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BIOTECHNICAL ASPECTS OF AQUACULTURE PRODUCTION OF COMMON MEAGRE *ARGYROSOMUS REGIUS* IN FLOATING CAGES IN DAKHLA BAY, MOROCCO

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ABSTRACT

This study is the first contribution to monitoring the rearing of common meagre *Argyrosomus regius* in floating cages anchored in Dakhla Bay, southern Morocco. The aquaculture potential of common meagre in Dakhla Bay was evaluated by zootechnical monitoring of two production cycles. The first batch consisted of 20,000 fingerlings of 4.5 ± 0.13 g in mean initial weight and 6±0.19 cm in fork length, and was caught on 26 August 2019 under a condition factor of about 2.08 ± 0.35. The second batch consisted of 30,000 individuals of 3 ± 0.11 g in average initial weight and 6±0.26 cm in average initial length, and was caught on 4 June 2020 under a condition factor of about 1.39 ± 0.21. During the first experiment, which lasted 16 months, a high growth potential of common meagre was observed. The fish reached an average weight of 1265 ± 69.2 g and an average length of 48±4.32 cm with a specific growth rate (SGR) of 0.58 ± 0.11% day^{-1} and a daily growth index DGI of 2.45 ± 0.91 g ind^{-1} day^{-1}. The feed conversion ratio was 1.18 (FER = 0.84), final density was 36.94 kg m^{-3} and condition factor (k) recorded a mean value of 2.18±0.39 throughout the cycle. The survival rate at the first harvest was 89.86%. After 18 months of rearing, the fish of the second cycle reached a weight of 1285±69.2 g and a size of 47 ± 5.36 cm, with an SGR of 0.49 ± 0.12 % day^{-1} and a DGI of 2.34 ± 1.35 g ind^{-1} day^{-1}, an FCR of 1.21 (FER =0.83), the final density of 28.43 kg m^{-3} and a condition factor of 1.35 ± 0.32. The survival rate was 92.19%. However, the results of the statistical analysis showed that there was no significant difference between the two production cycles ($P > 0.05$). These results confirm that common meagre is a very promising species for the diversification of aquaculture in Dakhla Bay and throughout Morocco.

Keywords:
Moroccan aquaculture
Common meagre
Fish farming
Growth performance
Diversification

How to Cite

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INTRODUCTION

Marine aquaculture is one of the fastest-growing sectors of animal production in recent years. Technological advances have increased the volume of production and improved the quality of products on the market (FAO, 2022). The development of new markets is achieved through the diversification of production. Such diversification can be considered the most important strategy for aquaculture development. It allows the market to grow by increasing existing markets and opening up new potential demand (Metian et al., 2020). Moreover, according to the same authors, it will increase the efficiency of aquaculture companies by allowing them to breed species that require the same farming technology and have different breeding cycles.

Common meagre *Argyrosomus regius* (Asso y del Rio 1801) is a migratory fish species belonging to the family Scienidae. It occurs throughout the eastern Atlantic, including the Mediterranean and Black Seas, and ranges from Norway to Gibraltar and the Congo (Griffiths and Heemstra, 1995). A number of biological characteristics make leanness an attractive option for aquaculture. These characteristics include being able to withstand a wide range of environmental conditions, growing rapidly even in captivity, and utilising dry feed well. In addition, this species has high meat quality and is suitable for industrial processing (Duncan et al., 2013; Fountoulaki et al., 2017; Birol and Dilara, 2018; Ghozlan et al., 2018).

Global production of meagre is mainly based on aquaculture (68% compared to capture fisheries) with a production of more than 37,000 tonnes in 2019, while wild-caught lean fish volumes amounted to about 18,000 tonnes (32%) in 2019. Due to increasing consumer demand, meagre production has increased significantly over the past decade. This expansion has been observed in several Mediterranean countries (Egypt, Spain, Turkey, and Greece) (EUMOFA, 2022). In Morocco, a breeding trial of common meagre was conducted in 2003 in M'diq Bay by the National Institute for Fisheries Research (www.inrh.ma) and a private company, which yielded very encouraging results in terms of growth potential, reflected in a weight gain of 1,400 g in 19 months, a daily growth rate (DGR) of about 15.2%, a feed conversion ratio (FCR) of 1.29, and a survival rate of 98.8% (INRH activity report). Other studies were conducted in Morocco with the same species but on a hatchery scale. The first study, conducted by Sedki et al. (2017) focused on the omission of rotifers in larval rearing of meagre. This study confirmed the possibility of direct use of Artemia in the diet of common meagre. The second study, conducted by Ben-Bani et al. (2018), investigated the effects of protein-lipid ratio (P/L) in the diet on growth performance and feed utilization by meagre juveniles. The authors confirmed a very close relationship, with a very low P/L ratio inevitably leading to poor zootechnical performance. Although encouraging results were obtained in the experiment conducted by INRH in 2003, there are currently no fish farms that practice the rearing of common meagre in Morocco.

The potential of Dakhla Bay in southern Morocco for fish farming has been studied (Izzabaha et al., 2020; Gjije et al., 2022) and the results are very encouraging for the rearing of sea bass and gilthead sea bream in floating cages, recording an average growth of four months during the rearing of these species in the Mediterranean Sea, up to an average weight of 500 g, starting from juveniles with an average weight of 2 g.

This study is a monitoring of the zootechnical performance of common meagre in floating cages within the pilot farm of INRH, located in Boutalha, Dakhla Bay. Two imports of fingerlings were carried out from a European hatchery, the first in late August 2019 and the second in June 2020. In this article, we focus on all aspects of rearing to provide an overview of the growth and survival potential of this species in the floating cage environment in Dakhla Bay.

MATERIALS AND METHODS

Site description

Dakhla Bay on the Saharan coast of Morocco is one of the most important bays in the south of the country (Fig. 1). It is separated from the Atlantic Ocean by the Oued Eddahab peninsula and measures about 37 kilometers in length and between 10 and 12 kilometers in width. It is oriented NE-SW and is connected to the Atlantic Ocean on the south side by a 13-kilometer channel (Hilmi et al., 2017). The selection of the site for the INRH pilot fish farm was based on several opportunities that the Boutalha area offers for implementing fish culture activities in floating surface cages (Izzabaha et al., 2020).

Biological model

Two fingerling supply operations were carried out from the hatchery for a total of 50,000 fingerlings. The first was on 26 August 2019 with 30.000 fry with an individual average initial weight of 4.5 ± 0.13 g and an individual average initial size of 6 ± 0.19 cm. This importation had the mortality of 10,000 fry during transport from the hatchery to the fish farm due to the breakdown of dissolved oxygen in a tank of the truck transporting live animals. Therefore, the initial biomass was 90 kg. The second importation of fry was carried out on 4 June 2020 for a quantity of 30,000 fry with an individual average initial weight of 3 ± 0.11 g and an individual average size of 6 ± 0.26 cm, with an initial biomass of 90 kg (Table 1). In case of mortality during transport, the fry supplier added 5% of the requested quantity.

The transportation of the fish to Morocco is carried out by special trucks suitable for this kind of product. During the

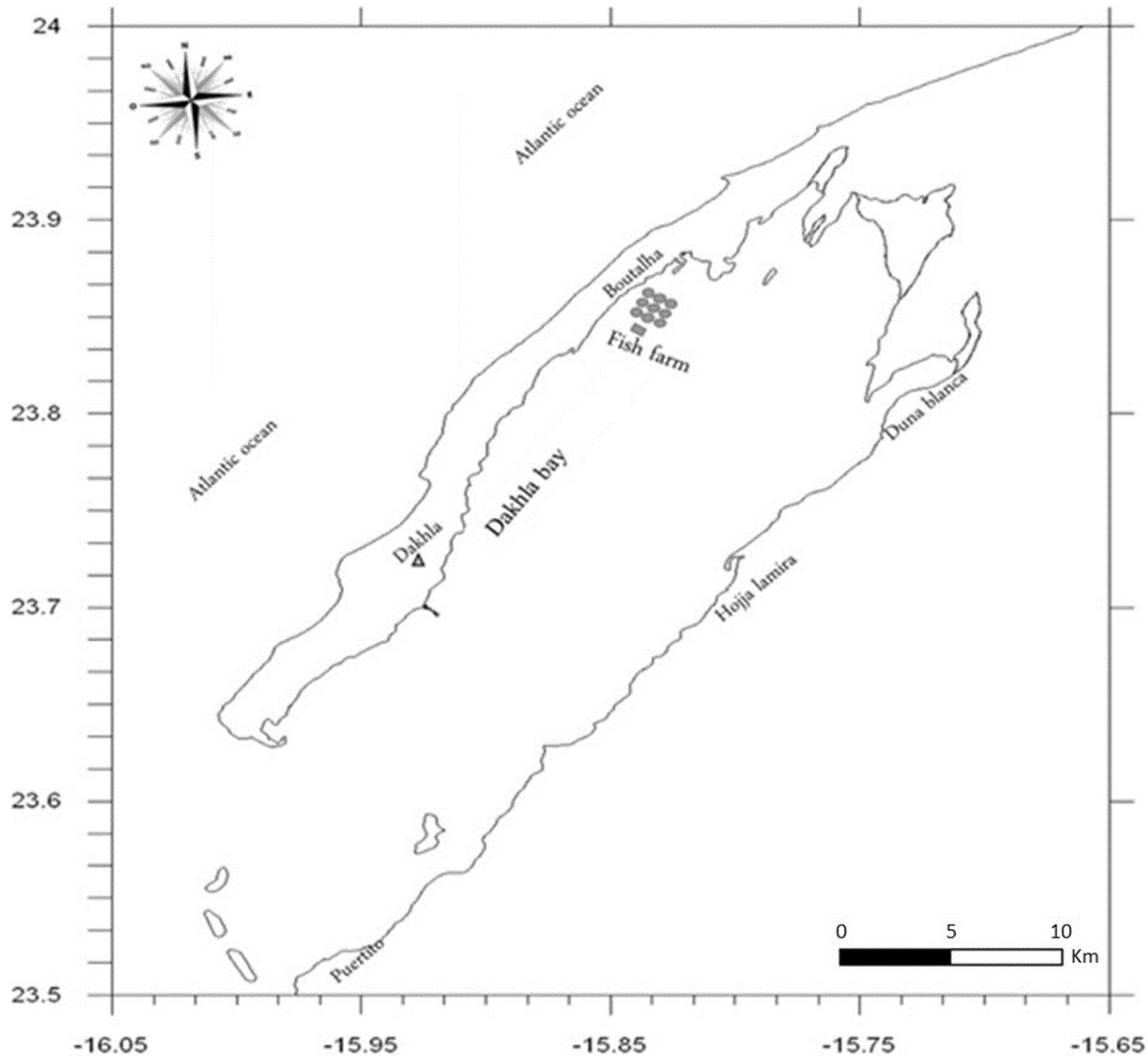

Fig 1. The geographic location of the INRH pilot fish farm

trip, the fingerlings are placed in tanks (2 m^3 in volume) that are supplied with oxygen via a bubbler system. Also, the truck features a reserve source of liquid oxygen to fill the tanks in case the initial system is insufficient.

After arrival on site, the fingerlings are gradually acclimatized to the temperature on site by gradually changing the water in the tanks. Then they are placed into small cages built in Cubi floats. These cages were previously cleaned, scraped out and repaired as needed. The net used in the pre-growing cages had a mesh size of around 5 to 6 mm.

Rearing system and feeding protocol

The farming technique employed was a floating platform made of Cubi floats (Fig. 2). The structure contains a total of four small cages of 416 m^3 in total volume (104 m^3/cage). The biomass of meagre fingerlings is distributed in two cages with 10.000 individuals per cage. In the beginning, the following characteristics of the cage net are used: a mesh size of 4 mm, a depth of 5 m and the use of an anti-bird net made from the net of a purse seine. After reaching 100 g, meagre fingerlings were transferred to a circular cage of 12 m in diameter with a total volume of 565 m^3, achieved by utilizing a 5 m high rearing net.

The feed used was a pelleted feed designed for sea bass, with the pellet size changing according to the age of the grow-out individuals (Table 2). During the pre-growing period, the feed was administered at satiety two to three times per day, and just once during the growing phase. The distribution method of the feed is an important point in the management of a farm. It is always done in the direction of currents and winds so that the feed is not carried away by the currents outside the cage. The distribution of feed is done manually with good dispersion.

Table 1. Information on the two importations of common meagre fingerlings

		Batch 1	Batch 2
Information about the origin of the fingerlings	Hatchery	LES POISSONS DU SOLEIL	
	Shipping date	20/08/2019	29/05/2020
	Date of spawning	19/06/2019	27/02/2020
	Date of hatching	20/06/2019	29/02/2020
	Total effectiveness of the batch	31 889	32 837
	Average weight	6.93 g	5.02g
	Age	62 days	90 days
Information about fingerling arrival	Date of arrival	25/08/2019	04/06/2020
	Start date of rearing	26/08/2019	04/06/2020
	Average weight	4.5 ± 0.13 g	3 ± 0.11 g
	Average length	6 ± 0.19 cm	6 ± 0.26 cm
	Mortality	10000 (1 tank) DO problem in the tank	Negligible
	Sanitary status of the fingerlings	good condition	good condition

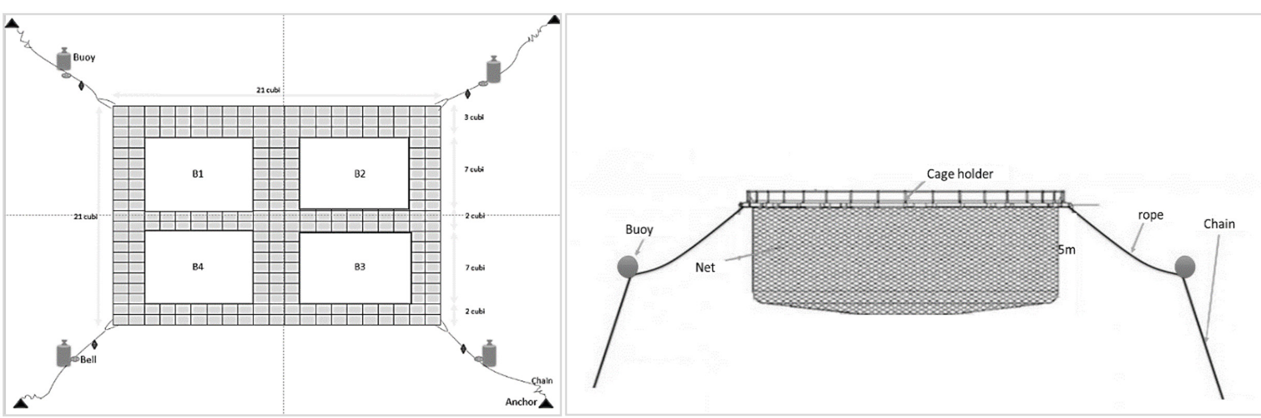

Fig 2. Rearing structures used: Cubi cage (left) and circular cages (right)

Indeed, two mistakes are to be avoided, underfeeding and environmental pollution. During the growing period, the fish are systematically fed with only one ration per day. The various maintenance tasks of the rearing structures and fish are carried out regularly, especially after storm events. These activities are the main part of the work carried out by the divers and fishermen.

Monitoring of the zootechnical indicators and rearing medium characteristics

During the whole period of the experiment, the growth in weight and length were measured during the pre-growth phase by random sampling of 200 individuals divided into sub-samples of 50 individuals for a frequency of 15 days, and during the growth phase by individual measurements of 30 individuals randomly sampled with a monthly frequency. The total length is measured from the anterior end of the closed mouth to the posterior end of the caudal fin, using a ruler with marked units. The total weight is measured with a portable scale (Megatech; Max. 8000 g; graduation: 20 g and precision: 0.001). Meagre is a relatively unstressable fish and its manipulation does not require the use of anaesthetics.

Monitoring of the rearing medium is done by controlling the physicochemical factors that influence species growth. These parameters are transmitted in real-time by a continuous YSI (Yellow Springs Instrument) multiparameter water quality probe placed in the area of

Table 2. Rationing parameters for common meagre

Feed conversion ratio	Average weight (g)	Temperature (°C)									Granulometry (mm)	Net mesh (mm)
		12	14	16	18	20	22	24	26	28		
-	1-4	3.71	4.64	5.57	6.49	7.42	8.35	8.81	9.28	8.81	1	-
0.8 – 1	4-7	3.04	3.8	4.56	5.32	6.08	6.84	7.22	7.61	7.22	1	6
0.8 – 1.3	7-10	2.55	3.19	3.82	4.46	5.1	5.73	6.05	6.37	6.05	2	
1.4 – 1.6	10-50	2.09	2.62	3.14	3.67	4.19	4.71	4.97	5.24	4.97	3	8
1.4 – 1.6	50-100	1.7	2.12	2.54	2.97	3.39	3.82	4.03	4.24	4.03	3	12
1.5 – 1.7	100-200	1.35	1.69	2.02	2.36	2.7	3.03	3.2	3.37	3.2	4.5	15
1.5 – 1.7	200-400	1.09	1.37	1.64	1.91	2.18	2.46	2.59	2.73	2.59	4.5	20
1.6 – 1.8	400-600	0.89	1.11	1.33	1.55	1.77	1.99	2.1	2.21	2.1	6	25
1.7 – 1.9	>600	0.72	0.9	1.08	1.25	1.43	1.61	1.7	1.79	1.7	7-8	25

floating cages. Data is received through a network system. The collected information includes water temperature in °C, dissolved oxygen (DO) in mg l^{-1}, turbidity in FNU, hydrogen potential (pH), chlorophyll in µg l^{-1} and salinity in psu.

Statistical analysis

The Shapiro-Wilk test was used to check the normal distribution of the data. The Mann-Whitney test was applied to detect significant differences between the means of both production cycles. Similarly, the relationship between size and weight was determined using a slope test. The probability threshold for significance was set at $P < 0.05$ value. The statistical tests were performed using SPSS 26.0 and R software.

RESULTS

Farming medium

The recorded profile of physicochemical parameters influencing the rearing performance of meagre fish was within the optimum range for the welfare of this species. The values of water temperature, dissolved oxygen concentration, pH and salinity are presented in Figure 3, with average values of 21.08 ± 1.57 °C, 7.51 ± 0.45 mg l^{-1}, 8.34 ± 0.19 and 37.55 ± 0.36 psu, respectively. The average value of turbidity (5.74 ± 2.42 FNU) and chlorophyll (6.53 ± 1.94 µg l^{-1}) indicate very favorable water quality for fish farming.

Zootechnical indicators

a) Weight and linear growth

After 493 days of rearing, fingerlings of the first rearing cycle reached 1265 ± 69.2 g in average weight and 48 ± 4.32 cm in average length, starting with 4.5 ± 0.13 g and 6 ± 0.19 cm, respectively, while during the second cycle, fingerlings reached a weight of 1285 ± 81.16 g and a size of 47 ± 5.36 cm after 544 days of rearing, starting with 3 ± 0.11 g and 6 ± 0.26 cm.

The weight growth curve is exponentially increasing over time. The first rearing months are characterized by a slowdown in weight growth, which is justified by the adaptation of the fingerlings to the physicochemical and hydrodynamic conditions of Dakhla Bay, while the growth in size was fast during the beginning of the rearing period and then becomes slower with time. The analysis of the two rearing cycles indicated that the growth gain recorded for the first cycle fry was better than that of the second cycle (Fig. 4). However, statistical analysis shows that the Mann-Whitney test reveals that there was no significant difference between the two production cycles ($P > 0.05$).

b) Growth indexes: SGR, DGI, CF and allometric relationship

For the first production cycle, the specific growth rate and daily growth index of meagre fingerlings have high average values of about 0.58 ± 0.11% d^{-1} and 2.45 ± 0.91 g ind^{-1} d^{-1}, respectively. On the other hand, we recorded an SGR of 0.49 ± 0.12% d^{-1} and a DGI of 2.34 ± 1.35 g ind^{-1} d^{-1} for the second rearing cycle. The monthly evolution of these two parameters is presented in Figure 5.

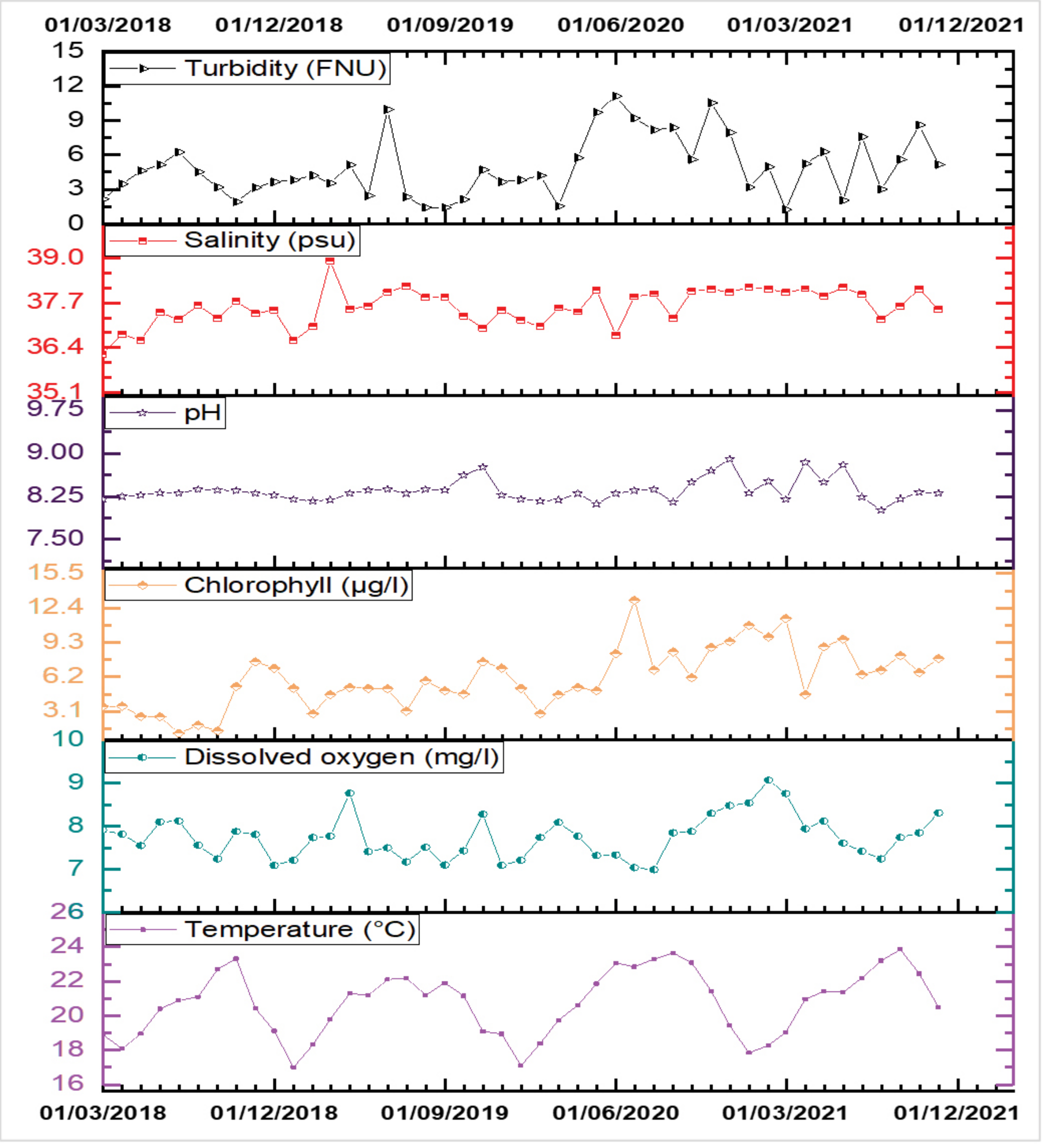

Fig 3. Vatiation of physicochemical parameters of the farming medium

The condition factor (k) recorded an average value of all cycles of about 2.18 ± 0.39 and a value of 1.35 ± 0.32 for the fish of the second cycle. These results indicate that common meagre is reared under optimal conditions for its growth.

The allometric relationship between the length and weight of common meagre is of a minorizing type, as confirmed by the significant slope test observed in both rearing cycles ($P < 0.05$). The relationship between size and weight can be described as follows:

For cycle 1: $Y=0.1323X^{2.368}$ with $R^2 = 0.9559$

For cycle 2: $Y=0.015X^{2.9666}$ with $R^2 = 0.9964$

The established equation reflects adequately the relationships between the total weights of fish and their corresponding lengths, which is justified by the correlation coefficient of about 0.95 and 0.99. This relation allows the determination of the weight of the fish based on its length (Hureau, 1970).

c) Feed efficiency

During the distribution of the feed, meagre is fed much more at depth than at the surface, and the ingestion rate is faster at depth and in darkness. It reacts slowly to the distributed feed and has a small appetite. It reacts less quickly than the other species (sea bass and sea bream)

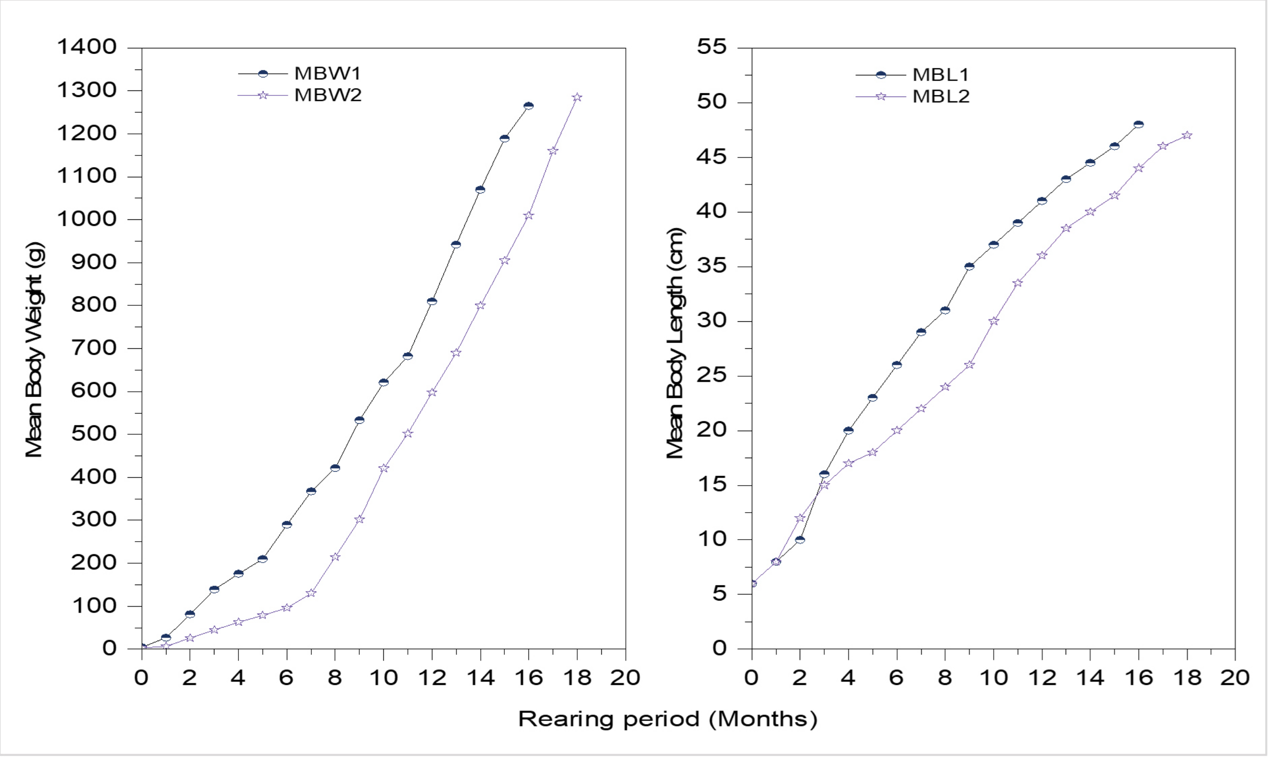

Fig 4. Weight and length of common meagre in Dakhla Bay

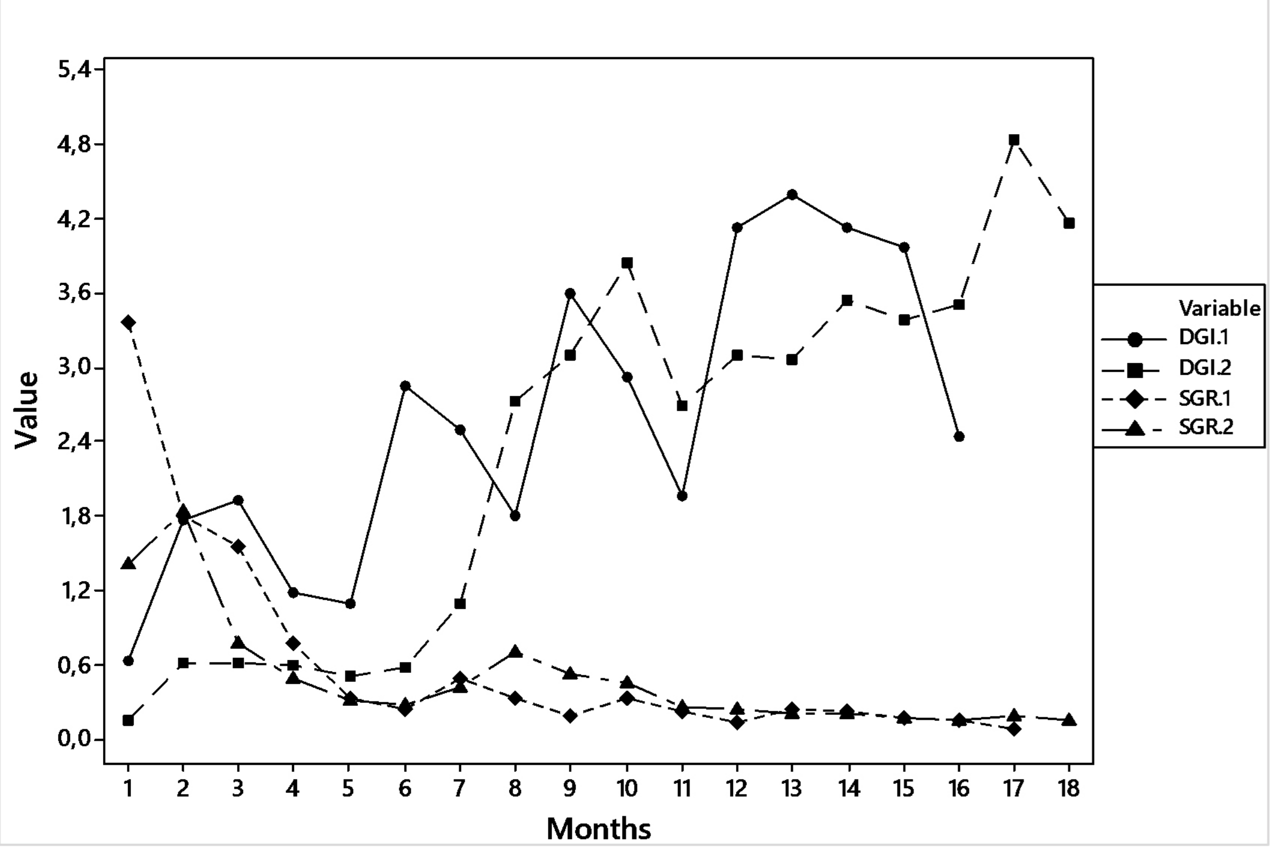

Fig 5. Monthly variations of specific growth rate (SGR) (%/d) and daily growth index (DGI) (g/ind/d) of meagre

which are very active in responding to the feed and have a large appetite. The values of the feed conversion ratio recorded are around 1.18 and 1.21, with feed efficiency of 0.84 and 0.83, respectively, for the first and second cycles. These results demonstrate a good feed utilization by common meagre.

d) Biomass and density variation

After 16 months of rearing, the first cycle biomass (B1) exceeds 20.8 tons, although the initial biomass is only 45 kg, and the final biomass (B2) for the second cycle is about 32.12 tons. Similarly, the density increases rapidly, reaching an average value of more than 36.94 kg m^{-3} for C1 (D1) and 28.43 kg m^{-3} for C2 (D2), starting from a value of 0.43 kg m^{-3} and 0.87 kg m^{-3}, respectively (Fig. 6). These two parameters require rapid intervention in order to increase the volume for rearing this species and, consequently, to decrease the impact of density on growth performance.

e) Disease and mortalities

The survival rates achieved are 89.86% and 92.19%, respectively, for the first and second rearing cycles (Fig. 7). However, the mortality was mainly due to the rearing conditions and the stress caused by the operations (transfer, sampling, etc.). In the same way, no significant diseases were observed during the experiment, except for a few single cases of parasites found on the skin (Fig. 8), particularly among the fish of the second cycle.

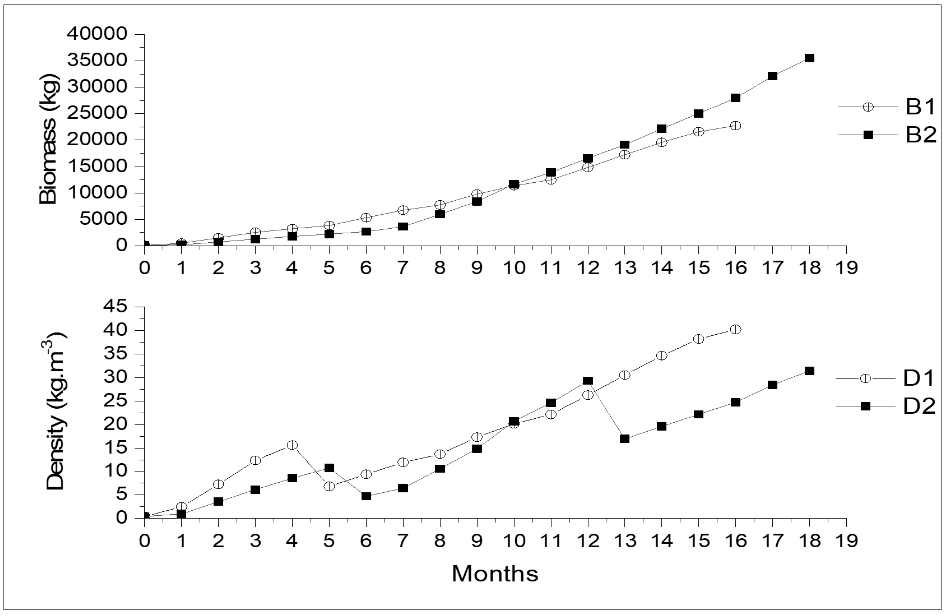

Fig 6. Variation in biomass and stocking density of common meagre for the two production cycles

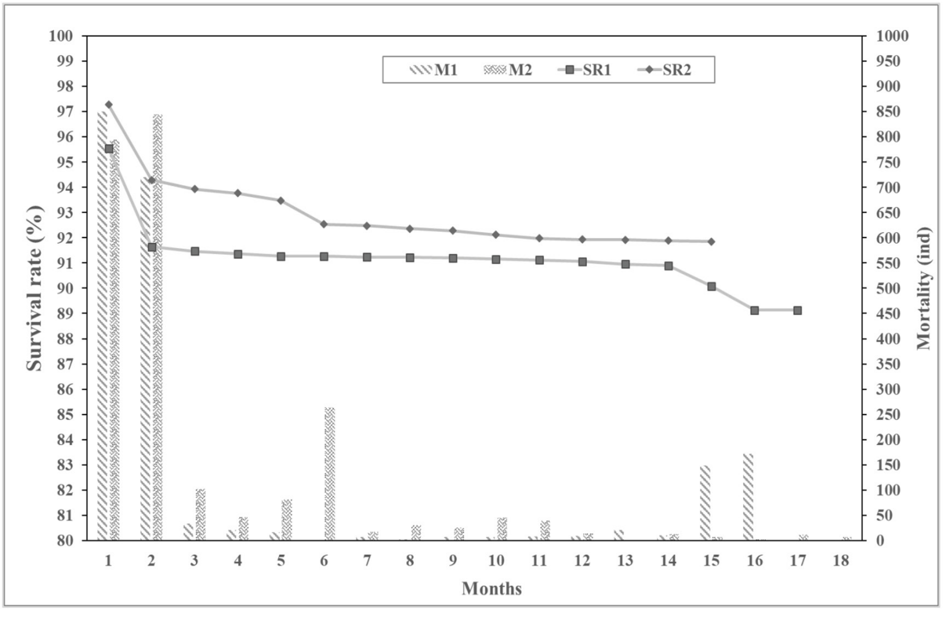

Fig 7. Monthly variations in common meagre mortality

Fig 8. Parasites observed on the skin of meagre fry reared in Dakhla Bay

DISCUSSION

The growth results obtained in this study for meagre in floating cages in Dakhla Bay, as shown by a weight gain of about 1200 g, a daily growth index of about 2.45 grams/fish/day, and a feed conversion ratio of 1.18 (Table 3), are higher than those of the FAO report (FAO, 2004) in which meagre reached a weight of 1200 g in 24 months, whereas in the present study, the first production cycle batch reached the same weight after only 16 months.

Further studies (Table 4) demonstrate that the growth of meagre fish is affected by several conditions, such as initial weight at grow-out, physicochemical parameters of the medium, feeding, and monitoring of parameters such as density, biomass, sanitary status, etc.

Also, the research carried out by INRH between 2003 and 2005 (Benbani, 2007), regarding a comparative trial between the meagre farming in floating cages and in a controlled environment (tanks), has shown that the most suitable farming method for this species is sea cage farming and that meagre is well adapted to the conditions of local Moroccan waters. This species can also be reared in brackish water ponds (El-Shebly et al., 2007) but the drawback is a very low feed conversion.

The feed conversion ratio was 1.18 for C1 and 1.21 for C2, while similar trials recorded values of 1.7 (FAO, 2005), 0.9-1.2 (Monfort, 2010) and others (Table 4), which indicates that the feed intake for common meagre in Dakhla Bay was well-handled and digested.

The physicochemical parameters of the rearing medium are evolving in the optimal range for rearing this species. For example, the temperature is around 24°C as the maximum value and 16°C as the minimum value, which corresponds to the values established by Cárdenas (2010), as well as for dissolved oxygen which is evolving around 6.99 mg l^{-1} and 8.28 mg l^{-1}.

Furthermore, the process of digesting the feed releases nutrients and allows the fish to use them as cell building blocks (growth) or as a source of energy. These metabolic processes require large amounts of oxygen. During the feeding process, there is a maximum consumption of oxygen, which is maintained during the time needed for the nutrients to be digested and absorbed. On the other hand, if the feed is more energetic, the consumption of dissolved oxygen in water will be more limited, so it is better to decrease the ration to avoid oxygen deficiency after feeding. Another solution is to divide the feed into several small portions, thus avoiding a large consumption peak that would put the fish in a critical zone. As for temperature, it affects both the feeding requirements of meagre and the availability of dissolved oxygen. As for any poikilothermic species, the metabolic activity, and thus the food requirements of common meagre, increase until the thermal optimum which is the highest level of food efficiency. In parallel, oxygen requirements change; they are doubled for a warming, and the dissolved oxygen rate in the water changes inversely. The more the water is warm, the more the oxygen level decreases. Therefore, periods of very high temperatures are very difficult to manage in terms of feeding. The amount of available oxygen must be the primary element of the feeding strategy. In the same way, at very cold temperatures, the feeding rate also decreases to the point where the fish take almost no food. Too much feed distribution is then equal to unnecessary waste.

Concerning the health status, there are few reports in the scientific literature that discuss pathological problems of farmed meagre, which confirms that meagre is disease resistant when compared to other marine fish species (FAO, 2005). The survival rate recorded in this study was around 89%, which means that mortalities were significantly low. The health status of the fish was better, except for some parasites observed on the skin of some individuals during the pre-growth phase. However, according to FAO (2004), cases of *vibriosis* caused by *Vibrio anguillarum*, *oodiniosis* caused by *Amyloodinium ocellatum* and parasitosis caused by Gyrodactylus sp. can also be observed in meagre farms.

Table 3. Assessment of the zootechnical indicators for the rearing of meagre in Dakhla Bay

Parameters	**Unit**	**C1**	**C2**
Rearing start date	-	26/08/2019	04/06/2020
Initial weight	g	4.5 ± 0.13	3 ± 0.11
Final weight	g	1265 ± 69.2	1285 ± 81.16
Rearing period	months	16	18
Initial biomass	kg	45	90
Final biomass	kg	20872.5	32125
Initial density	kg/m^3	0.43	0.87
Final density	kg/m^3	36.94	28.43
Amount of feed	kg	24610	38662
Feed conversion ratio	-	1.18	1.21
Feed efficiency	-	0.84	0.83
Initial size	cm	6 ± 0.19	6 ± 0.26
Final size	cm	48 ± 4.32	47 ± 5.36
Daily growth index	g/ind/d	2.45 ± 0.91	2.34 ± 1.35
Specific growth rate	% /d	0.58 ± 0.11	0.49 ± 0.12
Condition factor	-	2.18 ± 0.39	1.35 ± 0.32

Table 4. Comparative growth of zootechnical performance of farmed meagre

Country/area	Rearing technique	Period (months)	Initial weight (g)	Final weight (g)	Feed con-version ratio	Survival rate %	Bibliographic reference
Morocco/Dakhla Bay	Floating cages	16	4.5	1265	1.18	89	Current study
Morocco/M'diq Bay	Floating cages	19	16.5	1426	1.29	98.8	(Benbani, 2007)
Turkish/Aegean Sea	Floating cages	14	8.22	373.96	1.92	*	(BIROL et Dilara, 2018)
Spain (Mediter-ranean)	Floating cages	12	5	1100	1.7	*	(Geof and Gavin, 2013)
Spain/Andratx - (Mediterranean)	Floating cages	8	110	1850	2.73	100	(Pastor et al., 2002)
Egypt	Pond / brackish water	14	17.7	1014	3	84	(El-Shebly et al., 2007)

CONCLUSIONS

These findings have affirmed the promising potential of the meagre species for aquaculture diversification in Dakhla Bay and Morocco in general. However, further research is necessary to gain a comprehensive understanding of the aquaculture prospects of meagre *Argyrosomus regius*. Zootechnical performances achieved for the first and second cycles of rearing meagre in floating cages in Dakhla Bay can be improved by monitoring and enhancing rearing conditions, particularly in terms of stocking density and the welfare of farmed individuals. Additionally, it is advisable to investigate the impact of the initial season of rearing on the growth of meagre. This can be accomplished by monitoring the physicochemical parameters of the medium, such as temperature, and analyzing their significant influence on the biological growth of the species.

BIOTEHNIČKI ASPEKTI AKVAKULTURNE PROIZVODNJE HAME *(Argyrosomus regius)* U PLUTAJUĆIM KAVEZIMA U ZALJEVU DAKHLA, MAROKO

SAŽETAK

Ovo istraživanje je prvi doprinos praćenju hame *Argyrosomus regius* (Asso y del Rio 1801) koja se uzgaja u plutajućim kavezima usidrenim u zaljevu Dakhla, južno od Maroka. Zootehničkim praćenjem dvaju proizvodnih ciklusa procijenjen je akvakulturni potencijal hame u zaljevu Dakhla. Prva serija sastoji se od 20.000 jedniki mlađi srednje početne težine 4,5 ± 0,13 g i duljine vilice 6 ± 0,19 cm, a zaprimljena je 26. kolovoza 2019. s faktorom kondicije od 2,08 ± 0,35. Druga se serija sastoji od 30.000 jedinki prosječne početne težine 3 ± 0,11 g i prosječne početne duljine 6 ± 0,26 cm, a primljena je 4. lipnja 2020. s faktorom kondicije od 1,39 ± 0,21. Tijekom prvog pokusa koji je trajao 16 mjeseci, zabilježili smo visok potencijal rasta hame. Riba je dosegla 1265 ± 69,2 g prosječne težine i 48 ± 4,32 cm srednje duljine sa specifičnom stopom rasta (SGR) od 0,58 ± 0,11% dan^{-1} i dnevnim indeksom rasta DGI od 2,45 ± 0,91 g ind^{-1} dan^{-1}. Omjer konverzije hrane bio je 1,18 (FER = 0,84), konačna gustoća bila je 36,94 kg m^{-3}, a faktor kondicije (k) pokazao je srednju vrijednost za cijeli ciklus od 2,18 ± 0,39. Stopa preživljavanja dobivena tijekom prvog ciklusa bila je oko 89,86%. Dok su ribe drugog ciklusa postigle težinu od 1285 ± 69,2 g i veličinu od 47 ± 5,36 cm nakon kraja 18 mjeseci uzgoja, uz SGR od 0,49 ± 0,12% dan^{-1} i DGI od 2,34 ± 1,35 g ind^{-1} dan^{-1}, FCR 1,21 (FER = 0,83), konačnu gustoću od 28,43 kg m^{-3} i faktor kondicije od 1,35 ± 0,32. Dobivena stopa preživljenja bila je oko 92,19%. Međutim, prema provedenoj statističkoj analizi, rezultati pokazuju da ne postoji značajna razlika između dvaju proizvodna ciklusa ($P > 0,05$). Ovi rezultati potvrđuju da je hama vrsta od koje se mnogo očekuje u pogledu diverzifikacije akvakulture u zaljevu Dakhla i diljem Maroka.

Ključne riječi: marokanska akvakultura, hama, uzgoj ribe, performanse rasta, diverzifikacija

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