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EFFECT OF SPIRULIN (ARTHROSPIRA PLATENSIS) A AND NANNO-CHLOROPSIS (NANNOCHLOROPSIS GADITANA) SUPPLEMENTATION ON GROWTH PERFORMANCE, FEED UTILIZATION AND CARCASS COMPOSITION OF NILE TILAPIA (*Oreochromis niloticus*)

[39]

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ABSTRACT

The study was carried out at Faculty of Agriculture, Ain Shams University to assess the effect of two of algae species *(Arthrospira platensis* and *Nannochloropsis gaditana*) on growth performance of monosex tilapia fish *(Oreochromis niloticus)*, fish were fed on a basal diet supplemented with 0,3,5,7% of each algae. To perform seven experimental treatments were assigned in three replicates each. The experiment was designated as follows:

(T1) control (without algae), (T2) basal diet supplemented with 3% spirulina (spiru 3), (T3) basal diet supplemented with 5% spirulina (spiru 5), (T4) basal diet supplemented with 7% spirulina (spiru 7), (T5) basal diet supplemented with 3% Nannochloropsis (nanno 3), (T6) basal diet supplemented with 5% Nannochloropsis (nanno 5) and (T7) basal diet supplemented with 7% Nannochloropsis (nanno 7). Experimental tanks were a part of closed recirculating system, where almost constant environmental conditions were kept throughout the experimental period. Twenty-one quadrate fiber glass tanks with 108-liter water capacity were stocked with 15 fish per tank. The individual initial body weight (2.7 g) was recorded at the beginning of the experiment. All fish in each tank was weighed every two weeks during the whole experimental period. The fish were fed the experimental diet for 95 days Results indicated that nanno 5 treatment had higher significant trend (P<0.05) final body weight (FBW), average weight gain (AWG) and average daily gain (ADG) compared with the other experimental treatments. The best specific growth rate (SGR), feed conversion ratio (FCR) and feed efficiency ratio (FER) were found in nanno 7. Also, it was observed that spiru 7 have a high significant difference (P<0.05) in protein efficiency ratio (PER) and protein productive value (PPV). On the other hand, the results showed that the lowest AWG, ADG and (FER) appeared in spiru 7%. No mortality in nanno7 and spiru 7. Finally, using of nano 5% or spiru 7% enhance growth performance and feeding in tilapia fish.

Key words: microalgae, *(Arthrospira platensis)* , *Nannochloropsis gaditana*, feed additive and tilapia.

INTRODUCTION

Microalgae play an important role in aquatic food chain and are popularly used in rearing of aquatic animals like mollusks, shrimps and fishes at different growth stages **(Borowitzka 1988**). They are required for larvae nutrition during a brief period of life cycle and are used either for direct consumption or indirectly as prepared feed. In most instances, the whole algae are used as feed or feed supplement. Data on chemical composition of algae give the basic information on the nutritive potential of the algae biomass **(Brown et al 1997)**. The nutritional value of microalgae is influenced by their size, shape, digestibility, and biochemical compositions **(Brown et al 1997).** Most of these biomolecules are not produced in the animal/human body but termed as essential; therefore, it is highly recommended to make these biomolecules available for food and feed purposes**. (Yaakob et al 2014)**

Spirulina, *Arthrospir platensis* is a freshwater blue-green filamentous alga, and it is receiving increasing attention for its bioactive components such as vitamins (especially vitamin A and B12), minerals, polyunsaturated fatty acids, carotenes and other pigments that have antioxidants activity **(Madhava et al 2000 and Lin et al 2007).** It is also containing high protein contents (up to 70% on dry weight) and lipids (7–16%) **(Vonshak 1997).** These nutritional elements make as a potential food items for persons suffering from coronary illness and obesity. (*Arthrospira platensis*) Spirulina is suitable for animal feeding **(Cohen, 1997**) and as supplement nutrients for humans **(Qureshi et al 1995)**. In addition, *(Arthrospira platensis*) Spirulina is considered one of the most concentrated natural sources for nutrition to both terrestrial and aquatic animals. Therefore, Spirulina could be an excellent source of useful nutrients **(Glombitza and Koh, 1989)** as well as a good energy source that can be used as crucial component for animal feeding **(Kishimoto et al 1994, Kim et al 2013).**

Nannochloropsis gaditana represents a genus of marine microalgae with high photosynthetic efficiency and can convert carbon dioxide to storage lipids mainly in the form of triacylglycerols and to the ω-3 long-chain polyunsaturated fatty acid eicosapentaenoic acid (EPA). Recently, *Nannochloropsis gaditana* has received ever-increasing interests of both research and public community **(Xiao *et al* 2016**) This microalga is an important food source and feed additive in the commercial rearing of many aquatic animals, especially live food organisms such as rotifers which, in turn, are used to rear the larvae of marine finfish. **(Durmaz. 2007).** The microalgal genus *Nannochloropsis gaditana* has been receiving ever-increasing research interest owing to its ability to synthesize not only neutral lipids for biodiesel production but also EPA for functional food **(Hoffmann *et al*2010** and **Ma et al 2014).**

The specific aim of the present study was to examine the effect of dietary supplemented with two species of microalgae (*(Arthrospira platensis) Spirulina* and *Nannocholoropsis gaditana*) with different levels on growth performance, feed utilization and carcass composition of Nile tilapia.

MATERIALS AND METHODS

Seven treatments with triplicates were carried out at Faculty of Agriculture, Ain Shams University to assess the effect of two types of algae (*(Arthrospira platensis) Spirulina* and *-Nannochloropsis gaditana*) on growth performance of monosex tilapia fish *(Oreochromis niloticus)* which supplemented in basal diet at (3,5,7%) for each algae.

1. The rearing system

Twenty-one quadrate fiber glass tanks 60 × 30 × 60 cm, width, depth, height, respectively, were used. During the experimental period the fish tanks were receiving a constant water supply from a header tank. In this system, the used water drained from the rearing tanks was piped into mechanical and biological filtration system and then returned to the fish tanks. Mechanical filtration and biological filtration carried out by screens and submersible media bags, respectively. The system was provided with a thermostatic water heater (2.5KW) to control temperature at desired levels. Rearing tanks were continuously aerated by air stones that were connected to air lines of a small air blower (0.12 Hp).

3. Algae

Dried *Arthrospira platensis (Spirulina)* were obtained from phytoplankton laboratory, limnology department, Central Laboratory of Aquaculture Research; Agriculture Research Center: Egypt and dried *Nannochloropsis gaditana (Nanochloropsis*) were obtained from Biotechnology lab, National Research Council (NRC) Egypt. The two types of algae were supplemented to basal experimental diet at (3, 5, 7%) for each alga. The chemical composition of these algae was shown in **Table 1**

Table. 1 Chemical composition of the two type of algae as dry matter basis

	Spirulina	Nannochloropsis
Dry matter (%)	90	90
Crude protein (%)	43	17.5
Crude fiber (%)	4	3
Ether extract (%)	3.5	18
Ash (%)	11	15
NFE (%)	28.5	36.5

4. Experimental diets

The formulation of experimental diet shown in **Tables 2.** The chemical analyses of the experimental diets were carried out to estimate dry matter (DM), crude protein (CP), ether extracts (EE), crude fiber (CF) and ash according to the method described by **A.O.A.C (1975).** Amino acids of basel diet were calculated according to **NRC (1993),** spirulina according to **Ogbonda et al (2007)** and *Nannochloropsis gaditana* according to **James et al (1984)**

Fish in each tank were fed two times daily (six days a week) the seventh day, fish were fasted. The daily feed allowances were calculated according to fish metabolic body weight (**Meyer-Bergdorf et al 1989)** by using the following equation:

Daily feed allowances / tank = (Fish weight$^{0.8}$ * 1.7%) * fish number.

To avoid changes in the chemical composition of fish diets, *Arthrospira platensis* and *Nannochloropsis gaditana* were used as feed additives to replace part of soybean meal and wheat middling, respectively.

5. Fish sampling and nutritional criteria

Fish fingerlings were obtained from World Fish Center located at El Shrkia Governorate. A total of 315 fish werje randomly distributed to 21 ponds, the individual initial body weight (2.7 g± 0.095) was recorded at the beginning of the experiment. All fish in each tank was weighed every two weeks during the whole experimental period. According to the data of body weights, the following parameters were estimated: weight gain, average daily gain, specific growth rate and nutritional parameters were calculated according to **Cho and Kaushik (1985)** as following:

Average weight gain (AWG)

AWG (g/fish) = average final weight – average initial weight

Average daily gain (ADG)

Daily gain was estimated according to the following formula:

ADG = (wt $_2$-wt $_1$)/ t

Where:

wt 1 = first fish weight in grams.

wt 2 = following fish weight in grams.

t= period in day.

Specific growth rate (SGR %/day)

SGR = (Ln wt$_2$- Ln wt$_1$) x100/t.

Where:

Ln = (log l0x)$^{3.303}$

t= period in day

Feed conversion ratio (FCR)

The feed conversion ratio was calculated according to the following equation:

$$FCR = \frac{\text{Total feed consumption (g)}}{\text{Final body weight (g) - initial body weight (g)}}$$

Feed efficiency ratio (FER)

The feed efficiency ratio was calculated according to the following equation:

Protein efficiency ratio (PER)

$$FER = \frac{\text{finalbody weight (g) - initialbody weight (g)}}{\text{Total feedconsumption (g)}}$$

The protein efficiency ratio was calculated according to the following equation:

$$PER = \frac{\text{Finalbody weight (g)} - \text{initialbody weight (g)}}{\text{proteinintake (g)}}$$

Protein productive value (PPV) = 100 [protein gain in fish (g) / protein intake in feed (g)];

Survival rate

(Z/X) X 100

Where:

Z is surviving fish number

X is the initial fish number

3. Statistical analysis:

The statistical analysis was applied on the collected data according to **Steel and Torrie (1980)** using **(SAS,2009)**, Differences between means were tested for significance according to Duncan's multiple rang test **(Duncan, 1955).**

$$Yijk=U+Ti+ Dj+ (TD)_{IJ} +e_{ijk}$$

Where:

Yij =observation.

Table.2 Formulation of the experimental diets **(% dry matter bases).**

Ingredient (%)	T1	T2	T3	T4	T5	T6	T7
Fish meal	15	15	15	15	15	15	15
Soymeal 48	39	36	34	32	39	39	39
Wheat middling	25	25	25	25	22	20	18
Rice bran	7	7	7	7	7	7	7
Yellow corn	9	9	9	9	9	9	9
Fish oil	1	1	1	1	1	1	1
Plant oil	1	1	1	1	1	1	1
Spirulina	0	3	5	7	0	0	0
Nannochloropsis	0	0	0	0	3	5	7
Salt	1	1	1	1	1	1	1
Premix	1	1	1	1	1	1	1
lime stone	1	1	1	1	1	1	1
Chemical composition % (DM bases)							
Dry matter	91.3	91.1	91.3	91.2	91.3	91.1	91.3
Protein	34	33.8	33.7	33.6	34	34.1	34.1
Ether extract	5.29	5.37	5.42	5.47	5.34	5.37	5.4
Crud fiber	4.07	4.07	4.07	4.07	4.07	4.08	4.09
Ash	10.37	10.46	10.75	11.08	11.29	11.76	12.69
NFE	37.57	37.4	37.36	36.98	36.6	35.79	35.02
Calculated amino acid profile of the experimental diet							
Arginine	2.54	2.79	2.96	3.12	2.61	2.65	2.70
Histidine	0.84	0.86	0.88	0.90	0.85	0.87	0.88
Isoleucine	1.53	1.59	1.64	1.68	1.55	1.57	1.59
Leucine	2.60	2.63	2.65	2.67	2.67	2.71	2.76
Lysine	2.18	2.19	2.20	2.21	2.24	2.28	2.31
Methionine	0.63	0.68	0.71	0.75	0.64	0.64	0.64
Cysteine	0.48	0.48	0.48	0.48	0.49	0.49	0.49
Phenylalanine	1.55	1.56	1.57	1.58	1.60	1.63	1.66
Threonine	1.34	1.34	1.34	1.34	1.38	1.41	1.44
Tryptophan	2.78	2.78	2.78	2.78	2.78	2.78	2.78
Tyrosine	1.28	1.46	1.57	1.69	1.31	1.34	1.36

U = the overall mean.
Ti= the effect of algae type.
Dj= the effect of algae level.
$(TD)_{IJ}$= the effect of interaction
e_{ijk}= random error

RESULTS AND DISCUSSION

1. Water quality assessments

Quality of water was checked every fortnight to determine pH, ammonia (NH_3), nitrite-nitrogen (NO_2-N) and nitrate- nitrogen ($N0_3$-N). All measurements were carried out in the Limnology and Plankton Laboratories in the Department of Limnology of Central Laboratory for Agricultural Climate according to the standard methods of American Public Health Association **(APHA, 1985) and Boyd (1990).** Water temperature and oxygen saturation were measured daily at 8.00 am by an oxygen meter (Lutron model Do – 5509). Water quality was generally good in all tanks due to the continuous water replacement during the whole period. The pH values were measured in wastewater samples using a combined electrode connected to a pH meter (Coming Co. pH meter model 345). Ammonia-Nitrogen (NH^{+4}), (NH_3), nitrate (No_3) were determined according to the methods described by **Sauter and Stoub (1990).** The water quality parameters were given in **(Table 3)**

Table 3. Averaged water quality determinations during the experimental period

Parameter	Reading
Average Temperature (C°)	26
Oxygen (mg / L)	6
pH	7.1
Ammonia (mg / L)	0.28
Nitrite (mg / L)	1

2. Growth performance and feeding utilization parameters.

Data in **Table (4)** showed the growth performance of tilapia fingerlings fed different levels of both (*Arthrospira platensis*) Spirulina and *Nannochloropsis gaditana* algae. By increasing (*Arthrospira platensis*) Spirulina algae levels in fish diets from 3 to 7%, growth performance of tilapia fish was reduced significantly (P>0.05). the lowest significant (P<0.05) average weight gain (19.13 g/ fish) was recorded by the group fed 7% (*Arthrospira platensis*) Spirulina (T4). Fish groups fed *Nannochloropsis gaditana* in diets showed no significant changes in the average weight gain. However, fish group fed 5% *Nannochloropsis gaditana* (T6) showed the highest significant AWG. Results of **Sarker et al (2018)** showed no significant reduction in weight gain of tilapia fish when they added 3 and 5 % *Nannochloropsis gaditana* in diets, whereas reduction in tilapia weight gain was observed with increasing *Nannochloropsis gaditana* levels higher than that. Also, **Riveros et al (2018)** found that supplemented Atlantic salmon diet up to 5% *Nannochloropsis gaditana* diet had positive effect on its growth performance.

In the present research it was noticed that the highest ADG and SGR **(Figure 1 & 2)** have been achieved by feeding tilapia fingerlings diets included nanno 5%(T6), nanno 7% (T7) respectively. Where the differences were significant (P<0.05) among all treatments. Results in Table 4 showed that 5% and 7% *Nannochloropsis gaditana*, was greater than previous parameters. These results are supported by **(Patterson *et al* 2013** and **Tibaldi *et al* 2015)** who demonstrated that dietary supplementation with various microalgae, including a related *Nannochloropsis gaditana* species up to 25% is acceptable based on growth performance, nutrient utilization, carcass yields, organ weights, sensory evaluation, digestive enzyme activities and intestinal histological parameters. So, the reason for the improvement in growth rates showed in nanno 5 may be explained by **(Schneider and Roessler, 1994**. **Khozin- Goldberg & Iskandarov, 2011)** who reported that *Nannochloropsis gaditana* accumulates significant amounts of membrane-bound eicosapentaenoic acid (EPA). **Apt and Behrens (1999)** showed that *Nannochloropsis gaditana* species are widely used as aquafeed and have been proposed for the commercial production of EPA. The major fatty acids in *Nannochloropsis gaditana* are 14:0, 16:0, 20:4ὡ6 and 20:5ὡ5

In the present study no mortality was observed in nanno7 and spiru 7 **(Table 4 and Figure 3).** Tilapia survival rates were not affected significantly (P>0.05) by different feeding treatments. These findings agree with the result of **Ben Hafsa et al. (2017)** who reported that *N. oculata* are used widely in aquaculture for feeding and pathogens prevention**.** *Isochrysis galbana* and *nannochloropsis oculata* possessed important functional properties such as antioxidant, antimicrobial, anticholinesterase and antiproliferation activities, demonstrating the important value of these microalgae. The present results are also agree with **Qureshi *et al*. (1996)** who reported that (*Arthrospira platensis*) Spirulina could stimulate the immune system via increasing the phagocytic and the natural killer activities and with **Bermejo *et al.* (2008**) who reported that most antioxidant capacities of (*Arthrospira platensis*) Spirulina protein extract are attributable to the biliproteins contained in this microalga, such as phycocyanin so that we can use (*Arthrospira platensis*) Spirulina to improve the immunity capacity of the animals which consume it.

Table 4. fish growth parameters fed different experimental diets

Treatments Growth parametes	Control	Spirulina			Nannochloropsis		
	T1 (0)	T2 (3)	T3 (5)	T4 (7)	T5 (3)	T6 (5)	T7(7)
IBW	2.73±0.095	2.46±0.066	2.60±0.115	2.73±0.240	2.84±0.095	2.80±0.166	2.26±0.103
FBW	25.63^{ab}±1.58	24.7^{bc}±0.81	24.22^{bc}±1.55	21.86^{c}±0.26	23.30^{bc}±1.80	27.22^{a}±0.96	23.82^{bc}±0.596
AWG	22.75^{ab}±1.61	22.27^{ab}±0.8	21.50^{ab}±1.46	19.13^{c}±0.40	20.39^{ab}±1.84	24.35^{a}±0.76	21.55^{ab}±0.49
ADG	0.23^{ab}±0.17	0.234^{a}± 0.17	0.226^{ab}±0.17	0.20^{b} ± 0.17	0.21^{b} ± 0.17	0.256^{a} ± 0.17	0.22^{ab} ± 0.17
SGR	2.22^{ab}±0.06	2.32^{ab}±0.06	2.22^{ab}±0.06	2.12^{b}±0.06	2.11^{b}±0.06	2.29^{ab}±0.06	2.40^{a}±0.06
SURVIVL	97.7 ±1.00	98.6 ±1.00	96.9±1.00	100±1.00	99.4 ±1.00	98.6 ±1.00	100 ±1.00

Values are the mean ± S.E. of triplicate groups.

Values in the same raw, with different superscripts are significantly different (P<0.05). IBW: initial body weight; FBW: final body weight; AWG: average weight gain; ADG: average daily gain; SGR: specific growth rate; SR: survival rate.

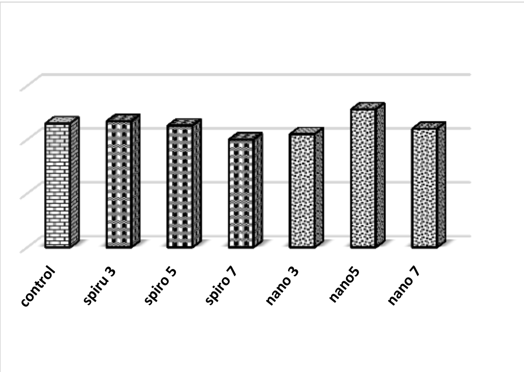

Fig. 1. ADG (glday/fish)of tilapia fish fed different types and level of algae

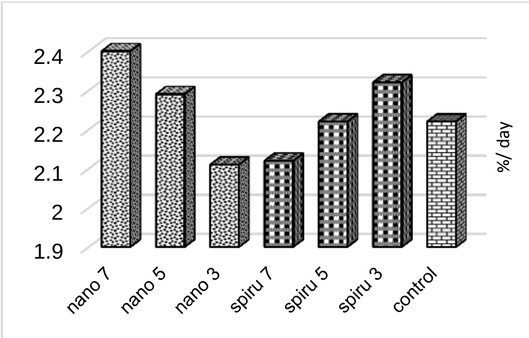

Fig. 2. SGR of tilapia fish fed different types and levels of algae

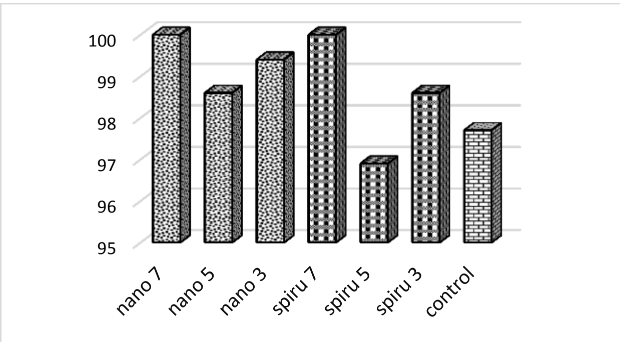

Fig. 3. Survival of tilapia fish fed different types and levels of algae

Results in **Table (5)** and **Figures (4 and 5)** show that the inclusion of different levels of *Nannochloropsis gaditana* and (*Arthrospira platensis*) Spirulina in tilapia diets had no significant effects (P>0.05) on FCR. However, group fed diet 7% (T7) *Nannochloropsis gaditana* had the highest significant FER (P<0.05). No significant differences (P>0.05) was observed between the other algae levels in FER. These may be due to that the levels of *Nannochloropsis gaditana* and (*Arthrospira* *platensis*) Spirulina used in the present study were slightly lower than that required to achieve effects. These results are agreed with **(Adel et al 2016),** who found that dietary supplementation of *Spirulina platensis* up to 10% had no effects on growth performance, digestive enzyme activities, humoral and skin innate immune responses and disease resistance in the great sturgeon (*Huso huso).* Their results demonstrated that dietary supplementation with *S. platensis* (up to 10% level) could be useful for maintaining the overall health status of great sturgeon. **Sørensen et al (2017)** reported that feeds with 20% alga had negative effect on feed intake, FCR, lipid and energy retention and health of the fish. The defatted *Nannochloropsis oceania* can be used at modest inclusion levels, around 10%, without negative effects on the performance of Atlantic salmon.

The PER and PPV% results of the current research **(Table 5 and Figures 6 and7)** showed that by increasing the inclusion levels of (*Arthrospira platensis*) Spirulina, PER and PPV have been improved. The highest significant PER and PPV were obtained by adding 7% (*Arthrospira platensis*) Spirulina or 7% *Nannochloropsis gaditana* in fish diets.

Table 5. Feed utilization parameters of tilapia fed different experimental diets

Treatments / Feed utilization parameters	Control	Spirulina			Nannochloropsis		
	T1 (0)	T2 (3)	T3 (5)	T4 (7)	T5 (3)	T6 (5)	T7(7)
Feed Intake	$44.63^{ab}\pm0.924$	$41.40^{bc}\pm0.23$	$41.53^{bc}\pm1.52$	$39.06^{c}\pm0.731$	$41.0^{bc}\pm2.05$	$46.66^{a}\pm0.317$	$40.6^{bc}\pm0.63$
FCR	1.47± 0.13	1.38± 0.13	1.52 ±0.13	1.77 ± 0.13	1.79 ± 0.13	1.42 ± 0.13	1.37 ± 0.13
FER	$0.71^{ab}\pm0.02$	$0.73^{ab}\pm0.02$	$0.71^{ab}\pm0.02$	$0.67^{b}\pm0.02$	$0.68^{ab}\pm0.02$	$0.75^{ab}\pm0.02$	$0.76^{a}\pm0.02$
PER	$2.72^{b}\pm 0.003$	$2.74^{ab}\pm0.01$	$2.74^{ab}\pm0.00$	$2.76^{a}\pm0.005$	$2.73^{b}\pm0.008$	$2.72^{b}\pm0.005$	$2.72^{b}\pm0.00$
PPV	$19.07^{cd}\pm0.07$	$20.80^{bc}\pm0.23$	$20.74^{ab}\pm0.15$	$20.0^{a}\pm0.084$	$20.91^{ab}\pm0.219$	$21.48^{d}\pm0.127$	$22.90^{ab}\pm0.034$

Values are the mean ± S.E. of triplicate groups.

Values in the same raw, with different superscripts are significantly different (P<0.05).

SR: survival rate; FCR: fed conversion ratio; PPV: protein productive value; and PER: protein efficiency ratio

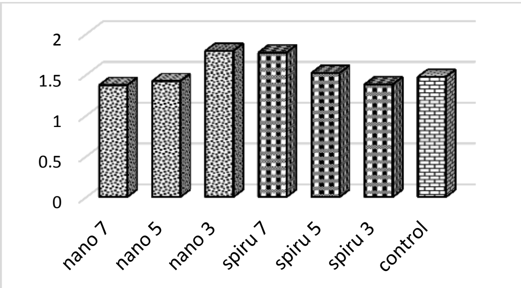

Fig. 4. FCR of tilapia fish fed different types and levels of algae

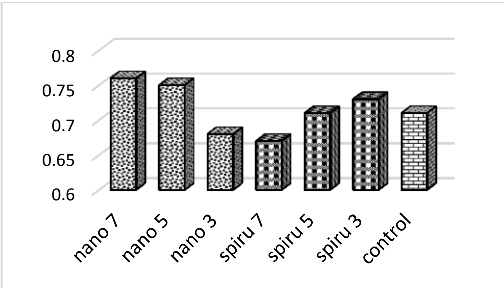

Fig. 5. FER of tilapia fish fed different types and levels of algae

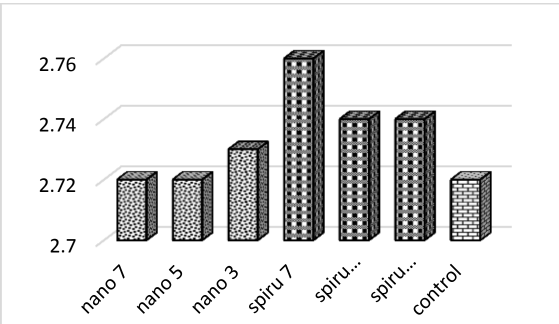

Fig. 6. PER of tilapia fish fed different types and levels of algae

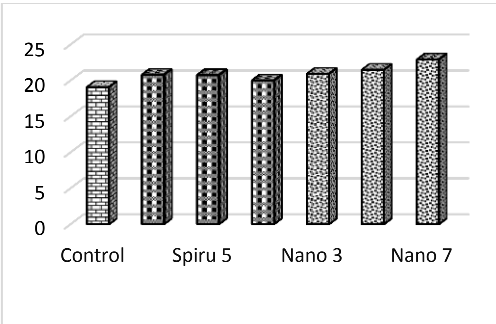

Fig. 7. PPV% of tilapia fish fed different types and levels of algae

2. Chemical composition of fish carcass

Chemical composition of the experimental fish was represented in **Table (6).** The results showed that treatments contain *Nannochloropsis gaditana* had the higher dry matter DM content. Protein content ranged between (55.8 to 61.25 %), the highest value was recorded by Nanno 7 (T7), while the lowest (55.8%) was for the zero group. Also, it was noticed that 7% of both algae species (*Arthrospira platensis*) Spirulina and *Nannochloropsis gaditana*) improved protein content in fish body.

The highest lipid content was for Nanno7 (T6) (20.7%) while the lowest value obtained by spiru 7 (T4) (16.3%). On the other hand, fish in control group had the highest ash content (21.35%) but nanno 5 (T6) had the lowest value (17.7%).

These results were in contrary with **Sørensen et al (2017)** who reported that Neither the whole body, nor fillet proximate composition of Atlantic salmon was affected by the intake of *Nannochloropsis gaditana* except lipid content. **Haas et al (2015)** found that there is no significant different in body composition when they fed Atlantic salmon diets contained 50 and 100 % *Nannochloropsis gaditana* replaced with fish oil. **Sarker et al (2018)** reported that Whole body proximate composition of Nile tilapia fillets did not significantly differ among dietary treatments when they replaced fish meal by 33%, 66% and 100% of *Nannochloropsis oculate*

Shearer (1994) reported that proximate composition varies with life stages of fish and is also influenced by endogenous factors such as genetics, size and sex, as well as exogenous factors such as feed composition, feeding frequency and environment.

Table 6. Chemical analysis of Nile tilapia fish (dry-basis) fed different experimental diets

	Control	Spiru 3	Spiru 5	Spiru 7	Nanno 3	Nanno 5	Nanno 7
DM	22.1^{d}±0.08	22.8^{c}±0.05	22.8^{c}±0.05	23.17^{c}±0.05	24.5^{a}±0.05	24.4^{a}±0.05	24.1^{b}±0.05
CP	57.58^{d}±0.05	57.2^{e}±0.03	59.1^{b}±0.06	59.2^{b}±0.00	58.4^{c}±0.05	56.8^{f}±0.05	61.25^{a}±0.02
EE	17.8^{d}±0.003	18.3^{c}±0.01	17.8^{d}±0.01	16.3^{f}±0.14	17.2^{e}±0.01	19.9^{b}±0.05	20.7^{a}±0.11
Ash	21.35^{a}±0.08	19.87^{c}±0.08	18.9^{f}±0.05	20.8^{b}±0.01	19.18^{e}±0.01	17.7^{g}±0.01	19.4^{d}±0.005

a, b means of the same raw with different superscript are significantly different ($p<0.05$).

CONCLUSION

The results of the present study showed that adding algae ((*Arthrospira platensis*) Spirulina , or Nannochlorpsis) improved the productive performance of Tilapia fish under laboratory condition. More studies are still needed to approve the types, the optimum levels, the mode of action of each algae species and the interaction with the other environmental parameters in the field.

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تأثير إضافة طحالب الاسبيرولينا والنانوكلوروبسيس على أداء النمو، كفاءة الاستفادة من الغذاء وتكوين الذبيحة لأسماك البلطي النيلي

[39]

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الموجـــــــز

أجريت هذه الدراسة بكلية الزراعة جامعة عين شمس لتقييم تأثير إضافة نوعين من الطحالب المجهرية (الاسبيرولينا والنانوكلوروبسيس) كإضافات غذائية على الأداء الإنتاجي لأسماك البلطي النيلي وحيد الجنس وذلك بمعدلات إضافة(7,5,3%) لكل من تلك الطحالب على العليقة الأساسية. حيث تم عمل سبعة معاملات لكل معاملة ثلاث مكررات كالتالي:

المعاملة الأولى هي العليقة القياسية 34 % بروتين، والمعاملة الثانية هي العليقة الأساسية مضافا إليها 3% سبيرولينا والمعاملة الثالثة عبارة عن العليقة الأساسية مضافا إليها 5% سبيرولينا والمعاملة الرابعة عبارة عن العليقة الأساسية مضافا إليها7% سبيرولينا والمعاملة الخامسة عبارة عن العليقة الأساسية مضافا إليها 3% نانوكلوروبسيس والمعاملة السادسة عبارة عن العليقة الأساسية مضافا إليها 5% نانوكلوروبسيس والمعاملة السابعة عبارة عن العليقة الأساسية مضافا إليها7% نانوكلوروبسيس. وأجريت التجربة في 21 حوض تجريبي من الألياف الزجاجية بأبعاد (60*30*60) طول * ارتفاع *عرض على التوالي) ملحق بنظام مغلق يتم فيه الحفاظ على الظروف البيئية بشكل شبه ثابت خلال فترة التجربة. وكانت كثافة الأسماك 15سمكة / حوض بوزن بداية متوسطه 2.7 جرام. وقد تم وزن الأسماك كل أسبوعين. وتمت التغذية على عليقة 34% بروتين لمدة 95 يوم. وقد أظهرت النتائج أن المعاملة التي تحتوي على 5% نانوكلوروبسيس تزيد معنويا في كل من وزن الجسم النهائي، متوسط الزيادة الوزنية ومعدل الزيادة اليومية عن باقي المعاملات. كما لوحظ أن أعلى ومعامل تحويل غذائي وكفاءة استفادة من الغذاء كانت لتلك الأسماك التي تغذت على 7% نانوكلوروبسيس. كما وجد أن المعاملة التي تحتوي على 7% سبيروليناا تزيد معنويا عن باقي المعاملات في كل من كفاء الاستفادة من البروتين والقيمة الإنتاجية للبروتين. وعلى الجانب الآخر لم يحدث تفوق في كل من المعاملات التي تحتوي 7% من كل من الاسبيرولينا والنانوكلوربسيس. ويتضح من ذلك أن استخدام طحلب الاسبيرولينا بإضافة قدرها 7% أو استخدام طحلب النانوكلوروبسيس بإضافة قدرها 5% يحسن الأداء الإنتاجي وكفاءة الاستفادة من الغذاء لأسماك البلطي النيلي.

الكلمات الدالة: الطحالب المجهرية – الاسبيرولينا – النانوكلوروبسيس – الإضافات الغذائية

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