MISSTOW

Survey – State of the Art (D2.1)

Task Leader CETENMA

January, 2012

CONTENT

1. INTRODUCTION

This document represents the deliverable D2.1 of the Project MISSTOW, approved under the call 2010 of the Eco-innovation program, part of the “Competitiveness and Innovation Framework Programme 2007-2013” (CIP) of the “Executive Agency for Competitiveness and Innovation” (EACI) of the “European Commission” (EC). Project ID is ECO/10/ 277241.

The objective of the Project is the development of a “Mobile Integrated Sustainable System for Treatment of Organic Wastewater”. The regions participating on it are Galilee (Israel), Patras (Greece) and Murcia (Spain). It is coordinated by the Israeli SME Peleg-HaGalil, operating in the field of water, and it counts with other three Partners that are the Technology Centre MIGAL, also in Israel, The University of Patras (Greece) and the Technology Centre CETENMA, in Murcia.

This Survey forms part of the Work Package 2, “System requirements definition and design”, and its development has been the responsibility of CETENMA, together with the contributions from the rest of the partners of the Project. It is being delivered on the month 6th from the commence date of the Project. It is being delivered on the month 6th from the commence date of the Project, i.e., January 2012.

The aim of this Survey is to summarize the current situation of the olive oil and wine business – main potential users of the technology that will be developed under the Project – at European level in general and specifically in the three participating regions. To achieve this end, the partners have collected the data of the productions of olives and grapes on the one hand, and olive oil and wine on the other. The current production technologies and trends have been described when it comes to olive oil and wine, and the environmental challenges that these business face have been introduced. The study also counts with a list of wineries and olive mills existing in the three regions.

It is expected that this Survey, together with the Report on Regulatory Concerns (deliverable D2.2., to be issued on March 2012) will be used as reference documents to develop the deliverable D2.3, Business Analysis and Strategy, as well as the deliverable D6.1, Exploitation and Business plan.

2. OLIVE OIL AND WINE BUSINESS IN EUROPE

The olive grove and the vineyard are two of the most important agriculture products of Spain, Greece and, in the last years also of Israel, by the economic, social relevancy, and territorial incident. In fact, Spain is the first country in production of olive and grape worldwide. The olive oil and wine are the principal products obtained from this agricultural activity, although, the olive grove provides a wide range of secondary products and by-products that must be considered.

The olive trees and vineries an enormous territorial projection, having become two of the principal sectors of the food-processing in Greece, Spain and Israel by economic, social, environmental, landscape and cultural importance. In last years, Spain, Greece and Israel are between the first twenty producing and exporting world countries of olive oil and wine.

At present, there is a need to stimulate the consumption of olive oil and of wine in the European countries out of the Mediterranean basin. This sector must lead the business management, commercialization and internationalization, orientating the productions to the market, providing them with added value and promoting a sustainable sector in the medium and long term, from three points of view: economic, social and environmental. The main actions where Europe must work are: the re-equilibrium of the value-chain, and the improvement of the quality and the commercialization of the product.

On the other hand, the promotion must constitute a clear and constant bet of the sector, with the aim to inform the consumer about the added value of the nutritional characteristics of oil and wine and about quality, origin, and healthy and nutritional characteristics inside the Mediterranean Diet.

From the 1980s, the importance of the policies of the European Union about protection of the environment and the natural resources has been increasing quickly. The reasons are the threats to environmental deterioration. However, occasionally, countries of European Union demand protective measures, at national and international level.

The European Union generates about 2,000 millions of tons / year of residues. The olive oil and wine industry produces highly polluted wastes depending on the extraction system. In Mediterranean Regions of Europe, olive oil and wine producers suffer the generation of wastewater from olive mills and wineries respectively. This has become an environmental problem demanding to be solved, due to the polluted waste produced by the numerous small producers dispersed along the regions.

The aim of this survey, in addition to summarize the current situation, is to identify wastewater problems occurring in olive mills and wineries at the Region of Murcia, Patras and Galilee. The survey includes information and data about the amount of olive and grape production, olive oil (*Figure 1)* and wine (*Figure 2*) manufacturing technologies used in the Mediterranean area and the impact of residues generation in both sectors.

Figure 1: *A small olive oil mill in an Arab village in Israel*

Figure 2: *Achaia Clauss, Imperial Cellar in Greece*

3. OLIVES AND GRAPES PRODUCTION

Olive oil and wine are important products in the Mediterranean Sea Basin because it has social and economic value to a large portion of the population.

3.1. Olives

In the world, there are approximately 820 million of olive trees and 98% of them are located in the Mediterranean area. The cultivable world surface occupied by olive grove comes close to 0.35%. The European Union is a World leader in surface of olive grove; Spain, Italy and Greece are leading the rank. Table 1 shows the top world olive producers, their production in tones and the harvested area in 2010.

In Israel, as in some Mediterranean countries, the Olive agricultural branch is very important. There are more than 17 500 Hectares of olive's grove un-irrigated crops and around 6 500 hectares of irrigated land. Most of the olive trees are in the Galilee. The productions are: 15 000 tone for edible and 10 000 ton for olive oil.

In Greece, the occupied surface was 834,200 hectares (FAO 2010). The production of olives was 1,809,800 ton (FAO 2010) and there were 132 million of olive trees (PROSODOL-LIFE 2009-2012). In Western Greece Region, there are more than 1 million olive trees and the total olive oil production is about 35 to 40 thousand tones (IOOC 2004). Except from Western Greece Region, Greek areas with extensive olive trees cultivations are Crete, Ionian Islands, Messinia, Lesvos and Lakonia. Olive tree cultivation is important, not only financially, but also on social level as 450 thousand families deal with olive tree cultivation. The production process of olive and olive oil is a sector that is growing fast and the average annual growth rate is estimated to be greater than 4% (IOOC 2004).

In Spain, there were 2,092,800 hectares of occupied surface by olives trees and there were 170 million of olive trees with a production of olives of 8,014,000 ton (FAO 2010). In the Region of Murcia, there are 31,847 hectares of occupied surface by olives trees, with a production of olives of 39,312 ton in 2010. Most of the olives are destined to the olive oil production (36,812 ton) (CARM 2010).

***Table 1**.Olives worldwide production (FAO 2010)*

Position	Country	Production (ton.)
1	Spain	8,014,000
2	Italy	3,170,700
3	Greece	1,809,800
4	Morocco	1,483,510
5	Turkey	1,415,000
6	Syrian Arab Republic	1,014,900
7	Tunisia	876,400
8	Egypt	611,900
9	Algeria	555,200
10	Portugal	239,600
18	Israel	73,500

3.2. Grapes

The winery sector has a significant relevance among the agro - food industry with a total cultivated surface of vineyard in the world of 7,203,986 hectares, out of which 3,753,783 are cultivated in Europe (FAO 2010) (Table 2).

In Israel, the occupied area by vineyards was 5,720 hectares of vineyards with 95,075 ton of grapes produced (FAO 2010).

In Greece, the occupied area by vineyards was 99,300 hectares. The grapes production was 1,002,900 ton (FAO 2010). In Western Greece Region, especially in Patras, the number of cultivated vineyards is 76,531 hectares and the production of grapes that become wine is 121,843 tones (ASG 2005). The cultivated vineyards in Western Greece Region cover 13.4% of cultivated area at country level and they are reduced by 52,609 hectares (BPBoFoWGR 2011).

In Spain, the occupied area by vineyards was 1,002,100 hectares. The grapes production was 6,107,200 ton (FAO 2010). In the Region of Murcia, there are 37,006 hectares of occupied surface by grapes trees (CARM 2010). The grapes production was 100,000 ton in 2010.

Table 2. *Worldwide grape producers (FAO 2010)*

Position	Country	Production (ton.)
1	China	8,653,900
2	Italy	7,787,800
3	United States of America	6,220,360
4	Spain	6,107,200
5	France	5,848,960
6	Turkey	4,255,000
7	Chile	2,755,700
8	Argentina	2,616,610
9	India	2 ,263,100
10	Iran (Islamic Republic of)	2,255,670
16	Greece	1,002,900
52	Israel	95,075

Figure 3. *The decanter system at an olive oil plant.*

4. OLIVE OIL AND WINE PRODUCTION VOLUMES

Olive oil and wine production has suffered variations in the last years in European countries due to either poor weather conditions (water scarcity, hail) or by the lack of needed subsidies received from public bodies to the agriculture sector.

4.1. Olive oil

Table 3 shows the largest olive oil producers worldwide. Spain is the first producer, followed by Italy and Greece. The three of them share most of the olive oil production in the world (3 269,249 tons) (FAO 2010).

Table 3. *Worldwide olive oil producers (FAO 2010)*

Position	Country	Production (ton.)
1	Spain	1,487,000
2	Italy	548,500
3	Greece	352,800
4	Syrian Arab Republic	177,400
5	Morocco	169,900
6	Turkey	161,600
7	Tunisia	160,100
8	Portugal	66,600
9	Algeria	33,600
10	Jordan	21,412
17	Israel	5,300

In Israel, the olive oil production was 5,300 ton, most of it was produced in the Galilee.

In Greece, there are 2,800 olive mills and the olive oil production was 352,800 ton. The peninsula of Peloponnese is the region of Greece where more olive oil is produced of this country. Most of this olive oil (80%) is virgin-oil, and more than a half is exported. In Western Greece Region, the total olive oil production per year is about 35 to 40,000 tones.

In Spain, there are 1,730 olive mills and 1,487,000 ton of production of olive oil (FAO 2010). In the Region of Murcia, there are 50 olive mills, approximately. There was an olive oil production of 675,000 hectoliters in 2010, giving an average of benefits about 150 millions of Euros during the last year (INFO 2011).

4.2. Wine

In the year 2010, worldwide wine production was 26,217,239 tons, with 16,505,454 tons produced in Europe. Table 4 shows the list of the world's larger wine producers.

Table 4. *Worldwide wine production (FAO 2010)*

Position	Country	Production (ton.)
1	Italy	4,580,000
2	France	4,541,820
3	Spain	3,610,000
4	United States of America	2,211,300
5	China	1,657,500
6	Argentina	1,625,080
7	Australia	1,133,860
8	South Africa	921,700
9	Chile	915,238
10	Germany	720,000
14	Greece	303,000
52	Israel	7,300

In Israel, the wine production was 7,300 ton (FAO 2010). There are 21 wineries and the regions of Israel that they production wine are: Galilee, Shomron, Samson, Judean Hills, Néguev.

In Greece, the wine production was 303,000 ton (FAO 2010). In Western Greece Region, the total wine production is 232 thousand hectoliters, which represents 6.7% of wine production at country level (BPBoFoWGR 2011).

In Spain, the wine production was 3,610,000 ton (FAO 2010). The most important Spanish regions in wine production are: Andalucia, Murcia, Castilla y Leon and La Rioja. In the Region of Murcia, there are 91 wineries and the wine production was 675,000 hectoliters in 2010 and this industrial sector employs 1,011 people (INFO 2011).

Figure 4: *Existing separation system (very expensive)*

5. PRODUCTION TECHNOLOGIES

5.1. Olive oil

In general terms, the olive oil process consists on separation of the oil contained in the olive from the solid paste and olive vegetation water. The olive oil industry works to transform the olive fruit into olive oil by extraction methods including grinding, pressing, decantation and centrifugation operations.

The gathered olive is taken to the oil-mill, the leaves and branches are eliminated, and usually olives are washed. Afterward, olives are stored in hoppers. This step may not overcome 48 hours long. After storing, it is time for olive oil extraction. Next steps of the extraction process depend on the extraction method used in obtaining oil. The main extraction processes are: (1) traditional press process, (2) 3-phase system, and (3) 2-phase system.

Traditional press process.

First, olives are crushed at stone mill. The objective is breaking up the fresh olive cell walls to release all the olive oil, so big drops of oil which are able to separate from other phases are created. Next, the olive oil paste is agitated in semispherical containers in order to homogenize its solid content. These equipments have a heater system for increasing the oil drops size in order to easily separate oil and water.

The following process step is water decantation. It consists of arranging a series of connected warehouse tanks where the oil passes from one tank to another (always through the top of them) and the water decants.

3-phase system.

Olives are crushed in mills, followed by the mix of the paste (at horizontal semicylindrical mixer). Inner warm water circulation keeps the temperature of the olive paste between 27-35ºC. Then, the paste goes to a horizontal centrifuge unit (centrifugal decanter), where three different phases are obtained by means of its different densities *(Figure 5*).

- Olive cake (OC): A solid mix of olive bones, skin and flesh.

- Oil: It needs to be refined.
- Olive mill waste water (OMW): It is wastewater constituted by vegetation water and process water.

Some water is needed to be added to the paste in order to improve phase separation. Nevertheless, the presence of this water has a negative influence on the oil extraction performance. The optimal relation paste/water varies from 1:0.6 to 1:1.3. Two types of liquids are obtained from the centrifugal decanter, a greenly liquid formed by oil and some water and another brown liquid constituted by the watery phase and some oil. The greenly liquid goes to a vertical centrifuge where water is added for oil cleaning (remove its water content). More wastewater is generated at this stage.

Although this oil has a better quality than the oil obtained using the press system, the 3-phase system is expensive and consumes more energy and water. The volume of wastewater is therefore higher. The wastewater is also highly polluted, which makes its treatment by conventional methods very difficult to achieve.

2-phase system.

This process uses new models of horizontal centrifuges which are capable of separating the oily phase from olive paste without any addition of water. There is not waste liquid phase, but two phase olive mill (TPOW) has a higher percentage of humidity. This humidity comes from the vegetation water. There is also a vibratory sieve installed at the outlet of the centrifuge to separate any bone or impurity which could be mixed with the oil *Figure 6*.

The process steps of both 3-phase and 2-phase systems are similar at each early step of the process, that is, the initial washing up of fresh olives and the gridding of the olive using horizontal semicylindrical mixer. Then, the centrifugation of the olive paste in the 2-phase system is different from the centrifugation carries out in the 3-phase system since there is not generation of OMW as a waste. From the mechanical point of view, the 2-phase horizontal centrifugal decanter varies from the 3-phase one because of its rotating capacity. The value of G developed by the 2-phase centrifuge is 3,000 – 3,600 rpm, while the 3-phase centrifuge is lower (2,000-2,600 rpm).

The oily phase obtained in the horizontal centrifuge goes to a vertical centrifuge. In this step of the process, it is needed to add certain quantity of water to oil in order to wash it and remove any trace of humidity. Wastewater is generated in this step. The quantity of this wastewater is low as compared with OMWW generated at 3-phase system, and it is normally mixed with the TPOW.

***Figure 7**: Casa Pareja Olive Oil Mill, Region of Murcia, Spain.*

In Figure 8 the 3 and 2-phase olive oil extraction processes is schematically shown. Table 6 shows a comparison of characteristics of wastes produced from different extraction systems

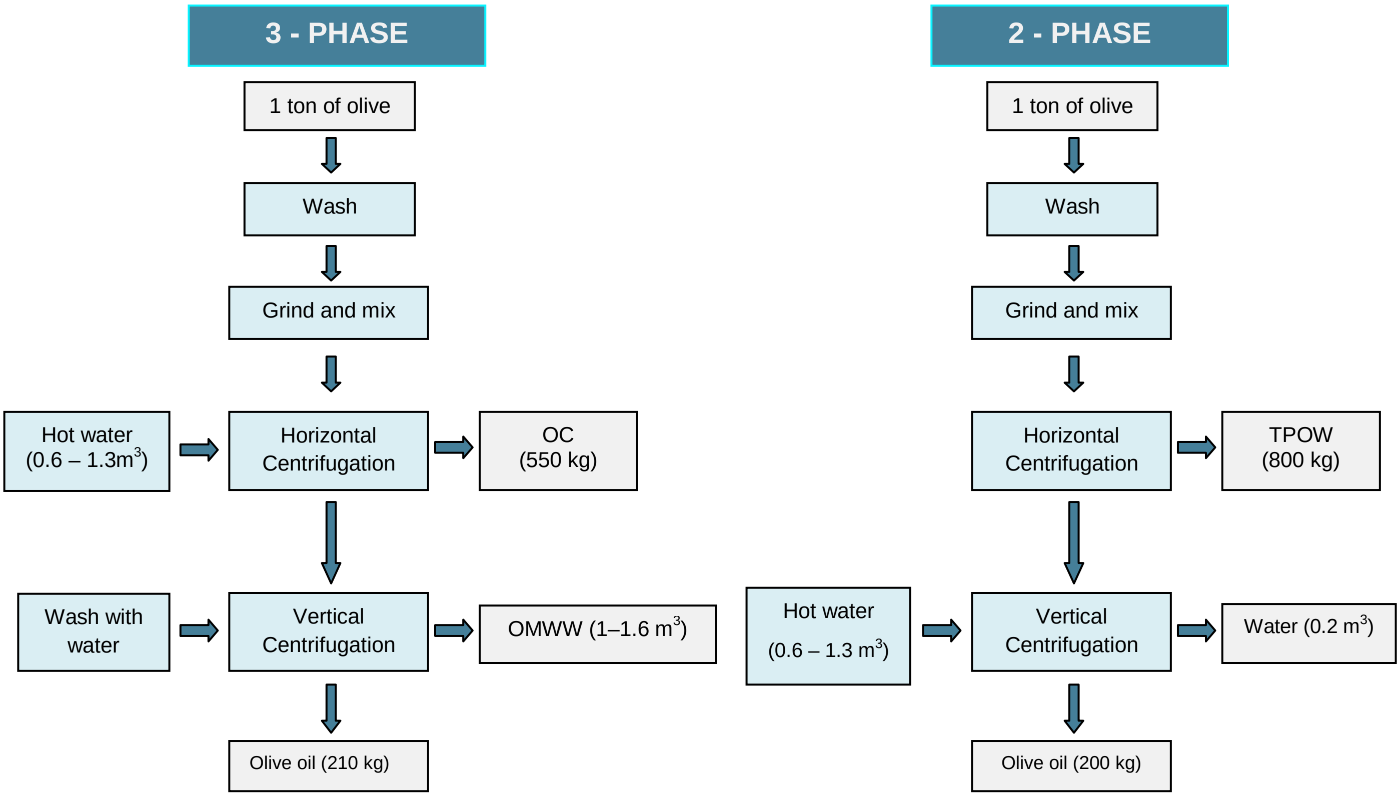

***Figure 8:** Steps of the oil extraction process depending on the type of extraction system.*

The virgin oil, proceeding from the centrifugal vertical machines, is clarified in warehouses by conical bottom, in which it remains approximately one day, to be afterwards separated by decantation. The new obtained oil is the final product that happens to be stored in warehouses where it continues the stabilization and waits to its exit of factory, bulk good or to packaging. *Table 5* shows a comparison of characteristics of wastes produced from different extraction systems.

***Table 5**: Comparison of characteristics of wastes produced from different extraction systems.*

Characteristics	3-phase extraction system	2-phase extraction system
Solid wastes (kg/fruit tone)	500	800
Wastewaters (l/fruit tone)	1 200	250
Humidity (%)	90	99
BOD_5 of wastewaters (g/ l)	80	10
Polyphenols in wastewater (mg/l)	164	200
Acridity indicator	0.5	-

The sum up, the 2-phase system has a higher environmental performance compared to the 3-phase system due to the fact that water is not added to the paste, which avoids the formation of emulsions oil / water and the generation of OMW.

ISRAEL – GALILEE.

In Israel most olive mills are located in the Arab villages and most of them are using advanced technologies, but the mills are located near the houses and in most cases in the middle of the village. Some old olive mills still exist using the traditional press process (Fig. 9): olive press grinded by stones that work by applying pressure to olive paste to separate the liquid oil and vegetation water from the solid material. The oil and vegetation water are then separated by standard decantation. This basic method is still used today, and it is still a valid way of producing high quality olive oil if adequate precautions are taken.

Most Olive Oil Mills in Israel are based on the 3-phase system. Their method of olive oil extraction uses an industrial decanter to separate all the phases by centrifugation. In this method the olives are crushed to a fine paste. This can be done by a hammer crusher, disc crusher, depitting machine or knife crusher. Afterwards the paste is pumped in to an industrial decanter where the phases will be separated. Water is added to facilitate the extraction process with the paste.

Figure 9: *An old mill in the village Magar, Galilee.*

The decanter is a large capacity horizontal centrifuge rotating approximately 3,000 rpm. The high centrifugal force created allows the phases to be readily separated according to their different densities (solids > vegetation water > oil). Separated oil and vegetation water are then rerun through a vertical centrifuge, working around 6,000 rpm that will separate the small quantity of vegetation water still contained in oil and vice versa.

GREECE - PATRAS

In Greece, there are about 3,000 olive mills in operation that are dispersed all over the country. They are mainly small-size, but also medium-size, industries that have family character. The installed capacity is 130 HP for most of them. 70% of these olive mills are classical type hydraulic presses. In Greece, there are barely any centrifugal type olive mills that use the two-phase extraction process, because of the management of 'pulpa' (olive paste), which is the final waste, which is not familiar to olive oil producers and the cost of installation of treatment plants for this type of waste is too high. The annual operation period for olive mills is from November to March.

In Western Greece Region, there are 291 olive mills that are of centrifugal type using the three-phase extraction process and it is believed that they overdraw the production needs of the area. More specifically, in Patras area there are 93 olive mills that are shown in the annexes.

SPAIN - MURCIA

In the Region of Murcia, the sector of the olive oil has suffered important changes in the last years. A few years ago it was a local sector which used traditional oil extraction techniques. Nowadays, it has turned to be intensive agriculture exploitation with drip irrigation and modern industrial facilities (oil-mills), where a great quality virgin-oil is obtained, capable of competing, on national and international level.

There are approximately 45 olive-mills placed at the Region of Murcia. Together with the long-established olive mills distributed along the territory, especially at the interior area of the Region, there have recently been added new production plants created by cooperative entities. These cooperatives have adapted facilities from other sectors, such as the canned food industry, to produce olive oil.

The traditional press system is obsolete and it has almost become a manufacturing relic in the Region of Murcia. In fact, only some family owned olive mill facilities remain in this region. Another non-extended oil extraction system is the 3-phase system. Due to the high volume of wastewater generated during the 3-phase process and the associated environmental problems, the majority of the oil mills in the Region of Murcia use the 2-phase extraction system, which produces TPOW as a waste and olive oil as a valuable product.

The olive oil extraction process starts with the reception of the olive at the olive mill facility. The olive is harvested carefully and in most of the cases, it comes with its leaf and the stem. Once separated, these by-products are excellent for animal food, especially goats, so they are sold to farmers at low price. The olives are then washed up in a rotating drum to remove dirt, stones, insects, etc. It has been found that the 40 % of the oil mills of the Region of Murcia do not clean the olives. Finally, the olives are weighed to know the quantity of clean olives which will be an important data to calculate the mass balance.

After washing, the olives are gridding using horizontal mixers. Then, the olive paste is centrifuged in horizontal decanters, separating the oily phase from the paste, and so generating the semi-solid waste called TPOW. This separation step does not need any water addition. There is not waste liquid phase, but the waste solid paste TPOW has a higher percentage of humidity. This humidity comes from the vegetation water. There is also a vibratory sieve installed at the outlet of the centrifuge to separate any bone or impurity which could be mixed with the oil. The oily phase goes then to a vertical centrifuge where some water is added to wash the olive oil and remove any trace of humidity, so wastewater is generated at this step of the process. This wastewater is usually mixed with the TPOW.

The oil is stored in tanks made of impermeable materials which avoid contamination and oxidation. In addition, oil is kept at constant temperature (15-20ºC). Low temperatures could freeze the oil and therefore contributes to its oxidation. The storing phase will also help to lose part of the bitter aroma of the oil.

The TPOW is disposed in evaporation rafts, or managed by companies called "orujeras", which are placed in the neighbouring provinces of Castilla La Mancha or Andalucia. Extracted oil quantity with the 2-phase system is approximately 15-21% (w/w) of the total of fresh olive.

Most of the olive mills in the Region of Murcia have a diesel boiler to heat the water used during the process and for heating the offices and keep the vault temperature at optimal range. Biomass boilers, particularly the boilers fed by olive bones are very popular nowadays due to the low prize of the bones compared to diesel fuel. Olive mills using biomass boilers do not need extra energy during the production months.

Figure 3: *Oil olive extraction. Aguirre Olive Oil Mill, Region of Murcia, Spain*

5.2. Wine

In general terms, the phases to produce wine and the wastes generated at them are the following (see also *Figure 4)*:

- Grapes reception and selection. Grapes are produced leaving those in poor conditions, green or overripe, leaf litter and other parts of grapes. The destination of these wastes is the distillation composting or a distillery for the alcohol extraction.
- Pitting: a solid waste called stalk is produced. It is used as a source of organic matter in agriculture.
- Alcohol fermentation: robust wine and SO_2 is generated.
- Pressing: It is generated a pomace that is transported to distillery. The seeds are used as animal foods. The grape skin is used for dye industries.
- Malolactic fermentation: SO_2 is generated
- Addition of clarifiers.
- Filtration.
- Cold stabilization: potassium bitartrate is generated. It is used in food, chemical and pharmaceutical industry.

Figure 5: *Casa La Ermita winery, Region of Murcia, Spain*

In Figure *15* the wine production process is schematically shown.

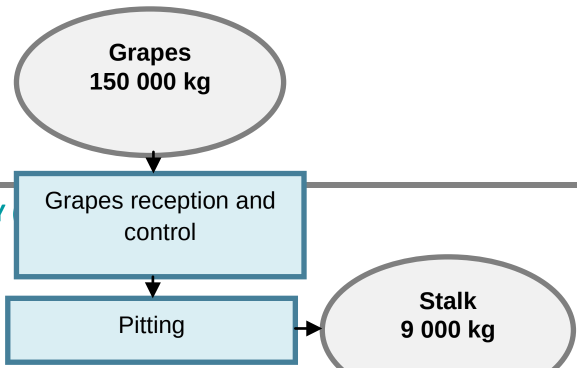

Figure 6: *Red wine process (Rodríguez Luego 2002)*

6. ENVIRONMENTAL IMPACTS AND TREATMENT TECHNOLOGIES

The industrial activity of wine and olive oil sectors generates several environmental issues, mainly due to the wastewater generation. Both olive mill and winery wastewater constitute a serious pollution problem because of the recalcitrant character of the high organic content wastewaters. The current available treatments are economically unsatisfactory, since the majority of olive mills and wineries are mostly family owned, so a complete wastewater treatment facility operation cannot be afforded.

6.1. Olive oil

The olive oil sector has undergone important changes in equipments used for the olive treatment during the last 10 years. Most of the world's oil is made with centrifugal decanters instead of the traditional hammer crushers, disc crushers or the press system. The current trend is toward the 2-phase systems.

Table 7 shows average volumes of wastewater generated in different steps of the 3- and 2-phase processes.

***Table 6**: Average volumes of the wastewater generated in different steps of the three- and two-phase olive oil extraction processes (Borja, Raposo et al. 2006)*

Effluent (l/kg olives processed)	3-phase process	2-phase process
Washing of olives	0.09	0.05
Horizontal centrifuge	0.90	0.00
Washing of olive oil (vertical centrifuge)	0.20	0.15
General cleaning	0.05	0.05
Total effluents	1.24	0.25

The oil extraction process produces different types of waste streams, according to the oil extraction technology used as oil extraction process. The traditional press-system generates dry pomace and vegetable wastewater, called oil mill wastewater (OMW). There is no addition of water, but the oil is in direct contact with oxygen. The 3-phase system produces relatively dry pomace, but a huge amount of OMW, whereas the 2-phase system produces aqueous solid residues from the primary centrifugation and wastewater from the final oil wash, which reduces considerably the water consumption of the olive mill as compared with 3-phase system.

Although OMW has been produced since ancient times, during the last four decades its disposal has led to pollution and environmental degradation, in whole Mediterranean region. The main reasons for this degradation are: (a) the industrialization of agriculture, which has resulted in an increase in olive oil production, (b) the conversion of traditional (pressure-type) OM (which produce 3.25 m^3 OMW per ton of olive oil produced) into 3-phase OM, (which produce 5 m^3 OMW per ton of olive oil produced), (c) the dispersed location of a large number of small-sized OM, which has resulted in the expansion of pollution sources, and d) the exclusion of OM personnel from the decision-making processes.

From the environmental point of view, the 3-phase system has the worst performance, as more water is added, so the volume of generated wastewater is therefore higher than the other processes. This OMW is also highly polluted, which makes its treatment by conventional methods very difficult to achieve. The negative effects of its disposal to the environment could be disastrous in rivers, beaches, coasts, lands and also in the municipal sewage system. Then, wastewater is not discharged, but accumulated in evaporation rafts, generating these way health problems and visual and environmental impacts. The use of these rafts is the most important environmental problem of this industry, due the risk of spills and soil contamination.

Due to the high volume of wastewater generated during the 3-phase process and the associated environmental problems, the modern 2-phase system is normally used in Spain, and similarly in the Region of Murcia. The rest of the Mediterranean countries (as Greece or Israel) use mainly the 3-phase system, except In Italy, where both systems are used.

In Greece, exists barriers inhibiting any real progress in solving the environmental problem caused by OM. Environmental laws and regulations do exist but they are not enforced because of the high cost of any method proposed up to date for solving the OMW problem. Therefore there is no incentive for OM owners or necessity to implement any proposed technology and spent money on environmental issues. This is due fines are very cheap, rarely imposed and all OM operate each year with a temporary permit just for 3-4 months, as long as is their annual operating period lasts. The existing case as instructed by public authorities providing the temporal environmental permits is that OM construct a tank where

OMW is collected and calcium hydroxide is to be added in order to achieve flocculation and sedimentation of some part of the organic solids contained in OMW. Then the supernatant is free to be disposed in adjacent rivers or even to dry streams. However not even the proposed methodology is followed by OM owners since a) it does not really contribute to solving the environmental problem b) large amounts of calcium hydroxide are required and also c) chemical sludge is produced that is also a similar problem to handle. Therefore, the only existing solution is to dispose OMW directly and without any prior treatment to rivers or water or dry streams causing tremendous environmental and aesthetical problem wherever an OM is installed.

Solutions of constructing central systems for the treatment of OMW have not either succeeded since their cost is even higher than individual systems. On the other hand it is difficult for small family-type OMs to reach a common understanding of the problem and its solution and therefore agree to collaborate towards a common solution for their problem.

More problems do really exist:

- OM owners have serious difficulties to operate a system during the whole the year, since olive oil production is a seasonal activity (from mid October to mid of February).
- Family-owned OMs are quite small SMEs which are very hesitating in introducing new (and moreover costly) technologies into their business.
- Even if a new technology is introduced, there will be urgent training needs for the use of the proposed system by the OM owner and operator.

In Israel, OMW generated in olive mills is flushed into a pit. In most cases under the mills are at the nearby yard, and has a capacity of up to 100 cubic meters or more. In addition, at the end of the process, the "solid fraction" accumulates outside the mill, and in most cases is used as animal feed. When it is mixed with the leaves that were blown at the initial cleaning stage, it has even a big demand by farmers. In some other parts of Israel, mainly at the big towns and central Industrial Technological Park there are modern and more sophisticated olive oil mills, but still working with the 3-phase technology and producing a high percentage of wastewater, which are affecting frequently the Sewage works nearby.

Figure 7: *The residue after the extraction process at the backyard of the mills (the mills are located under the house shown)*

In Spain, the small amount of wastewater generated in second centrifugation step is normally mixed with the two-phase olive pomace (TPOP), which is a semi-solid waste with water content above 56% (w/w). This waste is managed by companies called “orujeras” or kept inside evaporation rafts at the olive mill facility. These rafts are formed by a thick layer of isolating material and have to be legally authorized in the Region of Murcia by the "Confederación Hidrografica del Segura", which is the public regional entity responsible for the polluted liquid spillages to land and rivers.

Today in Spain, the environmental problems associated with TPOP are similar to those existed with OMW before the 90’s. The evaporation rafts, which were previously occupied by the OMW, are today by TPOP, but the environmental risk is the same: the leaching of water by lack waterproofing and spills in hard rain events.

The efforts to find a solution to the OM wastes are more than 50 years old, but today yet there is not any really efficient alternative of treatment, not so much by technical issues but socio-economic. Industry has not adopted any specific technology, especially in OMW case, due the high investments costs associated with the proposed technologies, the short period in which wastes are produced (3-5 months), and the small size of OMs. In addition, administrative and legal pressure is not too demanding, so companies don’t treat this wastes effectively, which are actually very dangerous because of its high organic matter content.

OMW Treatment Technologies. In recent years, various strategies have been proposed for treatment and revalorization of OMW. Many processes have been focused on reducing the phytotoxicity of the effluent, in order it re - used in agriculture.

- **Evaporation**. The storage of OMW in evaporation ponds is the treatment system of OMW most widely used, because it requires low investment and favorable climate and the Mediterranean countries fulfill this question. Nevertheless, this method requires large areas and it produces problems; for example: such as odors, insect infestation or risks of leaks or spills.

  Evaporation takes place mainly in the summer months, being produced a concentrate which must be managed in order to have the rafts ready for the following season. The main way of managing these sludge are the landfill disposal (although laws are increasingly limiting it), and the use in agriculture. Most studies on the recovery of this waste are based on composting.

  Besides natural evaporation, forced evaporation processes for the treatment of the OMW have also been evaluated. The process consists of applying thermal energy to concentrate the OMW by means of water evaporation. Several problems such as high energy consumption, management problems with the produced concentrate and the fact that the distillate cannot be directly disposed or used for irrigation without additional stages of treatment, makes forced evaporation a low efficient system.

- **Direct application to soil**. Experiences have demonstrated both positive and negative effects in the direct application to the soil of OMW as fertilizer. The positive effects are related to the high concentration of nutrients, specially potassium, and its potential to mobilize ions of the soil. The negative effects are associated with the high content of mineral salts, low pH and the presence of phytotoxics, especially polyphenolic compounds (Paredes, Cegarra et al. 1999).
- **Physic-chemical treatments**. It consists to addition of chemicals to produce coagulation, precipitation or degradation of organic compounds in order to reduce COD and toxicity.

  - **Coagulation-flocculation**. By the addition of coagulants and flocculants, the colloidal and suspended material can be destabilized, favoring the formation of aggregates easy to eliminate by sedimentation or flotation. This system can eliminate suspended matter of OMW, but yield of organic matter removal are only moderate, due most organics are dissolved. Therefore, this system cannot produce effluents which can be spilled or re-used in agriculture. For this reason, this systems need to be combined with other technologies to do possible removal organic dissolved matter, as biological treatments (aerobic or anaerobic) or chemical advanced oxidation processes. This system produces also a residual waste stream containing removed solids that must be managed, for example in composting.

- **Chemical precipitation**. The addition of chemical products, usually $Ca(OH)_2$, may do possible the precipitation of dissolved organic matter, transforming soluble into insoluble forms. Additionally, wastewater is washed down by the formed precipitate, removing suspended matter. This process has high performance to eliminate suspended matter but a medium performance to eliminate organic dissolved matter and so it would obtained an effluent which cannot be reused in agriculture or spilled due its high organic content. As in the case of coagulation-flocculation, there is a need to manage the formed sludge.
- **Advanced Oxidation Processes**. Oxidation processes that involve generation of hydroxyl radicals, which can interact to organic and inorganic products. This is a family of methods based on the high oxidizing ability of the radicals HO• and it are different process depending how these radicals are generated. For example: combinations with ozone, ultraviolet radiation, Fenton reagent, hydrogen peroxide or electricity. These processes can be applied to degradation of dissolved organic matter, but they are more expensive that traditional biological methods. Other advantage is the degradation of toxic substances or not biodegradable, like phenolic compounds in present OMW.

- **Biological treatments.** Family of treatment processes which use micro-organisms, mainly bacteria, to carry out the removal of certain compounds in water, taking advantage of its metabolic activity over these components. This way, biodegradable organic compounds, either soluble or colloidal, as well as nutrients (N and P) are removed. Biological treatments are mainly divided into aerobic and anaerobic treatments.
  - **Composting:** One of the main technologies for OMW treatment and its subsequent use as fertilizer (Roig, Cayuela et al. 2006). By composting, problems related with direct application of OMW can be solved, especially the associated with phytotoxicity (Tomati, Galli et al. 1995). In order to produce an

effective composting, a suitable texture for the product is needed. Accordingly, OMW must be mixed with solid substrates such as straw or agricultural residues (Paredes, Bernal et al. 2002).

- o **Aerobic treatment**: These systems are divided into activated sludge systems and trickling-bed systems. For OMW treatment, aerobic systems can be expensive, due basically to: (1) High concentration of organic matter leading to the need of system with long retention times and high aeration costs; and (2) presence of toxic compounds hardly biodegradable, such as phenolic compounds, with a huge negative effect over the treatment process. Moreover, disposal of generated sludge is needed.
- o **Anaerobic treatment**. Cost-effectiveness of anaerobic processes increase with the organic matter concentration of the wastewater. Therefore, anaerobic treatment for OMW is one of the more interesting options. Furthermore, sludge production is much lower than in aerobic treatment. The main drawback is the inhibitor effect of phenolic compounds and volatile organic acids presents in OMW. The most important advantage is that biogas is obtained as by-product, which can be used in boilers to obtain heat with which to warm the reactor (the anaerobic process is highly dependent on the temperature). Yields of organic matter removal are not as high as the obtained in aerobic treatment. Therefore, a subsequent treatment step could be needed in order to achieve legal regulation for treated water disposal or reuse in irrigation. It is important having in mind that pretreatments are necessary to remove suspended matter. Otherwise, retention time should increase, enhancing reactor sizes and consequently investment outlay.

- **Extraction of valuable compounds:** some species present in OMW may be interesting for cosmetic and pharmaceutical industries. These compounds include polyphenols such as hydroxytyrosol and oleuropein. Several systems for the extraction of these compounds have been proposed, such as using hyperthermophilic enzymes (Briante, Patumi et al. 2004) or centrifugation-ultrafiltration processes (Turano, Curcio et al. 2002), which allow the extraction from OMW of compounds like sugar or poliphenols, thereby reducing their pollutant charge.

TPOP treatment tecnologies. Due its high water content, the TPOP brings several problems to the OMs, since specific machinery is needed for its transport, storage, etc.

In the 2-phase olive mills of Spain, TPOP and wash water are usually mixed and stored in evaporation ponds. This waste, which has no less than a 65% of water, is picked up by the olive-pomace companies to extract the 3% of residual oil contained. This oil is called pomace oil and is obtained by physical (centrifugation) and chemical methods (organic solvent extraction). Olive-pomace companies generate 2 products from TPOP: olive pomace oil and dry olive cake called “orujillo” which is a solid waste with 10 to 12% of moisture that is obtained drying TPOP in horizontal dryers using hot gases to 500 °C. These gases are generated in boilers which use dry olive cake as fuel. Nowadays, the olive pomace companies are adapting to technological advances installing cogeneration systems in order to produce electricity and drying the orujillo with residual heat.

The dry olive cake has appropriate characteristics that allow its use as fuel: granular shape, 12 % moisture, LCV of 2,700 kcal/kg, lack of sulphur and other components. Therefore, it can be used not only as fuel in the olive-pomace facilities, but in co-generation plants in order to produce heat and electricity. In recent years, government of Spain has promoted the construction of co-generation facilities located in OMs concentration areas. These facilities are using dry olive cake as fuel to generate steam, whose is used to feed steam turbines for electricity generation. Anyway, electricity generation by using dry olive cake as fuel is nowadays not economically profitable without Government financial aids.

The small benefit of the TPOP residual oil extraction process as compared with three-phase system has led to investigate other ways of valorization for this waste.

- **Direct application to soil**. TPOP may also be used as a fertilizer, alone or mixed with olive vegetable wastes (leaves or tree trimmings). The direct application of fresh TPOP may lead to a poor distribution in the soil due its high humidity. Therefore, there is a need for specific application machinery. The possible benefits of direct use as fertilizer are related with its high potassium content, low economic value, and that it’s produced near agricultural areas, thus reducing transport needs. Although less phytotoxic than OMW, several studies has shown that direct application causes an increase in C/N ratio, so it must be combined with a source of N, like manure.
- **Composting.** In general, TPOP direct application to the soil can significantly affects its structural integrity. Therefore it is suitable to submit it previously to a stabilization process such a composting. By means of specific microorganisms, may be produced a non toxic and cheap compost with good humidity and nutrient source. Unlike other

wastes, the TPOP compost does not contain heavy or pathogens. Nevertheless, when used, it very important to consider parameters such as salinity of the soil (specially potassium), decrease of pH, or concentration of polyphenols.

The TPOP composting process has three phases:

1) TPOP is mixed with olive leaves and is carried to evaporation rafts. It is 4:1 mix of TPOP / leaves (w/w), or 50% in volume ratio.

2) Formation of aerobic fermentation piles, where its organic material is oxidized and lignocellulosic and lignoprotein compounds, nutrients (N,P,K) and C/N ratio and are fixed.

3) Continuous oxygenation and thermoevaporation of TPOP. In this phase, occurs thermogenesis that it is made by determinate fungi and bacteria, which use cellulose as a substrate with certain condition of temperature, humidity and oxygen.

The composting process of the TPOP presents several problems that must be considered, especially due to its high water content, which makes it difficult to transport and handle. Its characteristic structure provides poor aeration, so that must be mixed with substrates such as straw or crop residues, to give an adequate texture. To carry out properly the composting process must be controlled moisture, nutrient balance and specially the air distribution.

In recent years, a variety of composting, called vermicomposting, is being studied, because its low cost. It is based on the ability of some worms (like the *Eisenia Andrei*) for transforming organic waste into stabilized, high quality and humidified fertilizer. This way the production of compost from TPOP alone or mixed with manure or WWP sludge has been studied

- **Anaerobic digestion**. Anaerobic digestion of organic wastes allows the production of biogas (CH_4 + CO_2) as an energy source to produce heat or electricity and organic matter partially stabilized which can be used in agriculture. The main drawback of this way of valorization is the presence of inhibitory compounds, such polyphenols.

- **Extraction of valuable compounds**. TPOP can be used as low cost substrate for producing several added-value organic compounds. These include phenolic compounds or pectins.

6.2. Wine

Wine production has been traditionally seen as an environmentally friendly process. However, it requires a considerable amount of resources such as water, fertilizers and organic amendments, and on the other hand produces a large amount of wastewater and organic wastes. Most of wastewater generated comes from the cleaning of machinery.

Environmental analysis of the wine industry shows that the main effluents of the sector are wastewater and organic solid wastes. To achieve the increasing legislation requirements, wastewater problems have been solved by the construction of wastewater treatment plants for one single industry or a group of cellars in developed countries. These facilities had a positive effect on minimizing the environmental impact on the aquatic ecosystems. However, the production of sludge from these treatment plants has been increasing over the last years.

In recent years, wine industry has invested not only in wastewater treatment but also in water saving and wine by-products and sludge valorization. Problems associated with waste generation in the wine industry are of special relevance during the grape harvest, a very short period of time between September and October in the Mediterranean area.

It has been estimated that, for example, the Spanish wine industry generates between 2 and 3 million tons per year of wastes or by-products, mainly produced during the vintage period (FEV 2003; MAAM 2004). Most of the wastes generated in a cellar (80–85%) are organic wastes. In Figure 17, an approximate distribution of the wastes generated in the wine industry is presented (Ruggieri, Cadena et al. 2009). Grape pomace (or OC) is produced during grape press and is constituted by peels and seeds. The rest of wastes are lees, which are generated in the clarification of wine fermentation process; stalk, constituted by branches and leaves of the grapevine, and wastewater sludge from wastewater treatment.

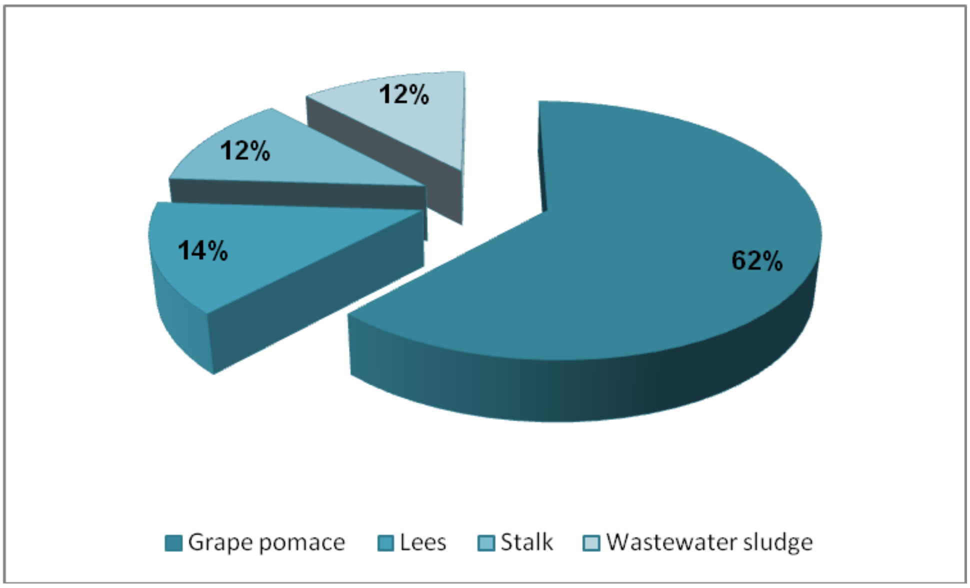

***Figure 8**: Approximate distribution of the organic wastes produced in the wine industry*

Some of these wastes have been traditionally recovered by using them as raw materials in other industrial sectors or directly for animal feed (Kammerer, Kljusuric et al. 2005; Arvanitoyannis, Ladas et al. 2006). Other materials, however, are not valorized due to their low economical value, such as stalk and wastewater sludge. The current management of these wastes is carried out via external companies.

Nevertheless, this is an expensive and difficult alternative for the wine industry, with high transport costs (low bulk density of stalk, transport required in short time, etc.), high disposal costs (incineration, landfill) and high environmental and social impacts.

Additionally, international legislation on sludge application to soil is becoming more exigent and the direct application will be prohibited in the next future (2008/98/EC 2008).

Like everyone in industry nowadays, there is an onus to find a sustainable solution in all activities undertaken.

There are broad opportunities to achieve a largely sustainable operation at wineries through:

- Treatment of wastewater to produce an effluent quality for irrigation (making use of the used water, and regarding it as a resource rather than a waste product);

- Application of residuals byproduct use for compost production to provide a rich nonputrescible organic resource which may be used to improve soil qualities / general beneficial application.

Achievement of a sustainable operation may be further enhanced through application of anaerobic digestion (for wastewater residuals and pomace / lees) for generation of biogas, which would be used for energy production / use at the winery and wastewater treatment plant. Figure 18 shows a diagram of a typical complete treatment for wineries effluents and residues.

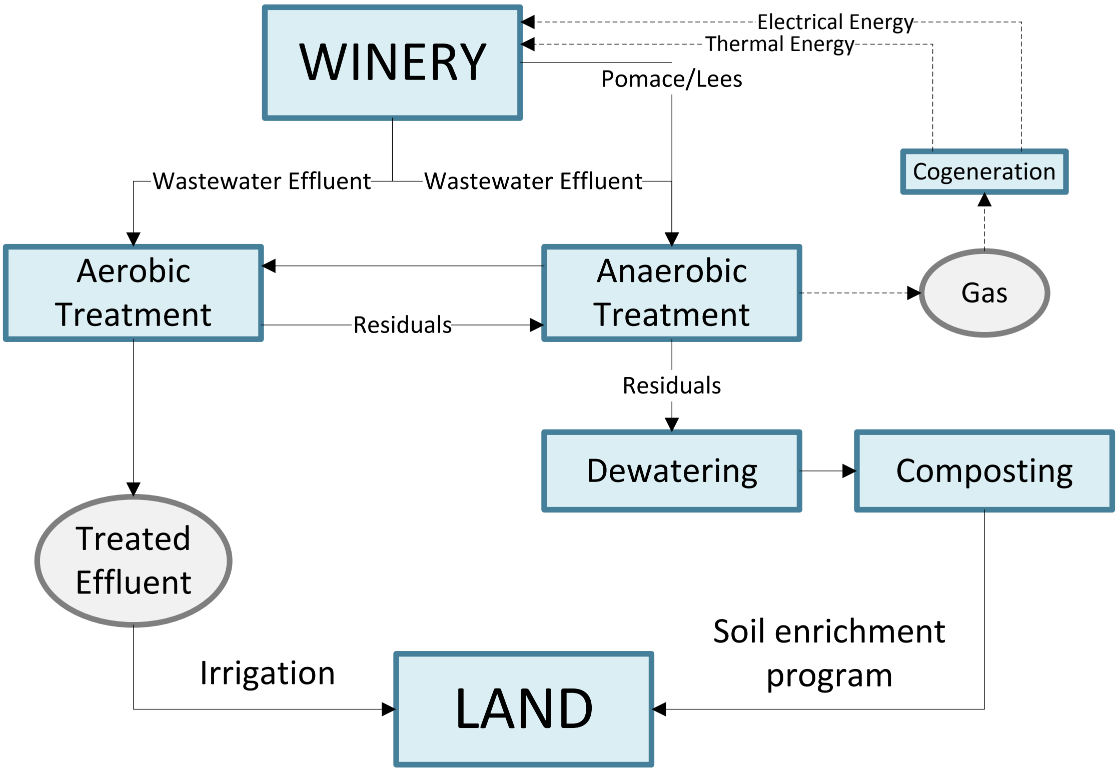

Figure 9: *Treatment of effluents and residues of wine production*

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8. ANNEXES

8.1. Questionnaire

OLIVE MILL SURVEY- REGION OF MURCIA

OLIVE MILLS' STATE-OF-THE ART SURVEY

ORGANIZATION

Survey date:			
Brands:			
Products:			
Register address:			
Production site address:			
Telephone:		Web:	
VAT:		Activity codes:	

Contact 1		Contact 2
Name:		Name:
Work position:		Work position:
Mobile:		Mobile:
E-mail:		E-mail:

ORGANIZATION DATA

Campaign 2010		Campaign 2009
Milled olive (Tn Olive):		Milled olive:
Olive oil production (Tn/year):		Olive oil production:
Energy sources:		Energy sources:
Energy consumption:		Energy consumption:
Regular staff:		Regular staff:
Fixed-term staff:		Fixed-term staff:
Seasonal staff:		Seasonal staff:

PRODUCTION AND MANAGEMENT OF WASTE

Exercise 2010		Exercise 2009
Extraction process (2P/3P/Mix):		Extraction process (2P/3P/Mix):
TPOW (kg/kg olive; Ton/year):		TPOW:
TPOW selling (€/(Ton):		TPOW selling:
Alpechín (kg/kg olives; Ton/año):		OMWW:
Added water:		Added water:
Storage/management TPOW/OMWW:		
Storage/management wastewater:		
Production months:		

TREATMENT OF WASTE STREAMS

Own treatment plant (YES/NO):	
Wastewater treatment units:	
Wastewater treatment system efficiency:	
Treated wastewater stream to sewage (m^3):	
Wastewater treatment cost (WWTP, municipal taxes etc):	
OMWW/TPOW management cost:	
Wastewater management cost:	
Interested on test Pilot plant? (YES/NO):	

Current/possible treated water use:

- ☐ Irrigation
- ☐ Discharge on the land/river/sea
- ☐ Discharge on sewage system

WASTE STREAM CHARACTERIZATION

COD (mg/l)	Phenols (mg/l)
$COD_{disuelta}$ (mg/l)	TKN (mg/l)
TSS (mg/l)	OP (orthophosphates) (mg/l)
VSS(mg/l)	DO (disolved oxygen) (mg/l)
pH	

BOD (mg/l)
Conductivity (mS/cm)

NOTES

Terms definitions:

OMWW: wastewater from the 3-phase olive oil extraction process.

(OC): wet solid from the 3-phase olive oil extraction process.

TPOW: Wet paste from the 2-phase centrifugation method for olive oil extraction.

8.2. Olive mills

GALILEE - ISRAEL

Production financial statue in ISRAEL								
Tons Olive	Tons Olive/2000	Tons Oil	Tons Oil/2000	daily operation (h) rate/24 hours	Season Duration /days	Pressing Charge US$/kg	Land Area (m^2)	Bldg Area (m^2)
0	5040	0	1510	24	0	48	800	800
240	1215	74	376	18	20	5	1,000	400
1,440	4320	430	1290	24	15	48	2,000	600
600	3000	0	0	20	10	42	1,000	800
336	1680	100	500	24	10	5	1,200	700
360	1080	112	360	24	15	4.8	500	500
0	3600	0	1116	24	0	48	3,000	1,000
500	1200	150	360	24	20	5	1,000	600
240	720	74	223	24	20	47	1,000	1,000
1,800	7200	558	2232	15	15	46	2,000	1,000
3,600	7200	1116	2232	24	30	41	2,000	1,000
0	2700	0	800	24	0	4	700	700
0	4800	0	1440	16	0	45	1,200	1,000
0	2160	0	670	24	0	4	1,100	700
0	1500	0	465	24	0	48	120	120
108	216	32	65	24	15	48	400	400
90	240	30	80	12	15	46	300	300
900	2700	300	900	24	15	49	3,000	1,000
1,260	2520	378	756	14	30	46	1,150	270
1,440	4320	432	1296	24	20	48	2,000	1,000
720	2160	216	667	24	15	5	600	400
0	2025	0	628	18	0	48	2,000	1,000
720	2160	216	648	18	20	44	1,200	1,000
0	1440	0	447	24	0	56	2,000	600
3,780	7560	1170	2340	24	45	54	4,000	1,000
0	1215	0	365	18	0	47	1,000	250
360	1620	108	486	24	10	45	3,000	1,000
420	900	120	270	12	14	46	1,200	1,000
360	2160	108	648	24	10	47	1,000	500
0	2160	0	65	18	40	45	1,600	600

0	1080	0	324	18	0	38	2,000	800
1,100	2362	342	700	15	20	4	600	300
270	1080	80	320	12	15	4	3,000	300
0	720	0	220	8	0	6	400	400
252	1020	78	300	24	7	5	1,400	600
0	1050	0	315	14	0	42	600	600
0	720	0	218	16	0	46	1,000	600
216	648	67	200	12	15	48	3,000	350
216	864	65	268	24	15	48	1,100	1 000
105	450	32	139	10	7	46	0	0
0	576	0	180	12	0	46	800	800
0	1620	0	500	18	0	5	0	0
0	1200	0	372	16	0	2. 1	0	0
480	2161	150	670	24	10	45	1,000	800
21,913	**Total**							

PATRAS (PELOPONNESE) – GREECE (Period 2009-2010)

Olive mill code	Location	Olives (Tons)	Extra virgin olive oil	Virgin olive oil **(**Tons)	Lampante olive oil **(**Tons)	Total olive oil quantity **(**Tons)	Pomace **(**Tons)
1 1313100	Kerineia	94,892	24,875			24,875	44,095
2 1312804	Platanos	118,777	25,977			25,977	49,890
3 1313002	Rododafni	188,500		41,506		41,506	75,400
4 1334450	Alsos	357,734	69,591			69,591	143,094
5 1331485	Vraxneika	941,514	134,548			134,548	387,885
6 1311239	Katw Potamia	267,713	65,625			65,625	107,085
7 1331531	Kamares	465,598	5,654	28,265	9,126	93,931	223,230
8 1331540	Lousika	225,7046		286,574		286,574	1,172,465
9 1334700	K. Mazaraki					0	
10 1331558	Mintilogli					0	
11 1312707	Selianitika	166,082	27,236			27,236	66433
12 1330012	Araksos					0	
13 1330047	Iswma Farrai	1,764,742	245,988			245,988	934,190
14 1334990	Glafkos	593,366	83,653			83,653	296,683
15 1310119	Mamousia	258,133		57,057	57,057	57,057	111,463

16	1330250	Saravali	711,457	99,706			99,706	420,490
17	1310127	Rodia	291,026	57,959			57,959	122,230
18	1313360	Koumari Aigiou	114,267	23,433			23,433	35,040
19	1310070	Dafnes	358,438		70,693	70,693	70,693	170,220
20	1330152	Patra	470,754	70,542			70,542	249,470
21	1330160	Xalandritsa	46,575	85,529			85,529	204,860
22	1333960	Elaioxwri					0	
23	1330179	Petroxwri	611,377	81,132			81,132	254,855
24	1330462	Patra	185,485	25,581			25,581	81,780
25	1330020	Mataragka	397,068	69,548			69,548	163,725
26	1330756	Platanovrush	542,687		79,539	79,539	79,539	28,559
27	1331329	Apidewn	1,478,347	190,159			190,159	653,165
28	1330446	Xalandritsa	1,131,988	193,801			193,801	612,600
29	1330187	Petroxwri	906,934	132,715			132,715	645,260
30	1330209	Krinos					0	
31	1310305	Aigio					0	
32	1330764	Mixoi	80,207	116,178			116,178	393,485
33	1330284	Kallithea	1,062,073	162,794			162,794	620,405
34	1334964	Santomeri	319,075		51,865		51,865	135,895
35	1334980	Kallithea	1,264,315	183,309			183,309	697,040
36	1330960	Murtos	1,973,135	270,562			270,562	1,313,615
37	1330390	Peta	1,314,539		130,298		130,298	509,960
38	1331507	Vasiliko	606,386	87,489			87,489	29,6310
39	1334301	Kareika					0	
40	1330349	Anw Axaia	1,734,749	291,510			291,510	891,240
41	1311450	Akrata	99,285	20,977			20,977	39,714
42	1310429	Marmara Aigeira	36,131	80,936	4,328	68	85,332	152,800
43	1310380	Elaiwnas	169,395		34,092	547	34,639	97,425
44	1330403	Xaikali	2,882,770	372,502			372,502	1,563,300
45	1330438	Anw Velitses	81106	114296			114296	405414
46	1330241	Mazaraki	2,059,872		357,471		357,471	1,050,265
47	1339993	Platanovrush	538,408	82,947			82,947	268,925

48 1330489	Elaioxwri					0	
49 1330500	Anw Axaia	1,749,211	232,782			232,782	961,930
50 1331752	Vasiliko	2,451,255	357,738		769	35,8507	1,305,243
51 1330535	Fragka					0	
52 1330543	Petas	702,553		109,259		109,259	295,075
53 1330450	Xalandritsa	149,588	26,341			26,341	69,085
54 1310550	Diakopto	422,213	93,728			93,728	200,680
55 1310992	Katw Mauriki	50,531	9,658			9,658	22,000
56 1330640	Krini	1,612,418	253,701			253,701	884,892
57 1310658	Aigion	230,398	30,100	13,005	3,020	46,125	103,680
58 1330667	Petroxwri	738,521	100,416			100,416	335,585
59 1330670	Petrwto					0	
60 1330713	Kamares Eirineou	705,134	139,791	17,120	371	157,282	345,643
61 1310720	Aigeira	445,245	74,148	80,724		154,872	181,650
62 1330730	Kaminia	600,744	75,137			75,137	235,580
63 1330632	Farrai	1,898,291	270,421	33,386		303,807	1,157,650
64 1334991	Kritharakia	444,584		67,749		67,749	200,062
65 1310763	Aigio	187,367		40,349		40,349	78,694
66 1310798	Kouloura Aigiou					0	
67 1331655	Katw Salmeniko	429,430	79,220			79,220	211,070
68 1310810	Mauriki	385,485			77,017	77,017	50,719
69 1310828	Aigeira	54,542	11,326	71,920	71,920	130,031	257,570
70 1330896	Anw Soudena	2,231,000	268,400			268,400	1,243,020
71 1310917	Elaiwnas	31,682				6,083	15,340
72 1333054	Perivola	726,421	108,450			108,450	370,000
73 1330942	Lousika	366,500				43,197	144,890
74 1310968	Elaiwnas	44,140					
75 1311603	Rodia	197,152	38,534				
76 1311042	Aigio					*0*	
77 1311808	Aigeira	425,652	99,280			99,280	198,600
78 1311085	Aigio	278,789				51,473	75,760

79	1331094	Psathopurgos	739,957	68,647	1,262	1,262	138,557	486,710
80	1311514	Dafnes	186,202	38,276			38,276	96,620
81	1331140	Xalandritsa	520,668	90,825			90,825	328,000
82	1311182	Diakopto	395,427				84,390	170,370
83	1333704	Mataragka	1,518,436	239,221			239,221	684,291
84	1331620	Drepano					0	
85	1337260	Drepano	886,030				147,805	510,229
86	1311638	Kouloura Aigiou	143,494				29,333	60,270
87	1310844	Dafnes	206,331	41,528			41528	103850
88	1331337	Ziria	119,050	21,277	1968		23245	60000
89	1331361	Kritharakia	833,770		149,535		149535	447250
90	1331396	Iswma	689,502	80,173	1735		81908	365210
91	1312600	Dimitro	648,691	55,111	81,287		136398	259476
92	1331442	Murtos	2,421,200	343,960			343900	1218650
93		Xaikali	2,089,748	260,689		832	261521	1676900
		Total	**6,048,6347**	**7,056,516**	**222,4750**	**164,932**	**9,446,198**	**31,203,098**

MURCIA – SPAIN (Period 2009 – 2010)

AREA	Villages	Names	Phases	Olive (Ton)
VEGA DEL SEGURA	Murcia	Destilerías Bernal		
	Murcia	Eustaquia Pérez (El Pérez)	2	800
	Murcia	Olimendros S. L.		
	Murcia	Productos del Olivar S. L.		
	Molina de Segura	Antonio López Hernández y otro		
	Abarán	San José Artesanos		
	Abarán	Juan Bastida		
	Archena	Alimentos Valle de Ricote		
	Lorquí	Royal Garden Golden		
	Calasparra	Cooperativa Agra		
ALTIPLANO	Abanilla	Antonio Lucas Rubira	2	30
	Abanilla	Cooperativa Olivarera Santa Cruz	2	1,100
	Abanilla	Carlos Almarche Riquelme	2	15
	Abanilla	Francisco Gaspar Ramirez Rubir		
	Abanilla	Juan Navarro Ruiz		
	Jumilla	Almazara Fergua	2	1,000
	Jumilla	B. S. I. Corporación Alimentaria		
	Jumilla	Casa Pareja		
	Jumilla	FEPAMI, S. L.	2	1,000
	Jumilla	Luis Herrera Mora		
	Jumilla	Rosario Carmen Jacobo Martínez		
	Yecla	Almazara de Ortegas		
	Yecla	Cooperativa La Purísima		

	Fortuna	Jose Ramón Gómez		
NOROESTE	Bullas	Frusemur	2	1,800
	Cehegin	Aceites Juan Maravillas		
	Cehegin	Aceites La Marra	2	130
	Cehegin	ACEMUR	2	5,000
	Moratalla	Aceites Comendador		
	Moratalla	Cooperativa Coseche	2	1,000
	Moratalla	Cosecheros de albaricoque		
	Moratalla	Estación Servicio Palmeras		
CAMPO DE CARTAGENA	Fuente Álamo de Murcia	Giménez Casanova	2	1,000
VEGA DEL GUADALENTÍN	Alhama de Murcia	Hacienda San Miguel		
	Alhama de Murcia	Pedro Gómez Balsas	2	5,000
	Alhama de Murcia	Productos Belchi Salas		
	Alhama de Murcia	Pronat	3	1,000
	Totana	Alfonso Benítez Urrea		
	Totana	Coato S. C. L.		
	Lorca	LA PACA	3	1,000
	Lorca	Alcaparras Asensio Sánchez		
	Lorca	Aguirre	2	1,000
	Lorca	Imazara		
	Lorca	Bartolomé Martínez Martínez	3	300
	Lorca	Hermanos Martínez Zapata	3	1,000
	Lorca	Pedro Lasso Gázquez		

	Puerto Lumbreras	Almazara La Estación		
	Puerto Lumbreras	Diego García Fuentes	2	3,000
RÍO DE MULA	Pliego	La Pleguera	2	64
	Pliego	Cooperativa Vega de Pliego	2	1,500

8.3. Wineries

GALILEE – ISRAEL

Israeli wine is produced by hundreds of wineries, ranging in size from small boutique enterprises to large companies producing over ten million bottles per year. Wine has been produced in the Land of Israel since biblical times. In 2009, Israeli wine exports totaled over $22 million.

Today, Israeli winemaking takes place in five vine-growing regions: Galil (Galilee, including the Golan Heights), the region most suited for viticulture due to its high elevation, cool breezes, marked day and night temperature changes and rich, well-drained soils; the Judean Hills, surrounding the city of Jerusalem; Shimshon, located between the Judean Hills and the Coastal Plain; the Negev, a semi-arid desert region, where drip irrigation has made grape growing possible; and the Sharon plain near the Mediterranean coast, surrounding the towns of Zichron Ya'akov and Binyamina, which is the largest grape growing area in Israel. The main wineries are listed below:

Name	Address and telephone
Carmel	P.O.B. 2 Rishon LeZion 75100. Telephone: 97239488851/4
Barkan	Kibbutz Hulda, PU. Box 146, Doar Na Sorek 76842. Telephone: 97289355858
Golan Heights	Box 183, 12900. Katzrin. Telephone: 046968420
Binyamina Wine Cellars	34 Hanassi St., Binyamina Telephone - +972- 4-6388643 Fax - +972-4-6389021
Efrat Winery	1 Steinberg Street-90822 Motza, Phone: +972 2 5346022 Fax: +972 2 5340760
Tishbi Estate	Road 652 Binyamina Tel. 972-4-6380434/5 Fax. 972-4-6380223
Galil Mountain	Kibbutz Yiron M.P. Merom Hagalil 13855 Israel Tel: +972-4-686-8740 Fax: +972-4-686-8506

Recanati	P.O.Box 12050 Industrial zone Emek Hefer Tel: +972-(0)4-6222288, Fax: +972-(0)4-6228828
Dalton Winery	Dalton Industrial Park, Merom Hagalil, 13810 Tel: +972 04 698 7683, Fax: + 972 04 698 7684
Domain Castel	Ramat Raziel, Haute Judee 90974 Tel: +972 2 534 22 49; Fax: +972 2 570 09 95

PATRAS – GREECE

Name	Adress
Achaia Clauss Wine Company	Petroto Patron, Patras, 26500
G. Karelas	Skagiopouliou 41 – 43, Patras, 26222
Union of Agricultural Cooperatives of Patras – Patraiki	38 Anthias Street, Patras, 26332
Parparousis Athanasios	Achilleos 2, Proastio, Patras, 26442
Antonopoulus Vineyards	25 th Martiou St. Beach Patrases Patras, 26500
B. G. Spiliopolus	Akti Dimaion 87, Patras, 26333

MURCIA – SPAIN

Area	Village	Name
VEGA DEL SEGURA	Murcia	I. A. Los Ceperos, S. L.
ALTIPLANO	Jumilla	Casa De La Ermita
	Jumilla	Asensio Carcelen N. C. R.
	Jumilla	Bodega 1890 S. A.
	Jumilla	Bleda S. L.
	Jumilla	Delampa
	Jumilla	Fernández, S. A.

	Jumilla	Huertas, S. A.
	Jumilla	Josefa Gilar Lila
	Jumilla	Juan y Ángel Fernández
	Jumilla	Miguel Guardiola
	Jumilla	Olivares
	Jumilla	Omblancas
	Jumilla	Salzillo, S. L.
	Jumilla	San Isidro B. S. I.
	Jumilla	Silvano García
	Jumilla	Viña Elena, S. L.
	Jumilla	Grandes Vinos S. L.
	Jumilla	Gilar Guardiola
	Jumilla	Luzón, S. L.
	Jumilla	Julia Roch Melgares e Hijos, C. B.
	Jumilla	Pedro Luis Martínez, S. A.
	Jumilla	Agapito Rico, S. L.
	Jumilla	Hijos de Juan Gil, S. L.
	Jumilla	Viña Campañero, S. L.
	Jumilla	Fepami, S. L.
	Yecla	Antonio Candela e Hijos
	Yecla	Castaño, S. L.
	Yecla	Casa de las especies.
	Yecla	Evine, S. R. L.
	Yecla	La Purísima, S. C. L.
NOROESTE	Bullas	A. García Noguerol, S. L.
	Bullas	Balcona, S. L.
	Bullas	Carrascalejo S. L.
	Cehegin	Fernando Carreño Peñalver, S. L.
	Bullas	Madroñal
	Bullas	Agrovinícola Ntra. Sra. Rosario
	Bullas	San Isidro Agrovinícola
	Bullas	Enológico Q y M
	Moratalla	Tercia de Ulea