

# Publishable summary

**Grant Agreement number: 222.400**

**Project acronym: WHETLAC**

**Project title: Transformation of the residual whey permeate from the cheese manufacture: lactic acid production**

**Funding Scheme:**

**Period covered:                    from 1/11/2008                    to 30/04/2011**

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**Project website** ¡Error! Marcador no definido. **address: <http://www.whetlac.cartif.com.es/>**

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<sup>1</sup> Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

## ***Publishable summary***

This section must be of suitable quality to enable direct publication by the Commission and should preferably not exceed four pages.

The publishable summary has to include all the distinct parts described below:

- A summary description of project context and objectives,
- A description of the work performed since the beginning of the project and the main results achieved so far ,
- The expected final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far),
- The address of the project public website, if applicable

In line with this, diagrams or photographs illustrating and promoting the work of the project, as well as relevant contact details or list of partners can be provided without restriction.

**The publishable summary should be updated for each periodic report.**

### **Summary description of project context and objectives.**

The general objective of this project was the development of a new production technology for obtaining lactic acid from deproteinized whey at low cost. This is a new environmental friendly production technology based on green chemistry principles.

The whey is the liquid remaining after the separation of milk fat and casein from whole milk. Approximately 85% of the total milk used for manufacturing cheese is discarded as whey. Most milk plants do not have proper treatment systems for the disposal of whey and the dumping of whey constitutes a significant loss of potential food and energy, as whey retains about 55% of total milk nutrients. Among the most abundant of these nutrients are lactose, soluble proteins, lipids and mineral salts.

The potential market to produce lactic acid at a low cost with higher purity from whey, based on new production technologies will suppose a great increase in the demand and the evolution of new applications.

Project Scientific and Technical Objectives attained.

- Fermentation of whey permeate into lactic acid by means of using immobilized fermentative bacteria in polyvinyl alcohol gel particles.
- Implementation of NIR (Near InfraRed) technology to monitor the pre-treatment and fermentation process, from the raw material (permeate whey) to fermentation stream.
- Supercritical fluids technology application in the purification step:
  - Application of simultaneous extraction and reaction of lactic acid as a novel purification process. Final purity of obtained lactic acid above 90%.
  - Use of heterogeneous catalysis. Conversion attained was complete.

### Main conclusions

Initial project hypothesis has been confirmed from the technical point of view. It has been possible to obtain pure lactic acid by means of the proposed technologies. The final price for lactic acid produced by this way is still 2 times higher when compared with similar marketable products, although of this, this technology could suppose a reliable option for whey processing if compared with other emerging technologies.

### Partners:

- 1. Fundación CARTIF (Spain).
- 2. Porto Conte Ricerche (Italy).
- 3. Natex Prozesstechnologie Gesmbh (Austria).
- 4. Hijos de Salvador Rodriguez S.A. (Spain).
- 5. Fratelli Pinna Industria Casearia S.p.A. (Italy).
- 6. Highland Fine Cheesses (United Kingdom).
- 7. Indlacto Mures S.r.l. (Rumania).
- 8. Ragactives (Spain).
- 9. Biofarmitalia S.p.A. (Italy).

## Description of the work performed since the beginning of the project and the main results achieved so far

To achieve results, the WHETLAC project was broken-down into 8 Workpackages (WP). Six of these WP were of technical nature; one was focus on dissemination and exploitation activities, and the final WP was devoted to the management role.

A brief description of the work performed and results achieved is presented:

- **Material characterisation:** It was necessary to obtain suitable raw material to develop the process, to fix on the optimal pre-treatment of whey at laboratory level and to define quality controls as well as the reference methods of analysis to use along the Project.
- **Biological processing through fermentation:** The fermentation process to transform lactose in lactic acid using deproteinised whey was optimised. Specific actions performed were: Strain selection. Entrapping of lactic bacteria in lecticular-shape particles. New immobilisation methodology definition. Evaluation of the process versus free cell fermentation. Modelization of the biological process a bioreactor design.
- **Application of near infrared (NIR) spectroscopy to process control:** It was applied successfully NIR technology to follow up the fermentation process. The actions carried out for this were: spectroscopic analysis of the calibration samples, development of the calibration models and external validation of the developed methods. Finally it was used as a routine method.
- **Purification of lactic acid:** It was defined a purification process based on the use of supercritical fluids. Main parameters affecting isolation process were characterised. Specific objectives attained were the following: Modification and adaptation on lab facilities to carry out simultaneous reaction and extraction in supercritical medium. Solid catalyst selection and kinetic characterisation of reaction. And process validation versus the up-to-date technologies.
- **Process demonstration and scale-up:** The process was performed at demonstrative scale using two pilot plants. Definition of process units and study of the operation was carried out. The information gathered allowed to obtain relevant information regarding: Process cost estimation, main process affecting parameters and other engineering details.
- **Exploitation and dissemination:** The main objective in this task was to obtain information for the definition of an exploitation plan and to diffuse results properly. The main actions executed were: Study of socio-economic aspects, user needs and potential market. Definition of the potential sectors in which the results of the project could be applied. Project website construction and publication.

Finally it can be commented that all the technical results were achieved as expected at the beginning. Regardless of that, it was necessary to solve some technical unforeseen details, which in turn resulted in a small delay in project execution.

So a whole process for the obtaining of lactic acid from whey was obtained. From a technological point of view, the process is capable to achieve a purity grade well above 80-90% which was one of the targets of the project. By now it is studying the possibility to collaborate with third parties to finally make use of this technology.

## Final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far)

The general view of global competitive market (milk and their products included whey) is becoming shaped by an increasing number of multinational companies that have their origins in countries that

are not among the most advanced from a technological point of view or from a brand country reputation. These companies use different strategies (ranging from setting strategic alliances to subsidiary rights acquisitions) to operate at international level. Despite the fact that they do not possess advanced technologies in their field, they have expanded at world scale by means of innovative business formulas. Globalization has favoured this process as well as the occurrence of narrow niche markets in very different countries.

Regardless of the previous comments, according to some market surveys, the major players in the whey and lactose ingredient industry are the leading dairy and cheese companies in the world such as Lactalis, Friesland, Campina, Fonterra, Arla Foods, Glanbia, Murray Goulburn and Hilmar.

Specialist whey and lactose ingredient companies such as Meggle, Euroserum, Milei and Davisco also play a significant role, particularly in various specialty products. It is also interesting to mention that Nestlé and Danone (two of the largest dairy companies) are not actual producers but users of whey and lactose ingredients.

Concerning the markets, EU-27 and the US are the major consumers and producers for whey products. At the same time, Asia is rapidly increasing its lactose market. It seems that Asian region (China included) will present the highest growth both in absolute and relative terms in the near term.

The global market for lactic acid has been not very affected by global crisis of previous years; even it is showing consistent growth with a projection in the near term. It seems that the volume growth is achieved by:

- rise in demand from existing end-use markets and,
- emergence of new product applications and sectors (such as bioplastics).

Growth in demand for lactic acid, its salts and esters in industrial applications will be driven mainly by availability of lactic acid-based biodegradable polymers and, to a lesser degree, lactate solvents. In this sense, the Whetlac process presents the advantage of producing high purity lactic acid as well as lactic acid based solvents. Regarding the set of products derived from lactic acid and the different possible applications, the Whetlac process would allow the possibility of producing several different types with small changes in the process configuration.

The main obstacles to large-scale use of biodegradable lactic acid-based polymers in packaging applications is the cost. Also, there is controversy about the true amount of energy (often in the form of fossil fuels) consumed to produce PLA from raw materials such as corn. Proposed process here could help to shift this situation to a greener solution but further research efforts are required.

There are many affected SMEs: The European sector of cheese is fragmented with a high quantity of SMEs providing products that vary greatly from place to place, even when taking into account the consumer habits of each country. It was found during the project that the developed technology is capable of be used in most of the whey types produced.

The cheese product sector is firmly-established in all European countries, which provides the project with a broad potential for dissemination and social and economic impact. In fact the dissemination has been executed not only in the participating countries but also at a world scale.

Give European cheese SMEs access to specialist developers in the different fields of activity, which would not be otherwise possible. This is due to the fact that these enterprises are isolated in rural communities remote from these centres or even in the case of their rare closeness, the cheese SMEs

limited by their lack of human and financial resources. In this sense, the access to the technology could be compromised due to facilities costs. The setting of strategic alliances among stakeholders could overcome this situation.

The RTD Performers contributed with their pilot plants. This has been very important for the SMEs because it allowed an intermediate validation before the industrialization phase. The efficiency in the use of those specialised research facilities has been increased this way.

The technology was test under different situations, by testing the whey produced from different types of cheese from different european regions. This has ensured checking of the new process under whey with different quality characteristics, and determining of possible effects on the acid lactic production.

Whetlac developed a new use for whey from the dairy enterprises. Although the production costs for the by-product commercialization is still higher. It is still possible to increase returns to the cheese manufacturers by means of technology transfer to third parties, or even to develop further the technology to finally adapt the results.

One distinctive aspect of the whey and its derivate market is that related sector companies are forging strategic alliances in order to overcome technology obstacles and barriers to gain market access. Examples of the high grade of interrelation of these companies have been observed during the execution of Whetlac project.

So in brief, the recent evolution of the market is characterised by the appearance of merging and alliances constitutions. This situation is quite similar to other food products sectors. In this sense, a reliable opportunity could be obtained by means of setting up the same concept extended to the Whetlac process. Share of knowledge and risks for further development could be a chance to implant at a high scale the process.

According to the Project evolution and results obtained, SMEs had been concluded the following ideas which in turn have defined the final business concept.

During cheese manufacturing the production of by-products is inevitable (as it happens in most food productions). Traditionally such products have been considered as waste and dumped as sewage. With more attention in recent years to environmental issues, such sewage may even be an expense for industry.

However, quite often developments in processing technology and market demands make it economically attractive to process and market such by-products as ingredients. Efforts aimed to reuse the by-products are not only related with the process but also the application and marketing of these products require skills different from those normally found within the traditional dairy business.

The challenge is to get access to the right information in order to be able to judge the alternatives to disposal of or processing the by-products. And this vision can be applied for the present Whetlac Project but also as a general approach for dairy SME strategies.

Under this scenario, a reasonable chance for the use of the results is understood as the following possibilities:

- Patent and licensing the process for another uses.

- Partnering. To sell the “know how” to a third stakeholder related with production of lactic acid and/or to establish possible alliances of collaboration.

At this moment, it can be stated that, the exploitation is foreseen jointly by the SMEs, through transfer/licensing part of the new technological process to third parties. The main objective for this approach is to study possible further developments to make finally profitable the results.

The proposed action plan would be:

Phase 1: Definition of the final agreement by the SME concerning the partnering approach. To gather written objections and permissions among involved parts.

Phase 2: Contact with possible partners (Enterprises related with the production of lactic acid at large scale). Negotiation and deal making. Seek for financial and possible investors.

Phase 3: Plan execution.

### **Address of the project public website**

Further information and contact details can be obtained from this website:

<http://www.whetlac.cartif.com.es/>