Deliverable Report

Deliverable No:	D28.3	**Delivery Month:**		23
Deliverable Title	Report on product and process solutions for each species based on technological, physical and sensory characteristics			
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WP Title:	Socioeconomics-New product development			
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Task Title:	New product development			
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Objective: Report on product and process solutions for each species, based on technological, physical and sensory characteristics: An estimation of optimum fish sizes for developing new products identified in Sub-task 28.1.2 based on basic somatometric measurements and evaluation of losses. Further examination of chemical-mechanical properties of fish species during cutting and minimal processing was performed, which will result in a definition of process solutions for each species (HCMR, IRTA, CTAQUA, ULL).

Description: A report will be delivered, where the following will be mentioned: (a) commercial sizes of fish (from six the studied species) suitable for processing, (b) which sizes achieve best edible proportions and filleting yields, (c) potential product range for the various commercial sizes, (d) based on the fact that size and composition (especially fat contents) affect the technological properties of the fish, there will be included correlations between these quality attributes and evaluation of crucial parameters influencing the processing yields and the quality of the processed product (e.g. colour, potential gapping, general appearance, texture, water binding capacity & water losses etc.).

Deviations: Deliverable 28.2 is delivered with a 4-month delay due to the 2-month deadline extension of a preceding deliverable, the results of which were a prerequisite for the completion of the present deliverable. The delay of this deliverable will not create further delays or affect the completion of other Tasks in the DOW.

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1. Introduction

1.1. General introduction

One significant aspect of the market success potential of farmed fish is their quality as perceived by the consumer. Two important aspects in the multi-parameter set that constitute quality, are the nutritional and the technical characteristics of the fish. The former refers to the nutritional value of the food, while the latter to the processing technical losses and the edible yields. Apart from the contents in polyunsaturated fatty acids (due to their numerous health benefits), part of the nutritional quality refers to the total composition of the fillet. This also reflects the nutritional status image that the fish has among the consumer (Vanhonacker *et al.*, 2013). The technical quality expressed as somatic indexes (condition index CI, hepatosomatic index HIS, gonadosomatic index, viscerosomatic index VSI) and technical yields (dressing yield, filleting yield) on the other side, are mainly economic aspects and are of interest to both consumers and processors. Furthermore, the organoleptic quality of the fish, *i.e.* the human sensory impression, is among the capital factors for purchasing any fish (Grigorakis, 2007).

1.2. Objective

The objectives of this deliverable included:

1. Measurement and calculation of the somatometric indexes of the studied species at commercial sizes.
2. Correlation of commercial sizes with losses, edible proportions and filleting yields for each species in order to evaluate possible commercial sizes with best yields.
3. Analysis of the proximate composition of fillets of all species.
4. Sensory description of the appearance, aroma, flavour, taste and texture of the studied species.
5. A correlation of the sensory profile of the studied species with fillet composition and mechanical texture.

2. Materials and methods

2.1. Fish origin / rearing/ sampling

Specimens of meagre (*Argyrosomus* regius), greater amberjack (*Seriola dumerili*), pike perch (*Sanders luciperca*) and Atlantic halibut (*Hippoglossus hippoglossus*) used in the present study were of aquaculture origin. On the contrary, wreckfish were obtained from two different locations from the wild, due to the absence of any farmed individuals, and grey mullet were also obtained from the wild due to absence of available farmed ones in commercial sizes.

The greater amberjack fish were sampled from two different marine-cage units in Greece. The first sampling originates from NW Greece (Corfu Island), while the second sampling from a fish farm in the proximity of Athens (in Argosaronikos), both populations being fed on commercial feed. Two different commercial sizes were chosen of distinct difference; small fish of 1-1.5 kg and much larger fish of 15-20 kg. The reason was that this allowed better correlations of the studied parameters with size. It also allowed the evaluation of smaller commercial sizes that facilitates marketing of the fish as whole or filleted, and larger commercial weights that give the production ability for various processed forms or fillet parts.

For the rest of the species, we were not able to have distinct groups of different sizes due to their limited availability. Wreckfish were sampled from the wild (since no farmed fish occur). Grey mullet individuals were also feeding directly from the wild. The fish characteristics, sampling and size information are all included in table 2.1.

Table 2.1: Origin, season of sampling and fish size information of fish used in Task 28.3

Species	Season	N	Origin – farming conditions	Feed	Fish Size	
Greater Amberjack (*Seriola dumerili*)	Feb. 2015	10	Farm (Corfu S.A.)-NW Greece - floating sea cages	Commercial extruded feed	1-1.5 kg	
Greater Amberjack (*Seriola dumerili*)	Apr. 2015	8	Farm (Argosaronikos S.A.) – Attiki, C. Greece - floating sea cages	Commercial extruded feed	15-20 kg	
Pikeperch (*Sander lucioperca*)	July 2014	10	France –fresh water intensive farming	Commercial extruded feed	1-2 kg	
Grey Mullet (*Mugil cephalus*)	Feb. 2015	10	Wild fish. Bay of Cadiz (Spain) – earthen ponds with sea water	Natural feeding	500g-1 kg	
Meagre (*Argyrosomus regius*)	Nov. 2014	10	Farm (Andromeda Group), Burriana, Spain – floating sea cages	Commercial extruded feed	1.5-2 kg	
Wreckfish (*Polyprion americanus*)	Febr. 2015	5	Five specimens: 2 caught in FAO 34.1.2 ATLANTIC N by Canary Islands fishermen and 3 caught in Azores by Galicia´s fisheries	Natural feeding	Three specimens of 2-3 kg Two specimens of 25-30 kg	

Apart from somatic measurements, described below, one fillet from each fish was vacuum packed and stored in -20°C until sensory analysis, as it was necessary to gather all fish samples together to have the sensory analysis conducted. The other fillet was used for composition analysis.

2.2. Somatic measurements

Fish total weight and body length (fork length) were measured in all sampled individuals. Fish were subsequently gutted and body weight, visceral, gonad and liver weights were measured. Where possible, also visceral fat was separated from the rest of the viscera and weighed. Fish were subsequently filleted and fillets were also weighed. The following somatometric indexes were calculated individually:

Condition index (CI) = [100× body weight (g) / body length^3 (cm^3)]

Dressing yield (DY) = [100×(gutted body weight /body weight)]

Filleting yield (FY) = [100 × (fillet weight /body weight)],

Hepatosomatic index (HSI) = [100 × (liver weight / body weight)],

Gonadosomatic index (GSI) = [100 × (gonad weight / body weight)] and

Viscerosomatic index (VSI) = [100 × (total viscera weight / body weight)].

Visceral fat index (VFI) = [100 × (visceral fat weight / body weight)].

2.3. Proximate composition analysis

Fish fillet proximate composition analysis (protein, fat, moisture and ash), was conducted by the custom AOAC (2005) methods. Specifically, moisture was calculated gravimetrically after complete drying fish tissue and total inorganic content (ash%) after total burn of organic mater. Total protein content was determined by the Kjeldahl method, calculated as % Nitrogen x 6.25. Crude fat was determined after ether extraction.

2.4. Sensory analysis of fillets

Five fish species (pikeperch, meagre, greater amberjack, grey mullet and wreckfish) were sensory characterized in four modalities: odour, appearance, flavour and texture. To make this characterization, a list of sensory attributes was used to assess and score the fish samples. The list of descriptors was created starting from a list of 94 descriptors from a previous study (Lazo *et al.*, 2015). To narrow the list down, one session of CATA (Check-All-That-Apply) was performed to reduce the number of descriptors and use only those who were useful for describing and discriminating the five fish species under study. Afterwards, assessors scored the attributes previously selected with the CATA method in two sessions. Twenty-two descriptors were retained after applying a two way ANOVA (fish species and tasting session) keeping those able to discriminate among the samples. Once the final list was set up, panellists were trained to become familiar with the included descriptors, therefore references scales were developed to score the intensity of each attribute to assess.

2.4.1 Reference scales

Odour descriptors

A Fish paste, (Sea bream –*Sparus aurata*- fillets cooked for 20 min at 115º C, cooled to room temperature and then passed through a mixer) was used as a base in the development of the scales for the following attributes.

- Butter:

  Fish paste + melted butter (brand CADI).

  Three scale references were prepared for different parts of the 10 point scale: in 50 g of fish paste 0 g of melted butter were incorporated for the low part (score 0), 2 g for the medium part (score 5) and 3 g for the high part (score 10).

- Sea food:

  Fish paste + Velvet crab (*Necora puber*) precooked meat.

  Three measures were prepared for different parts of the 10 point scale: 25% crab - 75% fish paste for the low part (score 2), 40% crab - 60% fish paste for the medium part (score 5), and 75% crab - 25% fish paste for the high part (score 10).

- Sardine
Fish paste + Cod liver oil (Omega cod capsules content).
Three measures were prepared for different parts of the 10 point: in 10g of fish paste 0.5 g of cod liver oil was incorporated for the low part (score 2), 1 g for the medium part (score 5) and 2 g for the high part (score 10).

- Earthy
Fish paste + Geosmine solution (Geosmine flavour standard capsules brand AROXA).
Geosmine solution: 1 capsule (280 ng) dissolved in 50 ml of water.
Three measures were prepared for different parts of the 10 point scale: in 10g of fish paste 4 ml of solution were incorporated for the low part (score 2), 5 ml for the medium part (score 5) and 7 ml for the high part (score 8).

Flavour descriptors
A Fish paste, (Sea bream -*Sparus aurata*- fillets cooked for 20 min at 115ºC, cooled to room temperature and then passed through a mixer) was used as a base in the development of the scales for the following flavour attributes.

- Acid
Fish paste + citric acid solution (Citric acid anhydrous ACS Panreac).
Citric acid solution: 1 g dissolved in 69 g of water.
Three measures were prepared for different parts of the 10 point scale: in 10 g of fish paste 2ml of solution were incorporated for the high part (score 10), 1 ml for the medium part (score 5) and no solution was incorporated for the low part (score 0).

- Bitter
Fish paste + proteolitic enzyme solution (Enzyme mix Delvolase DSM).
Proteolitic enzyme solution: 50 ml enzyme mix dissolved in 50 ml of water.
Three measures were prepared for different parts of the 10 point: for the high part (score 10) 1 ml of solution was incorporated in 10 g of fish paste, this mix was evaluated after 30 min of enzymatic activity. For the medium part (score 5) 1 ml of solution was incorporated in 10 g of fish paste and after 30 min of enzymatic activity 10 more grams of fish paste were added to the mix before evaluation, no enzyme solution was incorporated to the fish paste for the low part (score 0).

- Butter
Fish paste + melted butter (brand CADI).
Three measures were prepared for different parts of the 10 point scale: in 50 g of fish paste 0 g of melted butter were incorporated for the low part (score 0), 2 g for the medium part (score 5) and 5 g for the high part (score 10).

- Boiled vegetables
Fish paste + vegetable puree.
Vegetable puree: 50% of potatoes voyage variety (*Solanum tuberosum*) and 50% green beens (*Phanseolus vulgaris*).
Three measures were prepared for different parts of the 10 point scale: 60% puree - 40% fish paste for the low part (score 2), 65% puree - 35% fish paste for the medium part (score 5) and 75% puree - 25% fish paste for the high part (score 9).

- Earthy
Fish paste + Geosmine solution (Geosmine flavor standard capsules brand AROXA).
Geosmine solution: 1 capsule (280 ng) dissolved in 50ml of water.
Three measures were prepared for different parts of the 10 point scale: in 10 g of fish paste 3 ml of solution were incorporated for the low part (score 2), 4 ml for the medium part (score 5) and 5 ml for the high part (score 9).

- Sea food:
Fish paste + precooked meat of Velvet crab (*Necora puber*).
Three measures were prepared for different parts of the 10 point scale: 15% crab - 85% fish paste for the low part (score 2), 40% crab - 60% fish paste for the medium part (score 5), and 50% crab - 50% fish paste for the high part (score 10).

Texture descriptors
Three parts (low, medium and high) of the 10 point scale were prepared for all of the texture descriptors, each part of the scale was represented by a different fish species as a reference of the attribute's intensity. Sample preparation: Fresh filets cut in pieces of 4x3x2 cm and cooked at 115ºC in a convection oven in individual transparent glass jars with lids (Model B-250, Juvasa Spain).

- Firmness (sample's hardness when pressing with tongue towards palate)
▪ Halibut (*Hippoglossus hippoglossus*) cooked for 20 min for the low part of the scale.
▪ Sea bream (*Sparus aurata*) cooked for 20 min for the medium part of the scale.
▪ Tuna (*Thunnus thynnus*) cooked for 75 min for the high part of the scale.

- Crumbliness (sample's easiness to fall to small pieces when biting)
▪ Tuna (*Thunnus thynnus*) cooked for 75 min for the low part of the scale.
▪ Sea bream (*Sparus aurata*) cooked for 20 min for the medium part of the scale.
▪ Halibut (*Hippoglossus hippoglossus*) cooked for 20 min for the high part of the scale.

- Juiciness (sample's juice released when biting)
▪ Halibut (*Hippoglossus hippoglossus*) cooked for 15 min for the high part of the scale.
▪ Salmon (*Salmon salar*) cooked for 15 min for the medium part of the scale.
▪ Tuna (*Thunnus thynnus*) cooked for 85 min without lid for the low part of the scale.

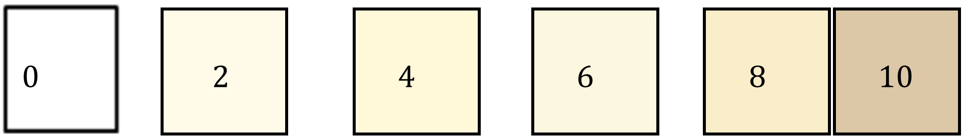
- Chewiness (time needed to chew the sample before swallowing)
▪ Halibut (*Hippoglossus hippoglossus*) cooked for 20 min for the low part of the scale.
▪ Sea bream (*Sparus aurata*) cooked for 20 min for the medium part of the scale.
▪ Tuna (*Thunnus thynnus*) cooked for 75 min for the high part of the scale.

- Pastiness (paste formed when chewing the sample)
▪ Halibut (*Hippoglossus hippoglossus*) cooked for 20 min for the low part of the scale.
▪ Sea bream (*Sparus aurata*) cooked for 20 min for the medium part of the scale
▪ 1 ml of proteolitic enzyme solution (1:1 Delvolase DSM with water) incorporated to 10 g of fish paste, incubation at room temperature for 30 min to allow enzymatic activity. High part of scale.

- Teeth adherence (ability of teeth to cling when chewing sample)
▪ Halibut (*Hippoglossus hippoglossus*) cooked for 20 min for the low part of the scale.
▪ Sea bream (*Sparus aurata*) cooked for 20 min for the medium part of the scale.
▪ Salmon (*Salmon salar*) cooked for 15 min for the high part of the scale.

Appearance descriptors
Pictures were used to illustrate all of the appearance attributes. Different parts of a 10 point scale were developed as a reference of the attribute's intensity. Each one of the pictures represented a score of the corresponding scale as a guidance to use by panellists when assessing the fish species.

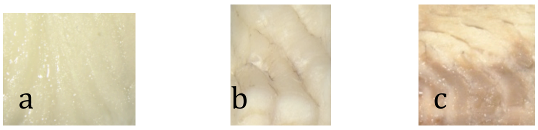
- Colour white to brown (to assess inside of the fillet)
Different shades of colours were extracted from cooked fish photographs with the software GIMP 2 (image treatment) and placed from light to dark to make the following scores of the scales.



- Colour uniformity

Three filets of 3 fish species were cooked (115ºC during 20 min) individually and a transversal cut was made to each one of them in order to evaluate the homogeneity of the colour inside the fish.

- Catfish (a) (*Ictalurus furcatus*) was used for the high part of the scale (score 10)
- Angler fish (b) (*Lophius psicatorius*) was used for the medium part of the scale (score 5)
- Sea bream (c) (*Sparus auratus*) was used for the low part of the scale (score 1)



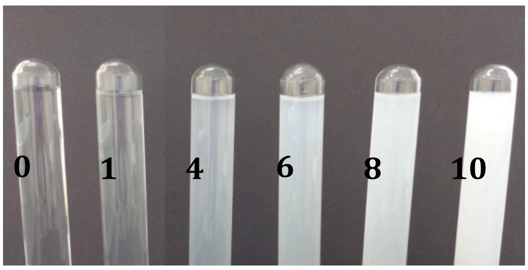
- Exudates quantity

A turbid solution (3 ml of milk in 7 ml of water) was prepared to use as fish exudate. Cooked pieces of sword fish (4 cm x 3 cm) were placed inside transparent glass jars individually; afterwards different quantities (0.2 ml, 1 ml, 3 ml and 5 ml) of the turbid solution were added in each jar, which was placed tilted 45º (using a base) to show the exudate quantity.

Score: 2 4 6 8

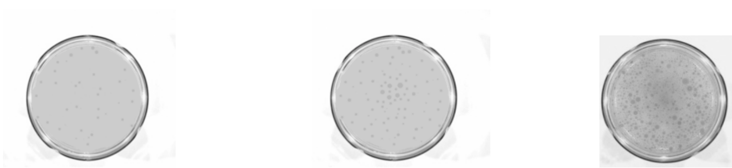
- Exudates' turbidity

A solution (5 ml of milk in 40 ml water) was prepared as a base to make dilutions in test tubes to present a scale of turbidity. Plain water was used as the lowest part (score 0), 0.1 ml sol + 9.9 ml water (score1), 1 ml sol + 9 ml water (score 4), 2 ml sol + 8 ml water (score 6), 3 ml sol + 7 ml water (score 8), 5 ml sol + 5 ml water (score 10).



- Fat droplets

Three different amounts of oleoresin colorant were added to three different jars containing 20 ml of a turbid solution (6 ml milk in 14 ml of water). To simulate fat droplets scale 10 µl were used for the low part (score 2), 50 µl were used for the medium part (score 4) and 100 µl were used for the high part (score 9).

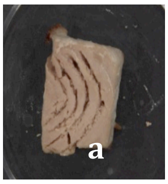


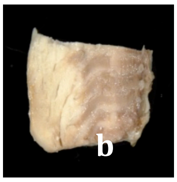
Score: 2 4 9

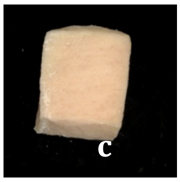
- Laminar structure

Three different species of cooked fish (115ºC during 20 min) were used to visualize the separation of the myomeres in the fish structure.

Tuna (a) was used for the high part of the scale (score 10), sea bream (b) for the middle part (score 5) and Sword fish (c) was used for the low part (score 1).







2.4.2 Cooking procedure and panellists

In all cases, samples were cooked in a convection oven at 115ºC for 20 minutes in individual transparent glass jars designed to make samples easy to visualize. Jar lids were used to retain the samples' odour within the jar during the cooking process (Model B-250, Juvasa, Spain). Jars were then placed inside electrical heaters at 60ºC to keep them on a steady serving temperature during the tasting process.

Eight panellists with previous experience in sensory profiling of food products were recruited for this training before evaluating the samples.

Sample analysis was performed in five sessions, testing all samples in each session. Panellists assessed samples in the following order: odour modality first then appearance followed by flavour and finally texture.

In each tasting session, the order of sample presentation and the first order and carry-over effects (MACFIE. *et al.*, 1989) were blocked. In all cases, the evaluation of species was carried out in isolated sensory testing booths (ISO, 2007). All assessors were provided with mineral water to cleanse their palates between samples.

2.5. Mechanical Texture Analysis

Three animals from each species (pikeperch, meagre, greater amberjack, grey mullet and wreckfish) were selected for the instrumental analysis of texture. Two different tests were carried: a non-destructive compression test (30%) with a spherical probe (18.4 mm diameter) and a Texture Profile Analysis (TPA, compression of 75%) (BOURNE, 1978) with a cylindrical probe (25 mm diameter). All the tests were performed with a TA-HDplus Texture Analyser (Stable Micro System, Surrey, England) at a constant speed of 1 mm/s. The non-destructive test (spherical probe) was performed both in the raw and cooked samples in three different locations of each filet whereas the TPA was only carried out in the cooked samples in two different locations of each filet (**Fig. 2.1**)..

Figure 2.1: Examples of the different Texture Profile Analysis (TPA) tests performed.

2.6. Statistics- correlations

- One way ANOVA was conducted to establish statistically significant differences in proximate composition, somatic indexes and mechanical parameters between the different species. Sensory data was submitted to a three-way ANOVA thus including fish species, tasters and replicates as fixed factors.
- A two-tail Pearson's correlation was used in all fish species separately to examine how somatic indexes relate to body weight and how they correlate with each other. Levels of significance were established at p=0.05.
- Principal component analysis (PCA) was used to establish the main relationships between the different sensory attributes and the fish samples.
- Discriminant analysis (DA) was used to exhibit the ability of sensory descriptors to differentiate between the five species.

2.7. Additional literature data obtained

Because the number of individuals obtained herein were limited and also refer to limited time of the year, in order to have a more complete image of the actual quality characteristics of the studied species, a literature review gathered all available data for these species and the same quality parameters were gathered where available. For all studied parameters weighed means were calculated, taking into account the literature average values and the number of individuals analyzed in each study.

3. Results

3.1. Somatometry – technical indexes

The somatic indexes and technical yields of the studied species are analytically presented (Table 3.1).

Table 3.1: Somatic indexes and technical yields of the studied species (CI: condition index, HSI: hepatosomatic index, GSI: gonadosomatic index, VSI: viscerosomatic index, VFI: visceral fat index)

	Body weight (g)	CI	Dressing yield (%)	Filleting yield (%)	HSI	GSI	VSI	VFI
Greater amberjack (*Seriola dumerili*)								
Batch 1	1028	1.90	90.6	45.6	2.04		7.10	0.24
	1213	1.97	93.0	48.0	1.91		5.10	0.16
	1452	1.76	93.1	51.2	1.81		5.06	0.56
	1219	1.82	92.8	47.0	1.50	0.00	5.70	0.64
	1069	1.83	93.5	53.2	1.35	0.00	5.15	0.29
	1514	2.04	92.8	50.2	1.58	0.00	5.67	0.56
	941	1.86	92.2	51.9	1.31	0.00	6.52	0.09
	1017	2.01	93.3	49.9	1.55	0.00	5.19	0.27
	1094	2.00	93.5	53.5	1.59	0.00	4.89	0.41
	1329	1.89	92.9	54.3	1.44	0.00	5.67	0.71
Average ± sd	**1187±193**	**1.90±0.09**	**92.8±0.79**	**50.5±2.89**	**1.61±0.24**	**0.00±0.00**	**5.60±0.71**	**0.39±0.21**
Batch 2	15400	1.49	95.0		1.04	0.62	3.31	
	10000	1.52	94.5		1.00	0.85	2.4	
	12200	1.47	95.4		0.78	0.49	2.66	
	14200	1.56	94.2		1.41	1.09	3.08	
	13800	1.56	94.6		1.34	0.91	2.86	
	13500	1.35	94.4		1.52	1.19	2.53	
	12100	1.55	94.9		1.16	0.54	2.66	
	12800	1.54	94.8		0.90	0.47	3.21	
Average ± sd	**13000±1629**	**1.51±0.07**	**94.7±0.39**		**1.14±0.26**	**0.77±0.27**	**2.83±0.33**	

Pikeperch (*Sander lucioperca*)							
	1271.8	0.69	90.7	38.9	1.04	0.63	8.33
	762.4	0.40	95.1	36.4	0.64	0.14	3.70
	1120.4	0.73	92.7	41.3	0.98	0.06	6.33
	1067.4	0.80	93.4	35.4	1.13	0.05	6.01
	1043.9	0.70	94.0	38.6	0.77	0.06	5.52
	912.6	0.63	92.8	27.8	0.82	0.57	6.30
	1013.3	0.76	94.7	38.4	0.58	0.09	4.18
	1476.8	0.76	93.2	31.7	0.67	0.03	6.26
	939.9	0.80	94.4	41.1	0.68	0.62	4.84
	1357.9	0.86	93.5	32.1	0.77	0.04	5.77
	1096±218	**0.71±0.12**	**93.5±1.26**	**36.2±4.42**	**0.81±0.18**	**0.23±0.26**	**5.73±1.30**
Grey mullet (*Mugil cephalus*)							
	754	1.14	88.4	36.0	1.28	0.56	9.72
	945	1.04	88.9	31.6	1.21	0.50	9.39
	576	1.14	87.4	35.8	1.21	0.50	10.8
	682	1.11	88.1	37.7	1.80	0.48	9.60
	877	1.14	89.6	41.7	1.46	0.59	8.35
	551	1.09	90.4	36.6	1.28	0.38	7.95
	816	1.06	88.6	35.1	1.35	0.48	9.56
	928	1.17	88.1	38.6	1.67	0.42	9.83
	821	0.96	84.3	31.8	1.69	0.32	13.7
	539	1.06	83.9	37.1	1.60	0.34	14.2
	748.9±154	**1.09±0.06**	**87.7±2.12**	**36.2±3.00**	**1.46±0.22**	**0.46±0.09**	**10.3±2.08**
Meagre (*Argyrosomus regius*)							
	1965.4	0.91	91.4	43.9	1.33	0.28	5.96
	2028	0.81	91.4	38.4	1.23	0.22	5.82

	1753.8	0.93	91.5	37.1	1.06	0.08	5.35	
	2069.6	0.91	91.0	36.8	1.09	0.09	5.54	
	1836.4	0.83	90.7	35.7	1.10	0.20	5.76	
	1798.2	0.92	89.7	37.7	1.50	0.17	6.73	
	1751.6	0.85	90.9	37.3	0.92	0.51	5.10	
	1641.4	0.80	91.2	40.9	1.00	0.07	5.90	
	1723.2	0.88	91.5	37.7	1.06	0.34	5.50	
	1778.2	0.82	91.9	38.5	1.38	0.06	5.81	
	1834±140	**0.87±0.05**	**91.1±0.62**	**38.4±2.36**	**1.17±0.19**	**0.21±0.14**	**5.75±0.44**	
Wreckfish (*Polyprion americanus*)								
	27485	2.41	91.5	59.7	0.87	0.42	8.15	2.07
	28605	2.18	91.5	56.2	1.21	0.94	8.10	0.64
	2651	2.4	91.7	45	1.52	0.02	7.70	0.21
	2989	2.54	92.4	44.9	1.62	0.06	7.01	0.58
	3411	2.9	88.2	47.3	3.1	0.04	11.4	1.36
	13028±13786	**2.49±0.27**	**91.1±1.64**	**50.6±6.87**	**1.66±0.85**	**0.30±0.37**	**8.47±1.70**	**0.97±0.74**

3.2. *Proximate composition*

The proximate composition of all studied species is presented in **Table 3.2**. The correlations between the various somatic parameters and the total weight are included in **Table 3.3**, while their correlations with each other appear in **Table 3.4**.

Table 3.2: Proximate composition of great amberjack (batch 1: n=10, batch 2: n=5), pikeperch (n=10), grey mullet (n=10), meagre (n=10) and wreckfish (n=5).

	Protein %	Fat %	Moisture %	Ash %
Greater amberjack (*Seriola dumerili*) - Batch 1	22.9±1.29	3.87±0.93	71.03±1.07	1.35±0.49
Greater amberjack (*Seriola dumerili*) - Batch 2	20.5±0.56	12.3±0.11	65.5±0.55	1.31±0.04
Pike perch (*Sanders lucioperca*)	21.8±0.43	0.06±0.02	76.6±0.58	1.31±0.07
Grey mullet (*Mugil cephalus*)	21.4±0.72	0.58±0.01	76.5±1.07	1.27±0.16
Meagre (*Argyrosomus regius)*	20.7±0.20	0.53±0.35	77.2± 0.29	1.35±0.00
Wreckfish (*Polyprion americanus*)	19.3±0.30	0.71±0.17	78.4±0.52	1.15±0.05

Table 3.3: Correlations of somatic parameters with total weight (two tail Pearson correlation).Where correlations are significant (or show tendency) the level of significance stands in parenthesis.

	CI	DY	FY	HSI	GSI	VSI	VFI
Great amberjack (*Seriola dumerili*)	-0.920 (p=0.000)	0.833 (p=0.000)	0.078	-0.655 (p=0.003)	0.187	-0.901 (p=0.000)	0.741 (p=0.014)
Pike perch (*Sander lucioperca*)	0.603 (p=0.065)	-0.526	-0.202	0.181	-0.250	0.602	
Grey mullet (*Mugil cephalus*)	-0.046	0.220	-0.112	0.078	0.325	-0.247	
Meagre (*Argyrosomus regius)*	-0.745 (p=0.013)	0.914 (p=0.000)	0.016	-0.547	-0.339	-0.938 (p=0.000)	
Wreckfish (*Polyprion americanus*)	-0.635	0.229	0.970 (p=0.006)	-0.649	0.898 (p=0.038)	-0.171	0.462

Table 3.4: Correlations of various somatic parameters (two-tail Pearson correlation, *p=0.05, **p=0.01, ***p=0.001)

Greater amberjack (*Seriola dumerili*)	
CI-DY	-0.776 ***
CI-HSI	0.647**
CI-VSI	0.863***
DY-VSI	-0.941***
VSI-HSI	0.673**
Pike perch (*Sanders lucioperca*)	
DY-VSI	-0.984***
VSI-HSI	0.712*
Grey mullet (*Mugil cephalus*)	
CI-FY	0.775**
DY-VSI	-0.996***
DY-GSI	0.639*
VSI-GSI	-0.650*
Meagre (*Argyrosomus regius)*	
CI-DY	-0.838**
CI-VSI	0.804**
DY-HSI	-0.666**
DY-VSI	-0.978
VSI-HSI	0.720**
Wreckfish (*Polyprion americanus*)	
CI-HSI	0.887*
DY-VSI	-0.998**

3.3. Sensory Analysis

The five selected species were found statistically different for all sensory descriptors assessed with the exception of Seafood odour (**Table 3.5**). In general, noticeable differences between the five species assessed were observed (**Fig. 3.1**).

Table 3.5: Mean values for each sensory descriptor and species.

Descriptor	Amberjack	Wreckfish	Meagre	Grey Mullet	Pikeperch	RMSE
O Butter	2.6^{b}	3.8^{a}	3.8^{a}	2.4^{b}	1.4^{b}	1.487
O Seafood	1.2	1.4	1.4	0.6	0.6	1.109
O Sardine	1.4^{ab}	2.3^{a}	1.7^{ab}	2.2^{a}	0.9^{b}	1.638
O Earthy	0.8^{b}	0.5^{b}	0.7^{b}	1.6^{ab}	2.7^{a}	1.509
Colour	3.7^{ab}	4.5^{a}	3.1^{bc}	3.9^{ab}	2.2^{c}	1.245
Colour homogeneity	8.6^{a}	7.4^{ab}	6.8^{b}	6.7^{b}	7.7^{ab}	1.602
Exudates	7.0^{b}	8.2^{a}	5.5^{c}	2.6^{d}	5.0^{c}	1.503
Turbidity	1.1^{c}	6.3^{b}	5.7^{b}	2.2^{c}	8.0^{a}	1.947
Fat droplets	5.9^{a}	6.1^{a}	5.7^{a}	0.8^{b}	0.8^{b}	2.000
Laminar structure	6.3^{a}	3.9^{b}	4.5^{b}	4.7^{b}	4.7^{b}	1.904
Acid	4.5^{a}	0.7^{b}	0.6^{b}	0.7^{b}	0.6^{b}	1.210
Bitter	2.0^{b}	1.6^{b}	1.8^{b}	3.2^{a}	1.5^{b}	1.485
Butter	2.5^{a}	2.1^{a}	2.3^{a}	1.0^{b}	0.8^{b}	1.369
Seafood	1.0^{ab}	1.1^{ab}	1.5^{a}	1.1^{ab}	0.4^{b}	1.057
Boiled vegetables	1.6^{b}	2.9^{a}	2.9^{a}	2.3^{ab}	2.6^{ab}	1.379
Earthy	0.7^{bc}	0.4^{c}	0.2^{c}	1.5^{b}	2.8^{a}	1.401
Firmness	5.8^{ab}	6.6^{a}	4.8^{bc}	5.8^{ab}	4.1^{c}	1.596
Crumbliness	5.5^{b}	4.0^{c}	6.4^{ab}	5.8^{b}	7.3^{a}	1.506
Juiciness	5.8^{a}	4.9^{ab}	5.8^{a}	4.3^{b}	5.2^{ab}	1.248
Chewiness	6.1^{ab}	6.5^{a}	4.0^{c}	5.2^{b}	3.8^{c}	1.291
Pastiness	3.9^{ab}	3.1^{bc}	4.2^{a}	2.7^{c}	4.3^{a}	1.342
Teeth adherence	6.8^{a}	3.3^{b}	3.7^{b}	3.5^{b}	2.8^{b}	1.593

a-c: mean values in the same row with different superscripts differ significantly ($p \leq 0.05$).

Figures 3.2 to **3.5** show the mean values obtained for each sensory attribute within each sensory modality (odour, appearance, flavour and texture). Principal component analysis (**Figure 3.6**) summarizes the main relationships between different attributes and fish samples. It is worth to mention the homogeneity of the raw material within the same species, which is expected for those species coming from aquaculture, but more surprisingly for the wild wreckfish.

Discriminant analysis showed that the most discriminant sensory variables between the species studied were two visual descriptors (turbidity and fat drops) and the acid taste. However, as shown in **Table 3.5** and **Figure 3.7**, almost all descriptors contributed significantly to differentiate between the five species. None of the confidence ellipses (95%) shown in **Figure 7** are overlapped, thus indicating a clear sensory distinction between the different species. In the same vein and according to the confusion table shown in **Table 3.6**, all the different animals were correctly classified in their respective species (null classification error).

Table 3.6: Confusion matrix obtained by means of the discriminant analysis.

from \ to	Amberjack	Grey Mullet	Meagre	Pikeperch	Wreckfish	Total	% correct
Amberjack	5	0	0	0	0	5	100%
Grey Mullet	0	5	0	0	0	5	100%
Meagre	0	0	5	0	0	5	100%
Pikeperch	0	0	0	5	0	5	100%
Wreckfish	0	0	0	0	5	5	100%
Total	5	5	5	5	5	25	100%

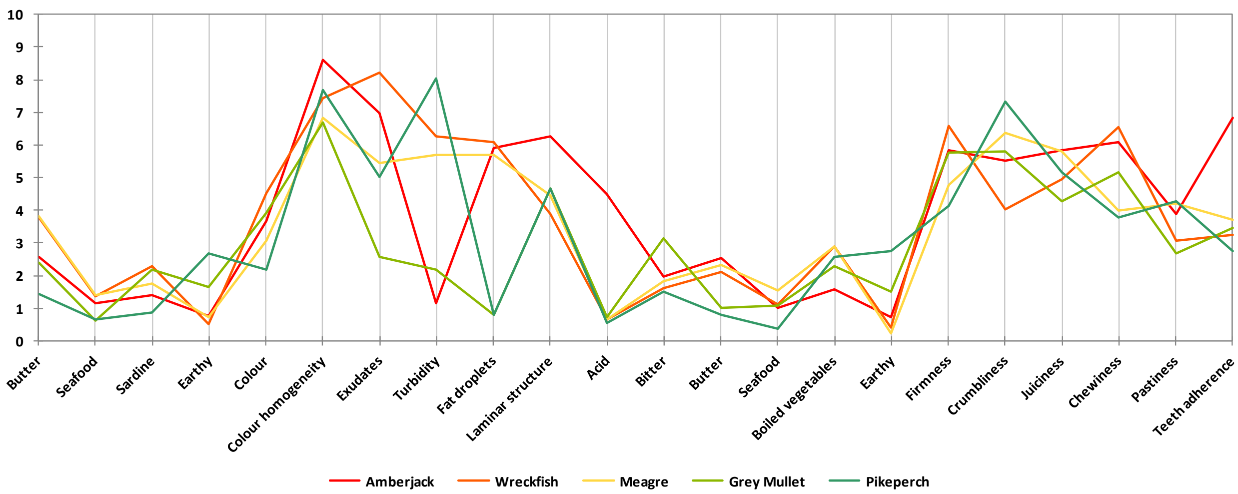


Figure 3.1: Mean values for each species and sensory descriptor (scale: 0-10).

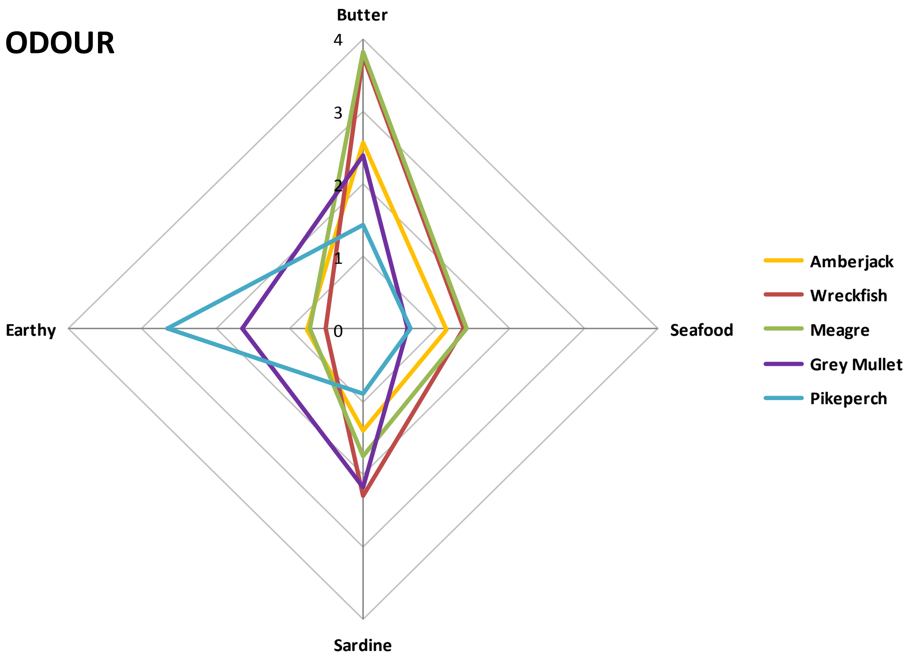


Figure 3.2: Mean values of odour descriptors for each species (rated on a 0-10 scale).

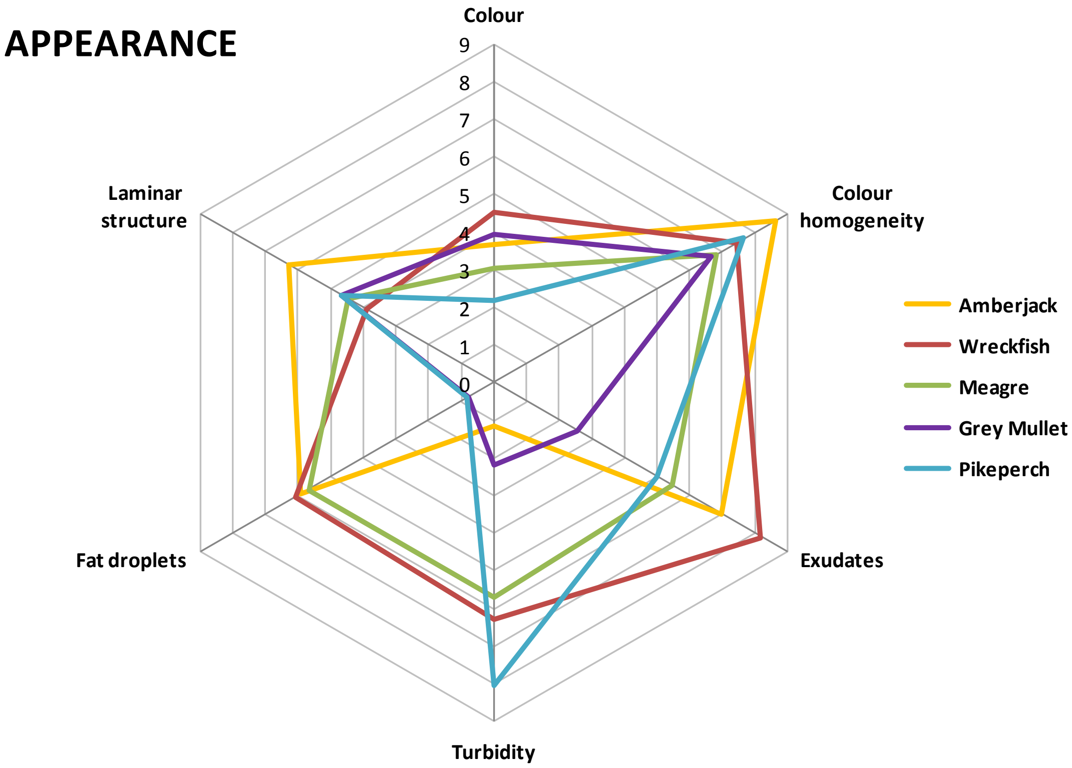


Figure 3.3: Mean values of appearance descriptors for each species (rated on a 0-10 scale).

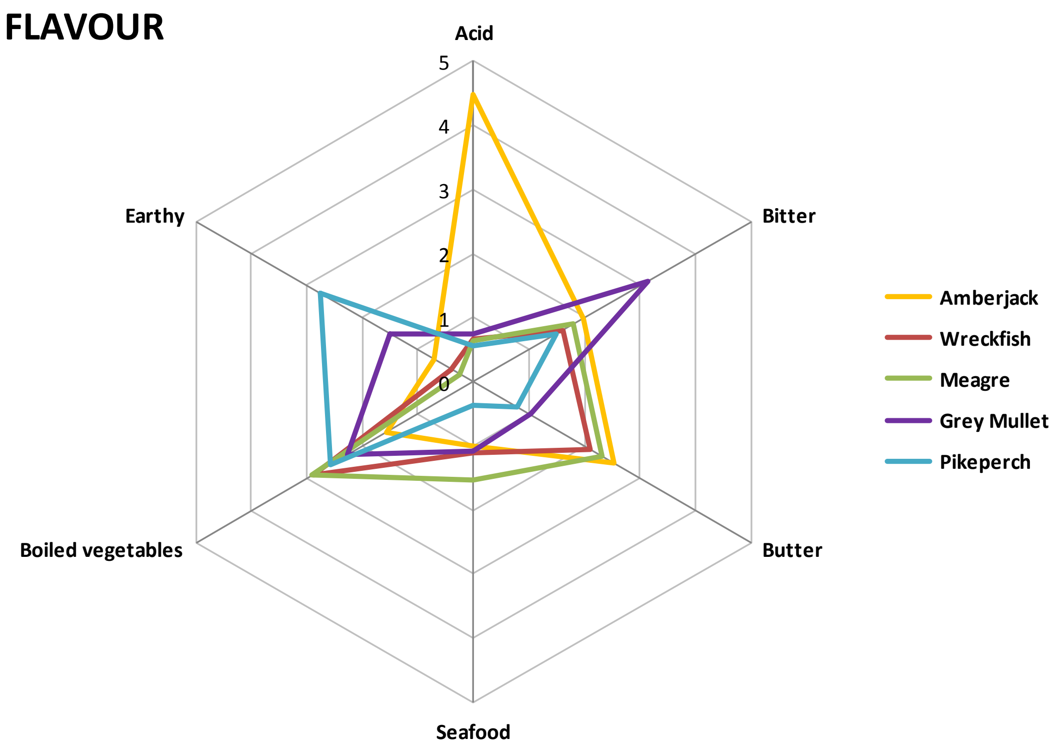


Figure 3.4: Mean values of flavour descriptors for each species (rated on a 0-10 scale).

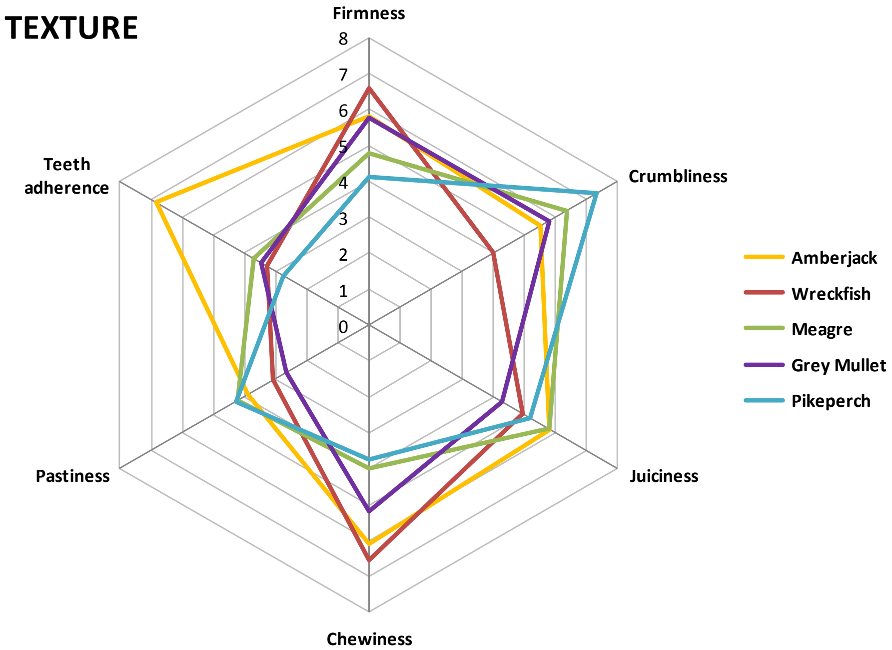


Figure 3.5: Mean values of texture descriptors for each species (rated on a 0-10 scale).

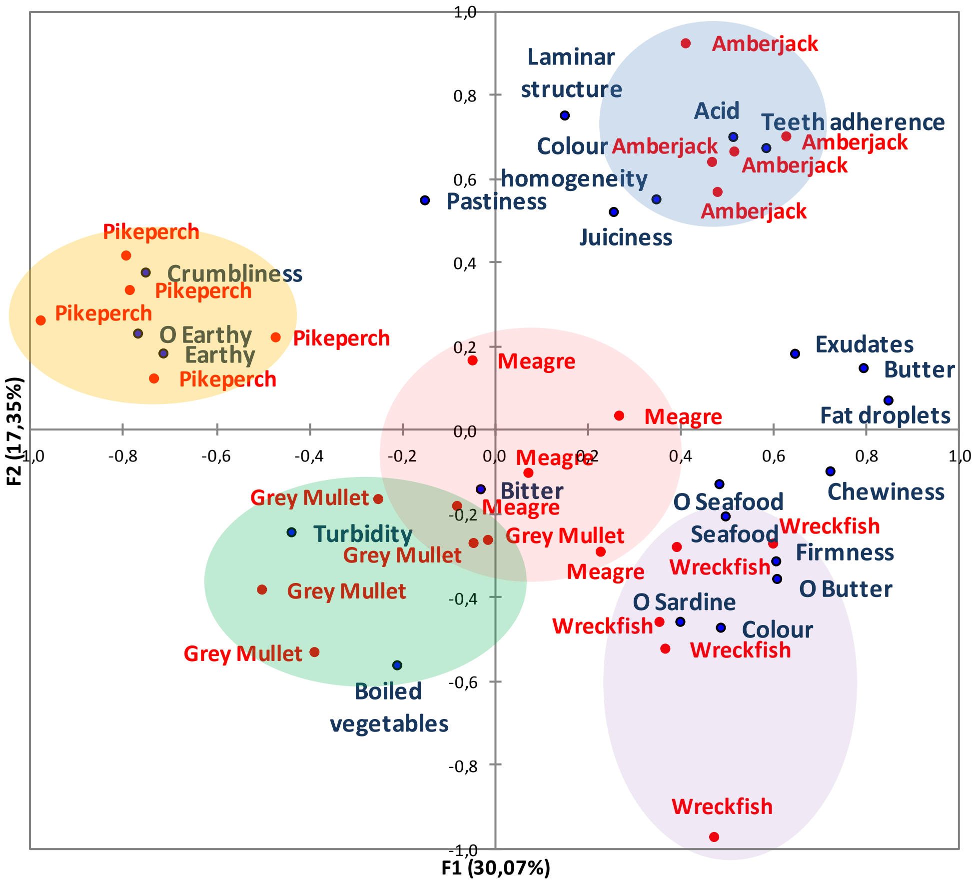


Figure 3.6: Biplot of fish samples and sensory descriptors (PCA).

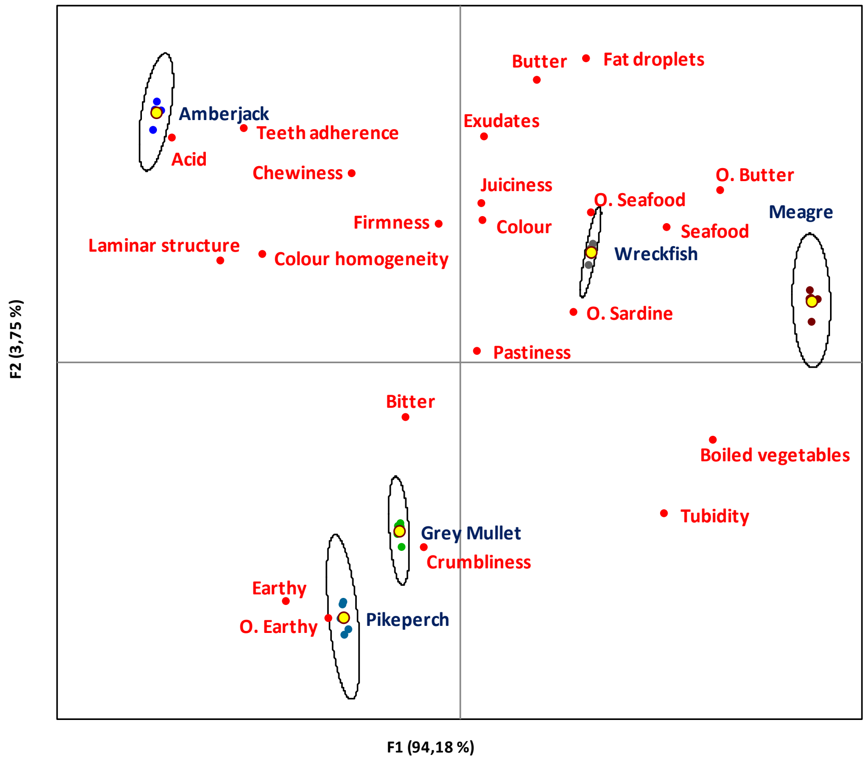


Figure 3.7: Results of the discriminant analysis of the different species and their corresponding confidence interval.

3.4. Mechanical Textural Analysis

Three parameters were retained from the tests performed with the spherical probe: the maximum force, the total area under the curve and the slope in the central section of the force vs. time curve (Figure 3.8). From the TPA curve, the parameters retained were those described by BOURNE (1982): Hardness, Fracturability, Cohesiveness, Springiness, Adhesiveness, Chewiness, Gumminess and Resilience (Figures 3.9 and 3.10).

In general and for the non-destructive compression results differed depending on whether the samples were raw or cooked (Table 3.7), thus being more discriminant among species once cooked.

Table 3.7: Mean values obtained by means of the non-destructive analysis (spherical probe) in raw and cooked fillets.

Parameter	Pikeperch	Amberjack	Wreckfish	Grey Mullet	Meagre	RMSE
			Raw filet			
Area (g.s)	734.365^{ab}	965.351^{a}	1029.162^{a}	382.296^{b}	620.098^{ab}	341.095
Maximum Force (g)	394.431	383.881	368.025	365.197	332.218	154.248
Slope (g/mm)	98.566^{b}	67.654^{b}	64.356^{b}	166.732^{a}	80.901^{b}	44.528
			Cooked filet			
Area (g.s)	698.379^{b}	1147.351^{ab}	1604.290^{a}	1043.076^{ab}	806.270^{b}	548.574
Maximum Force (g)	315.173^{b}	383.881^{b}	430.600^{ab}	607.736^{a}	376.173^{b}	148.261
Slope (g/mm)	73.491^{b}	69.396^{b}	65.992^{b}	192.837^{a}	92.875^{b}	43.233

a-b: mean values in the same row with different superscripts differ significantly ($p \leq 0.05$).

Table 3.8: Mean values obtained by means of the Texture Profile Analysis (TPA) in cooked fillets.

Parameter	Wreckfish	Meagre	Pikeperch	Grey Mullet	Amberjack	RSME
Hardness (g)	7032.007[a]	4402.660[ab]	2251.515[b]	3328.627[b]	3985.741[ab]	1777.484
Fracturability	2692.451[a]	2411.794[a]	1552.622[ab]	2120.979[a]	842.088[b]	500.450
Cohesiveness	0.429[a]	0.339[ab]	0.371[ab]	0.273[b]	0.320[ab]	0.065
Springiness	0.813	0.806	0.781	0.757	0.702	0.113
Adhesiveness (g.s)	-164.104[ab]	-14.348[a]	-9.569[a]	-43.003[a]	-204.834[b]	88.543
Resilience	0.084[a]	0.072[ab]	0.059[bc]	0.046[cd]	0.033[d]	0.011
Gumminess (g)	3119.958[a]	1512.629[ab]	837.860[b]	926.254[b]	1354.291[b]	905.912
Chewiness (g)	2553.380[a]	1222.768[ab]	655.033[b]	726.368[b]	1040.990[b]	774.737

a-d: mean values in the same row with different superscripts differ significantly (p≤0.05).

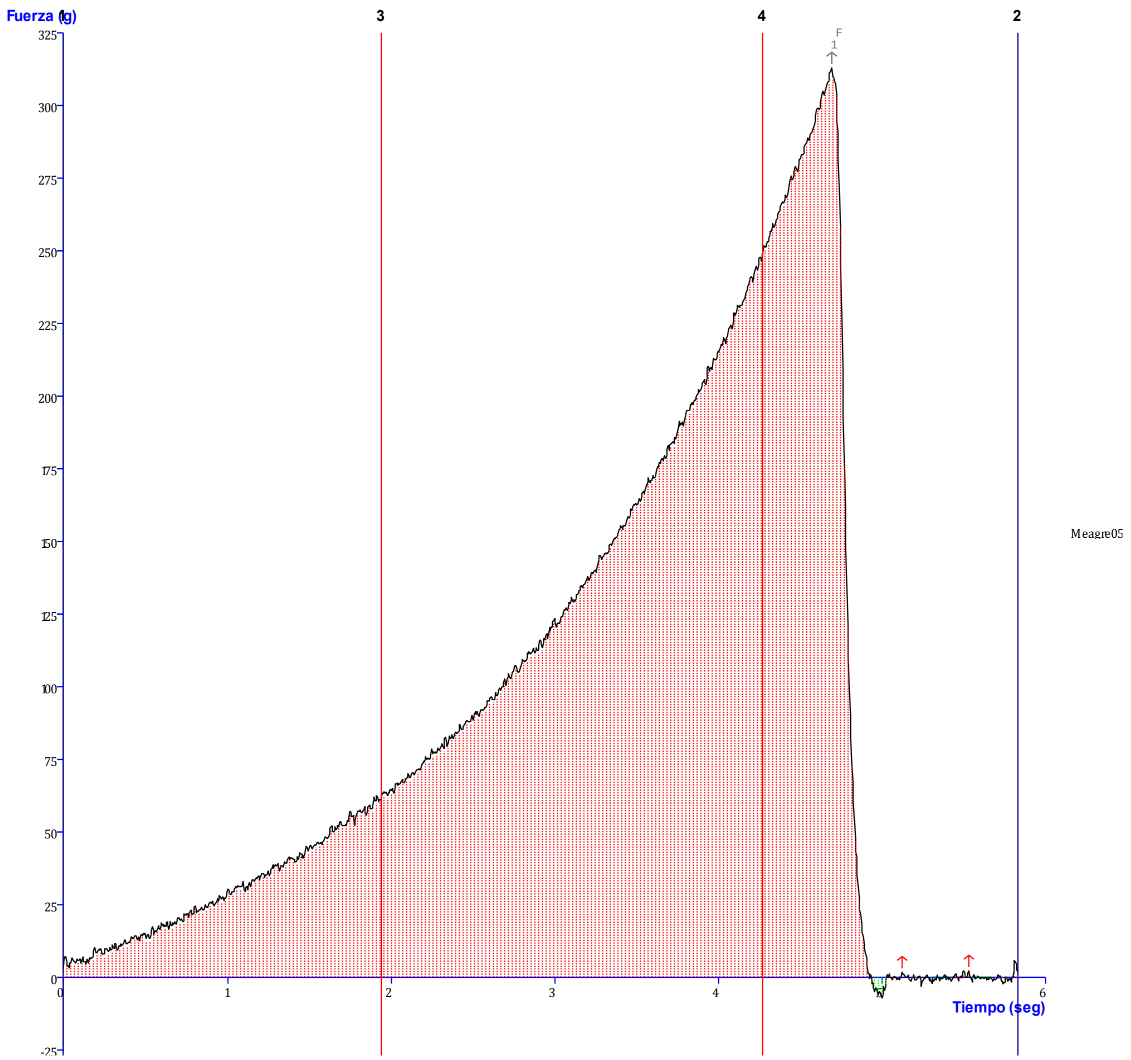


Figure 3.8: Parameters obtained from the non-destructive compression tests.

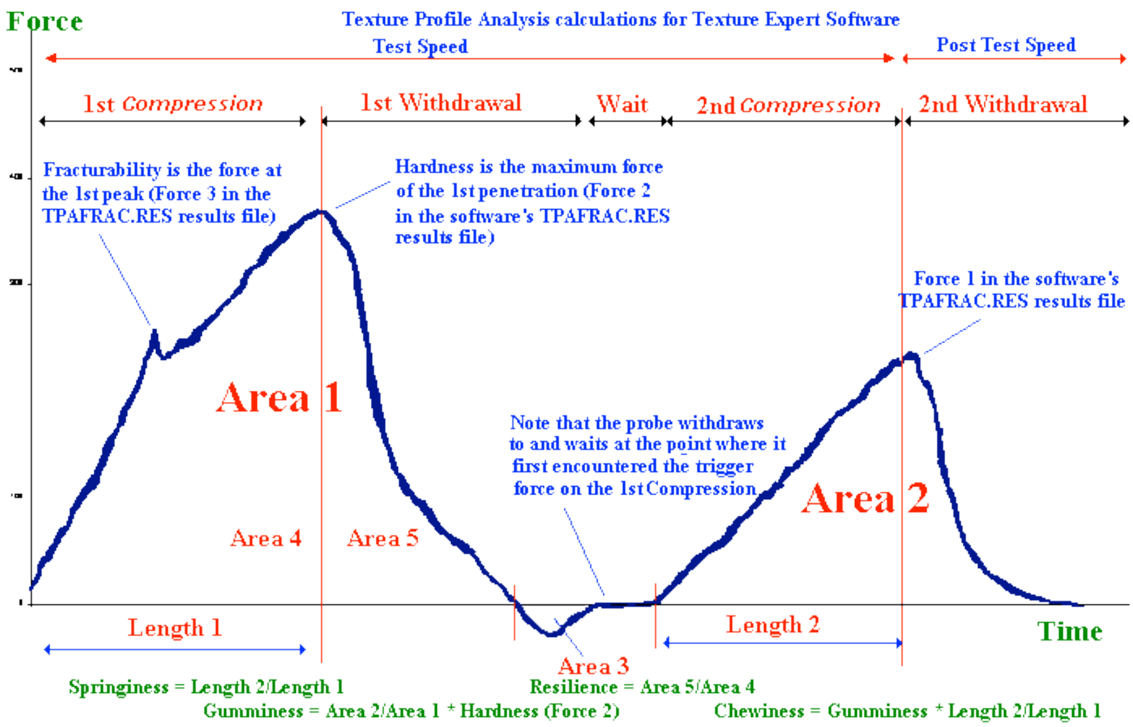


Figure 3.9: Parameters obtained from the Texture Profile Analysis curves.

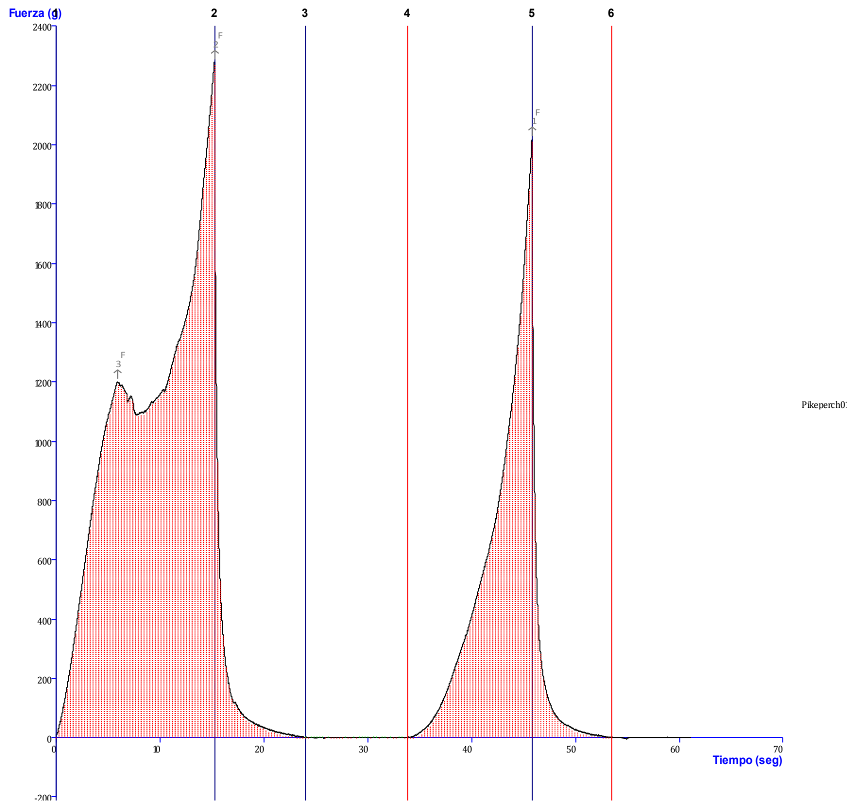


Figure 3.10: Example of curve Force vs. Time obtained by means of the TPA test.

3.5. Somatic indexes and fillet composition obtained in the literature

The somatic indexes (and technical yields) and the fillet composition data for the studied species, as gathered from the existing literature, appear in **Table 3.9** and **Table 3.10**, respectively. Literature data on the technical yields of the studied species are very limited and scarce, and more should be obtained in the future.

Data for fillet composition are sufficient for most species, with the exception of grey mullet (where data exhaust only in the fillet fat contents). The same appear to be the problem with wild meagre, where data is limited to those deriving from Sinanoglou *et al.* (2014). However, there is a serious probability that these authors have mistaken their so-assumed wild specimens. This can be postulated by the fact that they mentioned a fatty acid profile with high n6 fatty acids and in specifically of the 18:2n6 (linoleic acid) which is scarce in marine food chain and characterizes farmed fish due to its dietary terrestrial plant oil origin (Tocher, 2003; Linder, 2010). A potential explanation is that the authors have been probably provided with farmed escapees. For this reason this reference was not taken into account in regard with the wild fish.

Table 3.9: Technical and somatometric characteristics of DIVERSIFY fish species in the literature. Values represent weighed means. In parenthesis the total number of studies taken into account and the total number of fish that contributed to the weighed mean are given.

Species		FY	VSI	HSI	CI	References
Meagre	farmed	43.3 (6/266)	4.96 (4/204)	1.50 (3/194)	1.05 (2/154)	(Poli *et al.*, 2003; Grigorakis *et al.*, 2011; Giogios *et al.*, 2013; Martelli *et al.*, 2013; Nathanailides *et al.*, 2013; Sinanoglou *et al.*, 2014)
Pikeperch	farmed	55.1 (3/84)	5.20 (2/78)	1.28 (2/78)	1.15 (5/116)	(Jankowska *et al.*, 2003; MolnÁR *et al.*, 2006; Kowalska *et al.*, 2011; Zakęś *et al.*, 2012)
	wild	51.2 (1/6)	-	-	0.91 (1/6)	(Jankowska *et al.*, 2003)

Table 3.10: Fillet proximate composition of DIVERSIFY fish species in the literature. Values represent weighed means. In parenthesis the total number of studies taken into account and the total number of fish that contributed to the weighed mean are given.

Species		Moisture %	Protein %	Ash %	Fat %	References
Meagre	farmed	72.8 (6/212)	20.5 (3/120)	1.34 (4/150)	2.12 (7/218)	(Poli *et al.*, 2003; Hernández *et al.*, 2009; Grigorakis *et al.*, 2011; Giogios *et al.*, 2013; Martelli *et al.*, 2013; Sinanoglou *et al.*, 2014)
Grey mullet	farmed	76 (1/6)	-	-	10.0 (1/6)	(El-Sebaiy *et al.*, 1987)
	wild	-	-	-	2.10 (2/7)	(Özogul & Özogul, 2007; Özogul *et al.*, 2009)
Wreckfish	wild	76.5 (1/62)	19.8 (1/62)	1.10 (1/62)	1.13 (1/62)	(Roncarati *et al.*, 2014)
Pikeperch	farmed	77.2 (2/36)	20.3 (2/36)	1.16 (2/36)	1.29 (2/36)	(Jankowska *et al.*, 2003; Kowalska *et al.*, 2011)
	wild	79.8 (3/40)	18.08 (3/40)	0.94 (3/40)	0.84 (4/52)	(Jankowska *et al.*, 2003; Çelik *et al.*, 2005; Guler *et al.*, 2007; ÖKsÜZ *et al.*, 2009)
Greater amberjack	farmed	71.7 (2/39)	23.2 (1/30)	-	6.65 (2/39)	(Thakur *et al.*, 2009; Rodríguez-Barreto *et al.*, 2012)
	wild	76.7 (1/9)	-	-	3.64 (1/9)	(Rodríguez-Barreto *et al.*, 2012)

4. Discussion

4.1. Biometric parameters and yields

The dressing yield is an important parameter, because it determines the yield for the fish when sold as gutted, without further processing, which is one common way of commercialization in EU for fresh and frozen fish. The filleting yield is an important parameter, especially for species that filleting is among their custom processing, because it describes their actual edible gain. The dressing yields for all species were quite similar, slightly exceeding 90%.

Regarding the literature data, the respective data is actually limited mainly to meagre and pikeperch (**Table 3.9**). For grey mullet, the lack of respective data may be due to the fact that it is not common to be commercialized in filleted forms. Thus, although for grey mullet such data collection may be of minor importance, this does not apply for the great amberjack that filleting is of importance due to its large commercial sizes.

Our present data showed that filleting yield is species-specific. The highest filleting yields were noticed for great amberjack and for wreckfish, in both cases exceeding 50%. For pikeperch, grey mullet and meagre the filleting yield was found to be similar and slightly lower that 40%. The present filleting yield for pikeperch is lower that the values mentioned in the literature, both for wild and farmed individuals. It is worth mentioning that these values (ours and literature ones) concern fish of similar weights. No possible explanation can be assumed herein. As species with higher filleting yield can give higher profit when filleted, amberjack and wreckfish can be advantageous in this aspect.

4.2. Correlations of somatic indexes and yield with fish size

The condition index (CI) is indicative of the feeding condition of the fish and has been shown to increase in well-fed fish, as in the intensive farming-originated fish in comparison with extensively farmed and wild fish (Floss et al., 2002; Grigorakis, 2007; Piccolo et al., 2007; Martelli et al., 2013). When concerning the CI, only intra-species comparisons are meaningful, since possible differences between species are most likely to be due to their different allometry.

The condition index was negatively correlated with body weight in great amberjack and meagre, was positively correlated in pikeperch, while no correlation was observed for wreckfish and mullet. These differences can be due to different allometry in the species. Thus, species with high head proportion in relation to the rest of the body, such as amberjack and meagre, seem to exhibit a negative body weight - condition index correlation. This is also confirmed by similar trends for these two species in aspects of negative body weight-VSI and positive body weight-DY correlations. The latter imply that DY (that includes the head weight) increases with body weight, while the opposite happens with the visceral weight. As a result of these, the CI is also negatively correlated with DY and positively with VSI for these two species. As a technical output, these two species offer better profits when commercialized as gutted due to their higher somatic weight.

Wreckfish is a species with similar allometry with meagre and amberjack, *i.e.* big head to body proportion. The fact of no significant trends observed for wreckfish similar to meagre and amberjack, may be due to low number of individuals obtained for this species. Pikeperch, on the other side, show positive correlation between body weight and CI, thus implying that fish show a "plump" appearance as their body weight increase.

An interesting observation is that filleting yield does not seem to correlate with fish size in none of the species, with the exception of wreckfish that produces higher fillet as body weight increases (Table 3.3). However, this observation for wreckfish is based on a small number of individuals (n=5). Therefore, more secure conclusions for this species can be reached only if more individuals can be obtained in the future. As a conclusion there is no optimum size for filleting, and all commercial sizes can be equally efficient in producing fillets.

4.3. Proximate fillet composition

In general, fillet protein content of all fish species was quite similar, nearing a 20% of total fillet constituents. This is observed both in the present results (**Table 3.2**) and in the literature findings (**Table 3.10**). Fillet protein is generally believed to be stable in adult fish and not to be influenced by external parameters (Love, 1992; Grigorakis, 2010). However, there have been some cases where seasonal changes have been reported for wild fish populations (Gökçe *et al.*, 2004; Patrick Saoud *et al.*, 2008). Reduction of muscle protein in adult fish has been mentioned in cases of mobilization under prolonged fasting (Love, 1992).

The observed fillet composition for the studied species, distinguishes the great amberjack fillet for its profoundly higher lipid contents (**Table 3.2**). Additionally, a significant increase of fillet fat with fish size was observed for this species. All other species exhibited fillet fat of <1%, *i.e.* they appear to be low-fat species. However, we must take into account that all individuals were obtained during the winter period when lipid depots are generally reduced and this has been observed for both wild and farmed populations (Grigorakis, 2010). The meagre and pikeperch are indeed a low-fat species and this has been amply confirmed by the literature (see references in **Table 3.10**), and thus similar fat patterns will be expected throughout the year. However, the grey mullet is supposed to contain higher fillet fat, can be characterized as a medium- to high-fat species (El-Sebaiy *et al.*, 1987; Özogul & Özogul, 2007; Özogul *et al.*, 2009) and aquisition of more individuals in various seasons would clarify this.

Although seasonality in fillet fat depots has been mentioned for wild fish of various species (Gökçe *et al.*, 2004; Özyurt *et al.*, 2005; Özyurt & Polat, 2006; Ersoy *et al.*, 2008; Cardinal *et al.*, 2011; Ozogul *et al.*, 2011), no similar pattern was able to be distinguished in the only study occurring for wreckfish sampled in the same area for various times of the year (Roncarati *et al.*, 2014). On the contrary, the latter study found a correlation of wreckfish size with the fillet fat depots, with smaller fish exhibiting higher fillet fat. Although this is opposite to the general rule that fat depots increase with size (Grigorakis, 2010), the authors explained that as a consequence of the metabolic cost of gonad maturation in larger fish. The same study mentioned lower fillet protein content.

4.4. Sensory analysis

The sensory profiles differed between species and this becomes evident both from the statistically significant differences in their average values of the descriptors (**Table 3.5**) and from the discriminant analysis results (**Fig. 3.6**). From the present results, it can be concluded that pikeperch and grey mullet are characterized mainly by “earthy” odour and flavour and that amberjack is characterized by an “acid” flavour. The two former observations can possibly be related with the fish origin – environment since these are the two species not originating from a marine sea cage environment. Pikeperch are reared in freshwater recirculating tank systems, while grey mullet are reared in saltwater earthen pond systems. On the other hand, marine species (greater amberjack, meagre and wreckfish) are characterized with higher notes of “butter” flavour. Grey mullet on the other side, exhibited higher value in bitter flavour.

The “acid” flavour that is characteristically pronounced in the great amberjack, is possibly related to its high fat content when compared to the rest of the species (Table 3.2). Another sensory descriptor that has been related to fat content is “juiciness” (Love, 1992; Grigorakis, 2010), and this characterized the wreckfish that has significantly higher fat, but also meagre which is a lean fish. The fact of high juiciness in low-fat meagre could possibly explained by the water-protein interactions in fillet, resulting into high bound water

As shown in the results, mechanical texture analysis exhibited differences between raw and cooked fish and was more discriminant between species in cooked samples. For cooked samples, both non-destructive compression and TPA (**Table 4**) provided different results. For instance, wreckfish was the hardest species in the TPA test, whereas grey mullet had the highest mean value for the maximum force (equivalent to hardness) in the non-destructive test. This discrepancy can be explained by the different behaviour exhibited by the fish samples once their structure was broken. In any case, and even if chewing food products always involves high compression ratios and destructive processes, higher resistance to low deformation forces may be especially interesting in different procedures aimed to keep the integrity of the filet during its processing and/or packaging.

The results of sensory analysis and those of TPA in cooked samples are in agreement in a certain degree. Thus, hardness (a.k.a. sensory firmness) that was found significantly lower in sensory terms for pikeperch (**Table 3.5**), received also the lowest TPA value for the same species. Exactly the opposite (*i.e.*, highest sensory and TPA values) was observed for wreckfish. Chewiness exhibited the highest sensory and mechanical values in wreckfish and the lowest in pikeperch, respectively, but no similar sensory and TPA pattern was observed for the rest of the species.

4.5. Report on product and process solutions

Although, there are numerous inevitable uncertainties due to technical reasons (limited number of fish, limited dietary histories and limited seasons examined) some suggestions can be drawn upon these results.

1) Technical yields do not seem to be significantly influenced by fish size, with the exception of dressing yield that correlates positively with body weight in great amberjack and meagre. Thus for these two species it is technically more profitable to have fish of large commercial sizes, when commercialized as gutted.
2) Fish species reared in ponds or in freshwater, *i.e.* the grey mullet and the pikeperch, characterized by the presence of "earthy" odour and flavour, maybe be better used for the design of products that come with dressing spices or sauces that can cover these earthy characters that are mostly unwanted. Thus, ideas such #14 and 21 (fresh products with spices or marinates) or 25 and 13 (frozen products with marinates) presented in Deliverable 28.2 List of ideas for new product development can be ideal for these species.
3) Greater amberjack may be advantageous for raw (*e.g.,* Carpaccio or tartar, ideas 24, 30 and 38 of D.28.2) and smoked (idea 2 of D28.2) products due to its high fillet fat contents and distinct sensory characteristics (high acid flavour and juiciness). On the other hand, it may be disadvantageous when referring to the frozen products, due to its vulnerability to fat oxidation. If frozen products are going to be designed for greater amberjack, they should be made with fish smaller fish of 1-2 kg, because they have relatively low fillet fats as opposed to larger fish (of 10-15 kg) that are more fatty.
4) Meagre and pikeperch may be ideal for fish burgers (*e.g*,. fish burger in the shape of fish: idea 6 of D.28.2) due to their low chewiness (opposite to amberjack and wreckfish). This is justified by the fact that these new products refer to children, which would in their majority prefer less "chewy" fish.

5. Conclusion

Five fish species were studied for their fillet composition, their technical yields, their fillet sensory properties and mechanical texture. What can be concluded is:

- The condition index of the fish is usually indicative of the nutritional status of the fish, meaningful only in intra species comparisons, and has been found to correlate positively with body weight in the cases of great amberjack and meagre.
- The dressing yields for all species are quite similar, slightly exceeding 90%.
- No other significant correlations of technical yields with fish size (body weight) were observed. This implies that body weight is not a crucial parameter in processing.
- Great amberjack showed high fillet fat reaching 4% in 1-1.5 kg fish and exceeding 12% in 15-20kg fish. All other fish exhibited very low fillet fat, not exceeding 1%.
- All fish species showed similar and typical fillet protein averaging 20%.
- Average values of the sensory descriptors, as well as discriminant analysis, show significant differentiation in the sensory properties of the five fish species. Grey mullet and pikeperch are characterized by the presence of earthy odors and flavours. All marine origin species (amberjack, wreckfish and meagre) are characterized by higher butter flavor. Wreckfish is characterized by acid flavor. Meagre and pikeperch are characterized by lower chewiness.
- Texture profile analysis also showed differentiation between fish species and some relevance with the values received for the sensory textural descriptors.
- Some processing recommendations – products best fitted for each species have been suggested.

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