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DETERMINATION OF FILLET YIELD IN CULTURED BLUEFIN TUNA, *THUNNUS THYNNUS* (LINNAEUS 1758) IN TURKEY

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SUMMARY

Fillet yield determination was carried out in fattened cultured bluefin tuna (BFT) in two different fish farms, Antalya and İzmir, in Turkey. The fish were filleted by single filleter and average fillet yield was obtained 73.92% ±1.50 and 74.41%±1.40 for big size fish (>120 kg) and 73.18%±1.45 for medium size fish (60 to <120 kg) in the first farm. The size of the bluefin tuna did not affect the yield in the first farm. The second trial was carried out in a bluefin tuna farm in İzmir. The fish were filleted by multi filleters and the fillet yield was 71.4% (±2) for large size tuna, 71.1% (±1.4) for medium size, and the average fillet yield was found to be 71.3% (±1.6). There were no significant differences (p>0.05) between the size of tuna and the fillet yield in both farms. However, loin yield was significantly higher in the first farm than in the second farm. The conversion factor that is currently in use for exported bluefin tuna fillet (1.67) by ICCAT needs to be re-modified for farmed fattened bluefin tuna. Therefore, the present conversion needs to be reconsidered for farmed tuna and a new conversion factor may be suggested as 1.38 for farmed bluefin tuna.

RÉSUMÉ

Un calcul du rendement des filets de thon rouge engraissé (BFT) a été réalisé dans deux fermes différentes : Antalya et Izmir, en Turquie. Les poissons ont été découpés en filets par un fileteur et l'on a obtenu une production moyenne des filets de 73,92% ±1,50 et 74,41%±1,40 pour les poissons de grande taille (>120 kg) et de 73,18%±1,45 pour les poissons de taille moyenne (60 à <120 kg) dans la première ferme. La taille du thon rouge n'a pas affecté la production dans la première ferme. Le deuxième essai a été mené dans une ferme de thon rouge à Izmir. Les poissons ont été découpés par plusieurs fileteurs et l'on a obtenu une production des filets de 71,4% (±2) pour les thons de grande taille, 71,1% (±1,4) pour ceux de taille moyenne, et la production moyenne des filets s'est établie à 71,3% (±1,6). Il n'est apparu aucune différence significative (p>0.05) entre la taille du thon et la production de filets dans les deux fermes. Toutefois, le poids de la longe était considérablement plus élevé dans la première ferme que dans la deuxième. Le coefficient de conversion actuellement utilisé par l'ICCAT pour les filets de thon rouge exportés (1,67) doit être modifié à nouveau pour le thon rouge engraissé. C'est pourquoi la présente conversion doit être réexaminée pour le thon engraissé et un nouveau coefficient de conversion de 1,38 pourrait être suggéré pour le thon rouge engraissé.

RESUMEN

Se llevó a cabo un cálculo del rendimiento en filetes para el atún rojo (BFT) engordado en dos instalaciones de engorde diferentes, en Antalia e Izmir, Turquía. Los atunes rojos fueron fileteados por un solo fileteador, y se obtuvo una producción media de filetes del 73,92% ±1,50 y 74,41%±1,40 para ejemplares grandes (>120 kg) y 73,18%±1,45 para ejemplares de talla media (60 a <120 kg) en la primera instalación de engorde. La talla de atún rojo no afectó a la producción en la primera instalación de engorde. La segunda prueba se llevó a cabo en la instalación de engorde de atún rojo de Izmir. Los atunes fueron fileteados por varios fileteadores y la producción de filetes se sitúo en 71,4% (±2) para los atunes grandes y en 71,1% (±1,4) para los atunes medianos, y el promedio de producción de filetes se situó en 71,3% (±1,6). No se observaron diferencias significativas (p>0,05) en lo que concierne a la talla del atún y la producción de filetes en ambas granjas. Sin embargo, el peso de los lomos fue significativamente superior en la primera instalación de engorde que en la segunda. El factor de conversión ICCAT que se utiliza actualmente para los filetes de atún rojo exportados (1,67) tendría que volverse a modificar para el atún rojo engordado. Por lo tanto, la

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conversión actual tiene que reconsiderarse para el atún rojo engordado y podría sugerirse un nuevo factor de conversión de 1,38 para el atún rojo engordado.

KEYWORDS

Bluefin tuna, Thunnus thynnus, yield predictions, fish fillets, fish conversion factor

1. Introduction

Bluefin tuna (BFT) farming dates back to late 1960s by a Japanese farm in Canada. Farming BFT was rapidly developed in the Mediterranean in 1990's. Initially large lean tuna was captured in the trap and was used for farming. Later, small to medium size tunas were caught and fattened over a period. Most of the fish were fattened several months then exported to the Japanese market. Initially, this product created a medium quality tuna in market and encourages the Mediterranean fishermen to concentrate efforts on blue fin tuna (Miyake *et al.*, 2003). The farming of BFT has been in progress for the last five decades. It is quite new for Turkey since the first BFT farm was established in early 2000s. Currently, total 11 BFT farms are approved by Ministry of Agriculture and Rural Affairs (MARA) and only 9 of them are operational. Annual productions capacities of these farms are almost 8140 metric tons (Deniz, 2008).

The aim of tuna farming is to increase the quality and quantity of tuna meat. Since such increase is not involved in fishing effort, it is hoped that the wastage of catching small tunas might be avoided and serve for better use of blue fin stocks. The ICCAT started the BFSD programme for frozen tuna in 1993 and fresh tuna in 1994. According to the Program, all the ICCAT members have to request any blue fin products, when imported to their lands, to be accompanied by a BFSD in which the weight of products by flag of the fishing vessels, general area and type of the products have to be recorded. The major objective of the Program is to identify unreported catches of blue fin tuna (Miyake *et al.*, 2003). Most of the tuna are imported to Japan and it covers most of the farmed fish exported on all over the world. Exported tuna are generally not whole and somehow processed as loin, fillet or dressed. To estimate the annual production of round weight BFT, fillet/ round weight conversion factor has been used. As reported by Miyake *et al.* (2003), for the products, the following conversion factors have been used and the increase in weight during farming has not been back calculated yet. Therefore the estimated value represents the harvest (landing) live weight.

Dressed x 1.25 = Round
Filleted x 1.67 = Round
Gilled and gutted x 1.13 = Round
Others x 2 = Round
Belly meat x 10.29 = Round

By this conversion factor, for each 100 kg fillet exported total 167 kg tuna are deducted from the exporting country's quota. However, BFT farmers and processor suggested that farmed BFT has higher meat yield than its wild counterpart and the use of the conversion factor 1.67 may not be appropriate for farmed tuna. Up to now, no data has been available on fillet/loin yield of farmed BFT to back calculate the round weight of BFT exported to International market. A new research was necessary to determine fillet and loin yield of BFT farmed in the Mediterranean Sea. For this reason, this research has been conducted in October 2008 and January 2009 in two BFT farms in order to make this uncertainty clear.

2. Material and methods

This research was carried out in two tuna farms in Antalya and İzmir Bay. The first experiment was conducted in Antalya Bay in October 2008 and the second experiment was carried out in a BFT farm in İzmir Bay in January 2009. A total 15 BFT were used in the first experiment with a different size and weight. The fish were harvested from the floating cages, and then transferred to the fish processing plant within 2 hours. The fish were weighed and labelled then filleted by a professional single filleter. Each fillet was weighed and recorded to the corresponding total body weight of BFT. In the second trial, the fish were harvested from the cages and transferred to the on board freezing vessel. Then the fish were selected randomly, labelled and weighed on the commercial digital scale with a (± 0.1kg sensitivity. Total 35 BFT were filleted by international multi filleters and loin/fillet weights were recorded as the same manner with the first experiment. BFTs were divided into 3 groups according to their weight and subjected to the different processing techniques namely loin (>120 kg), fillet (60-<120 kg) and dressed (<60 kg). In this study, only fillet and loin yields were determined. Yield percentage was determined as the ratio of fillet-loin weight to the total weight of the fish.

$$\% \text{ of yield} = \frac{W2}{W1} \times 100$$

Where; W1 is the total weight of fillet/loin and W2 represents the total weight of the fish

3. Results and discussion

A total of 50 BFT specimens were analysed for their meat yield. The experiment was carried out in a tuna processing plant. BFTs were processed based on their body weight. In this research both large size fish meat yield and medium size fish meat yields were measured. Tuna fish weighing over 120 kg (large size) are processed as loin (**Figure 1**), those between 60-120 kg (medium size) are filleted (**Figure 2**) and those less than 60 kg (small size) are dressed. The fillet yields of BFT raised in different farms are depicted on **Table 1**. The overall fillet yield of BFT was calculated as 73.92% and 71.3% in BFT that were fattened in Antalya and İzmir Bay, respectively.

The effect of fish size on meat yield was also investigated. The present findings showed that providing the BFT are raised in the same feeding regime and environmental condition, the effect of fish size on the fillet yield was negligible ($p=0.684$).

The second trial was carried out in İzmir bay and a total of 35 BFT were used. Fourteen of them were >120 kg and the remaining 21 fish were between 68 to 87 kg. The fillet yield of large size BFT farmed in İzmir Bay was 71.5% and the medium size BFT was 71.2% **(Table 1)**. The effect of the size (medium and big size) was statistically insignificant ($p=0.124$) in İzmir's specimen as well.

Figures 3 and **4** show the relationship between fillet yield and round weight. Linear relationships were obtained between body weight and fillet/loin yield in both the Antalya specimens ($y= 0.7516x – 1.8961$, $R^2 = 0.9989$) and the İzmir specimens ($y= 0.7146x – 0.1394$, $R^2 = 0.9991$). Based on this trend line, the fillet weight can be estimated by a given total weight of BFT for the corresponding farm.

Table 1 shows a comparative result of fillet yield in both farms. Compared to the fillets yields of BFT in the two farms, loin yield of big size BFT samples obtained in Antalya Bay was significantly higher (74.4%) than the BFT fattened in İzmir Bay (71.45%, $p<0.05$). The fillet yield of medium size BFT farmed in Antalya was not statistically significant ($p>0.05$) from the İzmir specimen. The small standard deviation in fillet yield indicates that the effect of the fish filleters is too small on meat yield. However, differences in the loin yields in two farms seem to be originated from the geographic location. It is obvious that the average fillet yield in BFT of both farms is much greater than that used in ICCAT's conversion factor **(Table 1)**.

According to the ICCAT conversion factor (1.67), 100 kg fillet or loin can be obtained from 167 kg round weight BFT. In this case, fillet/loin yield of BFT is accepted about 59.9%. The current findings indicate that fattened BFT yields in both farms were much greater than that calculated for wild BFT. The use of the present conversion factor may cause overestimation of fattened BFT loin to back calculate traded round BFT for statistics and official records.

Calculated new conversion factors for both BFT farms are depicted on **Table 1.** The conversion factor was similar for fillet and loin in the same farm, but it was significantly different between the two farms. It must be pointed out that new calculated conversion factor is much lower than the ICCAT conversion factor and this factor needs to be searched in other BFT farms that are operating in the Mediterranean countries.

In conclusion, the conversion factor for BFT cultivated in Antalya Bay was calculated as 1.34-1.37 and 1.40-1.41 in BFT farmed in İzmir Bay for loin and fillet, respectively. As indicated above, differences in the loin yields between the two farms may probably be due to the geographic location. As a result of the present study, the average conversion factor may be given for both regions as 1.38 and the use of this new conversion factor may be recommended to ICCAT Commission to calculate the total round weight of farmed BFT that are traded.

References

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Table 1. Comparison of meat yield of BFT raised in Antalya and İzmir Bay.

Size of BFT	*% yield of BFT (Antalya)*	*Calculated conversion factor*	*% yield of BFT (İzmir)*	*Calculated conversion factor*
Group 1 (Loin) >120 kg	74.41±1.40 (n=9)	1.34	71.4±2.0 (n=14)	1.40
Group 2 (Fillet) <120 kg	73.18±1.45 (n=6)	1.37	71.1±1.4 (n=21)	1.41
Overall mean ± SD	73.92 ±1.50 (n=15)	1.35	71.3±1.6 (n=35)	1.40

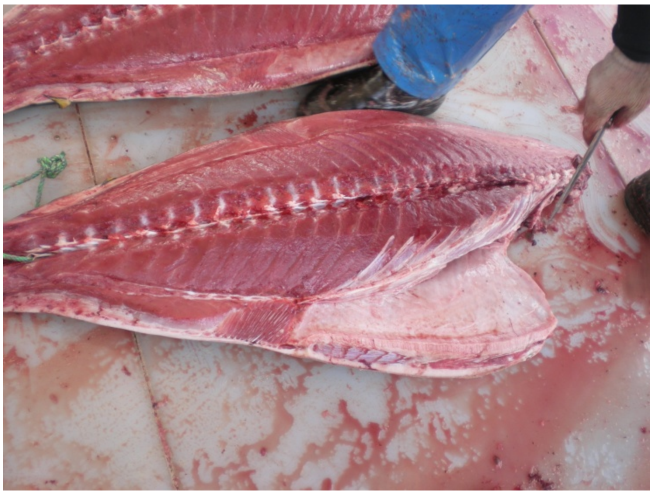

Figure 1. Filleting operation in farmed bluefin tuna.

Figure 2. Farmed BFT loins prior to freezing.

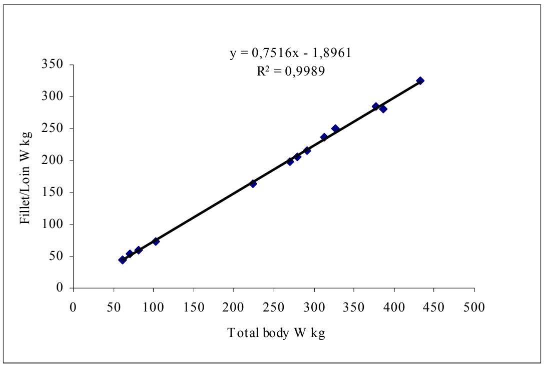

Figure 3. Body weight and loin/fillet yield relationship in BFT farmed in the Mediterranean Sea (Antalya).

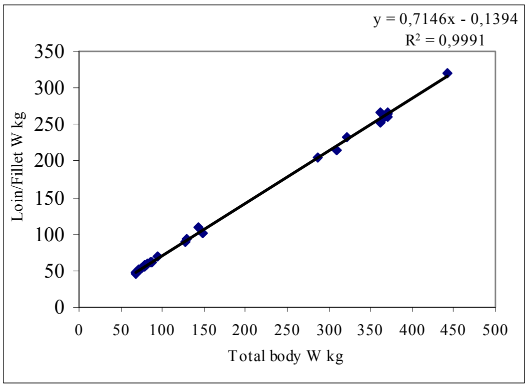

Figure 4. Body weight versus to loin/fillet yield in BFT farmed in Izmir Bay.