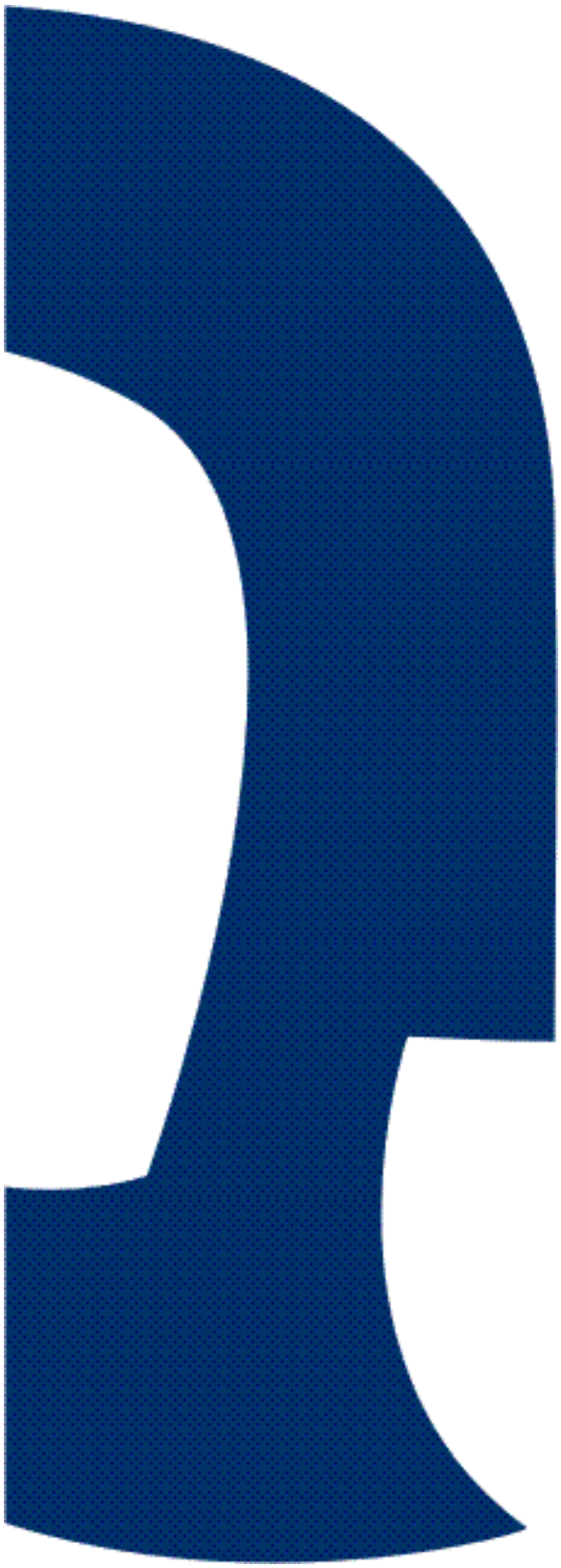
FACULTAD DE CIENCIAS DEL MAR

UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA



Improvements in larval culture techniques of Sea bream (*Sparus aurata*) in the first feeding phase.

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Final assignment for the Marine Science degree

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ABREVIATIONS

ANOVA	Analysis of variance
APROMAR	Asociación Empresarial de Productores de Cultivos Marinos de España
DAH	Days after hatch
DHA	Docosahexanoic acid 22:6 (n-3)
EPA	Eicosapentanoic acid 20:5 (n-3)
FAO	Food and Agriculture Organization of the United Nations
GIA	Aquaculture Research Group
PUFAs	Polyunsaturated fatty acids
t	tons
UV	Ultraviolet

1. Introduction

1.1 Aquaculture

The term "aquaculture" includes a set of activities, techniques and knowledge about the cultivation of aquatic plants and animals species (Rueda, 2011).

The cultivation of aquatic organisms on a large scale is a relatively recent practice, although, on a small scale, this activity has existed since ancient times in some countries, eg as a form of production in China with carp (*Cyprinus carpio*) and Egypt cultivating tilapia (*Oreochromis sp*). These origins are documented between 2000-1000 BC from the beginning of pastoralism and agriculture (Rueda, 2011).

Today, aquaculture is considered an important engine of economic and food development in the world. More than half of the total food of aquatic origin consumed today by the world population comes from aquaculture farms. In these farms, fish, crustaceans, algae, molluscs and other invertebrates are grown. (FAO, 2016).

FAO (2016) data estimates that by 2050 demand of fish will have to be met by the demand of 9 billion people in a society that will be affected by climate change and financial difficulties. Aquaculture has been the trigger for the impressive growth in the supply of fish for human consumption since fishery production began to decline (Figure 1). Although aquaculture provided only 7 per cent of fish for human consumption in 1974, this percentage increased to 26 per cent in 1994 and to 39 per cent in 2004, with China having played the most important role in this growth, with over 60 % of world production.

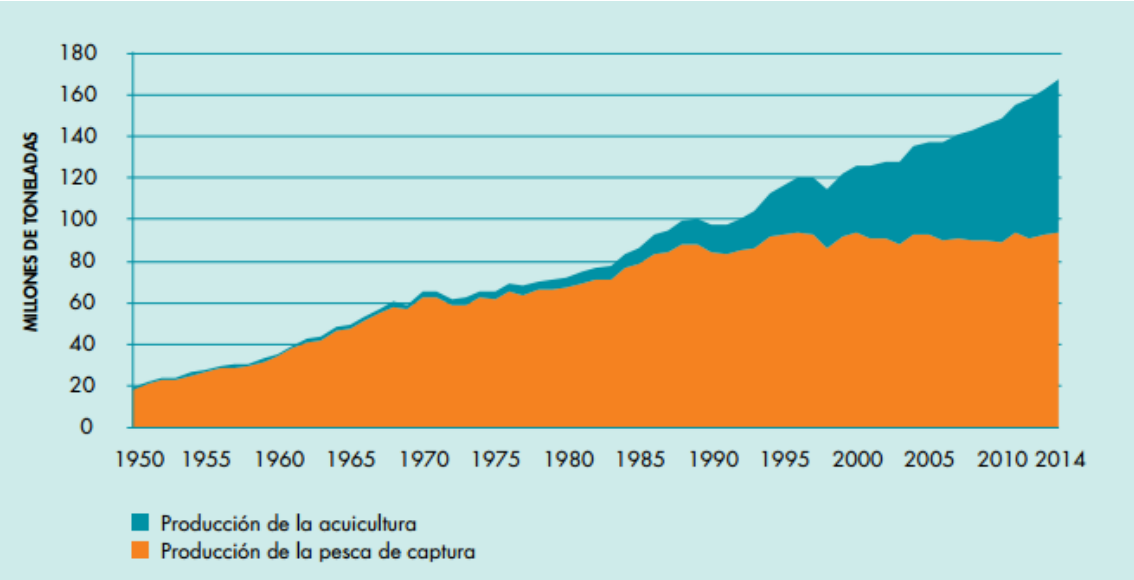

Figura 1. Development of global aquatic production (aquaculture and fisheries) from 1950 to 2014 (FAO, 2016).

The main living aquatic resource in Spain is the mussel, which in 2014 produced 220,449 tonnes (t). Aquaculture production in Spain in 2014 amounted to 282,242 t, the main species of which were mussel (*Oncorhynchus mykiss*) 220,449 t, followed by sea bass (*Dicentrarchus labrax*), 17,376 t, sea bream (*Sparus aurata*), 16,230 t and rainbow trout (*Oncorhynchus mykiss*), 15,111 t, reaching a value in its first sale of 450.1 million euros (APROMAR, 2016).

1.2 Larviculture

The second species of fish most cultured in Spain after sea bass is the sea bream (*Sparus aurata*) (APROMAR 2016). This species has facility for cultivation and a high growth rate. Eggs should be incubated for approximately 2 days and their hatching rate is around 70%. The larval density in the tanks can range from 50-150 larvae / liter. Survival is high, usually above 20% and may reach 30-35% in some cases (Ortega, 2009; Fernández-Ártiles, 2014).

During larval culture, many species of fish present a critical stage in the first days of life, and therefore have a high mortality rate. The main factors influencing survival may

be anatomical and physiological anomalies of genetic origin, water quality (presence of harmful compounds), the occurrence of diseases, inadequate environmental conditions and poor nutrition (Pascual & Yúfera, 1987).

For the larvae to ingest and digest the first exogenous food, it is important that the development of the digestive tract, the opening of the oral cavity, the formation of the connection between the esophagus and the intestine and the functionality of the liver and pancreas, In addition, the size of the mouth determines the amount and type of prey that will consume the larva, as well as other morphological characteristics associated with the digestive system like a salient mouth and able to suck. All these characteristics will also determine the amount of food they will consume. Pigmented eyes, functional digestive system and good swimming ability will favor the capture, ingestion and assimilation of prey (Rivera & Botero, 2009).

Two strategies have been used for the feeding of marine fish larvae for some years: The first involves the use of live prey such as rotifers, brine shrimp or copepods. These zooplankton organisms are used because they have the appropriate size to the larvae buccal cavity, in addition, they are abundant organisms and have slow movement that stimulate the predatory activity of the larvae (Cerecedo-Civera *et al*., 2004; Fernández-Ártiles, 2014). The second has been directed to the development of artificial diets, and in particular of microparticles.

In general, the production of live food is difficult to maintain and also requires extensive work and space. In contrast artificial diets are easier to produce, and their cost of production is lower. However, satisfactory results have not yet been obtained with artificial diets as with live food. This is due to the morphological limitations of the larvae as they lack a fully developed digestive system and have low enzymatic activity (Lazo, 2000; Conceição *et al*., 2010; Fernández-Ártiles, 2014).

Among all zooplankton organisms used for larval cultivation the most used is rotifer, *Brachionus sp*, is essential in the first days of cultivation (Chen *et al*., 2004).

This zooplankton species is an excellent starting food due to its adequate size (130-320 μm), because it has a fast production rate, is suitable for growing large quantities in controlled conditions, has the capacity to grow and reproduce in high Density and we

can artificially manipulate their nutrition (Dhert *et al*., 2001). Some authors, for example, Hernandez-Cruz, 1993, Conceição *et al*., 2010 and Jeeja *et al*., 2011 determined that *Brachionus sp* presents a high protein content (between 29-63%), however, the lipid content is lower (9-28 % of its dry weight).

Marine fish contain high levels of unsaturated fatty acids (HUFA), of which eicosapentanoic acid (EPA) and docosahexaenoic acid (DHA) stand out. These essential fatty acids play an important role both in the structure and in cell membranes function (Sargent *et al*., 1997, Hamre *et al*., 2013).

The larvae have an extremely limited ability to convert linolenic acid to 20: 5 (n-3) and subsequently to 22: 6 (n-3). This is due to a deficiency in the enzyme, responsible for elongating and desaturating polyunsaturated fatty acids (PUFA) (Sargent *et al*., 1997). For this reason, there is an essential requirement for DHA and EPA. The requirement for DHA is greater than EPA because its important in various physiological functions. On the other hand, DHA and EPA should be included in artificial diets, in aadequate proportion to avoid a negative effect on neurological and visual systems (Sargent *et al*., 1999). It is important to mention that in energy terms, the inclusion of high levels of HUFAs in diets may result in an energetic limitation for larvae, since these are relatively poor substrates for energy generating systems via fatty acid oxidation. Therefore, an adequate balance between polyunsaturated, monosaturated and unsaturated fatty acids is necessary, and this can be obtained by the inclusion of phospholipids in the diets (Sargent *et al*., 1999).

In order to supply these components in the diets, carotenoids are principally used, among them we find astaxanthin, a carotenoid belonging to the group of xanthophylls, found in microalgae and crustaceans and used as an alimentary supplement in aquaculture (Sánchez-Galindo, 2012).

Several studies have shown that astaxanthin plays a fundamental role in improving food efficiency, accelerating the growth rate and improving larval survival (Mayers, 2000).

In order to obtain the adequate levels these fatty acids for the correct feeding of the larvae requires the enrichment of the rotifers that these larvae fed. Normally for the enrichment of these rotifers, microalgae, such as *Nannochoropsis sp* or *Isochrysis sp*

will be used, with good results due to their higher content of PUFAs (Conceição *et al*., 2010; Fernández-Ártiles, 2014).

1.3 Objective

The main aim of this study is to evaluate the effects of differents diets, on growth and survival of larvae of *Sparus aurata* based on their feeding with rotifers enriched with an enriching agent based on microalgae lyophilized *Isochrysis sp* with presence or absence of astaxanthin.

2. Material and Methods

The experiment was carried out with larvae of Sea bream (*Sparus aurata*) during the months March and April of 2017 at the Experimental Station of Aquaculture Research Group (GIA) in the Marine Science and Technology Park, belonging to the University of Las Palmas de Gran Canaria in Taliarte (Telde, Gran Canaria). This experiment was a continuation of the work done in 2014 by the Graduate in Marine Sciences Isabel María Fernández Artiles in these same facilities.

Larvae for this experiment were obtained from the natural spawning of Sea bream breeders (figure 2). Eggs were collected in a special net and then, incubated for 24 hours with gentle flow of water. Dead and unfertilized eggs sank into the net, while fertilized eggs remained floating. Subsequently they were counted volumetrically and separated into fractions of 18,000 eggs to tank. After sowing the eggs we evaluated the hatching rates and survival on the 3rd day to know if the breeding was good and to have an estimate of how many larvae would be born in the tanks. For this experiment 12 glass fiber tanks of 200 l were used, although the volume used was 180 l (figure 3). The sea water supplied to the tanks was previously filtered and sterilized with ultraviolet (UV).

Figure 2. Larvae obtained from natural spawning of sea bream (*Sparus aurata*).

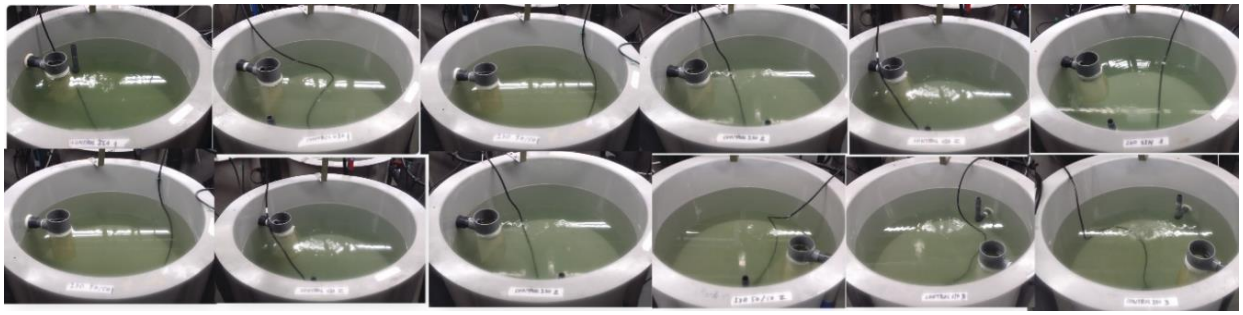

Figure 3. 12 glass fiber tanks of 200 l were used, although the volume used was 180 l.

All tanks were provided with central aeration and lower water inlet circuit and surface outlet. The water renewal was 20% a day throughout the experiment. The drains of the tanks had mesh networks of 315 μm, allowing the exit of organic waste and the remaining rotifers but not the exit of the larvae, obtaining the renewal of the culture medium.

Temperature (° C) and oxygen (mg ml-1) were measured daily at the same time of day. These data were taken with the Oxy Guard-Guardhandy beta apparatus, Zeigler Bros, Gardners, Mg m.

The culture was maintained under a controlled photoperiod for 12 hours of light and dark with 1700 lux artificial lighting (Digital Lux Tester YF-1065, Powertech Western Australia, Australia), with the salinity of the water being around 37 ‰.

Four days after hatching (DHA) larvae opened their mouths and we started with the exogenous feeding. To maintain adequate growing conditions for larvae and rotifers, 1 l of the microalgae *Nannochloropsis sp* was added once daily during the experiment. The rotifers used in this experiment were cultivated in the GIA facilities and were enriched with the different treatments, always the day before the larval feeding. About 300 rotifers for milliliter were grown daily and enriched for 17-18 h. Each of the rotifers tanks was supplied with the enrichment tested, always in a proportion of 0.2 grams/million of rotifers.

The treatments that were tested are made with *Isochrysis sp*. We had four diets, a diet containing astaxanthin, to this diet we call it ISO diet. We have another diet to which the pigment astaxanthin was extracted and we call it SIN diet. Another of diets supplied was made by mixing two above diets by 50% each and referred to as the 50/50 diet. The fourth diet used was the one that is used in the GIA facilities and it is the enriching industrial Ori-Green, to this last diet was denominated GIA diet.

During the 20 days of the experiment, three samples of size and weight were made. The first one was taken on the 4th day after hatching (DHA) with a sample of 30 larvae collected randomly from the tanks. The other two samples were taken on days 12 and 18 DAH, in these cases, with a number of 30 larvae per tank. To measure the larvae we took a sample of 30 larvae from each tank and placed them on a Petri plate, then used the PJ-R3000 profile projector to measure them one by one (figure 4). Later we should weigh each plate with the 30 larvae in a estimate weight.

Figure 4. The PJ-R3000 profile projector. It used to measure larval length.

Biomass was obtained by multiplying the dry weight of the larvae by the number of animals that survived.

At the end of the experiment, the larvae were counted in each tank in order to analyze larval survival for each treatment.

Before the end of experiment, activity test was carried out. Twenty-five larvae tank-1 were selected and putted on plastic containers with clean seawater. These larvae were exposed out of the water in mesh for 30 seconds. Immediately, allocating them in its corresponding plastic container to determine survival after 24 h. Final survival was calculated by individual counting of all alive larvae.

Statistical analysis of data was performed using the IBM SPSS software. In the first place we had to know if the size and weight samples followed a normal distribution. To do this, we performed a nonparametric test of Kolmogorov-Smirnov for samples with more than 50 data and of Shapiro-Wilk for samples of less than 50 data. After confirming that the samples follow a normal distribution, the analysis of the variance was performed, using the ANOVA function in the statistical program and comparing the significant differences that might exist between different diets. The variances homogeneity test, a Levene test was also performed. When the ANOVA results showed significant differences between the different diets, we proceeded to perform a Tukey test that showed that diets presented significant differences between them.

3. Results

The results of temperature (° C) and oxygen (mg ml-1) averaged **20.51 ± 0.58 ° C** and **6.19 ± 1.24 mg ml -1** respectively.

Hatching rate of spawning was **96.60%** and survival rate on 3rd day was **96%.**

The results of the larval size and weight data as well as the biomass, the survival rate and the activity test were obtained along the experiment are showed in Table 1, (p-value > 0.05).

Tabla1. Total length, dry, weight, biomass, survival rate and activity test larvae fed with different diets along the experiment.

	4º DAH		12º DAH		18º DAH				
	Lenght(mm)	**Weight(mg)**	**Lenght(mm)**	**Weight(mg)**	**Lenght(mm)**	**Weight(mg)**	**Biomass(mg)**	**Survival rate(%)**	**Activity test(%)**
Initial	3,326±0,258	0.06	-	-	-	-	-	-	-
ISO DIET	-	-	$3,583\pm0,337^{a}$	$0,067\pm0,004^{a}$	$4,893\pm0,442^{ab}$	$0,087\pm0,011^{a}$	$292,911^{a}$	$20,18^{a}$	$89,3^{a}$
GIA DIET	-	-	$3,468\pm0,287^{a}$	$0,077\pm0,037^{a}$	$4,803\pm0,443^{a}$	$0,121\pm0,070^{a}$	$316,727^{a}$	$11,64^{a}$	$95,47^{a}$
50/50 DIET	-	-	$3,544\pm0,317^{a}$	$0,079\pm0,024^{a}$	$5,036\pm0,422^{b}$	$0,099\pm0,033^{a}$	$246,761^{a}$	$15,13^{a}$	$84,8^{a}$
SIN DIET	-	-	$3,588\pm0,361^{a}$	$0,063\pm0,004^{a}$	$4,968\pm0,409^{b}$	$0,084\pm0,036^{a}$	$184,936^{a}$	$14,39^{a}$	$97,7^{a}$

Values (mean and standard deviation) with the same letters are not significantly different (p-value > 0.05) (n=30)

3.1 Lenght

Total length data obtained on the 12 DAH were not significant (p-value >0.005) and showed very little variation among the four diets supplied. The best result was obtained in SIN diet (3.588±0.361mm), while the lowest data was recorded in GIA diet (3.468±0.361mm) (Figure 5).

However, the size data obtained on the 18 DAH showed significant differences between the diets supplied (p-value = 0.003), differences were observed between GIA diet (Ori-Green diet) lenght (4.803 ± 0.443 mm) and 50/50 diet which has a mean of 5.036±0.422. The other diets (ISO diet and SIN diet) did not present significant differences between them (Figure 6).

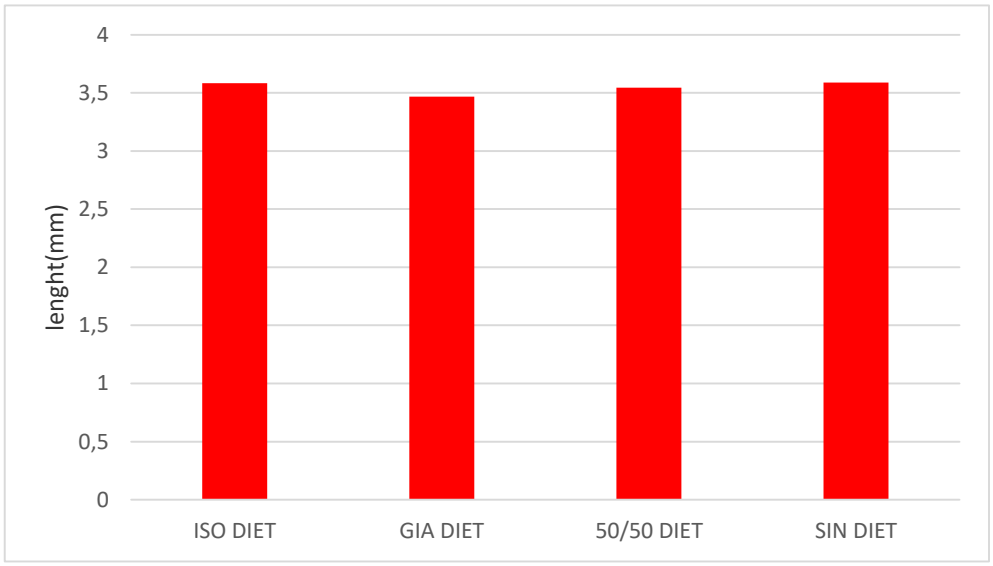

Figure 5. Total lenght larvae sea bream larvae (12 DAH) fed with the different diets (p-value>0.05) (n=30).

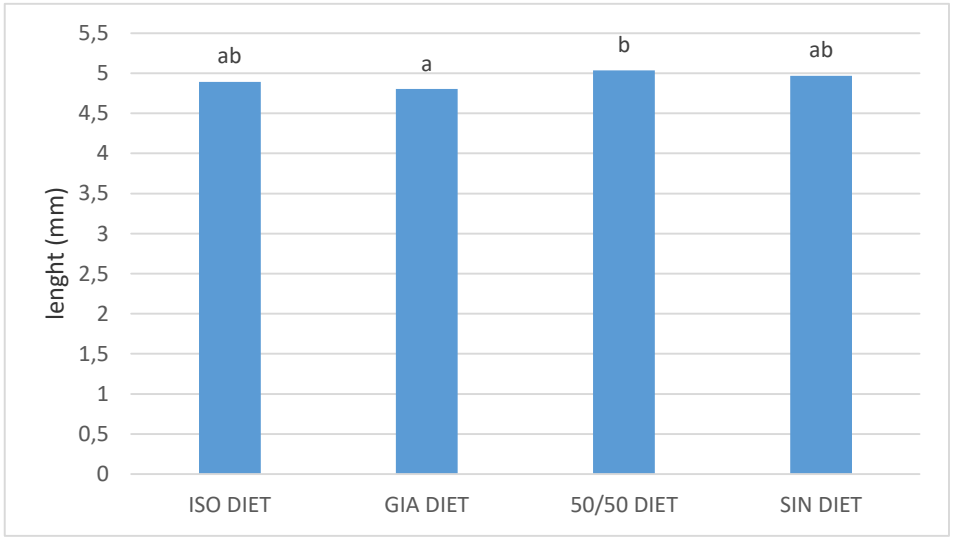

Figure 6. Total lenght of sea bream larvae fed with the different diets at the end of experiment (n=30). The diets with the same letters are not significantly different (p-value > 0.05).

3.2 Weight

Intermediate weight results obtained were not significant (p-value >0.05). Although small weight differences were observed between the 50/50 diet (half with astanxanthine and half without astaxanthin) which recorded the highest weight (0.079 ± 0.024 mg) and the SIN (No astaxanthin) diet which registered the lowest weight of the four diets supplied with an average of 0.063 ± 0.004mg (Figure 7).

Total weight results on the 18 DAH were also not significant (p-value >0.05). Weight gain was recorded in all diets with respect to the data obtained on the 12 DAH. The diet with the highest weight was the GIA diet (Ori-Green diet), which recorded a mean weight of 0.121 ± 0.070 mg. The lowest weight was found again in the SIN diet with a mean of 0.084 ± 0.036 mg (Figure 8).

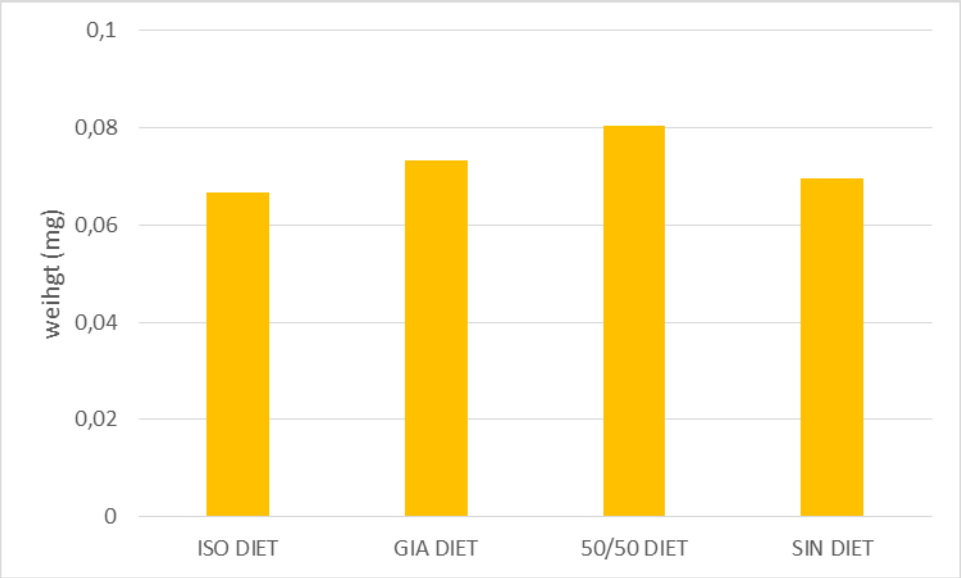

Figure 7. Intermediate dry weight of sea bream larvae fed with the different diets.

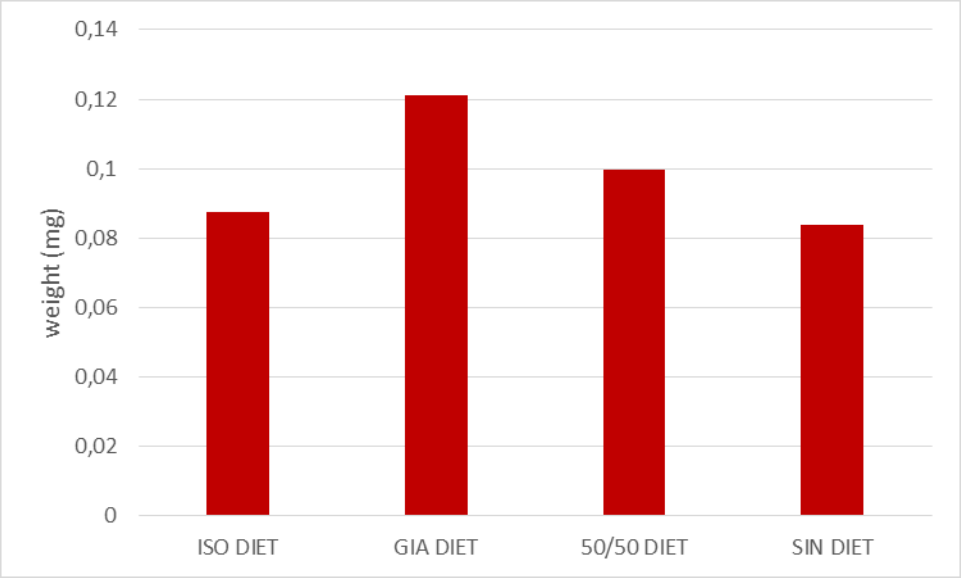

Figure 8. Dry weight of sea bream larvae fed with the different diets at the end of experiment.

3.3 Biomass

The biomass data obtained did not show significant differences (p-value> 0.05). The recorded biomass results revealed that the biomass data recorded in the diets with the presence of axtasanthin (ISO and 50/50) recorded the highest biomass data, while SIN (No astaxanthin) diet recorded the lowest biomass level (Figure 9).

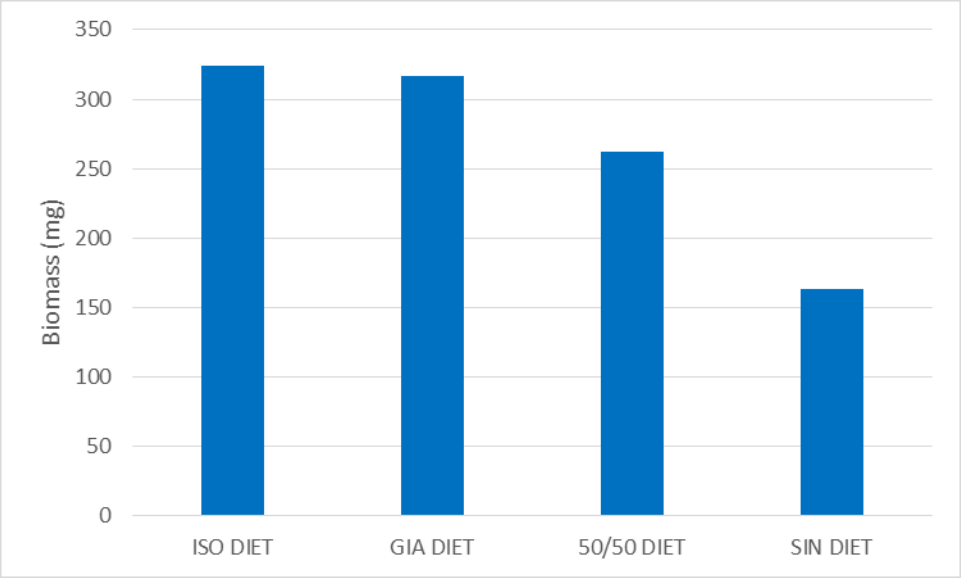

Figure 9. Biomass (mg) of sea bream larvae at the end of the experiment according to different diets.

3.4 Survival rate

Survival rate of larvae fed different diets did not present significant differences (p-value >0.05). The highest survival rate was obtained in ISO diet (astaxanthin diet) while the number of animals that survived the GIA diet was the lowest followed by the SIN diet which also recorded a low survival rate (Figure 10).

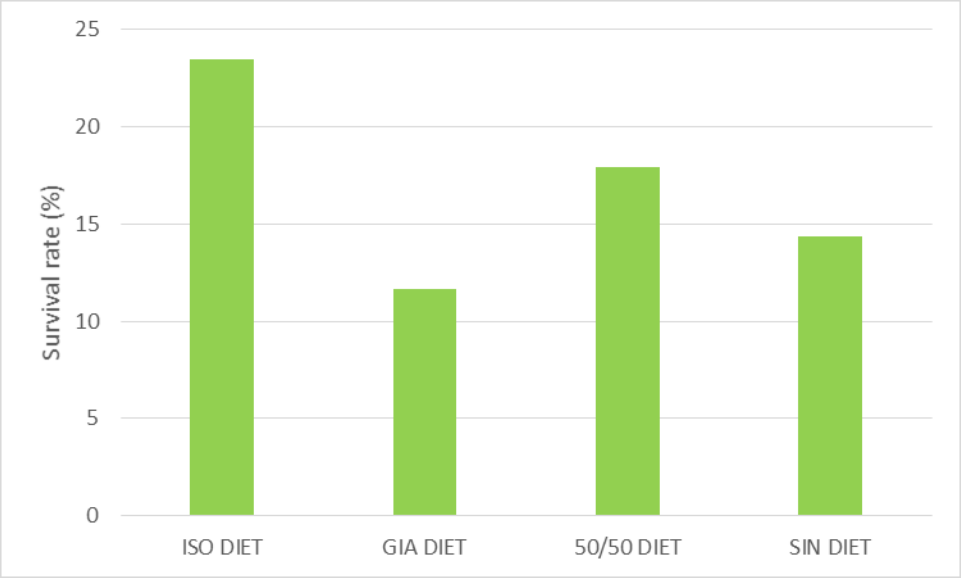

Figure 10. Survival rate (%) of sea bream larvae at the end of the experiment according to different diets

3.5 Activity test

The activity test data obtained did not show significant differences (p-value> 0.05). It showed that the animals most resistant to stress were those that were fed with the SIN diet and recorded a percentage of 97.7% survival. Less stress-resistant larvae were those fed diets containing astaxanthin (ISO and 50/50) with the lowest survival percentage in the 50/50 diet with 84.8% (Figure 11).

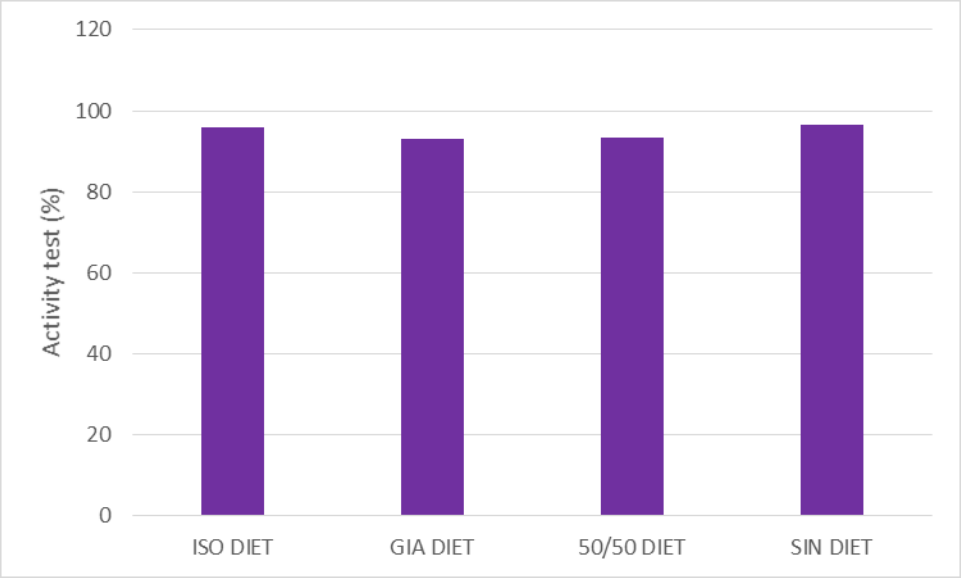

Figure 11. Survival rate of sea bream larvae in response to activity test at the end of the experiment according to different diets (P >0.05), (n=25)

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4. Discussion

Most fish species present a critical stage during the first days of life, resulting in a high mortality rate. Feeding is one of the most influential factors and the main lines of research are focused on the reduction of this mortality rate with the improvement of the quality of the food supplied (Pascual & Yúfera, 1987).

There are many studies on the importance of the use of carotenoids in the nutrition of aquatic species. As a source of antioxidants and vitamins, axtasanthin has reported very positive results in terms of larval growth and survival (Roldan-Libenson *et al*., 1999; Meyers, 2000).

In our experiment we found significant differences in larval size, with larvae being the largest ones fed diets based on *Isochrysis sp* (ISO diet, 50/50 diet, Sin diet). The GIA diet (Ori-green diet) reported the smallest mean size of larvae. This result does not agree with the work described by Fernández-Ártiles (2014), whose size data were not significant. Probably this difference is due to the quality of the spawning. Fernandez-Palacios (2005) stated that the quality of the spawning influences the quality of larvae.

Sorandra-Rota (2014) obtained significant differences in the sizes of larvae enriched with astaxanthin, being these the ones that obtained better results. In addition, other studies have corroborated that the presence of astaxanthin positively influences the size of the larvae. In an experiment carried out by Roldan-Libenson *et al.,* 1999, working with *Paralabrax maculatofasciatos*, In an experiment carried out by Rolda-Libenson *et al.*, 1999 in which they compared two larvae tanks of species, one fed with rotifers enriched with lobster oil (rich in astaxanthin) and the other with squid oil, resulted in a higher growth in larvae fed on rotifers enriched with lobster oil (rich in astaxanthin). This does not correspond to the results obtained in our experiment. If we compare the diets with *Isochrysis sp* based on the presence or absence of astaxanthin, we can observe that there are hardly any differences between the ISO and 50/50 diets (presence of astaxanthin) and the diet SIN In astaxanthin). Therefore, we can not say that astaxanthin has directly affected the size of the larvae. These authors stated that to find positive results with the diets rich in axtasanthin the larvae should be fed for an extended period of time. May be it is a reason why in our experiment we did not find significant

differences, since our treatment lasted approximately 20 days which larvae were ating during 15 days.

The weight results of the larvae fed the GIA diet showed the highest mean weight. These larval weight results could be related to the larval density within the tank. Roo *et al.*, 2010 analyzed larval growth based on population density and showed that the lowest population densities recorded the highest growth rates. Fernández-Ártiles (2014) corroborated that the larvae with lower larval density recorded the highest growth data, this coincides with our results considering that the lowest survival rate is recorded precisely in the larvae fed with the GIA diet, so we can state that lower density of larvae favored the increase of their weight.

In biomass data we perceived good results in diets containing *Isochrysis sp*, although the highest biomass data was recorded in the GIA diet. (Hernández-Cruz *et al.*, 1999; Roo *et al.*, 2010; Fernández-Ártiles, 2014) observed high biomass in larvae fed with *Isochrysis sp*, this increase is associated with reduced growth. However, this does not agree with our data since we recorded the highest biomass index in the GIA diet, which in turn shows the highest growth. These results may be due to the high error rate of the biomass of the larvae fed with the GIA diet, probably due to the so-called "tank effect" that occurred in some of the tanks in which it was fed with this diet. We can not give a concrete reason why high mortality occurs in these tanks.

Among the diets with *Isochrysis sp*, we found a high survival in the ISO diet (presence of astaxanthin). Roldan-Libenson *et al.*, 1999, proposed that rotifers fed an enricher with high pigmentation favors the pigmentation of the rotifer itself so they will be more visible to the larvae and facilitate their capture, although it also states that the main benefit of the presence of pigment is the great nutritional contribution that this presents in our experiment we can perceive a tendency of improvement of the survival thanks to the presence of astaxanthin.

It should be noted that the presence of PUFAs such as DHA and EPA in diets contribute to improvements in the evolution of larval culture, such as improvements in vision, resulting in greater efficacy in captures (Rivera & Botero, 2009, Fernández-Ártiles, 2014). *Isochrysis sp* in particular has a high DHA content that favors larval survival and

development (Fernández-Ártiles, 2014). This can be contrasted with our data observing that the greatest survivals are recorded in the diets based on *Isochrysis sp*.

The activity test performed to evaluate the resistance of the larvae does not show significant differences. The resistance rate to the highest activity test was that of larvae fed with diet SIN (not astaxanthin) and do not provide accurate information that may lead us to believe that the presence of *Isochrysis sp* has favored the resistance of the larvae to the stress. This is contrary to that reported by Fernandez-Ártiles (2014) whose data showed that the diet with *Isochrysis sp* reported the best results in terms of survival. For this reason these data need to be corroborated by the corresponding biochemical analyzes to be able to assure ourselves of the amount of fatty acids that the diets possess and requirements of larvae are being covered.

5. Conclusion

1. The presence of astaxanthin in the diets seems to provide good survival results. This may favors the predatory capacity of the larvae, and make catching of prey easier by larvae.

2. The growth and development of the larvae is affected by the density of larvae that exist in the tank.

3. The absence of astaxanthin in the diet would not impair the resistance of the larvae to stressful situations.

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Hoja de experiencia personal.

Descripción detallada de las actividades desarrolladas durante la realización del TFT con su temporalización.

La realización de este experimento se llevo a cabo en las instalaciones del Parque Científico-Tecnologico de Taliarte. Para la obtención de los distintos resultados se tomaron 12 tanques con larvas de Dorada (*Sparus aurata*) y durante 15 dias fueron alimentadas con distintos tratamientos. Durante los días que duró el experimento dedicaba parte del tiempo a la búsqueda de bibliografía para el desarrollo de la introducción y la discusión de este trabajo. Al final del experimento tome datos de talla peso y supervivencia de las larvas de cada tanque para la obtención de los distintos resultados reflejados en este trabajo. Para el tratamiento de datos utilicé el programa estadístico SPSS para conocer si había obtenido diferencias significativas entre las diferentes dietas que suministré. Una vez obtenido los datos procedí a escribir el manuscrito empleando la bibliografía buscada para discutir con otros autores los resultados de mí trabajo. Durante el experimento tuve varias tutorías con la Dra. Carmen María Hernández Cruz, la cual me ha ido guiando durante todo el tiempo que estuve escribiendo el documento. Entre la duración del experimento y el tiempo de escritura del manuscrito trasncurrieron un total de 2 meses.

Formación recibida (cursos, programas informáticos, etc.)

Durante la realización de este trabajo tuve que adquirir conocimientos en la practica del cultivo de larvas, aprendiendo a tratarlas durante los primeros días de vida, el tipo de alimentos que debía suministrar, como mantener los tanques para el correcto desarrollo de un cultivo de larvas y cuales son las mejores técnicas para conseguir resultados positivos en crecimiento y supervivencia de las mismas. A si mismo, tuve que adquirir conocimientos acerca del uso del programa estadístico SPSS para poder procesar todos los datos obtenidos.

Nivel de integración e implicación dentro del departamento y relaciones con el personal.

Durante mi estancia en el Parque científico tecnológico de Taliarte tuve la ocasión de trabajar con ciencificos muy reconocidos en el ámbito de la acuicultura. Desde el principio me sentí acogido no solo por los doctores del centro sino por los técnicos de la planta y los estudiantes. Siempre se mostraron dispuestos a colaborar conmigo en todo lo que necesitaba y siempre me trataron como uno más en su equipo. Gracias a ellos mi nivel de conocimientos sobre este mundo fue bastante satisfactorio.

Aspectos positivos y negativos más significativos relacionados con el desarrollo del TFT.

Los aspectos positivos sin duda ha sido la cantidad de conocimiento y destrezas que he adquirido durante la elaboración del mismo. Me ha ayudado a verme como una persona autosuficiente y capaz de trabajar en el ámbito de las ciencias marinas.

Los aspectos negativos es sin duda en los momentos mas duros del proyecto, tanto por la cantidad de horas que hay que dedicarle como en los momentos en los que no tienes claro si el trabajo que estas haciendo va por buen camino, esos momentos son los que generan mas inseguridad.

Valoración personal del aprendizaje conseguido a lo largo del TFT.

Valoro de forma muy positiva el aprendizaje adquirido. He conseguido mayor destreza a la hora de elaborar proyectos de investigación, elaboración de manuscritos y sobretodo los procesos a seguir durante un proyecto de cultivo larvario que es sin duda uno de los experimentos mas duros y complicados que un experto en acuicultura puede desarrollar. Por lo tanto me siento muy satisfecho con mi paso por estas instalaciones y por los conocimientos adquiridos.