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# Effects of Dietary Protein Sources Supplemented with and Without Garlic and Onion on Nile Tilapia Fingerlings

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## Abstract
Groups of diets according to replacement levels of fish meal with soybean meal were processed: first groups of fish fed on diets contained : 25% fish meal (FM) + 75% soybean meal (SBM); second groups of fish fed on diets contained 50% FM + 50% SBM and third groups of fish fed on diets contained: 75% FM + 25% SBM. Each group included four treatments supplemented with different levels of garlic and onion level. Fish were reared in thirty six glass aquaria for 84 days, triplicate per treatment. The results showed that the best growth performance values and feed utilization were significantly ($P<0.05$) realized with fingerlings fed diets containing 50% FM + 50% SBM (experiment 2). Addition of 10% mixture of garlic and onion (D 8) significantly ($P<0.05$) increased growth performance and feed utilization rather than solitary addition. Fingerlings fed either D8 diets realized the highest values for protein efficiency ratio (PER), protein productive value (PPV %), energy utilization (EU %) and feed conversion ratio (FCR). The results indicate that the diet composed of 50% FM + 50% SBM with 10% mixture of garlic and onion for 84 days best enhanced growth performance, diet utilization efficiency on Nile tilapia mono-sex (*O. niloticus*) fingerlings.

## 1. Introduction

According to the proposed principles of organic aquaculture feeds, all fish meal (FM) components must be derived from fishery resources certified to be sustainability managed [1], where FM is the protein source traditionally used in aquaculture diets, yet it is a limited resource and is expensive [2]. 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 [3].

Soybean meal (SBM) is less expensive than FM, readily available [4] 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 [5]. 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 [6]. Furthermore, SBM has significantly less phosphorous than FM [7] Increasing the availability of nutrients from SBM not only enhances its utilization in aquaculture industry but also reduce the potential of aquatic environment pollution.

Garlic (*Allium sativum*), a 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, also a member of B- complex, A, C and F vitamins [8]. It has long been recognized that garlic has several beneficial effects for human and animals; exhibiting antimicrobial, antioxidant, and antihypertensive properties [9] and [10] has proved to be hypolipidemic [11], and insecticidal [14]. Garlic extract has also been shown to reduce serum cholesterol levels [15]; [16]. It is also used as immunostimulants and growth promoters for Nile tilapia [18]; [19]; [20]; [21].

Garlic bulbs (dry matter basis) contain 6.1% crude protein, 0.65% ether extract, 0.86% crude fiber, 1.48% crude ash and high concentrations of trace minerals (Se), glucosinolates and enzymes [22], 17 amino acids, which include lysine, arginine and cysteine [23]; [24]; [25].

Similarly, onion (*Allium cepa*) is a member of family Alliaceae, used as a medicinal plant (antibiotic, antiseptic and anti-infectious) and has, 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 [27]. Simultaneously, it have been considered a digestive material and used to improve 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

Three groups of diets according to replacement levels of fish meal with soybean meal as following: experiment (1) consists of: 25% fish meal (FM) + 75% soybean meal (SBM); experiment (2) 50% FM + 50% SBM and experiment (3): 75% FM + 25% SBM. Each group included four different levels of garlic and onion: a) three treatments considered as control diets (without garlic or onion: D1, D5, D9), b) three treatments supplemented with 4% garlic (D2, D6, D10) c) three treatments supplemented with 6% onion (D3, D7, D11) and d) three experimental treatments supplemented with 10% mixture (4% garlic and 6% onion: D4, D8, D12). Triplicate per treatment were used in this study.

## 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 Liter water /aquarium in triplicate. Before starting the experiment, fingerlings were acclimatized 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 blended 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. 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 [29]. The concentrations of ammonia, total alkalinity, nitrate, and nitrite were determined according to [30]. Ammonia and nitrite were measured at weekly intervals, while water temperatures were recorded daily in each aquaria .Also, dissolved oxygen was measured daily by oxygen meter and pH using pH meter.

## 2.5. 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 [31]. Gross energy (GE) and energy content (Eco) were calculated from [6] as 5.65, 9.45, and 4.11 kcal/g for protein, lipid, and carbohydrates, respectively.

## 2.6. Statistical Analysis

Growth parameters were made according to [32]. Data were analyzed by analysis of variance (ANOVA) using the SAS ANOVA procedure [33]. Duncan's multiple range tests was used to compare differences among means. Effects of the various treatments were considered significant at $P < 0.05$. All percentages and ratios were transformed to arcsine values prior to analysis [34].

# 3. Results

***Table (1).*** *Composition and proximate analysis of experimental diets.*

| Ingredients | Diets | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Diets (contained 75 % FM protein & 25 % SPM) | | | | Diets (contained 50 % FM protein & 50 % SPM) | | | | Diets (contained 25 % FM protein & 75 % SPM) | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Fish meal (C.P.60%) | 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 (cp.44%) | 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 |
| Yeast | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Garlic meal | - | 4.0 | - | - | - | 4.0 | - | - | - | 4.0 | - | - |
| Onion meal | - | - | 6.0 | - | - | - | 6.0 | - | - | - | 6.0 | - |
| Mixture G & O | -- | - | - | 10.0 | - | - | - | 10.0 | - | - | - | 10.0 |
| Corn oil | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Vitamin & Minerals[1] | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Proximate analysis (%)[2] | | | | | | | | | | | | |
| Moisture | 5.38 | 5.75 | 5.65 | 5.54 | 6.52 | 6.21 | 6.75 | 6.82 | 7.15 | 5.33 | 5.38 | 6.0 |
| Crude protein | 35.11 | 35.01 | 35.0 | 35.03 | 35.26 | 35.2 | 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 | 3.66 | 3.97 | 3.8 | 3.91 |
| Ash | 7.41 | 7.56 | 7.93 | 8.25 | 8.58 | 8.92 | 9.21 | 9.07 | 9.41 | 9.89 | 10.22 | 10.13 |
| Crude fiber | 4.41 | 6.01 | 7.97 | 7.1 | 4.42 | 5.11 | 6.88 | 6.04 | 3.48 | 4.29 | 5.81 | 5.10 |
| NFE[3] | 46.65 | 40.140 | 38.08 | 38.41.6 | 40.57 | 39.79 | 37.46 | 38.24 | 41.08 | 41.41 | 39.76 | 39.77 |
| Gross energy Kcal | 440.9 | 438.3 | 426.5 | 432.0 | 432.0 | 434.3 | 432.0 | 427.5 | 432.5 | 427.6 | 429.2 | 422.9 |
| P:E ratio | 79:63 | 79:88 | 82:08 | 84:08 | 80.82 | 87.36 | 83.02 | 82.29 | 81.47 | 82.11 | 83.61 | 82.57 |

[1]Vitamin and mineral premixed according to [51].
[2]Values represent the mean of three sample replicates.
[3]NFE = 100 - (% protein + % fat + %fiber + % ash).

***Table (2).*** *Effects of Garlic & Onion on growth performances of Nile tilapia.*

| Diets | Average (g/fish) | | Gain (g/fish) | ADG (g/fish/day) | SGR (%/day) | RGR (%) |
|---|---|---|---|---|---|---|
| | Initial | Final | | | | |
| Diets (contained 75 % FM protein & 25 % SPM) | | | | | | |
| 1 | 3.14±0.04 | 24.6±0.9$^{b}$ | 21.49±0.96$^{d}$ | 0.26±0.01$^{c}$ | 1.84±0.02$^{c}$ | 784.3±21.7$^{d}$ |
| 2 | 3.12±0.03 | 26.8±0.3$^{b}$ | 23.72±0.27$^{c}$ | 0.28±0.01$^{b}$ | 1.94±0.01$^{c}$ | 860.2±01.3$^{c}$ |
| 3 | 3.12±0.06 | 28.7±0.4$^{a}$ | 25.54±0.35$^{b}$ | 0.30±0.01$^{a}$ | 2.00±0.01$^{a}$ | 918.6±01.9$^{b}$ |
| 4 | 3.11±0.04 | 31.2±0.6$^{a}$ | 28.04±0.56$^{a}$ | 0.33±0.01$^{b}$ | 2.10±0.01$^{b}$ | 998.7±06.4$^{a}$ |
| F | 0.18 | 65.97** | 64.49** | 71.8** | 166.97** | 190.14** |
| M.S. | 0.00165 | 0.355 | 0.356 | 0.000042 | 0.000183 | 130 |
| Diets (contained 50 % FM protein & 50 % SPM) | | | | | | |
| 5 | 3.12±0.01 | 32.21±0.1$^{d}$ | 29.09±0.09$^{d}$ | 0.35±0.001$^{d}$ | 2.78±0.002$^{d}$ | 1032.27±1.99$^{d}$ |
| 6 | 3.13±0.01 | 37.26±0.1$^{c}$ | 34.13±0.06$^{c}$ | 0.41±0.001$^{c}$ | 2.95±0.002$^{c}$ | 1190.29± 2.05$^{c}$ |
| 7 | 3.13±0.01 | 41.45±0.1$^{b}$ | 38.31±0.12a$^{b}$ | 0.46±0.001$^{b}$ | 3.07±0.002$^{b}$ | 1322.77± 2.34$^{b}$ |
| 8 | 3.12±0.01 | 45.04±0.1$^{a}$ | 41.92±0.11$^{a}$ | 0.50±0.001$^{a}$ | 3.18±0.006$^{a}$ | 1443.61± 7.84$^{a}$ |
| F | 1.7 | 9547.47** | 9959.23** | 9963.98** | 6369.49** | 4995.63** |
| M.S | NS | 0.0096 | 0.0092 | 0.0000013 | 0.000014 | 18.8 |
| Diets (contained 25 % FM protein & 75 % SPM) | | | | | | |
| 9 | 31.4±0.1 | 31.64±0.6$^{d}$ | 28.50±0.07$^{d}$ | 0.34±0.001$^{d}$ | 2.75±0.01$^{d}$ | 1007.55±5.12$^{d}$ |
| 10 | 31.2±0.1 | 34.26±0.6$^{c}$ | 31.14±0.05$^{c}$ | 0.37±0.001$^{c}$ | 2.85±0.01$^{c}$ | 1098.08±1.60$^{c}$ |
| 11 | 31.3±0.1 | 36.14±0.6$^{b}$ | 33.01±0.05$^{b}$ | 0.39±0.001$^{b}$ | 2.91±0.01$^{b}$ | 1154.53±1.78$^{b}$ |
| 12 | 31.4±0.1 | 38.65±0.6$^{a}$ | 35.51±0.05$^{a}$ | 0.42±0.001$^{a}$ | 2.99±0.01$^{a}$ | 1230.90± 3.39$^{a}$ |
| F | 2.75 | 7287.76** | 8063.43** | 8056.67** | 2258.81** | 2446.12** |
| M.S | NS | 0.00362 | 0.00327 | 0.0000005 | 0.0000134 | 10.9 |

[1]Values are mean ± standard deviation. Values in the same column with same superscripts are not significantly different. IBW, initial body weight. FBW, final body weight. SGR (%/day), specific growth rate = (ln FBW/ln IBW)/time days /84).

***Table (3).*** *Effects of Garlic & Onion on feed utilization of Nile tilapia.*

| Diets | Feed intake g/fish | FCR | PER | PPV% | Energy gain (kcal) | Energy utilization |
|---|---|---|---|---|---|---|
| Diets (contained 50 % FM protein & 50 % SPM) | | | | | | |
| 1 | 66.2±0.6$^{bc}$ | 3.1±0.10$^{d}$ | 0.93±0.04$^{d}$ | 14.24±0.5$^{d}$ | 31.53±1.5$^{d}$ | 10.64±0.4$^{d}$ |
| 2 | 67.2±0.4$^{b}$ | 2.8±0.02$^{c}$ | 1.01±0.01$^{c}$ | 16.52±0.1$^{c}$ | 36.88±0.5$^{c}$ | 12.52±0.1$^{c}$ |
| 3 | 68.7±0.4$^{b}$ | 2.7±0.02$^{b}$ | 1.06±0.01$^{b}$ | 17.80±0.2$^{b}$ | 40.62±0.7$^{b}$ | 13.69±0.2$^{b}$ |
| 4 | 73.3±0.2$^{a}$ | 2.6±0.06$^{a}$ | 1.09±0.02$^{a}$ | 18.50±0.4$^{a}$ | 44.33±1.1$^{a}$ | 14.04±0.3$^{a}$ |
| F | 174.58** | 32.79** | 33.38** | 104.75** | 85.71** | 91.31** |
| M.S. | 0.171 | 0.000399 | 0.000458 | 0.122 | 1.06 | 0.0771 |
| Diets (contained 50 % FM protein & 50 % SPM) | | | | | | |
| 5 | 72.15±1.0$^{c}$ | 2.48±0.03$^{c}$ | 1.14±0.02$^{b}$ | 20.55±0.04$^{d}$ | 47.31±0.75$^{d}$ | 15.02±0.03$^{d}$ |
| 6 | 83.24±1.0$^{b}$ | 2.44±0.03$^{c}$ | 1.16±0.02$^{b}$ | 20.76±0.02$^{c}$ | 55.12±0.81$^{c}$ | 15.30±0.03$^{c}$ |
| 7 | 84.59±1.0$^{b}$ | 2.21±0.02$^{b}$ | 1.29±0.01$^{a}$ | 23.95±0.04$^{b}$ | 63.64±1.01$^{b}$ | 17.78±0.01$^{b}$ |
| 8 | 91.12±1.0$^{a}$ | 2.17±0.02$^{a}$ | 1.31±0.01$^{a}$ | 24.72±0.05$^{a}$ | 70.59±1.07$^{a}$ | 18.12±0.02$^{a}$ |
| F | 186.04** | 134.12** | 131.47** | 9290.04** | 364.77** | 220.4 ** |
| M.S | 1.00 | 0.00055 | 0.000167 | 0.00149 | 0.843 | 0.00066 |
| Diets (contained 25 % FM protein & 75 % SPM) | | | | | | |
| 9 | 73.32±0.20$^{d}$ | 2.57±0.01$^{d}$ | 1.11±0.02$^{bc}$ | 18.89±0.27$^{d}$ | 45.80±0.31$^{d}$ | 14.44±0.14$^{d}$ |
| 10 | 80.38±0.04$^{c}$ | 2.58±0.01$^{c}$ | 1.10±0.02$^{c}$ | 19.06±0.14$^{c}$ | 50.16±0.50$^{c}$ | 14.59±0.14$^{c}$ |
| 11 | 81.82±0.20$^{b}$ | 2.48±0.01$^{b}$ | 1.15±0.01$^{ab}$ | 20.08±0.13$^{b}$ | 53.06±0.69$^{b}$ | 15.48±0.17$^{b}$ |
| 12 | 85.70±0.12$^{a}$ | 2.41±0.01$^{a}$ | 1.18±0.01$^{a}$ | 20.85±0.04$^{a}$ | 57.13±0.11$^{a}$ | 15.76±0.0$^{a}$ |
| F | 3452.56** | 2249.00** | 32.16** | 93.18** | 327.51** | 76.75** |
| M.S | 0.0232 | 0.0000083 | 0.000423 | 0.0272 | 0.209 | 0.0164 |

[1]Values are mean ± standard deviation. * = (P≤0.05) **= (P≤0.01)
Values in the same column with same superscripts are not significantly different.
FCR, feed conversion ratio=dry feed fed/body weight gain. FER=feed efficiency ratio. PER=protein efficiency ratio.

***Table (4).*** *Initial and final whole body composition (wet weight basis) of Nile tilapia.*

| Diets | Dry matter | Crude protein | Crude fat | Ash | Gross energy(kcal) |
|---|---|---|---|---|---|
| **Initial** | **21.33±0.2** | **9.4±0.1** | **4.2±0.1** | **2.9±0.03** | **103±0.3** |
| Diets (contained 75 % FM protein & 25 % SPM) | | | | | |
| 1 | 31.26±0.60$^{a}$ | 14.43±0.1$^{d}$ | 6.10±0.1$^{b}$ | 3.99±0.04$^{c}$ | 138.39±0.38$^{b}$ |
| 2 | 29.16±0.60$^{b}$ | 15.60±0.1$^{c}$ | 6.36±0.1$^{a}$ | 4.25±0.02$^{a}$ | 148.40±0.51$^{a}$ |
| 3 | 29.75±0.90$^{b}$ | 16.00±0.1$^{b}$ | 5.39±0.1$^{c}$ | 4.24±0.03$^{ab}$ | 151.03±0.43$^{a}$ |
| 4 | 32.19±0.16$^{a}$ | 16.19±0.1$^{a}$ | 6.35±0.1$^{a}$ | 4.19±0.02$^{b}$ | 153.12±3.00$^{a}$ |
| F | 33.14** | 502.66** | 24.5** | 64.13** | 64.13** |
| M.S | 0.303 | 0.00368 | 0.00216 | 0.000700 | 14.8 |
| Diets (contained 50 % FM protein & 50 % SPM) | | | | | |
| 5 | 27.87±0.2$^{c}$ | 17.24 ±0.18$^{b}$ | 6.05±0.06 | 4.57±0.02$^{b}$ | 154.49±1.95$^{b}$ |
| 6 | 28.17±0.2$^{b}$ | 17.21 ±0.18$^{b}$ | 6.07±0.11 | 4.59±0.09$^{b}$ | 154.55±1.95$^{b}$ |
| 7 | 28.78±0.2$^{b}$ | 17.71 ±0.32$^{b}$ | 6.17±0.10 | 4.65±0.06$^{ab}$ | 160.09±1.14$^{a}$ |
| 8 | 29.22±0.2$^{a}$ | 18.31 ±0.19$^{a}$ | 6.24±0.10 | 4.77±0.10$^{a}$ | 162.73±1.23$^{a}$ |
| F | 27.42** | 15.82** | 2.48 | 4.17* | 19.62** |
| M.S | 0.04 | 0.0505 | NS | 0.00535 | 2.60 |
| Diets (contained 25 % FM protein & 75 % SPM) | | | | | |
| 9 | 27.53±0.4 | 16.45±0.21$^{b}$ | 6.34±0.06$^{a}$ | 4.72±0.04$^{a}$ | 152.56±1.28 |
| 10 | 27.69±0.2 | 16.65±0.09$^{b}$ | 6.32±0.08$^{a}$ | 4.73±0.07$^{a}$ | 153.55±1.22 |
| 11 | 27.70± 0.1 | 16.83±0.12$^{b}$ | 6.22±0.11$^{a}$ | 4.66±0.05$^{a}$ | 153.61±1.69 |
| 12 | 27.76±0.2 | 17.06±0.06$^{a}$ | 6.13±0.05$^{b}$ | 4.51±0.05$^{b}$ | 154.19±0.08 |
| F | 0.48 | 11.68** | 5.37* | 9.81** | 0.92 |
| M.S | NS | 0.0174 | 0.00566 | 0.00315 | NS |

Means in the same row bearing different superscripts differ significantly at 0.05 levels. Values are means ± SD (N = 3 for whole wet body composition of fish).

The proximate composition of the experimental diets is shown in Table (1). There was not much variation in the content of various nutrients among the different experimental diets. 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.

There were no differences in the initial fish weight of fish stocked but the performances differed significantly ($P \leq 0.05$) in terms of weight gain and specific growth rate (SGR). The

performance of Nile tilapia fingerlings fed the experimental diets is summarized in Table 2 & 3. All fish fed diets contained 50% fish meal protein and 50% soybean protein (diets 5, 6, 7 & 8) exhibited excellent growth rates through the study. No mortalities observed during the experimental period in all treatments.

Also the diet 8 supplemented with 10% mixture of onion and garlic exhibited excellent growth rate and differed significantly ($P \leq 0.05$) in terms of weight gain and specific growth rate (SGR) from other diets. The control diets (1, 5 and 9) without onion or garlic supplement produced the lowest growth rate and feed utilization (Table 2 & 3). However the control diet 5 (contained 50% fish meal protein and 50% soybean protein) produced higher growth rate and feed utilization than other control diets (1 & 9).

Tilapia fed on diets 2, 6, 10 supplemented 4% garlic showed slighter lower final body weight, specific growth rate and the value were ($P \leq 0.05$) significantly different from those fish fed the diets (3, 7, 11).

The highest values of feed conversion (FCR), feed intake (FI) and protein efficiency ratio (PER) were observed for fish fed the diets 4, 8 & 12 supplemented with 10 mixture of onion and garlic. There significantly ($P \leq 0.05$) different from other diets of treatments specially the control diets (1, 5 and 9) without onion or garlic supplement (Table 4).

There are significantly ($P \leq 0.05$) differences were found in the whole body-dry matter of fish fed the different experimental diets. An increase in the whole body protein content was observed in fish fed diets (4, 8 & 12) (contained 50% fish meal protein and 50% soybean protein), also there is an increase of protein content in diet (8) supplemented with 10% mixture of onion & garlic and showed significantly ($P \leq 0.05$) different among treatments supplemented with onion and garlic when compared to other diets (Table 5). The whole-body ash and energy contents showed similap trend in the whole-body protein content of Nile tilapia.

## 4. 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 in the experimental glass aquaria were temperature (28 ± 0.5°C), dissolved oxygen (6.7 ± 0.4 $mgl^{-1}$), total ammonia (0.08 ± 0.01 $mgl^{-1}$), nitrite (0.06 ± 0.01 $mgl^{-1}$), total alkalinity (165 ± 35 $mgl^{-1}$), chlorides (573±110 $mgl^{-1}$) and pH (8.4±0.11). These results are in accordance with finding of [42] working with mono-sex Nile tilapia.

Increasing SBM up to 75% in Exp 1 diets decreased fish growth performance to the lowest values. Similar results have been reported by [35] who replaced SBM instead of FM and [36] who replaced canola seed meal instead of FM in Nile tilapia diets. In contrast, [37] reported that growth of Nile tilapia was improved with increasing SBM inclusion level instead of FM up to 75%. In that respect, [38] 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 decrease in growth performance and feed utilization resulted from increasing SBM substitution level.

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. [39] recommended 3 g dry garlic/kg diet for better growth of Nile tilapia. [40] found that garlic improved the growth performance of Nile tilapia and similar results were reported by [41]; [21] and [42] for Nile tilapia fed with diets contained garlic meals. Moreover, [18] recorded the highest growth performance of Nile tilapia fed on 3% garlic, while [43] recommended 2.5%. On the contrary, [20] found no significant differences ($P>0.05$) in Nile tilapia growth when fed with diet supplemented with 10 and 20 g garlic $kg^{-1}$ feed, however several studies [44] on rainbow trout; [45] on hybrid tilapia; [46]; and [18] on Nile tilapia concluded that apparent protein digestibility was improved with increasing levels of garlic in fish diet due to garlic exhibiting antimicrobial [12], antioxidant [9] and hepatoprotective [14] which lead to increasing fish growth.

The highest final weight, weight gain, average daily gain (ADG) and specific growth rate (SGR %) obtained with fish fed mixture of garlic and onion supplemented diets (Diets 4, 8 12). [47] Found that onion and garlic dietary rise in liver free amino-acids; meanwhile, the garlic fed fish supplemented diets causing a rise in muscle free amino-acid levels and lead 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 (4, 8 and 12) (containing 50% fish meal protein and 50% soybean protein) supplemented with mixture of 4% garlic and 6% onion) grew significantly ($P<0.05$) better compared to other experimental diets. Fish fed Diet (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 increased growth performance, meanwhile increasing soybean meal replacement level up to 75% in diets (9, 10, 11 and 12) decreased growth performance significantly ($P<0.05$) than diets (5, 6, 7 and 8) in spite of being better than diets (1, 2, 3 and 4). Similar results have been reported by [42]; [48] and [39].

Regardless dietary FM replacement with SBM, the results 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 [41]; [18]; [39]; [40] and [42] found that feed intake increased with increasing garlic levels, while feed conversion ratio decreased. Fish fed Diet (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 [35] and [36].

In concordance with the present study, results of [41]; [39], [18], [49], [50] and [42] support the present results; while in contrast, [43] reported that there were no significant changes in fish body composition caused due to addition of different garlic levels.

## 5. 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 (*O. niloticus*) fingerling under laboratory conditions. More clearly, the maximum percentage of FM could be replaced by SBM is 50% in Nile tilapia (*O. niloticus*) mono-sex fingerling diets, with mixture of 4% garlic and 6% onion, to improve growth performance and feed utilization.

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