Description of the processing stages of a Protected Designation of Origin Fish Product: The Greek Caviar *"Avgotaracho Messolongiou"*

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Abstract

The "avgotaracho Messologgiou" PDO is a traditional product with protected designation of origin of which quality control based on the experience of the producers. This is salted, semi-dried whole ovaries of Mugil cephalus that caught during species spawning seaward migration in the barrier traps of the well-defined lagoon system of Mesolonghi-Etolikon. In the present study a description of the processing stages of the above product was conducted. Results showed that fresh ovaries drying on ambient air according to climatic conditions for approximately 8 days (mean 7.7 days), up to a weight reduction of about 33.63% (SD: 4.3%) of the initial weight. Thereafter, dried ovaries pass through the waxed-coating stage in which dried weight increased about 20.1% (SD: 4.3%). Although quality control is based on the experience of the producers, processing stages were characterized by high accuracy. The effect of climatic conditions on the processing stages was also analysed and discussed. The certification of the product as PDO would safeguard the traditional character of the product against the imports of frozen roes of M. cephalus originating by other regions due to the global expansion of the species.

Key-words: *PDO fish products, avgotaracho Messolonghiou, Messolonghi–Etoliko lagoons, dried salted roes, Mugil cephalus*

1. Introduction

Greek avgotaracho with trade name "avgotaracho Messolonghiou" is produced from fish caught in the Messolonghi–Etoliko lagoons, is famous for its quality and flavour and has a great commercial value (about 140€/kg at 2005) at local markets (KATSELIS et al., 2005). Documented history on the quality and commercial value of "avgotaracho

Messolonghiou" has been described since 16th century (TSELEBI, 1990), while a detailed description of the production has been reported since early of 20th century (PANAGIOTOPOULOS, 1916; STASINOPOULOS, 1926). Nowadays two types of "avgotaracho Messolonghiou" were processed. The traditional one that was produced by using traditional equipment based on producers' experience and the modern type that follows a standardized technique on salting, drying and waxing by using modern processing equipment.

The traditional product of "avgotaracho Messolonghiou" has been identified by the EU (07/02/1996), because of its long history and well-known reputation, as product with protected designation of origin (PDO) with the code EL/PDO/0017/0446 (EC 1263/96 with the name avgotaracho Messolonghiou PDO). It is the oldest PDO of the category of "Fresh fish, molluscs, crustaceans and products derived there from" and along with the roes extracted from *Coregonus albula*, which is the most commercially important fresh water species in Finland (MUJE et al., 2002), are the only EU PDO's derived from fish products. The main issues for the production of "Avgotaracho Messolonghiou" to be certified as a PDO were described in details in the above-mentioned Law that: (a) the origin of the fish must be from the Mesolonghi-Etolikon lagoons, (b) fish are caught using barrier traps during their spawning migration and (c) the whole process should be carried out in the lagoon facilities.

Almost 20 years after the certification of avgotaracho Messolonghiou PDO the first certified laboratory for the production of this product, which could be used by all fisherman associations that are leasing different sites of the system, was established by the fishermen association "Messolonghiou Renaissance". The PDO process was approved by the National organisation for the certification of qualifications and vocational guidance. This effort oriented to safeguard the traditional character of the product due to pressures received by roes produced by other Greek laboratories that are operating throughout the year by importing fresh (from the early of 20th century) (PANAGIOTOPOULOS, 1916) or frozen liver and gonads of other species and/or of *M. cephalus* by other countries (member states of EU and/or third countries). The establishment of a certified laboratory might also compensate the decrease of the traditional avgotaracho Messolonghiou values in local markets due to finance crisis occurred in Greece (MAKRI and KOUTSOURIS, 2015).

So far studies referred to avgotaracho Messolonghiou were focused on: (a) authentication of the mullet roe through biochemical methods (KLOSSA-KILIA et al., 2008), (b) chemical composition and nutritional value (KALOGEROPOULOS et al., 2008), (c) production estimation based to the landings of *M. cephalus* (KATSELIS et al., 2005, and (d) spawning migration of *M. cephalus* (VIDALIS et al., 1997; KATSELIS et al., 2007; 2015). Data on the product parameters during its manufacturing process are limited on rough estimations at each stage of the process (ROGDAKIS, 1994) and no information existed for the product traceability.

The aims of the present study were to assess the main technical characteristics of the manufacturing process of the *avgotaracho Messolonghiou PDO* followed by different producers in order to improve the traceability of the *PDO* product. The effect of climatic conditions on the processing stages was also examined, because air humidity is a critical factor on the food drying process (CHEN, 2009). It worthy to note that no data given for the obtained product's chemical composition (e.g., protein, oil, moisture, ash

and fatty and amino acid), because our aim was not to present an industrial-type manufacturing process, but to describe the stages and the traditional equipment and techniques followed by small-size units of fishermen to produce a traditional manufactured PDO fish product.

2. Materials and Methods

Traditional type of avgotaracho Messolonghiou

Ovaries for the production of avgotaracho Messolonghiou are derived from *M. cephalus* caught in the barrier traps of the lagoon and the stages for the traditional production of the product were listed below (Figure 1) (PANAGIOTOPOULOS, 1916; STASINOPOULOS, 1926):

Stage 1, sex separation: After fish caught, each specimen was disaggregated by sex as, fishermen slightly pushed the abdominal part of the fish to exert the genetic material; in males the genetic material is composed by a milky white liquid, whereas in females this is yellow and females are usually larger than males.

Stage 2, gonad extraction: The abdomen part of the fish was carved across the ventral fins below gills and up to anus and ovaries were removed from the visceral cavity. Ovaries are retained by the genital hole and are separated from the fish through a cut across the top of the anal fin up to the abdominal part located in 3-4 cm distance from the anus. This part of the abdominal area is called "foukari".

Stage 3 salting: Ovaries were immersed into seawater to be cleaned from blood and oddments of visceral organs. Then, ovaries were sequentially placed into wooden boxes, in which layers of natural salt have been deposited for approximately 2-6 hours according to their weight. Then, the ovaries are extracted, washed by seawater and released by the part of the abdominal area located in 3-4 cm distance from the anus ("foukari").

Stage 4, drying: Ovaries are sequentially placed onto a wooden plank by intervening between each other wooden sticks and the whole pack were placed into in a room (called "tsardaki" or "sintrivani") for drying. The "tsardaki" is located at a shady place that allowed the roes drying at ambient air and contamination by insects was prevented using an insect net all around the product. After 36-48 hours the ovaries are reversed onto the plank and the process continues.

Stage 5, final product: Fish roes are ready for immediate consumption or for maintaining in freeze for longed period (> 1 year) by covering all around with a thin layer of wax.

Samples of avgotaracho Messolonghiou PDO

The manufacturing process of avgotaracho Messolonghiou PDO carried out within Messolonghi-Etolikon lagoons (38o30'N21o05'E-30o15'N21o35'E) and the whole process was supervised by the Fishery Supervision of Western Greece Region (public service). Ovaries were derived from *M. cephalus* specimens caught in permanent fishing devices, namely barrier traps installed at the interface between the lagoon and the sea (KATSELIS et al., 2003), from 25 of August to 4 of October 2013. *M. cephalus* specimens were derived by two fishermen associations out of total eight fishermen associations leasing different parts of the lagoon system. The sampled roes were processed in

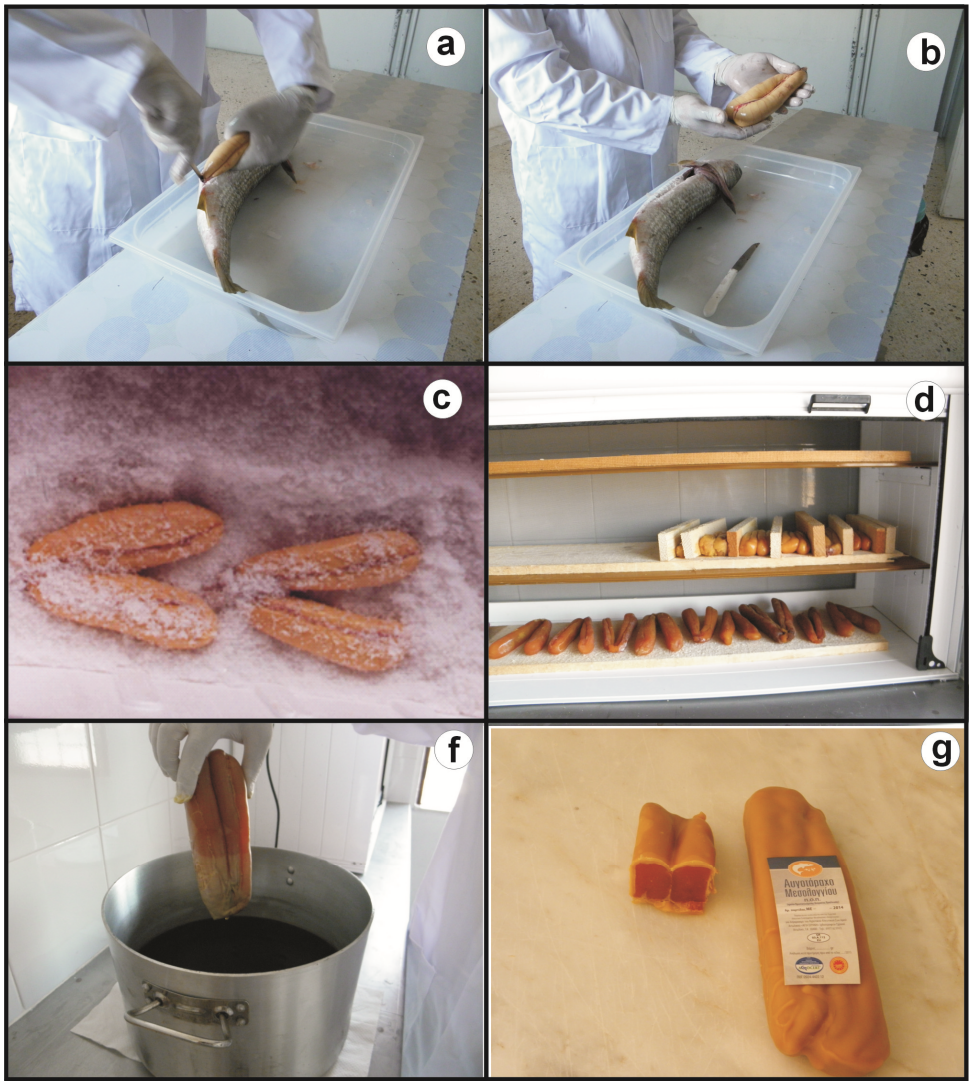

Figure 1. *Stages of the manufacturing process of the avgotaracho Messolonghiou PDO: (a,b) dissection of the ovaries from individuals of Mugil cephalus, (c) salting, (d) drying, (e) waxing and (f) final product.*

the above-mentioned certified laboratory and the entire manufacturing stages (as described above) were elaborated by fishermen/members of the two fishermen associations, which are also the same that caught the *M. cephalus*.

To better implement product traceability each piece was separately recorded in official bulletins by a member of the association according to the process established by the implementation of certification of origin. Each piece of roe acquires a unique number (EU/PDO label) that corresponds to any particular piece that ends up in the market in order to safeguard the origin of the product against roe products from other regions.

Sampled roes represent 70% of the total avgotaracho Messolonghiou PDO produced by the two fishermen associations in the Mesolonghi-Etolikon lagoons in 2013.

Data and analysis

Total body fish weight (W_{fm}), wet (W_{wt}), dried (W_{dr}) and waxed ovary weight (W_{wx}) (to the nearest 0.01 g), draining duration (DD), number of days needed for the manufacturing process were provided from the official bulletins. The gonadosomatic indices based on the wet (GSI_{wt}) and waxed (GSI_{wx}) ovary weights were estimated as:

$GSI_{wt} = 100*(W_{wt}/ W_{fm})$ and $GSI_{wx} = 100*(W_{wx}/ W_{fm})$, respectively.

Correlation analysis was used to investigate the linear relationships between pairs of the above variables (r; P< or equal to 0.05), while differences between producers on the above relationships were tested by analysis of covariance (ANCOVA; P=0.05) (ZAR, 1999).

The percentage changes in the ovary weight during drying (C_{dr}) and waxing (C_{wx}) processes were estimated as follows: $C_{dr} =100(1-W_{dr}/W_{wt})$ and $C_{wx} =100(W_{wx}/W_{dr}-1)$, respectively.

The coefficient of variation (CV) was computed for each variable according to:

$$CV = (100 \times SD) / X_m ,$$

where X_m and SD are the mean and standard deviation values. Differences on mean values and variances estimated from the samples derived between the two associations were tested using t-test (t-test; P=0.05) and F-ratio (F-ratio test; P= 0.05), respectively (ZAR, 1999). The percentage differences (Dif%) of biological variables between producers were calculated as follows:

$Dif\%=100(|X_1-X_2|)/X_{1,2}$, where X_1, X_2 and $X_{1,2}$ are the mean values of each of the different producers and pool sample, respectively.

The daily mean (Ta; ^oC), minimum (Tmin; ^oC), and maximum (Tmax; ^oC) air temperature, maximum (RHmx; %) and minimum (RHmn; %) relative humidity, wind velocity (v; m sec^{-1}) and wind direction (d; degree) during the period from 2 September to 20 October 2013. This period corresponds to the total drying period of the sample. Climatic data were provided by the meteorological station in Etoliko (www.meteo.gr).

The mean daily wind velocity and direction were also estimated and disaggregated into two components at the axes of the east-west (v_1) and north-south (v_2) according to the formulae:

$$v1 = v \cdot \cos(2\pi \frac{(450^o - d)}{360^o}) \text{ and } v2 = v \cdot \sin(2\pi \frac{(450^o - d)}{360^o}), \text{ where } \pi=3.14.$$

A Principal Component Analysis (PCA) was applied on the climatic variables [(rows) X (columns): (mid-date of drying period of each ovary) X (mean value and standard deviation of climatic variables of drying period of each ovary)]. PCA is a linear dimensionality reduction technique that reduces the possible collinearity between the original climatic variables and replaces the original variables by a smaller number of uncorrelated variables (factors) while keeping their maximum variance projecting them into a lower-dimensionality space. Factor loadings estimated the weight of each variable to the corresponding factor, while the produced data set of factor scores (FS_λ) per factor

λ indicated the linear relationship between the initial variables and the extracted factors (HAIR et al., 1998).

To identify linear relationships among the drying period, weight change of ovary during the draining and waxing and the climatic conditions, a multi-regression model (MREG) was applied:

$$Y_j = \left(c + \sum_{i=1}^{m} (k_i * X_i) + SE \right)_j ,$$

where Y_j is the DD, C_{dr} and C_{wx} for j=1, 2 and 3 respectively, c, and k_i, are coefficients estimated by the least squares regression techniques; for j=1 the X_i are the W_{wt} and FS_λ, for j=2 the X_i are the DD, W_{wt} and FS_λ and for j=3 the X_i are the C_{dr}, DD, W_{wt} and FS_λ, respectively; m is the number of the X variables and SE is the standard error (Zar, 1999). Significant X_i variables used in the final model were selected through the backward stepwise variable selection method (F-to-remove; $P \leq 0.05$) (ZAR, 1999). The explained variance of each depended variable is an index of the importance of the selected variable on the depended variable. The Variance Inflation Factor (VIF) was used to evaluate the collinearity level of the explanatory variables of multi-regression analysis. High value of VIF means a high level of collinearity. A common cut off threshold is VIF =10 (HAIR et al., 1998).

All models were developed using SPSS ver. 17.0 statistical package.

3. Results

A total number of 602 individuals of *M. cephalus*, which were used for the dissection of a corresponding number of ovaries, were sampled by two fishermen associations (276 and 326 specimens, respectively) in the Messolonghi-Etoliko lagoons. Table 1 presented the descriptive statistics of the variables relating to biological estimates of the sampled roes for each stage of the manufacturing process between the two studied fishermen associations. The CV of the abovementioned estimated distributions ranged from 12.9% (for C_{dr}) to 35.1% (for Wg_{dr}) (Table 1). Specimens of the *M. cephalus* used for the production of the roe mostly weighting from 750 g to 1750 g (93%) and that of the dissected ovaries (75%) from 150 g to 350 g.

Ovary mean weights (W_{wt}, W_{dr} and W_{wx}) and their variances, GSI_{wt} and GSI_{wx}, mean C_{wx}% and W_{fm} variance were significantly differed (t-test: $P<0.05$; F-ratio; $P<0.05$) between the two studied fishermen associations. In contrast, mean values and the variance of C_{dr}, and C_{wx}, and of mean W_{fm} were not significantly differed (t-test: $P>0.05$; F-ratio; $P>0.05$) between the two producers. The between producer percentage differences of the above variables ranged from 1.0 % (for DD) to 8.4% (for GSI_{wx}) (Table 1).

Significant positive correlations ($r>0.11$; df=602; $P<0.05$) between pairs of variables were recorded (Table 2). High correlations ($r>0.86$) were found between fish and gonad weights, among gonad weights ($r>0.97$) and between gonadosomatic indices ($r=0.90$) at different stage of the process. Significant differences on the relationships among pairs of variables between two studied fishermen associations were also found (ANCOVA; $F>75$; df=3,599; $P<0.05$).

Table 1. *Mean (SD: standard deviation), minimum and maximum values (Min-Max) of variables relating to biological estimates and to stages of the manufacturing process (abbreviations in text) between the different producers. ns: non-significant statistical difference, *: significant statistical difference at P=0.05.*

							Statistical comparison		
							for Mean	for Variance	
	Mean (SD)[a]	CV (%)	Min-Max	Producer 1	Producer 2	Dif%		F-ratio[b]	
Wfm (g)	1321.3 (359.5)	27.2	570-2980	1314.0 (403.5)	1329.8 (300.2)	1.2	ns	1.81	*
Wg_{wt} (g)	283.7 (99.3)	35.0	70-670	293.8(110.6)	271.9 (82.7)	7.7	*	1.79	*
Wg_{dr} (g)	188.1 (65.8)	35.1	52-455	194.1 (72.4)	180.8 (56.3)	7.0	*	1.66	*
Wg_{wx} (g)	224.6 (75.8)	33.2	65-512	232.9 (83.1)	214.9(65.1)	8.0	*	1.63	*
GSI_{wt} (%)	21.3 (3.4)	16.3	4.5-31.7	22.0(2.7)	20.4 (3.9)	7.6	*	2.83	*
GSI_{wx} (%)	16.9 (2.7)	16.4	4.5-24.63	17.6(2.2)	16.2 (3.1)	8.4	*	2.10	*
Drying duration (DD;days)	7.76 (2.6)	34.2	4-17	7.8 (2.7)	7.7 (2.5)	1.0	ns	1.09	ns
drying (C_{dr};%)	33.6 (4.3)	12.9	19.1-64.6	33.8 (4.2)	33.4(4.4)	1.0	ns	1.09	ns
waxing (C_{wx};%)	20.1 (4.3)	21.4	9.2-43.7	20.8(4.2)	19.3(4.3)	7.4	*	1.05	ns

a: sample number=602, b: critical value=1.21

Table 2. *Correlation coefficients between biological variables (abbreviations in text). *: significant statistical difference at P=0.05.*

	Wfm	Wg_{wt}	Wg_{dr}	Wg_{wx}	GSI
Wg_{wt}	0.87*				
Wg_{dr}	0.86*	0.98*			
Wg_{wx}	0.86*	0.97*	0.98*		
GSI	0.19*	0.63*	0.61*	0.61*	
GSI_{wx}	0.11*	0.52*	0.58*	0.59*	0.90*

Sample number=602

PCA on climatic variables extracted four factors explaining 88.1% of the initial variance (Table 3). Using a cut-off value of ±0.50 for the four factor loadings, F_1 positively associated with the RHmx and RHmn relative humidity and the standard deviation of Ta, Tmax and Tmin, whereas negatively associated with the Ta, Tmax and Tmin. F_2 negatively associated with the standard deviation of RHmx and of east-west wind component (v_1). F_3 positively associated with east-west wind component (v_1) and the standard deviation of north-south wind component (v_2) and negatively with the standard deviation of RHmn. F_4 positively associated with the north-south wind component (v_2) (Table 3). Factor scores showed positive (F_1, F_2 and F_3) and negative (F_4) significant

Table 3. *Results of Principal Components Analysis (PCA) and factor loadings for each climatic variable (abbreviations see text) on the four extracted PCA factors after varimax normalized rotation. ExplVar: percentage explained variance, CExplVar: cumulative percentage of explained variance. With bold marked the important values (cut-off value of ±0.50).*

	Factors			
	F_1	F_2	F_3	F_4
ExplVar	45.81	16.86	15.77	9.20
CExplVar	45.81	62.67	78.44	87.64
	Factors loadings			
Climatic variables	F_1	F_2	F_3	F_4
Ta	**-0.98**	0.07	-0.03	0.14
SDT	**0.88**	0.32	-0.17	0.05
Tmx	**-0.97**	0.01	0.02	0.17
SDTmx	**0.77**	**0.51**	-0.05	0.24
Tmn	**-0.95**	0.20	-0.16	0.09
SDTmn	**0.72**	0.25	-0.37	-0.23
RHmx	**0.76**	0.47	0.24	-0.10
SDRHmx	-0.41	**-0.80**	-0.33	0.00
RHmn	**0.82**	0.35	0.24	-0.28
SDRHmn	0.15	-0.24	**-0.68**	-0.11
V_1	0.48	-0.23	**0.75**	0.32
SDV_1	0.04	**-0.88**	0.16	-0.13
V_2	-0.25	0.14	0.05	**0.93**
SDV_2	-0.01	-0.07	**0.85**	-0.18

Table 4. *Statistically significant coefficients (c, ki) at P=0.05 of multi-regression model for the drying duration (DD), the percentage stage of the ovary weight during draining (C_{dr}%) and the percentage change of the dried ovary weight during waxing (C_{wx}%), the wet weight of ovary and climatic PCA factors (FS1-FS4). VIF: Variance inflation factor of explanatory variables; SSQ: sum of squared; explVar%: percentage of explained variance; coefficient of determination (R^2); np: no participate in the model.*

C	DD				C_{dr}				C_{wx}			
	5,7				31,0				18,64			
variables	k_i	SSQ	ExplVar%	VIF	k_i	SSQ	ExplVar%	VIF	k_i	SSQ	ExplVar%	VIF
C_{dr}	np			np	np			np	0,18	165,4	1,4	1,1
DD	np			np	0,34	966,2	8,7	1,8				1,8
Wg_{wt}	0,01	528,4	12,6	1,0				1,2	-0,02	1601,8	14,0	1,2
FS_1	0,31	1149,4	27,4	3,4	0,10	176,6	1,6	4,5	-0,07	118,3	1,0	4,5
FS_2				2,2				2,2				2,2
FS_3				1,2				1,2				1,2
FS_4	0,5	176,1	4,2	1,8				2,0				2,0
Model SSQ		1854,9	44,1			1142,8	10,3			1885,4	16,5	
Residuals		2347,1				9971,4				9532,5		
Total SSQ		4202,0				11114,2				11417,9		
R^2		0.441				0.103				0.165		

($0.05<r^2<0.94$; df=601; $P<0.05$) linear relationship with the mid-date of the studied period.

The results of the multi regression analyses are shown in Table 4. VIF values in three models ranged from 1.0 to 4.5 indicating a low level of collinearity between the independent variables. For the DD the most explanatory variables with positive linkage were the W_{wt} and the PCA factors F1 and F4 that cumulatively explaining 44.1% of the initial variance of DD. For the C_{dr} the most explanatory variables with positive linkage were the DD and the factor F1 that cumulatively explaining 10.3% of the initial variance (Table 4). For the C_{wx} the most explanatory variables with positive linkage were the W_{wt} and factor F_1 and with negative linkage the percentage of the C_{dr} that cumulatively explaining 16.5% of the initial variance of C_{wx} (Table 4).

4. Discussion

The description of the processing stages of the Greek caviar PDO "Avgotaracho Messolonghiou" was the aim of the present study. At the same time the effect of climatic conditions on the processing stages was also analysed. Sampled roes represented approximately 70% of the labelled PDO roes directed to the markets in 2013. The manufacturing process described herein and reported in details to the EC 1263/96 ensuring the certification of the product as PDO and was characterized by: (a) the exclusive use of local products, (b) the fact that the whole process was carried out in the lagoon facilities by members of fishermen associations and (c) the high consistency of the traditional processing methods that were based on the experience of the fishermen.

With respect to (a) PDO "Avgotaracho Messolonghiou" is locally produced by *M. cephalus* caught at the barrier traps of the Mesolonghi-Etolikon lagoons during the spawning seasonal migration of the species (late July to mid-October; Katselis et al. 2005), which coincides with the period of the study. The dissection of the ovaries conducted without any prior process of cooling or freezing of the ovaries, which are necessary when the ovaries are derived from other regions. The latter is enhanced due to the global expansion of the species, for which gonadal maturation period is diversified depending on the area (i.e. Mesolonghi-Etolikon lagoons: August-October: VIDALIS et al., 1997; Levantine Sea: September-October; ERGENE, 1999; and Australia waters: April-August; MEYNECKE and LEE, 2011).

The dissected ovaries are washed and salted with natural sea salt in order to reduce the inhibition by microorganisms (RAVISHANKAR and JUNEJA, 2014) and are left in air-dried conditions for approximately 8 days (mean 7.7 days). During that period the ovaries lost slightly more than 30% of their initial water content. Then, dried ovary was covered with layers of melted wax, which creates protective layers for the maintenance of the roe for several months without the need for freezing. The weight of the final product (waxed fish roe) representing about 20% of the mean weight of the fish species caught.

The high accuracy of the empirical process was highlighted by the low variation of the above-mentioned study parameters (CV<21%) for both sampled roes derived from the two fishermen associations. The same was also true for the percentage changes in the ovary weight during drying (C_{dr}) and waxing (C_{wx}) (mean percentage difference of C_{wx} and C_{dr} were 7.4% and 1.0%, respectively: Table 1). The weight increased by wax-

ing (C_{wx}=20.1±4.3%) is in agreement with the corresponding values estimated by a previous study (C_{wx}≈20%: ROGDAKIS, 1994). Drying rate impact on numerous food characteristics such as structural (e.g., density, porosity, specific volume), optical (e.g., color, appearance), textural (e.g. compression, stress relaxation and tensile test) and sensory (e.g. aroma, taste, flavor) components and nutritional aspects (e.g. vitamins, proteins, fats) (KROKIDA and MAROULIS, 2000). The importance of the above-mentioned parameters was out of the scope of the present study. Another aspect that that enhances the high consistency of the manufacturing process is the low differences on GSI's estimated from the sampled roes between the two studied associations (<10% of the mean value), as well as between the corresponding values estimated from a previous study (KATSELIS et al., 2005) conducted in the same area [(16.9% (SD=2.8%) and 16.0 (SD=2.3%), respectively].

The duration of the PDO "avgotaracho Messolongiou" processing is also a critical stage to decrease the water concentration and thus improves food safety (LEISTNER, 1992). In the present study the duration of the process was mainly determined by the experience of the fishermen and the prevailing climatic conditions during drying (mainly by the thermo-humidity factor: F1; Table 4). This might be related with the evaporation rate occurred by the surface area of the ovary; this rate was positively associated with the surface area and negatively with the relative air humidity (CHEN, 2009). Our results (factor F1 in Table 3) supports this hypothesis, because drying duration is negatively associated with the ovary surface area and positively with the relative air humidity.

The traditional manufacturing process of *avgotaracho Messolonghiou* follows the corresponding stages of *bottarga* (BERNASCONI et al., 2007) and *karasumi* (CHIOU and KONOSU, 1988) up to the stage of the first drying. Indeed, the mean drying duration of each ovary in the present study was 7.76 days closed to the drying duration of first drying stage of *bottarga* (≈ 5 days; BERNASCONI et al., 2007) and of *karasumi* (few days; CHIOU and KONOSU, 1988). The last stage of production for *bottarga* and *karasumi* consists by further drying under mechanical pressing (CHIOU and KONOSU, 1988; BERNASCONI et al., 2007), whereas the final stage of production for *avgotaracho Messolonghiou PDO* is the waxing. Waxing prevents further water loss resulting in a significant difference proximate composition between *avgotaracho* and other above-mentioned fish roe products (KALOGEROPOULOS et al., 2008).

In conclusion, the processing of the avgotaracho Messolonghiou PDO based on the exclusive use of traditional methods and local materials. Although the quality control is based on the processor's experience, the processing stages were characterized by high consistency. The certification of a product as a PDO, such as the avgotaracho Messolonghiou, enhances its economic profitability. This attains significant importance in a fisheries-dependent area such the studied one (TZANATOS et al., 2005) having vital importance for the local economy.

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