

RESULTS OF THE FIRST GROWTH TRIAL CARRIED OUT IN MALTA WITH 60 KG FARMED ATLANTIC BLUEFIN TUNA (*THUNNUS THYNNUS* L.)

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SUMMARY

As part of its scientific objectives, the Federation of Maltese Aquaculture Producers (FMAP) organised and carried out its first growth trial in a cage of one of its members in order to determine the increase in weight and length of Atlantic bluefin tuna (Thunnus thynnus)(BFT). The growth trial, which lasted from February to June 2009, used approximately 300 bluefin tuna from the 2008 fishing season. The average sea temperature during the experiment was 17°C. Other measurements were taken at each sampling point, as were samples for further analyses (chemical, histological and genetic). From an average round weight (RWT) of 60.9kg the bluefin tuna grew to an average RWT of 87.4 kg, an increase of 43.5%. Fork length (FL) increased from an average of 142.5cm to an average of 157.9 cm by the end of the trial period, an increase of 10.8%. The results obtained here clearly indicate a significant growth in farmed bluefin tuna even at the low average temperature of 17°C. The data presented here, along with other data and indicators available, should be used to update stock assessments incorporating more realistic input RWT figures from bluefin tuna farms.

RESUME

Dans le cadre de ses objectifs scientifiques, la Fédération maltaise des producteurs aquacoles (FMAP) a organisé et réalisé son premier essai de croissance dans une cage de l'un de ses membres afin de déterminer l'augmentation de poids et de taille du thon rouge de l'Atlantique (Thunnus thynnus) (BFT). L'essai de croissance, qui a été mené de février à juin 2009, a utilisé environ 300 thons rouges provenant de la saison de pêche 2008. La température moyenne de l'eau de mer pendant l'expérience était de 17 °C. D'autres mesures ont été prises à chaque point de l'échantillonnage, et des échantillons ont été réalisés en vue de procéder à des analyses supplémentaires (chimiques, histologiques et génétiques). Depuis un poids vif moyen de 60,9 kg, le thon rouge a atteint un poids vif moyen de 87,4 kg, ce qui représente une augmentation de 43,5 %. La longueur à la fourche a augmenté d'une moyenne de 142,5 cm jusqu'à une moyenne de 157,9 cm à la fin de la période de l'expérience, soit une augmentation de 10,8 %. Les résultats obtenus indiquent clairement une croissance significative du thon rouge engraisé, même à une température moyenne basse de 17 °C. Les données présentées dans ce document, ainsi que d'autres données et indicateurs disponibles, devraient être utilisés pour actualiser les évaluations de stock en intégrant des chiffres d'entrée de poids vif plus réalistes provenant des établissements d'engraissement de thon rouge.

RESUMEN

Como parte de sus objetivos científicos, la Federación de Productores Acuícolas de Malta (FMAP) organizó y llevó a cabo su primer ensayo de crecimiento en una jaula de uno de sus miembros con el fin de determinar el aumento en peso y talla del atún rojo del Atlántico (Thunnus thynnus L.) (BFT). El ensayo de crecimiento, que duró desde febrero a junio de 2009, utilizó aproximadamente 300 atunes rojos de la temporada de pesca de 2008. La temperatura media del mar durante el experimento fue de 17°C. Se llevaron a cabo otras mediciones en cada punto de muestreo, y se tomaron muestras para realizar otros análisis (químicos, histológicos y genéticos). Desde un peso vivo medio (RWT) de 60,9 kg, el atún rojo creció hasta un peso vivo medio de 87,4 kg, lo que supone un aumento del 43,5%. La longitud a la horquilla (FL) aumentó desde una media de 142,5 cm hasta una media de 157,9 cm al final del periodo de ensayo, un aumento del 10,8%. Los resultados obtenidos indican claramente un crecimiento significativo en el atún rojo engordado incluso con una temperatura media baja, de 17°C. Los

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datos presentados aquí, junto con otros datos e indicadores disponibles, debería utilizarse para actualizar las evaluaciones de stock incorporando unas cifras de entrada de peso vivo más realistas procedentes de las instalaciones de engorde de atún rojo.

KEYWORDS

Atlantic bluefin tuna, Thunnus thynnus, farming, growth, length, weight

1. Introduction

The growth of the Atlantic bluefin tuna (*Thunnus thynnus* L.) (BFT) in the wild has been described by various authors using different von Bertalanffy growth models. The development of BFT farming, whereby fish are not harvested immediately but are transferred into cages for the purpose of increasing the weight and quality of the fish, results in growth characteristics which are different to those in the wild. As a consequence, a new measure of the growth rate occurring in cages is required in order to be able to calculate the quantity of BFT placed in the cages at the beginning of the farming period, data which is essential for the purpose of carrying out meaningful and accurate stock assessments. Unfortunately information on the growth rates of BFT in cages is limited. As part of its programme to provide scientific information on the growth occurring in BFT farmed in Maltese cages, the Federation of Maltese Aquaculture Producers (FMAP) carried out its first growth trial in a cage of one of its members.

2. Materials and methods

Approximately 300 bluefin tuna (BFT) caught by commercial purse-seining during the 2008 fishing season (Mediterranean, FAO Fishing Area 37, SubArea 37.2.2) were transferred from a larger stock of fish at the beginning of February 2009 into a 50m diameter, 20m deep cage belonging to Fish and Fish Ltd, which is situated in 55m deep water off the South East coast of Malta, for the purpose of carrying out the growth trial. The cage site is an exposed offshore site experiencing strong currents and having good water circulation. Salinity during the experiment was 37.8 ppt and oxygen saturation was >95%. The average water temperature during the trial period was 16.9°C (average temperatures: February: 15.0°C; March: 14.8°C; April: 15.8°C; May: 19.1°C; June: 21.9°C). All harvesting was carried out in the presence of Government of Malta Harvesting Officers.

At the beginning of the trial (2nd February 2009) 31 fish were harvested and individually weighed (RWT) using a digital balance having an accuracy of ± 1 kg. The following measurements were also recorded for each fish when possible: fork length (FL), curved fork length (CFL), first dorsal length (LD1), gilled and gutted weight (GG), dressed weight (DWT) and sex of fish. In addition, the following samples were taken when possible: first dorsal fin for age determination, gonads for histological analysis, livers for histological analysis, livers for chemical analysis, caudal fins for DNA analysis and piece of tail meat for chemical analysis.

During the experiment, the fish were fed by experienced staff on commercially available defrosted mackerel (*Scomber* spp.) and herring (*Clupea harengus*) twice a day according to standard farm practices.

The trial was concluded on the 19th of June. At the end of the experiment another 31 fish were harvested. The individual RWTs of the harvested fish were recorded. In addition, the same measurements and samples taken at the beginning of the trial were also taken where possible.

3. Results and discussion

The measurements taken from the beginning of the trial and the end of the trial are summarised in **Tables 1** and **2**, respectively. Fish grew from an average RWT of 60.9kg to an average RWT of 87.4kg at the end of the trial. FL increased from 142.5cm to 157.9cm (final FLs calculated from CFLs using a factor of 0.955 (Parrack, Brunenmeister and Nichols, 1979)). This represents an increase in RWT and FL of 43.5% and 10.8% respectively over the trial period.

Giant BFT (>185cm, 122kg) have been reported to show increases in weight of 7.5% between May/June and July/September (Rivas, 1955, cited in Mather, Masan and Jones, 1995) and up to 10% per month between the

months of August and October (Butler, 1974, cited in Mather et al., 1995). Therefore, it is not unreasonable to expect that BFT, which are kept in cages for the main purpose of increasing the weight and quality, to exhibit a significant increase in RWT and FL during the period between capture and eventual harvesting. The restricted swimming activity combined with consistent high level of feeding enables fish to put on weight rapidly and efficiently.

Other authors have also seen significant increases in RWT and FL after rearing BFT in farms.

Karativ, Ticina & Franicevic (2002) reported significant increase in RWT and FL in a preliminary study using small numbers of tagged 4kg (64cm) and 15kg (96cm) BFT in Croatia. After a rearing period of 516 days, the smaller fish had grown to 27kg in RWT and 111cm in FL (increases of 547% and 73% respectively). During the same period the larger fish had a RWT of 52kg and a FL of 138cm (256% and 43% increases respectively). In another preliminary trial reported by Katavic, Ticina & Franicevic (2003) in Croatia, it was found that tagged BFT having a starting average RWT of 12kg reached approximately 45kg after 540 days (an increase of 275%). Smaller BFT of 5kg starting RWT grew to between 25 and 30kg in the same period (an increase of between 400 and 500%).

In an experiment (Croatia) with tagged 1 and 2 year old BFT Ticina, Katavic & Grubisic (2007) found growth of 326% and 219% over the experimental period lasting between 507 and 526 days and between 572 and 597 days respectively at an average temperature of 18.1 and 18.6°C respectively (and even though the tagged fish actually lost weight during the first two months post-tagging). In a separate cage trial with approximately 25 MT of BFT with an initial average RWT of 6.4kg and at an average temperature of 18.3°C, the same authors harvested fish of 28.3kg average RWT, equivalent to a growth of 343%, after 511 days.

In two cage trials with larger BFT carried out in the south of Spain and during which 12 fish were randomly harvested from each cage at two monthly intervals, Gimenez-Casalduero & Sanchez-Jerez (2006) found that over a six month period, BFT of 140.7kg RWT grew to 303.9kg (116% increase in RWT) in one cage and from 131.4kg to 202.3kg (54% increase) in the other cage. FLs in the two cages increased from 193.2cm to 253.3cm (31% increase in FL) and from 194.3cm to 233.9cm (20% increase) respectively over the experimental period.

The trial described in this paper was designed to provide an indication of the levels of growth which can be expected from this fish under farming conditions in Malta. The level of growth achieved was obtained at the relatively low temperature of 17°C. In Malta the average temperature of the second half of the year, during which any new stock will be reared, is around 24°C; the difference in temperature in the second half of the year would be expected to have a very big impact on the growth rate of the BFT and the increase in RWT and FL would be expected to be even bigger than that seen in this experiment.

Further experiments are required to determine the growth rates of BFT of different sizes grown under different rearing conditions and under different environmental conditions. The results presented here, along with some available indicators, already provide some of the necessary information required to better establish the growth rates applicable in BFT farms. These should then be used to carry out of a more accurate updated stock assessment incorporating more realistic input RWT figures from BFT farms.

Acknowledgments

This work was funded by the Federation of Maltese Aquaculture Producers as part of their ongoing research programme on bluefin tuna biology.

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Table 1. Summary of measurements taken and samples available from the beginning of the first growth trial with farmed bluefin tuna, *Thunnus thynnus*, carried out in Malta (RWT = Round weight; FL = Fork length; CFL = Curved fork length; LD1 = First dorsal length; GG = Gilled and gutted weight; DR = Dressed weight).

<i>Parameter</i>	<i>n</i>	<i>Average</i>	<i>Standard deviation</i>
RWT (kg)	31	60.9	8.5
FL (cm)	31	142.5	6.3
CFL (cm)	31	149.9	6.9
LD1 (cm)	31	43.2	1.8
GG (kg)	17	54.8	6.4
DR (kg)	19	47.5	7.2
Sex	30	19 female/11 male	
	<i>Samples available</i>		
First dorsal fins		10	
Gonads for histology		31	
Livers for histology		31	
Livers for chemical analysis		21	
Fins for DNA analysis		30	
Tail meat for chemical analysis		21	

Table 2. Summary of measurements taken and samples available at the end of the first growth trial carried out with farmed bluefin tuna, *Thunnus thynnus*, in Malta (RWT = Round weight; FL = Fork length; CFL = Curved fork length; LD1 = First dorsal length; GG = Gilled and gutted weight; DR = Dressed weight).

<i>Parameter</i>	<i>n</i>	<i>Average</i>	<i>Standard deviation</i>
RWT (kg)	31	87.4	15.7
CFL (cm)	20	165.4	11.9
FL (cm) ¹	20	157.9	11.4
GG (kg)	1	81.0	
DR (kg)	30	69.1	13.3
Sex	14	9 female/5 male	
	<i>Samples available</i>		
Gonads for histology		14	
Livers for histology		15	
Livers for chemical analysis		15	
Fins for DNA analysis		27	
Tail meat for chemical analysis		27	

¹ FLs calculated from CFLs using a factor of 0.955 (Parrack, Brunenmeister and Nichols, 1979).