USE OF SOME MICROBIAL BIOMASS AS GROWTH PROMOTERS FOR *OREOCHROMIS NILOTICUS* FINGERLINGS DIETS.

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(Received 5/5/2010, Accepted 19/6/2010)

SUMMARY

The aim of the present study evaluate the effects of three types of feed additives, two blue green algaee strains (*Spirulina* sp. and *Spirulina pacifica*) and one yeast strain (*Saccharomyces cerevisae*) on growth performance in Nile tilapia fingerlings. Four diets were formulated to be isocaloric and isonitrogenous containing (about 4616 kcal/kg DM) and (about 31.49% CP) for tilapia fingerlings: one a control diet without supplements; a second supplemented with 1% *Spirulina* sp.; a third supplemented with 1% *Spirulina pacifica* and a fourth, supplemented with 1% *Saccharomyces cerevisae.* A total number of 120 Nile tilapia fingerlings with average initial body weight of 7.08±0.08 g/fish were randomly distributed into four treatment groups and stocked into 12 glass aquaria (70 liter each). The tilapia fingerlings were fed for 12 weeks with the fourth diets. Results indicate that the fingerlings fed with diets with feed additives at level 1% exhibited greater growth than those fed with the control diet. All feed additives treatments improved the tested parameters in Nile tilapia (*Oreochromis niloticus*) comparing with control treatment. The diets supplemented with *Spirulina* sp. and *Saccharomyces cerevisae* produced the highest growth performance and feed efficiency. All feed additives supplementation appeared to improved protein content without significant difference however, fish fed the control diet had the lowest protein content. Carcass lipid recorded the highest value in the control treatment, which were statistically different from the supplemented treatments. Ash content increased significantly ($P<0.05$) with the increase of feed additives, while the lowest ($P<0.05$) was obtained in fish fed the control diet. Fish fed diets containing probiotic exhibited higher ($P<0.05$) glucose, lipid and protein values. Also, feed additives supplementation significantly ($P<0.05$) decreased Aspartate aminotransferase and alanine aminotransferase values compared with control group, suggesting that *Spirulina* sp. and *Saccharomyces cerevisae* an appropriate growth-promoters in tilapia diets. It can be concluded that the addition of 1% feed additives in tilapia fingerlings diets improves fish growth and feed utilization .

Keywords: Feed additives; Nile Tilapia; Oreochromis niloticus; blue green algae (Spirulina), Saccharomyces cerevisae and growth parameters.

INTRODUCTION

Nile tilapia, *Oreochromis niloticus (L.)* is an important species for freshwater aquaculture. Improving fish performance and disease resistance of cultured organisms are major challenges facing fish culturists. Moreover, bacterial diseases are one of the limiting factors for fish culture including Nile tilapia.

Probiotics, as defined by the Food and Agricultural Organization of the United Nations and World Health Organization (FAO/WHO, 2006), are "live microorganisms administered in adequate amounts which confer a beneficial health effect on the host." The microorganisms referred to in this definition are non-pathogenic bacteria (small, single celled organisms which do not promote or cause disease), and one yeast, *Saccharomyces*. They are considered "friendly germs," due to benefits to the colon and the immune system. The word probiotic is a compound of a Latin and a Greek word; it means "favorable to life." Probiotics is also sometimes used to refer to a form of nutritional therapy based on eating probiotic foods and dietary supplements. Although probiotic supplements have also been used with farm animals, most are produced for human consumption in the form of dairy products containing two types of microbes—lactobacilli and bifidobacteria. As with the extended use of royal jelly, probiotics are now also being used in face creams and similar cosmetic products.

One of the chief difficulties in benefiting from probiotic supplementation has been assuring survivability of the bacteria as it passes through the acidity of the stomach and the digestive processes of the small intestine and successfully colonizing in the colon. Recently, a new probiotic with exceptional survivability and colonization characteristics, as demonstrated in studies, has emerged. This probiotic, screened from many strains of lactobacilli and named after its co-discoverers, Sherwood Gorbach and Barry Goldin, is known as Lactobacillus GG (LGG). LGG was demonstrated effective against *Psuedomembranous colitis*, an infection of the colon by *Clostridium difficile* as a result of antibiotic overkill of beneficial bacteria (FAO/WHO, 2006). Several mechanisms have been suggested as modes of action for probiotic bacteria. Though, probiotic and live microbes that may serve as dietary supplements to improve fish growth, enhanced nutrition, immune responses and survival rate, have received some attention in aquaculture (Venkat *et al.,* 2004 and Kesarcodi-Watson *et al.,* 2008).

Several authors pointed out that one of the main modes of action and beneficial effects of probiotics in aquaculture organisms is enhancement of nutrition of host species through the production of supplemental digestive enzymes and higher growth and feed efficiency, prevention of intestinal disorders and pre-digestion of antinutritional factors present in the ingredients (Thompson *et al.,* 1999 and Verschuere *et al.,* 2000).

Spirulina is considered a rich source of protein, vitamins, minerals, essential amino acids, and fatty acids (gamma - linolenic acid (GLA), and antioxidant pigments, such as carotenoids (Belay *et al.,* 1996). Several studies have been conducted using dried Spirulina as a feed supplement (Chow and Woo, 1990 and Watanabe *et al.,* 1990), and *Spirulina platensis*, which is commercially produced in Cuba, has been considered for partial substitution of microalgae in the feeding of white shrimp *Litopenaeus schmitti* protozoeas (Jaime *et al.*, 2004).

The present study was undertaken to evaluated the effects of three types of feed additives, two blue green algae strains (*Spirulina* sp. and *Spirulina pacifica*) and one yeast strain (*Saccharomyces cerevisae*) on growth performance, feed utilization, body composition and blood hematology in Nile tilapia fingerlings.

MATERIALS AND METHODS

This study has been carried out at the Wet Fish Laboratory, Department of Animal Production, Faculty of Agriculture, Kafrelsheikh University, Egypt.

Experimental fish:

Nile tilapia, *Oreochromis niloticus* fingerlings were brought from a fresh water commercial farm in Motobas, Kafr El-Sheikh governorate, Egypt. Prior to the start of the experiment, fingerlings were placed in a fiberglass tank and randomly distributed into glass aquaria to be adapted to the experimental condition until starting the experiment. Fish were fed on the control diet for two weeks, during this period healthy fish at the same weight replaced died ones. All the experimental treatments were conduced under an artificial photo period equal to natural light/darkness period (12h light: 12h darkness).

Experimental diets:

Four diets were formulated to containing feed additives for tilapia fingerlings: one a control diet without supplements; a second supplemented at 1% (w/w) with blue green algae containing *Spirulina pacifica* (*Arthrospira platensis,* was obtained from Kailua-kona, Hawii, U. S. A.); a third supplemented at 1% (w/w) with other isolate from blue green algae bacterial containing *Spirulina* sp. (local isolate, this isolate was isolated in previous study (unpublished data)) and a fourth, supplemented at 1%(w/w) with the yeast *Saccharomyces cerevisae*. The basal and tested diets were formulated from the commercial feed ingredients. The dry ingredients were grounded through a feed grinder to very small size (0.15 mm).

Experimental diets were formulated (Table 1) to be isonitrogenous and isocaloric (about 31.49% crude protein and about 461.63 kcal GE/100g diet. The ingredients were weighted and mixed by a dough mixer for 20 minutes to homogeneity of the ingredients. The estimated amount of oil components (sunflower oil) was gradually added (few drops gradually) and the mixing operation was continued for 20 minutes. The diets were pelleted through fodder machine and the pellets were dried under room temperature. The diets were collected, and stored in plastic bags in refrigerator at 4Ċ° during the experimental period to avoid the deterioration of nutrients.

Experimental design of rearing fish:

A total of 120 Nile tilapia, *Oreochromis niloticus* fingerlings with an average initial body weight about 7.08g ±0.08 were randomly divided into four treatment groups and stocked into 12 glass aquaria (70 liter each). Three aquaria were assigned for each treatment. Fresh tap water was stored in fiberglass tanks for 24h under aeration for dechlorination. One third of all aquaria were replaced daily. Five air stones were used for aerating the aquaria water. Fish feces and feed residues were removed daily by siphoning. Fish from each replicate were weighted at the start of each experiment and counted and weighted every two weeks throughout the experimental period (12 weeks).

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

Item	Diet[5] No (On DM basis, %)			
	D1	D2	D3	D4
Herring fish meal	15	15	15	15
Soybean meal	35	35	35	35
Yellow corn	30	30	30	30
Wheat bran	15	14	14	14
Sunflower oil	3	3	3	3
Vitamins and minerals premix[1]	2	2	2	2
Spirulina sp.	-	1	-	-
Spirulina pacifica	-	-	1	-
Saccharomyces cerevisae	-	-	-	1
Total	100	100	100	100
Dry matter	91.25	91.20	90.89	91.12
Crude protein %	31.38	31.46	31.58	31.53
Ether extract %	6.05	6.06	6.04	6.07
Crude fiber %	5.03	4.10	4.25	3.92
Total ash %	4.49	4.46	4.43	4.48
Nitrogen free extract %	53.05	53.90	53.68	54.00
Calculated energy value				
GE (kcal/kg)[2]	4583	4625	4620	4637
DE (kcal/kg)[3]	3437	3469	3465	3478
P/E,mg/kcal[4]	91.30	90.67	91.14	90.66

[1]Vitamins and minerals premix at 2 % of the diet supplies the following per kg of the diet: 75000 IU Vit.A; 9000 IU Vit. D3 ; 150 mg Vit. E ; 30 mg Vit. K3 ; 26.7 mg Vit. B1; 30 mg Vit. B2; 24.7 mg Vit. B 6 ; 75 mg Vit.B12; 225 mg Nicotinic acid ; 69 mg Pantothenic acid ; 7.5 mg Folic acid; 150 mg vit. C; 150Biotien; 500 mg Choline chlorid 300 mg DL-methionine; 93 mg Fe; 11.25 mg Cu; 210 mg Zn; 204 mg Mn; 5 mg Se and Co 5 mg (Local market).

[2]GE (Gross energy) was calculated according to NRC (1993) by using factors of 5.65, 9.45 and 4.22 K cal per gram of protein, lipid and carbohydrate, respectively .

[3]DE (Digestible energy) was calculated by applying the coefficient of 0.75 to convert gross energy to digestible energy according to Hepher et al., (1983).

[4]P/E (protein energy ratio) = crude protein x 10000 / digestible energy, according to Hepher et al., (1983).

[5] Diets: D1 (control): without supplements, D2:1% Spirulina pacifica, D3: 1% Spirulina sp. and D4: 1% Saccharomyces cerevisae.

Fish in all treatment were daily fed the experimental diets at a rate of 3% of live body weight per day. The feed amount was given three times daily (9 00, 1200 and 1500) in equal proportions, six days a week for 12 weeks. Fish were weighed biweekly and feed amounts were adjusted on the basis of the new weight.

Chemical analysis:

Proximate chemical analyses were made of diet ingredients and a sample of fish at the beginning and end of the experiment according to standard methods (A.O.A.C., 1992) for dry matter, crude protein, ether extract, crude fiber and ash. Gross energy (GE) contents of the experimental diets and fish samples were calculated by using factors of 5.65, 9.45 and 4.22 kcal/g of protein, lipid and carbohydrates, respectively (NRC, 1993) .

Measurements of water parameters:

Water samples were taken each two days for ammonia and pH analysis. Analytical methods were done according to the American Public Health Association (APHA, 1985). The pH values were determined by (A digital pH-meter). Water temperature and oxygen level were measured daily at 8 o'clock by (Oxygen meter model 9070). In all treatments water quality parameters for water temperature ranged between 26 to 28°C, pH (7.5 to 8.0); dissolved oxygen (5.60 to 6.50 mg/L) and water ammonia (0.08 to 0.13 mg/L). All the water quality parameters were within the acceptable ranges for fish growth (Boyed, 1984).

Blood parameters:

Blood samples were collected at the end of experiment, fish in each aquarium were weighted and 5 fish were taken randomly for blood sampling. The blood was collected using heparinized syringes from the caudal vein. Blood samples were centrifuged at 4000 rpm for 20 minutes to allow separation of plasma which was subjected to determine plasma total protein (Tietz, 1990). Blood plasma total lipids were determined according to the method of McGowan *et al.* (1983). Glucose concentration was determined according to Trinder (1969). Alanine aminotransferase (ALT) and activity of aspartate aminotransferase (AST) were determined by the methods of Young (1990).

Statistical analysis:

The obtained numerical data were statistically analyzed using SPSS (1997) for one-way analysis of variance. When F-test was significant, least significant difference was calculated according to Duncan (1955).

RESULTS AND DISCUSSION

Chemical composition of diets:

Experimental diets (Table, 1) contained nearly similar levels of DM, CP, EE, CF, Ash, NFE, GE, DE and P/E ratio. The CP and GE content of experimental diets were around 31.49 % and 4.62 kcal/g, respectively. These values were within the range suggested for tilapia by Jauncey and Ross (1982) and NRC (1993).

Growth performance and survival rate:

Data in Table (2) show the growth performance and nutrient efficiencies on Nile tilapia fingerlings fed diets containing probiotic. Results showed that, average initial live body weight of tilapia among the different experimental treatments ranged between 7.06 and 7.10 g. Statistical analysis showed that no significant differences (P>0.05) in initial body weight among the different experimental treatments, indicating the accuracy of randomization process between the experimental treatments.

Table (2): Growth performance parameters of Nile tilapia (*O. niloticus*) fed on the experimental diets.

Item	Treatments				SE*
	T_1	T_2	T_3	T_4	
Initial weight, g/fish	7.10	7.08	7.07	7.06	0.08
Final weight, g/fish	34.21^b	39.52^a	37.19^{ab}	40.81^a	0.68
Average total gain[1], g/fish	27.11^b	32.44^a	30.12^{ab}	33.75^a	1.21
Average daily gain[2], g/fish/day	0.32^b	0.39^a	0.36^{ab}	0.40^a	0.03
Specific growth rate[3] (SGR % /day)	1.87^b	2.05^a	1.98^{ab}	2.09^a	0.08
Survival rate[4], %	100	100	100	100	0.001
Feed intake (FI), g/fish	44.52	45.23	44.61	46.72	1.74
Feed conversion ratio[5] (FCR)	1.50^a	1.27^c	1.35^b	1.26^c	0.15
Protein efficiency ratio[6] (PER)	2.13^c	2.50^a	2.35^b	2.51^a	0.14
Protein productive value[7] (PPV, %)	37.49^b	45.15^a	42.62^a	44.78^a	1.38
Energy retention[8] (ER, %)	24.05^b	27.62^a	26.47^a	27.16^a	1.54

**Means in the same rows having different superscript letters were significantly different at 0.05 level.*

** Standard error of the mean derived from the analysis of variance.*

1. ATG (g/fish) =Average final weight (g) – Average initial weight (g).

2. ADG (g/fish/day) = [ATG (g)/experimental period (d)].

3. SGR (%/day) = 100(Ln final weight–Ln initial weight)/experimental period (d).

4. SR =100[Total No of fish at the end of the experimental/Total No of fish at the start of the experiment].

5. FCR = DM Feed Intake (g)/Live weight gain (g).

6. PER = Live weight gain (g)/ Protein intake (g).

7. PPV (%) =100 [Final fish body protein (g)–Initial fish body protein (g)]/crude protein intake (g).

8. ER % = 100 [gross energy gain / gross energy intake]

It is clearly shown (Table, 2) that although averages of initial weight of fish for the different experimental group were the same, however. All the tested growth parameters (gain, ADG and SGR) showed that, the diets supplemented with *Spirulina* sp. and *Saccharomyces cerevisae* administered to the fingerlings (T_2 and T_4) produced the best growth rate. On the other hand, the group of fish fed control diet (T_1) exhibited the lowest final body weight. Statistical analysis showed that, the group of fish fed diets supplemented with 1% of *Spirulina pacifica; Spirulina* sp. and *Saccharomyces cerevisae* had significantly (P<0.05) higher values than those control diet (without supplements).

Also no significant differences was observed between fish groups fed diet supplemented with 1% *Spirulina* sp.; *Spirulina pacifica* and *Saccharomyces cerevisae.*

Results show that, treatments (T_4 and T_2) had the statistically highest feed conversion ratio of the probiotic-supplemented diets, though the other probiotic-supplemented diet (T_3) had feed conversion ratios significantly lower than those for the control diets ($P < 0.05$). The best conversion ratio was recorded for the 1% of *Saccharomyces cerevisae and Spirulina* sp. (1.26 and 1.27, respectively) treatments.

In general, fish fed with the diets supplemented with feed additives showed better feeding efficiency than those fed with control diet (without supplemented). The protein efficiency ratio (PER), protein productive value (PPV %) and energy retention (ER %) were significantly higher in the treatments containing 1% *Spirulina pacifica* and 1% *Saccharomyces cerevisae* than in other treatments (Table, 2). The lowest PER, PPV and ER were recorded for the control treatments.

All the probiotic-supplemented diets resulted in growth higher than that of the control diets, suggesting that the addition of feed additives mitigated the effects of the stress factors. This resulted in better fish performance, with better growth results in the diets supplemented with the yeast. Similar results were observed by Va'zquez-Jua'rez *et al.* (1993) when yeast isolated from the intestines of wild rainbow trout and introduced into the digestive tracts of domestic rainbow trout, producing a significant increase in the growth of the cultured trout. Also, Lara-Flores *et al.*, (2003) studied the effect of three types of feed additives, two bacteria and one yeast on growth performance in Nile tilapia fry, results indicate that the fry fed diets with a feed additives supplement exhibited greater growth than those fed with the control diet, of the probiotic treatments, the diet supplemented with yeast produced the best growth performance and feed efficiency, suggesting that yeast is an appropriate growth-stimulating additive in tilapia cultivation.

It is also necessary to consider the possibility of interspecies differences, as suggested by Noh *et al.,* (1994), who studied the effect of supplementing common carp feeds with different additives, including antibiotics, yeast (*S. cerevisiae*) and bacteria (*S. faecium*). They observed better growth response with probiotic-supplemented diets, but obtained the best growth with a bacterium, not yeast. Similar results were reported by Bogut *et al.* (1998), who fed common carp diets supplemented with *S. faecium*, reporting that the bacterium has a better probiotic additive for carp than yeast, clearly in contrast to the present results for tilapia.

The best FCR values observed with probiotic-supplemented diets suggest that addition of feed additives improved feed utilization even under stress conditions, with yeast being the most effective of the supplements tested in the present study. Similar results have been reported for feed additives use in diets for piglets (Gil, 1998). In practical terms, this means that probiotic use can decrease the amount of feed necessary for animal growth which could result in production cost reductions.

The PER and PPV results indicate that supplementing diets with feed additives significantly improves protein utilization in tilapia. This contributes to optimizing protein use for growth, a significant quality given that protein is the most expensive feed nutrient. The improvement in the biological value of the supplemented diets in those treatments with high population and low dietary protein demonstrated that the feed additives supplements performed more efficiently in stress situations (Lara-Flores *et al.*, 2003).

The improved fish growth and feed utilization may possibly be due to improved nutrient digestibility. In this regard, Tovar *et al.*, (2002), Lara-Flores *et al.* (2003), and Waché *et al.*, (2006) found that the addition of live yeast improved diet and protein digestibility, which may explain the better growth and feed efficiency seen with yeast supplements. Also, De Schrijver and Ollevier (2000) reported a positive effect on apparent protein digestion when supplementing turbot feeds with the bacteria *Vibrio proteolyticus*.

Body composition:

Feed additives supplementation significantly affected whole-fish body composition except for dry matter, which did not differ (Table, 3). Fish fed the control diet had the lowest protein content; however, all feed additives supplementation appeared to improved protein content without significant difference. Carcass lipid content was also affected by dietary treatments, the highest values in the control treatment, which were statistically different from the supplemented treatments. The lowest overall lipid content was recorded for the *Spirulina* sp. (T_2) treatment, which was not statistically different with all other treatments. Ash content increased significantly ($P<0.05$) with the increase of feed additives and the highest ash content was obtained in fish fed 1% *Saccharomyces cerevisae*, whereas the lowest ($P<0.05$) was obtained in fish fed the control diet.

Table (3): Effect of probiotic on Nile tilapia body composition (%, on DM basis).

Item	Initial fish	Treatments				SE*
		T_1,Control	T_2	T_3	T_4	
Dry matter, %	23.72	28.52	28.64	28.90	28.18	0.29
Crude protein, %	57.10	58.84^b	60.21^a	59.68^a	60.52^a	1.42
Ether extract, %	17.65	20.24^a	19.58^b	19.89^b	19.42^b	0.56
Ash, %	14.21	14.42^b	15.53^a	15.80^a	15.88^a	0.10
Energy, Kcal/100g	536	551	545	545	544	2.54

**Means in the same rows having different superscript letters were significantly different at 0.05 level.*

**Means of the standard error derived from the analysis of variance.*

These results suggest that *Saccharomyces cerevisae* and *Spirulina* sp. supplementation plays a role in enhancing feed intake with a subsequent enhancement of fish body composition. The better feed intake in feed additives supplemented diets may have been due to increased fish appetite resulting in a higher feed intake and therefore improved growth. Moreover, due to the high feed intake and nutrient utilization, the deposited nutrients increased. On the other hand, changes in protein and lipid content in fish body could be linked with changes in their synthesis, deposition rate in muscle and/or different growth rate (Lara-Flores *et al.*, 2003; Abdel-Tawwab *et al.*, 2006 and Abdel-Tawwab *et al.*, 2008).

Biochemical blood parameters:

Results in Table (4) showed that, Fish fed diets containing probiotic exhibited higher ($P<0.05$) glucose, lipid and protein values. Also, feed additives supplementation significantly ($P<0.05$) decreased Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) values compared with control group (without supplementation). Biochemical analyses often provide vital information for health assessment and management of cultured fish (Cnaani *et al.*, 2004).

Table (4): Blood plasma parameters of Nile tilapia fed on the experimental diets.

Item	Treatments				SE*
	T_1	T_2	T_3	T_4	
Plasma glucose, mg/dl	58.11[b]	62.54[a]	63.87[a]	64.65[a]	0.45
Plasma total protein, g/dl	5.10[b]	7.58[a]	6.97[a]	7.64[a]	0.15
Plasma total lipid, g/dl	4.23[b]	5.28[a]	4.89[a]	5.84[a]	0.12
AST, U/dl	115[a]	108[b]	112[b]	105[b]	3.45
ALT, U/dl	46[a]	42[b]	41[b]	40[b]	1.58

**Means in the same rows having different superscript letters were significantly different at 0.05 level.*

** Standard error of the mean derived from the analysis of variance.*

In the present study, fish fed diets containing 1% feed additives exhibited higher glucose, lipid and protein values. These results suggest an improvement of fish health when fed a probiotic supplement. Moreover, the measurement of Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) in plasma is of considerable diagnostic value in fish, as it relates to general nutritional status as well as the integrity of the vascular system and liver function. This result agrees with Abdel-Tawwab *et al.*, (2008) who investigated the use of commercial probiotic as a growth and immunity promoter for Nile tilapia, *Oreochromis niloticus;* they found that biochemical parameters were improved in fish fed probiotic.

CONCLUSION

It can be concluded that the addition of 1% feed additives in tilapia fingerlings diets improves fish growth and feed utilization .Based on these results, use of a 1% supplement of *Spirulina sp.* and *Saccharomyces cerevisae* in tilapia fingerlings feeds is recommended to stimulate growth performance.

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إستخدام الكتلة الحيوية الميكروبية كمنشطات نمو في علائق إصبعيات البلطي النيلي

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أجرى هذا البحث بمعمل بحوث الأسماك بقسم الإنتاج الحيواني بكلية الزراعة – جامعة كفر الشيخ وذلك لبحث تأثير إضافة ثلاثة أنواع من الإضافات الحيوية ، إثنان من البكتريا وواحد من الخميرة الجافة على أداء النمو والاستفادة من الغذاء والعناصر الغذائية وكذلك التركيب الكيماوي لجسم الأسماك. تم تركيب أربع علائق تجريبية متزنة في نسبه البروتين (٣١,٤٩%) والطاقة (٤٦١٦ ك كالورى/كجم مادة جافة) – الأولى عليقة المقارنة بدون إضافات ، الثانية أضيف لها ١% من *Spiurlina sp.*، والثالثة أضيف لها ١% من بكتريا *Spiurlina pacicfica* أما العليقة الرابعة فقد أضيف لها ١% من خميرة حية جافة *Saccharomyces cerevisae* وتم عمل تقييما حيويا خلال فترة التجربة والتي امتدت لمدة ١٢ اسبوع. وقد تم استخدم أثنى عشر حوض زجاجي سعة كل منها ٧٠ لتر بواقع ثلاثة أحواض لكل معامله . وتم تخزين عشرة اسماك (بمتوسط وزن ابتدائي ٧,٠٨ جم/سمكه) في كل حوض .

وأظهرت نتائج التجربة أن اصبعيات البلطي النيلي التي تغذت على العلائق المضاف لها الإضافات الحيوية بنسبة ١% أعطت أحسن النتائج في قياسات النمو وكفاءة الاستفادة من الغذاء مقارنة بمجموعة المقارنة. وكانت أحسن النتائج في المجاميع التي تغذت على العليقة الثانية (*Spiurlina sp.*) والرابعة (*Saccharomyces cerevisae*). في نهاية التجربة أزداد محتوى الجسم من البروتين والرماد في جميع الأسماك المعاملة وكانت مجموعة المقارنة أقل الأسماك في محتوى البروتين بينما كانت أكثر المجموعات في محتواها من الدهون ، كما أظهرت النتائج ارتفاع نسبة الجلوكوز والليبيدات والبروتين الكلى في بلازما الدم للمجموعات المعاملة مقارنة بمجموعة المقارنة بينما انخفضت أنزيمات الكبد معنويا في المجاميع المعاملة مقارنة بمجموعة المقارنة.

ومن النتائج السابقة فانه يوصى بإضافة هذه الإضافات الحيوية إلى علائق اصبعيات البلطي النيلي بنسبة ١%.