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Effect of some Protein Sources on White Shrimp Production under Lake Qarun Condition

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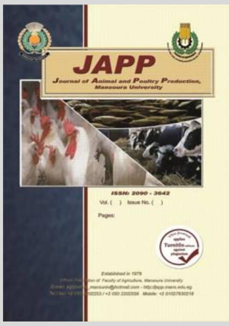

ABSTRACT

The present study was conducted at Shakshouk Fish Research Station, Fayoum Governorate, National Institute of Oceanography and Fisheries (NIOF), Egypt to investigate the effect of protein sources (fish meal (FM), meat meal (MM), and FM + MM and plant protein (corn gluten meal CGM)) on growth parameter, feed utilization, carcass chemical composition and economic efficiency. Pacific white shrimp (*Litopenaeus vannamei*) juvenile with an average weight of 3 ±0.13g initial body weight were randomly distributed into eight rectangular fiberglass tanks of 1.5 m^3 water capacity at a rate of 40 juveniles/ tank. The experment was carried out from 21 September 2019 and continued for 80 days. The result showed that, survival rate was within the range 86.25–97.50%, with significant differences were observed. The highest total weight gain, daily gain and SGR values were obtained with the FM diet compared with the other diets (FM+MM, MM and CGM).The best FCR (lowest) was recorded with shrimp fed on FM, with insignificant differences among (FM, MM and FM+MM).The worst FCR was recorded with shrimp fed on CGM. The lowest protein content was recorded with shrimp fed on CGM; also the highest content of EE was with (CGM) diet. The best net returned and economic efficiency was recorded with diets contained fish meal followed by diet contained fish meal + meat meal then meat meal and the least CGM.These results indicated that the best growth rate for shrimp was obtained with feeding FM diet then feeding on FM+MM and MM diets under experimental conditions.

***Keywords**:* Pacific white shrimp, protein sources, growth performance, feed utilization, carcass chemical composition, survival rate, economic efficiency.

INTRODUCTION

Interest with white leg shrimp Litopenaeus vannamei culture has increased globally and locally in recent years, and is an economically important shrimp farmed worldwide (Lu *et al.* 2015; FAO, 2015). With a global output of 4,156 000 tons in 2016 (FAO, 2018). It accounts for over 90 per cent of total world production of shrimp and is commonly farmed in many countries around the world. Growth in aquaculture has been possible thanks to scientific advances in culture technology, intensive cultivation practices under controlled environmental conditions (Marappan *et al.*, 2020).

Interest of *Penaeus vannamei* culture in Egypt has started recently due to the existence of many problems that it was facing, as mentioned by Megahed *et al.*, 2019 who reported that Egyptian marine shrimp suffering mass mortalities due diseases. The GAFRD with some stakeholders has directed their direction to the introduction of *Litopenaeus vannamei* from National Aquaculture Group (NAQUA; Saudi Arabia) from 2015, 2016 and ongoing for 2017 to use broodstock from previous years in addition to new introduction of post larvae of *Litopenaeus vannamei* from NAQUA. The production of 2015 and 2016 was not such encouraging on the economic level and the confirmation of EMS diseases and other shrimp viruses such as WSSV, IHHNV, YHV and TSV could be behind the low productivity and high mortality. However, after the establishment of modern hatcheries, these problems have lessened, and its cultivation has gradually started to spread, especially in the northern coast. Currently, there are more than five commercial hatcheries to produce them (Ghalioun Company - Harraz - Medhat Al Sharif - Sayed Abu Omar - Sharif Shams Al Din). Egypt produced 15103 ton from various species of shrimp most of them from natural fisheries only 135 ton from aquaculture (GAFRD, 2017).

Shrimp diet normally has a high amount of fishmeal to fulfill the requirements for protein and amino acid. However, the limited resources of fish meals cannot sustain the growing aquatic feed industry this makes searching for alternatives to fish meal very essential nowadays. Many studies have reported the substitution of fishmeal with other sources of protein, such as soya bean meal (Alvarez *et al.*, 2007; Sookying and Davis, 2011), bone and meat meal (Hernández *et al.* 2008), Protein concentrate for soya beans (Chen *et al.*, 2017; Xie *et al.* 2016).

Animal protein sources have better nutritional properties than vegetable sources: greater digestibility and a balance between essential / non-essential amino acids, lack of anti-nutritional factors and higher crude protein. The highest nutritional qualities of animal protein sources have been widely used to complement soybean meal, allowing higher levels of FM to be replaced by poultry and

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fish by products to flourish those that require a lower level of replacement (Sanchez-Muros *et al*., 2018).

Percentages of substitution were obtained with up to 50 per cent with the rice (Oujifard *et al*., 2012), canola (Suarez *et al*., 2009) and Cowpea (Aya *et al*., 2015) But hasn't reached 100%. Amaya *et al*. (2007) and Molina-Poveda *et al.* (2015a, b) achieved similar growth and productive performance to a white shrimp control diet fed a diet in which soy, millet and maize gluten meals were replaced by 100 percent FM, Suarez *et al*. (2009) achieved good growth and survival outcomes, and confirmed L. Vannamei could be fed with plant meals (70% soya bean/30% canola), thus reducing the amount of FM from 30 to 6 g/100 g dry weight (corresponding to an 80 % reduction). The growth decreases observed in experiments where FM was replaced with vegetable protein sources were attributed to the inadequate amino acid balance (Lim and Dominy, 1990). The combination of various vegetable meals enhances the profile of amino acids and dilutes the anti-nutritional compounds of each source by enabling greater substitution of FM if only one source is used.

The present study was aimed at investigating the possibility of shrimp cultivation on the water of Lake Qarun and determines the optimum protein source in the diet to achieve optimum growth and maximize economic efficiency.

MATERIALS AND METHODS

This research was conducted from 21 September 2019 and continued for 80 days at National Institute of Oceanography and Fisheries (NIOF), Shakshouk Research Station, Fayoum Governorate, Egypt. Pacific white shrimp (*Litopenaeus vannamei*) juveniles were obtained from Birket Ghalioun Aquaculture project, Kafr El-Skeik Governorate, where transported in plastic bags with oxygen and acclimatized to the laboratory conditions 14 days before random distribution eight rectangular fiberglass tanks of 1.5 m^3 water capacities. Shrimp juveniles of 3 ±0.13g initial body weight were stocked at 40 juveniles per tank, all tanks were permanently ventilated. The bottom of each tank was covered by a sand layer about 5 cm for shelter. Shrimp were held under natural photoperiod condition throughout the experimental period. The water used in the trials was obtained from Lake Qaroun. About 30% of water tanks were changed twice every week. At the beginning trials 25 shrimp were taken for body chemical analysis, 15 shrimp from each tank were randomly taken for body chemical analysis this is at the end of the experiment and Use both Fish meal, meat meal, corn gluten and soybean meal(protein sources), linseed oil and fish oil were used as a lipid source. Wheat flour was used as sources of carbohydrate, all ingredients obtained from local market. The experimental diets were (T1 fish meal (FM), T2 meat meal (MM), T3 FM+MM and plant protein PP (T4). Diets prepared by mixing water with dry ingredients. The pelleted diet was then developed via a 1.5 mm diameter meat mincer. The pellets were air-dried and stored at -20 ° C before use; the diets have been formulated to contain almost 40 per cent crude protein (Alava and Lim, 1983). Table 1 indicates the composition of the diets, Feed was offered by hand at two meals/day (9:00 and 14:00 h) for 6 days a week at 5% (Antunes *et al*. 2018) of body weight daily and the amount of diets were readjusted after each weighing (every 15 days). Feed Intake was reported daily. Sampling of all the experimental fish collected initial and final data for growth efficiency.

Statistical analysis

The experimental data were presented as mean. All data were analyzed using the Social Sciences Statistical (SPSS 2017) release 25.0 statistical software. To determine the statistical significance between groups, a one-way analysis of variance (ANOVA) and Duncan's multiple range tests were used. The significant differences at level P < .05 were determined.

Table 1. Chemical Composition of the experimental diets.

Items	Diets			
Ingredients, g/kg	T_1 FM	T_2 MM	T_3 FM+MM	T_4 CGM
Fish meal	334	0	170	0
Meat meal	0	365	185	0
Corn glutin meal	0	0	0	330
Soybean meal	408	416	400	415
Wheat flour	188	149	175	185
Linseed oil	50	50	50	50
Fish oil	10	10	10	10
Vit & Min. *	5	5	5	5
Calcium phosphate	5	5	5	5
Total	1000	1000	1000	1000
Chemical composition	(as fed, %)			
Dry matter, DM	90.41	90.10	91.05	90.78
Crude protein, CP	40.31	39.99	40.14	40.34
Ether extract, EE	9.62	9.48	9.60	7.78
Crude fiber, CF	3.74	4.37	4.01	5.75
Ash	9.88	5.56	7.73	7.89
Nitrogen free extract. NFE**	26.86	30.70	29.57	29.02
GE, kcal/g***	4.444	4.597	4.555	4.443
Prices of Kg, L.E	13.47	10.45	12.00	9.100

***Vit & Min: Each kg contains 2000000 IU vitamin. A, 400000 IU vitamin. D_3 , 4000 mg vitamin. E, 300 mg vitamin K_3, 200 mg vitamin B_1 , 800 mg vitamin B_2, 4000 mg nicotinic acid, 2.0 mg B_{12}, 2000 mg pantothenic acid, 300 mg vit. B_6, 200 mg folic acid, 10mg biotin , 100 mg choline chloride, 1600 mg Cu, 156 mg I, 6421 mg Fe, 12800 mg Mn, 9000 mg Zn, 32 mg Se and 53 mg cobalt.**

****Nitrogen free extract (NFE %) It was calculated by the formula = 100 – Crude protein – Crude lipid – Crude fiber – Crude ash.**

***** Gross energy was calculated according to NRC (1993) as 5.65 for crude protein, 4.11 kcal/g for carbohydrates and 9.45 crude fats.**

RESULTS AND DISCUSSIONS

The values of average water quality parameters was 28 to 33°C **(**temperature), 29 to 32‰ (salinity**)**, 5.3-6.8 Mg/L **(**dissolved oxygen) and 7.07 to 7.55 for ph**.** These parameters are within the optimum range for *Litopenaeus vannamei* recommended by Van-Wyk and Scarpa (1999).

Results of growth performance parameters and survival rate of shrimp fed on the different diets are indicated in Table 2. No significant difference was observed in the initial average length and weight of the shrimp among treatments. Survival % ranged 86.25–97.50%, with significant differences among experimental treatments. Concerning data in Table 2 the highest values (P≤0.05) of final weights were recorded with shrimp fed on FM. Shrimp fed the CGM diet recorded the lower values. The same trend was recorded for total weight gain, daily gain and SGR. These results indicated that FM diet under experimental conditions recommended to obtain the highest growth performance for *Litopenaeus vannamei* shrimp compared with other dietary protein sources may be due to its optimum essential amino acid, minerals and vitamins profile. These results are supported by some preceding studies (Carvalho *et al* 2016) Investigate several sources of protein such as Chilean fish meal (FM), soy protein concentrates (SPC), corn gluten meal (CGM) and meat and bone meal (MBM). They noticed high growth rates at all levels of inclusion: FM and low growth rates at higher levels of inclusion: PBM, CGM, MBM and showed impaired growth rates, especially for CGM and MBM.

Several studies regarding protein sources in the diet recorded a reduction on the growth of *L. vannamei* as the CGM level increased (Molina-Poveda *et al*.,2015), While the opposite was recorded for Plant protein meal (Cruz-Suárez *et al*.,2007),meat and bone meal (Forster *et al*.,2003).

These results agreed with the results of Molina-Poveda *et al.* (2015b) which found an inverse relationship between the increase of CGM levels and final weight, specific growth rates compared to those fed on the FM diet.

Survival is typically the final health predictor, survival in this study decreased with diets that include CGM or MM without FM. A shortage of one ingredient often results in lower survival rates Therefore, For this analysis, plant protein diets could be mainly responsible for lower shrimp-fed survival compare the FM diets.

Table 2. Effect of protein sources on growth performance and survival % of *Litopenaeus vannamei*.

Items	Protein sources				SED*
	T_1 FM	T_2 MM	T_3 FM+MM	T_4 CGM	
Initial length, cm	7.00	6.75	6.45	6.75	0.435
Final length, cm	12.30^{a}	11.30^{b}	12.05^{ab}	10.45^{c}	0.297
Initial weight, g	2.98	3.07	2.93	3.05	0.145
Final weight, g	11.21^{a}	9.29^{a}	9.87^{a}	6.78^{b}	0.783
Total weight gain,g/shrimp	8.24^{a}	6.23^{b}	6.94^{ab}	3.73^{c}	0.675
Daily gain, mg/ shrimp	102.94^{a}	77.88^{b}	86.75^{ab}	46.57^{c}	8.444
SGR, %/day	1.66^{a}	1.39^{b}	1.52^{ab}	0.99^{c}	0.071
Survival, %	97.50^{a}	93.75^{ab}	95.00^{ab}	86.25^{b}	3.750

- (a, b, c ..) Average in the same row having different superscripts differ significantly (P≤0.05).
*** SED is the standard error of difference**
FM, Fish meal. MM, Meat meal. PP, plant protein.

Feed utilization of *Litopenaeus vannamei*.

The results in Table 3 showed that significant differences (P≤0.05) were obtained in all feed utilization parameters among treatments, except the feed intake. The best FCR (lowest) was recorded with shrimp fed on FM, with insignificant differences among (FM, MM and FM+MM). The worst FCR was recorded with shrimp fed on CGM. PER and EER, values obtained for shrimp fed FM were relatively highest than those for the other feeds. PPV and EPV values were highest with shrimp fed FM compared to the other feeds.

The improvement in diets which contain fish meal or animal protein source generally may be due to the effect of fish meal, it has good nutrition profile and high digestibility (Bendiksen *et al.* 2011; Olsen and Hasan, 2012; Xie *et al.*, 2014). These results agreed with the results of Molina-Poveda *et al.* (2015b) they found major variations between dietary treatments in the FCR. The inclusion of CGM up to 8.6 per cent had a negative effect but similar FCRs were found in the diet of CGM25 and the diet of CGM0.

Table 3. Effect of protein sources on feed utilization of *Litopenaeus vannamei*.

Item	T_1 FM	T_2 MM	T_3 FM+MM	T_4 CGM	SED
Feed intake, g/shrimp	15.31	15.47	15.39	16.59	0.845
FCR	1.87^{b}	2.49^{b}	2.22^{b}	4.52^{a}	0.349
Protein utilization					
PER	1.34^{a}	1.01^{b}	1.13^{b}	0.55^{c}	0.057
PPV, %	22.71^{a}	18.72^{b}	16.28^{b}	6.42^{c}	1.78
Energy utilization					
EER	0.121^{a}	0.088^{b}	0.099^{b}	0.050^{c}	0.005
EPV, %	59.17^{a}	44.78^{b}	46.72^{b}	23.77^{c}	3.052

- (a, b, c ..) Average in the same row having different superscripts are differ significantly (P≤0.05).
*** SED is the standard error of difference**

Several plant proteins and other protein sources have been used to replace the FM, although over-substitution of FM has generally inhibited animal development, one of the possible explanations is animal nutrient sensing and metabolism is impaired after dietary FM has been reduced (Wang *et al*.,2016; Xu *et al*., 2016). The protein content of the dietary ingredients is generally the most important factor affecting shrimp efficiency, and the digestibility of protein is the first measure of shrimp availability. The nutritional content of dietary protein sources depends on the composition of amino acids and their digestibility (Molina-Poveda *et al*., 2015a).

Body chemical composition of *Litopenaeus vannamei*.

The results of body chemical composition at the beginning and end of the experiment are presented in Table 4. The results showed that insignificant differences (P≤0.05) were obtained in moisture, crude protein (CP), ash and gross energy (GE) of body composition at the end of the experimental period, however ether extract (EE) had significant differences. The lowest protein content was recorded with shrimp fed on CGM; also the highest content of EE was with (CGM) diet.

Table 4. Effect of protein sources on body chemical composition of *Litopenaeus vannamei*.

Items	Start	T_1 FM	T_2 MM	T_3 FM+MM	T_4 CGM	SED*
Moisture	73.29	76.55	74.49	76.89	77.37	3.097
CP	70.46	74.64	73.25	68.27	65.43	3.729
EE	9.53^{ab}	7.97^{b}	10.24^{ab}	10.33^{ab}	12.11^{a}	1.262
Ash	17.88	14.90	14.01	19.40	20.02	3.052
GE, kcal/g	4.79	4.86	5.00	4.74	4.75	0.105

- (a, b, c ..) Average in the same row having different superscripts are differ significantly (P≤0.05).
*** SED is the standard error of difference**

We believe that animal protein sources, particularly fish meal, have improved protein levels in the body As a result of balance their amino acids. High digestibility, excellent amino acid, and FM fatty acid profile make it an essential source of protein in shrimp feed (Katya *et al*, 2016; Tacon and Metian 2008). Also Yang *et al.* (2015) Assessed dietary replacement of FM with extruded soya meal (ESBM) of juvenile *L. vannamei*. The findings showed the crude lipid content of the entire shrimp body fed a diet of either 16.82% and 25.26% ESBM (high plant protein) Was substantially higher than those given with an ESBM diet of 4.28 per cent (p<0.05). On the other hand, it may explain low body protein ratio and high body fat ratio in CGM diets it is due to the digestion and absorption of carbohydrates. The ability to use carbohydrates as a source of energy varies from fish, shrimp, to terrestrial animals. Carbohydrates are less effective for fish and shrimp than terrestrial animals (Guo *et al*, 2006).

Economic efficiency:

Table 5 presents the economic efficiency parameters for the shrimp vannamei. The results showed that shrimp fed diets containing fish meal T_1, mixed T3 and meat meal T_2 respectively had the highest significant ($P \leq 0.05$) values in total feed costs, total outputs, net return and economic efficiency, compared with the CGM T_4. On the other hand, Substitute fish meal with meat meal or mixture of fish meal and meat meal were better than the CGM group. Similarly, there is no substantial difference (P 0.05) between fish meal replacement with meat meal or fish meal and meat meal mixture. Many feed, animal by product and microbial sources of protein have already been evaluated as potential substitutes for FM in shrimp feed (Ayisi *et al*. 2017). Protein is the most costly nutrient in realistic shrimp diets, of which fish meal (FM) is the most widely used source of protein in commercial feed (Oujifard *et al*. 2012). Fish meal in diet lead to increase final body weight and improved shrimp growth at harvesting resulted improved net returns than CGM diets.

Table 5. Effect of protein sources on economic efficiency of *Litopenaeus vannamei*.

Item / treatment	T_1 FM	T_2 MM	T_3 FM+MM	T_4 CGM	SED*
Feed Costs[1]	8.25^a	6.47^{bc}	7.39^{ab}	6.04^c	0.415
Other costs	10	10	10	10	
Total cost	18.25^a	16.47^{bc}	17.39^{ab}	16.04^c	0.415
Total output [2]	32.79^a	26.13^a	28.13^a	17.54^b	2.341
Net return[3]	14.54^a	9.66^a	10.74^a	1.5^b	2.008
Economic efficiency %[4]	79.67^a	58.65^a	61.76^a	9.35^b	11.400

*** SED is the standard error of difference**

1- Total feed costs per treatment = feed costs per one kg diet × feed intake.

2- Total outputs per treatment, LE = shrimp price × total shrimp production

3- Net return per treatment (LE) = total outputs – total costs .

4- Economic efficiency per treatment (%) = (net return / total costs) × 100.

Selling shrimp price = 75 L.E/ kg.

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تأثير بعض مصادر البروتين على إنتاج الجمبرى الابيض تحت ظروف بحيرة قارون

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أجريت هذه الدراسة بمحطة أبحاث أسماك شكشوك، محافظة الفيوم، المعهد القومي لعلوم البحار والمصايد. مصر في الفترة من 21 سبتمبر 2019 واستمرت لمدة 80 يومًا بهدف دراسة تأثير مصادر بروتين مختلفة (مسحوق السمك، مسحوق اللحم، مسحوق السمك واللحم، مصدر بروتين نباتي عبارة عن جلوتين الذره) علي كل من مظاهر النمو, معدل الإعاشة, التركيب الكيماوي للجسم وكفاءة الإستفادة من الغذاء لزريعة الجمبري الفانمي (*Litopenaeus vannamei*) مع عمل تقييم إقتصادي. استخدمت في هذه الدراسة زريعة الجمبري الفانمي بمتوسط وزن جسم 0.13g ±3 وتم توزيعها عشوائيا على ثمانية تانكات مستطيلة من الفيبرجلاس سعة 1.5 م 3 من المياه وبمعدل تسكين 40 حيوان/ التانك. أظهرت النتائج تراوح معدل البقاء بين 86,25٪ - 97,50٪ فيما سجلت عليقة مسحوق السمك أعلي قيم بالنسبة لوزن الجسم النهائي، الزيادة اليوميه، معدل النموالنوعي، أفضل معامل تحويل غذائي مقارنة بباقي المعاملات بينما سجلت العليقة المتضمنه جلوتين الذرة أسوء معامل تحويل غذائي. وبالنسبة للتحليل الكيماوي للجسم سجلت عليقة الجلوتين أقل محتوي من بروتين الجسم وأعلي معدل لدهون الجسم. وأظهرت نتائج التقييم الإقتصادي إرتفاع العائد والكفاءة الإقتصادية مع عليقة مسحوق السمك تلتها عليقة مسحوق السمك واللحم معا ثم عليقة مسحوق اللحم.

الكلمات الداله: الجمبري الأبيض – مصادر البروتين – اداء النمو – معدل البقاء – الكفاءة الإقتصاديه.