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EVALUATION OF THE YEAST "*Saccharomyces cerevisiae*" AS AN ADDITIVE TO TILAPIA, *Oreochromis niloticus,* FEEDS

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ABSTRACT

This experiment was conducted to determine the optimum level of adding the yeast *Saccharomyces cerevisiae* to tilapia feeds. Two types of feed were used, the first feed type contained fish meal and the second feed type contained a whole plant ingredients. Four experimental diets were formulated for each type of feed. The dried bakery yeast (DBY) was added to three of the experimental diets at levels of 0.1%, 0.2% or 0.3%. The fourth experimental diet did not contain the (DBY) and used as a control diet. These experimental diets were fed to tilapia, *Oreochromis niloticus* fingerlings for a period of seven weeks. The results showed that growth performance and feed utilization had improved at all addition levels of (DBY). The addition of the (DBY) at levels of 0.2% or 0.3% had showed no significant improvement rather than this given the 0.1%. The addition of (DBY) to a whole plant diet had resulted in growth rates that are significantly equivalent to that of a diet containing fish meal without the addition of DBY. Therefore, it could be recommended that the use of 0.1% of DBY to tilapia diets would be of economic worthiness.

INTRODUCTION

With increasing consumer demand for fish and declining supply from natural waters, the aquaculture industry has to compensate this shortage in fish supply. As aquaculture technology has evolved, the push toward higher yields and faster growth has evolved the replacement of natural foods with prepared diets. This type of feeds should contain not only necessary nutrients but also complementary additives to keep organisms healthy and to support maximum growth. Growth promoters include hormones, antibiotic, ionophores and some salts (NRC, 1993). However, the improper use of these growth promoters may cause adverse effects to the animal and to the final consumer and could also lead to resistance in pathogenic bacteria in the case of antibiotic. (Fuller, 1992).

Consequently, fish nutritionists have tried to examine other materials to be used as growth promoters in fish feeding. Recently, probiotics have been used for supplementing diets in many fish species. Common carp fed on diets supplemented with yeast (*S. cerevisiae)* gained better growth response compared with those fed on either antibiotics or bacteria (*S. faecium)* (Noh *et al.,* 1994). Bogut *et al.,* (1998) reported that *S. faecium* has a better probiotic additive for carp than yeast. A significant increase in the growth of cultured trout was observed when yeast isolated from the intestines of wild trout was introduced into the digestive tracts of cultured trout (Vázquez – Juárez *et al.,* 1993). Lara. Flores *et al.,* (2003) concluded that the addition of 0.1% *S. faecium*, L. aceidophilus or *S. cervisiae* in tilapia fry diets improves animal growth, and the yeast produced the best results. They also noted that

the addition of yeast decreases the effects of stress factors such as low dietary protein level and high stocking density. The objective of this research is to investigate the optimum level of addition of the (*S. cerevisiae)* yeast in two types of tilapia feeds containing either fish meal or plant-ingredient diet.

MATERIALS AND METHODS

The experiment was conducted for a period of 7 weeks, using a mixed sex Nile tilapia (*Qreochromis niloticus,* 11.04g average weight) fingerlings purchased from EL Wafaa Farm, Giza, Egypt.

The experimental system was a closed recirculating water system consisting of twenty four fibreglass aquarium of 60-litre (L) each. Water flow out of each aquarium 2L/min. into a submerged biofilter after passing through a mesh net to remove solid impurities. Water was then collected in a common reservoir from which the filtered water is pumped up to the rearing units. The water used in the system was stored-tap water, which was aerated using a blower aerator-type. Five percent of the total water volume was renewed daily. A thermo controlled electric heater was used to adjust water temperature.Range of values representing water quality is shown in Table (1).

The fish were kept in plastic tanks then divided into 24 groups of fish. Each group was transferred into the rearing aquarium and kept for a period of 2 weeks to be accustomed to the laboratory condition before the implementation of the experimental treatments.

Table (1): Ranges of water temperature ℃, pH, dissolved oxygen, ammonia and nitrate mg/L during the feeding experiment.

Temperature ℃	Dissolved O_2 mg/L	Ammonia mg/L	Nitrate mg/L	pH
25-28	5.5-6.7	Not detected	39-42.5	6.5-7.5

Eight and nearly isonitrogenous and isocaloric diets were formulated to contain 30% crude protein (C.P.) and 4200 Kcal/ Kg diet. These experimental diets were divided into two groups of diets. The first group contained fishmeal (diets; Ao.0, Ao.1, Ao.2 and Ao.3) while the second group was containing ingredients of plant origin only (diets; Po.0, Po.1, Po.2 and Po.3). Diets Ao.1, Ao.2, Ao.3, Po.1, Po.2 and Po.3 were supplemented with a commercial dried bakery yeast *Saccharomyces cerevisiae* (DBY) at 0.1%, 0.2% and 0.3%, respectively. Both diets Ao.0 and Po.0 were not supplemented with yeast and were used as control diets. Table 2 shows diets formulation and Table 3 shows their chemical composition. Feed ingredients were finely grinded and the different ingredients were mixed manually. Yeast was diluted in slightly warm water before adding it into the former mixture. More water was added to each diet till paste was formed and then passed through a meat mincing machine to convert the mixture into pellets. The wet pellets were sundried and stored at -4℃. Each diet was fed to three replicate groups of 24fish, each at daily rate of 3% of body weight for 7 weeks. At the 7^{th} day of each week, fish in each aquarium were weighed and the

percentage of the ration offered was altered according to their body weight change. At the beginning of the experiment, one hundred fish were killed, as a control group and were kept frozen for chemical analysis. At the end of the experimental period, fish of each aquarium were killed.

Analysis of the different experimental feed ingredients, formulated diets and whole fish body were carried out for moisture, nitrogen, ether extract, crude fiber according to the procedures of The Association of Official Analytical Chemists (A.O.A.C., 2000). Crude protein was calculated as nitrogen content x 6.25. Amino acids (Lysine and Methionine) were determined according to the method of the (Official Journal of the European communities 19-9-98).

Mean of weight gain (wg), relative weight gain (wg%), and average daily gain (ADG) were calculated as follows:

$$Wg = w_1 - w_0$$

$$Wg\ \% = \frac{w_1 - w_0}{w_0} \times 100$$

$$ADG = \frac{wg}{\text{experimental period / d}}$$

Where w_0 means initial weight, w_1 means final weight, and d means experimental period in days.

Averages of feed conversion ratio (FCR), protein efficiency ratio (PER) and protein retained were calculated as follows:

$$FCR = \frac{\text{Feed intake (g)}}{\text{wg (g)}}$$

$$PER = \frac{\text{Weight gain (g)}}{\text{Protein intake (g)}}$$

$$\text{Protein retained\%} = \frac{B - B_0}{BI} \times 100$$

Where B_0 means initial body protein content (g); B means final body protein content (g); BI means protein intake (g).

Water temperature, pH, dissolved oxygen, ammonia NH_3, and nitrate No_3, were all periodically measured during the feeding trials. Water temperature ℃ was measured using a thermometer, pH using ORION, pH /ISE meter model 710A, ATI ORION ion meter was used with ammonia electrode model 93.07 and oxygen electrode model 97.08. Nitrate was measured according to standard methods (APHA, 1989). Data were statistically analyzed using the general linear model for analysis of variance (SAS Institute, 1990). To verify the interaction (protein sources X levels of yeast supplementation), a factorial arrangement (2 X 4) was applied.

Significant differences among treatment means were separated by Duncan's new multiple range test (Duncan,1955).

Table (2): Formulation of experimental diets containing different levels of *S. cerevisiae*.

Ingredients %	A 0.0	A 0.1	A 0.2	A 0.3	P 0.0	P 0.1	P 0.2	P 0.3
Fish meal	18.00	18.00	18.00	18.00	--	--	--	--
Soy bean meal	12.63	12.63	12.63	12.63	24.78	24.78	24.78	24.78
Corn gluten meal	12.63	12.63	12.63	12.63	24.78	24.78	24.78	24.78
Yellow corn	52.40	52.30	52.20	52.10	41.95	41.85	41.75	41.65
Min. & Vit. Mix[1]	03.00	03.00	03.00	03.00	03.00	03.00	03.00	03.00
Mono calcium phosphate	--	--	--	--	02.00	02.00	02.00	02.00
DL. Methioine	--	--	--	--	00.12	00.12	00.12	00.12
L. Lysine. HCL	--	--	--	--	00.65	00.65	00.65	00.65
Corn oil	01.34	01.34	01.34	01.34	02.72	02.72	02.72	02.72
Dried bakery yeast	--	0.10	0.20	0.30	--	0.10	0.20	0.30
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[1] **Vitamin – mineral mixture supplied per Kg: Vit. A, 12000 I. U; Vit. D_3, 2200 I. U; Vit. E, 10 mg; Vit. K_3, 2 mg; Vit. B_1, 1mg; Vit. B_2, 4mg; Vit. B_6, 1.5mg; Vit. B_{12}, 10µg; Niacin, 20 mg; Pantothenic acid, 10 mg; Folc acid, 1mg; Biotin, 50 µg; Choline choride, 500mg; Copper, 10mg; Iodine, 1mg; Iron, 30mg; Manganese, 55 mg; Zinc, 50 mg and Selenium, 0.1 mg.**

Table (3) : Chemical composition of experimental diets containing different levels of *S. cerevisiae*. (as fed basis)

[1] **NFE = 100 – (moisture + crude protein + ether extract + crude fiber + Ash)**

Ingredients %	Ao. 00	Ao. 10	Ao. 20	Ao. 30	Po. 00	Po.10	Po. 20	Po. 30
Moisture	07.60	08.70	08.20	09.50	09.70	08.70	09.40	09.50
Crude protein	30.70	30.80	30.20	30.90	31.00	30.40	31.30	30.40
Ether Extract	05.21	04.99	05.33	05.06	05.24	05.11	04.98	05.20
Ash	04.79	04.93	04.80	05.27	04.16	04.78	04.30	04.32
Fiber	02.85	03.10	02.79	03.10	03.20	03.46	03.10	03.19
Nitrogen Free Extract[1]	48.85	47.57	48.68	46.17	46.70	47.55	46.92	47.39
Calcium	01.56	01.66	01.80	01.68	01.32	01.38	01.36	01.32
Phosphorus	0.695	00.74	00.75	00.71	00.83	00.84	00.80	00.85
Lysine	1.67	1.65	1.69	1.59	1.69	1.66	1.61	1.60
Methionine	0.79	0.81	0.77	0.79	0.80	0.75	0.76	0.74
Digestible energy Kcal/100 gm diet[2]	411.73	409.41	412.41	408.03	413.58	408.53	412.58	412.33

[2] **DE was calculated according to Wang *et al*,(1985), based on 4.5 Kcal/g protein; Kcal/g lipid; 4 Kcal/g carbohydrate.**

RESULTS

Data representing Survival %, initial weight, final weight, weight gain, relative weight gain, average daily gain, feed conversion ratio, protein efficiency ratio and protein retained in fish given the various experimental diets are shown in Table (4). The statistical analysis of the data is presented in Table (5). Mean values for survival% were not significantly different (P>0.05) among fish given the various experimental diets. However fish given diets supplemented with DBY (Ao.1, Ao.2, Ao.3, Po.1, Po.2, Po.3) tended to have the best survival% regardless of dietary protein source. Fish given diets

that were not supplemented with DBY (diets Ao.0, Po.0) had the lowest survival%.

Feeding fish on a diet that based on plant-protein without the addition of yeast (diet Po.0) produced the lowest final weight, weight gain, relative weight gain and average daily gain, with statistically lower values ($P<0.05$) than the other treatments.

The addition of DBY to diets containing fish meal (diets Ao.1, Ao.2, Ao.3), generally improved growth performance of fish comparing to the unsupplemented diet (diet Ao.0). Weight gain and average daily gain of fish given the supplemented diets (diets Ao.1, Ao.2, Ao.3) were statistically ($P<0.05$) higher than those given the unsupplemented diet (diet Ao.0). However, final weight of fish given diet (Ao.3) was not statistically ($P>0.05$) higher than those given diet (A.o.o). Whereas, final weight of fish given diet (Ao.2 or Ao.3) was significantly different ($P<0.05$) from those given diet (A.o.o).

Similarly, fish given whole plant diets and supplemented with DBY (diets Po.1, Po.2 and Po.3) had statistically ($P<0.05$) higher weight gain, weight gain% and average daily gain comparing to those given diet (Po.0). Final weight of fish given diet Po.2 was statistically higher ($P<0.05$) than those given diet (Po.0). However, final weight of fish fed on diet Po.1 or diet Po.3 was not statistically higher ($P>0.05$) than those fed on diet Po.0.

Feed conversion and protein efficiency ratios were not statistically ($P>0.05$) different if fish fed either the unsupplemented (diet A.o.o) or (diet Po.0). However, fish given diet A.o tended to have better feed conversion and protein efficiency ratios comparing to diet Po.o. Adding DBY to either diets (diets Ao.01, Ao.02, Ao.03, Po.1, Po.2 or Po.3) did not significantly ($P>0.05$) improve feed conversion ratio over that of their respective diets. Supplementation with DBY only improved protein efficiency ratio in case of diets; Ao.1, Ao.2 or Ao.3. Protein retained in fish given diet A.o.o was statistically higher ($P<0.05$) than that of fish given diet Po.o. Addition of DBY to diets Ao.1, Ao.2, Ao.3 significantly improved ($P<0.05$) protein retained in fish. Addition of DBY to diets Po.1, Po.2 or Po.3 improved protein retained in fish, though, this improvement was not statistically significant ($P>0.05$).

Regardless of DBY addition levels, growth performance and feed utilization parameters were not statistically ($P>0.05$) different among fish given diets containing fish meal and supplemented with 0.1%, 0.2% or 0.3% DBY (diets Ao.1, Ao.2 or Ao.3).

Also, the former parameters were not statistically ($P>0.05$) different among fish given whole plant diet and supplemented with 0.1%, 0.2% or 0.3% DBY (diets Po.1, Po.2 or Po.3). At any supplementation level, whole plant diet (diets Po.1, Po.2 or Po.3) resulted in growth rates that are significantly equivalent ($P<0.05$) to that of a diet (Ao.o) containing fish meal without the addition of DBY. Table (6) shows body chemical composition of fish fed the different experimental diets. The statistical analysis of the data is presented in Table (7). Body moisture, crude protein, ether extract and ash contents were no statistically different ($P>0.05$) among fish given the various experimental diets.

Table (4): Growth and Feeding Performance of Tilapia fed diets supplemented with varying levels of *S. cerevisiae*.

Mean Values	Ao. 0	Ao. 1	Ao. 2	Ao. 3	Po. 0	Po.1	Po. 2	Po. 3
Survival %	$74.99_{\pm 13.75}$	$90.72_{\pm 3.32}$	$87.56_{\pm 7.08}$	$90.27_{\pm 4.94}$	$97.16_{\pm 9.00}$	$83.33_{\pm 7.09}$	$95.83_{\pm 1.96}$	$91.66_{\pm 5.19}$
Initial weight/g	$10.98_{\pm 0.36}$	$11.60_{\pm 0.36}$	$11.27_{\pm 0.44}$	$10.80_{\pm 0.35}$	$11.25_{\pm 0.79}$	$10.40_{\pm 0.41}$	$11.13_{\pm 0.57}$	$10.91_{\pm 0.82}$
Final weight/g	$33.39^{cd}_{\pm 1.35}$	$39.35^{a}_{\pm 1.02}$	$38.40^{ab}_{\pm 0.79}$	$37.86^{abc}_{\pm 1.3}$	$27.77^{e}_{\pm 0.85}$	$32.39^{de}_{\pm 1.26}$	$33.59^{bcd}_{\pm 2.57}$	$32.53^{de}_{\pm 0.57}$
Weight gain	$22.41^{b}_{\pm 0.49}$	$27.75^{ab}_{\pm 1.24}$	$27.13^{a}_{\pm 0.58}$	$27.06^{a}_{\pm 0.95}$	$16.52^{c}_{\pm 0.66}$	$21.99^{b}_{\pm 2.21}$	$22.46^{b}_{\pm 1.25}$	$21.62^{b}_{\pm 0.76}$
Relative weight gain	$204.10^{bc}_{\pm 2.64}$	$239.22^{abc}_{\pm 17.87}$	$240.73^{ab}_{\pm 12.75}$	$250.60^{a}_{\pm 7.1}$	$146.84^{d}_{\pm 4.9}$	$211.44^{abc}_{\pm 11.81}$	$201.80^{bc}_{\pm 11.4}$	$198.17^{c}_{\pm 13.23}$
Average daily gain mg/day	$448.20^{b}_{\pm 6.04}$	$555.00^{a}_{\pm 20.9}$	$542.60^{a}_{\pm 30.5}$	$541.20^{a}_{\pm 24.14}$	$330.40^{c}_{\pm 10.68}$	$439.80^{b}_{\pm 27.94}$	$449.20^{b}_{\pm 25.22}$	$432.40^{b}_{\pm 32.04}$
Feed conversion ratio	$01.67^{abcd}_{\pm 0.13}$	$01.23^{cd}_{\pm 0.05}$	$01.25^{bcd}_{\pm 0.21}$	$01.22^{d}_{\pm 0.07}$	$02.21^{a}_{\pm 0.23}$	$01.88^{abc}_{\pm 0.15}$	$01.90^{abc}_{\pm 0.19}$	$02.09^{ab}_{\pm 0.3}$
Protein efficiency ratio	$01.9^{5b}_{\pm 0.13}$	$02.64^{a}_{\pm 0.19}$	$02.65^{a}_{\pm 0.1}$	$02.65^{a}_{\pm 0.13}$	$01.46^{b}_{\pm 0.14}$	$01.75^{b}_{\pm 0.17}$	$01.68^{b}_{\pm 0.2}$	$01.56^{b}_{\pm 0.11}$
Protein retained %	$29.77^{b}_{\pm 1.2}$	$41.56^{a}_{\pm 2.4}$	$42.08^{a}_{\pm 2.48}$	$41.07^{a}_{\pm 2.15}$	$19.17^{c}_{\pm 2.1}$	$22.84^{bc}_{\pm 2.26}$	$23.51^{bc}_{\pm 3.2}$	$21.88^{c}_{\pm 1.55}$

Values with the same letter for each parameter are not significantly deferent (p>0.05)

Table (5): Analysis of covariance for data given in Table 4

S.O.V.	DF	M.S. OF								
		Survival %	Initial Weight/g	Final weight/g	Weight gain	Relative Weight Gain	Average daily gain mg/day	Feed conversion ratio	Protein efficiency ratio	Protein retained %
Factor A	1	17.733	0.346	193.574	177.562	11668.859	71024.627	2.319	4.438	1709.100
Factor B	3	271.449	0.134	39.858	40.941	3501.515	16376.420	0.161	0.312	85.487
A x B	3	62.033	0.657	1.261	0.449	267.823	179.560	0.066	0.101	22.900
Error	16	262.018	1.323	8.119	5.874	564.305	2557.354	0.154	0.101	21.281

A: Feed types.
B: Levels of DBY addition.

Table (6): Body chemical composition of Tilapia fed diets supplemented with *S. cerevisiae*.

Mean Values	Initial	Ao. 0	Ao. 1	Ao. 2	Ao. 3	Po. 0	Po.1	Po. 2	Po. 3
Moisture	78.07	$74.32_{\pm 2.27}$	$73.96_{\pm 1.71}$	$74.01_{\pm 2.23}$	$73.88_{\pm 0.99}$	$76.70_{\pm 1.48}$	$76.41_{\pm 2.37}$	$75.31_{\pm 1.49}$	$74.98_{\pm 1.58}$
Crude protein	48.31	$53.45_{\pm 2.33}$	$54.62_{\pm 2.36}$	$55.01_{\pm 1.41}$	$53.91_{\pm 1.45}$	$51.44_{\pm 1.98}$	$51.96_{\pm 1.47}$	$52.10_{\pm 2.14}$	$51.38_{\pm 1.7}$
Ether Extract	24.33	$25.77_{\pm 0.79}$	$25.01_{\pm 0.95}$	$26.30_{\pm 1.78}$	$27.11_{\pm 0.83}$	$27.40_{\pm 0.79}$	$27.39_{\pm 0.8}$	$26.49_{\pm 1.03}$	$28.56_{\pm 0.93}$
Ash	15.03	$14.26_{\pm 0.74}$	$15.31_{\pm 1.25}$	$14.68_{\pm 1.00}$	$13.95_{\pm 0.67}$	$13.89_{\pm 1.11}$	$15.87_{\pm 1.97}$	$14.90_{\pm 0.84}$	$14.72_{\pm 0.7}$

Table (7): Analysis of covariance for data given in Table 6

S.O.V.	DF	M.S. OF			
		Moisture	Crude protein	Ether Extract	Ash
Factor A	1	19.602	38.330	11.971	0.226
Factor B	3	1.447	1.650	3.266	2.207
A x B	3	0.749	0.216	1.240	0.701
Error	16	14.936	14.229	4.853	5.089

A: Feed types. B: Levels of DBY addition.

DISCUSSION

The present work showed that the best fish survival was achieved with diets supplemented by DBY, irrespective to either source of dietary protein or supplementation levels. Similar results were reported by Lara-Flores *et al.* (2003). When tilapia, *Oreochromis niloticus* fries were fed on diets containing 0.1% *S. cerevisiae*. Bud *et al.* (2003), also observed that the higher survival of carp, *Cyprinus carpio* was achieved by given *S. cerevisiae to fish at levels* 0.1% & 0.2%. Improvement of fish survival could occur due to the presence of M. Glucan, an insoluble polysaccharide from the cell wall of *S. cerevisiae* that has been shown to induce protection against bacterial pathogen in fish (Robertsen *et al.*, 1990; Engstad *et al.*, 1992).

Growth performance and feed utilization were statistically ($P<0.05$) improved after adding DBY at levels of 0.1%, 0.2% or 0.3% to diets containing either fish meal or plant protein. No interactions were observed between neither dietary protein source components nor levels of addition of yeast in our work. Hussein (1998) reported that tilapia, *Oreochromis niloticus* fingerlings fed a basal diet supplemented by 10% live yeast yielded a significantly higher ($P<0.05$) body gain over that of the basal diet. De Silva *et al.*,(1989) explained the improvement in fish growth fed diets containing live yeast by the fact that live yeast is a source of protein, some enzymes, such as amylase, protease and lipase which may improve food digestion and consequently food utilization. Hussein *et al.*, (2001) reported that weight gain and feed conversion ratio of tilapia, *Oreochromis niloticus* fed 15%, 30%, 45% and 60% canola meal and supplemented with 5 millilitre / kg diet, with Y-7 and G1 yeast strains had insignificant ($P<0.5$) differences as compared to control group. They also reported that the addition of G4 yeast strain led to significant ($P<0.05$) improvement in weight gain and feed conversion ratio. Improvement of fish performance as a result of having yeast in their diets may be related to its high content of vitamin B6 which stimulates growth hormone (Giri *et al.*, 1997). Increasing vitamin B6 intake may also increase the level of B6 in red blood cells and consequently increases the O2 affinity to hemoglobin which leads to high O2 uptake (MC. Coy, 1986). Therefore, increasing secretion of growth hormone coincided by high O2 uptake may stimulate metabolism and then growth.. In contrary to our results and the previously reviewed authors' results, Teleb *et al.*, (1993) concluded that tilapia, *Oreochromis niloticus* fed diets containing 1% DBY had a similar gain as a control group, diet containing 2% DBY showed growth depression while a diet containing 3% showed very high mortality even with fish replacement. They attributed these negative effects to a possible adverse effect of yeast type. Despite this conclusion, the use of the diets in a mash form in that experiment could be the reason for the reported adverse effects as this mash will be dispersed in water and fish would not be able to consume the whole dietary ingredients. In addition, the unconsumed residues of the diet would also adversely affect water quality in the aquarium.

It is concluded that:

1-The addition of DBY at levels of 0.1%, 0.2% or 0.3% to tilapia diets had resulted in significant improvement.

2-The addition of DBY at levels of 0.2% or 0.3% had showed no significant improvement rather than this given by the 0.1%. Therefore, it could be recommended that the use of 0.1% of DBY to tilapia diets is of economic worthiness.

3-The addition of DBY to a whole plant diet had resulted in growth rates that are significantly equivalent to that of a diet containing fish meal without the addition of DBY.

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تقييم استخدام خميرة الخباز كإضافات في علائق أسماك البلطي النيلي

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أجريت هذه التجربة لتحديد المستوي الأمثل لإضافة خميرة الخباز لعلائق أسماك البلطي النيلي. استخدم نوعين من العلائق إحداهما تحتوي علي مسحوق السمك وكانت الأخري عليقة نباتية. تم عمل أربع علائق تجريبية لكل نوع منهما مع الاحتفاظ بإحدي هذه العلائق الأربع بدون إضافة خميرة كعليقة مقارنة. أما باقي العلائق فقد أضيفت إليها الخميرة بنسب ٠,١ % ، ٠,٢ % أو ٠,٣ % وغذيت أسماك البلطي النيلي لمدة سبعة أسابيع علي هذه العلائق. وكانت نتائج التجربة كالتالي: حدوث تحسن معنوي فى معدل النمو وكفاءة استخدام الغذاء. العلائق المحتوية علي ٠,٢% أو ٠,٣% لم تكن أفضل معنوياً من العليقة المحتوية علي ٠,١%. إضافة الخميرة إلي العلائق النباتية أحدث تحسناً معنوياً في نمو الأسماك يقارب النمو المتحصل عليه عند تغذية الأسماك علي العلائق المحتوية علي مسحوق السمك دون إضافة الخميرة. لذلك فان تغذية الأسماك عند مستوي إضافة خميرة بنسبة ٠,١% هو المستوي الأمثل .