EFFECT OF STOCKING DENSITY ON GROWTH PERFORMANCE AND FEED UTILIZATION OF SEA BASS (*Dicentrarchus labrax*) IN CAGES SUSPENDED ON NATURAL POND

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ABSTRACT:

Stocking density is considered a priority topic in aquaculture research due to its bearing on the welfare of farmed fish and the need for future recommendations governing stocking density management on fish farms. This study was carried out to investigate the growth performance and feed utilization response of sea bass (*Dicentrarchus labrax*) to different stocking densities. Two duplicate groups of sea bass (mean BW=32.83 g) were reared in six cages (2 m^3 each) suspended at natural pond with a proximate area of 20 hectare at three stocking densities (30, 45 and 60 fish/m^3 equal to 1.0, 1.5 and 2.0 kg/m^3) for 225 days.

Significant differences ($P \leq 0.05$) on final fish weight, weight gain and daily gain were observed. Fish reared at the highest densities (60/m^3) had the lowest mean final body weight (225 g) while those of the lowest densities (30/m^3) showed the highest mean final body weight (270 g) while (45/m^3) are in between. The differences between the lowest and higher density was 20%. A similar tendency was observed for SGR, 0.85 and 0.92 in the highest and lowest densities, respectively.

Significant difference in FCR were observed groups ranging from 2.76 to 3.24 by about 17% between the lowest and highest density. Survival rate was insignificantly ($P \leq 0.05$) affected and was around 96% independently of the density and the period. Part of the mortality observed was due to fish jumping out of cages and other part after sampling**.** Regarding economic efficiency the net returns of cage improved with increasing density and the best net returns was observed with the density 45/m^3 followed by densities 60 and 30 fish/m^3 respectively.

In conclusion the best density was 45 fish/m^3 which improved by 33% than the lowest density (30 fish/m^3, one kg/m^3) and 17% than the highest density (60 fish/m^3, 2.0 kg/m^3) for economical evaluation.

Key words: Sea bass, growth performance, feed utilization and economic evaluation

INTRODUCTION:

European sea bass (*Dicentrarchus labrax*) is one of the most important species cultured in the European Union with an annual production around 51,000 tons at year 2006, **(FAO, 2007).** Wide competition among producing countries in the Mediterranean area (such as Greece, Italy and Turkey) and mainly reared through intensive techniques in both flow-through land-based systems and sea cages with stocking densities around 35–50 kg/m^3 **(Lemarié *et al*., 1998; Paspatis *et al*., 2003).** There is increasing interest from farming industries, retailers and consumers to investigate the quality differences between cultured and wild fish **(Prescott and Bell 1992; Webster *et al*. 1993; Sylvia *et al*. 1995; Alasalvar *et al*. 2001, 2005).**

Effect of stocking density on growth performance was illustrated by many authors different in densities used/m^3 but all of them used recirculation intensive system **(Lemarié *et al*., 1998; Paspatis *et al*., 2003, Lupatsch *et al*., 2010, Wedemeyer, 1997; Ashley, 2007, Ellis *et al*., 2002; Turnbull *et al*., 2005; North *et al*., 2006).** No references are available about production of sea bass under natural system in cages on lacks or sea.

The great importance of stocking density in achieving the aims of the controlled production of several fish species has been reported by several investigators **(Kilambi *et al*., 1977; Papoutsoglou *et al*., 1979, 1980, 1987, 1990; Carr and Aldrich, 1982; Holm *et al*., 1990; Pickering, 1990, Christiansen *et al*., 1992; Jorgensen *et al*., 1993).** In most of the fish species so far investigated, an inverse correlation between growth rate and stocking density has been found due to decreased food utilization **(Carr and Aldrich, 1982; Mackintosh and De Silva, 1984; Papoutsoglou *et al*., 1987, 1990).**

Stocking density is widely recognized as a critical husbandry factor in intensive aquaculture because it represents a potential source of chronic stress, which may affect physiology and behaviour of farmed fish **(Wedemeyer, 1997; Schreck *et al*., 1997; Ellis *et al*., 2002).** However, highly intensive recirculation systems of densities up to 100 kg/m^3 are being developed **(Blancheton, 2000).** It has been demonstrated that rearing at inappropriate stocking densities may impair the growth, reduce immune competence and induce abnormal behaviour **(Procarione *et al*., 1999; Irwin *et al*., 1999; Montero *et al*., 1999; Ellis *et al*., 2002; Iguchi *et al*., 2003; Barcellos *et al*., 2004; Kristiansen *et al*., 2004; Schram *et al*., 2006).**

Generally high density is considered as a potential source of stress, with a negative effect on fish growth rate **(Lefrançois *et al*., 2001)** and survival and feeding rates **(Rowland *et al*., 2006).**

European sea bass *Dicentrarchus labrax* show phase inversion in their feeding rhythms on a seasonal basis: fish which were diurnal in summer and autumn, changed to nocturnal in winter, and returned to being diurnal in later spring **Sa´nchez-V´azquez *et al*., 1998.**

Daily feed intake and specific growth rate decreases were observed at increasing density levels on several species such as Atlantic cod (*Gadus morhua* L.) **(Lambert and Dutil, 2001)**, brook charr (*Salvelinus fontinalis*) **(Vijayan and Leatherland, 1988),** gilthead sea-bream (*Sparus aurata*) **(Canario *et al*., 1998)** and largemouth bass (*Micropterus salmoıdes*) **(Petit *et al*., 2001).**

The aim of this work is to study the possible production of sea bass under Fayoum conditions for first time in cages on Rayyan lack under different stocking densities.

MATERIALS AND METHODS:

This study investigated the effect of stocking density on growth performance and feed utilization of sea bass reared in cages under natural water condition. It started on 25/9/2008 till 8/5/2009, a proximally 225 days in Rayyan region Fayoum Governorate.

Sea bass fingerlings were obtained from El-Wafaa farm company, El-Behira Governorate, Egypt. A total of 270 sea bass fingerling with an average body weight of 32.83 g were distributed in 6 cages 2 × 1×1 m (tall × width × depth) suspended in a natural pond approximately 20 hectare at three stocking density (30, 45 and 60 fish/m^3 equal 1.0 kg, 1.5 kg and 2.0 kg/m^3) using two cages/density. Fish fed a diet contained 45% CP (Table 1) at a rate of 3% of body weight twice a day.

Fish weighed every two week in order to adjust the feed in the cage according to a new weight obtained.

Statistical analyses were performed using **SPSS, 1997.** Statistical significant between treatments was evaluated at the 5 % probability level.

RESULTS AND DISCUSSION:

Average water salinity was 15.2 – 16.5 % during the experiment period, the temperature was stable around 27-30^o in summer and 15-18^o in winter and. oxygen concentration was suitable (5.3-6.8), pH around 7.5

Growth performance:

The effect of stocking density on growth performance was shown in Table 2. Significant differences on final fish weight, weight gain and daily gain were observed between groups of the two highest and the lowest stocking densities. Final mean weight showed a decreasing tendency with increasing stocking density. Fish reared at the highest densities (60 fish/m^3) had the lowest mean final body weight (225 g) while those of the lowest densities (30 fish/m^3) showed the highest mean final body weight (270 g) while (45 fish/m^3) was in between. The differences between the lowest and highest density were 20% in final weight. A similar tendency was observed for SGR, 0.85 and 0.94 with (45 fish/m^3) and (30 fish/m^3) respectively but the highest density was in between.

Table (1). Composition and proximate analysis of feed (on as fed basis).

Items	%
Ingredients	
Fish meal	22
Soybean	24
yellow corn	10
Gluten	30
vit & min	2
Calcium phosphate	1
Linseed oil	11
Chemical composition	
DM	9.44
Crude protein, CP	45.18
Ether extract, EE	15.66
Ash	7.69
Crude fiber, CF	2.20
Nitrogen free extract. NFE[1]	19.83
GE, kcal/g*	4.810

1, Calculated by differences   * Calculated according to NRC, 1993.

The results obtained clearly show that the growth rate of European sea bass juveniles increased with decreasing stocking density. This finding agrees with growth studies reported by **Wallace *et al*., 1988; Baker and Ayles, 1990; Jorgensen *et al*., 1993,** while growth rates inversely associated with stocking density have been reported for the majority of the fish species studied **(Refstie and Kittelsen, 1976; Papoutsoglou *et al*., 1979, 1980, 1987, 1990; Fagerland *et al*., 1981; Leatherland and Cho, 1985; Vijayan and Leatherland, 1988; Erlod *et al*., 1989; Zoccarato *et al*., 1994; Al-Jerian, 1996).** Reasons for the growth performance of sea bass juveniles observed in the present study may be due to that low density fish takes better requirements of oxygen and others namely feed.

Table (2). Effect of stock density on productive performance of sea bass through the experimental period.

Parameters	Stocking density/ m^3			SED
	30 (1 kg)	45 (1.5 kg)	60 (2 kg)	
Initial mean body weight, g	34	31	33.5	1.22
Final mean body weight, g	270^{a}	257.5^{a}	225^{b}	9.35
Total gain, g $^{(1)}$	236^{a}	226.5^{a}	191.5^{b}	10.12
Daily gain, g $^{(2)}$	1.20^{a}	1.14^{a}	1.00^{b}	0.04
SGR, % $^{(3)}$	0.92^{ab}	0.94^{a}	0.85^{b}	0.02

* Average in the same row having different superscripts differ significantly P≤0.05.
* SED is the standard error of difference
Experimental period = 225 days
(1) = Final weight - Initial weight
(2) = Total gain, g /period in days.
(3) = 100 (ln Final weight-ln Initial weight)/period in days, where ln is the natural log.

Feed utilization:

The effect of stocking density on feed utilization was shown in Table 3. Significant differences in feed conversion ratio (FCR) was observed between groups of the two highest and the lowest stocking densities. The FCR improved with low stocking density (2.76) than high socking density (3.24) by difference about 17% between them.

The survival rate was insignificantly (P≤0.05) affected. It was around 96% independently of the density and the period. Part of the mortalities observed was due to fish jumping out of cages and other part after sampling**.**

Table (3). Effect of stock density on feed utilization of sea bass through the experimental period.

Parameters	Stocking density/ m^3			SED
	30 (1 kg)	45 (1.5 kg)	60 (2 kg)	
Feed intake, g/fish	650	642.5	620	7.36
FCR	2.76^{b}	2.84^{b}	3.24^{a}	0.13
Survival rate%	96.5	96.5	96.75	1.93
Feed intake, kg/cage	39.0	57.8	74.4	---

* Average in the same row having different superscripts differ significantly P≤0.05.
* SED is the standard error of difference

Economic evaluation:

The effect of stocking density on economic evaluation was shown in Table 4. Although increasing final body weight of the lowest density, the net returns of cage improved with increasing density and the best net returns was observed with the density 45 fish/m^3 followed by densities 60 and 30 fish/m^3 respectively.

In conclusion the best density was 45 fish/m^3 which net returns improved by 33% than the lowest density (30 fish/m^3, one kg/m^3) and 17% than the highest density (60 fish/m^3, 2.0 kg/m^3).

Table (4). Effect of stock density on economic efficiency of sea bass through the experimental period.

Parameters	Stocking density/ m^3		
	30 (1 kg)	45 (1.5 kg)	60 (2 kg)
Costs, L.E/cage			
Feed	**312**	**462.4**	**595.2**
Fish	**120**	**180**	**240**
Other costs	**10**	**10**	**10**
Total costs, L.E.	**442**	**652.4**	**845.2**
Cage biomass, kg	**16.2**	**23.18**	**27.0**
Selling price, L.E/ cage	**648**	**927**	**1080**
Net returns/cage	**206**	**274.6**	**234.8**

Price of one kg selling fish = 40 L.E Price of kg feed = 8 L.E

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تأثير كثافة التخزين على اداء النمو والاستفادة من الغذاء لأسماك القاروص المسكنة في أقفاص معلقة فى حوض طبيعى

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تعتبر كثافة التخزين ذات أولوية فى البحوث السمكية لتأثيرها على الأسماك المستزرعة والحاجة المستقبلية للتوصيات التى تحكم كثافة التخزين فى المزارع السمكية.

أجريت هذه الدراسة بغرض معرفة استجابة مظاهر النمو والاستفادة من الغذاء لأسماك القاروص للكثافات المختلفة. استخدم مكررين من اسماك القاروص بمتوسط وزن ٣٢.٨٣ جم ربيت في ٦ أقفاص (٢ م^{٣}) مثبتة فى حوض طبيعى بمساحة ٢٠ هكتار تقريبا بثلاثة كثافات (٣٠، ٤٥ و ٦٠ سمكة/م^{٣} والتى تساوى ١، ١.٥ و ٢ كجم/م^{٣}) لمدة ٢٢٥ يوم.

وجدت اختلافات معنوية فى الوزن النهائى ومعدل الزيادة فى الوزن و معدل الزيادة اليومية. الاسماك التى ربيت بكثافة عالية (٦٠ سمكة/م^{٣}) كانت أقل فى الوزن النهائى (٢٢٥ جم) أما الاسماك التى ربيت بكثافة قليلة (٣٠ سمكة/م^{٣}) كانت أعلى فى الوزن النهائى (٢٧٠ جم) والاسماك متوسطة الكثافة (٤٥ سمكة/م^{٣}) كانت نتائجها بينهما الفروق فى الوزن النهائى بين أعلى وأقل كثافة كان حوالى ١٦.٥%. معدل النمو النسبى أخذ نفس الاتجاه لأعلى وأقل كثافة كان ٠.٨٥ و ٠.٩٢ على الترتيب.

وجدت اختلافات معنوية فى معدل الاستفادة من الغذاء والتى تراوحت بين ٢.٧٦ و ٣.٢٤ بفارق ١٧% بين أقل وأعلى كثافة تربية على الترتيب. أما معدل الاعاشة كان غير معنوى وتراوح حول ٩٦% تقريبا وكان جزء من الوفيات نتيجة قفز الاسماك من الاقفاص أما الجزء الباقى بعد أخذ العينات.

بالنظر للكفاءة الاقتصادية تحسن صافى الربح من القفص بزيادة الكثافة وكان أحسن صافى ربح مع الكثافة ٤٥/م^{٣} تبعه ٦٠/م^{٣} ثم ٣٠/م^{٣} نستخلص من ذلك ان أحسن كثافة وجدت كانت ٤٥ سمكة/م^{٣} والتى تحسنت بمعدل ٣٣% عن أقل كثافة و ب ١٧% عن أعلى كثافة.