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Effect of feeding frequency and feeding time on growth performance, feed utilization efficiency and body chemical composition on Rabbitfish *Siganus rivulatus* fry and juvenile under laboratory condition

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ABSTRACT

The present study consisted of two trials that conducted to evaluate the feeding frequency and the feeding time on growth performance, feed efficiency and body composition of rabbitfish *Siganus rivulatus*, the fish fed on one diet (35% crude protein). The first trial was conducted on rabbitfish fry (initial weight 0.18 g ± 0.012) and consisted of different three treatments of feeding frequency, the first treatment the daily meal divided into two times, the second treatment the daily meal divided into three times and the third treatment, the meal was divided into four times.

The second trial was conducted on rabbitfish juvenile (initial weight 0.948 g ± 0.124) and consisted of different four treatments of feeding time. fish fed in two times the first treatment fed at 9am and 11am, the second treatment fish fed at 11am and 1pm, the third treatment fish fed 1pm and 4pm and the fourth treatment fish fed at 9am and 4pm. The statistical analysis of results indicated that, feeding frequency feeding time appeared significantly differences between the treatments in growth performance and feed utilization parameters. The total gain in weight and feed conversion ratio were affected by feeding frequency and feeding time. The results affirmed that, the third treatment (four time feeding /day) in the first trial and both the first and second treatments in the second trial were the best of the growth performance and feed utilization parameters.

Keywords: Rabbitfish, feeding frequency, feeding time, growth performance and feed utilization

INTRODUCTION

Marbled spinefoot rabbitfish *Siganus rivulatus* is a potential candidate for warm water marine aquaculture diversification (Lam, 1974).Rabbitfishes belong to the genus *Siganus* of the family siganidae (Woodland, 1990). Siganids are herbivorous marine and brackishwater fishes that are found throughout the indo-west pacific (Woodland, 1983), and the more common species are the objects of traditional subsistence and commercial fisheries throughout this region. There has been interest in the culture of these fishes in ponds or cages in several areas (Duray, 1990).

Rabbitfish are considered to be excellent food fish in many parts of the world especially in the eastern Mediterranean and indo-pacific regions (Lam, 1974) and are economically important and relatively easy to rear and thus considered suitable for aquaculture (Hara *et al*., 1986). Additionally, rabbitfish have a high market value in Eastern Mediterranean countries (Stephanou and Georgiou, 2000), invaded the eastern Mediterranean via the Suez canal.

Marbled spine foot rabbitfish *Siganus rivulatus* is one of the most important commercial marine fish in Egypt. Whereas Egypt production of rabbitfish was about

1363 ton in 2014, Mediterranean Sea took part in 822ton production, Red Sea (466 ton) and lakes (75 ton) according to (GAFRD, 2014) and also, In previous years, Lake Qaroun was developed by rabbitfish fry and appeared the first production in 2010 and reached this production about (1 ton), a maximum rabbitfish production of Lake Qaroun about 5ton obtained in 2012, (GAFRD, 2014).

The feeding regime has become diverse but the thumb rule of feeding stock at optimum level should be very economical so as to have savings in feed cost and the overall economic justification. (Webster *et al*., 1992).

The success of culturing fish depends on maximizing cost effective manner in the production process. It is known that inappropriate feeding practices in aquaculture may lead to over feeding which results in feed wastes in pond water and consequently higher production costs and contamination of aquatic environment. Meanwhile insufficient feeding lead to poor growth and high fish mortalities which make losses in the aquaculture business (Eroldogan *et al.,* 2006). As well as the amount of the daily feed intake, frequency and timing of the feedings and presentation of the predetermined ration are the key factors of feed management strategies, influencing the growth and feed conversion (Goddard, 1995 and Jobling, 1995). On the contrary, some studies (Robinson *et al.,* 1995 and Jarboe and Grant, 1996) reported that feeding time and feeding frequency did not significantly influence the weight gain, feed consumption, feed conversion ratio (FCR), and survival in a single-size catfish production unit.

Feeding frequency affectson fish growth (Wang *et al*., 1998, Lee *et al*., 2000, Zhou *et al*., 2002, Riche *et al*., 2004, Schnaittacher *et al*., 2005, Tucker *et al*., 2006 and Silva *et al*., 2007). as does feeding time (Sundararaj *et al*., 1982, Noeske and Spieler, 1984, Noeske*et al*., 1985, Reddy *et al*., 1994, Boujard *et al*., 1995). Together, feeding frequency, time and ration size play a determinant role in regulating feed intake, growth and waste outputs of fish (Silva *et al*., 2007).

The feeding frequency is one of the most important variables influencing growth and the feed conversion ratio in aquaculture husbandry practices (Biswas *et al*., 2010, Lee and Pham, 2010 and Aydin *et al*., 2012) and by controlling the optimum feeding frequency, farmers can successfully reduce the feed cost and maximize growth and also able to manage other factors such as individual size variation and water qualities which are deemed important in rearing of fish in culture conditions (Shearer, 1994).

The feeding behaviour of fish has been much studied, and there are many indications that the time of feeding affects growth, feed efficiency and body composition (see review by Bolliet *et al*., 2001). A number of studies have demonstrated that feeding time affects growth performance in fish (Baras *et al*., 1998). It has been suggested that the optimal feeding time to promote growth might correspond to the natural daily peak of feeding activity in any particular species.

The study aimed to determine the best feeding frequency and the optimum feeding time, giving the best growth performance and feed utilization of rabbitfish (*Siganus rivulatus*) fry and juvenile.

MATERIALS AND METHODS

The present study was conducted using the research facilities of Shakshouk Fish Research Station, Fayoum Governorate, National Institute of Oceanography and Fisheries (NIOF), Egypt. Rabbitfish (*Siganus rivulatus*) fry and juveniles were obtained in two groups, the first group (Fry) or the first trial fish from (Mediterranean

Sea) National Institute of Oceanography and Fisheries (NIOF), Alexandria Governorate-Egypt. The initial average weight **(W_1)** for this group 0.18 g ± 0.012 (SE standard error) and initial average length (L_1) 2.76 cm ±0.057 (in date 19/7/2015). The second group (juvenile) or the second trial fish was obtained from (Mediterranean Sea) Maadiaregion-Behaira Governorate- Egypt, initial average weight **(W_1)** for this group 0.948 g ± 0.124 (SE standard error) and initial average length (L_1) 3.97 cm ± 0.200 (in date, 7-8-2015).Two groups fish were acclimatized to be adapted to water salinity of Lake Qaroun 33 ‰ for one week before size sorting and removal of large and small fish.

Diet preparation

One artificial diet was formulated by hand and used in this study with the first trial and the second trial (Table 1), the diet formulated to be almost containing 35% crude protein.

Table 1: Ingredients and chemical analysis proximate of the experimental diet

Ingredients	**(g/100 g)**
Fish meal (72%CP)	**22**
Extruded full fat Soybean meal (37% CP)	**43**
Wheat bran minutes	**28**
Fish oil	**4**
Super yeast	**1**
Starch	**1.7**
Vit. & Min. & premix	**0.3**
Total	**100**
chemical analysis % on Dry matter basis	***As fed***
Moisture (M)	**6.94**
Dry matter (DM)	**93.06**
Crude protein (CP)	**36.44**
Ether extract (EE)	**13.78**
Crude fiber (CF)	**3.10**
Nitrogen free extract (NFE)	**39.02**
Ash	**7.66**
Gross energy (GE, Kcal/g)*	**5.09**
Protein / Gross energy (P/GE)	**7.16**

Notice: -Chemical analysiswas determined according to **(A.O.A.C, 1984)** and **NFE** was calculated by difference.
*Calculated according to **NRC (1993).**

The first trial: Effect of feeding frequency

This trial was one way began 25/7/2015 and ended 3/11/2015, (100 days). Average initial weight (W_1) of fry was 0.18±0.012g, initial average length (L_1) 2.76cm ± 0.05 and initial condition index (CI_i) was 0.85gcm^{-3}. It was conducted to investigate the effect of dividing meal on growth and feed efficiency**.**

Experimental tanks

The indoor rectangular tanks laboratory were made of fiberglass, this trial consisted of six tanks. The dimensions of each tank were 4m length, m width and 0.50m height and the water volume of each tank was 1.50m^3.

Trial design and distribution of fish in tanks

This trial consisted of three treatments, in the first treatment the daily meal divided into two times at 9 am and 4 pm, in the second treatment the daily meal divided into three times at 9 am,1pm and 4pm and the third treatment, the meal was divided into four times at 9 am, 11am, 1pm and 4pm. Fish fed on diet (35% CP)

Table (1) feeding rate was 7% of fish body weight and fish were stocked at 30 fish of each tank.

The second trial: Effect of feeding time

This trial was one way began 15/8/2015 and ended 17/11/2015, (95 days). Average initial weight (W_1) of juvenile was 0.948±0.124 g, initial average length (L_1) 3.97 cm ± 0.200 and initial condition index (CI_i) 1.51gcm^{-3}. It was conducted to know the optimum feeding time of rabbitfish juvenile during day.

Experimental tanks

The indoor circle tanks laboratory were made of fiberglass, this trial consisted of eight tanks. The dimensions of each circle tank was 1.75 m diameter and 0.70 m height, the water volume of each tank was 1.60m^3.

Trial design and distribution of fish in tanks

This trial consisted of four treatments to evaluate four different feeding times during day, where the first treatment fish fed in two times at 9am and 11am, the second treatment fish fed in two times at 11am and 1pm, the third treatment fish fed in two times 1pm and 4pm and the fourth treatment fish fed in two times at 9am and 4pm. Fish feeding on diet (35% CP) Table (1) at 5% of fish body weight and stocking density was 40 fish per tank.

Water exchange.

The water exchange was every two days and about 35% of water volume / tank as water exchange rate in the first and the second trails.

The system of running water in experimental units (tanks)

The system contained on water pump, sand filter unit and two large tanks (1000 liter/tank) used to storage the water at a point between the water source (Lake Qaroun water) and experimental tanks. The water pump was drowning the water from water source to the sand filter unit, hence to the large tanks and hence to experimental units.

The system of aeration in experimental units (tanks).

The system contained on air pump or blower connected to a network of plastic pipes this pipes transport the air to each tank, the air was controlled by tap of each pond or tank, and the air diffusers was used to distribute of air in all experimental unit trends.

Water quality of the indoor tanks laboratory (in the experimental units)

The water quality of the indoor tanks laboratory (in the experimental units) were measured of each trial. Temperature, pH, salinity and EC were measured daily at 1pm; dissolved oxygen (DO) was measured every week and Nitrite (NO_2), Nitrate (NO_3), Ammonia (NH_4) were measured every two weeks. By centigrade thermometer; Orion digital pH meter model 201; Refractometer (VITAL Sine SR-6, China); Conductivity meter model (YSI.SCT-33) and oxygen meter (Cole Parmer model 5946) respectively. While NO_2, NO_3 and NH_4were measured by the chemical methods according to (Mullin and Riley, 1955 and APHA, 1992).

Measurements of growth performance and some of the internal organs

Final condition index (CI_f), Total weight gain (TG), average daily gain (ADG), Relative growth rate (RGR), specific growth rate (SGR), survival rate (SR), hepatosomatic index (HSI), viscerosomatic index (VSI), feed intake g/ fish (FI), feed conversation ratio (FCR), feed conversation efficiency (FCE), protein efficiency ratio (PER), protein productive value (PPV), energy efficiency ratio (EER), energy productive value (EPV) and lipid retention (LR).

The parameters were calculated according the following equations:

$(CI_f) = (W_2/ L^3_2) \times X$ Whereas, W_2:is final weight, L_2: is the final length of fish in cm and X: is a constant equal to 100 (Anderson and Gutreuter, 1983), TG, g = final weight (W_2)-initial weight (W_1), ADG, g/day = average weight gain, g / experimental period, day, RGR, % = $[(W_2 - W_1) / W_1] \times 100$, SGR, % /day = $[(\ln W_2 - \ln W_1)/t] \times 100$ whereas ln: is the natural log. and t: is the time in days, SR% = (Number of fish at end/ Number of fish at start) × 100, (HSI) = (liver weight/body weight) ×100 and (VSI) = (weight of viscera and associated fat tissue/body weight) ×100.

Measurements of feed utilization efficiency

FI, g/fish feed intake during the trial period/ the final number of fish for this trial, FCR = feed intake, g / weight gain, g., FCE, % = (weight gain, g./ feed intake, g) × 100, PER= Weight gain, g/ Protein intake, g., PPV, % = (Retained protein, g/ Protein intake, g) × 100, EER = Weight gain, g/ Energy intake, Kcal, EPV, % = (Retained Energy, Kcal/ Energy intake, Kcal) × 100, LR, % = (Retained lipid, g/ lipid intake, g) × 100.

Chemical analysis of feeds and whole fish body

The conversional chemical analysis of diet and whole body fish samples were carried out as described by (A.O.A.C, 1984) and Gross energy (GE) estimated For formulated diets the factors 5.64, 9.44 and 4.11 Kcal/g for CP, EE and carbohydrates respectively were used (NRC, 1993), for fish 5.5 and 9.5 Kcal/g for protein and fat respectively (Viola *et al.*, 1981).

Statistical analysis

The analysis of variance and LSD of Duncan Waller were used to compare treatment means. Data were analyzed using stat graphic package software (SPSS, 2007) SPSS Inc. Released 2007. SPSS for Windows, Version 16.0. Level of significant was 0.05.

RESULTS AND DISCUSSION

The first trial: Effect of feeding frequency

Water quality of the first trail

Water quality parameters recorded in this experiment are shown in Table (2). The averages of water temperature, water pH, water salinity, electrical conductivity (EC), dissolved Oxygen, and nitrite (NO_2), nitrate (NO_3), ammonia (NH_4) values in all treatments were within the acceptable limits for rabbitfish (*Siganus rivulatus*) fry as reported by (Westernhagen and Rosenthal, 1975, Huguenin and Colt, 1989,Meade, 1989, Davis, 1993,Lawson, 1995 ,ANZECC, 2000, EPA, 2003, Saoud *et al.*, 2007a and Saoud *et al.*, 2008).

Table 2: Means (±SE) of water quality parameters

Items	**Treatments(feeding frequency)**		
	(T1)Two times	**(T2)Three times**	**(T3)Four times**
Temperature (°C)	26.310±0.262	26.560±0.825	26.600±0.456
pH	7.935±0.485	8.240±0.210	8.235±0.205
Salinity ‰	32.610±0.810	32.590±0.910	32.680±0.980
ECmS/cm*	47.050±0.050	47.000±0.500	47.450±0.100
DO mg/l	6.290±1.110	6.795±0.605	6.235±1.16
NO_2 mg/l	0.198±0.001	0.196±0.003	0.192±.002
NO_3 mg/l	0.282±0.008	0.277±0.002	0.279±0.006
NH_4**mg/l**	0.091±0.003	0.092±0.005	0.090±0.020

*,mS/cm, millisiemens/centimeter

Effect of feeding frequency on growth performance of rabbitfish (*Siganus rivulatus*) fry:

The averages of final length (L_2, cm), final condition index (CI_f, gcm^{-3}), final weight (W_2, g), total gain in weight (TG, g), daily gain (ADG, g), relative growth rate (RGR, %) specific growth rate (SGR/day %) , survival rate (SR%), hepatosomatic index (HSI, %) and viscerosomatic index (VSI, %)are shown in Table (3) The statistical analysis of results indicated that, feeding frequency appeared significantly differences at level (0.05) between the third treatment and both the first and second treatments in growth performance parameters (W_2, g), (TG, g), (ADG, g/ day), (RGR, %)and (SGR/day, %). Whereas, the third treatment was better than the second and first treatment. No significant differences between the treatments of (L_2, cm), (SR, %), (HSI, %) and (VSI, %); but (L_2, cm) in the third treatment was the best comparable to other treatments and (SR, %) was lowest with the firs treatment comparable to other treatments.

Table 3: Effect of feeding frequency on growth performance of rabbitfish (*Siganus rivulatus*) fry.

Items	Treatments(feeding frequency)			SED*
	(T1)Two times/day	(T2) Three times/day	(T3) Four times/day	
Initial weight (W_1), g	0.18	0.18	0.18	-
(L_2), cm	7.41	7.55	7.72	0.20
(CI_f, gcm^{-3})	1.20	1.17	1.32	0.08
(W_2), g	4.92^b	5.07^b	6.08^a	0.104
(TG), g	4.74^b	4.88^b	5.90^a	0.109
(ADG), g/day	0.047^b	0.048^b	0.058^a	0.001
(RGR),%	2633.30^b	2713.80^b	3280.50^a	57.82
(SGR/day, %)	3.30^b	3.33^b	3.51^a	0.022
(SR, %)	83.33	100	93.33	5.44
some of the internal organs parameters				
(HSI, %)	2.18	2.00	2.40	0.64
(VSI, %)	18.52	20.51	21.36	3.26

(a, b) Average in the same row having different superscripts significantly different at ($P \leq 0.05$).
*, SED is the standard error of difference

However, the statistical analysis don't appear significantly differences between the second treatment and the first treatment, but the second treatment parameters (W2, g, TG, g, ADG, g, RGR, % and SGR/day, %) were higher than the first treatment parameters. These results cleared the positive effect of feeding frequency and increased feeding frequency resulted in greater growth for several fish species such as rainbow trout, *Salmo gairdneri* (Grayton and Beamish, 1977); Arctic charr, *Salvelinus alpines* (Jobling 1983), common carp, *Cyprinus carpio* (Charles *et al*., 1984); juvenile halibut, *Hippoglossus hippoglossus* L., (Schnaittacher *et al.,* 2005) and goldfish, *Carassius auratus* (Priestly *et al*., 2006).These results in agreement with Daudpota *et al*. (2016) reported that, the optimum feeding frequency of juvenile Nile tilapia (from initial body weight of 1.0 g to 5.8 g) is four times daily, Haruna *et al*. (2014) reported that, four times per day feeding frequency had the best growth performance for the culture of *Clarias gariepinus*. Significantly ($p<0.05$) best growth was obtained in the 6 times a day treatment of Nile tilapia fingerlings (Pouomogne and Ombredane, 2001).As well as Barakat *et al.* (2011) found that, feeding rabbitfish three times daily is better than feeding them once or twice daily and also improves muscle ultrastructure and quality.

In the same trend, many of studies confirmed the positive effect of feeding fequancy such as (Sultana *et al*., 2001, Turker, 2006, Choobkar, 2008 and Habib *et al*., 2014). The positive effect of feeding frequency on growth performance of some fish may be due to fish juveniles uptake a high daily diet ratio to meet their nutritional requirement, thus they ingest adequate amount of diet. High feeding frequency results in high daily diet intake ratio and small amounts of diet per feeding (Sanches and Hayashi, 2001).

Furthermore, under optimal temperatures such as those used in the present experiment (Saoud *et al.*, 2008), gastric evacuation rates are rapid and fish require more than one feeding per day. As well as feeding once a day did not show any worsening of the growth performance of South American catfish due to higer feed storage capacity in the stomach for a prolonged period (Carneiro and Mikos, 2005). In generally feeding frequencies plays an important role in the keeping on water quality and reduce the uneaten feed, which affects water quality negatively. Feed losses and poor water quality decrease the feed efficiency. (Kurtkaya and Bilguven, 2015).

In contrast, the results were at variance with Gokcek *et al.* (2008) who reported that weight gain and growth performance of Himri Barbel, *Barbusluteus,* fry were decreased with increased feeding frequency. Mizanur and Bai1 (2014) suggest that, a feeding frequency of 1 meal/day was optimal to improve weight gain in growing Korean rockfish grown from 93 to 133 g at a water temperature of 15°C, and from 100 to 132 g at 19°C.

Effect of feeding frequency on Feed utilization efficiency of rabbitfish (*Siganus rivulatus*) fry:

Feed intake (FI, g/fish), feed conversion ratio (FCR), feed conversion efficiency (FCE, %) protein efficiency ratio (PER), protein productive value (PPV, %), energy efficiency ratio (EER), energy productive value (EPV, %) and lipid retention (LR, %) were shown in Table (4). The results indicated that, no significant differences of feed intake (FI) between the treatments but the first treatment (T1) had the highest (12.58 g/fish) in FI.

Significant differences in all treatments of other parameters, (FCR, FCE, PER, PPV, EER, EPV, and LR) were found, the third treatment (T3) was the best of all treatments in this parameters and achieved better FCR than T2 and T1 while T2 was the better than T1 in parameters of feed utilization efficiency.

Table 4: Effect of feeding frequency on feed utilization efficiency of rabbitfish (*Siganus rivulatus*) fry.

Items	Treatments (feeding frequency)			SED*
	(T1)Two times	(T2)Three times	(T3)Four times	
(FI, g/Fish)	12.58	10.52	12.02	0.950
(FCR)	2.56^{a}	2.13^{b}	2.02^{b}	0.126
(FCE, %)	37.67^{b}	46.86^{ab}	50.25^{a}	3.730
Protein utilization				
(PER)	1.03^{c}	1.28^{b}	1.35^{a}	0.014
(PPV, %)	51.19^{b}	73.10^{a}	75.41^{a}	0.816
Energy utilization				
(EER, g/Kcal)	0.074^{c}	0.091^{b}	0.096^{a}	0.001
(EPV, %)	43.69^{c}	52.61^{b}	56.75^{a}	0.013
Lipid utilization				
(LR, %)	91.40^{c}	92.72^{b}	105.02^{a}	0.327

(a, b and c) Average in the same row having different superscripts significantly different at level ($P \leq 0.05$).

*SED is the standard error of difference

The results cleared that the third treatment (T3) was the best of the feed utilization parameters, this results agree with Haruna *et al.* (2014). They reported that, four feeding times gave the best result in terms of feed conversion ratio (FCR) and other growth indices. This referred that, both growth and feed utilization were most efficient at high feeding frequency; Daudpota *et al.* (2016) reported that, fish fed the four and five times daily showed significantly higher (P<0.05) in feed conversion ratio (FCR) and PER. than the other groups. This result was also confirmed by Sultana *et al.* (2001) where they found that, the least FCR value was observed in the treatment where the fish fed with a feeding frequency of four times in a day.

The protein efficiency ratio (PER) of the present study followed the opposite trend to FCR values, significantly (p<0.05) the highest PER was produced with treatment (four times feeding per day). Thus a feeding schedule of four times a day seemed to be optimum resulting a good growth and may be suggested as a recommended frequency for culture of *Cyprinus carpio.* In addition, Choudhury *et al.* (2002) cleared that, the protein utilization capacity of *Labeorohita* fish at four and six times feeding frequency was higher than two times. Tung and Shiau (1990) stated that, the best FCR was achieved with 6 meals per day feeding. In the same trend, many of studies confirmed the positive effect of feeding frequency on FCR (Josekutty and Jouse, 1996, Jarboe and Grant, 1997, Golden *et al*., 1997 and Poumogne and Ombredane, 2001).

On the contrary Jarboe and Grant (1996) and Dada *et al.* (2002) found no significant influence of feeding frequency on FCR in different fish species. Obe and Omodara (2014) reported that, there was no significant difference between food conversion however, the best feed conversion ratio was achieved by the fish fed at one time a day while poorest feed conversion ratio was recorded with the fish fed at three times daily. Moreover, Kurtkaya and Bilgüven (2015) reported a non-linear relationship between FCR and feeding frequency, and highest FCR was obtained in group of fish fed at sixtimes daily.

Hence, the first treatment (T1) was the worst in feed utilization efficiency parameters, this lead to overfeeding of fish, which can overload the stomach and intestine, leading to decreases in digestive efficiency and reductions in feed utilization (Hung and Lutes, 1987, Storebaken and Austreng, 1987).

Effect of feeding frequency on body chemical composition and energy content of whole body rabbitfish (*Siganus rivulatus*) fry:

Body chemical composition and energy content of whole body rabbitfish (*Siganus rivulatus*) fryat the beginning and the end of the experimental period are shown in Table (5) Moisture (M), dry matter (DM), crude protein (CP) and ether extract (EE) contents of fish whole body were significantly (P≤0.05) affected by feeding frequency. The highest protein content in fish body at the end of the experimental period was obtained with the second treatment (T2) (56.57) followed by (T3) (55.81) and (T1) (49.59) respectively. While, (T1) had the highest lipid value (32.56) followed by (T3) and (T2) (28.90, 26.63) respectively. Ash content and gross energy (GE, Kcal/g) of fish whole body at the end of the experimental period were insignificantly (P≤0.05) affected by feeding frequency.

From Table (5), it can be observed that, CP value increased with increasing feeding frequency unlike EE value which decreased with increasing feeding frequency, this may be agree with (Obe and Omodara, 2014) and disagree with (Daudpota *et al.,* 2016).

Table 5: Effect of feeding frequency on body chemical composition and energy content (on DM basis) of whole body rabbitfish (*Siganus rivulatus*) fry.

Items	Start	Treatments (feeding frequency)			SDE*
		(T1)Two times	(T2)Three times	(T3)Four times	
(M, %)	80.70	69.79^{c}	71.10^{a}	70.33^{b}	0.014
(DM, %)	19.30	30.21^{a}	28.90^{c}	29.59^{b}	0.044
(CP, %)	50.17	49.59^{c}	56.57^{a}	55.81^{b}	0.014
(EE, %)	9.75	32.56^{a}	26.63^{b}	28.90^{ab}	1.280
Ash, %	34.57	15.07	17.23	16.59	3.300
(GE, Kcal/g)	3.68	5.82	5.64	5.82	0.122

(a, b and c) Average in the same row having different superscripts significantly different at level ($P \leq 0.05$).

*, SED is the standard error of difference

The second trial: Effect of feeding time

Water quality of the second trail

Water quality parameters recorded in this experiment are shown in Table (6). The averages of water temperature, water pH, water salinity, electrical conductivity (EC), dissolved Oxygen, and nitrite (NO_2), nitrate (NO_3), ammonia (NH_4) values of all treatments were within the acceptable limits for rabbitfish (*Siganus rivulatus*) juvenile as reported by (Westernhagen and Rosenthal, 1975, Huguenin and Colt, 1989, Meade, 1989, Davis, 1993, Lawson, 1995, ANZECC, 2000, EPA, 2003, Saoud *et al*., 2007a and Saoud *et al*., 2008).

Table 6: Means (±SE) of water quality parameters

Items	**Treatments (Feeding at)**			
	(T1) 9am-11am	**(T2) 11am-1pm**	**(T3) 1pm-4pm**	**(T4) 9am-4pm**
Temperature (°C)	26.315±0.350	26.287±0.343	26.303±0.352	26.390±0.360
pH	8.095±0.292	8.112±0.312	8.030±0.263	8.010±0.271
Salinity, ppt (‰)	33.800±0.256	33.888±0.233	33.750±0.210	33.803±0.293
EC, ms/cm*	47.900±0.050	47.950±0.010	47.400±0.080	47.602±0.028
DO, mg/l	6.546±0.441	6.550±0.445	6.480±0.460	5.083±1.184
NO_2, mg/l	0.192±0.006	0.193±0.002	0.195±0.003	0.194±0.001
NO_3, mg/l	0.277±0.001	0.276±0.001	0.274±0.004	0.275±0.002
NH_4 **mg/l**	0.885±0.003	0.881±0.001	0.884±0.004	0.883±0.003

*mS/cm, millisiemens/centimeter

Effect of feeding time on growth performance of rabbitfish (*Siganus rivulatus*) juvenile:

The comparison of growth performance of rabbitfish juvenile (*Siganus rivulatus*) is shown in Table (7). The averages of (L_2, cm), ($CI_{f,\ g/cm^3}$), final weight (W_2, g), (TG, g), (ADG, g), (RGR, %) (SGR/day %) and (SR, %) were significantly affected by feeding time, the first treatment (T1: feeding at 9am, 11am) and the second treatment (T2: feeding at 11am, 1pm) were superior than the fourth treatment (T4: feeding at 9am, 4pm) and the third (T3: feeding at 1pm, 4pm) in all growth parameters (W_2, g), (TG, g), (ADG, g/day), (RGR, %) (SGR/day %) whereas, T1 was the highest in these parameters compared to other treatments it recorded 6.28, 5.33, 0.056, 562.23 and 1.99 respectively. Also, the T4 was the better than T3 in this parameters.

There was significant difference in (L_2, cm) the T1 had highest (L_2, cm: 7.90) followed by the T2, T4 and T3. The T2 had highest (SR, %:87.5) followed by the T1, T4 and T3.

Table 7: Effect of feeding time on growth performance of rabbitfish (*Siganus rivulatus*) juvenile

Items	Treatments (Feeding at)				SED*
	(T1) 9am-11am	(T2) 11am-1pm	(T3) 1pm-4pm	(T4) 9am-4pm	
(W_1), g	0.948	0.948	0.948	0.948	-
(L_2), cm	7.90^a	7.86^a	6.92^c	7.67^b	0.0440
(CI_f)	1.27^a	1.28^a	1.11^b	1.15^b	0.0126
(W_2), g	6.28^a	6.22^a	3.71^c	5.20^b	0.0707
(TG), g	5.33^a	5.27^a	2.76^c	4.25^b	0.0316
(ADG), g/day	0.056^a	0.055^a	0.029^c	0.044^b	0.0030
(RGR),%	562.23^a	555.90^b	291.13^d	448.31^c	0.0316
(SGR/day, %)	1.99^a	1.98^a	1.43^c	1.79^b	0.0140
(SR, %)	85^{ab}	87.5^a	62.5^c	82.5^b	0.9350

(a, b and c) Average in the same row having different superscripts significantly different at level ($P \leq 0.05$).
*, SED is the standard error of difference

The results in Table (7) cleared that, no significant difference between the (T1) and the (T2) in all growth parameters except (RGR, % and SR, %). On the other hand, (T3) was the lowest of all treatments in all growth parameters and the worst of all treatments. These results affirm that the morning feeding or feeding in the before noon influenced positively on growth performance compared with the feeding in the afternoon at (1 pm, 4pm); and also it can be observed decrease in feed intake gradually from the morning though mid-day. Hence, appeared a detrimental effect on growth performance of the (T3) which took their meals in the afternoon and (T4) which took the second meal in the afternoon also. This reason may be related to relatively low temperature degree at the before noon and was supported by Ani *et al.* (2013)who reported that, the growth performance of the fish, feed intake of fish is controlled by three factors which are the environmental factor, the fish physiological factor and the feed factors, Kasumya (1995), Wynne *et al.* (2005) and NRC (2009) reported that, the environmental factors in relation to feeding time and water physico-chemical quality have a marked impact on the feed intake of the fish as they can affect the fish physiological endowment capable of creating all sort of stress and neuro-endocrinological imbalance. These results are in agreement with the findings of Noeske and Spieler (1984). Timing the dailymeal may be a valuable tool for aquaculture. Noseke *et al.* (1985) reported that feeding time affected weight gain and fat deposition in channel catfish and are in partial agreement with Bolliet *et al.* (2000) who found that, rainbow trout fish fed the low energy (6% lipid) diet at 09:00 hours tended to have a better growth performance and had a better nutrient retention efficiency than those fed at19:00 hours and trout fish fed at dawn have a higher post-prandial increase in metabolic rate than those fed at night, which may lead to a higher amount of protein available for growth. In addition, it has been previously suggested that the effect of feeding time on growth performance might fluctuate depending on season, fish size and ration (Baras *et al.,* 1998 and Azzaydi *et al.,* 1999).

Likewise, the best growth was observed in rainbow trout fed at dawn, poorest growth in those fed at midnight, and growth rates of fish fed at mid-day or dusk were intermediate (Boujard *et al.,* 1995). However, the results differ with Harpaz *et al.* (2005) who found that, the feeding time factor had almost no effect on fish growth rate. Asian sea bass appear to consume food whenever it is fed, even during the night. Robinson *et al.* (1995) reported that, no differences in weight gain and feed consumption by fish fed at different times of the day. Also Verbeeten *et al.* (1999) referred to greenback flounder fish consumed significantly more feed in the evening than in the morning.

Effect of feeding time on Feed utilization efficiency of rabbitfish (*Siganus rivulatus*) juvenile:

The results of feed utilization parameters are shown in Table (8). The results were significantly affected by the feeding time; there were significant differences at level ($P \leq 0.05$) between the averages in feed intake, FCR, FCE %, PER, PPV%, EER, EPV% and LR%. The results of feed utilization parameters were the best with (T1) and (T2) compared with (T4) and (T3). Results showed that, FI (g/fish), FCR, FCE%, PER, PPV%, EER , EPV% and LR% for the (T1) 12.96, 2.43, 41.12, 1.12, 61.93, 0.080, 49.96 and 98.34, (T2) 13.02, 2.47, 40.47,1.10, 59.23, 0.080, 49.14 and 100.35.The statistical analysis don't appear significantly differences at level ($P<0.05$) between the (T1) and (T2) except FI of (T1) which was lower than FI of (T2), LR,% of (T1) which was lower than LR,% of (T2) and FCE, % of (T1) which was higher than FCR,% of (T2).

Table (8) Effect of feeding time on Feed utilization efficiency of rabbitfish (*Siganus rivulatus*) juvenile

Items	Treatments (Feeding at)				SED*
	(T1) 9am-11am	**(T2)11am-1pm**	**(T3) 1pm-4pm**	**(T4) 9am-4pm**	
(FI, g/Fish)	12.96^{c}	13.02^{b}	14.98^{a}	12.84^{d}	0.0186
(FCR)	2.43^{c}	2.47^{c}	5.42^{a}	3.02^{b}	0.0316
(FCE, %)	41.12^{a}	40.47^{b}	18.42^{d}	33.09^{c}	0.0187
Protein utilization					
(PER)	1.12^{a}	1.10^{a}	0.50^{c}	0.90^{b}	0.0707
(PPV, %)	61.93^{a}	59.23^{a}	26.88^{b}	60.00^{a}	3.5355
Energy utilization					
(EER, g/Kcal)	0.080^{a}	0.080^{a}	0.036^{c}	0.065^{b}	0.0014
(EPV, %)	49.96^{a}	49.14^{b}	22.33^{d}	40.92^{c}	0.0186
Lipid utilization					
(LR, %)	98.34^{b}	100.35^{a}	45.76^{d}	84.57^{c}	0.0187

(a, b , c and d) Average in the same row having different superscripts significantly different at level ($P \leq 0.05$).
*, SED is the standard error of difference

Table (8) cleared that, the best FCR was obtained with (T1) and (T2) followed by (T4) while (T3) obtained the worst FCR in all treatments. In general (T1, T2) were better than (T4) in the feed utilization efficiency parameters while (T3) was the poorest in the feed utilization efficiency parameters. The morning or the before noon feeding affected positively on the feed utilization efficiency parameters, this is due to fish were fed in time or time relevant after a long hungry period resulting in increase of the feed utilization efficiency parameters. This results in partial agreement with Modde and Ross (1983) who showed that the stomach volume of wild juvenile pompano rose throughout the morning and peaked in the early afternoon, Heilman and Spieler (1999) reported that, feeding activity occurred throughout the light period with an extreme peak in the early morning, and addition to the feeding activity peaked at dawn and progressively lessened during the rest of the light period.

Bolliet *et al.* (2000) said that, the post-prandial protein synthesis was also higher in fish fed in the morning than in those fed at the beginning of the night. In the same trend Ge´lineau *et al.* (1996) showed that trout fed at dawn had higher protein retention efficiency and better growth than trout fed at midnight, even when both groups ingested the same amount of feed.

These results were at variance with Jarboe and Grant (1996) reported that feeding time or frequency was found not to influence, FCR, of the larger catfish and Robinson *et al.* (1995) supported that, time of feeding had no significant impact on feed consumption, feed conversion. Moreover, Verbeeten *et al.* (1999) indicated that, the feeding time had no effect on feed consumption and over the range of feed consumption rates measured, feed efficiency became significantly lower at higher rations when the flounder fish were fed in the morning.

Hence, it can be say, the effect of feeding time on growth and the feed efficiency rely on fish behavior, fish species, fish size, season, ration and the water quality (Reddy *et al*, 1994, Baras *et al*., 1998 and Azzaydi *et al*., 1999).

Effect of feeding time on body chemical composition and energy content of whole body rabbitfish (*Siganus rivulatus*) juvenile:

Body chemical composition and energy content of whole body rabbitfish (*Siganus rivulatus*) juvenile at the beginning and the end of the experimental period are shown in Table (9). Moisture (M), dry matter (DM), crude protein (CP) and ash contents of fish body whole body were significantly (P≤0.05) affected by feeding time; whereas , the (T1) had the highest CP(55.91) followed by (T3: 55.35), (T4: 55.20) and (T2: 54.69) respectively. The (T3) had the highest ash (15.99) followed by (T2: 14.55, T1: 14.34 and T4:12.67).

Table 9: Effect of feeding time on body chemical composition and energy content (on DM basis) of whole body rabbitfish (*Siganus rivulatus*) juvenile.

Items	Start	Treatments (Feeding at)				SED*
		(T1)9am-1am	(T2)11am-pm	(T3)1pm-4pm	(T4)9am-4pm	
(M, %)	81.48	71.94^{a}	71.10^{b}	70.95^{c}	69.36^{d}	0.013
(DM, %)	18.52	28.06^{d}	28.90^{c}	29.05^{b}	30.64^{a}	0.031
(CP, %)	62.02	55.91^{a}	54.69^{d}	55.35^{b}	55.20^{c}	0.018
(EE, %)	11.78	29.75	30.75	28.48	30.93	1.562
Ash, %	24.03	14.34^{ab}	14.55^{ab}	15.99^{a}	12.67^{b}	1.021
(GE, Kcal/g)	4.53	5.90	5.93	5.75	5.97	0.151

(a, b , c and d) Average in the same row having different superscripts significantly different at level (P≤0.05).
* SED is the standard error of difference

However, ether extract (EE) contents and gross energy (GE, Kcal/g) of fish whole body at the end of the experimental period were not significantly at level (0.05) affected by feeding time.

CONCLUSION

The results concluded that, growth performance and feed utilization efficiency of rabbitfish fry and juvenile were affected by feeding frequency and feeding time whereas, increased feeding frequency has been shown to positive effect and improve the growth of rabbit fish fry. The results of first trial cleared that, the best growth and feed utilization were obtained with four times feeding a day. In the second trial the feeding time affected also on the growth and feed utilization whereas the feeding efficiency in the morning was better than the before noon feeding and the before noon feeding was better than the afternoon feeding. Results of this trial confirmed that, the worst feeding time at 4 pm and the best feeding time at 9 am, the first treatment (feeding time at 9am and 11 am) and the second treatment (feeding time at 11am and 1 pm) were better than the fourth treatment (feeding time at 9 pm and 4 am) and the third treatment (feeding time at 1pm and 4pm) in growth performance and feed utilization of rabbitfish juvenile.

REFERENCES

Anderson, R.O. and Gutreuter, S. J. (1983). Length, weight and associated structural indices. In: Fisheries Techniques (Ed. by L.A. Nielson and D.L. Johnson).American Fisheries Soc. Bethesda, MD, USA. pp. 283-300.

Ani, A. O.; Okpako, B. A. and Ugwuowo, L. C. (2013). Effect of feeding time on the performance of juvenile African catfish (*Clarias gariepinus,* Burchell 1822). Online J. Anim. and Feed Res., 3:143-148.

ANZECC (2000). (Australian and New Zealand Environment and Conservation Council) and ARMCANZ (Agriculture and Resource Management Council of Australia and New Zealand), Australian Guidelines for Water Quality Monitoring and Reporting. National Water Quality Management Strategy Paper No. 7, ANZECC and ARMCANZ, Canberra.

A.O.A.C, (1984). Official Methods of Analysis. S. Williams (Ed). Association of Official Analytic Chemists, Inc. Arlington, Virg. USA.

APHA (1992).Standard Methods for the Examination of Water and Waste water, 18^{th} edition. American Public Health Association, Washington, D.C.1268.

Aydin, I.;Ak, O., Kucuk, E., Polat, H. and Ceylan, B. (2012). Optimum temperature and growth performance of hatchery reared black Sea flounder (*Platichthys flesus luscus* Pallas, 1814). Turk. J. Vet. Anim. Sci., 36:101–106.

Azzaydi, M.; Martinez, F.J., Zamora, S., Sanchez- Vazquez, F.J. and Madrid J.A. (1999).Effect of meal size modulation on growth performance and feeding rhythms in European sea bass (*Dicentrarchus labrax* L.).Aquacult.,170: 253–266.

Barakat, A.; Roumith, R., Abd El-Meguid, N. E., Ghanawi, J. and Saoud, I. P. (2011).Feed regimen affects growth, condition index, proximate analysis and myocyte ultrastructure of juvenile spine foot rabbitfish (*Siganus rivulatus*). Aquacult.Nutr.*,*17: 773–780.

Baras, E.; Tissier, F., Westerloppe, L., Melard, C. and Philippart, J.C. (1998).Feeding in darkness alleviates density dependent growth of juvenile vundu catfish (*Heterobranchus longifilis*). Aquat. Living Resour*,* 11: 335–340.

Biswas, G.; Thirunavukkarasu, A. R., Sundaray, J. K. and Kailasam, M. (2010). Optimization of feeding frequency of Asian seabass (*Lates calcarifer*) fry reared in net cages under brackishwater environment. Aquacult., 305: 26-31.

Bolliet, V.; Azzaydi, M. and Boujard, T. (2001). Effects of feeding time on feed intake and growth. In: Boujard, T., Jobling, M., Houlihan, D. (Eds.) Food intake in fish. Blackwell Sci. Oxford, UK, pp. 233–249.

Bolliet, V.; Cheewasedtham, C., Houlihan, D., Gélineau, A. and Boujard, T. (2000).Effect of feeding time on digestibility, growth performance and protein metabolism in the rainbow trout (*Oncorhynchus mykiss*) interactions with dietary fat levels. Aquat. Living Resour. 13: 107–113.

Boujard, T.; Gelineau, A. and Corraze, G. (1995). Time of a single daily meal influences growth performance in rainbow trout (*Oncorhynchus mykiss* Walbaum). Aquacult. Res.*,* 26:341–349.

Carneiro, P.C.F. and Mikos, J.D. (2005).Feeding frequency and growth of silver catfish (*Rhamdia quelen*) fingerlings. Ciência Rural, *35:*187-191.

Charles, P.M.; Sebastian, S.M., Raj, M.C.V. and Marian, M.P. (1984).Effect of feeding frequency on growth and food conversion of (*Cyprinus caprio*) fry.Aquacult., 40:293–300.

Choobkar, N. (2008).The effects of feeding frequency on FCR and SGR factors of the fry of rainbow trout (*Oncorhynchus mykiss*) Researsh and Farming Techniques. Aquacult. Asia Magazine, 39-40.

Choudhury, B. B. P.; Das, D. R., Ibrahim, M. and Chakraborty, S. C. (2002). Relationship between feeding frequency and growth of one Indian Major carp (*Labeo rohita* Ham.) Fingerlings fed on different formulated diets. Pakistan J. Biol. Sci., 5: 1120-1122.

Dada A. A.; Fagbenro, O. A. and Fasakin, E.A. (2002). Determination of optimum feeding frequency for (*Heterobranchus bidorsalis*) fry in outdoor concrete tanks. J. Aquacult. in the tropics., 17: 167-174.

Daudpota, A. M.; Abbas, G Kalhoro, I. B., Shah, S. S., Kalhoro, H., Hafeez-ur-Rehman, M. and Abdul Ghaffar, A. (2016).Effect of Feeding Frequency on Growth Performance, Feed Utilization and Body Composition of Juvenile Nile Tilapia (*Oreochromis niloticus* L.)Reared in Low Salinity Water. Pakistan J. Zool., 48:171-177.

Davis, J. (1993). Survey of Aquaculture effluents permitting and standards in the South. Southern Regional Aquaculture Centre, SRAC publication no 465 USA, 4PP.

Duray, M.N. (1990). Biology and culture of siganids. Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, iloilo, Philippines.

EPA (2003). The Environment Protection (Water Quality) Policyían overview, both the overview and a copy of the Water Quality Policy with an accompanying explanatory report are available on the EPA web site-www.epa.sa.gov.au/pub.html-or call (08) 8204 2004.

Eroldogan, O.T.; Kumlu, M. Kiris G.A. and Sezer, B. (2006). Compensatory growth response of *Sparus awrata* following different starvation and refeeding protocols. Aquaculture Nutr., 12: 203-210.

GAFRD (2014). Fish statistics year book.24th Edition, General Authority for Fish Resource Development, Agriculture ministry, Egypt.

Ge´lineau, A.; Me´dale, F. and Boujard, T. (1996). Effect of feeding time on postprandial nitrogen excretion and energy expenditure in rainbow trout, J. Fish Biol., 52: 655–664.

Goddard, S. (1995). Feed Management in Intensive Aquaculture. Chapman and Hall, New York, 194p.

Gokcek, C. K.; Mazlum Y. and Akyurt, I. (2008).Effect of Feeding Frequency on the Growth and Survival of Himri Barbel (*Barbus luteus* Heckel, 1843) Fry under Laboratory Conditions. Pakistan J. Nutr., 1: 66-69.

Goldan, O.; Popper, D. and Karplus, I. (1997).Management of size variation in juvenile gilthead sea bream (*Sparus aurata*), I: particle size and frequency of feeding dry and live food. Aquacult.,152: 181-190.

Grayton, B.D. and Beamish, F. H. (1977). Effect of feeding frequency on food intake, growth and body composition of rainbow trout (*Salmo gaidneri*).Aquacult.,11: 159-172.

Habib, M. A.; Sharker, Md. R., Rahman, Md. M. Ahsan, Md. E. and Pattadar, S. N. (2014). Effects of feeding frequency on growth and survival in fry of gold fish (*Carassius auratus,* Hamilton) in outdoor rearing system. Int. J. Fisheries and Aquat. Studies, 4:97-102.

Hara, S; Kohno, H. and Taki, Y. (1986). Spawning behavior and early life history of the rabbitrish, Siganus guttatus, in the laboratory. Aquacult., 59: 273-285.

Harpaz, S.; Hakim, Y., Barki, A., Karplus, I., Slosman, T. and Eroldogan. O. T. (2005). Effects of different feeding levels during day and/or night on growth and brush-border enzyme activity in juvenile (*Lates calcarifer*) reared in freshwater re-circulating tanks. Aquacult., 248:325–335.

Haruna, M. A.; Muhd, I. U., Ahmad, M. K. and Umar, R. (2014).Evaluation of different feeding frequanceis on growth performance and feed utilization of (*Clarias gariepinus*, Burchell, 1822). Fingerlings buyer. J. Pure and Appl. Sci., 7:142 – 144.

Heilman, M. J. and Spieler, R. E. (1999). The daily feeding rhythm to demand feeders and the effects of timed meal-feeding on the growth of juvenile Florida pompano (*Trachinotus carolinus*). Aquacult.,180:53–64.

Huguenin, J. E., and Colt. J. (1989). Design and Oper- ating Guide for Aquaculture Seawater Systems. Elsevier,Amsterdam,Dev. Aquacult. Fish. Sci., 20: 264p. Hung, S.S.O. and Lutes, P.B. (1987). Optimum feeding rate of hatchery-product juvenile white sturgeon (*Acipenser transmontanus*) at 20°C.Aquacult., 65: 307-317.

Jarboe, H. H. and Grant , W. J. (1996).Effects of Feeding Time and Frequency on Growth of Channel Catfish (*Zctalurus punctatus*) in Closed Recirculating Raceway Systems. J. world aquacult. Soc., *27:* 235-239.

Jarboe, H.H., Grant, W.J. (1997). The influence of feeding time and frequency on the growth, survival, feed conversion, and body composition of channel catfish (*Ictalurus punctatus*) cultured in a three-tier, closed, recirculating raceway system. J. Appl. Aquacult., *7:* 43-52.

Jobling, M. (1995). Fish Bioenergetics. Chapman and Hall, London, 309p.

Josekutty, P. A. and Jose, S. (1996). Optimum ratino size and feeding frequency for rearing of (*peneaus monodon*). Fabricus fish Technol. Soc. Fish Technol. India, 33: 16-20.

Kasumya O. A. (1995). Olfactory and Gustatory Responsibility of Young Sturgeon and Paddle Fish to Natural and Artificial Diurnal Stimuli. Proceeding of International Symposium on Acipenserid. VNIRO Publishing Moscow. pp 22-33.

Kurtkaya, G. and Bilguven, M. (2015). The Effects of Feeding Frequency on Growth Performance and Proximate Composition of Young Nile Tilapia (*Oreochromis niloticus* L.). J. Agric. Facul. Uludag Uni., *1:* 11-18.

Lam, T. J. (1974).Siganids: their biology and mariculture potential. Aquacult., 3: 325-354.

Lawson, T. B. (1995). Fundamentals of Aquacultura Engineering. New York: Chapman and Hall, 355p.

Lee, S. M. and Pham, M. A. (2010).Effects of feeding frequency and feed type on the growth, feed utilization and body composition of juvenile olive flounder (*Paralichthysolivaceus*).Aquacult.Res.,*41: 166–171.*

Lee, S. M.; Cho, S. H.and Kim, D. J. (2000).Effects of feeding frequency and dietary energy level on growth and body composition of juvenile flounder, (*Paralichthys olivaceus* Temmink and Schlegel). Aquacult. Res., 31: 917–923.

Meade, J. W. (1989). Aquaculture Management. New Branch. York: Van Nostrand Reinhold.

Mizanur, R. M. and Bai1, S.C. (2014). A Review of the Optimum Feeding Rates and Feeding Frequency in Korean Rockfish (*Sebastes schlegeli*) Reared at Seven Different Water Temperatures. Fish Aquat. Sci*., 17:*229-247.

Modde, T. and Ross, S.T. (1983). Trophic relationships of fishes occurring within the surf zone habitat in the northern Gulf of Mexico. Northeast Gulf Sci., 6:109-120.

Mullin, J.B. and Riley, J.P. (1955). The spectrophotometric determination of nitrate in natural waters, with particular references to see water.Analytica, chemical ACTA., 12: 464-480.

Noeske, T. A. and Spieler, R. E. (1984).Circadian Feeding Time Affects Growth of Fish. Transaction of the American Fisheries soci., 113: 540-544.

Noeske-Hallin, T. A.; Spieler, R.E., Parker, N.C., Suttle, M. A.(1985). Feeding time differentially affects fattening and growth of channel catfish. J. Nutr. *115:* 1228–1232

NRC (1993). National Research Council, Nutrient requirements of fish. National Academy Press, Washington D.C., USA.

NRC (2009). National Research Council , Predicting Feed Intake of Food Production Animals. In the National Academics Home Board of Agriculture (BOA), National Academy of Science Washington DC 20001. pp 7-24.

Obe, B. W. and Omodara, G. K. (2014).Effect of Feeding Frequency on the Growth and Feed Utilization of Catfish Hybrid (*Heterobranchus bidorsalis X Clarias gariepinus*) Fingerlings. J. Agric. and Environ. Sci., 3:09-16.

Pouomogne, V. and Ombredane, D. (2001). Effect of feeding frequency on the growth of tilapia (*Oreochromis niloticus*) in earthen ponds, *TROPICULTURE,* 19:147-150.

Priestly, S.M.; Stevenson, A.E. and Alexandar, L.G. (2006). The influence of feeding frequency on growth and body condition of the common goldfish (*Carassius auratus*). American Society for nutrition. J. Nutr., *136:*1979S–1981S.

Reddy, P. K.; Leatherland, J.F., Khan, M. N. and Boujard, T. (1994). Effect of the daily meal time on the growth of rainbow trout fed different ration levels. Aquacult. Int., 2: 165–179.

Riche, M.; Oetker, M., Haley, D.I., Smith, T. and Garling, D.L. (2004) Effect of feeding frequency on consumption, growth, and efficiency in juvenile tilapia (*Oerochromis niloticus*).Israeli J. Aquacult.Bamidgeh,*56:* 247–255.

Robinson, E. H.; Jackson, L. S. and Li, M. H. (1995). Effect of Time of Feeding on Growth of Channel Catfish. J. world aquacult.soc., 26:320-322.

Sanches, L.E.F. and Hayashi, G.(2001). Effect of feeding frequency on Nile tilapia (*Oreochromis niloticus,* L.) fries performance during sex reversal in hapas. Maringa, *23:*871–876.

Saoud, I. P.;Mohanna, C. and Ghanawi, J. (2008).Effects of temperature on survival and growth of juvenile spine foot rabbitfish (*Siganus rivulatus*). Aquacult. Res., 39: 491-497.

Saoud I. P.; Kreydiyyeh, S., Chalfoun, A. and Fakih, M. (2007). Influence of salinity on survival, growth, plasma osmolality and gill Na-K-ATPase activity in the rabbitfish (*Siganus rivulatus*). J. Exp. Mar. Biol. Ecol., 348:183–190.

Schnaittacher, G.; King, V.W. and Berlinsky, D.L. (2005). The effects of feeding frequency on growth of juvenile Atlantic halibut (*Hippoglossus hippoglossus* L). Aquacult. Res.*,* 36:370–377.

Shearer, K.D. (1994). Factors affecting the proximate composition of cultured fishes with emphasis on salmonids. Aquacult.*,*119: 63-88.

Silva, C. R.; Gomes, L. C. and Brandao, F. R. (2007). Effects of feeding rate and frequency on Tambaqui (*Colossoma macropomum*) growth, production and feeding costs during the first growth phase in cages. Aquacult., 264:135–139.

SPSS (2007). Statistical Package For Social Science (for Windows). Release 16 Copyright ©, SPSS Inc., Chicago, USA.

Stephanou, D. and Georgiou, G. (2000). Recent Experiences on the Culture of Rabbitfish (*Siganus rivulatus*) in Cyprus. CIHEAM-IAMZ, Zaragoza, pp. 95-301.

Storebaken, T. and Austreng, E. (1987). Ration level for salmonids. Growth, survival, body composition, and feed conversion in Atlantic salmon fry and fingerlings. Aquacult., 60: 189-206.

Sultana, S. M.; Das M. and Chakraborty, S. C. (2001).Effect of feeding frequency on the growth of common carp (*Cyprinus carpio* L.) fry, Bangladesh J. Fish. Res., 5: 149-154.

Sundararaj, B. I.; Nath, P. and Halberg, F. (1982). Circadian meal timing in relation to the lighting schedule optimizes catfish body weight gain. J. Nutr., 112:1085–1097.

Tung P.H. and Shiau, S.Y. (1990).Effects of meal frequncy on growth performance of hybrid tilapia (*Oreochromis niloticus* x *O. aureus*) Feed different carbohydrate diets. Aquacult., 92: 343-350.

Turker, A. (2006).Effects of Feeding Frequency on Growth, Feed Consumption, and Body Composition in Juvenile Turbot (*Psetta maxima* Linnaeus, 1758) at Low Temperature. Turk. J. Vet. Anim. Sci., 30: 251-256.

Tucker, B. J.; Booth, M. A., Allan, G.L., Booth, D. and Fielder, D. S. (2006).Effect of photoperiod and feeding frequency on performance of newly weaned Australian snapper (*Pagrus auratus*). Aquacult., 258:514–520.

Verbeeten, B. E.; Carter, C.G. and Purser, G. J. (1999).The combined effect of feeding time and ration on growth performance and nitrogen metabolism of greenback flounder. J. Fish Biol., 55:1328–1343.

Viola, S.; Malady, S. and Rappaport, U. (1981).Partial and complete replacement of fish meal by soybean meal in feeds for Intensive culture of carp. Aquacult., 26:223-236.

Wang, N.; Hayward, R. S. and Noltie, D. B. (1998).Effect of feeding frequency on food consumption, growth, size, variation, and feeding pattern of age-0 hybrid sunfish. Aquacult., 165:261–267.

Webster, C. D.; Tidwell, J. H. and Yancey, B. A. (1992). Effect of Protein Level and Feeding Frequency on Growth and Body Composition of Cage Reared Channel Catfish. Prog. Fish culture, 54: 92-96.

Westernhagen, H. M. and Rosenthal, H. (1975). Rearing and spawning siganids (Pisces: Teleostei) in a closed sea water system. Helgol. Wiss. Meeresunters, 27:1-18.

Woodland, D.J. (1983). Zoogeography of the Siganidae (Pisces) and interpretation of distribution and richness pattern. Bulletin of Mar. Sci., 33:713-717.

Woodland, D.J. (1990).Revision of the fish family Siganidae with descriptions of two new species and comments on distribution and biology. Indo-Pacific Fishes, No. 19 Bernice Pauahi Bishop Museum, Honolulu, Hawaii.

Wynne, K., Stanley, S., McGowan, B. and Bloom, S. (2005). Appetite Control. J. Endocrinol., 291-318.

Zhou, Z., Cui, Y., Xie, S., Zhu, X., Lei, W., Xue, M. and Yang, Y. (2002).Effect of feeding frequency on growth, feed utilization, and size variation of juvenile gibel carp (*Carassius auratus* gibelio). J. Appl. Ichthyol., 19:244-249.

ARABIC SUMMARY

تأثير عدد مرات التغذية ووقت التغذية على مظاهر النمو ، كفاءة الأستفادة من الغذاء والتركيب الكيميائى للجسم لزريعة وصغار أسماك السيجان (البطاطا) تحت ظروف المعمل

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اشتملت هذه الدراسة على تجربتين لتقييم تأثير عدد مرات التغذية ووقت التغذية خلال النهار على مظاهر النمو وكفاءة الاستفادة من الغذاء لأسماك السيجان (البطاطا) وغذيت أسماك التجربتين بعليقة واحده (٣٥% بروتين خام). أجريت التجربة الأولى على زريعة السيجان بوزن ابتدائى ٠,١٨±٠,٠١٢جرام وغذيت الاسماك فى ثلاثة معاملات مختلفة، المعاملة الاولى قسمت الوجبة على فترتين حيث غذيت الاسماك فى التاسعة صباحا والرابعة عصرا، المعاملة الثانية غذيت الاسماك ثلاثة مرات يوميا فى التاسعة صباحا والواحده ظهرا والرابعة عصرا والمعاملة الثالثة غذيت الأسماك أربع مرات يوميا فى التاسعة صباحا والحادية عشر صباحا والواحده ظهرا والرابعة عصرا وجدت إختلافات معنوية بين المعاملات وزيادة عدد مرات التغذية أثرت ايجابى على نمو الأسماك والكفاءة الغذائية فكانت التغذية على أربع مرات يوميا أفضل المعاملات.

أجريت التجربة الثانية لأختبار وقت التغذية المناسب خلال النهار على صغارأسماك السيجان بوزن ابتدائى ٠,٩٤٨±٠,١٢٤جرام وغذيت الأسماك مرتين فى أربع معاملات مختلفة، أسماك المعاملة الأولى غذيت الساعة التاسعة صباحا والحادية عشر صباحا، المعاملة الثانية غذيت الساعة الحادية عشر والواحدة ظهرا ، المعاملة الثالثة غذيت الواحدة ظهرا والرابعة عصرا والمعاملة الرابعة غذيت التاسعة صباحا والرابعة عصرا أظهرت نتائج هذه التجربة فروق معنوية بين المعاملات وأكدت زيادة استفادة الأسماك المغذاه فى الصباح او قبل الظهر وكانت المعاملة الثالثة أسوأ المعاملات تاثيرا على النمو والكفاءه الغذائية.

ومن ذلك يمكن التوصية بتقسيم الوجبة الغذائية لأسماك السيجان على اربع دفعات وأن التغذية فى الصباح أفضل من التغذية بعد الظهر.