Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 24(6): 267 – 280 (2020)
www.ejabf.journals.ekb.eg

Effect of replacing fish meal in fish diet by zooplankton meal on growth performance of *Dicentrarchus labrax* (Linnaeus, 1758)

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ARTICLE INFO

Article History:
Received: Aug. 30, 2020
Accepted: Sept. 8, 2020
Online: Sept. 11, 2020

Keywords:
European sea bass;
Dicentrarchus labrax,
Fish meal;
Fish diet;
Zooplankton;
Growth performance;
Feed utilization;
Food conversion ratio

ABSTRACT

This study aimed to evaluate the effect of replacing fish meal in the fish diet by zooplankton meal on the growth performance of European sea bass, *Dicentrarchus labrax*. A total of 900 fingerlings of the *D. labrax* were collected from fish hatchery Kilo 21, Alexandria and transported to the fish rearing unit in El-Max Research Station, National Institute of Oceanography and Fishers (NIOF), Alexandria, Egypt. After two weeks for acclimation, the fish were divided into 5 groups, 3 replicates for each group (60 fish in one cubic meter of Haba for each replicate). The five experimental diets were: G_1: commercial diet (control group); G_2, G_3, G_4, and G_5 fish meal in this commercial diet was replaced by zooplankton meal as 25%, 50%, 75% and 100%, respectively.

The highest values of growth performance parameters and PER & FER of *D. labrax* were recorded in $\mathbf{G_5}$, while the lowest values were recorded in the control group. The best average of FCR (1.75±0.02) was recorded for $\mathbf{G_5}$ and its bad average (2.18±0.18) was recorded in $\mathbf{G_1}$. The present study concluded that zooplankton positively affected growth performance parameters and enhanced feed utilization of sea bass.

INTRODUCTION

Fish importance as food source is increase with the increasing of demands, especially in animal protein. A great attention has been paid to establishment fish farms. These farms could contribute partially in producing the demanded on animal protein sources consumed by human **(El-Kalla *et al*., 2001** and **Azab *et al*., 2005).** It is a particularly important protein source in regions where livestock is relatively scarce. Fish supplies less than 10% of animal protein consumed in North America and Europe, 17% in Africa, 26% in Asia and 22% in China**.** The FAO estimated that about one billion people worldwide rely on fish as their primary source of animal protein **(FAO, 2000).** In Egypt, the total fish production in 2016 was estimated at 1706273 tons of which 80% from aquaculture and 20% from natural fisheries. The production of Nile Tilapia, *Oreochromis niloticus* forms 68.6% from the total aquaculture and natural production in Egypt **(GAFRD, 2016)**.

European sea bass, *Dicentrarchus labrax* is the most important commercial and consumed marine fish. Sea bass (*D. labrax*) is one of the most important commercial fish species in Egypt and it is commonly used in aquaculture. Sea bass (*D. labrax*) is an euryhaline fish and for this reason, it is important for marine and brackish water fish farming. Sea bass is an economically important cultured fish species in the Mediterranean coastal waters (**El-Shebly, 2009**). The market demand is great and as a result, the price for fresh sea bass has increased markedly over the past decade due to the desirable aroma and quality attributes of this fish; consequently, its farming is deemed to be a profitable business. Thus, many fish farms on the Mediterranean coasts have gradually expanded their annual production from 581 tones in1995 to 53307 tons in 1999 **(FAO, 2001)**. It is the widely cultured in the Mediterranean area, with Greece, Turkey, Italy, Spain, Croatia and Egypt being the largest producers **(FAO, 2012)**.

Fish nutrition is a matter of great importance in the expanding Mediterranean aquaculture industry as better product quality and optimum growth can be achieved using the appropriate diets **(Parpoura & Alexis, 2001).** The main objective when formulating a fish diet is to provide a nutritionally balanced mixture of ingredients to support the maintenance, growth, reproduction and health of the animal at an affordable cost **(NRC, 1993).** As feed is one of the principle costs in feed production **(Lupatsch *et al.*, 2001)**, formulations must be based on our knowledge of nutritional requirements for them to be economically viable. Reproduction in fish, as in other vertebrates, is affected by environmental, social and nutritional factors. The effects of food ration size and nutrient composition of the diets on reproduction have been investigated in several important species in aquaculture **(Kjorsvik *et al.*, 1990; Bromage *et al.*, 1992)**. The quality and quantity of food are among the most important exogenous factors directly affecting growth and, indirectly, maturation and mortality in fish, thus being ultimately related to fitness **(Wootton, 1990).**

The dietary requirements of cultured fish are probably the most important factors influencing the success of any fish farming. Research on nutrition of fish has been expanded including the use of potential of new functional ingredients, feed additives and probiotics to improve the growth, feed utilization and fish health. The role of probiotics in nutrition and health of certain aquaculture species have been investigated **(Ringo *et al.*, 2010).**

Protein is the most expensive component in the diets for aquatic species. One of the most important problems in aquaculture industry over the world, especially in Egypt and developing countries, is the availability, cost, adulteration and bad treatments of protein during diet manufacture **(GAFRD, 2012)**. Despite the efforts in the formulation development of initial diets, live food still remains a stable option in terms of survival and growth compared to formulated diet alone **(Verreth *et al.*, 1987)**.

Therefore, plankton seems to provide a good source of immune and exogenous enzymes for larvae, however, the nutritional quality of plankton varies and plays a major role in producing high quality of fish larvae, juveniles and fry **(van der Meeren *et al.*, 2008)**. Investigations of zooplankton community in fish farm systems are important tools to evaluate the success of aquaculture ecosystem **(Tavares *et al.*, 2010** and **Ssanyu *et al.*, 2011)**.

Rotifers and copepods configured the main bulk of zooplankton community and they figured together 95.9% to the total zooplankton numbers in the water source used in the present study. Many authors found that rotifers and copepods represent the main bulk of zooplankton communities **(Case *et al.*, 2008** and **Ashour *et al.*, 2018)**.

Thus, the main objective of the present study was to evaluate the effects of replacing fish meal in fish diet by zooplankton biomass meal on the growth performance of European sea bass, *D. labrax*, feed utilization and food conversion ratio.

MATERIALS AND METHODS

1. Experimental fish:

A total of 900 fingerling specimens of *D. labrax* were obtained from fish hatchery Kilo 21, Alexandria, Egypt and transported to the fish rearing unit in El-Max Research Station, National Institute of Oceanography and Fishers (NIOF), Alexandria, Egypt (**Fig. 1**). All fish fries were nearly similar in length (23.56±2.92 mm) and in weight (147.78±15.63 mg),). Fish were acclimatized for two weeks in well aerated water and fed daily on a commercial fish diet.

2. Fish grouping and experimental diets:

After acclimation, the fish were divided into 5 groups with 3 replicates, 60 fish each. Consequently, the fish were randomly distributed to 60 fish per one cubic meter of haba in a concrete tank (1x 1 x 1 m). The haba were filled with tap water in which oxygen saturation is 5.6g/l at pH 7.9. Water temperature range was 26-27°C. The five fish groups were fed by different five diets which prepared by replacing fish meal content **(FM)** in the diet by zooplankton meal **(ZM)** as following:

G1: fed on commercial diet with 100 % FM +0 % ZM (control group)
G2: fed on commercial diet with 75 % FM +25 % ZM (group 2)
G3: fed on commercial diet with 50 % FM +50 % ZM (group 3)
G4: fed on commercial diet with 25 % FM +75 % ZM (group 4)
G5: fed on commercial diet with 0 % FM +100 % ZM (group 5)

The experimental diets were formulated to contain approximately 42 % crude protein. Total zooplankton and fish meal (animal protein), Soybean meal (plant protein) and were used as protein sources **(Tables 1&2)**. The experimental diets were also contained wheat (10%), yellow corn (15%) and fish oil (3%) as energy sources. Vitamin and mineral premixes (2%) were added to each experimental diet.

The feeding rate was 7% of wet the biomass twice a day, at 10.00 am and 2.00 pm, for six days a week for a period of 16 weeks. The composition and chemical analysis of the experimental pellets were measured and presented in Tables (1 & 2). The diets were analyzed according to the standard methods of **AOAC (1990)**. The experimental tanks were inspected daily to remove dead fish.

Environmental factors in all treatments of the experiment were recorded in ranges as the following: pH (7.15-7.30), dissolved oxygen (4.95-5.60 mg/l) and water temperature (24-32 °C).

Figure1: Photographs of fingerling (above) and small fish (below) of sea bass

Table (1): Ingredients composition (%) of diets used in experiment

Ingredient %	G1	G2	G3	G4	G5
Fish meal	35	26.25	17.5	8.75	0
Zooplankton	0	8.75	17.5	26.25	35
Soy bean	35	35	35	35	35
Yellow corn	15	15	15	15	15
Wheat	10	10	10	10	10
Vit & mnir	2	2	2	2	2
Fish oil	3	3	3	3	3
Total	100	100	100	100	100

Table (2): Chemical analysis of the experimental diets.

Groups	DM %	CP %	CF %	EE %	NFE %	Ash %
FM	93.38±0.96	62.31±2.38	9.73±1.25	13.82±1.13	7.13±0.09	7.01±0.09
ZM	90.04±0.05	66.54±1.18	7.51±0.49	8.62±0.72	10.39±0.21	6.94±0.13
G1	94.47±0.09	41.82±0.08	6.90±0.04	10.84±0.33	32.13±0.31	8.31±0.04
G2	94.34±0.07	42.99±0.12	6.33±0.03	9.02±0.13	35.60±0.19	6.06±0.06
G3	94.20±0.19	43.95±0.05	6.32±0.06	7.04±0.03	35.11±0.11	7.58±0.08
G4	94.84±0.08	44.91±0.02	6.01±0.11	7.39±0.06	35.58±0.15	6.11±0.04
G5	94.30±0.03	45.40±0.04	6.62±0.12	7.04±0.05	34.85±0.13	6.09±0.04

Fish meal (FM); Zooplankton meal (ZM); Dry matter (DM); Crude protein (CP); Crude fiber (CF); Ether extract (EE);Nitrogen free extract (NFE) ={100- (crude protein +ether extract+ crude fiber +ash)}

3. Measurements of growth performance and feed utilization parameters:

Final body length (**L**), length gain (**LG**), daily length gain (**DLG**), growth in length (**GL**), final body weight (**W**), total weight gain (**WG**), daily weight gain (**DWG**), growth in weight (**GW**), specific growth rate (**SGR**), feed intake (**FI**), food conversion ratio (**FCR**) in *Oreochromis niloticus* were determined according to **Castell & Tiews, (1980)**.

3.1. Final body length (mm):

The fish length (standard length) of each sampled fish, from each pond, was recorded at the end of the experiment.

3.2. Total length gain (mm/fish):

The length gain is calculated from the following equation:

$$LG = L_F - L_I$$

Where: L_F= average of final fish length (mm).

L_I = average of initial fish length (mm).

3.3. Daily length gain (µm/fish/day):

The average daily length gain is calculated from the following equation:

DLG = total length gain (µ)/ duration period (days)

3.4. Growth in length (%):

The growth in length is calculated from the following equation:

$$GL = \{LG / L_I\} \times 100$$

Where: **LG**= Total length gain (mm).

L_I = Initial average length of fish (mm).

3.5. Final body weight (mg):

The fish weight of each sampled fish, from each pond, was recorded at the end of the experiment.

3.6. Total weight gain (mg/fish):

The total weight gain is calculated from the following equation:

$$WG = W_F - W_I$$

Where: W_F = average of final fish weight (mg).

W_I = average of initial fish weight (mg).

3.7. Daily weight gain (mg/fish/day):

The average daily weight gain is calculated from the following equation:

DWG = total weight gain (mg)/ duration period (days)

3.8. Growth in weight (%):

The growth in weight is calculated from the following equation:

$$\mathbf{GW = \{WG / W_I\} \times 100}$$

Where: **WG**= Total weight gain (mg).

W_I = average of initial fish weight (mg).

3.9. Specific growth rate (%/day):

The specific growth rate is calculated from the following equation:

$$\mathbf{SGR = (Ln\ W_F - Ln\ W_I) * 100 / duration\ period}$$

Where: **Ln**= Natural log.

W_F = average of final fish weight (mg).

W_I = average of initial fish weight (mg).

3.10. Total Feed intake (mg/fish):

The total feed intake **(FI)** is calculated from the following equation:

FI = ∑{monthly average fish weight*(daily feeding rate *25 days)}

3.11. Food conversion ratio:

The food conversion ratio **(FCR)** is calculated from the following equation:

FCR = feed intake (mg)/ total weight gain (mg)

3.12. Feed efficiency ratio (FER):

The feed efficiency ratio is calculated by the following equation:

FER = Weight gain (g) / Feed intake (g)

3.13. Protein efficiency ratio (PER):

The protein efficiency ratio is calculated by the following equation:

PER = Total weight gain (g)/ Total protein intake (g).

Protein intake (TPI) = feed intake (g) X Protein% in the diet/100

4. Statistical analysis:

The obtained results were statistically analyzed using SPSS (version 16) for one-way analysis of variance. Differences between individual treatments were tested with Duncan Multiple range test at probability level of 5% when T-test was significant.

RESULTS

1. Effect of zooplankton replacement on fish growth performance:

1.1. Growth in length (mm & %):

Results in **Table (3)** and **Figure (2)** showed that, sea bass, *D. Labrax*, fed on different feed rations exhibited great variations in body length. The highest average body length (89.44±5.46 mm) was recorded in $\mathbf{G_5}$ (diet containing 35% ZM + 0% FM), representing the highest growth in length (277.48± 33.49%). While, the lowest average body length (79.67±4.82 mm) was recorded in $\mathbf{G_1}$ (diet containing 0% ZM + 35% FM), representing also growth in length (238.36± 8.23%).

1.2. Length gain (mm/fish):

Results showed that sea bass exhibited greatly variation in length gain. The greatest average of length gain (65.67± 4.36mm) was recorded in $\mathbf{G_5}$ (diet containing 35% ZM + 0% FM) and the lowest average of length gain (56.11± 1.26 mm) and (56.11± 1.84 mm) was recorded in **G1** and $\mathbf{G_2}$ **(Table, 3** and **Fig. 2)**.

1.3. Daily length gain (µ/fish/day);

The highest average daily length gain (547.22± 36.30 µ/fish/day) was recorded in $\mathbf{G_5}$ and its lowest length gain (467.58± 15.31µ/fish/day) was recorded in $\mathbf{G_2}$ **(Table 3 & Fig. 2)**.

Table (3): Total fish length (mm) of *D. labrax* fed on different feed rations during treatment period, length gain (LG), daily length gain (DLG) and growth in length (GL) "Data expressed as Mean ± SD"

Time (days)	treatments				
	G1	G2	G3	G4	G5
0 (Initial Time)	**23.56±2.92**	**23.56±2.92**	**23.56±2.92**	**23.56±2.92**	**23.56±2.92**
15	31.56±2.13	30.06±2.89	30.62±2.55	31.17±2.46	32.34±2.69
30	39.56±1.33	36.56±2.88	37.67±1.87	38.78±1.99	41.11±2.47
45	48.11±2.57	43.22±3.70	43.44±5.32	47.78±4.37	54.89±4.14
60	57.33±3.24	50.78±2.22	53.44±4.48	60.44±4.80	68.22±2.39
75	59.33±2.40	59.33±1.73	60.11±1.62	60.44±1.42	70.78±2.49
90	65.56±2.74	65.67±2.74	67.89±2.98	67.33±2.92	73.56±1.24
105	76.11±2.47	72.67±3.28	75.89±2.26	74.89±3.22	82.22±3.77
120 (final time)	**79.67±4.82**	**79.78±4.35^{NS}**	**82.11±7.67 ^{NS}**	**82.44±5.59 ^{NS}**	**89.44±5.46 ^{NS}**
LG (mm/fish)	**56.1± 1.26**	**56.1± 1.84 ^{NS}**	**58.3± 2.31 ^{NS}**	**58.9± 2.36 ^{NS}**	**65.7± 4.36 ^{NS}**
DLG (µm/fish/day)	**467.6±10.51**	**467.6±15.3 ^{NS}**	**486.1±19.3 ^{NS}**	**490.8±19.7 ^{NS}**	**547.2±36.30****
GL (%)	**238.4±8.23**	**237.1± 7.48 ^{NS}**	**245.3±10.8 ^{NS}**	**250.4±17.2 ^{NS}**	**277.5±33.49****

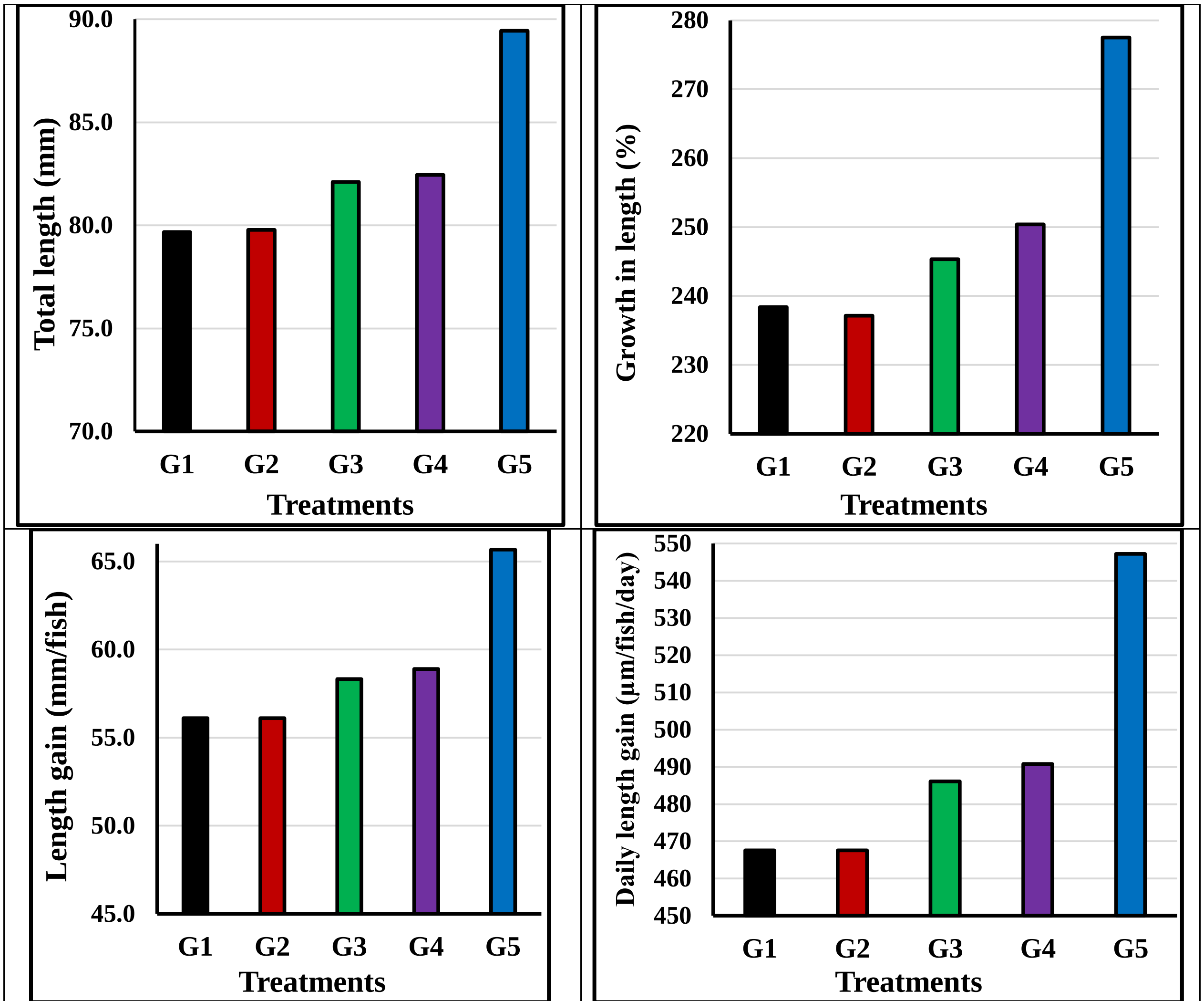

Fig. (2): The effect of fish meal replacement by zooplankton meal on different growth performance parameters in length of sea bass, *D. labrax*.

1.4. Growth in weight (mg& %):

Results in **Table (4)** and **Figure (3)** showed that sea bass fed on different feed rations exhibited great variations in body weight. The highest average body weight (3785. 6±281.47 mg) was recorded in **G_5**. While, the lowest average body weight (2667.8±111.37 mg) was recorded in **G_1**. Also, the highest growth in weight (2469.8± 286.26 %) was recorded in **G_5**; while the lowest growth in weight (1705.1± 350.00%) was recorded in **G_1**.

1.5. Weight gain (mg/fish):

The greatest weight gain (3637.8± 281.47 mg) was recorded in **G_5** and the lowest weight gain (2520.0± 107.29 mg) was recorded in **G_1(Table 4** and **Fig. 3)**.

1.6. Daily weight gain (mg/fish/day):

Results showed that *D. labrax* specimens fed on different feed rations exhibited great variations in daily weight gain (**DWG**). The greatest daily weight gain (30.31± 2.35 mg/fish/day) was recorded in **G_5** and the lowest daily weight gain (21.00 ± 0.89 mg/fish/day) was recorded in **G_1 (Table, 4** and **Fig. 3)**.

1.7. Specific growth rate (% / day):

The specific growth rate (**SGR**) of *D. labrax* fed on different feed rations exhibited great variations. The highest specific growth rate (2.70± 0.09%) was recorded in **G_5**, and the lowest specific growth rate (2.41± 0.02%) was recorded in **G_1 (Table, 4)**.

1.8. Total feed intake (g/fish) and Food conversion ratio:

Results in **Table (4)** showed that, the highest average feed intake (6340 mg) was recorded in **G_5** (diet containing 35% ZM + 0% FM) and the lowest average of feed intake (5006.67 mg) was recorded in **G_1** (diet containing 0% ZM + 35% FM). Accordingly, the best food conversion ratio (1.75) was recorded in **G_5**, followed by **G_4** (1.79). But, the bad food conversion ratio (2.18) was recorded in **G_1**.

1.9. Feed efficiency ratio (FER) and Protein efficiency ratio (PER):

Results in **Table (4)** showed that, the highest feed efficiency ratio (0.57) was recorded in **G_5** (diet containing 35% ZM + 0% FM) and the lowest average of feed efficiency ratio (0.46) was recorded in **G_1** (diet containing 0% ZM + 35% FM). Also, the maximum value of protein efficiency ratio (1.585) was recorded in **G_5**, followed by **G_4** (1.223). But, the minimum value of protein efficiency ratio (1.098) was recorded in **G_1**.

Table (4): Total fish weight (mg) of *D. labrax* fed on different feed rations during treatment period, weight gain (WG), daily weight gain (DWG), growth in weight (GW), specific growth rate (SGR), feed intake (FI) and food conversion ratio (FCR) "Data expressed as Mean ± SD"

Time (days)	Treatments				
	G1	G2	G3	G4	G5
0 Initial weight (mg)	**147. 8±15.63**	**147.8±15.63**	**147.8±15.63**	**147.8±15.63**	**147.8±15.63**
15	247.8±23.58	246.1±20.35	240.6±17.17	252.2±21.28	274.5±20.67
30	347.8±31.53	344.4±25.06	333.3±18.71	356.7±26.93	401.1±25.71
45	417.8±29.06	403.33±47.70	381.11±28.48	420.0±34.28	494.4±27.89
60	836.7±37.42	782.22±33.08	777.78±37.68	858.89±46.76	872.22±300.86
75	1207.8±122.86	1153.3±48.73	1202.2±79.18	1180.0±45.28	1557.8±114.32
90	1668.9±81.15	1598.9±80.69	1665.6±110.81	1622.2±90.25	1996.7±99.37
105	2275.6±374.04	1925.6±203.35	2023.33±152.48	1962.2±200.98	2827.8±413.58
120 final time (mg)	**2668±477.5**	**2733±618.9 ^{NS}**	**2800±608.79 ^{NS}**	**2954±795.3****	**3786±690.2 ****
WG (mg/fish)	**2520±107.29**	**2586±277.5^{NS}**	**2652.2±8.58 ^{NS}**	**2807±231.4****	**3638± 281.47****
DWG (mg/fish/day)	**21.0±0.89**	**21.6±2.31 ^{NS}**	**22.1±0.73 ^{NS}**	**23.4±1.93 ^{NS}**	**30.3±2.35 ^{NS}**
GW (%)	**1705.1±3.50**	**1781±94.3^{NS}**	**1795±74.05 ^{NS}**	**1925±265.6^{NS}**	**2470±286.26****
SGR (%/day)	**2.4± 0.02**	**2.4± 0.04 ^{NS}**	**2.5± 0.03 ^{NS}**	**2.5± 0.11 ^{NS}**	**2.7± 0.09 ^{NS}**
FI (mg/fish)	**5486.67**	**5006.67****	**5256.67***	**5500.00 ^{NS}**	**6340.00****
FCR	**2.18**	**1.94 ^{NS}**	**1.98 ^{NS}**	**1.79 ^{NS}**	**1.74****
FER	**0.46**	**0.52**	**0.50**	**0.51**	**0.57**
PER	**1.098**	**1.127**	**1.156**	**1.223**	**1.585**

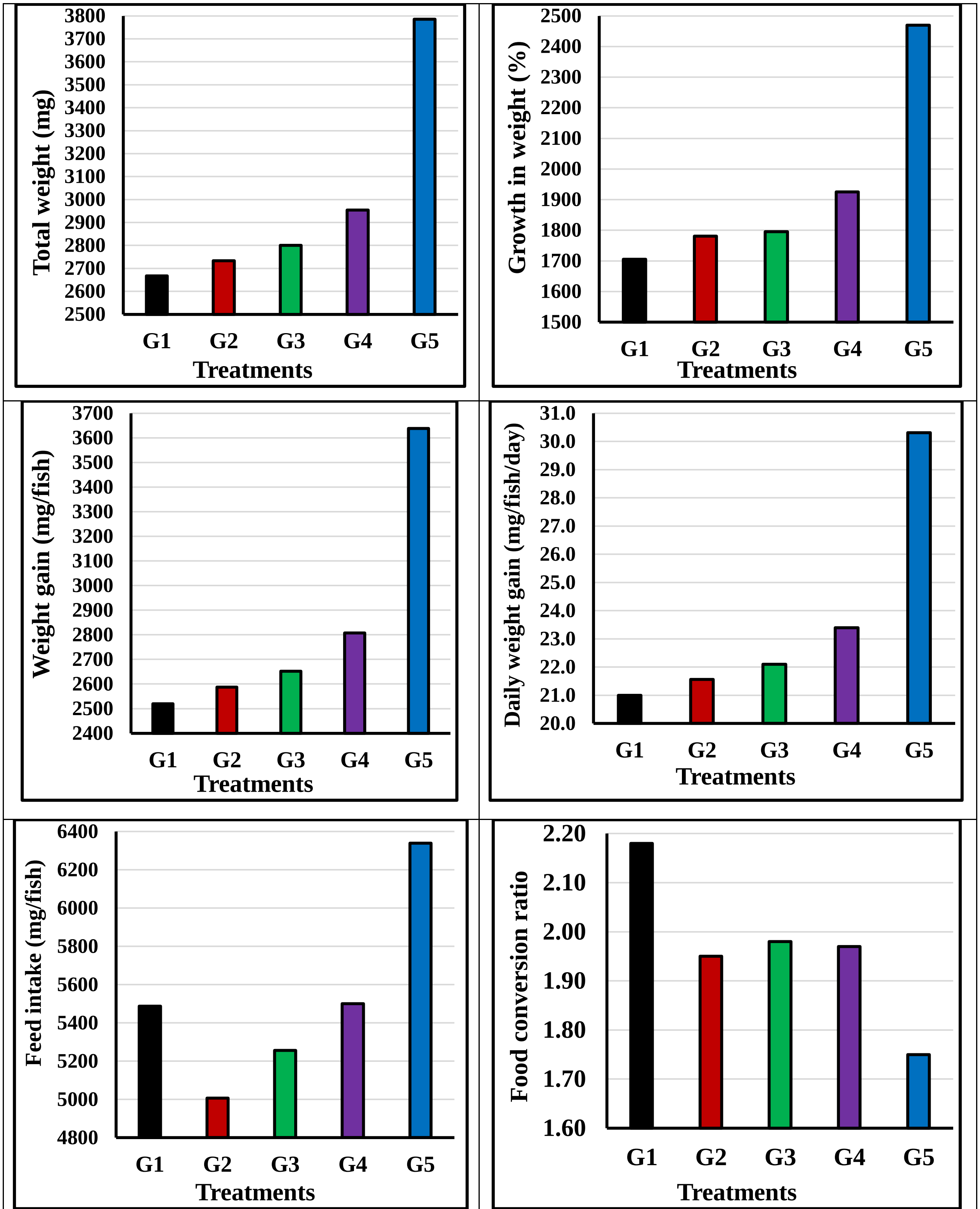

Fig. (3): The effect of fish meal replacement by zooplankton meal on different growth performance parameters in weight of sea bass, *D. labrax*, feed intake and food conversion ratio.

DISCUSSION

In the present study, the crude protein calculated for collected zooplankton mass, which was lower (66.54±1.18) than what calculated by **Mitra *et al.* (2007)** in CIFA farm at Kausalyaganga, Orissa, India. They reported that, all zooplankton community grown in freshwater earthen ponds, in the term of nutritional implication in nursery rearing of fish larvae and early juveniles contain crude protein ranged from 73% to 79%. **Suontama *et al*. (2007)** noted that crude protein for Antarctic krill (*Euphausia superba*), Arctic amphipod (*Themisto libellula*) and northern krill species (*Thysanoessa inermis*) ranged from 52.4 to 64.1%. **Kibria *et al*. (1997)** mentioned that, crude protein average of zooplankton was 63.04±10.70%, whereas **Proulex & Nove (1985)** stated that, the crude protein of zooplankton (*Daphnia magna*, *Scenedesmus sp*., *Artemia salina*) ranged from 44.3 to 60%.

The higher level of protein in copepods compared to rotifers could possibly lead to a higher muscular growth, since muscle-growth is a product of protein synthesis **(Liu & Xu, 2009)**. In the present study, the maximum growth performance averages for growth in length, length gain and daily length gain, growth in weight, total weight gains and daily gain and specific growth rate of *D. labrax* were recorded in G_5 and G_4; while the lowest averages were occurred in G_1 and G_2. The current results were higher than those mentioned by **Vartak & Singh (2009)** who found that, the length gain of *D. labrax* fed live food organisms as well as formulated diets was ranging from 15 to 23 mm with percentage ranging from 150 to 220% of the initial length. Also, **Mona *et al*. (2019)** found that this is consistent with the higher growth performance found for sea bream, *Sparus aurata* fish fry fed copepods.

The weight gain of the samples in treatments G_1, G_2, G_3 and G_4 were (2520, 2587, 2652 and 2807 mg) with weight gain percentage of (1705, 1781, 1795 and 1925%) respectively, while G_5 treatment was significantly gained the highest weight with 3637 mg and weight gain percentage exceeds 2469% during the period of the experiment. This result is higher than what mentioned by **Vartak & Singh (2009)** who feed the *D. labrax* on live food organisms as well as formulated diets, where this species gained from 200 to 330 mg weight.

In the present study, the specific growth rate ranged from 2.41 to 2.7% d^{-1} for all treatments, this result is higher than which reported in different waters bodies. **Groy *et al*. (2006)** mentiond that, the specific growth rate for *D. labrax* raised on diet containing pellet mill and twin screw extruder, **Pérez *et al*. (1997)** estimated it as 1.4 - 1.5% for *D. labrax* fed on fish meal and blood meal. **Ashour *et al*. (2018)** informed that, *O. niloticus* that grown on diet containing zooplankton with artificial diet has specific growth rate of 1.93% d^{-1}. On the other hand, our specific growth rate values were less than what mentioned (5.62% d^{-1}) by **Vartak & Singh (2009)** for Asian sea bass, *Lates calcarifer* grown on live food organisms and formulated diets.

The best feed conversion ratio (FCR) recorded in our results (1.74) was higher than that (0.96) observed by **Ashour *et al*. (2018)** for *Oreochromis niloticus* which reared on diet composed of zooplankton and artificial diet. Whereas **Olsen *et al*. (2006)** estimated it as 0.94-1.26 for *D. labrax* fed on Antarctic krill and *Euphausia superba* instead of fish meal. While protein efficiency ratio PER observed in our study (1.585) was lower (4.2) than that obtained by **Ashour *et al*. (2018).**

Conclusion: The growth performance parameters, the best food conversion ratio and high weight gain of *Dicentrarchus labrax* were positively correlated with high content of zooplankton (100% fish meal replacement).

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الملخص العربي

تأثير استبدال مسحوق السمك في علائق الأسماك بمسحوق الهائمات الحيوانية على معدلات أداء النمو لأسماك القاروص

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يهدف هذا البحث إلى تقييم تأثير استبدال مسحوق السمك في علائق الأسماك بمسحوق الهائمات الحيوانية على معدلات أداء النمو لأسماك القاروص (دايسنتراركاس لابراكاس). تم استخدام ٩٠٠ اصبعية من أسماك القاروص في هذه الدراسة والتي تم شرائها من مفرخ الاسماك بالكيلو ٢١ بالاسكندرية، ثم نقلت الى وحدة تربية الأسماك في محطة أبحاث المكس بالمعهد القومي لعلوم البحار والمصايد بالاسكندرية، مصر. بعد مرور اسبوعين من أقلمة الأسماك، تم تقسيمها الى ٥ مجموعات تجريبية، و ثلاث تكرارات لكل مجموعة (بواقع ٦٠ سمكة لكل تكرار وضعت في هابة داخل حوض خرساني ١م^{٣} (١٠٠*١٠٠*١٠٠ سم). غذيت كل مجموعة من الأسماك لمدة ١٦ أسبوع على عليقة خاصة. حيث غذيت المجموعة الضابطة على العليقة الأساسية، بدون استبدال مسحوق السمك بمسحوق الهائمات الحيوانية؛ المجموعة الثانية تم استبدال ٢٥% من مسحوق السمك في العليقة بمسحوق الهائمات الحيوانية؛ المجموعة الثالثة يتم استبدال ٥٠% من مسحوق السمك في العليقة بمسحوق الهائمات الحيوانية، المجموعة الرابعة يتم استبدال ٧٥% من مسحوق السمك في العليقة بمسحوق الهائمات الحيوانية والمجموعة الخامسة يتم استبدال ١٠٠% من مسحوق السمك في العليقة بمسحوق الهائمات الحيوانية.

أوضحت النتائج أن أعلى قيم لأداء النمو (النمو في الطول، زيادة الطول، الزيادة اليومية في الطول، النمو في الوزن، زيادة الوزن، الزيادة اليومية في الوزن ومعدل النمو النوعي) لأسماك القاروص سجلت جميعاً في أسماك المجموعة الخامسة التي غذيت على عليقة استبدل فيها ١٠٠% من مسحوق السمك بمسحوق الهائمات الحيوانية. كما كانت أقل قيم لهذة المعاملات في أسماك المجموعة الضابطة الخالية من مسحوق الهائمات الحيوانية. سجلت النتائج أيضاً أن أفضل معدل للتحول الغذائي (١.٧٥) ظهر في أسماك المجموعة الخامسة بينما اقل معدل للتحول الغذائي (٢.١٨) ظهر في أسماك المجموعة الضابطة أيضاً. استخلصت الدراسة أن استبدال مسحوق السمك في العليقة بمسحوق الهائمات الحيوانية قد أثر تأثيراً معنوياً على معدلات أداء النمو مما أدي لتحسين الاستفادة من الغذاء لأسماك القاروص. وأوصت الدراسة باستخدام هذه الطريقة في تغذية أصبعيات القاروص حيث أنها أقل تكلفة من الناحية الاقتصادية.