

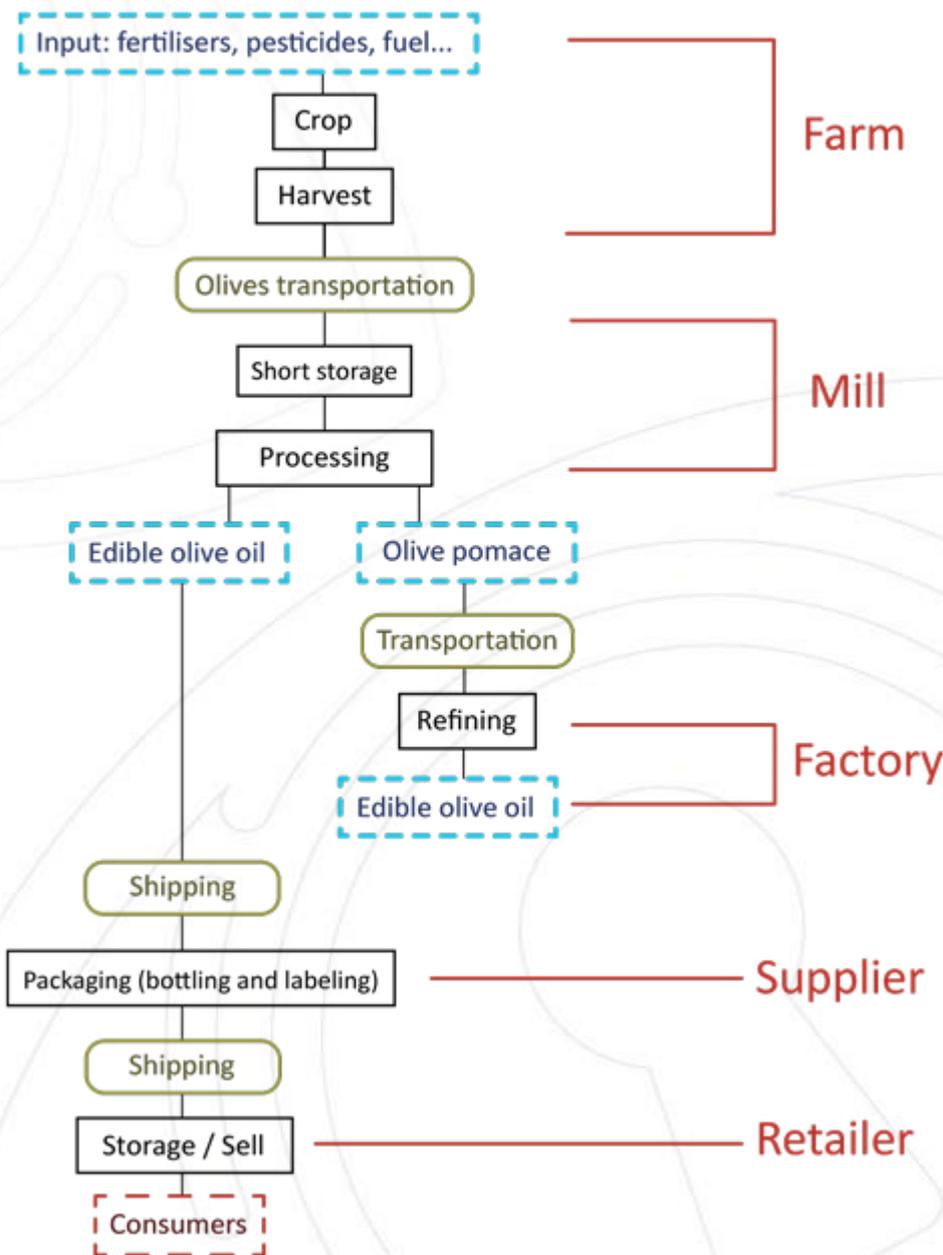
Olive Oil

Assuring the Quality and Authenticity
of the Liquid Gold of the Mediterranean

Objective

The aim of this Case Study is to present findings about Ambrosus being used in the Olive Oil industry for the purpose of: (1) traceability (origins assurance) (2) supporting producers for demonstrating the good quality of their practices and product. Below is the landscape of the olive oil value chain and the stakeholders within it as of today.

Supply chain and its stakeholders



History

The olive tree is among the oldest known cultivated trees in the world. The cultivation of the olive tree had commenced before written scripts emerged. Olive oil was used to worship the gods, to care for the elderly and honour the dead, and up to these days has a great significance in many religious ceremonies. Olive oil is acknowledged for its exceptional nutritional values and health benefits and is the inherent part of the Mediterranean diet. Tastes can considerably vary depending on the region of origin and the type of cultivar and are a key parameter in the specification of Designated Origins.

Quality

The Olive oil is classified into several categories depending on two main characteristics: peroxide value and UV absorption, based on tests performed in laboratory. Olive oils are also subject to an organoleptic tests to determine any sensory defects. Classification grade depends on the country, but olive oils can be globally ranked in five main categories:

- Extra virgin olive oil
- Virgin olive oil
- Ordinary olive oil
- Refined olive oil *Quality*
- Lampante olive oil



An extra virgin olive oils which shows a sensory defect will be automatically declassified as virgin olive oil. Refined olive oil is obtained by physical treatment or use of solvents. Lampante olive oil is not edible and should not be found in the food market. Quality can be affected by bad harvest, storage conditions, manufacturing process, packaging or simply by contamination of good oil with a small or very small amount of a defective oil. The latter will have a good chemical composition but will fail to organoleptic assessment.

Tests are performed by laboratories certified by the International Olive Oil Council (IOC).

Safety

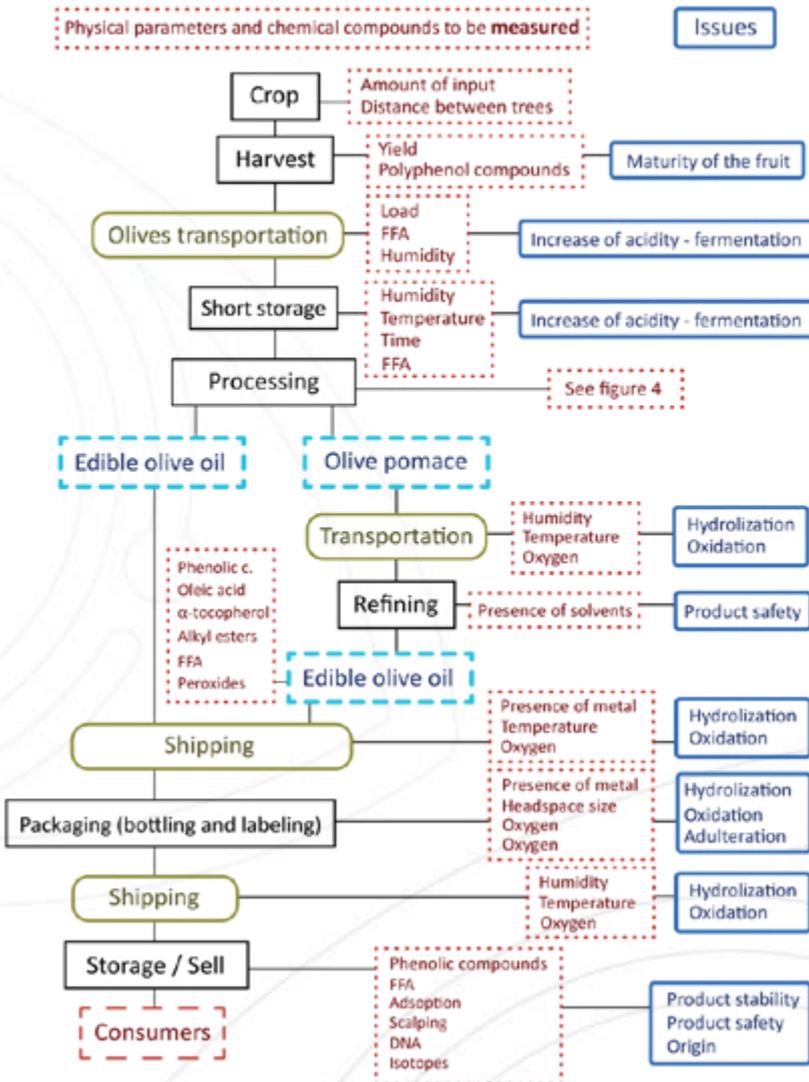
While the processing of the oil is relatively easy and does not imply a wide range of chemical substances, its production is not subject to big safety risks. Health hazards can occur in the case of refining oil from which solvent has not been properly removed and from the use of pesticides.

Health hazards also occur from adulteration with non-edible oil or addition of others oil which can trigger allergic reaction (in the case of nuts oil for instance).

Below are the parameters influencing quality and safety of olive oil at different stages of the value chain:



Whole parameters



Importance of high quality for health, taste and appearance

Olive oil is famous for its health benefits, and its main sources come from the phenolic compounds, α -tocopherol and oleic acid. Phenolic compounds α -tocopherol are known for their great antioxidant effects. Oleic acid is a monounsaturated fatty acid, it helps to decrease bad cholesterol and to protect against cardiovascular diseases.

Chlorophyll and anthocyanins are pigments present in the olives and the leaves. A high level of those compounds come from very ripe olives and/or olives not washed properly and give a bitter and unpleasant

taste to the oil. Fermentation, which can occur because of bad storage of the olives, is also a source of unpleasant taste.

The colour of the oil can greatly vary depending of the olive cultivar and is not a clue for quality. Olive oil is usually filtered to eliminate suspended matters. This extends the shelf life of the oil but also partially removes some important components such as phenolic compounds.

Fraud

The victim of its own success, olive oil is one of the most counterfeited and adulterated products in the world. It is estimated that one bottle out of four is mislabelled in the markets of Provence and that 70% of the olive oil sold in US is either counterfeited or adulterated.

History is full of scandals caused by fraud of olive oil and sadly some led to thousands of deaths, such as in Spain in 1981 due to olive oil adulterated with industrial grade-grapeseed oil. And, because of a lack of transparency of its supply chain, the origin of the fraud and the culprits have never been found.

More recently, in 2008, a large-scale fraud was discovered in Italy and led to the seizure of 85 farming operations as well as \$42.8 million in assets and arrests of 33 people. In 2016 a Chinese business man was sentenced to a four-year prison term and fined more than \$15 million for blending inferior grade palm and other low-cost oils into a mixture that was then marketed as high-grade olive oil.

Experts consider that these events are only the tip of the iceberg with many fraudulent activities remaining undiscovered. Unfortunately, both public and private organisations struggle to find solutions to tackle the fraud, to demonstrate good practices and quality and to prove traceability and origin of the oil.

Logistics and supply chain challenges

The consumption of the olive oil has historically been primarily confined to the Mediterranean region. But recent generic and commercial promotion efforts have stimulated interest in the consumption of olive oil and created new opportunities for Mediterranean producers to export to non-traditional markets. Historically destined for local market with a short distribution channel, new market opportunities have generated new challenges in term of logistics of the olive oil.

Since olive oil production is more expensive than other vegetable oils, logistics is a key driver for price-competitiveness for producers, and remains a big percentage of the production cost (20-25%).

The supply chain of the olive oil is relatively easy to approach thanks to a unique raw material. Farmers either bring their production to a mill or transform their olives in their own mill. Propertis of the oil is transferred to the miller and then to bottler and suppliers. In some cases, the oil stays in possession of the farmers who take care of the bottling and the sale of their own oil.

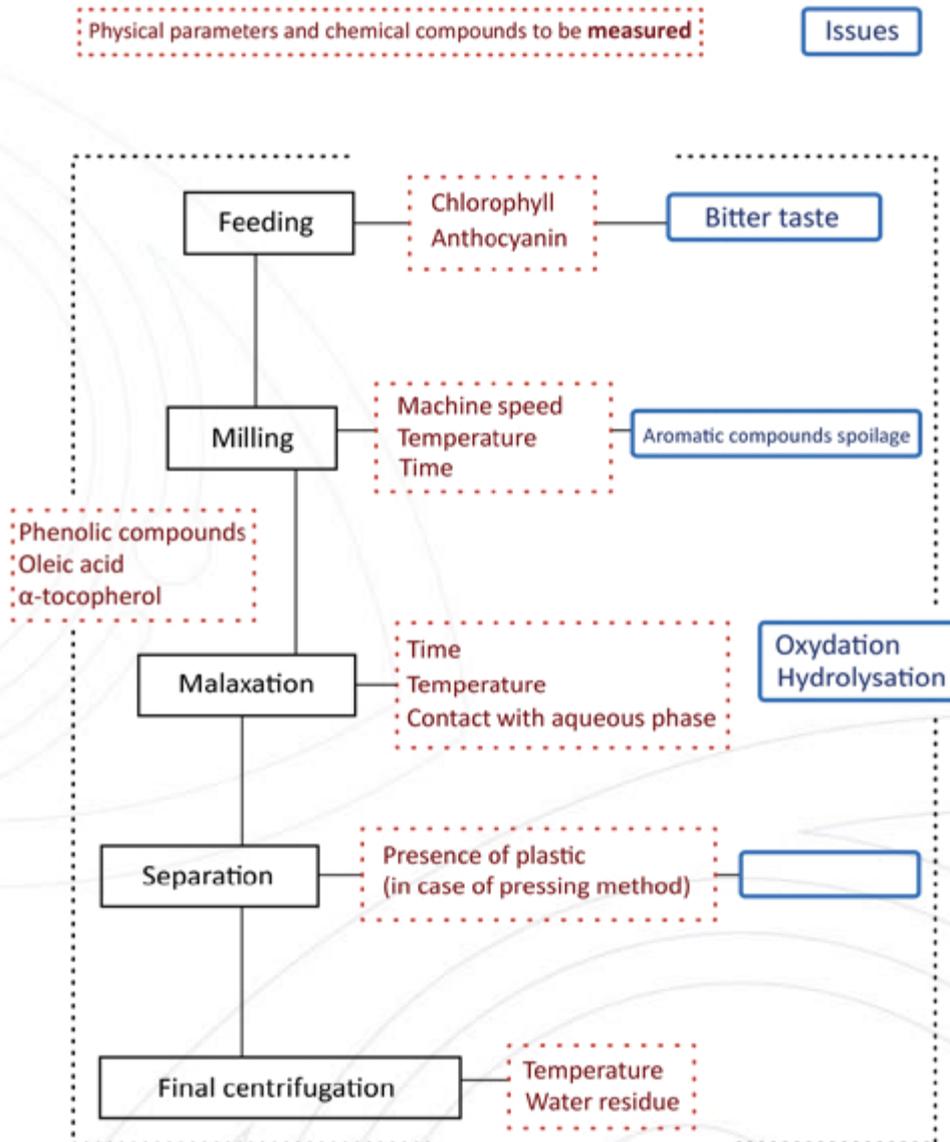
The first mile of the supply chain can be difficult to manage for producers as mills have a predefined process capacity which cannot be easily extended. Moreover, olives cannot be stored for too long before milling and the harvest has to be done in a short period. Harvest is a key step and all the necessary precautions should be taken in order to keep the fruit intact, because altered olives give poor oil. At the same time, fresh olives don't tolerate long storage and have to be processed shortly after harvesting. This has led to the development of micro-mills, diseconomies of scale, absence of constant processing conditions and a lack of suitable controls. The step between the fields and the mills can represent a bottleneck and lead to loss of quality especially in case of good crops. A better rationalization of the link between harvesting and milling would enhance revenue of farmers and millers as well as quality of the olive oils.

While it is relatively easy to have control on key factors such as temperature during the processing of the oil, it is much more difficult to audit them when the oil is ready to be bottled and shipped from the milling to the bottlers and/or suppliers.

Packaging and storage conditions also play a big role in protecting the oil from these physical threats and has to be taken into consideration. In addition, packages have to be inert in order to avoid adsorption of the oil by the package itself or migration of packaging component in the oil. They also have to be protected against fraudulent opening.

By-products of the olive oil has to be tightly controlled, due to the risk of environmental contamination. After treatment, byproducts have commercial value and can be used as fuel for water production, for plastic production, as livestock feed and as fertilizer.

Whole parameters - Process steps



Market

95% of the production of olive oil is concentrated around the Mediterranean basin and the average world consumption has almost doubled over the past 25 years.

The olive oil market is characterized by a great number of famers and mills with high labour costs, but a small number of bottlers and

retailers who control the market and have significant influence over prices.

Production of olives is subjected to cycles and thus to great fluctuations. Consequently, exports may greatly vary from year to year and prices can rise rapidly, which attracts investors and traders sometimes from remote regions.

The market is dominated by price competition. The asymmetry of the information distribution, with purchasers having an idea of an average value of the oil and suppliers owning more information about its actual value, is an incentive for sellers to provide the market with oils that have a market quality lower than the average. Giving access to more information to consumers will reverse this trend.

Issues description and hot spots

Adulteration and counterfeiting are the two main problems in the olive oil distribution, especially because big and trusted companies have already been implicated in such activities.

Proper storage of the olives before processing as well as proper storage of the olive oil are essential in the pursuit of good quality.

Temperature and time of processing are the main issues during the milling phase of the olives and good hygienic design has to be applied to the milling facilities in order to avoid contamination. This last point has been underestimated for a long time by mill builders, because oil is normally not subject to microbial alteration.

As explained below, all those point can be measured, monitored and controled, but once oil of good quality reaches the final consumer, consumer's own behavior can lead to spoilage of the oil. For instance, bottles kept opened for long periods are too often seen in private kitchen or restaurants.

Key parameters to measure

While olive oil is known for its relative long shelf life and its stability over time, this product can actually be subject to chemical and physical reactions affecting the quality and the taste.

Hydrolyzation, oxidation and fermentation are the three main reactions affecting oil. Hydrolyzation occurs when contact with water or simply humidity, oxidation in presence of light and fermentation in case of bad or too long storage conditions. High temperature during process steps can spoil aromatic compounds, thus the taste. It can also affect polyphenolic compounds which assure stability of the oil.

Tracking the hydrolyzation, oxidation and fermentation reactions would be expensive and would take time to be put in place. Instead, tracking the parameters which trigger these reactions is relatively easy and does not involve big investments. Accordingly, tracking length of process steps, temperature as well as presence of water and oxygen are suitable to assure the quality and the safety of the oil.

Origins and absence of adulteration have to be tested as well. At the moment, DNA and isotopes analysis are the tools for the demonstration of origin of the oil, but they require large databases because analysis alone cannot attest the origin of the oil, in fact samples have to be compared with others whereby the origin is proved through matching between two samples. In addition, the DNA analysis are expensive and challenging because DNA difficulty dissolves in fat and due to the presence of inhibitors in the oil. Moreover, these certifications can be done only when the oil has almost reached the final consumer.

In case of the Protected Designation Areas, producers have to show official documents such as Identification statements, cultivar register, manufacturing statement, market entry statements. But those documents are handwritten and can be fraudulent. In addition, traceability requirements are not extended after the oil has left the

manufacturing unit. Using RFID technology would enable to track the oil along the supply chain from end to end to assure its origin.

Adulteration can be analysed by different methods, but there is not a unique analysis which can be used to detect all the alterations and a wide range of tests have to be performed. This could be replaced, in case of a global overview of the supply chain, by a comparison of the amount of oil which should have been produced and the actual amount on the market.

Alpha version design of solution – incremental progress of solution

The first step is to use tools already developed and to deploy them along the entire supply chain. Analysis methods of phenolic compounds, α -tocopherol and oleic acid already exist and can be used as tracking tools. Phenolic compounds should be targetted first, because they can be used to monitor the whole milling process and are a key indicator of storage stability.

Then new monitoring tools can be implemented to monitor temperature, humidity, light and oxygen through the whole supply chain. Some of the captors can be put directly into RFID tag, and this would also assure the geographical tracking of the oil.

Eventually biotracers mixed with the oil itself will enable an extremely tight tracking of the oil and would resolve safety, quality and origin issues.

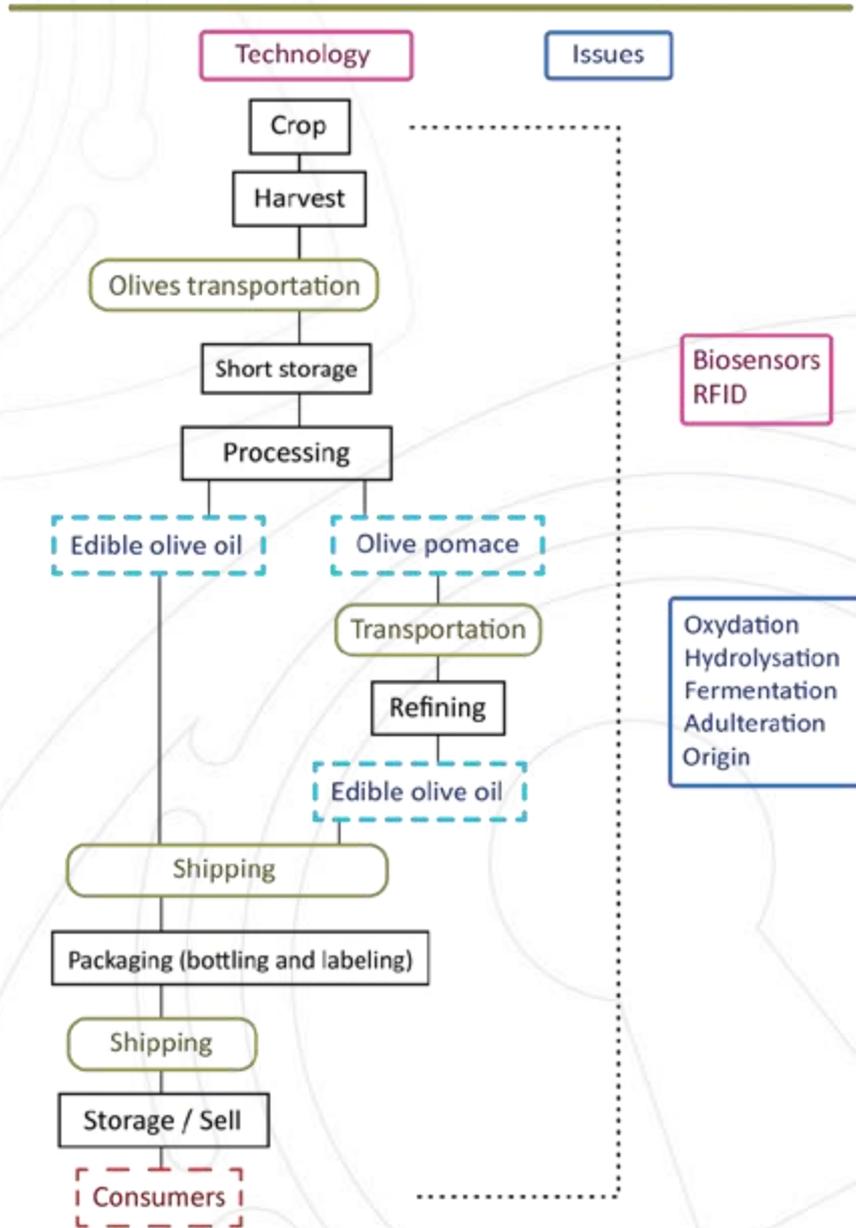
Data traceability

For the moment, most of the documentations are handwritten, pass from hand to hand and are not always well treated. Provence region in France, which produces oil of excellent quality, has launched a traceability management system called GestOlive.

However, data are entered manually and can be easily tampered with. In addition, this system doesn't follow the oil once it has left the mill.

Using a secure platform where data are automatically entered while parameters are analysed or monitored and this is done through the whole supply chain which would enhance greatly the traceability of the oils. Management of this data could also, for instance, enable a better rationalization of the link between harvest and milling, avoiding spoilage of olives and increasing the revenue of farmers.

Incremental Solution Final Step

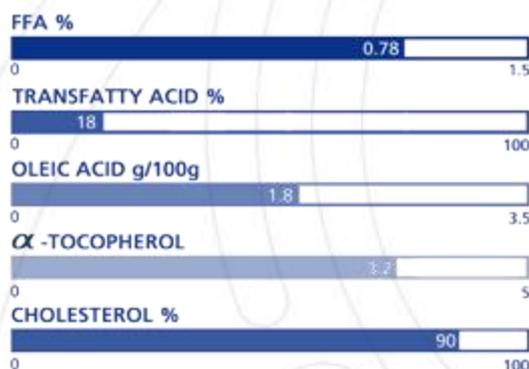
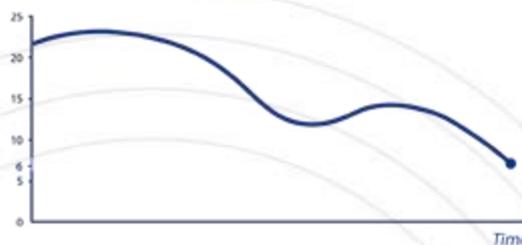


Consumer benefit with Ambrosus ecosystem

Final consumers benefit from our solution in different ways. It increases the traceability of the olive oil and the transparency of the supply chain, thus it will enable them to trust the safety, quality and origin of the product. In addition, the market is led by price competition and seller's motivations are going toward low quality olive oils. With access to safety, quality and origin information by the consumer, the information asymmetry rapidly decrease in favour of good quality products at affordable prices.

Consumers and any other stakeholders of the olive oil supply chain will have access to these information through mobile apps or integrated software with user-friendly interface enabling them to have a quick and easy access to information by scanning QR codes or NFC tags.

This is the UI of the first implementation of Ambrosus applications



1.PRODUCT NAME:
Extra Virgin Olive Oil
2.TRANSPORTATION: Land
3.STORAGE: Yes
4. MILLING FROM:
12.12.2016 2.15 to
14.12.16 9 am
MILL ADDRESS:
Tuscany, Italy
GPS DETAILS:
43.32215 11.3259
MONITORING QUALITY:
No problem encountered

Transformation of the Supply Chains

Ambrosus enables every stakeholder to have a comprehensive overview of the entire supply chain of the olive oil and to have access to the full history of the oil from the tree to the table.

The interoperability of the data and the tracking of the oil along its all journey helps the stakeholders to take better management decisions and, for instance, to help them to solve the challenges of the export logistics, including showing origins, quality and safety. It also completely removes the need of vertical integration that is done by some stakeholders.

Control and monitoring becomes endogenous, at the opposite of the current situation, and trust becomes the most important output.

We will be sharing insights into other food industries and supply chains, which are being transformed by Ambrosus on our website. For any enquiries please use the contact details below.

Join Ambrosus Ecosystem

For integrations and partnerships:

 ambrosus.io/#contact

 community@ambrosus.io

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