0.5°C), dissolved oxygen (6.7 ± 0.4 mg l^{-1}), total ammonia(0.08 ± 0.01 mg l^{-1}),nitrite(0.06 ± 0.01 mg l^{-1}), total alkalinity (165 ± 35 mg l^{-1}), chlorides (573 ± 110 mg l^{-1}) and pH (8.4 ± 0.11). These results are in accordance with finding of Abdel-Hakim *et al.*, (2008) working with mono-sex Nile tilapia.

The proximate chemical analysis (%) of FM, SBM, yellow corn, rice bran, garlic meal, onion meal, and active yeast are shown in Table (1). The composition and proximate analysis (%) of the twelve experimental diets used in the present experiment are shown in Table (2). The experimental diets were almost isonitrogenous (35.24 ±0.11) % and isocaloric (434.29±2.60 Kcal $100g^{-1}$) .The mean value of protein to energy ratio was (81.69±0.23) mg protein /kcal gross energy.

The effects of different replacement levels of fish meal (FM) by soybean meal (SBM) using garlic (*A.sativum*) and onion (*A.cepa)* as feed additives on growth performance of Nile tilapia (*O. niloticus*) fingerlings are summarized in Table (3). The result showed that fish fed G_2 diet grew as well as or better than the other groups (G_3 and G_1). Increasing SBM up to 75% in G_1 diets decreased fish growth performance to the lowest values. Similar results have been reported by Mbahinzireki *et al*. (2001) who replaced SBM instead of FM and Soltan (2005) who replaced canola seed meal instead of FM in Nile tilapia diets. In contrast, Tacon *et al*. (1983) reported that growth of Nile tilapia was improved with increasing SBM inclusion level instead of FM up to 75%. In that respect, Sullivan (2008) reported that lysine (EAA) content appeared to be lower in SBM than in FM and

as SBM substitution increased, lysine decreased. He added that the importance of Lysine as a limiting amino acid for growth and its role as a necessary building block for all protein in the body; plays a major role in calcium absorption; building muscle protein; and the body's production of hormones, enzymes, and antibodies, may explain the cause of decreasing occurred in growth performance and feed utilization resulted from increasing SBM substitution level more than 50%.

In comparison to control group, the addition of garlic only in the present study slightly increased growth performance, while the addition of onion only obtained better fish growth performances. Zaki and El-Ebiary (2003) found that 3 g dry garlic/kg diet is recommended as growth promoters for mono-sex Nile tilapia favorable growth. Abou-Zeid (2002) and Aly *et al.* (2008) found that garlic improved the growth performance for Nile tilapia and similar results were reported by El-Saidy and Gaber (1997); Metwally (2009) and Abd El-Hamid (2010) when fed Nile tilapia on diets contained garlic meals. Moreover, Shalaby *et al.* (2006) recorded the highest growth performance of Nile tilapia fed on 3% garlic, while Diab *et al*. (2002) recommended 2.5%. On the contrary, Salah *et al*. (2008) found no significant differences ($P>0.05$) in Nile tilapia growth when supplemented diet included 10 and 20 g garlic / kg feed, however several studies (Gomes *et al*., 1993 on rainbow trout; Degani *et al*., 1997 on hybrid tilapia; Goddard and Mclean, 2001; Khattab, 2001 and Shalaby *et al*., 2006 on Nile Tilapia) concluded that apparent protein digestibility was improved with increasing levels of garlic in fish diet.

The highest final weight, weight gain, ADG and SGR% obtained with fish fed mixture of garlic and onion included diets (D_4, D_8 and D_{12}). Al-Salahy (2002) found that onion and garlic dietary administration for *Clarias lazera* caused a rise in liver free amino-acids; meanwhile, the garlic fed fish presented a rise in muscle free amino-acid levels and according to enhanced muscle uptake of free amino-acids may enhance protein synthesis.

Concerning dietary fish meal replacement with SBM and feed additives, Nile tilapia fed diets D_4, D_8 and D_{12} (included 50% FM + 50% SBM and mixture of 4% garlic and 6% onion) grew significantly ($P<0.05$) better compared to other experimental diets. Fish fed D_8, recorded the highest growth rather than other treatments. Increasing SBM replacement level up to 50% with garlic, onion or mixture of both led to increase growth performance, meanwhile increasing SBM replacement level up to 75% in G_3 diets (D_9, D_{10}, D_{11} and D_{12}) decreased growth performance significantly ($P<0.05$) than G_2 diets (D_5, D_6, D_7 and D_8) in spite of being better than G_1 diets (D_1, D_2, D_3 and D_4). Similar results have been reported by Abd El-Hamid (2010); El-Saidy *et al*. (1999) and Zaki and El-Ebiary (2003).

Results of feed intake (FI), feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV) and energy retention (ER) (Table 4) revealed that differences were significant ($P<0.05$) between groups in feed and nutrients utilization. On the other hand, FI, PPV% and EU% were significantly ($P<0.05$) increased with increasing SBM substitution level up to 50% while FCR decreased and PER slightly affected.

Regardless dietary FM replacement of SBM levels, the effect of feed additives on feed and nutrients utilization clearly showed that FI, PER and FCR of Nile tilapia fingerlings increased significantly ($P<0.05$) with addition of garlic, onion and mixture of both. Similar results have been obtained by El-Saidy and Gaber, (1997); Shalaby *et al*. (2006); Zaki and El-Ebiary, (2003); Aly *et al*. (2008) and Abd El-Hamid, (2010) who found that feed intake increased with increasing *A. sativum* levels, while feed conversion ratio decreased. Fish fed D_8, recorded the highest feed intake (FI), protein efficiency ratio (PER), protein productive value (PPV), energy retention (ER) and the best feed conversion ratio (FCR) rather than other treatments. The present results are in agreement with the finding of Mbahinzireki *et al*. (2001) and Soltan (2005).

The chemical composition parameters of whole body of Nile tilapia *O. niloticus* fingerlings are summarized in Table (5). Regardless of dietary onion and garlic levels, increasing SBM inclusion level up to 50% increased dry matter (DM %), crude protein (CP %) was significantly ($P<0.05$) while EE% and ash% decreased.

No significant ($P>0.05$) differences was observed in energy content (kcal $100g^{-1}$) with increasing SBM inclusion level up to 75%, DM% and CP% decreased while EE% and ash% increased significantly ($P<0.05$). No significant ($P>0.05$) difference was noticed in energy content among all groups.

Regardless dietary SBM inclusion level, the effect of dietary onion and garlic, levels on chemical composition of harvested fish indicated that DM%, CP%, and energy content were significantly ($P<0.05$) increased with using garlic, onion or both mixture, where the mixture recorded the superior values, while control diet recorded the inferior values.

The present results showed that, DM% and CP% recorded the highest values associated with lower EE% and ash% values when fish fed D_8 diet. Using garlic and onion mixture realized the highest values in DM%, CP% and energy contents and lowest in EE% and ash%. In concordance with the present study, results of El-Saidy and Gaber (1997), Zaki and El-Ebiary (2003), Shalaby *et al.* (2006), Mohamed *et al*. (2007), Eid and Mohamed (2008), and Abd El-Hamid (2010) supported the previous results; while in contrast, Diab *et al*. (2002) reported that there were insignificant changes in fish body composition caused due to addition of different garlic levels.

Table 1. Chemical analysis (%) of the ingredients used in the experimental diets (on DM basis).

Ingredient*	DM **(%)**	CP (%)	EE (%)	CF (%)	Ash (%)	NFE (%)	Gross energy * (Kcal/100g DM)
Fish meal	89.59	63.18	4.10	1.00	17.95	13.77	452.44
Soybean meal	89.66	45.74	7.70	7.30	7.59	31.67	461.68
Yellow corn	89.49	9.49	3.80	3.20	2.64	80.87	422.71
Rice bran	89.00	15.12	3.90	10.60	6.40	63.98	385.88
Garlic meal	94.71	9.61	6.60	18.30	6.47	53.73	338.03
Onion meal	91.31	13.63	2.90	24.18	14.56	14.18	162.84
Active yeast	96.48	43.08	1.60	2.60	5.05	47.67	454.92

* Estimated, NRC, (1993), Using the factor 5.65, 9.45 and 4.11 for crude protein, ether extract and carbohydrate, respectively.
DM: Dry matter CP: Crude protein EE: Ether extract
CF: Crude fiber NFE: Nitrogen – free extract (Calculated by differences)

Table 2. Formulation and proximate analysis (%) of experimental diets (on DM basis).

Items	**G$_1$**				**G$_2$**				**G$_3$**			
	D$_1$	**D$_2$**	**D$_3$**	**D$_4$**	**D$_5$**	**D$_6$**	**D$_7$**	**D$_8$**	**D$_9$**	**D$_{10}$**	**D$_{11}$**	**D$_{12}$**
Ingredient (% as fed)												
Fishmeal	13.85	13.85	13.85	13.85	27.70	27.70	27.70	27.70	41.93	41.93	41.93	41.93
Soybean meal	46.77	46.77	46.77	46.77	25.89	25.89	25.89	25.89	4.44	4.44	4.44	4.44
Rice bran	10.46	10.46	10.46	10.46	12.80	12.80	12.80	12.80	15.21	15.21	15.21	15.21
Yellow corn meal	20.92	16.92	14.92	10.92	25.61	21.61	19.61	15.61	30.42	26.42	24.42	20.42
Active yeast	3	3	3	3	3	3	3	3	3	3	3	3
Garlic meal	-	4	-	-	-	4	-	-	-	4	-	-
Onion meal	-	-	6	-	-	-	6	-	-	-	6	-
Garlic and onion meal	-	-	-	10	-	-	-	10	-	-	-	10
Yellow corn oil	3	3	3	3	3	3	3	3	3	3	3	3
Vitamin and Mineral premix*	2	2	2	2	2	2	2	2	2	2	2	2
Proximate analysis (% DM)												
Dry matter	94.62	94.25	94.35	94.46	93.48	93.79	93.25	93.80	92.84	94.65	94.62	94.00
Crude protein	35.11	35.01	35.00	35.03	35.26	35.20	35.12	35.18	35.22	35.11	35.03	35.09
Crude fat	5.42	5.53	5.37	5.48	4.65	4.77	4.58	4.65	3.86	3.97	3.80	3.91
Crude fiber	4.41	6.01	7.97	7.10	4.42	5.11	6.88	6.04	3.48	4.29	5.81	5.10
Ash	7.41	7.56	8.25	7.93	8.58	8.92	9.21	9.07	9.41	9.89	10.22	10.13
NFE	46.65	45.89	43.41	44.46	47.09	46.00	44.21	45.06	48.03	46.74	45.14	45.77
Gross energy (kcal/100g)	440.9	438.3	426.5	432.0	436.3	432.6	423.0	427.5	432.5	427.6	419.0	422.9
P/E ratio (mg cp/kcal)	79.63	79.88	82.06	81.08	80.82	81.36	83.02	82.29	81.44	82.11	83.61	82.97

(G1) 25%FM:75%SBM ; 50%FM:50%SBM (G2) ; 75%FM:25%SBM (G3)
*Each Kg vitamin & mineral mixture premix contained Vitamin A, 4.8 million IU, D3, 0.8 million IU; E, 4 g; K, 0.8 g; B_1, 0.4 g ; Riboflavin, 1.6 g; B_6, 0.6 g, B_{12}, 4 mg; Pantothenic acid, 4 g; Nicotinic acid,8 g; Folic acid, 0.4 g Biotin,20 mg , Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg.

Table 3. Effect of different dietary SBM levels supplemented with onion and garlic as feed additives on growth performance parameter of Nile tilapia (*O. niloticus*) fingerlings.

	Treatment		Initial (g/fish)	Final (g/fish)	weight gain (g/fish)	ADG (g/fish/day)	SGR (%/day)
G_1	Control	D_1	3.14	24.67^{l}	21.53^{l}	0.19^{d}	1.85^{d}
	+ 4% garlic	D_2	3.12	26.84^{k}	23.79^{k}	0.21^{d}	1.92^{c}
	+ 6% onion	D_3	3.12	28.66^{j}	25.54^{j}	0.23^{d}	1.98^{c}
	+10% mixture	D_4	3.12	31.16^{i}	28.04^{i}	0.25^{cd}	2.06^{c}
G_2	Control	D_5	3.12	32.14^{g}	29.02^{g}	0.26^{cd}	2.09^{bc}
	+ 4% garlic	D_6	3.13	37.29^{d}	34.16^{d}	0.31^{bc}	2.25^{ab}
	+ 6% onion	D_7	3.13	41.46^{b}	38.33^{b}	0.34^{a}	2.31^{a}
	+10% mixture	D_8	3.12	45.04^{a}	41.90^{a}	0.37^{a}	2.38^{a}
G_3	Control	D_9	3.14	31.63^{h}	28.49^{h}	0.25^{cd}	2.07^{bc}
	+ 4% garlic	D_{10}	3.12	34.26^{f}	31.14^{f}	0.28^{c}	2.14^{b}
	+ 6% onion	D_{11}	3.13	36.13^{e}	33.00^{e}	0.29^{c}	2.18^{b}
	+10% mixture	D_{12}	3.14	38.65^{c}	35.51^{c}	0.32^{ab}	2.24^{b}
L.S.D (P<0.05)*			0.518	0.169	0.121	0.045	0.106

G_1: (25% FM + 75% SBM) G_2: (50% FM + 50 % SBM) G_3: (75% FM + 25% SBM)
*Mean in the same column bearing different superscript are significantly different at (P<0.05).
ADG = Average daily gain (g/fish day^{-1})
SGR= Specific growth rate (% day^{-1})

Table 4. Effect of different dietary SBM levels supplemented with onion and garlic as feed additives on feed and nutrients utilization of Nile tilapia (*O. niloticus*) fingerlings.

	Treatment		FI[1] (g/fish)	FCR[2]	PER[3]	PPV %[4]	Energy utilization (%)
G_1	Control	D_1	66.19^{k}	3.08^{a}	1.09^{c}	18.35^{e}	13.51^{f}
	+ 4% garlic	D_2	67.19^{j}	2.85^{b}	1.00^{c}	15.96^{g}	12.27^{i}
	+ 6% onion	D_3	68.77^{i}	2.68^{c}	0.93^{d}	13.72^{h}	10.93^{j}
	+10% mixture	D_4	73.32^{g}	2.62^{c}	1.06^{c}	17.36^{f}	13.35^{g}
G_2	Control	D_5	72.15^{h}	2.21^{f}	1.29^{a}	23.69^{b}	12.51^{h}
	+ 4% garlic	D_6	83.24^{d}	2.44^{e}	1.17^{b}	20.89^{c}	15.20^{b}
	+ 6% onion	D_7	84.59^{c}	2.49^{d}	1.15^{b}	20.29^{c}	15.13^{b}
	+10% mixture	D_8	91.12^{a}	2.17^{f}	1.30^{a}	24.41^{a}	17.35^{a}
G_3	Control	D_9	73.32^{g}	2.57^{d}	1.11^{b}	18.74^{e}	14.59^{d}
	+ 4% garlic	D_{10}	80.38^{f}	2.56^{d}	1.10^{b}	18.79^{e}	14.31^{e}
	+ 6% onion	D_{11}	81.82^{e}	2.48^{d}	1.15^{b}	19.79^{d}	15.04^{c}
	+10% mixture	D_{12}	85.57^{b}	2.41^{e}	1.18^{b}	20.54^{c}	15.15^{b}
L.S.D (P<0.05)*			0.125	0.097	0.089	0.461	0.061

G_1: (25% FM + 75% SBM) G_2: (50% FM + 50 % SBM) G_3: (75% FM + 25% SBM)
*Mean in the same column bearing different superscript are significantly different at (P< 0.05).
[1] Feed intake (g/fish) [2] Feed conversion ratio
[3] Protein efficiency ratio [4] Protein productive value

Table 5. Effect of different dietary SBM levels supplemented with onion and garlic as feed additives on body composition (% dry weight) of Nile tilapia (*O.niloticus*) fingerlings.

	Treatment		DM %	CP	EE	Ash	Energy content (kcal/100g)
G_1	Control	D_1	25.12^{j}	57.76^{l}	24.30^{a}	17.94^{a}	551.16^{b}
	+ 4% garlic	D_2	26.70^{i}	58.20^{k}	23.97^{b}	17.83^{a}	554.52^{a}
	+ 6% onion	D_3	27.12^{h}	58.88^{j}	23.61^{c}	17.51^{b}	554.96^{a}
	+10% mixture	D_4	27.26^{g}	59.32^{i}	23.32^{d}	17.36^{c}	554.71^{a}
G_2	Control	D_5	27.87^{d}	61.86^{c}	21.76^{i}	16.38^{g}	554.30^{a}
	+ 4% garlic	D_6	28.17^{c}	61.05^{e}	21.64^{i}	16.31^{g}	554.24^{a}
	+ 6% onion	D_7	28.77^{b}	62.41^{b}	21.43^{j}	16.16^{h}	554.29^{a}
	+10% mixture	D_8	29.22^{a}	62.67^{a}	21.34^{j}	15.98^{i}	554.91^{a}
G_3	Control	D_9	27.53^{f}	59.79^{h}	23.00^{e}	17.21^{d}	554.34^{a}
	+ 4% garlic	D_{10}	27.69^{e}	60.11^{g}	22.83^{f}	17.04^{e}	554.54^{a}
	+ 6% onion	D_{11}	27.70^{e}	60.75^{f}	22.45^{g}	16.81^{f}	554.56^{a}
	+10% mixture	D_{12}	27.76^{e}	61.47^{d}	22.08^{h}	16.44^{g}	554.72^{a}
L.S.D(P<0.05)*			0.119	0.094	0.127	0.113	2.221

G_1: (25% FM + 75% SBM) G_2: (50% FM + 50 % SBM) G_3: (75% FM + 25% SBM)
*Mean in the same column bearing different superscript are significantly different at (P<0.05).
Calculated based on 5.65, 9.45 and 4.11 (kcal g^{-1}) of protein, lipid and carbohydrate, respectively.

4. Conclusion

Onion and garlic meal as feed additives represent alternative solutions to thrive aquaculture feeds as growth promoters. It could be concluded that dietary SBM and onion and garlic inclusion levels affect growth performance, feed utilization and chemical composition of Nile tilapia (*Oreochromis niloticus*) fingerling under laboratory conditions. More clearly, the maximum percentage of FM could be replaced by SBM is 50% in Nile tilapia (*Oreochromis niloticus*) mono-sex fingerling diets, with mixture of 4% garlic and 6% onion, to improve growth performance and feed utilization.

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استجابة أصبعيات أسماك البلطى النيلي للعلائق التى تحتوى على نسب احلال مختلفة لمسحوق السمك بكسب لفول الصويا باستخدام الثوم والبصل

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في هذه التجربة ، تم تكوين أثنتا عشر عليقة تحتوى على35% بروتين خام و 429.93 كيلو سعر طاقة كلية من أجل دراسة اثر استبدال محتوى العليقة من مسحوق السمك بكسب فول الصويا بأستخدام مسحوق الثوم والبصل على الاداء الانتاجة والاستفادة من الغذاء لاصبعيات البلطى النيلى عن طريق تقسيم العلائق الى ثلاثة مجموعات اعتماداً على مستوى احلال مسحوق السمك بكسب فول الصويا: مجموعة 1): 25% مسحوق سمك + 75% فول الصويا . مجموعة 2): 50% مسحوق سمك + 50% فول الصويا ، مجموعة 3): 75% مسحوق سمك + 25% فول الصويا. وضمت كل مجموعة أربعة معاملات اعتمادا على مستوى اضافة مسحوق الثوم والبصل الى العليقة : مجموعة أ) المجموعة القياسية (بدون إضافة ثوم أو بصل)، مجموعة ب) مجموعة مضاف إليها ثوم بنسبة 4% ، مجموعة ج) مجموعة مضاف إليها بصل بنسبة 6% ، مجموعة د) مجموعة مضاف إليها خليط من الثوم والبصل بنسبة 10% (4% ثوم و 6% بصل على أساس المادة الجافة) بأستخدام ثلاثة مكررات لكل معاملة لمدة 84 يوم . وتم تسكين عشرة أصبعيات من أسماك البلطى النيلي وحيد الجنس بمتوسط وزن 3.12 ± 0.30 جرام/ سمكة .

اوضحت نتائج التجربة ان أفضل أداء انتاجى والاستفادة الغذائية من العليقة لأصبعيات أسماك البلطى النيلي وجدت في الأسماك التي غذيت على العليقة المحتوية على مسحوق السمك وكسب فول الصويا بنسبة 50%:50%. أظهرت النتائج أيضاً أن إضافة خليط من مسحوق الثوم والبصل الى العليقة بنسبة 10% قد حسن معنوياً معايير النمو وكفاءة الاستفادة من الغذاء مقارنة بالعلائق التى تم اضافة كل منهما بصورة منفردة إليها. وقد خلصت التجربة إلى أن إستخدام العليقة التى تحتوى مسحوق السمك وكسب فول الصويا بنسبة 50%:50% مع إضافة خليط من الثوم والبصل بنسبة 10% (4% ثوم و 6% بصل على أساس المادة الجافة) يمكن التوصية بها لتحسين النمو والاستفادة من الغذاء لأصبعيات أسماك البلطى النيلي وحيد الجنس.