"Piloting of eco-innovative fishery supply-chains to market added-value Adriatic fish product"

# D4.1.2. Report of the possible innovative harvesting and processing solutions for product value adding and market niche

WP4 -Innovating tools and processes for added-value Adriatic fishery products/ A4.1. The state of art of technological and process innovation

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# Contents

# 1. Introduction

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Evaluation of potential innovative harvesting, processing and transformation of target fish group to deliver added-value product, with associated analysis of market niche, and contribution to WP5 is the main driver of present analysis. The report will focus on the possibility of multiple purposes of the available processing solutions while following product trends on the markets.

The main business activity within this project is to initiate innovations in the process of harvesting, processing and packaging of fish to obtain high value-added products, ready-to-eat fishery products in the category of semi-finished and ready meals in the form of appetizers and main meals. The products refer to those for the preparation of microwave dishes and the production of fish marinades and salads according to traditional recipes.
The main raw materials in the production of ready-made and semi-finished meals are fish species, which were selected through a special market analysis, whose availability in terms of supply is unquestionable, the price is relatively low, and for which the market shows demand.

The analysis of the market emphasizes the examination of potentially new markets, mainly in Central and Eastern European countries and shows that there is a continuous increase in demand for planned products.
In order to achieve the previously defined strategic goals, the place and role of new processing opportunities in the health food production sector need to be recognized and properly valorized. Reaching the defined strategic goals should also be pursued through the improvement and modernization of the processing sector by:

- improving the balance of the processing with the environment;
- modernizing production at existing processing facilities,
- upgrading the already existing and introducing new processing technologies;
- introduction of new products into industrial processing;
- investing in the opening of new processing plants (construction of facilities and procurement of devices and equipment),
- favoring new process technologies and innovative products
- integrating processing into rural development.

The growing demands of the fish market are partly offset by increased processing capacity. More specifically, fishery processed products give way to more opportunities and more sales channels.

This momentum is a consequence of the growing needs of the world market for this type of production, although gradual growth can be expected due to strict rules in the application and compliance with strict food production standards. Unfortunately, it must be noted that a great opportunity of a different form of marine fish processing in the Republic of Croatia has not been used, and therefore this study opens the possibility of a new approach to the processing processes.

The basic products that we will later detail relate to the production of ready-made appetizers and main courses ready for direct consumption or consumption after a short heat treatment. Categorization of production is included in the food industry. The target markets are partly Eastern and Central European countries, as domestic sales are planned. The marketing channels are catering establishments and larger distribution chains.

# 2. Project effects

Product category developed by this project, among several others, represents the highest level of added value to fisheries products, as it opens up the benefits of consumption in the ever-increasing demands of fast-food consumers without losing any of the original characteristics of the product.

Modern lifestyles in Western European countries have already imposed these types of products on standard consumption, and this style is increasingly spreading into Eastern and Central European countries where demand for these types of products is emerging. The very rationale and definition of the product show that the effects are linked to several goals that lead to improved competitiveness and improved market efficiency of the processing sector in the Republic of Croatia.

Since its very start, the project would have more far-reaching effects both for the consolidation of the project and as an example for other producers, all of which could be seen as a way of adding value to fish and other marine organisms. After the piloting probe of the facility and the installation and implementation of equipment for the primary processing of fish and other marine organisms and the commencement of production, one of the key effects in terms of different valuation of fishery products in the Republic Italy and Republic of Croatia would become evident. In this context, the assumption that the introduction of a new type of product on the Italian and Croatian markets, in addition to exports, would lead to the partial increase of the fish consumption per capita, which is also a recommendation of professional and scientific health institutions.

By treating fish and other marine organisms, the project will be able to achieve added value for its primary products while reducing market pressures at the time of its saturation, thereby ensuring well-being for the fishing community.

# 3. Sales market analysis

For the purpose of the preparation of this study, a short marketing analysis was carried out to determine the possible raw material basis as well as the types of products that would be produced for the purpose of further evaluation of economic viability. The marketing analysis also looked into potential markets for product placement and determined that there was a justification for demand for this type of product.

In addition to analyzing consumption, consumer habits when selecting product types, imports and exports, target countries for a potential market, the marketing analysis included a review of the current distribution system in those countries, identifying possible market channels for entry. The data used in the analysis were downloaded, collected, sublimated, interpolated and verified by a number of official sources and primarily include the data collected (Eurostat, FAO, USDA and other sources such as CBI, World Bank, IMF, data from statistical offices and institutions of countries). It should be noted that certain data differ, so some should be taken with caution, but despite the differences, they surely show clear trends in individual countries.

A more detailed study, specifically focused on Croatian and Italian markets, will be carried out in D5.1.1, due at M15. The same deliverable will also assess and identify the species of interest for the project, based on ecological, technological and economic considerations.

The preliminary analysis conducted in this section shows the importance of gathering appropriate market intelligence before starting any business process and can greatly help in the quality assessment of opportunities and the possibility of starting new production in order to make good business decisions.

In order to establish fish processing and dressing trials, it is necessary to consider the market opportunities in both raw material procurement (procurement market) and product placement (sales market). This way the principle of completeness is satisfied before starting production. Following this principle, the project can properly consider the possibilities of successfully starting a new production or reorganizing a part of production related to the current marketing and processing of fish.

Products that are marketed generally are high value-added products, that is, cold and hot fish entrees and main courses ready for direct consumption or consumption after a short heat treatment in the microwave oven.

The product range is divided into:

- Cold appetizers that include fish salads and marinated anchovies and anchovies
- Ready-made entrees that include pasta and rice-based products - shorter heat treatment
- Main dishes – burgers - shorter heat treatment

The range offers a complete range of ready-to-serve products for restaurants and hotels, as well as the ability to sell in wholesale chains. Modern lifestyles, extended working hours and the consequent lack of time to prepare fish place this category at the top of suitable quick preparation products.

## 3.1. Seafood market in the EU and market drivers

The total EU market for fisheries products in 2016 amounted to 14.22 million tons, but the 28 EU countries' production accounts for a very small share compared to the world production of fisheries, i.e., only 3,1 % of production in 2016. However, in contrast with the production, the EU 28 is one of the largest distribution channels of fish and fish products. The five largest EU consumption markets are Spain, France, Italy, Germany and the United Kingdom, accounting for more than 70 % of total consumption in 2016. The EU market consumption is dominated by wild fisheries products which account for three quarters of the total. In 2016., 18,61 kg per capita of wild fish were consumed, while farmed products totaled 5,72 kg per capita. (EUMOFA 2016.).
The largest consumers are generally Mediterranean but also Scandinavian countries, while Central European countries and the new member states do not have a strong tradition of eating seafood. In some countries there is a rise in consumption due to the increasing personal revenues and increased trade.
In the long term, the consumption of fishery products in the EU is increasing. Consumers have an increased interest in specially packaged products, culinary delicacies, luxury products, value-added products, fish fillets and sustainable fisheries products.
On the other hand, European consumers are also switching to consuming non-EU products and fish such as channel catfish, tilapia and Nile perch. These products are appreciated for their neutral taste and low price.
In general, fishery products are increasing their market share due to their health image and quality, greater convenience in preparation and low prices.

## 3.2. Fishery production in the EU

In 2001., the registered EU catches amounted to 6.9 million tons, compared to 5.6 million tons in 2006. and 5.01 million tons in 2016. The catches have been following a downward trend over the last two decades. Although representing only 3.1 % of the total world production, the EU is still the fifth largest global producer after China, North America and South America. The main fishing countries in the EU are Spain, Denmark, the UK, France and the Netherlands. The catch of fish depends mainly on the European Commission's system of TAC quotas and other measures which are applied mostly on the Atlantic and which they are trying to establish in the Med area. It is predicted that the total TAC will decrease due to the depletion of European waters, so Europe is signing bilateral agreements with third countries to expand its fishing grounds. The North-East Atlantic with over 70 % of catches is the EU's most important fishing area. However, catches from this area are being reduced due to restrictions imposed by the EC or the implementation of CFP measures. State quotas have been set with catch limits for total quantities of each species. The commission's goal is to ensure the sustainable exploitation of living aquatic systems. Other important fishing grounds are the Mediterranean and the Black Sea. The main catch species are the Atlantic herring, followed by the sprat, European small pelagic whiting, Atlantic mackerel and European sardines.

## 3.3. Aquaculture

Aquaculture is an alternative source of production and it accounts for about 20 % of the total EU fish and shellfish production. In 2001., the aquaculture production amounted to 1.4 million tons, compared to 1.3 million tons in 2006. and 1.29 million tons in 2016, marking a significant decrease since 2001.

| | | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| Food use | Catches | 3.644.690 | 3.614.409 | 3.834.079 | 4.216.254 | 3.824.012 | 3.883.916 |
| | Aquaculture | 1.271.816 | 1.235.825 | 1.186.672 | 1.252.608 | 1.263.141 | 1.289.823 |
| | **Total production destined to food use** | **4.916.506** | **4.850.234** | **5.020.751** | **5.468.862** | **5.087.153** | **5.173.739** |
| Non-food use | Catches | 1.117.468 | 741.332 | 994.911 | 1.165.413 | 1.320.207 | 1.130.563 |

Table 1.: EU production details (tons) Source: EUMOFA based on elaboration of EUROSTAT, National sources, FEAP and FAO data

The growth of aquaculture in Europe is limited by high prices, technical constraints and strong productive market pressure from non-EU aquaculture producers such as Norway and China as well as Turkey for seabass/seabream. However, technical advances are also emerging that are creating new opportunities so that efforts are needed to boost aquaculture production in the EU. Mussels, rainbow trout, salmon, oysters are the main productive species in the EU and subsequently sea bass and sea bream, while there are some other standard niche species as well. France and Spain are the main producers of oysters and mussels.
Aquaculture production worldwide has shown a strong upward trend. In the EU, aquaculture production has had some fluctuations.
Spain is the largest producer and produces the most mussels. The second largest producer is France (producing mainly oysters, mussels and trout, followed by Italy and Greece, which are large producers of sea bream and sea bass. The UK is a major supplier of Atlantic salmon. Aquaculture is increasingly becoming an alternative to catches in the European Community.

## 3.4. EU import's objective

The EU is the leading net importer of fisheries products since demand exceeds production. The European fish processing industry relies on the supply of raw materials from other countries. Major importers of fisheries products such as the UK, Denmark and the Netherlands are re-exporting primary and processed fish to other EU countries. Norway is the largest supplier of fresh, chilled or frozen fish to the EU. Imports from other countries satisfied over 70 % of the EU needs in 2016. Freshwater tropical waters species include Vietnam catfish, Nile perch, tilapia and Chinese hake (cheap, double-frozen Alaska pollock steaks are all well positioned in exports from third countries), cuttlefish, squid and octopus. Third countries are increasing their share in shrimps and prawns but also in traditional species such as salmon and hake. Large quantities contain both prolonged shelf life and semi-prolonged shelf-life tuna products, as well as sardines and anchovies on the fresh market.

### 3.4.1. Imports by product groups

As concerns the imports, fresh, chilled or frozen fish is by far the largest product group and also the fastest growing one.
Many different types of fish are imported into the EU. The main species (based on import value) are salmon, cod, hake and tuna.

Salmon is the fastest growing product in imports. Most imported salmon come from Norway, then Sweden and Denmark (the two latter ones are within the EU) followed by Chile and China. Usually, the EU States supply most fresh or chilled salmon while the third countries supply mostly frozen salmon.
Cod imports are also increasing, but at a much lower rate than salmon. Freshwater fish such as tilapia, Nile perch and pangasius are among the fastest growing products in imports. Third countries are a major supplier with a strong rising import rate.
The main markets for fresh, chilled or frozen fish are Spain, Germany, France, Italy and the UK.
The largest part or about 80 % of the total import value consists of shrimp and prawns and 20 % of other crabs and lobster. The main market for fresh, chilled or frozen crabs is Spain, France, Italy and Belgium.
One of the most important products is tuna. It is mainly imported from Spain, Ecuador, Thailand and Seychelles. The main markets for long shelf life and semi-long shelf-life products are Italy, the UK, France and Germany.
Long and semi-long shelf-life crustaceans and mollusks are also an important category. Prepared shrimps and prawns are the most important products. Their import value has grown much faster than that of imports from other countries.
Processed crustaceans and mollusks are mostly sold in the UK, Denmark, France, Germany and Belgium.
As concerns fresh, chilled or frozen cephalopods, around 6o % of total imports consisted of squid and cuttlefish, while octopus accounted for 40% of imports. The third countries are the main suppliers of cephalopods. The main suppliers of squid and cuttlefish are India, Thailand and Morocco, while Morocco, Mauritania and Mexico are the most significant suppliers of octopus. The main market for fresh, chilled or frozen cephalopods is Spain and Italy.
Fresh, chilled or frozen mollusks other than cephalopods are the smallest production group in imports. The main suppliers are the Netherlands, the UK and France. The main markets are Spain, France, Italy and Belgium.

### 3.4.2. Role of imports from third countries

The EU production is increasingly unable to meet its demand, which is why imports from third countries are growing. The importance of third-country suppliers is increasing as imports from third countries are growing at a faster rate than total imports. Third countries are very strong in delivering shrimp and prawns, processed tuna and freshwater species. It is worth mentioning that tuna is one of the best positioned products. They are all are popular as an alternative to

traditional types or as new products and they contribute substantially to the variety or range of products that appear in the EU dealers/retailers and supermarkets. In addition, third countries are slowly but steadily evolving from exporters of raw materials for the fishing industry to exporters of value-added products.

Some countries even import raw materials, then re-export after having added value. Imports of fisheries products from third countries into the EU are expected to continue to grow. Increasing demand for food security and source security will impose more rules and regulations on third countries, which is a burden especially for small and medium-sized exporters. However, once the requirements are met, third-country suppliers can cover most of the EU market. Spain is by far the largest importer of fishery products from third countries, accounting for about 30 % of total EU imports.

Key highlights:

The EU relies heavily on imports of fisheries products to meet demand. This change is structural, as production in the EU is declining and consumption is rising
-Imports from third countries are strongly increasing
-New tropical farms and products are becoming more popular and can replace the more endangered traditional species and strike a balance in supply
-Demand for crustaceans and mollusks will remain strong especially in Southern European countries
-Demand for value-added products from third countries will increase, especially as they are priced very competitively compared to EU products
-Competition between third-country suppliers will intensify as they build production sites
-Increasing demand for food safety and consistency will impose more rules and regulations on the exporters from third countries
-Increasing demand for fisheries products from sustainable development can increase trade barriers for small and medium-sized exporters who lack the means to certify their products.

## 3.5. EU internal trade and re-export

In general, major producers are located in Northern Europe, and some of the major markets are located in the South, with some products (e.g., canned tuna) at the top of exports within EU trade. These exporters are among the largest producers of fishery catches. As concerns the imports, France and Italy are main importers within the EU fisheries product market, while imports from other parts of the world are relatively small. In contrast, Spain and the UK import more from the non-EU countries than from other EU countries. Trade relations are very strong among

neighboring countries. Trade flows are strong between the Netherlands and Germany, between Spain and France and between the Scandinavian countries. The main exporters are also re-exporters of fishery products from third countries. Internal trade between EU countries will continue to be important in the future.

## 3.6. Fish processing industry

The European fish processing industry is a small sector, nonetheless it represents significant employment potential, especially in those regions that are heavily linked to the fisheries income. The sector produces on average almost twice as much production value as the catch and aquaculture combined together. The most important product types are cans followed by fresh, chilled, frozen, smoked or dried fish.

Production has over the recent years continued to increase while employment in the sector has been declining, largely because smaller manufacturing companies cannot meet the new safety standards as well as production technology standards and are closing or merging with larger companies. Firms in the fish processing sector are very vulnerable to possible fluctuations in fish supply. In order to ensure a regular supply of fish, EU companies must rely partly on imports.

The countries with the largest fish processing industry are Spain, the UK, France and Denmark. The first three concern mainly products for human consumption, while in Denmark the processing is mainly focused on the production of fishmeal.
Processing is defined as any activity that adds value to raw products, such as fileting, cooking, panning, canning or smoking. The most important products are filets and breaded products, cooked but ready-made meals or easy-to-use items are becoming a subject of growing interest.

The current trend is also to divert part of the manufacturing industry from the country of origin of raw materials, especially because of cheap labor. Much of the fishing caught by the EU fleet goes to individual third countries for processing.

For example, shrimps harvested in EU territorial waters go to Morocco for processing and peeling and then return to the European market and trade again. The biggest reason is that cold water shrimps are inappropriate for processing because of their size and this process must be performed manually as a very intensive process. Sea fish, and especially cod, are increasing their trade with third countries for fileting and importing into the EU.
Another clear trend is the transfer of intensive tuna processing from Spain to Latin American countries due to lower labor costs and lower production costs.

| Products[27] | Per capita (kg) | % wild | % farmed |
|---|---|---|---|
| Tuna | 2,78 | 99% | 1% |
| Cod | 2,33 | 100% | 0% |
| Salmon | 2,19 | 5% | 95% |
| Alaska pollock | 1,59 | 100% | 0% |
| Shrimps | 1,56 | 62% | 38% |
| Mussel | 1,27 | 20% | 80% |
| Herring | 1,23 | 100% | 0% |
| Hake | 0,96 | 100% | 0% |
| Squid | 0,72 | 100% | 0% |
| Sardine | 0,69 | 100% | 0% |
| Mackerel | 0,58 | 100% | 0% |
| Surimi | 0,58 | 100% | 0% |
| Freshwater catfish (including pangasius) | 0,50 | 1% | 99% |
| Trout | 0,42 | 1% | 99% |
| Scallop | 0,35 | 84% | 16% |
| Others | 6,59 | 84% | 16% |
| **Total** | **24,33** | **76%** | **24%** |

Table 2.; Apparent consumption of most important species (live weight equivalent, 2016.) Source: EUMOFA based on elaboration of EUROSTAT and FAO data

## 3.7. Trends

According to FAO forecasts, the world production of fishery products was to increase to 179 million tons by 2015. The highest production growth was expected in aquaculture, especially in Asia and Africa. The catches would have stagnated and remained at around 95 million tons (with annual fluctuations), which in fact has to a large extent come true. Some species of fish in the Atlantic are under intense fishing pressure and the most threatened species are cod, hake, anchovy and small pelagic bluefin tuna. The EU policy is to transform the fisheries sector with a view to achieve sustainable and responsible management that guarantees the future of fish stocks. Therefore, the total allowable catch (TAC) of the species most affected by overexploitation has decreased significantly to ensure the recovery of these endangered fish

species. If this policy is successful, it may in the future result in the possibility of an increase in catches.

The fishing industry is specifically addressing raw material shortages by seeking alternatives, i.e., by importing other traditional species or introducing new species that are gradually replacing the traditional ones. The alternative is that the EU will increasingly depend on imports from the third countries. One of the ways of meeting its needs implies that the EU signs bilateral agreements on the exploitation of other fisheries. This is because the EU has lost advantage in supplying domestic production sufficiently, but is investing nonetheless in the development of its fisheries sector. The long-term effects of these agreements are unknown both as concerns the environment and the fish varieties.

The EC has tried to facilitate imports from third countries by reducing tariff rates on imports of raw and semi-processed fishery products. However, it must be mentioned that there is some resistance to these measures since they can lower the price of imported fish and thus jeopardize the prices of the fish from the EU fishing fleets.

Another limiting factor for the EU products price was the constant fuel price oscillation which led to several economic crises in the segments of the fishing fleet where the price of fuel plays a significant role per unit of effort. This problem has been particularly significant for trawlers and the EU introduced emergency measures to mitigate the consequences.

Aquaculture production cannot make up enough for the reduction in catches. Aquaculture production in the EU leads to technical constraints and inefficiencies. The EU aquaculture also faces strong competition from Chile and Norway, countries that produce with relatively low costs and in large quantities. New opportunities in aquaculture can come from the latest technologically advanced developments, which enable the cultivation of traditional catch species such as for example cod produced in aquaculture while the wild stocks are low.

However, aquaculture is highly dependent on fish food, which again consists largely of fish products for better farming performance. So, catching fish to make fish food is a limiting factor for aquaculture development.
Until recently it was impossible to grow individual species. However, the development of technology has now made this possible, as is shown by the example of cod farming in the UK and in Scandinavian countries. Further improvements in cultivation may lead to increased cod production in the future. Although many wild species can be produced in aquaculture, only a few are responsible for commercial aquaculture because production costs for some interesting species may be too high.

Key highlights:

- Reducing catches of many fish species in the North-East Atlantic, reducing intra-EU fish shipments as well as setting quota regimes for better valuated products

- Inefficient aquaculture in terms of breeding costs, technical difficulties and increased competition from third countries

- Increasing demand for alternative fish species for the fish industry and aquaculture

- Increasing competition between fish used for fishmeal production and for human consumption in connection with the rise of aquaculture in the world

- Increase fish output to other countries for primary processing and value addition, such as removal of the head and intestine, fileting, panning, etc.

- Bilateral agreements between the EU and third countries on the exploitation of fishing grounds which reduce export opportunities for local jobs and local fisheries delivery, although measures exist to protect local industries

- The new approach in aquaculture can lead to increased aquaculture production for more species in a more cost-effective way. Increased access to offshore technology.

## 3.8. Market channels

Importers, agents (representatives) and processing companies are the most important business partners for entering the European market. Retail channels consist of supermarkets and hypermarkets, fish retailers, fish markets and grocery stores. Large retailers have taken the lead over fish and fishmongers, especially in Northern Europe. In Southern countries such as Italy and Spain, wholesale chains have not gained direct dominance and strong wholesalers continue to prevail. Retail channels in Eastern European countries such as the Czech Republic and Hungary are changing with the entry of Western large retail chains that are rapidly gaining market share. However, such processes do not go smoothly in all countries and Poland is one of them, where these processes develop much more slowly.

Fisheries product distribution channels are being consolidated due to increased competition and improved logistics in trade. Consolidation prevails mostly as concerns frozen products or processed products, but it also changes the distribution channels for fresh or chilled fishery products.

Another emerging trend is large retail chains buying fish directly from producers - especially as concerns aquaculture products bought from one or more suppliers. The requirements for this supply primarily relate to safety, good service and efficiency. These trends lead to the shortening of the supply chain and more and more direct relationships between the supplier and the retailer, where delivery must be traceable at all times.

# 4. Opportunities to raise consumption and sales

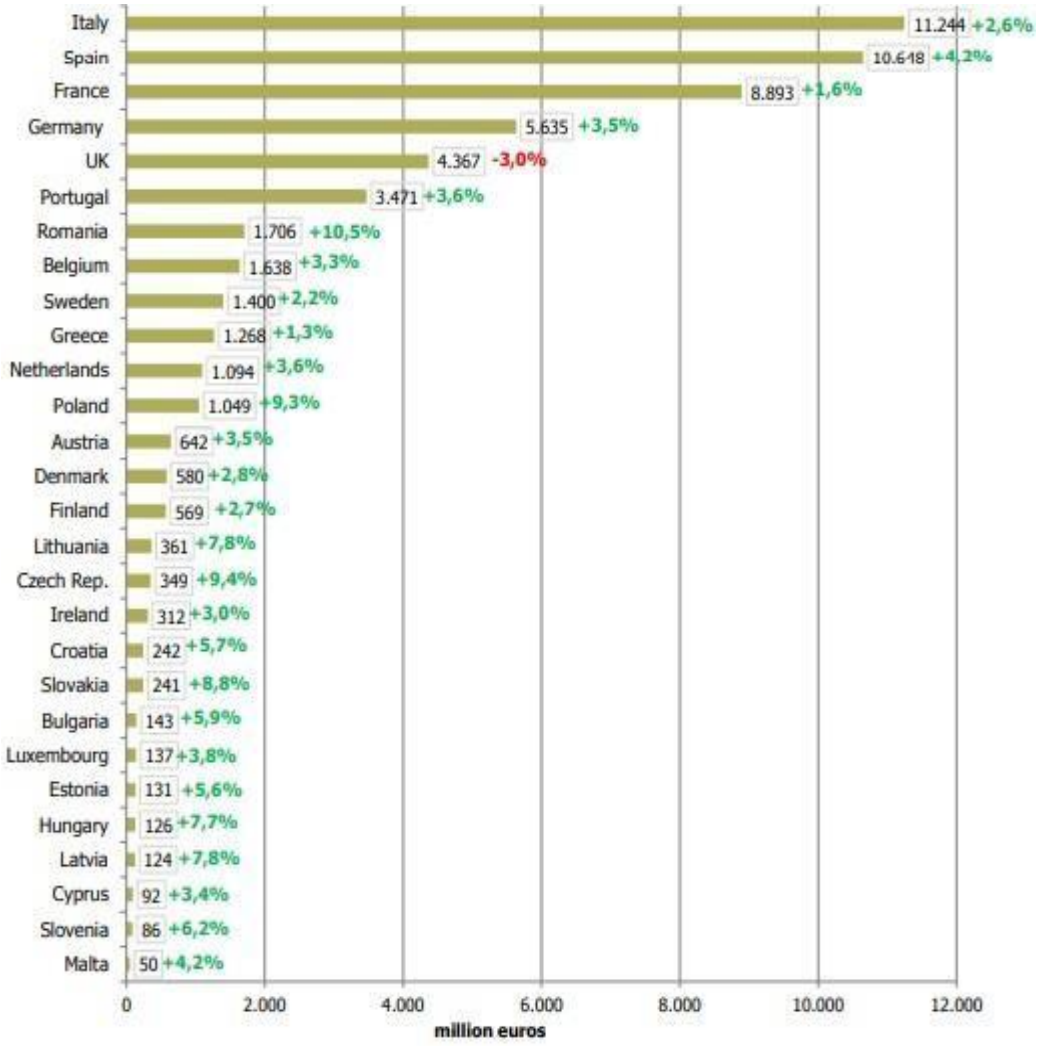
Sales of fisheries products in the EU offer many opportunities, but also threats. The main opportunities lie in the creation and adaptation of products according to market trends, consumption, production and trade.
Mainly it is the products that drive the need for a healthy product, practical packaging and affordability and sustainable trends that can benefit from a wide market opportunity. Fish processors who are dedicated to adding value and creating ready-made products as well as participating in trends can serve the growing demand. There are opportunities for excellence in quality, boned fish or fish filets as well as frozen ready meals like burgers.
Main triggers for development are standards for food quality and safety, and significant consolidation of the supply market, which causes demand for high production.
Of course, each trend must be analyzed in the light of the specific circumstances that determine possible developments.
In identifying technologies and niches, this analysis profiles the fishery products sold in the EU. Emphasis is placed on products that are of major interest for the fishermen and processors seeking to find new markets.

This analysis examines the following product groups:

- fresh, chilled or frozen fish and fish filets;
- fresh, chilled or frozen crabs;
- fresh, chilled or frozen cephalopods;
- fresh, chilled or frozen mollusks other than cephalopods
- fish products (durable and semi-durable products);
- crab and mollusk products.

## 4.1. EU consumption and market size

With an estimated consumption of 12.41 million tons (live weight), the EU is the second largest fishery product market after China, ahead of Japan and the US. In terms of value, Italy spends the most, followed by Spain and France, followed by Germany and the UK.




Graph 1.; Household expenditure on fishery and aquaculture products in 2017 and % variation 2017/2016 (Out-of-home consumption is excluded) Source: EUROSTAT (Purchasing Power Parities – PPPs –nominal expenditure)

In the context of price increases and data from individual countries, it can be assumed that the value of fishery products in the observed period shows an increase.
Consumption of fishery products differs greatly among EU Member States. The highest per capita consumption is in Portugal (57 kg), followed by Spain (45 kg), greater part of France (33 kg) and Italy (31 kg).

The EU's five largest consumer markets account for more than 60 % of EU spending. In general, the Mediterranean and Scandinavian countries are large consumers of fishery products. France has the largest market for fishery products, although its per capita consumption is not the highest one. Per capita consumption in Italy and the UK moves around the EU average, but because of its large population, they are an equally important market as Germany.

Central European countries do not have a strong tradition of consuming fishery products. Most of these countries are surrounded by land and lack a significant marine product sector, although consumption of freshwater species prevails. However, in these countries there is an increase in consumption of fishery products with the expansion of the market as well as an increase in personal income.

Total consumer volume is projected to grow modestly, but prices and values are expected to increase through the delivery of high value products. FAO predicts that consumption of frozen fish will decrease while consumption of fresh, chilled or frozen fish will remain stable and at the same level. The consumption of crustaceans and mollusks is expected to increase.

| Commodity group | Production (tonnes) | | Import (tonnes) | | Export (tonnes) | | Apparent consumption (tonnes) | | | Apparent consumption per capita (kg) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fishery | Aquaculture | Fishery | Aquaculture | Fishery | Aquaculture | Fishery | Aquaculture | Total | Fishery | Aquaculture | Total |
| Bivalves and other molluscs and aquatic invertebrates | 224.464 | 602.043 | 372.773 | 86.278 | 34.614 | 9.072 | 562.623 | 679.249 | 1.241.872 | 1,10 | 1,33 | 2,43 |
| Cephalopods | 93.217 | 2 | 541.428 | 0 | 30.617 | 1 | 604.027 | 1 | 604.027 | 1,18 | 0 | 1,18 |
| Crustaceans | 169.271 | 402 | 570.830 | 308.218 | 107.644 | 474 | 632.457 | 308.146 | 940.604 | 1,24 | 0,60 | 1,84 |
| Flatfish | 198.179 | 11.244 | 155.633 | 697 | 67.807 | 334 | 286.004 | 11.607 | 297.611 | 0,56 | 0,02 | 0,58 |
| Freshwater fish | 17.222 | 106.000 | 101.596 | 311.373 | 8.511 | 8.344 | 110.307 | 409.030 | 519.337 | 0,22 | 0,80 | 1,02 |
| Groundfish | 623.099 | 0 | 2.754.331 | 682 | 254.772 | 0 | 3.122.658 | 682 | 3.123.341 | 6,12 | 0 | 6,12 |
| Miscellaneous aquatic products | 55.390 | 672 | 310.184 | 0 | 15.399 | 0 | 350.175 | 672 | 350.847 | 0,69 | 0 | 0,69 |
| Other marine fish | 334.806 | 175.741 | 401.481 | 61.237 | 114.323 | 12.666 | 621.964 | 224.312 | 846.276 | 1,22 | 0,44 | 1,66 |
| Salmonids | 4.936 | 376.119 | 97.064 | 1.002.610 | 39.993 | 102.222 | 62.007 | 1.276.507 | 1.338.514 | 0,12 | 2,50 | 2,62 |
| Small pelagics | 1.762.776 | 0 | 603.119 | 0 | 686.842 | 0 | 1.679.054 | 0 | 1.679.054 | 3,29 | 0 | 3,29 |
| Tuna and tuna-like species | 400.556 | 17.599 | 1.365.450 | 95 | 301.969 | 9.754 | 1.464.037 | 7.941 | 1.471.977 | 2,87 | 0,02 | 2,88 |
| **Total** | **3.883.916** | **1.289.823** | **7.273.889** | **1.771.191** | **1.662.493** | **142.866** | **9.495.313** | **2.918.148** | **12.413.461** | **18,61** | **5,72** | **24,33** |

Table 3.; EU supply balance for fisheries and aquaculture products by commodity group and production method (2016, live weight equivalent FOOD USE ONLY) Source: EUMOFA based on elaboration of EUROSTAT and FAO data

## 4.2. Market segmentation

The European fisheries product market can be roughly divided into three main regions;

- Northern Europe including the UK, Ireland, Scandinavian countries and the Netherlands,
- Central Europe including Germany, Austria, Poland and the Czech Republic and
- Mediterranean countries.

In Northern Europe, most consumption is related to cold water fish such as cod, herring, mackerel, collie, flatfish and trout. In these countries, ready meals are more popular than in southern European countries and generally processed fishery products have a higher market share. In Mediterranean area, species such as hake, sardines, squid, octopus and various mollusks are more popular. In these states, much of the consumption consists of fresh, untreated fish, which is further prepared in-house.
France has a central position, with high demand for both non-treated groups and value-added products. Some species are popular across Europe such as tuna, salmon and shrimp.

Central European countries have a poor tradition of consuming fishery products and are at the lowest end of their consumption levels. When looking at brand development or branding, there are significant differences between various EU countries. Brands are very important for frozen, canned or semi-prolonged shelf-life fishery products. Brands therefore have a very strong position in countries where a lot of fishery products are bought frozen or processed (e.g., Germany).
Fish that are mostly sold over the counter or are exposed on a refrigerated display in supermarkets usually do not carry the brand. Therefore, where most products are sold fresh (for example Spain), brands have a smaller share of the market share.

Consumer age makes for another market segmentation. In many EU countries, the consumption of fishery products concerns people aged 50+. The age of the consumer is another way of segmenting the market. In many European countries, the consumption of fishery products is highest among people who are over 50. These consumers are far more likely to buy fresh and whole fish than younger consumers. However, all age groups eat fishery products. The young and especially children often choose fish sticks and canned fish with fresh fish, mollusks and cephalopods.

## 4.3. Major trends, market triggers and restrictions on fishery products

A general trend in the EU since 1980. is the increase in consumer volume. Although value data is inaccessible, the consumer value of fishery products has increased more than volume due to increased sales of affordable and luxury products. Prices are expected to rise as sales of these products are increasing in almost all EU countries and supply is increasing significantly. For the past ten years or more, the following fishery products have clearly influenced the increase in consumption levels;

- Salmon, with significant increase in consumption of fresh and smoked salmon, building a comparative availability platform with increasing farming which makes it an affordable product

- Shrimps and prawns, with tropical shrimps also providing additional supply

- Smoked filets in general; also, salmon and trout, mackerel, eels…
- Value-added products, e.g., surimi, sushi and ready meals;
- Fish filets and portions, responding to the need for convenience
- Exotic species such as tilapia, Nile perch and pangasius, which own their popularity to their neutral taste and low cost

The fisheries market was launched mainly because of its impact on health, convenience, acceptability and experience gained. Many fishery products that have been successful in the European market come in combined forms and are in demand by large consumer groups. Sustainable fisheries products are an equally important trend in countries such as the UK, Germany and the Netherlands.
The availability of fishery products has also increased due to the growing role of supermarkets and retail chains, which makes fishery products accessible to a wider range of consumers.

## 4.4. Health & quality

Fish enjoy a healthy image, an image that drives modern trends in healthy food consumption. Many consumers try to adopt a healthier diet, generally low in calories and high in nutritional values. Fish corresponds to this requirement since it has a lower content of fat and a high content of proteins, vitamins and minerals. Fish are also characterized by advantages or qualities that can be beneficial for certain health problems. For example, omega 3 fatty acids in fatty fish have a beneficial effect on the circulatory system and on preventing heart diseases. In many countries, health campaigns are held to raise awareness on the benefits of fishery products and inviting citizens to consume more fish.

Unfortunately, there is also negative publicity concerning the fish toxin levels. For example, there have been numerous warnings not to consume certain wild species from oceans, such as tuna and swordfish due to increased mercury concentrations.

## 4.5. Convenience and value-addedproducts

Due to time constraints, people spend less and less time buying and preparing meals. This trend is related to the increasing participation of women in the labor market as well as the increase of single households. Therefore, consumers often go to the super or hypermarkets once a week where they buy all their supplies at once at the so-called one stop shopping. In response to the demand for suitable products, supermarkets sell their food properly and offer ready-to-eat foods such as fresh (chilled) or frozen fish filets or ready-made products. In this way, the full range of fishery products will be increasingly more accepted and better suited to go in line with the consumer trends. Key highlights:

- Expanding the applicability of fish products, for example fish salads for lunch meals, fish sticks for quick meal preparation and fish products for appetizers or party snacks (for example tapas, burgers, sushi, and dim sum);
- Expanding new distribution channels for fishery products that can be consumed for lunch, dinner or quick ready-to-go meals
- Attract new consumers to fish that are normally difficult to prepare or consumers who are not familiar with fish products or do not normally consume them;
- Attracting high-income populations towards luxury fishery products;
- Attract low-income populations to low-priced products
- Attract new, unaccustomed consumers with more neutral-flavored species

Fortunately, there is an increased interest in product specialties and foreign culinary traditions. An increasing international tourist travel, a growing number of international and ethnic restaurants and special cooking programs have, for example, encouraged Northern European consumers to consume and adopt non-traditional fishery products which now have a permanent place on the menus. Some examples are deep-fried cuttlefish and calamari, king prawns (giant shrimp) and other tapas dishes, sushi and surimi. The growing ethnic population is also introducing new culinary traditions.

In general, new, tropical species such as tilapia, pangasius and prawns are already present on the menus or are being greatly introduced. However, it should be clear that not all consumers are familiar with the consumption of fish. In addition, scarce knowledge on fish preparation, the taste and smell of fish and the existence of bones act as a deterrent for fish consumption.

However, examples from France and Spain indicate that penetration of fishery products is possible in 90 % of households. In the UK and the Netherlands, more than 80 % of household penetration has been achieved.

## 4.6. Price-conscious consumers

Several countries such as the Netherlands, the UK and France have price sensitive markets where traders keep product prices low to attract price sensitive consumers in order to increase their share. Germany has always been aware of defined goals with strong discount rebate positioning, because in a competitive climate there is a very clear need for simple and inexpensive products. The success of “exotic “species such as Nile perch, tilapia and Vietnamese catfish is partly related to this trend. These products are generally cheaper than the rare and expensive EU products. For certain market segments, the taste may be of secondary importance, which explains the success of the double-frozen Alaska pollock steaks and filets made (but not caught) in China, sometimes with the misleading name Chinese cod.

## 4.7. Fisheries products from sustainable development

Increasingly, European consumers are becoming more environmentally aware of food production issues. Citizens and individual consumer groups regularly exert pressure on governments and manufacturing companies to emphasize these issues and adjust their purchasing behavior. There are several major consumer concerns with respect to the fisheries product market:

• over-exploitation of fishing grounds, reduction of certain traditional fisheries, conflict between fishing and preservation of nature
• ecological and sanitary aspects of fish farming (use of antibiotics, contamination of fresh water, use of fish as animal feed, LAPs - land animal products in fish feed);
• Social aspects in aquaculture and catch, such as child labor,
local producers' settings;
• animal welfare concerns and biodiversity - undersized fish seals, dolphins and turtles caught as by-catch
• Organic fishery products: this is a small but growing trend especially in Germany and the UK. Currently, only farmed fish can be labeled as organic. Caught fish cannot obtain an organization’s certificate easily because the product history is unknown.

These consumer concerns are often channeled through major retailers, who increasingly require suppliers to provide evidence that products come from sustainable production. Part of the chains are already running campaigns on the notion of sustainable production for the products they sell. Some retailers even create a brand. As a consequence, there is a growing supply of fisheries

products from sustainable farming and catches, especially in northern European countries (the UK, the Netherlands, Germany and Scandinavian countries) taking the lead in these trends.

The Marine Stewardship Council (MSC) is a well-known certification body which labels the sustainable way of fishing and catching fish by species. Another certification initiative for fishery products is Global Gap.
Some highlights:
- Expenditure in the EU is a growing value
- Consumption in the new Member States is growing strongly, as is the market which is at the same time driven by a growing net personal income
- Increasing demand for value added, luxury or special fishery products
- Acceptance of new species of fish as a replacement for traditional species
- Fisheries products have a positive health image and match the health trend in almost all EU Member States
- Consumer demand for sustainable catches and aquaculture products is increasing

Products can also carry geographical indications (GIs): Protected Designs of Origin (PDO), and Protected Geographical Indications (PGIs) as well as Traditional Specialties Guaranteed (TSG).

## 4.8. Exploring and entering marketing channels

The fish and shellfish market in Europe are characterized by a large number of small and medium-sized suppliers, processors and distributors. But because of the market dynamism, the structure is changing. The number of hands-on sales including importers, distributors, wholesalers, retailer agents (each with their own interests) is decreasing. The unification of distribution channels is the result of increased competition and improved logistics in the fish trade. Pooling is prevailing mostly in frozen fish and fish products, but pooling occurs in the case of fresh or chilled fish. Fresh fish is often not branded so individual traders can easily replace one supplier for another. In this segment, there is a trend that traders are increasingly circumventing the wholesale markets and buying fish directly from fishing companies and cooperatives.

Categories of business partners suitable for importing;

**Importers**
Importers buy and sell fishery products, mainly for the fisheries industry, retail chains and wholesalers. They usually handle the import formalities and become the owner of the goods. In most cases, they have long-standing contacts with their suppliers, and can advise the exporter on quality conditions, selecting the size and degree of processing, and the appearance of the packaging.

**Processing importers**
Importers may also be processors of final products. For example, sometimes shrimp and prawn importers also go into manufacturing and packaging consumer products. The supply chain of these products can be very short. Processors / importers can also transform raw materials into semi-finished products, for example filets and blocks, which are subsequently sold to another processing industry.

**Agents**
Representatives are intermediaries who establish contacts between exporters and importers and facilitate the buying or selling process. Often, they do not buy or acquire ownership of the products. They work on a commission paid by the supplier of the goods. Typically, these margins range between 2 and 5% of the purchase price (rates may vary). There are two types of representatives; Buyer representatives, for example the fish processing industry or re-exporters, and representatives representing sellers, mainly exporters. Representatives are well informed about market trends, pricing and potential customers. In many EU Member States the role of representatives is changing. Improved logistics and modern means of communication and information are increasingly facilitating direct contact between suppliers and importers, reducing the need for representatives. However, expanding specialty and separating business from service can create a new service for representatives who specialize in looking for new products and sales. Such representatives can be of great help to enter a new market.

There are considerable differences in the supply chains of certain products, as well as the different importance of different sales channels and different countries. Auctions, for example, are more important in certain countries (the Netherlands, Spain) but less important in others. Fresh, frozen canned or semi-durable and durable, value-added products reach consumers in different ways. The difference between consumer packaging and ready-to-use catering packages is also something to evaluate.

**Fishery products for industrial processing**

These are usually caught in domestic waters or imported from abroad and often repackaged and branded for a particular market to the importing company. In other cases, additional preparation or cooking is required from, for example, manufacturers of ready meals and snacks. Thanks to the growing demand for the convenience of products, the processing industry is gaining importance. Third-country processors and exporters that are well aligned with EU measures and standards are well positioned to compete with traditional producers. The trends leading to the dislocation of the industry entail better communication, logistics and international traffic. The growing importance of value-added products from third countries is being noted.

**Fishery products sold after retail and catering packaging**

An important share of fishery products reaches consumers without packaging. They are sold as fresh (chilled, often on ice) or frozen by fish traders.

But many supermarkets, especially in southern Europe, also offer products in this form. In northern Europe, it is common for such products to be sold fresh or frozen in packs or in catering packs. Packers usually buy fish at fish auctions directly from a ship or an importer, then pack and process fish according to their customers' requirements.

Such processing for packaging may include cleaning, fileting, boning and even seasoning. It is different from industrial processing in that the products remain largely unchanged.

**Fishery products in consumer or catering packages**

The most suitable business partners for these products are importers or wholesalers. In this channel, the basic distinction must be made between retail and foodservice because they have different distribution channels. Currently most retailers and catering organizations buy from European wholesalers and importers. However, direct purchases from abroad are on the rise. Large chains interested in purchasing will have large logistics and quality requirements.

**Branded fish products**

In recent years, many food companies have restructured their operations and sold brands that were not their primary business. As a result, many fishery products that have had their own brand or brands that have been transferred to new owners. Some brands are even owned by more than one company, each active in different geographical areas.

**Retail channels**

Retail channels consist of super and hypermarkets, fish retailers, public markets and other grocery stores. Supermarkets require more services, efficiency and above all, security in the

delivery of fish. The latter leads to a shorter supply chain and therefore, with more direct relationships between suppliers and retailers, delivery should be traceable at all times.

**Multiple retail chains**

They have become popular in the traditional way like fishmongers and fish markets. This is partly due to the demand for adequate food and the trend of buying in one place. Especially in Northern Europe, the quantity of fish sold from classic retailers and fish markets has dropped significantly.

Retailers are constantly looking for products that could replenish or supplement the traditional North Sea fish (partly due to their reduced quantities). Interesting examples are tilapia filets, Nile perch, pangasius and hake. The upcoming trend is the growing number of retail chains that will increasingly be directly related to producers, especially of aquaculture products from one (or more) wholesalers. While the traditional strong point of retail chains is frozen and canned products, they have begun to expand their range of fresh, repackaged products such as fish filet and shrimps and prawns. They use new techniques in modified atmosphere (MAP) packaging that extend the shelf life of fresh fish.

**Fish traders**

The range offered by fish traders and fish markets is different from multiple retail chains. Fish traders generally offer fresh and chilled fish, but some are also part of the frozen range of distributed products.

**Food service system**

Foodservice channels (also called the hospitality market) products into deliveries to hotels, restaurants and institutional canteens. The growing number of mid- and high-level restaurants are looking for special fish and shellfish. Imports consist mainly of frozen products such as mullets, sea bass, row of snipers, and substitutes, lobster tails and cuticles. They are distributed chilled in large packages or in catering packages. There is a small but growing market for fresh high-value air-transported species such as tuna, crab and lobster.

Institutional sectors (nursing homes, hospitals and senior citizens' homes) often buy from importers who specialize in the delivery of high-security products. The Foodservice Channel buys some fishery products directly from abroad. Most of these goods come from European wholesalers or importers.

### 4.8.1. Price structures between channels and price development

Margins vary strongly depending on the type of product, distribution channel, constant changes in supply and demand and consequent price fluctuations. It is impossible to draw the ratio of individual margins for each product or combination. The margins for importers are usually low and range from 5 - 10 % to cover business costs and risks. Competition in the EU marketplace prevents excessive trade margins, although in some cases these margins can go up to 25 % but there is a huge difference depending on whether the market in general is developed or not.

The retail margins of fisheries products vary and diverge in each EU Member State. Western European retailers tend to have higher operating costs and therefore apply higher margins. Retail margins for frozen and canned goods are lower than for fresh products. In general, retail margins for frozen and canned products are around 10 %, while retail margins for fresh products can be in the range between 30-50 %. Adding that margin and value added tax, the consumer price of fresh fishery products will be approximately 50 % higher than the CIF fixed price (Cost, Insurance and Turnover)

### 4.8.2. Factors affecting in-storeprices

There are world markets for many fishery products. This is especially the case with long shelf-life products internationally known as canned tuna and frozen shrimps and prawns. Such products have worldwide sales flows. For fresh and less-known products, there are regional sales channels. Examples include fresh seafood from the North Seas, which cannot be easily distributed outside Europe or the Chinese carp of the Americas that are virtually unknown in Europe. But regional markets are also influenced by global developments. Global supply and demand are a major determinant of fishery product pricing, while regional sales are also conditioned by regional development. This is because most traders do not buy in the random market but are tied in the long term to their own suppliers. Prices can fluctuate significantly and show seasonal, annual or long-term trends. In addition, the quality and origin of the product may explain some of the differences in price. Price differences between EU Member States can be explained by differences in the market structure and competitive environment, although the EU as a whole is a highly competitive environment.

The offer may be directly related to possible pollution of the waters, a decrease in the exploitation of fishing grounds or the climatic conditions affecting the reproduction of fish and shellfish. A well-known example is the El Nino phenomenon in the Pacific, which reduced the flow of cold nutrient waters and affected the decline of populations of certain fish species and, consequently, the catch volume. In some periods, climate change can reduce the volume of tuna catches and result in a smaller supply of tuna to the market. Strong demand for tuna has resulted in rising prices but also aqua cultured tuna can be affected by a drop in prices. Excessive imports of a particular type have a negative effect on the price of that species. One such example is the shrimp case where the price dropped dramatically due to shrimp and prawn over-shipment from third countries. Expectedly, the retailers started delivering this product through their channels and the sales were promising, but this eventually led to lower prices and the price has subsequently been declining for years.

On the other hand, strong demand can cause prices to rise. One such example is the price for Tilapia and Pangasius, which is relatively high because in major sales markets (US, Russia, and Europe) demand is growing strongly. Many large aquaculture producers are currently investing in manufacturing plants in Latin America and Asia.

### 4.8.3. Retail prices

Retail prices reflect not only the price of raw materials, but also the pricing policy of retailers with regard to competition and their bargaining position in the supply chain. Prices within the EU vary. The lowest price levels were recorded in Bulgaria, the Baltic States and the Central European countries, where revenue levels are lower than in the rest of the EU and lower-priced fishery products are sold there. The highest price levels can be found in the north-western European countries where most high value products are sold (Eurostat).

Consumers believe that the quality and freshness of fishery products is an important factor when deciding to buy a fishery product, but they are also conditioned by price, especially when the price seems too high. Consumer sensitivity to prices and price increases depend on the product. Canned products have always been perceived as cheap staple products and the sensitivity to the price increases is high. The price for such a product can only rise up to a certain extent above which consumers start perceiving it as a tax. Price sensitivity is lower for fresh products.

# 5. Conclusion

Overall, the long-term picture seems to be driving prices and margins and making fishery products an increasingly attractive category. Due to the fact that the production of fisheries products cannot meet the increase in global demand, the prices of fishery products have tended to rise over the past several decades. This is especially the case in the European market, where production of many indigenous species has decreased due to quota restrictions and consequently their market prices have increased significantly. On the other hand, the increasing price of energy products, especially fuel, is currently a threat for producer's margins. Modern fishermen usually use large quantities of energy for cooling and cold installations.

Aquaculture fish play an increasingly important role as a price regulator for other aquaculture and catch products. For example, salmon prices go down as do the production costs related to improving food performance and efficiency of the business. This affects the price of wild salmon and other fish species that may be a substitute for salmon. In this case, prices tend to fall.

The sale of EU fisheries products offers many opportunities but also threats to various market developers such as innovative oriented companies. The main opportunities are seen in creating or adapting products to follow market segments and capitalize on trends in consumption, production and trade. Current developments are favorable for new products, as EU fisheries and aquaculture production is deteriorating in the long run having support from export from third countries. Current technological options offer no alternative for replacing fisheries by-products and those from aquaculture. This process is costly and it depends on new technological processes that need to reduce production costs because in the EU, neither catches nor aquaculture will be able to meet growing demand. The European fish processing industry will depend heavily on the supply of raw materials from third countries where these can benefit. They can also benefit from the gradual abolition of customs barriers and increased access to the markets. Most new EU Member States show high growth rates in imports. The development of new transport solutions (by air, sea, road) and links with new members allow direct access which no longer depends on imports through Western countries.

Value-added products offer good opportunities. Exporters who choose to work with value-added products in preparing finished products and finding direct distribution channels will be able to serve the growing demand. Importers who manage to have good contractual relations in the new EU Member States will benefit from the upward trend in imports in those countries. Generally,

manufacturers whose products can be incorporated into accepted frameworks of health, benefits and satisfaction and sustainability trends can benefit from current sales opportunities.

It is evident that these trends and market developments provide both opportunities and threats for market developers. The trend can be both an opportunity and a threat. It is therefore important to carefully consider which of these two the trend can be seen as, based on specific circumstances that may arise. For example, an important trend in the sector is the pooling or concentration of purchasing power, which forces exporters to focus on higher quality, cost monitoring and greater efficiency and effectiveness. Leading retailers are choosing a limited number of high-volume suppliers that can meet their needs quickly and efficiently. If small suppliers can join forces, then they too can benefit from this trend and work with large customers. Exporters who fail to concentrate and increase their supply may ultimately be rejected by importers and their export opportunities will be limited to a decreasing number of small buyers.

Fishery products by definition include organisms caught in marine and inland waters as well as those from aquaculture. The term is used for fish, mollusks and crustaceans, which are the three main groups of aquatic organisms used commercially for human consumption.

# 6. Added value drivers

Value Added Fishery Products are strong drivers to ensure higher consumption of primary product and represent any activity in the supply chain that increases the usability of a product through processing and packaging, culinary attributes or economic viability of a seafood item.

Value-added fish products are mostly perceived as those products that have added ingredients. This can be a coating or a sauce, completely ready to use by consumers, but there are also many different processes where products are transformed, like fish filets, which are perceived by the customer as products with added quality and interest. Each stage of production for a value-added product needs to be added for ultimate price definition.

Recently, processing companies have been trying to add value to their raw material and make convenience food, ready to cook or even ready to eat, with the aim of developing market trade. Third countries are notably leading this trend but they are facing different tariffs depending on the product.

Consumer preferences were previously divided into the Northern part and the Mediterranean part.

Northern part

-Value-added products, fish fillets, fish for sandwiches and fast food

Mediterranean part

-Fresh fish and whole fish preferences

-Cephalopods - much liked food

Consumer trends are leading to higher purchases of fish in supermarkets, also as concerns purchases of more exotic, niche products such as sushi, surimi products and tropical fish species. Salmon is becoming one of the most consumed species while traditional fish products, such as bacalao (dried salted cod) consumption is stagnating.

Fish image is consolidated by healthy diet aspects such as avoiding red meat and more diversity in recipes.
The negative aspects concern overexploitation, use of antibiotics in aquaculture, heavy metals, dolphins.
Among other negative aspects for added value there is fragility of fish in storage and what is generally considered to be a complex preparation of the whole fish. The occasional customer finds the fish taste to be mainly insipid whereas more accustomed customers find it to be refined. Adding value can vary depending on the species and for some it can be too expensive.

As concerns the hyper/super market fish sale, which in most cases involves special offers and always refers to the same species (filets, trout, salmon...), it is difficult to find and buy certain other, less common species.

As concerns the traditional markets, less common species (sole, small mackerel...) can be easily found but there are limited opening hours.

When we compare fish consumers in the EU and their habits, we can establish a certain connection namely, we distinguish:

- rare or occasional consumer (once a month): prefers frozen fish
- average consumers (once a week): doesn't diversify much
- regular consumers (twice a week min): different types of preparation, appreciates the whole fish, consumes fish in restaurants

Opportunity for value-added products on EU markets

-Cephalopod exports for Southern EU market, value-addition possible: seafood salads, canned octopus

- Marine aquaculture production is expanding in the Arab world, but market for the two main species, seabass and seabream, is at a stalemate

- Sardines would need an image makeover: excellent source of Omega-3

- Live mollusks trade is difficult, only a handful of countries are allowed to export to the EU

- Shrimp is one of the most important items in export trade to the EU, but very few Arab countries are participating in this trade

# 7. Fisherman producer organizations (FPO) as a demonstration field for added value

## 7.1. Introductory note and general recognition process for PO's

**Producer organizations (PO's**) are established under the CFP to enable groups of fishermen to market the fish they catch. Within the EU there is a marketing regime for fisheries products which was previously governed by the Council Regulation 104/2000, 17th of December 1999. on the common organization of the markets in fishery and aquaculture products, which entered into force on 1st of January 2001. and currently it is governed by the Commission Implementing Regulation (EU) No 1418/2013 from 17th of December 2013. concerning production and marketing plans pursuant to Regulation (EU) No 1379/2013 of the European Parliament and of the Council on the common organization of the markets in fishery and aquaculture products,

Commission Implementing Regulation (EU) No 1419/2013 on 17th of December 2013. concerning the recognition of producer organizations and inter-branch organizations, the extension of the rules of producer organizations and inter-branch organizations and the publication of trigger prices as provided for by Regulation (EU) No 1379/2013 of the European Parliament and of the Council on the common organization of the markets in fishery and aquaculture products,

Commission Recommendation in 3rd of March 2014. on the establishment and implementation of the Production and Marketing Plans pursuant to Regulation (EU) No 1379/2013 of the European Parliament and of the Council on the common organization of the markets in fishery and aquaculture products.

This Regulation reformed the existing fisheries marketing regime to ensure that producers i.e. catchers were better able to match supply with the requirements of the market. In particular, the regulation enhances the role and structure of fish producer organizations. Today small-scale producers face huge challenges in market. They have to adopt a market-oriented approach if they want to compete in and benefit from local and global markets and indirectly influence fisheries sustainability. At present, Croatia has only 2 while Italy has 37 POs and the main goal of this study is to strengthen the approach for them;

## 7.2. Present situation and potentiality for PO's

Background information regarding recognition and role of fishermen producer organizations and general objective of PO's were previously presented to several serious existing fishermen organizations in Italy and Croatia, but in Italy there is a more organized approach to work in a collective way to face the market.

Collective action certainly implies the adaptation of the existing legal framework for PO's to present field situation regarding groups of voluntary fishermen today, sustainable fishing zones development strategies, information, training, access to technologies, organization of input supply and output marketing, access to credits and grants, compensatory and support measures from public authorities and strategy management of marine resources regarding the PO's rules.

If some of these objectives are achieved, great improvement can be expected in terms of technical innovation, organization of supply, improved access to credits and grants, better level of marketing and implementation of marketing standards, sustainable use of resources, fishing plans etc. Failure can be expected if the activities concerning the issue of establishing PO are not properly carried out, which can lead to only partial success. Assessment of results obtained with PO's can be easily checked and verified not only as concerns their technical and economic results, but also some problems which were efficiently detected. Secondly, it is possible to measure qualitative movements which may concern production practices such as product quality, food security, environmentally-friendly practices etc.

It is important to take into consideration all the needed support related to the establishment of PO's in terms of investments, time and resources. PO's largely depend on material results that can help ensure initial activity and long term efficiency depending on their share capital but they also suffer from unfair competition from market suppliers. In all these efforts, return cannot be measured in short term, because there is daily improvement in general management and in every domain of the established PO functioning. This is the reason why collective action must be taken. Adjustment of priorities and internal dynamics of organizations must be at times provided through external help. In conclusion, FPO's are needed, they must be involved in the preparation of public policies and should have access to institutional and financial resources for the production they contribute to and have a sound economic function partly defined in the CFP and COM policies.

If all this can be achieved regarding FPO's, sector policy can benefit as concerns several topical issues;

- Growth and innovation initiatives
- Implementation of fishery plans
- Enhanced engagement with stakeholders' groups
- Managing the environmental effects of fishing
- Very important international fisheries policy
- Sustainable, responsible and efficient use of fisheries
- Credible fisheries management
- Controlled value of marketed products for consumer protection
- Adding value
- Increased value that can be obtained from fishery resources

The unregulated market, or rather poorly organized marketing channels, lead to poorer marketing ability, inability to concentrate the product and connect only to traditional markets, which results in the fact that the product is less valued. In addition, there is a lack of primary processing which could help obtain a better product valorization of fresh fish.
Producer organizations are a key segment for establishing marketing strategies compatible with the European common trade market, and there is a lack of support as well as a lack of definition of criteria for their establishment. In addition, the association of producers lacks the necessary infrastructure and supra-structure, since the concentration of vessels can also be an incentive to join in an association.
Hygienic sanitary standards start from the very catch and landing of fish. This segment has not been developed everywhere equally and needs to be improved.
The fishing fleet is largely outdated, inadequately equipped and lacking in safety. Therefore, fishing effort is partly more significant in the inland fishing sea.
With regard to the lack of capital and insufficient bank support, it should be emphasized that a large part of fishermen is not able to obtain commercial and more favorable loans from banks due to taxes and other debts.

Social and demographic trends are already changing and will continue changing the lifestyle and behavior of consumers in the future. Although there are huge differences within the EU, we can expect an increase in the standard of living, more demanding consumers who expect quality, service, product diversification and favorable prices. The elderly will be economically more prosperous and will spend much more on their health and leisure than the previous generations.

Young people start their families at a later stage in life, which gives them more time to spend on their own areas of interest - travel and non-traditional cuisine. The rise of working women will entail less time for traditional cooking, but also an increasing involvement of the male population in day-to-day shopping and food preparation, all of which requires the appropriate marketing responses of food strategists. Shopping in major shopping centers on the outskirts of large cities and large settlements will also continue to increase progressively. Trust in food quality, compliance with prescribed standards and traceability are indispensable and binding for all actors in the global European market. Current standards will be improved by constant newly acquired scientific knowledge (e.g. new toxins). Several marine products have been classified as microbiologically risky and unsafe for nutrition security:

- Shellfish consumed in fresh-unprocessed state:
- Raw fish consumed without heat treatment, such as sushi;
- Gently salted, marinated, fermented, cold smoked fish;
- Products consumed semi-cooked (mollusks, crustaceans);

It is very likely that a system of supervision and control will evolve towards the timely identification of potential risk areas and seek to eliminate them. In this regard, it is recommended to consistently apply the HACCP system.

It should be emphasized that fish and fish-like products are high-quality, healthy food. These products also represent a source of livelihood for one part of the population, either as a primary product – catch, or as a secondary product through processing, marketing, services etc. Some categories of fish also have a fairly reasonable price, which can be crucial for the quality and well-balanced diet of socially disadvantaged segments of population.

# 8. Sustainable fishing vs. production income

The Regulation (EU) No 1380/2013 of the European Parliament and of the Council from 11th of December 2013. The Common Fisheries Policy endorsed the already established Community system for the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy (CFP) and set out objectives to ensure that fisheries activities and aquaculture contribute to long-term, environmental, economic and social sustainability. The achievement of these objectives should include rules aimed at ensuring the traceability, safety and quality of products placed on the market in the Union. The CFP should contribute to productivity growth, a decent standard of living in the fisheries sector and stable markets, and should ensure that food supplies are accessible and that the supply reaches the customer at reasonable prices. The CFP should contribute to Europe 2020. Strategy for smart, sustainable and inclusive growth and should help achieve the objectives set out in that strategy. As a member of the European Union, the Republic of Italy and Croatia are both obliged to implement the objectives of the CFP.

The Union and the Member States have committed to further restoring many fish stocks by adjusting exploitation rates to ensure that, within a reasonable time, the exploitation of marine biological resources restores and maintains a population of exploited stocks above levels that can provide the highest sustainable yield. Conservation measures such as multi-annual stock management plans and the avoidance of unwanted catches and the establishment of areas for recovery of livestock are prescribed for the achievement of the CFP's objectives regarding the conservation and sustainable exploitation of marine biological resources. The implementation of these measures results in a reduction in catches, which can have a negative socio-economic impact and the sustainability of fishing fleets as the revenue per vessel decreases in proportion to the reduction in catches. Also, smaller catches result in a reduction in raw material for the processing industry, tuna farming and for the final consumer.

## 8.1. Possible offsets for revenue reduction due to smaller catches

- Increasing market prices

As a result of smaller quantities of fish and fishery products on the market due to a decrease in total catches, prices per kilogram of catches may increase. However, the smaller quantity of fishery products on the market does not automatically imply an increase in prices. Market mechanisms are complex and depend on a number of factors and the financial interests of other stakeholders in the fish trade, making it difficult to predict the possible extent and duration of a purchase price increase. If the price per kilo were to increase to such an extent that it could cover the difference in the reduction of catches per vessel, the status of the fleet would remain unchanged and the objectives of the CFP as concerns the ecological, economic and social sustainability of fisheries would be reached.

• Cost reduction

In order to compensate for the loss of revenue resulting from the reduction of catches per vessel, a cost reduction orientation is possible. Due to reduced revenue per vessel, businesses can adjust and reduce the costs by firing some of employees, saving on fishing, shortening fishing time etc.... Vessel profitability is ensured by fewer fishing trips with shorter search times (fuel savings) and increased catch per day, fewer employees (reduced number of operations in catch manipulation), use of smaller quantities of ice, faster manipulation of catch…

The result is a degradation of the quality of catches, or obtaining catches not intended for human consumption, or even lack of fish and fishery products on the market.

• Raising quality by adding value to fisheries products

To compensate for the decrease in revenue due to the reduction of catches per vessel, it is possible to increase the price of products on the market by adding value through raising quality and preserving catches before unloading, by introducing new innovative technological solutions, adding value to fishery products through eco-certification and sustainable fishing or introducing new technological processing and packaging processes.

# 9. Technological procedures for increasing the quality of fish and other marine organisms

Categorization of fishery products:

• Fresh catch products: unprocessed fish products, whole or prepared, including vacuumed products or packaged in a modified atmosphere
• Processed catch products: These are non-processed fish products that have undergone a specific anatomical modification, such as evisceration, shredding, decapitation, fileting and chopping.
• Processed catch products: These are processed products from the processing of the catch products or from the further processing of the already mentioned processed products.

The cooling process lowers the product temperature to the approximate melting point of ice (about 4°C). When the products of the catch are brought to a temperature of -18°C they are considered frozen. An additional method of stabilization is the production of canned food. These are hermetically sealed containers that have been sufficiently heat-treated to destroy or deactivate any micro-organisms that can reproduce independently of the temperature at which the product is to be preserved. Fishery products are marketed fresh, processed or unprocessed. Processing operations include primary processing (cleaning- partial or whole), then fileting, freezing, salting and smoking.

Consumption of fresh and processed fishery products is influenced by traditional consumption habits. Despite the fact that the consumption of fresh fish is still the highest, consumption of fisheries processed products is increasing due to modern lifestyles, primarily because of their simpler and quicker preparation (cleaned and filtered). Bearing in mind the recommendations of the World Health Organization on increasing the intake of fish and fishery products due to their high nutritional value, it is expected that the consumption of processed fishery products and finished and semi-prepared meals increases. Over the last 20 years, there has been an increasing trend of consumption of chilled fresh fish and fish products. In the Republic of Croatia, whole fish

or other fishery products are marketed the most, while in other countries among which Italy, a larger number of products (filets, chunks, mollusks) have been developed.

What is needed to make fisheries products competitive in the market?

• Follow the diversification trend (by introducing new species and / or different products from freshly chilled fish and other marine organisms)
• Implement the principles of good hygiene practice from the moment of harvesting to the end consumer (keeping cold chain, careful manipulation of catch, innovative technological solutions)
• Introduce technologies that will ensure the quality and durability of this product group (presentation mode like salads, marinades sources, burgers, MAP, vacuum etc.)

# 10. Principles of good hygienic practices from the moment of harvesting to the moment the fish reaches the end consumer

Temperature affects microbial and enzymatic activity: low temperatures slow down the activity and growth of microorganisms, thereby slowing down the natural process of food spoilage.

Refrigeration - the method of preservation that minimizes the original food properties, durability depends on the type of fish, but the effect of temperature is the same for all species.

The process of preserving quality begins with the harvesting process, and it is of utmost importance to start the cooling process as soon as possible and to establish a "cold chain" to preserve the quality of the catch for further processing. Innovative solutions are possible at all stages, from fishing, transshipment, catch on board, landing, transport, processing, packaging to the end consumer. When catching small pelagic fish, it is crucial to carry out the "shock" procedure as soon as possible by storing live fish in a mixture of cold seawater and ice. The two most important species used for processing are sardines (Sardina Pilchardus), which make up the majority of catches in the winter (October to March) and anchovy (Engraulis Encrasicolus), which is fished in the summer (March to September). In order to ensure a good and quality product in the fish processing industry, it is first of all necessary to provide good raw material. In this chapter some of the innovative solutions for different kinds of products will be demonstrated.

**Harvesting small pelagic with pumps**

With new innovative technologies for catching fish from the surrounding fishnets, it is possible to accelerate the process of transferring the catch to thermal tanks by means of pumps, with a mixture of cold seawater and ice. The goal is achieved by keeping the caught fish alive all the way down to the thermal tanks in which the shock is carried out. This is applied to fish in the seawater during the whole process of fish-pumping from the net to the vessel. Passage through the pump is quick and with a large amount of water the fish comes to a separator where water and fish are separated almost instantly and from where the fish enters the water and ice emulsion tanks alive

and undamaged. The fish, upon entering the thermal tank, goes into a state of "shock" and immediately stops bleeding from the gill openings. This maintains the maximum quality and nutritional value of the catch for further processing.

The catch is pumped together with water to a separator, through which it reaches the second part of the discharge into the thermal tanks.

Today there are many different types of pumps of different capacities and sizes on the market, which are mainly intended for transfer of the juvenile fish on fish farms or are large capacity pumps intended for large factory ships, and there is a need to develop a system which can be used for fresh markets.

When a truck arrives at the factory for processing, the fish is either stored in a fresh fish storage or shipped directly to production. If the fish are of mixed types and sizes, they are first sorted and then processed in two ways: by salting or freezing.

**Freezing**

Freezing is a canning process that inhibits the activity of the micro-organism and almost completely stops all biochemical and fermentation changes. This way of preserving food preserves basic ingredients and unstable components such as vitamins. In order to preserve minerals and vitamins, the freezing process must be rapid. The faster the freezing process, the finer the crystals of ice and the smaller the cell structure destroyed. The anchovies are frozen, marinated and salted. The anchovies are frozen in blocks - tunnels and individually - I.Q.F. technology.

**I.Q.F. freezing technology**

Individual Quick Freezing or IQF technology enables individual freezing, which is advantageous when defrosting and preparing a frozen product for use. The entire freezing tunnel is hygienically clean and built for easy hygiene maintenance. The conveyor belt (IQF tape) is made of polymers that do not absorb moisture while all metal parts in the interior are made of stainless steel or galvanized material. All surfaces, including the floor where food can be accumulated, are smooth, sloped at an angle, with the ability to dry on their own and to easily remove food parts. When

using this technology, the fish is individually kept in the air during freezing without sticking together. Such freezing is made possible with the help of a specially designed IQF tape that allows uniform air distribution and directs it straight to the individual. Air flow from the starting freezing zone is directed towards the cooler air in the end zone, creating an airflow that accelerates heat exchange and provides quick and gentle freezing. Rapid freezing is made possible by the controlled and effective blowing of cool air, which maintains superior quality and achieves a temperature of -18°C with the bone. After freezing in brine, the product takes on a thin layer of frosting that freezes in the tunnel at -40°C. The glaze serves to protect the product from drying out. Unlike classic tunnels, this freezing system does not freeze fish by freezing in a stream of cold air, but retains all its natural properties. The entire freezing process from the entry of the raw material into the line to the packaging takes a maximum of 15 minutes. The short freezing path is extremely important to allow the formation of tiny ice crystals that do not damage the cellular structure, which significantly contributes to maintaining the quality.

**Machine for pulp and meat separation from fish and crabs**

Some fishery products can be used for pulp separation which make an excellent base for introduction of unit burgers. Goal is to detect the possibility of existing machinery or adaptation of it.

**Fileting adjustable non-standardized machinery**

To detect processing fileting machinery for fish of different sizes. Allow fileting of non-standardized products up to one measure (for example up to 1 kg) giving a benefit of semi-automated lines for fileting of different sizes -classes and different species.

**Machine for opening of raw Smooth Callista**

Currently, operators open manually the Smooth Callista shells into half-shell products. This process is both slow and more expensive than the finished product due to manual labor costs. The opening procedure creates about 60 % of discarded products. Now, there are no specific automated shucking machines. A suitable machine has to be developed for this species, in a manner that would limit the damage of the shell and creation of debris. The machine has to be calibrated for the strong body tissue attached to the shell.

Striped Venus (Chamelea gallina)

Development of a refrigerated clam product for restaurants by plasma sterilization

A stronger sterilization process of the products followed by an appropriate packaging process obtains such product. A sterilization process that uses plasma is a technology that is already used widely in other countries as an innovative approach. The process creates ozone, oxidative radicals and UV, which negatively affects the proliferation of bacteria and viruses, but leaves the shellfish still alive. It can be used both on dry or on products in water. The benefit of the process is that it can be more efficient at the sterilization of the product and be also faster to process. The plasma sterilization process is also compatible with the packaging process, and can also be applied after packaging is done.

Development of a refrigerated product for restaurants by using high pressures

A sterilization of the products can be obtained by aping extremely high pressure for a brief amount of time. In this case it can be applied up to 5.000-6.000 bars. However, this procedure requires detailed study on organoleptic properties on the specific product, as it can modify the protein structure. The process needs to be calibrated and find the optimal combination of pressure and exposition time.

# 11. Processing plants as leading transformation units for fish and other marine organism

Plants for processing fish and other marine organisms are mostly equipped with machinery for cleaning, fileting, cooling, cutting, drying, smoking and packaging products and waste reduction, software included.
Production begins with the primary processing of fish required to produce the final product and refers to the following basic technological units in the processing itself;

1. Evisceration and fileting of white fish
- cleaning and processing fish to filets
- finishing of filets
- substrate for further production

2. Cleaning, washing and cutting cephalopods
- cleaning and cutting of cephalopods
- cooking cephalopods
- substrate for further production

3. Fileting small pelagic fish
- making fresh filets
- substrate for further production

4. Purification of bivalve mollusks
- placement of live bivalve mollusks in the domestic market
- placement of heat-treated shells as a separate or assembled product in fresh or frozen state.

5. Marinating filets of small pelagic fish
   - marinating anchovy and anchovy filets
   - filet packaging
6. Production of salted fish
7. Sauce production
8. Line processing into final finished main dishes and appetizers
9. Fish burger line, dumpling
10. Freeze-thaw
11. Vacuum tray packaging line
12. Weighing and labeling line
13. Continuous freezing line
14. Panning line

While analyzing the demand and supply of the planned range on the domestic market, we found a chronic shortage of high- quality fish products, especially from domestic production. In addition to sterilized fish cans and a very small supply of salted fish, as well as frozen ready-made products that come down to clean re-packaging and are of very poor quality, there are almost no other assortments of domestic production.

In addition to the above existing equipment, the following equipment is required for the polyvalent production range within the production facility:

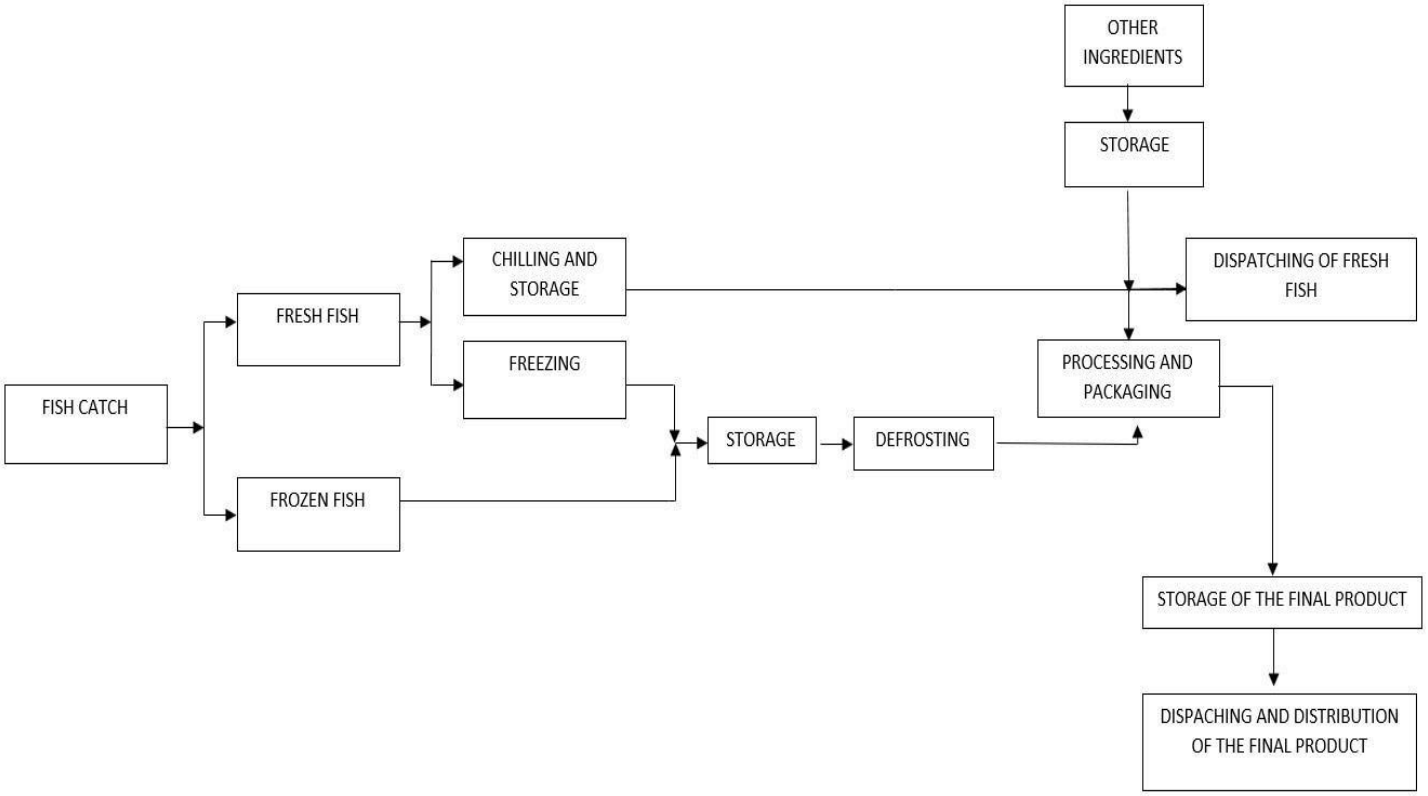
1. Sterilizer
2. Filler for small pelagic fish
3. Cooker for fish and sauce
4. Dryer and smoker
5. Desks
6. Equipment for brining and marinating
7. Transport-logistic machinery

## 11.1. Description of the main flow of the part of the process

Regardless of the production line of the production cycle, there are the following production phases:

1. Fresh and frozen fish reception
2. Fresh and frozen fish storage
3. Fresh fish freezing
4. Frozen fish thawing
3. Reception of other raw materials
4. Storage of other raw materials
5. Fish processing * (marinating, salting, preparing fish salads and sauces, smoking and drying)
6. Packaging
7. Storage of the finished product
8. Shipping and distribution of finished product

* Fish processing through technological processes will be elaborated in detail, depending on the type of production line by type of finished product, some of it will be explained in the following sections.




Graph 2. General flow of production process

# 12. Possible processing solutions

## 12.1. Cold and hot marinade

Marinating is a chemical method of preservation in which the use of salt and acetic acid with the addition of various spices ensures the durability of the product. Products produced by the marinating process are called marinades. Due to the different marinating procedures, we distinguish between cold and warm marinades.

Cold marinades
Cold marinades are obtained by marinating fresh and salted fish and warm ones from pre-cooked, baked or smoked fish.
Typically, fresh or salted fish intended for cold marinades is stored in cold and matured in a salty-acidic medium, a solution of salt and vinegar, which is slightly more concentrated at the initial stage than at a later pour. More specifically, the cold marinating process is divided into two parts: the first stage takes place in a ripening soak, then the product is placed in a specific container and stored in a suitable warehouse.
The raw material used usually involves sprats, anchovies, small mackerel and other small pelagic fish.

The technological process includes the following:
Raw Material Preparation: The fish are well washed to minimize initial pollution. Then, the inedible parts (head, bowels and tail) are removed. The fish can be machine- or manually cleaned. Depending on the type of the final product, the raw material can be additionally machined or hand-worked (spine removed, fileted…).

Rinsing: After cleaning and processing, the raw materials are again rinsed in a gentle solution of brine and acetic acid until all traces of blood and other impurities have been completely removed.

Maturation: This is the most important stage in the marinating process. The ripening soak is milder because it gives the product better properties (taste, smell, color), but also less durability and vice versa, so it is important to achieve the right measure. Ripening takes an average of 4 to 6 days.

Packaging and pouring: After ripening in the soak, the fish must be well rinsed and drained. It is then poured into plastic or glass containers with the addition of spices.

**Cold marinated products**

'Rusli' or marinated anchovies with red onions. It is the most common Dalmatian cold marinade. It is manufactured according to the technological process, but with the addition of larger quantities of red onion (up to 50 %).

Rollmops or marinated stuffed anchovy filets

The specificity of this product is that, as part of the production process, the anchovy is completely cleaned into a butterfly filet, which, after ripening, filled with pickles and red onions, is bent and placed in bundles in the final packaging. With its exceptional taste, this product features perfectly preserved filet skin, which gives the final product exceptional visual appeal.

Hot marinades

Hot marinades are marinade products where the fish is pre-cooked by cooking, baking or hot smoking. That is why they are mostly divided into cooked and baked marinades.

The process of producing hot marinades

The raw material is prepared as follows: the fish is well washed, cleaned (machine or by hand), well washed again, and then put in brine. After brining, it is again rinsed, drained, and breaded again. Breaded fish are baked at 160 and 180°C. Baked for 5 to 12 minutes and then allowed to cool. The chilled fish is put into plastic or glass containers and poured, and spices are added. The poured pan is allowed to stand for a while so that the meat absorbs the required amount of topping, and then a little topping is left before closing.

Baked marinade products

Saur or roasted marinated sardines

It has a specific taste that comes from the roasted protein and fat from fish meat and flour and various spices (pepper, cloves, mustard, bay leaf, boiled red onion and others) that are added to the pour.

## 12.2. Salted small pelagic fish

Salting is one of the oldest and simplest ways of canning. Salting is a chemical method of preservation where, with salt concentrations greater than 10 % in the meat of fish, the product's durability is ensured.

The process of producing salted fish products

After the fish is shocked or treated with ice and caught into processing, the technological procedures include the following:

1. Salt brine preparation: Make a salt solution or brine at a concentration of 25% salt in plastic containers.
2. Brining: Upon receipt, the fish is stacked in brine tanks, a line of fish and a line of fine salt, and until the container is full. Finally, the pre-prepared brine is added and left to rest for two hours.
3. Manual or machine cleaning of fish: After two hours in brine, the fish is taken out of the brine tanks and applied for cleaning. The cleaned fish is stacked in a trellised fish crate and immersed repeatedly in clean brine to completely remove impurities (sourdough, intestinal debris, etc.)
4. Salting: After washing, the fish is brought to a clean and soaked barrel (plastic barrel) for salting. Cover the bottom of the barrel with a layer of medium-granulated salt, and then layer the washed and clean fish. Sprinkle the salt layer evenly over this row, then arrange the next row of fish. Each row is well pressed with a round barrel diameter cap to fit the fish well. The fish fits "in the crown", that is, in a circle, so that its head is facing the barrel wall and its tail is towards the center. The last row is well protected with salt, covered well, a lid is placed and weighted.

5. Salt dressing: The brine concentration decreases significantly during the first 10 days of ripening, as water is extracted from the fish and its volume is reduced, and therefore the brine and fish should be replenished. Fish are supplemented from the same catch and salting day. Replenishment is repeated every couple of days. After the volume becomes constant salting is complete
6. Fish ripening and maintenance: The ripening of salted fish lasts from 2 to 6 months. During this period, it is necessary to reposition the barrels once a month to allow equal loading in the pyramid stacking. Then the surface is washed and salt changed from the top, the first layer of fish washed, and topped with saturated brine.
7. Clear
8. Fish designing and investing in jars
9. Oil filling
10. Closing
11. Storage and shipping

Salt products include salted anchovy and anchovy, cleaned in olive oil or filtered in olive oil. Both products follow the same technological process described above, with the addition of the fileting process prior to loading the cans.

## 12.3. Fish Burgers

Base for cost effective operation with fish burgers can be one of the innovative equipment which serve to separate meat from bone or scallop from meat in crabs and shrimps. In that way, with the automatization process we are obtaining the meat pulp which can be used for burgers. There are several ways of preparing the fish burgers.

## 12.4.Fish salad

The technological process of fish salads preparation consists of the following procedures:

12.4.1. Raw Material Preparation: Starts by defrosting the planned quantity for the planned daily production. After that, the raw material is washed from impurities in a light brine and thus the fish meat absorbs a sufficient amount of salt.

12.4.2. Cooking: The raw material is cooked or baked depending on the type of product. The cooking or baking mode depends on the type of raw material.
12.4.3. Raw material processing: After having been cooked or baked in cooking and baking appliances, the raw materials are cut into smaller pieces and the desired shape depending on the type of product.
12.4.4. Manual stacking of raw material in trays
12.4.5. Manual filling of oil (spill) and spices
12.4.6. Close the filled trays manually
12.4.7. Sterilization
12.4.8. Storage
12.4.9. The distribution

Fish salads in possible planned range include: octopus or musky octopus' salad, squid salad, prawn salad, and tuna-based fish salads with sauces and vegetables.

## 12.5. Fish sauces

The fish sauce production process consists of the following technological processes:

1. Raw Material Preparation: it starts by defrosting the planned quantity for the planned daily production. After that, the raw material is washed from impurities in a light brine and thus the fish meat absorbs a sufficient amount of salt.
2. Cooking: The raw material is cooked or baked depending on the type of product. The cooking or baking mode depends on the type of raw material.
3. Sauce Preparation: The sauce is prepared according to a specific recipe in the sauce cooker.
4. Raw material processing: After having been cooked or baked, the raw materials are milled with the addition of prepared sauce. Mix everything together well to the desired consistency.
5. Filling into dosing jars: The prepared mixture of raw material and sauce is dosed into larger jars.
6. Manual loading into trays
7. Close the filled trays manually
8. Sterilization
9. Storage

10. Distribution

Fish sauce products include a variety of tuna, salted fish and mollusk-based sauces, with the addition of sauces and spices. These products are very practical in modern nutrition where quick preparation is required.

In general, considering future development, among the possible innovative processing solutions, the preparation of mechanically deboned flash is very promising for the production of semi-finished seafood products to be further used for the production of sauces, fish burger, pasta filling etc. Among the most interesting species to be subjected to this procedure, shrimps, mantis shrimps and mullets also for the production of mixed burger have been selected.
The sanitation effect of high-pressure pasteurization (HPP) can be applied for the preparation of refrigerated seafood tartare; using this technology, the shelf life of these products can be increased from 2-3 days to 2-3 weeks. For this purpose, deep water rose shrimps, mantis shrimp, Norway lobster and mullet showed a satisfactory response to HPP treatment.
In addition, several physical methods have been tested in order to find a specific procedure to facilitate the opening of the hard clam (*Callista chione*). One of these techniques showed very good results at lab- scale, to be exploited through the implementation of an innovative pilot plant and the scale-up at industrial scale.

# 13. Modified Atmosphere Packaging (MAP)

The changing market demands have led to the development of new technologies for food production and preservation. The emphasis is on as natural and original foods as possible, minimally or partially processed. The products are more suitable for handling in retail, further contamination is prevented, there is additional contact of the product with oxygen (development of aerobic bacteria, fat oxidation), prolonged quality and durability of the product.

CA - CONTROLLED ATMOSPHERE

The canning process in which it changes i.e., modifies the composition of the initial atmosphere in which the product is located by reducing the $O_2$ content (from 21% to 3%) and increasing the $CO_2$ content (from 2 to 5% and more), thus slowing breathing and biochemical processes. It is carried out in chambers and large storage areas.

Types of controlled atmosphere:

Type I.- Relatively oxygen-rich atmosphere: $O_2$ 16-11% $CO_2$ 5-10% $N_2$ 79%
Type II Oxygen-poor atmosphere: $O_2$ 2-3% $CO_2$ 2-5% $N_2$ 92%
Type III Low-oxygen atmosphere: $O_2$ 2-5% $CO_2$ 0-2% $N_2$ 97%

MAP - a dynamic process that takes place in small unit packs. The principle is to change the composition of the initial atmosphere in the packaging in which the product is located, i.e., $O_2$ concentration is reduced and $CO_2$ and / or $N_2$ content is increased, thus reducing respiration (respiration), transpiration (loss of moisture), ethylene development and food sensitivity to ethylene, and slowing the growth of microorganisms.

The establishment of a modified atmosphere in the unit packaging aims to create a balanced composition of gasses and water vapor, the respiration rate of the raw material and the permeability of the plastic film should be harmonized.

ESTABLISHMENT METHODS OF MAP

Passive modification - using packaging in which the atmosphere of the modified composition is generated and maintained due to the process of respiration of the raw material.

Active modification - by the combined action of the breathing process and the addition of a mixture of gasses ($O_2$, $CO_2$, $SO_2$, $N_2$, $N_2O$, Ar etc.) into the packaging of the appropriate permeability; active packaging - by the combined action of the breathing process and the addition of additives that absorb or release $O_2$, $CO_2$, water vapor and other respiration products (ethylene, ethanol, etc.).

Recommendations:
For white fish, shrimps, prawns and caps: 40% carbon dioxide, 30% nitrogen 30% oxygen;
For oily fish and smoked fish products: 60% carbon dioxide and 40% nitrogen.
Modified atmosphere packaging (MAP) with novel gas mixture (e.g., argon, nitrous oxide) has proven to be able to protect fatty blue fish like mackerel, horse mackerel and sardine products from oxidation phenomena, increasing their shelf-life.

The advantages of MAP compared to other forms of packaging:
- High quality and extended durability
- low use of preservatives
- attractive appearance and easy handling for the consumer

Disadvantages of MAP compared to other forms of packaging:
- use of expensive equipment and materials

# 14. Contribution to analysis; Selected market evaluations and preferences for the process and product case study

There is a lack of sociological studies which show preferences in fish consumption, so we chose some highpoints from selected studies.

According to the sociological research (Čaldarović et al. (2017.)) in the Republic of Croatia conclusions and recommendations are:

### A. Concluding remarks and recommendations from the survey

· Fish are usually purchased several times a week
· Mostly cheap small pelagic and white fish are procured
· Freshwater fish predominate in the continental part of the country
· Customers generally prefer wild fish
· The habit of consuming farmed fish has not yet been developed
· Fish would be consumed more often if it were more accessible, cheaper and more diverse

### B. Concluding remarks and recommendations from the interview

Fish market vendors

· Fish sales are low due to high prices, lack of habit of buying fish, general impoverishment of the people, irregular supply of fish, impossibility of the availability of marketplaces due to the small possibility of parking, the lack of fresh fish in regular self-service, etc.
· The main reason for poor sales is the high price of fish
· The main reason for buying some fish (such as sardines) is low
price and to a lesser extent the belief that these fish are healthier than white fish
· An aggravating factor in shopping is the difficulty to park a car near the
fish market

· The facilitating factor when buying fish at the mall is in fact the parking and possibility of combining facilities as well as more affordable prices for imported fish
· It is aggravating that the largest number of fish in malls is imported for all those customers looking to buy exclusively our wild fish
· Buyers buy small pelagic and white fish alike
· Customers (mainly) distinguish between farmed and wild fish - more often they prefer wild fish, and they rarely buy farmed fish for two main reasons –
(1) origin (artificially nourished, bred, oily, inferior, etc.), and
(2) price which is higher than the price of the smallest wild fish
-Wild, domestic, our fish is mostly preferred

Restaurant chefs, owners, managers

· People in restaurants very often order a fish meal - the above applies to people who more or less regularly visit fish restaurants, whether in company of others or alone
· In hotel restaurants, the supply of fish fluctuates primarily according to the oscillating demand, the inability to store fresh fish for longer, and because of weaker control of procurement options
· The price of fish (purchase) is unjustifiably high, making it difficult for business to profit, it affects supply volatility and leads to impossibility of bid planning
· Fish for hotel restaurants is most commonly purchased in retail chains primarily because of the price, reliability of supply and security
· To ensure lower prices and better supply, fish imports should be increased - all of the suppliers who are in the "hassle of getting" fish outlined above all an open and under-regulated market.
· Guests prefer to order meat meals because of the significantly lower cost and also because of their eating habits.
· The problem is the procurement and preservation of raw materials, which is especially relevant for hotel restaurants where storage space is insufficient for longer term stock of frozen fish. This affects the supply fluctuations.
· In most cases, the procurement of fish is entrusted to the resourceful restaurant or hotel staff who deal with all of the above
· Most restaurant guests cannot distinguish if it is wild or farmed fish, fresh or frozen, except for a minor part, usually foreign guests who know the difference but don't pay much attention to it. Local or national guests mainly are the ones who in most cases insist on home-made, wild fish.
· The problem is the changing weather conditions that affect the fish offer stability the most. In poor weather conditions, there is a poor fish supply.

· The role of those who speak against the fish products is assessed mainly as negative, Outbursts appear as an illegitimate link in fish traffic – from catch, all the way to the restaurant table.

Guests at fish restaurants

· There are more regular guests in restaurants so, as was already noted, more regular guests have a habit of visiting, socializing and consuming fish and fish products.
· People go to restaurants mainly because of delicious food, habit and the belief that the fish is healthier
· Different guests respond differently to wild and farmed fish – some are more sensitive as regards imported and farmed fish
· The fish prices are unreasonably high in restaurants
· As expected, the eating habits in continental Croatia differ from those in Dalmatia.
In the continental Croatia, people mainly consume freshwater fish and prepare it differently from seafood in Dalmatia
· The problem of procurement and placement is very complicated both for owners and chefs because it is very difficult to secure a stable fish delivery.
· "Black market" - this term refers to unregulated sales and purchase of fish. Fishermen are demanding an instant payment in cash when unloading the fish, so when restaurants and hotels are unable to do so for a number of reasons, the fish unloaded is paid for "Under the table (bank)".

Fisheries

· There has been a significant increase in demand for farmed fish, which is an indicator of several processes. On the one hand, the catches of wild fish are smaller, on the other foreign fish is increasingly penetrating our country as a food item, and so it is partly replacing farmed fish. Furthermore, the number of tourists is constant, as is the number of restaurants and hotel restaurants that buy and offer fish more often.
· The placement of fish is not problematic, as is in fact evident from the results of the analysis There is an increasing demand for farmed fish which indirectly affects also the quality of farmed fish.
· The way fish are farmed is in itself a guarantee of quality. The survey found that there are differences between fish producers on fish farms. The ordinary customer will not be aware of these differences but a knowledgeable one will.

· The attitude of the state towards fish farms is estimated as non-stimulating, insufficiently active and generally negative. The state, is expected to show a lot more understanding, havein place certain incentivizing measures and incentives for mariculture, as for example happens in Turkey.
· Development of mariculture - it is expected that mariculture will continue and should continue developing.

***A study by M. Tomić, D. Matulić (2014) examines the factors which influence fresh fish consumption, underlining the following conclusions*:**

1. The theory of planned behavior has been validated in this research as a useful framework for understanding the determinants of fresh fish consumption in the household. For this reason, it is recommended that the theory of planned behavior be further used in fresh fish consumption research, especially since it is the only theory that simultaneously involves influence of attitudes, role of all important persons (subjective norm) and influence of perceived behavioral control over one's own behavior to intentional behavior.

2. The results of the study showed that doctors and nutritionists encourage Croatian consumers to consume fresh fish, and a positive relationship was found between the subjective norm and the intention to consume fresh fish. Based on this result, we suggest increasing the representation of info media posters in doctor's offices, hospitals and similar institutions. In this way, consumers would be further educated on the importance of consuming fresh fish. We believe it is equally necessary to increase the representation of nutritionists in promoting fish and fish products through media, modeled based on the promotion of toothpastes in which dentists regularly testify.

3. The results of the research show that Croatian consumers have a neutral opinion on the difficulty of buying fresh fish or recognizing how fresh the fish is. For this reason, it is necessary to educate consumers about the fish itself by linking knowledge of the biology, ecology and nutritional value of fish, which is feasible already starting from kindergartens, as in other educational institutions (schools, colleges…).

4. Based on the results of the research, it can be concluded that consumers of fresh fish in Croatia have an average level of so-called involvement in food preparation. In order to increase the involvement in the preparation of food, especially fish meals, it is recommended that fresh fish be prepared and proposed as a meal on culinary shows, in cooking schools and through the so-called quick and delicious fresh fish recipes. We also consider it necessary to educate consumers about the existing fresh fish cleaning tools that would simplify the process of preparing fish for lunch (shell cleaning, removal of bones, etc.)

5. Consumers of fresh fish have a neutral opinion on the availability of fresh fish on the market, therefore, it is suggested to organize various fresh fish domestic fairs in cities across Croatia, thus facilitating the availability and increasing the variety of fresh fish. Also, during such fairs fresh fish would be sold directly, thereby creating direct contact between the buyer and the producer, which is an additional advantage. Of course, this would occur in compliance with the basic veterinary health regulations and following the rules on the marketing and sale of fresh fish.

6. The results of the survey showed that moral obligation shows a positive association with the intention to consume fresh fish, which means that it is necessary to continue education on the importance of preparing fresh fish meals in the household.

7. As the habit of consuming fresh fish (with attitudes) is the strongest predictor of intention to consume fresh fish, it is necessary to encourage the consumption of fresh fish at a young age. Previous research has indicated that constant exposure to fresh fish at a younger age can contribute to higher fresh fish consumption at a later age (through preparation of dishes for children that are pleasing to the eye, with the exception of unpleasant smell and fear of finding bones).

8. Given that the results of the study showed that older consumers have a greater intention to consume fresh fish at home than younger consumers, it is necessary to attract younger consumers.
This may be possible through more detailed processing, i.e., fileting of fresh fish, to simplify the process of preparing meals at home. Also, expanding the product range of fresh fish and packaging with attractive packaging can contribute to a higher consumption of fresh fish by the younger consumer population.

# 15. Conclusion and recommendation

In the long term, the consumption of fisheries products in the EU is increasing. Consumers have an increased interest in quality, specialty products, culinary delicacies, luxury products, value-added products, fish filets and fisheries products related to sustainable development, and as one of the more important categories, the fish products intended for quick and easy preparation.

The Central and Eastern European countries do not have a strong tradition of consuming fishery products. Most of these countries are surrounded by land and lack a significant marine product sector and are governed by the consumption of freshwater species. However, in these countries there is an increase in consumption of marine fisheries products with the expansion of the market as well as an increase in personal income. The Central and Eastern European countries have a poor tradition of consuming fishery products which are at the lowest end of their consumption levels, but this is partly why they represent an interesting development market.

Total consumer volume is projected to grow modestly, but prices and values are expected to increase through the delivery of high value products and products for quick and easy preparation. FAO's predictions are that consumption of frozen fish will decrease. The consumption of crustaceans and mollusks is expected to increase. Markets in the new EU Member States such as Romania and Bulgaria together with Latvia and Slovenia show the highest growth rates in consumption. High growth rates are also present in Austria. Their growth values are above the EU average. Germany, Portugal and Slovakia also show good growth rates, in contrast to the markets of Poland, Ireland and the Netherlands rising below the EU average.

The new EU member states are a new market that is on the rise for placements in Western European countries. As revenues in these countries slowly increase, so does the demand for fisheries products. Some countries that have a tradition of catching and aquaculture, such as Poland, are also developing into a strong supplier to other EU Member States. Trade relations between surrounding countries in the EU are generally strong and reinforce the trade balance in the fishery product category.

Highlights:

- EU spending is a growing value, especially in the new member states
- Consumption in the new Member States is growing strongly, the market is growing, and at the same time, it is driven by rising net personal income
- Increasing demand for added value, luxury and special fishery products such as the anticipated range

- Acceptance of new species of fish as a replacement for traditional species
- Fisheries products have a positive health image and match the health trend in almost all EU Member States
- Consumer demand for sustainable catches and aquaculture products is increasing
- Selected species can represent a good raw material base for penetrating new markets

The EU relies heavily on imports of fisheries products to meet demand. This change is structural as production in the EU is declining and consumption is rising.

- Imports from third countries are increasing strongly
-New tropical species are becoming more popular and may replace the more endangered traditional species and strike a balance in the supply
-Claims for crustaceans and mollusks will remain strong especially in southern European countries
-Claims on value-added products from third countries will increase, especially as they are priced very competitively compared to EU products
- Competition between third country suppliers will intensify as they lift their production
- Increasing demand for food safety and consistency will impose more rules and regulations on exporters from third countries.

Supply and demand estimation

The traditional market for fresh fish caught in the eastern Adriatic coast is Italy, where a significant share of the total catch is placed. But in recent years, there has been a partial reluctance of primary producers to find new markets ranging from Spain, France, Austria, to the Eastern European block. One reason is the low cost of fresh fish so there is a potential to increase it.

When it comes to estimating the market in terms of demand for a planned type of product from multiple evolutions, we can conclude that demand and consumption are much higher than supply.

# 16. Required solutions and motivations for three PO's case studies

a. FC "Omega 3"

*(Improvement of quality by handling the caught product on board- innovative harvesting with pumps and dewatering unit, equality of fresh and frozen market orientation, shelf-life extension, certification, channels for sale product sample. Products are sardine and anchovy)* For the next projecting step harvesting pumps are chosen to obtain quality, fish welfare and easier manpower and work manipulation is a first driver to explore.

b. FC Istra

*(Handling large volumes of seasonal species, their transformation and storing for a rational market supply throughout the year, use of processing machinery for innovative products, certification, focused on musky octopus, shrimp, queen scallop, mullets, shelf-life extension, HORECA segmentation.)* For the next projecting step polyvalent machinery for fileting and meat/ separation for new processing segmentation is a first driver to explore. Possible fishing gear innovation.

c. OP Bivalvia

*(Penetrating the market with new unique products, shelf-life extension, packaging and processing for HORECA segmentation, certification.)* For the next projecting step exploring machinery for opening and higher shelf-life extension for new processing segmentation is a first driver to explore and possible gear innovation.

# 17. Analysis of value of fish processing chain in Split-Dalmatia County with identification and description of existing products and technologies for the PRIZEFISH project

## 17.1. Introduction

The geographical location of Split-Dalmatia County includes the central part of the Adriatic coast, from Vrlika in the north to the farthest Croatian island of Palagruža in the south, from Marina in the west to Vrgorac in the east. The County is divided into three geographical subdivisions: coasts, hinterland and islands covering 14.106,40 km$^2$ with an average population density of 100.2 inhabitants / km2. The most important economic activity is tourism, which is constantly increasing, while on the other hand, production and agriculture are declining. Despite the rich tradition and development of the coastal fisheries sector, in the last two decades most of the fishing industry has been relocated from the coastal area to the hinterland industrial zones. Investing in the fishing industry through EU funds has allowed the development and/or renewal of 8 large producers in the county with a high degree of technological development, however, despite officially registered activities; most establishments market unprocessed fish or finished products from other manufacturers and employ a small number of employees. For the analyses of the value of the fish processing chain in Split-Dalmatia County, official data were collected from the Ministry of Agriculture, Veterinary and Food Safety Administration during November of 2019., and all (29) approved establishments in the sector of food of animal origin contacted (Section VII - Fisheries Products) in the County were to collect data from the real sector and aim to contribute to a better understanding of the fishing industry as a specific sector of the Split- Dalmatia County.

## 17.2. Number of approved establishments per County of Republic of Croatia

According to the official data from the Ministry of Agriculture, Veterinary and Food Safety Administration out of 154 approved establishments in the sector of food of animal origin (Section VII - Fisheries Products[1]) in Split-Dalmatia County there are 29 which represent 19 % of the total number of approved establishments (Figure 1.).

[1] "Fishery products" means all seawater or freshwater animals (except for live bivalve mollusks, live echinoderms, live tunicates and live marine gastropods, and all mammals, reptiles and frogs) whether wild or farmed and including all edible forms, parts and products of such animals.

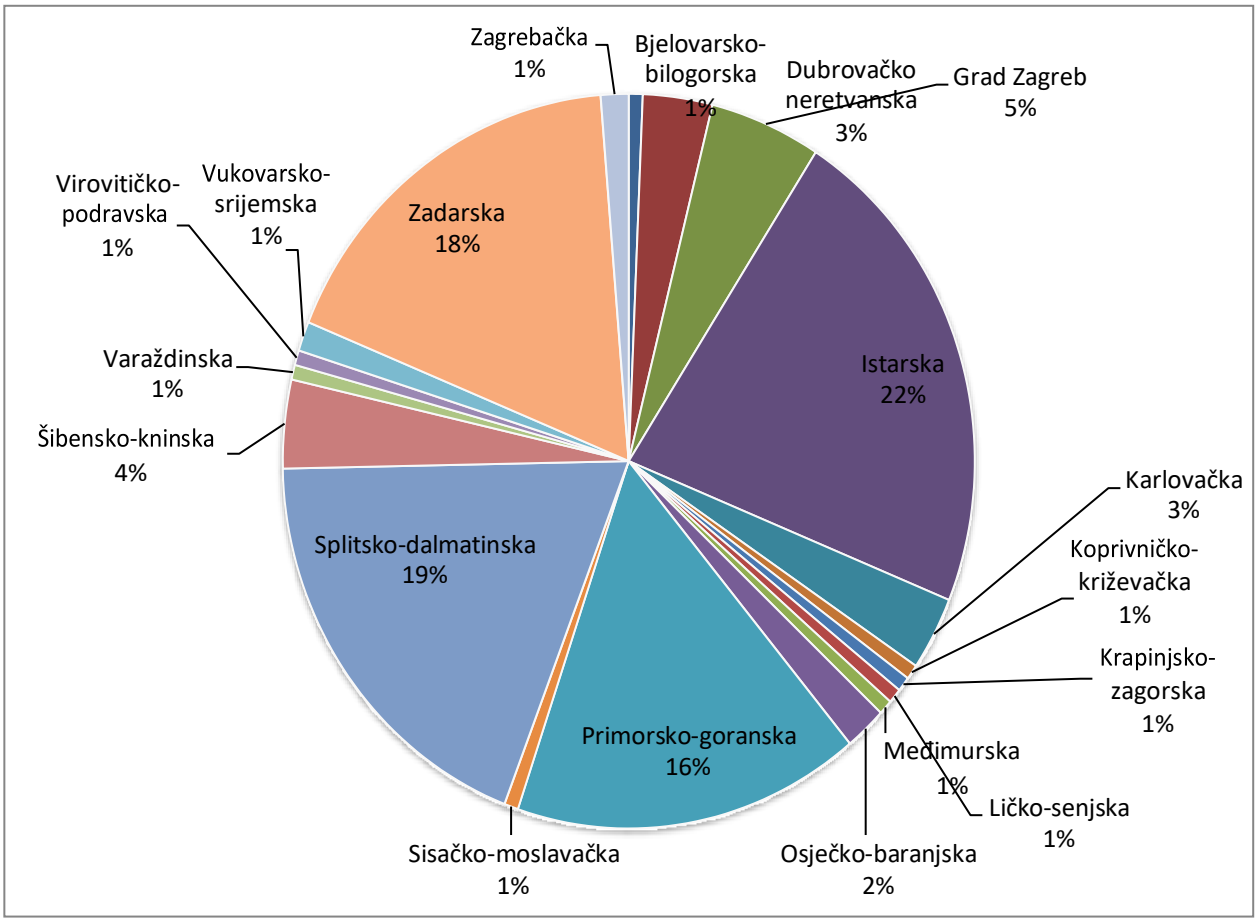



Figure 1.: Share of approved establishments per County of Republic of Croatia

## 17.3. The list of approved establishments in Split-Dalmatia County

The list of approved establishments in the Split-Dalmatia County, together with the listing of their registered activities, main raw materials and products, average annual production and the main market are shown in Table 1. For the purposes of this analysis, all the listed establishments were contacted to collect information (shown in the last four columns) in order to show the realistic situation in the sector.

Legend

SANTE activity CS –

cold storage
RW – re-wrapping establishment
WM – wholesale market
PP – processing plant CC
– collection center DC –
dispatch center

FFPP – fresh fishery products plant PC
–purification center
EU – export in EU Member States 3rd
– 3rd - export in third countries HR–
Republic of Croatia
IT – Italy
RTE – ready-to- eat

| No. | Number of approved establishments | Approved establishment | Address | Town and postal code | SANTE activity | Main raw material | Products | Yearly production in tones | Main market |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 107 | **CENTAURUS d.o.o.** | Mediteranskih igara 9/1 | Split, 21000 | CS-RW-WM; FFPP-PP-EU | Fresh and frozen fishery products | Fresh, frozen, marinated fishery products | 1000 t | HR, IT, AU |
| 2. | 133 | **CONEX TRADE d.o.o.** | Don Frane Bulića 209/a | Solin, 21210 | FFPP-PP | Small pelagic fish | Fresh and salted fish | 50 t | HR |
| 3. | 154 | **CONGER d.o.o.** | Put Benediktanaca 1/1 | Komiža, 21485 | CS-RW-WM; FFPP-PP | White fish (longline), shrimp | Fresh fish and shrimp | 20 t fresh fish<br>1 t shrimp | HR, EU |
| 4. | 354 | **VELPRO-CENTAR plus d.o.o.** | Kamen, 4. Gardijske 43b | Split, 21000 | CS-WM; FFPP | Fresh and frozen fishery products | Purchase and sale of products from other suppliers / manufacturers | Not available | HR |
| 5. | 452 | **RIBA KAŠTELA d.o.o.** | Put Gospe Stomorije 28 | Kaštel Novi, 21210 | FFPP-PP | White and pelagic fish (sardines, anchovies), shrimp i scampi | Shrimp meat, salted , marinated and frozen products | 200 t | IT |
| 6. | 453 | **ŽUVELA d.o.o.** | Ulica uvala Vira 5 | Hvar, 21450 | CS; FFPP | Fresh and frozen fishery products | Fresh and frozen fishery products | 343 t | HR 70%, EU 20%, 3rd 10% |
| 7. | 630 | **ST Delta** | Dračevac 15 | 21000 Split | CS-RW-WM; PP; EU-3rd | Dry cod, frozen fishery products | Dry cod, frozen fishery products | 500 t | HR, EU, BiH, Montenegro, Serbia |
| 8. | 829 | **BEK PUŠNICA d.o.o.** | Polinovac 54, Kaštel Novi | Kaštel Stari, 21216 | PP | Imported salmon, tuna and sward fish | smoked RTE products | 25 t | HR |
| 9. | 1335 | **RIBARSKA ZADRUGA KOMIŽA** | Hrvatskih iseljenika 4 | Komiža, 21485 | FFPP | White fish (longline/trawler) | Fresh fish | 300-500 t | HR, IT |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10. | 1582 | **SRDELA d.o.o.** | Serv. - gosp. zona Žedno-Drage b.b. | Supetar, 21400 | FFPP-PP | Small pelagic fish (sardines, anchovies) | Fresh, frozen and salted fish | 5 t salted 800 t frozen fish | HR |
| 11. | 1625 | **REGATA, obrt za trgovinu, proizvodnju i usluge** | Hrvatske mornarice 10 | Split, 21000 | CS-RW-WM; FFPP | Fresh and frozen fishery products | Fresh and frozen fishery products | Fresh 40 t frozen 60 t | HR, EU, 3rd |
| 12. | 2032 | **ANCORA COMMERCE d.o.o.** | Ulica Miće Marchija 5 | Hvar, 21450 | CS; DC-PC; FFPP | Fresh fishery products | Fresh fishery products | 400 t | HR |
| 13. | 2326 | **ANCORA COMMERCE d.o.o.** | Dugopoljska 27. | Dugopolje, 21204 | FFPP-PP | Fresh and frozen fishery products | Fresh and frozen fishery products | 3000 t | HR/EU |
| 14. | 2566 | **REČINA trgovački obrt, vl. Zdene Smodlaka** | Stinice 26 | Split, 21000 | FFPP | Fresh fishery products | Fresh fishery products | 150 t | HR |
| 15. | 2637 | **KONZUM plus d.o.o.** | Dubrovačka 4 | Dugopolje, 21204 | CS-RW; FFPP | Fresh and frozen fishery products | Purchase and sale of products from other suppliers / manufacturers | Not available | HR |
| 16. | 2668 | **CONEX TRADE d.o.o.** | Čaporice 144 | Trilj, 21240 | CS-RW; FFPP-PP, WM | Small pelagic fish (sardines, anchovies) | Frozen, marinated and salted fish – semi-finished products | 5000 t | HR, EU |
| 17. | 2872 | **TOMMY d.o.o.** | Matoševa 29 | Solin, 21210 | FFPP | Fishery products | Purchase and sale of products from other suppliers / manufacturers | 200 t farmed 4000-5000 t other products | HR |
| 18. | 2668 | **CONEX TRADE d.o.o.** | Čaporice 144 | Trilj, 21240 | PP | Sardine | Sardine cans | 1500 t | HR, EU, 3rd |
| 19. | 2971 | **OLASAGASTI d.o.o.** | Turjaci 379 | Sinj, 21230 | CS-RW; FFPP-PP | Anchovy | Salted anchovies | 500 t | Spain |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 20. | 3019 | **ADRIATICON d.o.o.** | Prisike II 15 | Gizdavac, 21247 | PP | Anchovy, cod | Salted anchovies, fish spreads | 15 t | HR |
| 21. | 3050 | **SARDINA d.o.o.** | Ratac 1 | Postira, 21410 | FFPP; PP; DC | Sardines, white farmed fish (sea bass, sea bream), yellow fin tuna. imported: hake, Atlantic and chub mackerel | Fish cans and pates, fresh farmed and frozen fish, fish meal and oil | 10-12 mil cans 550-600 t farmed fish | HR, EU, SAD, Australia, Russia, Canada, 3rd |
| 22. | 3148 | **RIBA DRAŽIN j.d.o.o.** | Kaštel Kambelovac, Biskupa F. Franića 78 | Split, 21000 | PP, WM | Anchovy, octopus, tuna, saddled seabream | RTE delicatessen products | 10 t | HR, Slovenia, Austria |
| 23. | 3156 | **FRIŠKINA d.o.o.** | Listešići 1 | Klis, 21231 | PP | Dispatch centre for white farmed fish | Fresh farmed fish | 50-60 t | HR |
| 24. | 3358 | **CANICULA d.o.o.** | Gizdavac, Radna zona Prisike 1/8 | Donji Muć, 20203 | PP | Anchovy , sardine | Salted and frozen anchovies and sardines | Salted fish filets 650 t Frozen filets 140 t | IT |
| 25. | 3367 | **METRO CASH & CARRY d.o.o.** | Cesta pape Ivana Pavla II 3 | Kaštel Sućurac, 21212 | CS; FFPP-PP | Fishery products | Purchase and sale of products from other suppliers / manufacturers | 30 t farmed 30 t fresh 45 t dry cod (not available for frozen products) | HR |
| 26. | 3476 | **MARINEX & Co. d.o.o.** | Bana Josipa Jelačića 10 | Dugoplje, 21 204 | CS-WM; FFPP | white farmed fish (sea bass, sea bream) | Fresh fish | 150 t | 70% HR, 30% EU |
| 27. | 3588 | **KATIĆ, obrt, vl. Ivica Katić** | Put Sv. Lovre 81 | Kaštel Lukšić, 21215 | FFPP; WM | Live shellfish | Live shellfish RTE salted products | 50 t live shellfish 10 t salted | HR |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 28. | 3157 | **ŽUVELA d.o.o.** | Put Dugiša 1 | Makarska, 21300 | CS-RW-WM; PC-DC; PP-FFPP | Fresh and frozen fishery products (trawler, small pelagic fish) | Purchase and sale | 300 t | HR |
| 29. | 3607 | **SAMSARA d.o.o.** | Čaporice 147 | Trilj, 21240 | FFPP; CS-WM | Imported salmon, tuna, swordfish and squid | Frozen and smoked products for WM | frozen 220 t smoked 15 t | HR, IT |

## 17.4. Distribution of main the activities between approved establishments

Despite the relatively large number of approved establishments in Split-Dalmatia County, only 43 % of them process and manufacture semi-finished[2] and final products. The main activity of 20 % of approved establishments is the purchase and sale of fresh and frozen fishery products without additional processing. These are the collection or dispatch centers of retail chains and fish farms or first buyers.

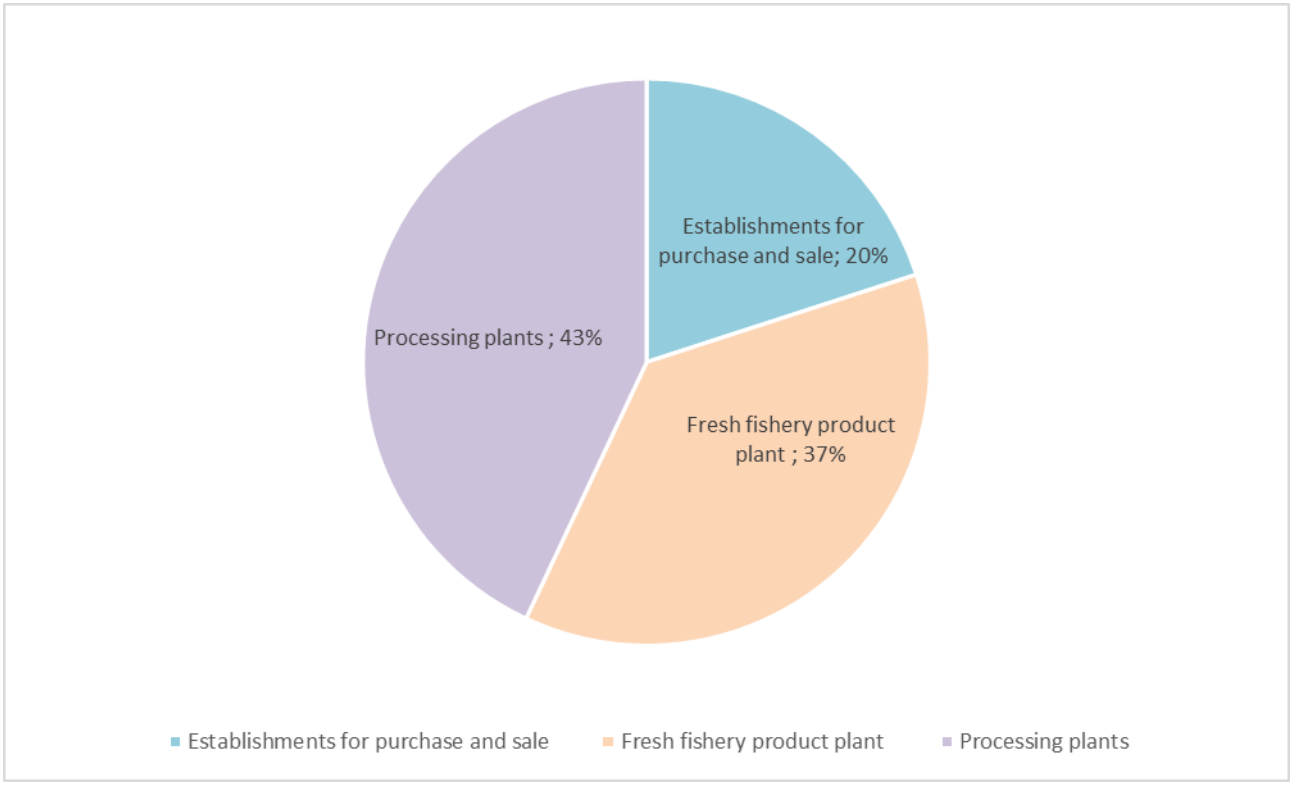



Figure 2.: Distribution of main the activities between approved establishments in Split-Dalmatian County

[2] Semi-finished products are those that are sold to other entities for finalization, such as barrels of salted fish salts, large containers of marinated product, and most often that other entity places them on the market under their brand. Manufacturers of semi-finished products usually do not have their finished products on the market.

## 17.5. Distribution of processing technologies and products

The technologies implemented in the facilities are complemented to the activities carried out in the facilities. Most establishments produce fresh (14), frozen (11) fishery products and salted fish (7), while all other products are represented in less than 10 % of the total products (Figure 3.). Three establishments marinate fishery products (mostly anchovy, shrimp, and cephalopods); two establishments carry out industrial smoking using imported raw materials (salmon, tuna, and swordfish). Three establishments produce/package RTE products (fish spreads, delicatessen products) using semi-finished products from other producers/suppliers. Raw fish from domestic catch are used for the production of salted fish, marinated anchovies and prawns and canned sardines, while the imported raw materials are used for the production of other products. One product is recently new on the market, in three establishments the sea urchin meat is cleaned and frozen, but in small quantities and only during the period when harvesting is allowed.

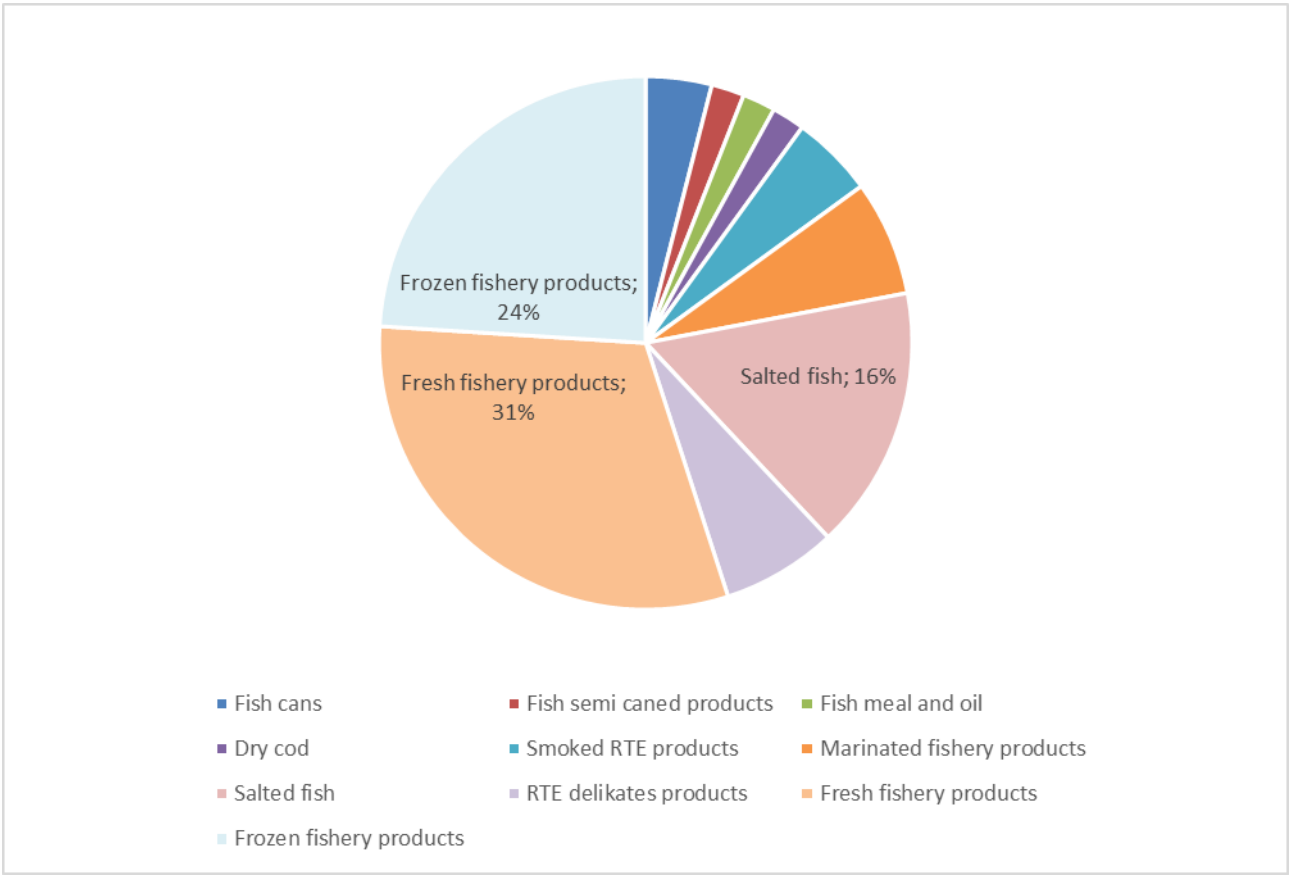



Figure 3.: Distribution of processing technologies and products in approved establishments in Split-Dalmatian County

[3] "Fresh fishery products" means unprocessed fishery products, whether whole or prepared, including products packaged under vacuum or in a modified atmosphere, that have not undergone any treatment to ensure preservation other than chilling.

Following freezing technologies are carried out in the described establishments: the individual quick freezing in a stream of cold air, contact freezing and freezing by immersion in brine (1 establishment). The salting procedures are carried out using salting methods in the crowns (barrels) and carne (tins). Of the two facilities that perform industrial smoking, one uses smoke obtained by burning sawdust in the smoking ovens and the other by burning the liquid smoke preparation. The marinating operations are carried out using cold marinating technology without heat treatment. The technological procedures for the production of canned fish (2 producers) are fully automated at a high level.

## 17.6. Analysis of the market

The approved facilities in the Split-Dalmatia County market their products in Croatia, some EU countries and 3rd countries, mainly from region as shown in Figure 4. 41 % of manufacturers market their products exclusively to the Croatian market, and 35 % to the Croatian and EU markets (Italy, Austria). Three establishments produce frozen and salted fish exclusively for the EU (Italian and Span) markets. Other markets which include Bosnia and Herzegovina, Montenegro and Serbia, the US and Canada and account for 15 %.

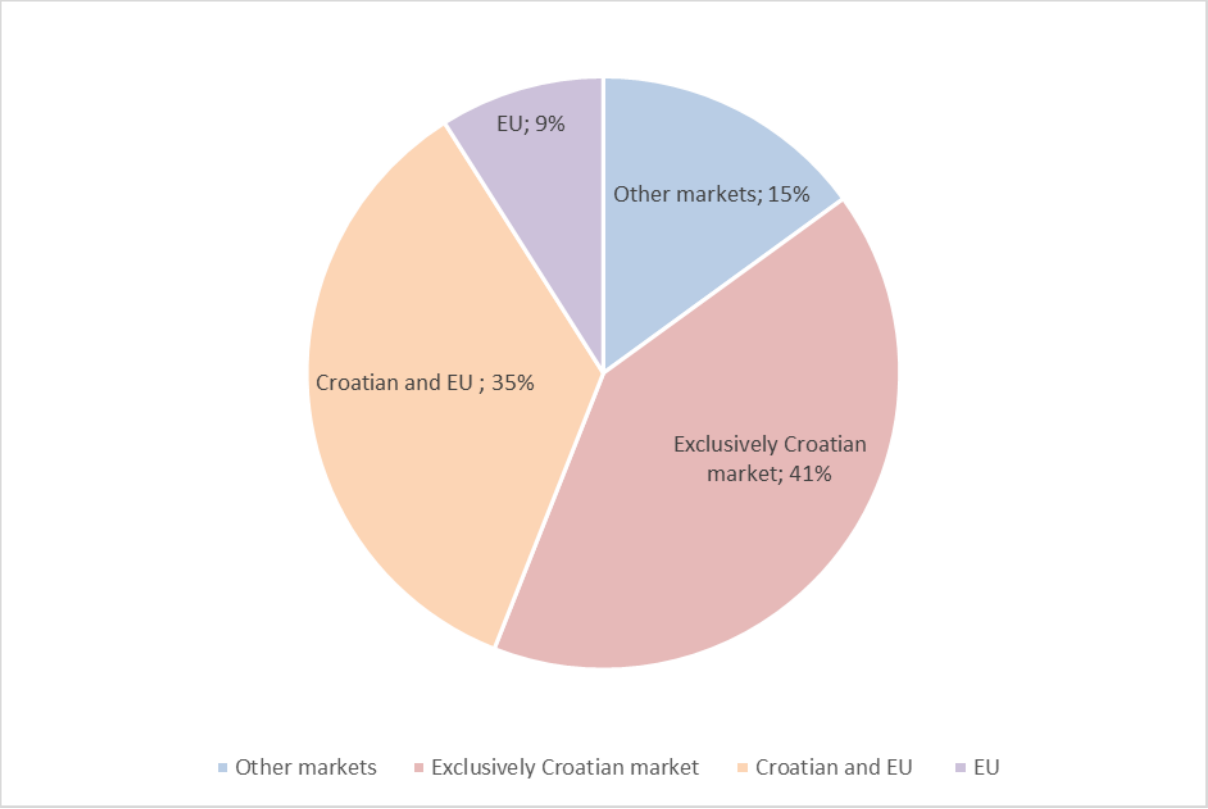



Figure 4: Analysis of the markets covered by producers in Split-Dalmatian County

After analyzing the fish processing chain of the Split-Dalmatia County, it can be concluded that it generates economic growth in the County and is closely linked to the growth of tourism as the dominant sector. However, without the development of other sectors and without the support of the political and institutional environment (for obtaining concessions, etc.), it cannot contribute to the long-term sustainable economic growth and development of the Split-Dalmatia County. Considering the local processing tradition and the Mediterranean orientation of the County, the fish processing sector has great potential for development in the future.