J. Animal and Poultry Prod., Mansoura Univ., Vol.4 (11): 659 - 673,2013

EFFECT OF DIETARY PROTEIN AND HYDROYEAST AQUACULTURE® PROBIOTIC LEVELS ON GROWTH PERFORMANCE, FEED UTILIZATION AND CARCASS COMPOSITION OF MONOSEX MALE NILE TILAPIA *Oreochromis niloticus* FINGERLINGS (L.)

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ABSTRACT

The main objective of this study was to evaluate the effects of the additional graded levels (0, 5, 10, 15 g / kg diet) of a new commercial probiotic Hydroyeast Aquaculture® to low crude protein (CP) levels (20 and 25%) in diets of monosex Nile tilapia, *Oreochromis niloticus* fingerlings for 8 weeks, regarding their growth performance, feed intake and nutrients utilization and carcass composition. Fish with an average initial body weight (7.5 ± 0.001 g) were distributed into eight treatments (three replicates per treatment). Fish in each treatment were stoked at 5 fish / aquaria (90×40×35 cm). The obtained results revealed that the high levels of CP (25%) and probiotic (15 g / Kg diet) had positive significant ($P \leq 0.05$) effects on fish growth performance parameters, feed utilization and fish carcass composition (DM, CP, and EC) compared with other treatments, but the interaction between them was not significantly affected on all the above parameters. So, it could be concluded that the high level of probiotic 15 g Hydroyeast Aquaculture® /kg diet is useful with low dietary CP level (25%) in feeding fish at early age stage for enhancing the production performance of Nile tilapia *O. niloticus* fingerlings, so this level of probiotic may be led to increasing the economic efficiency at large scale in the fish farms.
Keywords: Nile tilapia – fingerlings – probiotic – growth performance – feed utilization.

INTRODUCTION

Tilapias are the most successfully cultured fish in the world because of their fast growing and high efficiency to utilize the natural and artificial supplemented feeds (Ishak, 1980). Tilapias have become increasingly popular for farming as they are able to reproduce rapidly, easily bred in captivity, tolerate to a wide range of environmental conditions, highly resistant to diseases, and most important of all, have good nguil. Though the fish originated in Africa, and Asian countries have become the leading producers of these fishes (Rana, 1997). Tilapias are second only to carps as the most widely farmed freshwater fish in the world (FAO, 2010).

Nutrition is the most important factor of the culture process; it is often represent the major operating cost of aquaculture. Under intensive culture system, fish totally depend on complete balanced diets during their life stages. It is advisable for aquaculturist to know the optimum quality and quantity of feeds introduced to fish to avoid poor growth, health and reproduction. Fish cannot grow well without feeds and they should not be underfed. Conversely, overfeeding also should be avoided because feeds are expensive and excess feeding can also result in poor growth and water quality (Landau, 1992). Optimal feeding regimes may result in reduced feed costs by minimizing expenditure of metabolic rate of fish. Studies on feed stimulants can provide information on physiology of the animals concerned and may also detect additives, which can be incorporated into aquaculture feeds. Attractive feed may be looted and consumed quickly, thus reducing losses by leaching of essential water-soluble components. An addition of chemo-attractants to palletized feeds may increase ingestion rates and improve growth, survival and food conversion (El- Sayed *et al*., 2005).

Nowadays, a number of preparations of probiotics are commercially available and have been introduced to fish, shrimp and molluscan farming as feed additives, or are incorporated in pond water (Wang *et al*., 2005). Probiotics are defined as live microorganisms including many yeast and bacteria, which when administered in adequate amounts could enhance the growth and health of the host (Gatesoupe, 1999; Irianto and Austin, 2002a). The research into the use of probiotics for aquaculture is increasing with the demand for environment-friendly sustainable aquaculture (Vine *et al*., 2006). Many studies have pointed out that probiotics in fish diet improved growth performance and nutrients utilization (Mehrim, 2009; Ghazalah *et al*., 2010; Merrifield *et al*., 2010). The benefits of such supplements include improved feed value, enzymatic contribution to digestion, and inhibition of pathogenic microorganisms, antimutagenic and anti-carcinogenic activity, and increased immune response. Moreover, probiotic supplementation may provide vitamins, short chain fatty acids and/or digestive enzymes, and therefore may also contribute to host nutrition (Bairagi *et al*., 2002; John *et al*., 2006). So, growth-promoting effects, through better feed utilization and digestion, as well as biological control of pathogen colonization are the most important expected benefits of probiotic applications.

On the other hand, feed cost about over 50% of the variable costs in most aquaculture operations, with protein being the most expensive dietary source (El-Sayed, 1999), therefore applying the best feeding strategy can have a significant impact on optimizing profit, which is the primary goal of commercial aquaculture. Also, if more fish are able to survive until they are of marketable size, the subsequent cost of production would be reduced drastically. Consequently, the main objective of this study was to evaluate the effects of the additional of graded levels (0, 5, 10, 15 g / kg diet) of a new commercial probiotic Hydroyeast Aquaculture® to the low crude protein levels (20 and 25%) in diets of monosex male Nile tilapia, *Oreochromis niloticus* fingerlings regarding their growth performance, feed and nutrients utilization and carcass composition for a period of 8 weeks rearing in glass aquarium.

MATERIALS AND METHODS

The experimental management:

This study was conducted in Fish Laboratory Research, Faculty of Agriculture, Mansoura University, Al-Dakahlia governorate, Egypt. Healthy monosex male Nile tilapia (*O. niloticus*) fingerlings, with an average initial body weight of 7.5 ± 0.001 g were purchased from privet fish farm in Kafr El-Shekh governorate, Egypt. Fish were stocked into a rearing tank for two weeks as an adaptation period, and fish were fed a basal experimental diet during this period. Fish were distributed into eight experimental treatments (three replicates in each), as shown in Table 1. Fish in each treatment were stoked at 5 fish / aquaria. Each glass aquaria (90×40×35 cm) was constructed with an upper irrigation open, an under drainage, and an air stone connected with electric compressor for water aeration. Light was controlled by a timer to provide a 14 h light: 10 h dark as a daily photoperiod. The replacement of the aquaria water was done partially every day to remove the wastes then re-new the tap water (Chlorine-free). Water quality parameters were measured (Abdelhamid, 1996) including temperature (via a thermometer), pH (using Jenway Ltd., Model 350-pH-meter) and dissolved oxygen (using Jenway Ltd., Model 970- dissolved oxygen meter), in all aquaria day by day. Mean values of water temperature ranged between 25.5 and 27.6 ^{o}C, pH values 6.60 – 7.80 and dissolved oxygen 5.00 – 6.70 mg/l. All tested water quality criteria in the present study were suitable for rearing Nile tilapia (*O. niloticus*) fingerlings as cited by Abdelhamid (2000) and Abd El-Hakim *et al*. (2002).

Table 1: Details of the experimental treatments

Treat.	Details
T_1	Basal diet (20% CP) + 0 g Hydroyeast Aquaculture®/ Kg diet (as a control)
T_2	Basal diet (20% CP) + 5 g Hydroyeast Aquaculture®/ Kg diet
T_3	Basal diet (20% CP) +10 g Hydroyeast Aquaculture®/ Kg diet
T_4	Basal diet (20% CP) +15 g Hydroyeast Aquaculture®/ Kg diet
T_5	Basal diet (25% CP) + 0 g Hydroyeast Aquaculture®/ Kg diet (as a control)
T_6	Basal diet (25% CP) + 5 g Hydroyeast Aquaculture®/ Kg diet
T_7	Basal diet (25% CP) +10 g Hydroyeast Aquaculture®/ Kg diet
T_8	Basal diet (25% CP) +15 g Hydroyeast Aquaculture®/ Kg diet

CP: Crude protein.

The tested probiotic Hydroyeast Aquaculture® formula was showed in Table 2.Hydroyeast Aquaculture® probiotic produced by Agranco corp., Gables, International Plaza Suite, No. 307, 2655 Le Jeune Rd., 3rd Floor, Coral Gables, Fl 33134, USA. (http://www.agranco.com/hydroyeast_aquaculture.htm).

The experimental basal diet (BD), used in this study contained 20% or 25% crude protein. Ingredients of BD were bought from the local market and proximate chemical analysis was carried out according to AOAC (2000), as shown in Table 3. The ingredients mixed homogeneously and the tested probiotic at levels of 0, 5, 10 and 15 g / kg BD was added. The experimental diets were introduced manually twice daily at 900 a.m. and 1500 p.m. at 5% of the fish biomass in each aquaria. The feed quantity was adjusted bi-weekly according to the actual body weight changes

Table 2: Formula of the tested probiotic, Hydroyeast Aquaculture®

Ingredients	Units/ kg min.	Yeast probiotics	CFU*/ kg min.
Oligosaccharides	50,000 ppm	**Active live yeast**	5,000,000,000,000
Enzymes		**Probiotics**	
Amylase	3,750,000	*Lactobacillus nguilla us*	22,500,000,000
Protease	500,000	*Bifedobacterium longhum*	22,500,000,000
Cellulase	200,000	*Bifedobacterium thermophylum*	22,500,000,000
Pectinase	100,000	*Streptococcus faecium*	22,500,000,000
Xylanase	10,000		
Phytase	3,000		

*** CFU: Colony forming units.**

Table 3: Ingredients and proximate chemical analysis (% on dry matter basis) of the experimental basal diets

Ingredients (g)	Diet 1 (20% CP)	Diet 2 (25% CP)
Fish meal	10	14
Soybean meal	20	28
Yellow corn	30	26
Wheat bran	30	22
Sunflower oil	3	3
Molasses	5	5
Vitamins & minerals[1]	2	2
Chemical analysis (%)		
Dry matter (DM)	85.24	86.03
Crude protein (CP)	21.80	24.63
Ether extract (EE)	8.01	5.73
Ash	7.28	6.14
Crude fiber (CF)	6.76	8.09
Nitrogen free extract (NFE)	56.15	55.41
Total carbohydrates	62.91	63.50
Gross energy (GE)[2] (kcal/100 g DM)	457.12	453.98
Protein/energy (P/E) ratio (mg CP/kcal GE)	47.68	54.24
Metabolizable energy (ME)[3] (kcal/100g)	382.53	378.85

[1] Each 3 kg premix contains : Vit. A, 12000,000 IU; Vit. D_3, 3000,000 IU; Vit. E, 10,000 mg; Vit. K_3, 3000 mg; Vit. B_1 200 mg; Vit. B_2, 5000 mg; Vit. B_6, 3000 mg; Vit. B_{12}, 15 mg; Biotin, 50 mg; Folic acid 1000 mg; Nicotinic acid 35000 mg; Pantothenic acid 10,000 mg; Mn 80g; Cu 8.8g; Zn 70 g; Fe 35 g; I 1g; Co 0.15g and Se 0.3g.

[2] GE (kcal/100 g DM) = CP x 5.64 + EE x 9.44 + Total carbohydrates x 4.11 calculated according to NRC (1993).

[3] ME (kcal/100g DM) = Metabolizable energy was calculated by using factors 3.49, 8.10 and 4.50 kcal/g for Total carbohydrates, EE and CP, respectively according to Pantha (1982).

Fish sampling and performance parameters:

At the start and at the end of the experiment, fish samples were collected and kept frozen till the proximate analysis of the whole fish body according to AOAC (2000). Their energy content was calculated according to NRC (1993). Fish growth performance parameters such as average total weight gain (TWG, g), average daily gain (ADG, g), relative growth rate (RGR, %), specific growth rate (SGR, %/day) and survival rate (SR, %) were calculated. Feed conversion ratio (FCR), feed efficiency (FE, %), protein efficiency ratio (PER), protein productive value (PPV, %) and energy utilization (EU, %) were also calculated acording to Abdelhamid (2009).

Statistical analysis:

The obtained data were statistically analyzed using General Liner Models (GLM) procedure according to SAS (2001) for users guide, but ratio and percent data were arcsine transformed prior to analysis. Mean of treatments were compared for the significance (P ≤ 0.05) using Duncan's multiple rang test **Duncan (1955)**.

RESULTS AND DISCUSSION

Growth performance parameters:

Growth performance parameters of *O. niloticus* fingerlings fed different levels of crude protein (CP) and tested probiotic (Hydroyeast Aquaculture®) are illustrated in Table 4. Results revealed that the 25% CP treatment significantly (P ≤ 0.05) increased final body weight, total weight gain, ADG, RGR, and SGR compared with 20% CP treatment. Also, 15 g Hydroyeast Aquaculture® / Kg BD was the best treatment, followed by 10 g Hydroyeast Aquaculture® / Kg BD, which gave significantly high growth performance parameters (P ≤ 0.05) than 5 and 0 g Hydroyeast Aquaculture®/Kg diet treatments. However, SR was not affected by CP levels, probiotic levels or their interaction. In addition, the effect of interaction between dietary CP levels and probiotic levels on all growth performance parameters was not significant. Consequently, the high level of CP (25%) and high level of tested probiotic (15 g Hydroyeast Aquaculture® / Kg diet) showed positive effects on fish growth performance parameters.

Functional additive, like probiotics, is a new concept on aquaculture (Li and Gatlin III, 2004), where the additions of microorganisms on diets show a positive effect on growth caused by the best use of carbohydrates, protein, and energy (Chang and Liu, 2002; Irianto and Austin, 2002 a,b). In this respect, Eid and Mohamed (2008) proved that Biogen® and Prmifer® improved the growth performance, feed conversion, protein efficiency ratio and apparent protein digestibility for monosex male tilapia fingerlings as compared to fish fed the control diet. Also, El-Haroun *et al*. (2006) reported that Biogen® dietary supplementation improved growth performance and feed utilization, as well as economical profit in Nile tilapia. Moreover, Mehrim (2009) reported that dietary commercial probiotic (Biogen®) had significantly (P ≤ 0.05) increased all growth performance parameters of experimental Nile tilapia *O. niloticus* compared with the control group. In addition, probiotics may improve the growth performance and immune response of fish (Wang *et al*., 2008 a & b). Marzouk *et al*. (2008) reported that probiotics (*B. subtillis* and *Saccharomyces cerevisae*) revealed significant improvement in growth parameters of *O. niloticus*. Conversely, He *et al.* (2009) found that supplementation of dietary DVAQUA® showed no effects on growth performance, and survival rate of the hybrid tilapia (*O. niloticus* ♀ × *O. aureus* ♂). The reasons for the differences between fish species have not been elucidated, but might be due to the differences in aquaculture and physiological conditions, and the type of basal ingredients in diets.

Table 4: Effect of dietary protein (%), probiotic (Hydroyeast Aquaculture®, g / kg diet) levels and their interaction on growth performance of *Oreochromis niloticus* fingerlings

Treat.	Initial weight (g)	Final weight (g)	Total weight gain (g)	ADG	RGR	SGR	SR
Crude protein levels, % (CP)							
20	7.01	36.40^{B}	29.38^{B}	0.29^{B}	418.73^{B}	1.67^{B}	88.33
25	7.11	45.22^{A}	38.10^{A}	0.38^{A}	534.94^{A}	1.88^{A}	96.66
±SE	0.025	0.479	0.471	0.004	6.360	0.011	4.249
P-value	0.125	0.0001	0.0001	0.0001	0.0001	0.0001	0.184
Probiotic levels, g / kg diet (P)							
0	6.95	36.43^{D}	29.48^{D}	0.29^{D}	423.90^{D}	1.68^{D}	86.66
5	7.15	39.65^{C}	32.50^{C}	0.33^{C}	454.61^{C}	1.74^{C}	96.66
10	7.05	42.25^{B}	35.20^{B}	0.36^{B}	498.00^{B}	1.81^{B}	96.66
15	7.11	44.91^{A}	37.80^{A}	0.38^{A}	530.83^{A}	1.87^{A}	90.00
±SE	0.0365	0.678	0.666	0.006	8.995	0.015	6.00
P-value	0.134	0.0001	0.0001	0.0001	0.0001	0.0001	0.570
Interaction (CP*P)							
(T_1) 20/0	6.94	32.43	25.49	0.25	366.80	1.57	86.66
(T_2) 20/5	7.14	35.82	28.67	0.29	401.33	1.64	93.33
(T_3) 20/10	6.92	36.96	30.04	0.31	433.73	1.70	93.33
(T_4) 20/15	7.04	40.39	33.34	0.34	473.06	1.78	80.00
(T_5) 25/0	6.96	40.43	33.47	0.34	481.00	1.79	86.66
(T_6) 25/5	7.15	43.48	36.33	0.37	507.90	1.84	100.00
(T_7) 25/10	7.18	47.55	40.37	0.41	562.26	1.92	100.00
(T_8) 25/15	7.18	49.44	42.26	0.43	588.60	1.97	100.00
±SE	0.051	0.958	0.943	0.009	12.721	0.022	8.498
P-value	0.263	0.445	0.508	0.697	0.855	0.877	0.696

Mean in the same column having different capital letters are significantly different ($P \leq 0.05$).

ADG = Average daily gain (mg/fish/day); RGR= Relative growth rate; SGR = Specific growth rate (%/d); SR= Survival rate (%).

Additionally, all the probiotic-supplemented diets resulted in growth to be higher than that of the control diets, suggesting that the addition of probiotics mitigated the effects of the stress factors. This resulted in better *O. niloticus* performance, with better growth parameters in the diets supplemented with the yeast (Lara-Flores *et al*., 2010). Recently, Khalil *et al.* (2012) reported that Hydroyeast Aquaculture® probiotic is useful at levels of

15 g /kg diet and 10 g /kg diet for enhancing production performance of adult males and females *O. niloticus* respectively. Yet, many previous studies concluded the positive effect of using viable microorganisms in probiotic mixtures into diets of fish (Li and Gatlin III, 2004; Pangrahi *et al*., 2005; Barnes *et al*., 2006; Abo-State *et al.,* 2009). Accordingly, to the positive results of the tested probiotic on all growth performance parameters in the present study (Table 4) and those obtained by other attempts; probiotics may stimulate appetite and improve nutrition by the production of vitamins, detoxification of compounds in the diet, and by breakdown of indigestible components (Irianto and Austin, 2002a).

Feed and nutrients utilization:

Results of feed and nutrients utilization parameters of *O. niloticus* are shown in Table 5. Fish fed dietary 25% CP showed significant ($P \leq 0.05$) increase of FI and FE and improved FCR compared with diet inclusion of 20% CP. In contrast, data of PER showed a significant ($P \leq 0.05$) increase in dietary 20% CP than 25% CP. However, PPV and EU were not affected by dietary CP levels. Fish fed 10 and 15 g Hydroyeast Aquaculture®/Kg diet were the best treatments of feed and nutrients utilization, which revealed the highest ($P \leq 0.05$) FE, PER, PPV and EU compared with the diet inclusion of 5 g Hydroyeast Aquaculture® / Kg diet and the control group.

Meanwhile, no significant ($P \geq 0.05$) differences in FI among all treatments. In addition, the interaction effect between dietary CP and Hydroyeast Aquaculture® levels was not significant on all feed and nutrients utilization. Consequently, the high level of CP (25%) and high levels of tested probiotic (10 and 15 g Hydroyeast Aquaculture® / Kg diet) showed positive effects on feed and nutrients utilization among other dietary treatments. As the positive effects of the tested probiotic in the present study, especially at the high levels, Burr *et al*. (2005) reported that the increased nutrient digestibility associated with prebiotic or probiotic supplementation may be due to the favored microbial community producing enzymes that are either lacking or occurring only at low levels in the host. Better digestibility obtained with the supplemented diets suggests that the addition of probiotics improved diet and protein digestibility, which may in turn explain the better growth and feed efficiency seen with the supplemented diets. Similar results were obtained by De Schrijver and Ollevier (2000), who reported a positive effect on apparent protein digestion when supplementing turbot (*Scophtalmus maximus*) feeds with the bacteria *Vibrio proteolyticus*. They attributed this effect to the proteolytic activity of bacteria. Also, Lara-Flores *et al*. (2010) suggested the same effect in aquatic organisms. To confirm this findings, research which makes use of other ingredients and protein sources is needed because costs can be reduced by using cheaper proteins with higher digestibility.

Table 5: Effect of dietary protein (%), probiotic (Hydroyeast Aquaculture®, g / kg diet) levels and their interaction on feed intake and nutrients utilization of *Oreochromis niloticus* fingerlings

Treat.	FI	FCR	FE	PER	PPV	EU
Crude protein levels, % (CP)						
20	60.87^{B}	2.08^{A}	48.88^{B}	2.32^{A}	30.84	14.22
25	69.48^{A}	1.83^{B}	54.96^{A}	2.06^{B}	29.81	15.07
±SE	1.954	0.062	1.514	0.067	1.086	0.529
P-value	0.006	0.014	0.011	0.014	0.510	0.273
Probiotic levels, g / kg diet (P)						
0	63.23	2.15^{A}	46.56^{B}	1.97^{B}	23.95^{B}	11.12^{C}
5	62.91	1.95^{AB}	51.66^{AB}	2.18^{AB}	30.34^{A}	13.80^{B}
10	63.35	1.81^{B}	55.72^{A}	2.36^{A}	34.35^{A}	16.73^{A}
15	71.19	1.91^{AB}	53.73^{A}	2.25^{AB}	32.67^{A}	16.93^{A}
±SE	2.764	0.088	2.141	0.096	1.536	0.748
P-value	0.139	0.021	0.044	0.041	0.031	0.0001
Interaction (CP*P)						
(T_1) 20/0	56.65	2.23	45.12	2.14	23.76	10.90
(T_2) 20/5	59.95	2.09	47.94	2.28	30.60	13.11
(T_3) 20/10	55.73	1.86	54.39	2.58	37.78	17.13
(T_4) 20/15	71.15	2.14	48.06	2.28	31.24	15.74
(T_5) 25/0	69.82	2.08	48.00	1.80	24.14	11.34
(T_6) 25/5	65.88	1.81	55.38	2.07	30.08	14.49
(T_7) 25/10	70.98	1.76	57.05	2.14	30.92	16.33
(T_8) 25/15	71.23	1.68	59.41	2.22	34.10	18.13
±SE	3.909	0.125	3.028	0.135	2.173	1.058
P-value	0.233	0.507	0.455	0.528	0.185	0.499

Mean in the same column having different capital letters are significantly different ($P \leq 0.05$).
FI = Feed intake (g/fish); FCR = Feed conversion ratio, FE = Feed efficiency; PER = Protein efficiency ratio; PPV = Protein productive value (%); EU = Energy utilization (%).

Probiotics help in feed conversion efficiency and live weight gain (Al-Dohail *et al*., 2009; Saenz de Rodriguez *et al*., 2009). The supplementation of commercial live yeast, *S. cerevisiae*, improved growth and feed utilization of Nile tilapia (Lara-Flores *et al*., 2003; Abdel-Tawwab *et al*., 2008). Moreover, Olvera-Novoa *et al*. (2002) reported that fish fed 25 – 30% (of the dietary crude protein) yeast diets showed the best growth performance, feed conversion, protein efficiency ratio, nitrogen utilization, incidence cost, and profit index of *O. mossambicus*. Also, Abdel-Tawwab *et al*. (2008) confirmed that the better feed intake in yeast supplemented diets (1.0–5.0 mg/kg diet) may have been due to increased fish appetite resulting in a higher feed intake and therefore improved growth. Additionally, Mehrim (2009) tested the same probiotic (Biogen®) and reported similar positive effects on growth performance and feed conversion ratio of the Nile tilapia fish. Recently, Khalil *et al.* (2012) reported that Hydroyeast Aquaculture® probiotic led to significant improvement of feed and nutrients utilization parameters in both adult *O. niloticus* males and females. The observed improved of 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 better growth and feed efficiency with yeast supplements. In addition, enzymes in probiotic leads to improvement of growth and feed utilization (Saxena, 2008), since they lead to digestive enzyme activation (Xu *et al.,* 2009).

Fish Carcass composition:

Proximate chemical analysis of the whole body of *O. niloticus* fingerlings at the start or at the end of the experiment is summarized in Table 6. Fish fed dietary 25% CP showed significant ($P \leq 0.05$) increase of DM and CP contents of fish carcass compared with diet containing 20% CP. In contrast, data of EE and ash showed significant ($P \leq 0.05$) increase with 20 than 25% CP. However, no significant ($P \geq 0.05$) differences were found in EC between both dietary CP levels. Fish fed 15 g Hydroyeast Aquaculture®/Kg diet showed significant ($P \leq 0.05$) increase in DM, EE, and EC of fish carcass among other levels of probiotic. However, the diet containing 5 g Hydroyeast Aquaculture®/Kg diet significantly ($P \leq 0.05$) increased CP content in fish carcass compared with other probiotic levels and the control group. Also, the control group (free diet from the tested probiotic) showed increase in ash content of fish carcass than levels of probiotic treatments. In addition, the interaction effect between dietary CP and Hydroyeast Aquaculture® levels was not significant on all fish carcass composition parameters. Generally, the high level of CP (25%) and high levels of tested probiotic (15 g Hydroyeast Aquaculture® / Kg diet) had positive effects on fish carcass composition (DM, CP, and EC) than other dietary treatments. These positive effects of the high level of CP (25%) and high level of tested probiotic (15 g/ kg diet) on fish carcass confirmed by their positive effects on fish growth performance (Table 4), and feed and nutrients utilization (Table 5).

As the current findings in fish carcass composition was affected by dietary CP and Hydroyeast Aquaculture® levels, the yeast supplementation significantly affected of the whole-fish body composition (Abdel-Tawwab *et al*., 2008). These results suggest that yeast supplementation plays a role in enhancing feed intake with a subsequent enhancement of fish body composition. The proximate chemical analysis of Nile tilapia, *O. niloticus* whole body including total lipids and total ash were significantly influenced by dietary protein level only; meanwhile yeast supplements significantly affected ash content (Abdel-Tawwab, 2012). 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 (Soivio *et al*., 1989; Abdel-Tawwab *et al*., 2006).

In this topic, Khattab *et al*. (2004b) reported that crude protein, total lipids and ash were significantly ($P < 0.01$) affected by protein level and increasing stocking density rate of tilapia fish. Yet, Abdelhamid *et al*. (2007b) suggested that increasing dietary Betafin® level caused a significant improving in carcass composition of tilapia fish. On the other side, the present results are in close agreement with those reported by Khattab *et al.* (2004a), EL-Haroun *et al.* (2006) and Mohamed *et al.* (2007) for tilapia fish. Moreover, Eid and Mohamed (2008) found that no statistical differences were observed in whole body moisture, crude protein, ether extract and ash of monosex male, *O. niloticus* fingerlings fed diets containing different levels of commercial feed additives (Biogen® and Pronifer®), compared with the control treatment. Furthermore, Mehrim (2009) reported positive effects of inclusion of Biogen® at a level of 3 g/kg on carcass composition of monosex male, *O. niloticus* fingerlings. Recently, Khalil *et al.* (2012) studied the effect of Hydroyeast Aquaculture® probiotic in both adult males and females of *O. niloticus* and they suggested that fish carcass composition was took unclear trends between adult males and females within all treatments, which may be due to the differ in sexes, metabolism, physiological responses and sexual behaviors of fish during this stage of life, which affected in biochemical contents in their bodies. Generally, there is a negative relationship between crude protein and crude fat in the chemical composition of Nile tilapia carcass on one hand (Abdelhamid *et al*., 2007a; El-Ebiary and Zaki, 2003), and a positive correlation between crude protein and crude ash contents of Nile tilapia, on the other hand (Abdelhamid *et al*., 2007b).

Table 6: Effect of dietary protein (%), probiotic (Hydroyeast Aquaculture®, g / kg diet) levels and their interaction on carcass composition of *Oreochromis niloticus* fingerlings

Treat.	DM	CP	EE	Ash	EC
At the start:					
	18.16	57.93	19.47	22.59	510.50
At the end:					
Crude protein levels, % (CP)					
20	22.01^{B}	57.81^{B}	24.45^{A}	17.73^{A}	556.91
25	22.59^{A}	61.25^{A}	22.80^{B}	15.94^{B}	560.74
±SE	0.079	0.345	0.391	0.151	2.036
P-value	0.0001	0.0001	0.008	0.0001	0.202
Probiotic levels, g / kg diet (P)					
0	19.96^{D}	59.75^{B}	21.66^{C}	18.58^{A}	541.56^{D}
5	21.53^{C}	61.92^{A}	21.67^{C}	16.40^{BC}	553.81^{C}
10	23.46^{B}	59.01^{B}	24.46^{B}	16.52^{B}	563.76^{B}
15	24.26^{A}	57.44^{C}	26.71^{A}	15.84^{C}	576.16^{A}
±SE	0.112	0.488	0.553	0.213	2.880
P-value	0.0001	0.0001	0.0001	0.0001	0.0001
Interaction (CP*P)					
(T_1) 20/0	19.86	55.11	22.91	21.98	527.13
(T_2) 20/5	20.83	61.62	22.35	16.02	558.56
(T_3) 20/10	23.26	59.45	24.49	16.05	566.53
(T_4) 20/15	24.10	55.06	28.06	16.88	575.43
(T_5) 25/0	20.06	64.40	20.42	15.18	56.00
(T_6) 25/5	22.23	62.21	20.99	16.79	549.06
(T_7) 25/10	23.66	58.57	24.43	16.99	561.00
(T_8) 25/15	24.43	59.82	25.37	14.80	576.90
±SE	0.158	0.691	0.782	0.302	4.073
P-value	0.211	0.341	0.326	0.288	0.101

Mean in the same column having different capital letters are significantly different ($P \leq 0.05$).

DM = Dry matter (%); CP = Crude protein (%); EE = Ether extract (%); EC = Energy content (Kcal/100 g).

From the foregoing results, it could be concluded that the high level 15 g /kg diet of Hydroyeast Aquaculture® probiotic is the best level with the low dietary CP level (25%) for enhancing the growth performance, feed and nutrients utilization and carcass composition for monosex male Nile tilapia, *O. niloticus* fingerlings, so this probiotic may be led to increasing the economic efficiency at large scale in the fish farms.

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تأثير مستويات البروتين الغذائى والبروبيوتيك هيدروييست أكواكلشر على أداء النمو، الاستفادة الغذائية ومكونات الجسم لإصباعيات البلطى النيلى وحيد الجنس ذكور

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تهدف هذه الدراسة إلى تقييم تأثيرات إضافة مستويات متدرجة صفر، 5 ، 10 ، 15 جرام/ كجم علف من البروبيوتيك ®Hydroyeast Aquaculture إلى العلائق ذات مستويات البروتين المنخفض (20 أو 25 % بروتين خام) لإصباعيات البلطى النيلى وحيد الجنس ذكور على كفاءة النمو، الأداء والاستفادة الغذائية و مكونات الجسم فى تجربة غذائية استمرت لفترة 8 أسابيع فى الأحواض الزجاجية. وزعت الأسماك ذات متوسط الوزن الإبتدائى (7.5 ± 0.001 جرام) على ثمانية معاملات غذائية (ثلاث مكررات / معاملة). سكنت الأسماك فى الأحواض بمعدل 5 أسماك / حوض (أبعاده 90*40*35 سم).

أوضحت النتائج المتحصل عليها أن المستوى العالى من البروتين (25% بروتين خام) ، المستوى العالى من البروبيوتيك (15 جرام / كجم علف) أدى إلى تأثيرات إيجابية معنوية على كفاءة نمو الأسماك، الاستفادة من الغذاء ومكونات جسم السمك من المادة الجافة، البروتين والمحتوى من الطاقة مقارنة بالمعاملات الأخرى، كما أوضحت النتائج عدم وجود تداخل معنوي بين المعاملات لكل القياسات السابقة. **لذا يمكن التوصية** بأن المستوى العالى من البروبيوتيك 15 جم ®Hydroyeast Aquaculture / كجم علف هو المستوى الأنسب مع المستوى المنخفض من البروتين الغذائى (25%) لهذه المرحلة العمرية للأسماك لتحسين الأداء الإنتاجي لإصباعيات البلطى النيلى وحيد الجنس ذكور. لذلك فإن استخدام البروبيوتيك بهذا المستوى ربما يؤدى إلى زيادة الكفاءة الاقتصادية خاصة على نطاق أوسع فى المزارع السمكية.

قام بتحكيم البحث

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