



LIFE Project Number

**LIFE14 ENV/ES/000326**

**Final Report**

**Covering the project activities from 16/09/2015 to 31/08/2018**

Reporting Date

**28/11/2018**

LIFE PROJECT NAME or Acronym

**LifeCitrus**

Data Project

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<b>(%) of eligible costs:</b>	60%

Data Beneficiary

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## 2. LIST OF KEY-WORDS AND ABBREVIATIONS

AGROFOOD – Fundación Clúster Agroalimentario de la Región de Murcia (associated beneficiary)

AMC – AMC Innova Juice and Drinks S.L. (associated beneficiary)

CTC – Centro Tecnológico Nacional de la Conserva y la Alimentación (coordinating beneficiary)

FEDSERV – Federalimentare Servizi S.R.L. (associated beneficiary)

## 3. EXECUTIVE SUMMARY

The main objectives of the LifeCitrus project were to demonstrate the effectiveness of an innovative industrial process able to obtain natural ingredients from discarded parts of citrus fruits, as well as, to demonstrate the applicability of the obtained ingredients for the preparation of jams, jellies, juices and other foodstuffs.

In order to achieve these objectives, an intensive test programme and a detailed study has been done, as planned in the proposal, using a semi-industrial plant of the proposed process. The results of this have been collected in a key deliverable: report about the process effectiveness and the characterisation of obtained ingredients and final products.

The conclusion of this report is that the effectiveness of the proposed process and the obtained ingredient has been demonstrated. The transformation of citrus residues into a citrus puree for substituting commercial pectins is highly profitable. The application of the new ingredient as natural substitute for pectin generates a new line of industrialization. However, the location of the processing plant is a fundamental factor that may minimise the cost for residues transportation.

Throughout the test programme, the objectives of 3.000 kg residues processed, and 12 different foodstuffs produced have been achieved:

- In the first phase of the test programme, 3.160 kg of citrus discarded parts were shipped from the AMC's plant to CTC; 2.980 kg of them have been used in the test programme (actions B1 and B2) and 180 kg were used in action B3.
- In the second phase of the test programme, 27 samples of 13 different foodstuffs were prepared using the puree from the transformation of the citrus discarded parts.

However, the overall goal of 10.000 kg of citrus residues processed within the all implementation actions has not been achieved. Despite the number of tests developed in the demonstration and disclosure actions (B3, B4 and B5) was satisfactory, the additional residues processed on them were 2.596 kg in action B3 and 800 kg in action B4. Then, the total amount of residues processed in the project has been 6.556 kg.

The discarded parts of citrus fruits are currently considered as a residue of the citrus transformation industry and fresh citrus marketers, but they can be valorised through the proposed process, generating a waste reduction of between 60- 80% in volume, depending if the by-waste come from juice industries or from whole citrus. Then, other important objective of the LifeCitrus project has been to disseminate among European citrus farmers, marketers and industries, relative associations and public bodies the concept that citrus industry scrap may be seen no longer as a polluting agro-industrial residue but as a valuable natural raw material.

Given that the proposed process generates gelling agents not labelled with an 'E-number', usable as a natural ingredient in many food products replacing 'E-number' additives, the promotion of the use of the obtained ingredients in agro-food industries to produce healthy foodstuffs is also an objective of the project.

Great efforts have been done in order to spread the project know-how to industry operators and foster the replicability of the transformation process. 92 regional companies were contacted: 48 of them process lemon, 53 also process other citrus and non-citrus fruits and 43 produce jams, jellies and/or other foodstuffs. There were also contacted national and international companies: 58 of them process citrus fruits and 61 produce jams, jellies and/or other foodstuffs. After reaching the objectives of contact with 50 regional and 60 national/international companies, beneficiaries continued informing entities aiming to improve the replicability and transferability potential of the project.

Regarding the dissemination activities, every task planned in the proposal has been carried out. Particularly, the website has reached 10.971 visits from 82 different countries, achieving the foreseen objective of 10.000 visits. The conference was successfully organised and had 376 attendees from 17 different countries; moreover, beneficiaries participated in 7 national and international related congresses, while the objective was to participate in 2 congresses. The appearance of the project in media have been also satisfactory, being very helpful for that the two press-meetings and the two guided visits for journalists.

In regard to networking activities with other project, an intensive work has also been done. The objective of networking with 3 related projects has been achieved by far. Beneficiaries have developed networking activities with 13 Life projects and 2 Erasmus+ projects, among others.

The general progress of the project has been as scheduled in the proposal.

## **4. INTRODUCTION**

The processing of citrus fruits in the agro-industry has different phases from the collection of raw materials to obtaining the desired products. During this process, a significant amount of waste is generated.

The nature of the mentioned waste is low-quality fruits and, especially, parts of the fruits without commercial value (crust) removed during the transformation process. The huge volume of citrus waste is not being managed and eliminated using advanced scientific and technical approaches, but it is mainly done in an inadequate way implying negative environmental effects as:

- In case of the non-suitable soil reincorporation: organic wastes are a great source for plagues and pathologies.
- In case of being directly destined to animal feeding (what is the common practice): it has a short effectiveness and a potential danger for the cattle health, being particularly dangerous the FVW pesticide residues that it would be able to contain.
- Both, land filling and animal feeding, have a negative impact on the environment due to the emanating liquids which can ferment and contaminate soil and aquifers, besides the smelling problems.

These practices are caused by confused definitions as well as insufficient operative legislation, which only consider these materials as valueless, leftover elements of the productive processes, without taking into account their intrinsic nature and characteristics and their important potential for different novel, valued-adding utilities.

LifeCitrus aimed to demonstrate the effectiveness of an innovative industrial process able to valorise discarded parts of citrus fruits, currently considered as a residue of the citrus transformation industry and fresh citrus fruit packing. The process generates gelling agents not labelled with an 'E-number', usable as a natural ingredient in many food products like jams, jellies, juices, etc., replacing 'E-number'

additives. Besides, the particular characteristics of the innovative ingredient allows to produce foodstuffs without sugar.

Discarded parts of citrus fruits have a very high content of cell wall polysaccharides that are source of dietary fibre and constitute up to now the only raw material for the production of pectins used by the food industry as stabilisers or gelling agents.

Usually, pectins are extracted by a mineral acid at pH 1-2.5 and at 60-80°C. But this acid extraction presents several disadvantages, such as water pollution and corrosion. Furthermore, the residues obtained after the extraction of pectins are not suitable for human nutrition, although they are very rich in dietary fibre.

Moreover, enzymes have been tentatively used to extract pectin from the cell walls, but pectins obtained by enzymic degradation often have a low degree of polymerisation and only a few enzymes lead to the extraction of appreciable quantities of pectins with a high degree of polymerisation.

In other hand, the amount of water-soluble polysaccharides from citrus cell walls is greatly increased after extrusion-cooking, without extensive degradation of the polymeric structure. Then an appreciable amount of pectins with a high degree of polymerisation can be extracted by water from citrus fibres after extrusion-cooking. This treatment seems to degrade the rhamnogalacturonic backbone more than the side-chains, unlike extraction with acid which has a significant degradative effect on the arabinan pectic side-chains. Besides, the acid extraction also leads to more demethylation than the extrusion process.

The LifeCitrus process put in practice the extraction of pectins from discarded parts of citrus fruits using a water extraction after extrusion-cooking method, based on physical operations only (no dissolvent or chemical agents are needed).

The main objective of LifeCitrus has been to validate the technical and economic feasibility of the mentioned process for the valorisation of citrus industry residues, with potential to generate an economic profit for agro-industries and reduce the citrus fruits waste around an 60-80% of current volume. The project also aimed to demonstrate the applicability of the obtained ingredient for foodstuffs production, replacing chemical additives and obtaining natural products with an added value and better nutritional and functional properties.

The EU citrus fruits production is concentrated in the Mediterranean region. Spain represents nearly the 60% of the EU-28 total production, Italy about 30% and the remaining 10% is distributed among other Member States, mainly Cyprus, Greece and Portugal. The European citrus sector is strongly oriented towards the fresh product market. However, the convenience of citrus juice (in particular, orange juice) is reflected in its better adaptation to modern consumption habits that whole fresh fruits; and Germany, United Kingdom and France amount about the 60% of the fruit juice production in the EU.

As has been demonstrated thanks to the project, the application of the LifeCitrus process contribute to improve the competitiveness of the agro-industry businesses and to minimize their environmental impact, accordingly to the first steps of the EU waste hierarchy (prevention, re-use and recycling). At the same time, it fosters the elimination of artificial ingredients and additives in foodstuffs, as recommended by the World Health Organization.

Then, it is expected to, once the effectiveness of the transformation process and the obtained ingredient have been demonstrated, more companies get interested on implement the process or use the ingredient, which will create a new market without environmental impact and healthy aware.

## **5. TECHNICAL PART**

### **5.1 Technical progress, per Action**

#### **ACTION B1. Design and implementation of the demonstration plant**

Foreseen start date:	16/09/2015	Actual start date:	16/09/2015
Foreseen end date:	29/02/2016	Actual end date:	12/02/2016

CTC has a pilot plant in its industrial building in Molina de Segura (Spain), but this plant had to be enlarged and improved to be usable as semi-industrial scale plant in order to demonstrate the proposed process for the transformation of citrus residues into a valuable by-product. It was planned to carry out this action in 6 months and the schedule was fulfilled.

The first task carried out was to define the final design of the demonstration plant, what was ready on 30<sup>th</sup> October 2015, drawing up the corresponding report. This report is attached as a deliverable: '*B1 Design and implementation of the demonstration plant*'.

As described in the aforementioned report, the demonstration plant design entailed the incorporation of a high-speed knife cutter. The first step for the acquisition of this machine was to request offers to five different suppliers.

On 23<sup>rd</sup> November 2015, CTC contracted with *Productos Químicos de Murcia S.A.* the machine supplying, given that they provided the lowest cost offer, besides it complied with the technical requirements.

The installation of the high-speed knife cutter at the CTC plant was carried out on 11<sup>th</sup> and 12<sup>th</sup> January of 2016. This task involved the placement of the machine and its connection to the electrical and compressed-air systems.

On 18<sup>th</sup> December 2015, AMC sent 600 kg of lemon scrap to CTC, with which started the testing the washing stage of the process. Later, once the new machine was installed, the whole transformation line was tested. From 21<sup>st</sup> December 2015 to 12<sup>th</sup> February 2016, 356 kg of lemon peel were processed in five different essays: two only for the washing and enzymatic inactivation steps, and three for the complete process.

The testing task took a normal course. After that, some modifications on the original plant design were made:

- The plant design had a thermal sterilisation treatment and the packaging of the puree in vacuum bags that are conserved in cold storage, with regular microbiological analysis.
- The CTC technical staff decided the incorporation of a centrifugation stage, with a decanter machine, before the mashing one because they observed in the tests that it favours the extraction of water-soluble compounds as hesperidin.



*High speed knife cutter*

*Washer*

*Decanter*

Although action B1 was considered finished after this testing and tuning task, the sensory analysis done to the foodstuffs produced using the citrus puree (action B2) determined that the new ingredient could be detected in the texture of the products the chemical structures of fiber were broken, eliminating its gelling properties and therefore destroying the functionality as a gelling agent in the final product

obtained. Then, in order to solve this inconvenience, CTC acquired a new cutting head changed the configuration and number of blades for the prototype, high speed cutter machine, able to obtain smaller particles.

The modified cutting head was installed in May 2016 and has been used to prepare all the puree samples done since then. The sensory analysis of the foodstuffs cooked with the smoother puree have shown positive results of the cutting head substitution, because puree particles cannot be perceived in the products texture.

### **ACTION B2. Performing a test programme and characterisation of the process parameters and products specifications**

Foreseen start date:	01/03/2016	Actual start date:	25/02/2016
Foreseen end date:	28/04/2017	Actual end date:	30/08/2017

In February 2016, once the demonstrative plant was adjusted, CTC started performing the test programme for the characterisation of the process parameters and products specifications, in order to demonstrate de effectiveness of the innovative process and the new ingredient.

In the proposal, the action was planned to be developed in two consecutive phases: the first one for the production and packaging of the citrus puree and the second for the use of the citrus puree on the foodstuffs fabrication. However, finally these two phases were carried out concurrently.

This change of methodology has been positive, since has allowed a continuous adjustment of the innovative process based in both, the puree characteristics and the foodstuffs characteristics. In fact, as mentioned in the action B1, a relevant change in the process (the modification of the cutting head of the high-speed knife cutter machine) had to be done due to the unsatisfactory technical and sensory quality of the foodstuffs prepared with the citrus puree. The prompt detection of this need was thanks to carry out the two phases at the same time, which made possible to quickly modify the process and continue with the test programme with optimal means.

The test programme started on 25<sup>th</sup> February 2015 and, at first, was considered completed in April 2017, and works continued preparing the foreseen deliverable. However, an additional test was developed in June 2017 to evaluate the possibility of reducing the water consumption, together with some more tests that were done in July (of which CTC have not imputed hours to the project).

The citrus scrap used in the test programme was provided by AMC. 18 drums of citrus by-product (12 lemon, 4 orange, 2 clementine) were shipped from the AMC's plant to CTC, corresponding to 3.163 kg: 356 kg were used for tuning the plant in action B1, 2.627 kg in the tests performed in action B2 and 180 kg in producing puree for action B3.



*Lemon and orange purees*

Within this action, 13 test for the citrus puree production had been carried out: 7 using lemon discards, 4 with orange discards and 2 with clementine discards.

Residues from apples was analysed in November 2016, but, due to a short apple production season, it was not possible to carry out tests with them.

It has to be pointed that the difference between of the amount of by-products shipped from AMC (2.624 kg) and the amount of by-products processed (1.856 kg) is a consequence of the continuous production of leachate, which is thrown out when taking the citrus scrap for processing.

Using the puree obtained from the transformation of the citrus discarded parts, 27 samples of 13 different foodstuffs were prepared: 6 Strawberry jams, 2 ‘Empanada’ filling, 4 Sponge cake, 1 Courgette cream soup, 2Vichyssoise, 3 Tea biscuits, 1 ‘Paparajotes’, 1 Orange pastry, 1‘Salmorejo’, 1 Hamburger, 1 Almond beverage, 1 Quince jelly and 1 low calory apricot jam.

Nutritional and sensorial analysis of all these samples were carried out to assess their acceptability for consumers, comparing them with similar foodstuffs produced in the conventional way (using pectins, other gelling agents or flavourings).



Sponge cake (lemon/orange)

Hamburguers,

Low calory apricot jam

Quince jelly

The deliverable ‘B2 Report about the process effectiveness and the characterisation of obtained ingredients and final products’ was available on 30 August 2017. The report collects detailed information on all the test developed throughout this action and the obtained results.

### **ACTION B3. Region of Murcia demonstration and disclosure**

Foreseen start date:	01/08/2016	Actual start date:	27/10/2016
Foreseen end date:	29/06/2018	Actual end date:	30/07/2018

On 27<sup>th</sup> October 2016, AGROFOOD begun promoting the project at regional level. The first task was contacting regional companies with the objective of inform them about the innovative transformation process for agroindustry byproducts, the possibility to obtain added value ingredients and using them in the foodstuffs recipes and the availability of the demonstration plant for testing their own products.

Within this action 94 regional companies were contacted. Although the proposal objective of 50 companies contacted was early achieved, the beneficiaries kept informing companies to improve the replicability and transferability potential of the project.

Among the companies contacted, 41 of them process lemon, 57 also process other citrus and non-citrus fruits and 40 produce jams, jellies and/or other foodstuffs. The list of these companies is attached as *Annex I Regional companies contacted in Action B3*.

Regarding the workshops foreseen within this action, the first one, focused on regional lemon juice and oils industries and fresh lemon producers and marketers, was held on 1 February 2017, with the participation of 7 companies.

Baor Products	Original B2B	Lemon Concentrate
Antonio López Puche	Cítricos Cuello	Fruit Tech Natural (2 people)
Toñifruit		



The second workshop, focused on other regional citrus and fruit industries, fresh producers and marketers, was firstly scheduled for 12<sup>th</sup> May 2017, but, due to the low interest showed by the companies, it was postponed to 7 June 2017, when finally assisted 6 companies.

Natural Fruit Levante (2 people)	Juan Alarcón González	Antonio Martínez Lax
Milco Fuit SAT	Manuel García Campoy	Cítricos de Murcia (Cimusa) (2 people)

And the third workshop, focused on jam, jellies, canned vegetables and other agro-food regional industries, was held on 4 October 2017, with the participation of 9 companies.

Prosur	Postres Reina	Faroliva
Eurocaviar (2 people)	Mocitos (Frucomur) (2 people)	La Ceheginera
Coato	Marín Giménez	Cremofruit

In the three workshops, it was possible to achieve the objective established in the proposal of 6 participating companies. However, the number of companies invited to these activities was higher, but working groups seem to be not well received by companies in the sector, which prefer individual contact.

As a result of the direct contacts and workshops carried out within this action, 27 tests with 16 different regional companies were developed at the demonstration plant in CTC, achieving by far the proposal objective of 12-15 test.

In the one hand, 11 tests were for processing citrus scrap (7 companies); in total 2.596 kg of citrus residues were processed. In the other hand, 16 tests were for using the new ingredients in the preparation of 9 different samples (9 companies). The list of tests carried out is attached as *Annex II. Test at the demonstration plant - regional companies (action B3)*.

The deliverable ‘*B3 Summary report of the Region of Murcia demonstration initiatives*’ was available on 30 July 2018.

**ACTION B4. National and international demonstration and disclosure: citrus juice and oil industries, fresh producers and marketers**

Foreseen start date:	01/06/2017	Actual start date:	15/05/2017
Foreseen end date:	30/03/2018	Actual end date:	30/07/2018

In May 2016, the beneficiaries starting contacts with citrus juices and oil industries, fresh producers and marketers in order to inform them about the proposed innovative transformation process for agroindustry by-products, the possibility to obtain added value ingredients with them and the availability of the demonstration plant for testing their own products. Within this action, 58 companies and relevant associations at national and international level have been informed. The list of these entities is attached as *Annex III. National and international companies and relevant associations contacted in Action B4*.

Although the proposal objective of this task was 30 entities contacted, beneficiaries continued informing companies and associations aiming to improve the replicability and transferability potential of the project.

The first meeting foreseen in the proposal was held on 18<sup>th</sup> October 2017, in the framework of the Fruit Attraction Fair. This activity was organised by AMC, and CTC technicians also participated on it. 6 citrus companies and relevant associations attended to the meeting:

Torres Hermanos y Sucesores	Citriber	Benihort - Coop. Agrícola San Isidro de Benicarló
García Ballester	Frutas Tono	Mediterranean Fresh Fruit & Vegetable Exporters' Association (Turquía)

The second meeting was held on 15<sup>th</sup> November 2017, in the headquarters of FEDSERV in Rome. This activity was also organised by AMC, with the support of CTC and FEDSERV. 2 entities attended to the meeting:

Agrumaria Corleone	Orange fiber	
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In the second meeting, it was not possible to achieve the objective established in the proposal of 5 participating companies, despite the fact that a large number of companies had been invited, but after the meeting the partners contacted directly with 5 other companies to inform them of the results.

As a result of the direct contacts and meetings carried out within this action, 4 tests with 2 national (Spanish) companies were developed at the demonstration plant in CTC, achieving the proposal objective of 2-3 tests. The list of tests carried out is attached as *Annex IV Test at the demonstration plant – national and international citrus juice and oil industries, fresh producers and marketers (action B4)*.

Agrumaria Corleone showed a high interest in the project, but due to the costs associated with the realization of the tests in Murcia they did not carry out tests in the demonstration plant.

A total amount of 800 kg of citrus residues were processed in these tests. The deliverable '*B4 Summary report of the demonstration and disclosure initiatives for citrus juice and oil industries, fresh producers and marketers*' was available on 30 July 2018.

**ACTION B5. National and international demonstration and disclosure: jams, jellies and canned goods companies**

Foreseen start date:	01/09/2017	Actual start date:	15/05/2017
Foreseen end date:	29/06/2018	Actual end date:	30/07/2018

In May 2016, the beneficiaries starting contacts with jam, jellies, canned goods and other foodstuffs production companies in order to inform them about the new ingredient and the availability of the demonstration plant for testing their own products. Within this action, 73 companies and relevant associations at national and international level have been informed. The list of these entities is attached as *Annex V National and international companies and relevant associations contacted in Action B5*.

Additionally, the project has the collaboration of FIAB (Spanish Federation of Food and Beverage Industries) to promote demonstrative actions for the use of the citrus puree in food processing. FIAB is composed of 47 sector associations that group more than 8.000 companies. FIAB has helped to

disseminate LifeCitrus among the 13 associations of interest to the project. The list of the entities contacted through FIAB is also attached in the Annex V.

In total, 73 entities have been contacted, but it can be said that the information is available to more than 500 entities given the number of companies included in the FIAB associations. The proposal objective of 30 entities contacted within this action has been achieved.

The first meeting foreseen in the proposal was held on 31 October 2017, in FIAB headquarters in Madrid. This activity was included in the meetings of the working group on quality, production and sustainability of the FOOD FOR LIFE technology platform. The meeting was organised by FEDSERV, and CTC technicians also participated on it. 15 foodstuffs companies and relevant associations attended to the meeting:

CNTA	Link-Idi	Bioplat
Tepro Consultores Agrícolas	LEITAT	CDTI
XARTA	Betelgeux	Pons IP
Aves Nobles – Casa Matachín	Acciona Service	SEAM Start-up
Instituto de Sostenibilidad	MAPAMA-DGIA	AINIA

The second meeting was held on 15<sup>th</sup> November 2017, in the headquarters of FEDSERV in Rome. This activity was also organised by FEDSERV, with the support of CTC, and was scheduled together with the second meeting of the action B4 in order to facilitate the attendance of CTC technicians to both meetings. The attendance to these meeting was of 6 entities:

ASSITOL;, Ro.	Italcanditi spa;	ENEA (Bioag dept)
Ordine dei Tecnologi Alimentar	Confindustria Napoli	Ro.Na. Foodtech consulting; ,

In both meetings, it was possible to achieve the objective established in the proposal of 5 participating companies.

As a result of the direct contacts and meetings carried out within this action, 4 test with 3 national (Spanish) companies were developed at the demonstration plant in CTC, achieving the proposal objective of 2-3 tests. The list of tests carried out is attached as *Annex VI. Test at the demonstration plant – national and international jam, jellies and canned goods companies (action B5)*

The deliverable ‘*B5\_Summary report of the National and International demonstration and disclosure initiatives for jams, jellies and canned foods companies*’ was available on 30 July 2018.

### **ACTION B6. Training courses for agro-industry technicians**

Foreseen start date:	01/05/2017	Actual start date:	29/05/2017
Foreseen end date:	31/08/2018	Actual end date:	14/06/2018

Between May and June 2017, CTC staff were working on the course contents, preparing the supporting material and the documentation to be delivered to the students, which is found in the deliverable ‘*B6 Documentation of the courses offered to participants*’.

The course was structured in a theoretical part (10 hours) and a practical part (10 hours) developed in the demonstration plant of CTC.

The first edition of the course was held on 11-12 July 2017. It was scheduled on a summer month to facilitate the attendance to the course. It had 11 people attending (although 15 were registered),

technicians from companies and students from different parts of Spain and France. The entities to which these participants belong are:

Entity	Location
Doscadesa 2000	Murcia - Spain
Universidad de Granada	Granada - Spain
Citromil	Murcia - Spain
École Nationale Supérieure Agronomique de Toulouse	Toulouse - France
Basque Culinary	San Sebastián - Spain
Coato	Murcia - Spain
Novasanco	Alicante – Spain
El Zalao	Granada - Spain
CQM	Murcia - Spain

The second edition of the course was held on 23-24 January 2018. It had 18 people attending (although 22 were registered). The majority of attendants were technicians from national companies. The entities are:

Entity	Location
Frutas de Librilla S.L.	Murcia - Spain
Francisca Alemán Morales (freelance)	Murcia-Spain
Surinver	Alicante – Spain
El Zalao	Granada - Spain
Runakay	Murcia - Spain
Manuel López Fernández Envases Metálicos S.L.	Murcia - Spain
Cremofruit	Murcia - Spain
Alcurnia Alimentación	Murcia - Spain
Aceitunas Cazorla	Alicante – Spain
Toñifruit	Murcia – Spain
Ángel Antonio García García (Universidad de Murcia)	Murcia – Spain

The third edition of the course was held on 13-14 June 2018. It had 11 people attending (although 14 were registered), technicians from regional companies and students. The entities to which these participants belong are:

Entity	Location
Hero España (5 attendees)	Murcia - Spain
Caprichos del paladar	Murcia - Spain
Universidad de Murcia	Murcia - Spain
Universidad Católica de Murcia	Murcia - Spain
CIFEA	Murcia - Spain

In total, 40 people participated in the courses, achieving the proposal objective of 30 attendees to the course, within the three editions.

### **ACTION C1. Monitoring of the impact of the project**

Foreseen start date:	29/02/2016	Actual start date:	12/02/2016
Foreseen end date:	31/08/2018	Actual end date:	31/08/2018

At the project start, the table of the project indicators was reviewed in order to include all the parameters that may be useful for reporting the project impact. The definitive indicators list was ready on 15<sup>th</sup> February 2016 as a deliverable of the project: *'List indicators C1 action 29 June 2016'*.

In May 2016, CTC filled the LIFE Programme Database Indicators, as requested by the NEEMO Monitoring Team. The initial situation of the project and the objectives at the end of the project and five years beyond were established on this online tool. After that, the list of project indicators was updated including some new descriptors in accordance with the LIFE Programme Database Indicators.

A continuous monitoring of the project actions has been carried out, collecting day-by-day the corresponding indicators in the internal database. Moreover, at the end of the project, final results have been included in the online tool LIFE Programme Database Indicators.

### **ACTION C2. Conducting a detailed cost-benefit analysis and a feasibility study**

Foreseen start date:	01/04/2016	Actual start date:	01/04/2016
Foreseen end date:	28/02/2017	Actual end date:	22/02/2017

On 27<sup>th</sup> April 2016, CTC subcontracted the market and economic feasibility study to external company. The scope of work developed by this external company was:

- To carry out a market research about potential suppliers of industrial discarded citrus rinds, pulps and other parts and potential buyers of the gelling agents.
- A specific research focused on the biological certified sector and its particular market conditions.
- A cost-benefit analysis of the proposed innovative process at regional, national and international level.

Concurrently, CTC started contacts with engineering companies in order to design and budget a plant able to apply at industrial level the transformation process for citrus discards.

On 22 February 2017 CTC finished the deliverable *'C2 Cost benefit and feasibility study report'*, which includes four documents: *'Market research puree product from citrus by-products'*, *'Citrus fruit in the ecological agriculture'*, *'Cost-benefit analysis of the innovative LifeCitrus process'* and *'Feasibility study of the LifeCitrus process'*.

The conclusion of the cost benefit analysis and feasibility study is that obtaining citrus purees as a substitute for commercial pectin is highly profitable, taking into account that the location of the recovery plant is a fundamental factor in order to reduce costs of travel and transportation. Then, it can be said that the application of a natural substitute for pectins generates a new line of industrialisation, in addition to an environmentally sustainable process.

### **ACTION C3. Evaluation of the socio-economic impact**

Foreseen start date:	01/03/2016	Actual start date:	01/03/2016
Foreseen end date:	31/07/2018	Actual end date:	31/07/2018

On 28<sup>th</sup> March 2016, CTC subcontracted to external company for the development of the following tasks:

- Schedule the works for the evaluation of the socio-economic impact of the project in the Region of Murcia.
- Set up the initial socio-economic situation.
- Creation of a survey model addressed to representative samples of involved groups.
- Draw-up a report about the project's socio-economic impact.

On 22<sup>nd</sup> April 2016, the report about the initial socio-economic situation was done, as well as the survey to evaluate the impact of the project were ready. The survey was uploaded to the website of the project and a significant number of people/entities were asked to fill it.

At first, there was a short response to the online survey. Then, corrective actions had to be taken, such as give the survey in hand to visitors/attendees on every action planed in the LifeCitrus framework or other related events, taking into account that it was only directed to the regional public. Eventually, on 13<sup>th</sup> July 2018, 100 surveys had been filled out.

On 17<sup>th</sup> July 2018, the external company delivered the socio-economic impact report, that was review by CTC technicians, who finished the project deliverable '*C3 Study of the socio-economic impact of the project*' on the last week of July.

### **ACTION D1. Creation and update of the project website**

Foreseen start date:	16/09/2015	Actual start date:	02/11/2015
Foreseen end date:	31/08/2018	Actual end date:	31/08/2018

The first task developed under this action was the creation of the LifeCitrus logo. Second week of November 2015, some logos were shown to the project beneficiaries and on 25<sup>th</sup> November 2015 the final logo of LifeCitrus project was chosen. In January 2016, the corporate image of the project was finalised.

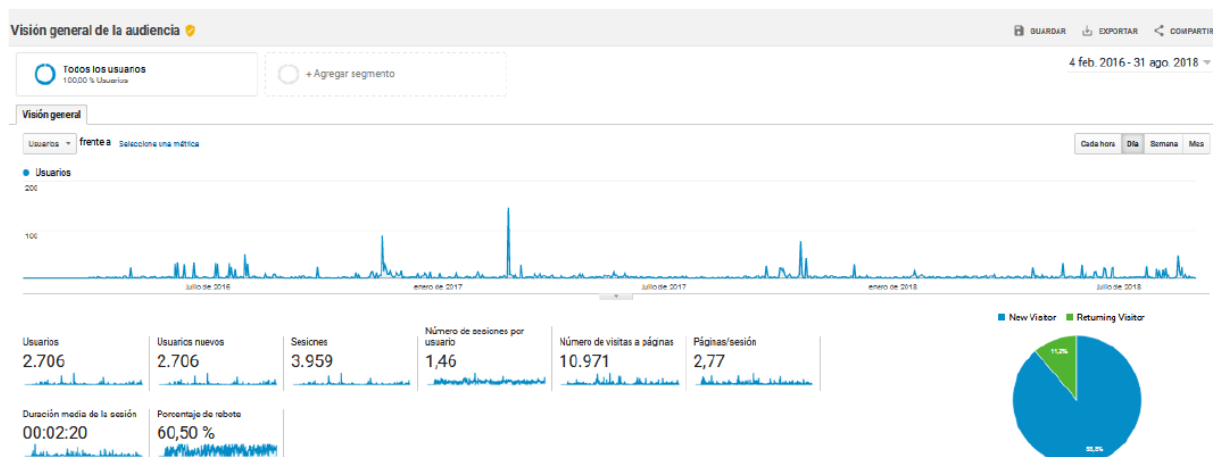
In December 2015, CTC started working on the website contents definition, as well as they contracted the Internet domain (lifecitrus.eu) and the hosting service. On January 2016 an external company was contracted for the web design and information uploading, and by the end of February 2016 the website was online in two languages (English and Spanish).

In December 2016, FEDSERV assumed the responsibility of this action. The translation of the website into Italian started in January 2017, achieving the complete translation in May 2017. Since then all the contents included in the web are available in three languages: English, Spanish and Italian.

During the project lifetime, the LifeCitrus website has been frequently updated with news related to the project progress, announcements of the projects activities (such as workshops, courses, ...) and publication of the project deliverables.

The statistical information of the project website from 04/02/2016 (when the website was launched) until 31/08/2018 (end date of the project) is showed in the picture.

The output foreseen in the proposal of 10.000 visits to the website has been achieved by far, with 10.971 visits from 82 different countries.



The main countries, per number of visits, have been: Spain (1.030 visits – 38.0%), UK (385 visits – 14.2%), France (257 visits - 9.5%), USA (172 visits - 6.4%), Italy (136 visits – 5.0%).



## **ACTION D2. Dissemination activities**

Foreseen start date:	02/11/2015	Actual start date:	05/11/2015
Foreseen end date:	31/08/2018	Actual end date:	31/10/2018

On November 2015 a communication agency was contracted in order to assist AGROFOOD in dissemination activities.

### Press meetings

The initial press-meeting was held on 11<sup>th</sup> December 2015. Besides the LifeCitrus introduction to the media, this event was taken into advantage to launch the project in the industrial regional sector. A press release was created for this event and was sent to 14 media. 7 different media attended the press-meeting, together with 23 attendees from companies, associations and universities.

The final press-meeting was held on 31 October 2018. Despite it was planned to be held at the end of the project, in August 2018, it was postponed after the project end-date seeking a wider audience, due to the news impact in summer is quite limited.

### Visits for journalists

On 9<sup>th</sup> November 2016 was carried out the first guided visit to the demonstration plant for journalist. This event had the attendance of 7 regional media, who informed about it through their respective channels (newspaper, television or radio).

The second visit for journalists was held on 17<sup>th</sup> January 2018. It had the attendance of 10 regional media and 1 national media, and 24 media made publications in the wake of this event.

### Video

In December 2016 a company was subcontracted to make the promotional video of the project, what was ready and uploaded into the project website on 23 February 2017. The length of the video is 5 minutes and includes information of the LifeCitrus project in three languages (Spanish, English, Italian). The video is posted in the video sharing platform YouTube ([link](#)).

### Conference

The LifeCitrus conference was held on 9-10 May 2017, within the framework of the Murcia Food Brokerage Event 2017 and the VIII Symposium on Food Technologies. This is an international event where the latest developments in food technology are shown and companies hold meetings to establish technology cooperation agreements.

The LifeCitrus conference presented the project results as well as explained the innovative process, the puree characteristics and the obtained products specifications. The event had 376 attendees from 17 different countries, most of them from Spain (328) but also from Italy, Portugal, Germany, Slovenia, England, Ireland, Romania, among others. There were technicians from companies (213), universities (56) and research centres (48), consultants (26) and others (33).

In addition, bilateral meetings were held with 15 different companies and research centres aiming for the technology transfer. Among the companies with which meetings were held are Univar, Innofood I+D+i, Domca, Deretil, Sitra, J. García Carrión and Irconfort. Meetings were also held with technicians from the University of Cartagena, University of Murcia, University of Alicante, Spanish National Research Council (CSIC), Functional Food Research and Development Centre Foundation, Madrid Science Park Foundation and ASINCAR.

### Newsletters

Throughout the project lifetime, six semi-annual reports (newsletters) were published, as planned in the proposal, in two languages (English and Spanish).

	Publication date	Links	
Newsletter 1	December 2015	<a href="#">newsletter1-EN</a>	<a href="#">newsletter1-SP</a>
Newsletter 2	June 2016	<a href="#">newsletter2-EN</a>	<a href="#">newsletter2-SP</a>
Newsletter 3	January 2017	<a href="#">newsletter3-EN</a>	<a href="#">newsletter3-SP</a>
Newsletter 4	June 2017	<a href="#">newsletter4-EN</a>	<a href="#">newsletter4-SP</a>
Newsletter 5	January 2018	<a href="#">newsletter5-EN</a>	<a href="#">newsletter5-SP</a>
Newsletter 6	June 2018	<a href="#">newsletter6-EN</a>	<a href="#">newsletter6-SP</a>



Newsletter are published in the LifeCitrus website and are also included in the magazine ‘CTC Alimentación’, which is biannually published and distributed to more than 1.000 entities.

#### ‘CTC Alimentación’ magazine

During the project lifetime, every edition of ‘CTC Alimentación’ have included a promotional page with summary information of the LifeCitrus.

Moreover, in June 2017 a ‘Special edition of the CTC Alimentación magazine’ (a project deliverable) was published ([link](#)).

#### Participation in congresses

The beneficiaries have participated in 17 national and international congresses with the LifeCitrus project, achieving by far the proposal objective of participation in 2 congresses.

Event	Place	Year	Type of participation
“Diaspora în Cercetarea Științifică și Învățământul Superior. din România -Diaspora și prietenii săi” 2016. Workshop: “Bioeconomie: producție, procesare și consum sustenabile”	Yimisoara-Romania	2016	Talk
EXPO Bioenergy Fair. Workshop FoodBioEnergy	Cremona-Italy	2016	Talk
International Congress LIFE ECOCITRIC	Castellón-Spain	2016	Talk
Food Matters Live Fair	London- UK	2016	Poster and stand
International Conference Aromatic and Medicinals Herbs in Food	Bucharest-Romania	2016	Talk and panel
III Jornadas de ciencia y tecnología de los alimentos	Murcia-Spain	2017	Talk
CIBUS Connect Fair 2017	Parma-Italy	2017	Talk
5th International Conference on Sustainable Solid Waste Management	Athens- Greece	2017	Talk
Technical seminar ERASMUS+ HERBATIS project	Barcelona-Spain	2017	Talk
Young Entrepreneurs of Federalimentare meeting	Naples-Italy	2017	Talk
PHILIP KOTLER MARKETING FORUM 2017. “Best practice Food” session	Milan-Italy	2017	Talk
Fruit Attraction Fair 2017	Madrid-Spain	2017	Poster, stand
Qualifood event – Food Bioenergy	Cremona-Italy	2017	Talk
POSTHARVEST project Erasmus+ (Initial Event-Opening Conference). Economy circular	Bursa-Turkey	2018	Talk
Final Conference Medicinal and aromatic plants – HERBS4YOUTH PROJECT	Murcia-Spain	2018	Talk
CIBUS Fair 2018	Parma-Italy	2018	Talk
9º ANQUE Chemistry International Congress	Murcia-Spain	2018	Talk and panel

## Articles

In February 2017, CTC agreed with the 'Alimentaria' magazine to publish a technical article with the results of the project. In February 2018, the article was delivered, and it was published in September 2018 (Alimentaria #496). This article is titled *Healthier food through the use of a new natural ingredient obtained during the recovery of citrus by-products*.

In August 2018 a scientific article with the most relevant project information was delivered to the 'Journal of the Science of Food and Agriculture', but this article was rejected. After the end of the projects, CTC had worked on a new scientific article that will be sent to the 'Journal of Food Processing and Preservation'.

## Other dissemination activities

The project has been disseminated continuously to all interested people and the demonstration plant of the process has been open to visits upon request. In the project lifetime, the plant has been visited by 475 people in a total of 38 visits.

The foreseen deliverable 'D2\_Document collecting all reviews and articles written inside the project' has been transformed in a summary report that collects articles, pictures and other information related to the dissemination activities carried out in the framework of the project: the project appearance in press, the participation in congresses and other events, the visits to the demonstration plant, etc.

## **ACTION D3. Notice boards**

Foreseen start date:	01/02/2016	Actual start date:	16/11/2015
Foreseen end date:	31/03/2016	Actual end date:	22/05/2017

A first informative board was created for the presentation of the LIFECITRUS project of 11<sup>th</sup> December 2015, with 1x2 meters size and a roll-up holder. This board has been used for the dissemination actions outside the beneficiary's headquarters.

On 5<sup>th</sup> April 2016, the final design of the notice boards was available and was sent for printing, also with 1x2 meters size and in a roll-up holder. Initially, only three notice boards were printed, and in April 2016, they were placed on the headquarters of three of the beneficiaries (CTC, AGROFOOD and AMC), respectively. These boards explain in Spanish and English the main aspects of the project

On 22<sup>nd</sup> May 2017 the Italian-English version of the notice board was available. Two notice boards of this version were printed, one that was placed on the FEDSERV headquarters and another used for dissemination actions outside there.



*Notice board placed at the beneficiary's headquarters (CTC, FEDSERV, AGROFOOD, AMC)*

## ACTION D4. Layman's report

Foreseen start date:	02/01/2018	Actual start date:	04/12/2017
Foreseen end date:	30/04/2018	Actual end date:	23/10/2018

FEDSERV started working in the content and design of the Layman's report in December 2017 and a preliminary version of the document was available in March 2018.

However, in the coordination meeting held on 14<sup>th</sup> March 2018, beneficiaries decided to delay the publication of the report in order to complete it with further information.

The final version of the Layman's report (a deliverable of the project) was available on 23<sup>rd</sup> October 2018. It was published in electronic format on the LifeCitrus website ([link](#)) and printed: 500 copies of the English-Spanish version and 500 copies of the English-Italian.

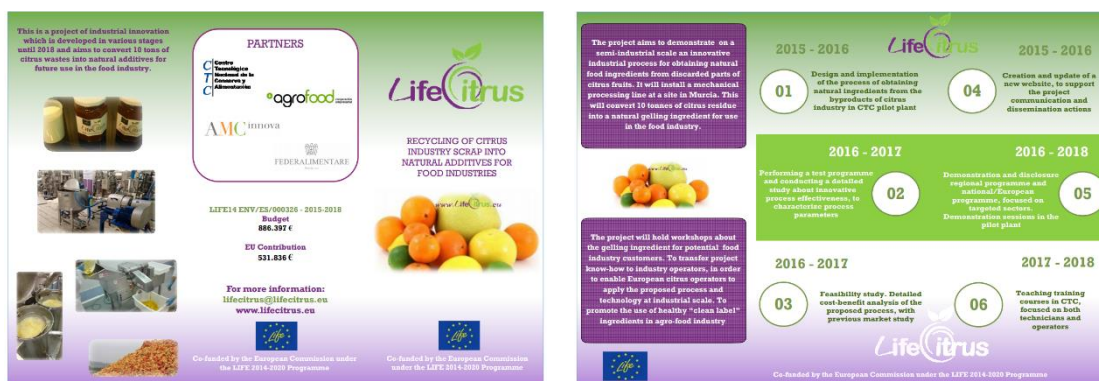
## ACTION D5. Informative brochures

Foreseen start date:	01/07/2016	Actual start date:	05/09/2016
Foreseen end date:	28/02/2018	Actual end date:	06/03/2018

The first brochure (May 2017) is a project deliverable and contains general information about the project and its objectives. 1500 copies of it was printed: 500 in English, 500 in Spanish and 500 in Italian.

Although the first brochure was ready a few months later than the scheduled in the proposal, in the meantime, beneficiaries were using a provisional leaflet which they printed occasionally for visits, fairs, etc.

FERSEV begun working in the second brochure in December 2017. The second brochure (a project deliverable) was published on 6<sup>th</sup> March 2018, containing the more relevant results of the project and its conclusions. 1500 copies of it was printed: 500 in English, 500 in Spanish and 500 in Italian.



First brochure (English)



Second brochure (English)

**ACTION D6. Networking activities**

Foreseen start date:	16/09/2015	Actual start date:	01/12/2015
Foreseen end date:	31/08/2018	Actual end date:	31/08/2018

Since the beginning of the project, the beneficiaries have been carrying out networking actions with other projects.

LifeCitrus have made networking with 13 LIFE projects:

LIFE AGROWASTE	LIFE FOODPRINT
LIFE WATERREUSE	LIFE FOOD WASTE STAND UP
LIFE FOOD WASTE TREATMENT	LIFE AQUEMFREE
LIFE ECOCITRIC	LIFE BAQUA
LIFE GISWASTE	LIFE CITRUSPACK
LIFE iCirBus 4 Industries	LIFE M3P Material Match Making Platform
LIFE WOGAnMBR	

and 3 Erasmus+ projects:

GOOD HERBS	HERBATIS
HERBS4YOUTH	

And 1 7<sup>th</sup> frame program

SATIN PROJECT	
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In summary, along the project lifetime, the beneficiaries have carried out networking activities with 17 projects financed by European funds. Mainly, these activities were exchange of information in visits and meetings, but also participation in events and collaboration in dissemination activities.

The objective foreseen in the proposal of create a network with, at least, 3 projects has been achieved by far.

Moreover, meetings have been also held with technicians of CITOLIVA (olive and oil technological center), in order to found synergies with this sector, and with technicians from the Basque Culinary Center, aiming to develop new products. At international level, personnel from the IBA Institute of Bucharest and the NGO No Gravity (Slovakia) were able to visit the LifeCitrus demonstration plant in the CTC.

The deliverable ‘D6\_Networking’ a document with the synergies found between projects after networking activities, was available on 28<sup>th</sup> June 2018.

### **ACTION E1. Project management by CTC**

Foreseen start date:	16/09/2015	Actual start date:	16/09/2015
Foreseen end date:	28/11/2018	Actual end date:	28/11/2018

On September 2015, CTC contracted an external company as advisory for the project management (support in review of technical documentation and financial statement).

On 26<sup>th</sup> October 2015, CTC and AGROFOOD representatives, assisted to the kick-off meeting organised by EASME in Brussels.

Along the project lifetime, 8 coordination meetings were carried out:

Date	Description	Attendees
05/11/2015	Kick-off meeting	CTC, AGROFOOD, AMC, External assistance
04/02/2016	Monitoring and coordination meeting	CTC, AGROFOOD, AMC, External assistance
22/06/2016	First monitoring visit	CTC, AGROFOOD, AMC, NEEMO External Monitor, External assistance
20/12/2016	Monitoring and coordination meeting	CTC, AGROFOOD, AMC, FEDSERV, External assistance
24/05/2016	Second monitoring visit	CTC, AGROFOOD, AMC, FEDSERV, NEEMO External Monitor, External assistance
14/11/2017	Monitoring and coordination meeting	CTC, AGROFOOD, AMC, FEDSERV, External assistance
14/03/2018	Third monitoring visit	CTC, AGROFOOD, AMC, FEDSERV, NEEMO External Monitor, External assistance
24/10/2018	Fourth monitoring visit	CTC, AGROFOOD, AMC, FEDSERV, EASME Project Advisor, NEEMO External Monitor, External assistance

Regarding the reporting activity, the Midterm report was sent to EASME on 24th April 2017, being its reporting period from 16<sup>th</sup> September 2015 (project start) until 31<sup>st</sup> December 2016.

The Progress report was sent to EASME on 5<sup>th</sup> January 2018, being its reporting period from 1<sup>st</sup> January 2017 until 31<sup>st</sup> October 2017.

### **ACTION E2. Indicators tables**

Foreseen start date:	28/02/2016	Actual start date:	01/02/2017
Foreseen end date:	28/11/2018	Actual end date:	28/11/2018

Based on the ‘List of project indicators to measure the impact and baseline used to evaluate the progress’ created in the action C1, the deliverables ‘E2 Mid-term report indicators table’ and ‘List indicators C1 action-E2 26 November 2018’ have been created.

The first one was prepared on February 2017 to be sent to EASME with the Midterm report.

### **ACTION E3. After-LIFE Plan**

Foreseen start date:	01/02/2018	Actual start date:	01/02/2018
Foreseen end date:	30/04/2018	Actual end date:	30/04/2018

CTC started work on this action in February 2018. The deliverable ‘E3After-LIFE plan’ was available on 30<sup>th</sup> April 2018.

This document set out the activities related to LifeCitrus that will be developed after its end, as well as the beneficiary in charge of each task and the sources of financing. The after-LIFE strategy has been approved by all the beneficiaries of the project.

## **5.2 Main deviations, problems and corrective actions implemented**

The relevant inconvenience found in the project development was the not satisfactory quality of the first foodstuffs produced using the citrus puree. The technical and sensory analysis done to these foodstuffs determined that the new ingredient could be detected in the texture of the products and the gellificant effect was lost. Then, in order to solve this inconvenience, the configuration of the cutting head was modified. CTC acquired a new cutting head for the high-speed cutter machine able to obtain smaller particles than the first one and improve their gellificant properties.

The sensory analysis of the foodstuffs cooked with the smoother puree obtained with the new cutting head shown positive results, because puree particles cannot be perceived in the products texture and positive increased of the fiber extraction.

This corrective action was able to be made promptly thanks to a change on the methodology followed in action B2. Despite in the proposal the action was planned to be developed in two consecutive phases: the first one for the production and packaging of the citrus puree and the second for the use of the citrus puree on the foodstuffs fabrication; finally, this two phases were carried out concurrently. It allowed a continuous tuning of the transformation process based in both, the puree characteristics and the foodstuffs characteristics.

## **5.3 Evaluation of Project Implementation**

Regarding the implementation actions, the methodology applied has slightly differed from the proposal plan. While the Action B2 was scheduled in two phases (the first one for the production and packaging of the puree and the second for using the ingredient on final products fabrication), these phases have been actually carried out together. This change of methodology has allowed the optimisation of the process, applying the necessary adjustments to it in order to obtain an ingredient with the appropriate quality to be used on the foodstuff production.

Due to the need to start with the second phase of the Action B2 earlier, the optimisation of the process was reached three months after the foreseen date. In consequence, the Action B3 started three months later than scheduled, but it is not an inconvenience for the project development nowadays.

A minimal change of methodology has also been done in the Action B3. While the task ‘launching the action: promotion and disclosure’ was scheduled in three different stages, one for each specific sector, this task is being carried out at the same time for the three sectors: lemon juice and oils industries and fresh lemon producers and marketers; other citrus and fruit industries, fresh producers and marketers; and jam, jellies, canned vegetables and other agro-food companies.

Regarding the citrus industry residues processed, only lemon scrap was used on the optimisation tests what allowed to the results comparison. Later, other citrus fruits discards have been processed aiming to demonstrate the effectiveness of the process to transform different citrus residues. It was concluded that when use whole lemon from farmer the yield of the process was 80%, but when the lemon waste came from juice industries, the yield of the implemented process was less than 80% due to the leaches after the juice extraction.

In relation to the monitoring, dissemination and management actions, the methodology applied has been the same planned on the proposal.

The positive results of the test programme, the conclusions of the cost-benefit and feasibility study and the hard work done in the capitalisation actions (B3, B4, B5, B6) are expected to make emerge a new market line. In the one hand, many foodstuffs producers have expressed their interest in using the citrus puree in their recipes for conventional pectins substitution. In the other hand, some citrus processed are studying the implementation of the citrus residues’ transformation process in their plants. Networking among these entities have been fostered aiming to achieve an effective replication of the project.

The creation of a new market for the production and application of the citrus puree will imply to deliver the EU added value objectives foreseen in the proposal. In the one hand, consider the citrus residues as a by-product and transform them into the citrus puree will prevent the adverse impact of a bad waste management, as well as will improve the industry efficiency. In the other hand, the citrus puree will substitute E-labelled ingredients in food and it will make possible the development of new low-calorie products.

Lastly, the performed actions for public awareness and dissemination have been effective to achieve the project objectives. The interest of companies, technicians and general public on the project has been demonstrated due to the significant participation on the dissemination activities developed in the LifeCitrus framework.

## **5.4 Analysis of benefits**

### **5.4.1 Environmental benefits**

Through the project actions – particularly B1, B2, B3 and B4– 6.556 kg of citrus residues have been processed, avoiding them to be landfilled.

Thanks to the dissemination actions carried out, the environmental awareness has increased. The need of reducing the waste generation and maximising recycling is better known, as well as, more industry operators and citizens now consider agro-industry residues as a valuable sub-product.

Currently, economic development and environmental protection are together. Nowadays, any industrial activity is carried out with reducing its environmental impacts. This is due to that in recent decades, the pressure exercised by different sectors of society and by the different administrations is translated into the development of a comprehensive legislation to protect the environment. The use of the new ingredient developed can even add value to food companies, making the most of their by-products for produce new ingredients that can enrich new foods. In addition, new companies can be created in areas with market potential and a distribution system that guarantees business and environmental success.

As a consequence, the follow points must be taken into account:

- In the Region of Murcia the agrofood sector is closely linked to the fruit and vegetable processing industry and produce a potential valuable by-product, and therefore can generate wealth for the area.
- The creation of companies is one of the main indicators of country's economic activity. With more companies, will be more employment, more public income and more possibilities of increasing the economic and social development of all citizens.
- From the geographical point of view, Region of Murcia is a peripheral region with respect to the main centres of transport and economic activity of the EU. Also, Region of Murcia is part of the Mediterranean Arc, therefore have great potential for development and favourable enclave for the location of economic activity.
- The strategy of LifeCitrus Environment & Resource Efficiency has been based on the valuation of the project under the economic, business and technological environment of the Region of Murcia, which is an Autonomous Community of Spain and belongs to the European Union. This Project has developed a new ingredient with application in the companies of the Region of Murcia. Moreover, the project has increased the scientific knowledge of Spanish institutions to continue working on the promotion of scientific, technological and business leadership of the Spanish R&D+I System at international level.

#### **5.4.2 Economic benefits**

It's a fact that citrus processing industries generates large quantities of waste resulting from their transformation process. These residues have a low economic value and its elimination is a cost that increase in the final price of the products.

The conclusion of the market research is that a new ingredient with gelling capacity, which can substitute conventional pectins, is of interest to the canned goods and other foodstuffs companies. In the Region of Murcia are located 150 of these companies, with relative importance in the regional economy.

This study also observes that the potential consuming companies of the citrus puree have a lack of knowledge about natural ingredients that may substitute pectins. This fact guarantees the success of market placing an ingredient such as the citrus puree once its characteristics and properties are disclosed.

The cost-benefit and feasibility study show that obtaining citrus purees as substitutes for conventional pectins using the residues of the citrus industry is highly profitable. The implementation of the process has a great capacity for the investments return. In terms of cash flows, if the investment is financed with own funds, the implementation of the process would be financed in just 1.66 years.

The LifeCitrus project has validated a new machinery capable of transform citrus residues in a new ingredient. This machinery can expand the food companies' applications as well as may increase the machinery manufacturers sales.

#### **5.4.3 Social benefits**

In summary, more than 5.000 people from the Region of Murcia had accessed to project information through all the dissemination actions carried out, contact with companies, training courses and website. These figures are greater if it is included the transfer of information to society in general, the internal communication of colleagues in companies, families and friends. Near 500 people have visited the demonstration plant, and the webpage had more than 10.000 visits.

All of these have helps to increase the society aware in resource efficiency, residues revalorising, waste management and healthy food.

The evaluation of the current social situation of the Region of Murcia and its employment figures, according to the Labor Market Report of the region (2016), determined that specialized hiring is not



significant in the worker market of the Region of Murcia. LifeCitrus project emphasis on the possibility of hiring university graduates in the regional agri-food sector.

#### **5.4.4 Replicability, transferability, cooperation**

Conclusions of the cost-benefits and feasibility study shows that obtaining citrus purees as substitutes for conventional pectins using the residues of the citrus industry is highly profitable. The implementation of the transformation process is more profitable for companies that generates the residue, due to two factors:

- The investment that citrus transforming industries have to make in order to implement the LifeCitrus process is not very high, since they already have most of the necessary machinery.
- The costs for the residue's transportation are relevant in the cost-benefit balance.

Given that, some of the citrus transforming companies that have tested the LifeCitrus process in the framework of the project have expressed their interest in implementing the process in their industries. They have decided to continue testing the possibilities of the process by their own means. CTC will give technical support to those companies that finally want to implement the LifeCitrus process in their industrial plants.

Moreover, many of the companies that have tested the citrus puree in their recipes thanks to the demonstration and disclosure programme of the project, have shown high interest in using the ingredient for the foodstuffs fabrication. However, there is not a market supplier of the citrus puree.

Project beneficiaries are promoting the networking between companies interested in buying the new ingredient and those others that are trying to implement the transformation process in order to create a market for the citrus puree. It will foster the implementation of the transformation process in industries as well as will make the new ingredient available for those companies interested in using it in their recipes.

#### **5.4.5 Best Practice lessons**

The methodology applied on the project developed the production of puree and its application for foodstuffs fabrication, is being more efficient than the planned on the proposal. The strategy employed lead to adjustment the implemented process according to the best practices in different ways:

- Reduction of citrus industries waste
- Avoiding the use of non-green extracted solvents
- Reduction of energy process consumption
- Optimization of water process consumption
- Training of industrial technicians

CTC already has a pilot plant installed in its industrial building in Molina de Segura (Spain). Throughout this project, this plant is been enlarged and improved to be usable as semi-industrial scale plant and perform the new process in optimal conditions. First, it has been done the definition of the essential additional equipment to complete the plant for demonstration. The line initially considered contemplated the acquisition of a new equipment and its installation in the pilot plant, in order to perform the test according to the best industrial practices. The objective of this prototype equipment is to obtain a citrus puree not detected easily in foods, available for use as a food ingredient, which non-affects the chemical structure of citrus peel fiber, with a capacity of semi-industrial scale, reliable construction and easy maintenance. The prototype has been redesigned during the project according to the best practises described above.

Proposed process is based on physical operations with no uses of chemical and/or organic solvents. It aims is to optimize the production of a valuable fruit or vegetable semi-elaborated, with minimum water consumption, high performance rate, low energy consumes, etc. In the same way, the semi-industrial plant will use lighting, security, loading and unloading, sewage treatment, waste management and all the available CTC facilities.

A total amount of 27 tests have been developed with citrus processing companies (especially lemon), farmers and traders to produce the new natural ingredient. Other companies of manufacture of canned food (fruit, vegetable and fish), confectionary and drinks tested the new ingredient used as a food ingredient for their gelling and hydrocolloid properties, high value of fibre and low energy value, to make new products too. At the end of this tests, it can be concluded that the developed LifeCitrus process for obtaining natural food ingredients from discarded parts of citrus fruits, has been optimized and it is environmentally sustainable according to the best industrial practices.

The results of the cost benefit and feasibility study of the developed LifeCitrus process concluded that the application of a natural substitute for pectin generates a new line of industrialization, in addition to an environmentally sustainable process. The uses of the citrus puree as a substitute of commercial pectin is highly profitable. The location of the recovery plant can be a fundamental factor. The implementation of the company together with the companies supplying raw material would save all the costs of travel and transportation. The cost of the supply water was also reduced.

Finally, with the aim to disseminate the best practises of the LifeCitrus process to citrus and food industries 3 Training courses were held at CTC facilities in the frame of the LifeCitrus project. The topics of the course were environmental legislation; characteristics and potential of citrus residues; concepts about the technology used in the process and use of the ingredient obtained for the manufacturing of new foods

#### **5.4.6 Innovation and demonstration value**

The challenge of the project is to obtain purees from citrus by-products that can be applied to all types of food and does not alter its organoleptic properties. Once the puree is obtained, it offers a wide range of possibilities to any company in the sector that seeks the development of increasingly natural foods.

In addition, project beneficiaries have contacted relevant companies and associations at the regional, national and international levels and workshops have been organized to explain their viability opportunities. Thanks to that, different agri-food companies are developing tests in the demonstration plant to learn more about the process and they are training with the CTC's staff, which promotes their replicability.

Information about the LifeCitrus project was sent and activities/collaborations were carried out:

- Exchange of information through email (including newsletters).
- Exchange of information through meetings.
- Attendance at meetings with technicians from food and environmental sustainability areas.
- Participation in seminars and conferences organized by partners from other projects.
- Collaboration request for the participation of other projects in events organized within the framework of the LifeCitrus project.
- Collaboration request to include information in the magazine 'CTC Alimentación' within the framework of the LifeCitrus project.
- Invitation to know the demonstration plant and organization of the visit.

We have pursued the objective of disseminate to Murcia citrus farmers, marketers and industries, that the by-products of the citrus industry should not be considered a polluting agroindustry waste. A lot of regional companies and farmers organized work meeting and demonstrative actions were carried out in the pilot plant of LifeCitrus project. A total of 94 regional companies have been contacted 41 lemon companies, 57 other citrus and non-citrus fruits and 40 canned foods, jams, jellies and/or other foodstuffs.

Three workshops were developed: the first workshop, focused on regional lemon juice and oils industries and fresh lemon producers and marketers with the attendance of 7 companies; the second workshop, focused on other regional citrus and fruit industries, fresh producers and marketers, had an attendance of 6 companies and farmers; and the third workshop, focused on jam, jellies, canned vegetables and other agro-food regional industries, had an attendance of 9 companies.

On the other hand, the project attempt to contact CAERM, but there was no response due to its high workload. Finally, ASAJA Murcia, which is close to farmers and organic production, were contacted, a meeting was organized, and the LifeCitrus team were able to report to farmers in their General Assembly.

The LifeCitrus team contacted with numerous companies, nationally and internationally, working meetings were organized and demonstrative actions were raised on the frame of LifeCitrus project. A total of 58 national and international citrus companies and 73 food companies, were encouraged to test their own citrus scraps or to participate in demonstrations at the semi-industrial CTC plant. In fact, 8 tests for 5 of them have been done. But it is noteworthy that the information is available to more than 500 companies through FIAB Association and the Spanish Food Technology Centers as CNTA and AINIA, which have known the LifeCitrus project in the organized meetings with them.

A total of 27 projects for making networking and synergies were identified, of which 17 projects established collaboration. In addition, 4 research and technology centers wanted to know the LifeCitrus project in more detail. 15 synergies have been detected and have allowed for the creation of a network of contacts among which the technicians of the LIFE ECOCITRIC project, LIFE CITRUSPACK, LIFE WOGAnMBR, LIFE FOOD WASTE STAND UP and the Basque Culinary Center (BCC).

Initial and Final press meeting were carried out with the attendance of 10 media companies 28 members of the regional university community and food companies. Two guided visits to the demonstration plant for journalist were carried out with the attended of 3 media companies. The LifeCitrus project appeared in 22 in press, radio and TV, a total of 10 newsletters, reviews and articles were published, 17 participations in national and international congresses and fairs and 475 people received information of the project and visit the pilot plant.

#### **5.4.7 Policy implications**

The success of the LifeCitrus project has contributed to achieve the objectives set out in the Roadmap for a Resource-Efficient Europe and the 7<sup>th</sup> Environmental Action Programme, given that the proposed process maximises the waste recycling, accordingly to the first steps of the EU waste hierarchy (prevention, re-use and recycling), as well as it limits the landfilling of residues or even their non-appropriate management.

Currently legislation only consider the citrus scrap as valueless, leftover elements of the productive processes, without taking into account their intrinsic nature and characteristics. However, LifeCitrus has demonstrated the effectiveness of the transformation process and the obtained ingredient, pushing up the value of the citrus residues. That's way it is expected that the LifeCitrus experience contribute for future legislation at regional, national and European level.

The circular economy is about reducing waste and protecting the environment, the Action Plan for the Circular Economy is organised into five key areas of action and five priority sectors (plastics, critical raw materials, food waste, biomass and bio-based products, and construction and demolition waste), with measures covering the whole life-cycle of products, from production and consumption to waste management and the market for recovered secondary raw materials. For each of them, it proposes a blend of smart regulations and incentives to help businesses, consumers, and national, regional and local authorities to drive the transformation to a circular economy. The LifeCitrus project is in the frame of circular economy policy because the aim of the project relies on citrus waste being reinjected back into product cycles as secondary raw materials, as an ingredient, which was once considered as a waste can become a valuable resource with high nutritional quality and safety.

The LifeCitrus project created a closed loop economies and markets because the public-private partnerships and all stakeholders worked together, which took a holistic approach to major barriers to implementation, allowing cooperation among heterogeneous stakeholders. This complementary approach was reinforced by the mobilisation of complementary sources of LIFE programme funding.

The LifeCitrus project responds the main challenges planning for 2016-2023 of the Roadmap to a Resource Efficient Europe and Circular Economy Package, because provides a new citrus waste

management concept, enhance capacity building and cooperation within different stakeholders: the citrus waste management sector, citrus companies and food companies, in order to prevent waste, keep materials circulating in the economy for longer and encourage the re-use of by-products.

Finally, it has to be pointed that no legal barriers have been found to implement the project.

### Annex I. Regional companies contacted in Action B3

Alcurnia Alimentación	Mocitos	Manuel García Campoy
Hida Alimentación	Aliminter	Golden Foods
Hero	Mensajero Alimentación	Filiberto Martínez
Cofrusa	Cofrutos	Probicasa
Abellán Biofoods	Cítricos de Murcia	Citromil
Riverbend	Toñifruit	Zumo Fresh Levante
Emily Foods	Juver	Coato
Derivados Cítricos	Frutas Apemar	Miguel Parra e Hijos
Mundosol Frutas	Panarro Foods	La Vega de Pliego
Marín Giménez	Baor Products	Original B2B
Lemon Concentrate	Antonio López Puche	Cítricos Cuello
Fruit Tech Natural	Frugarva	SAT Campotejar
Artelimón	Frutas Antoñete	Cítricos del sureste
Hortamira	La Vega de Cieza	García Aranda
La Niña del Sur	Cremofruit	La Vega del Mar Menor
Scorpyus Fruits	Blamuca	El Limonar de Santomera
Cítricos la Paz	Frutas Margoz	Tana
La Perla de Murcia	Hortimur	Frutas Buendía
Rabafruits	Agro Carrascoy	Eco Murcia
Araxsibon	Angibersan	Herabenza
Los Majos Bio	Productos Mediterráneos Belchi Salas	Alhama OYC
Camexa Inversión	Da Luna Plantaciones Ecológicas	La Ceheginera
Nanache	Natural Fruit Levante	Juan Alarcón González
Antonio Martínez Lax	Milco Fruit SAT	Helifrusa
Doscadesa 2000	El Huertanico	Mediterránea de Ensaladas
Postres Reina	Pastelería Gimar	Conservas Martínez
Joaquín Fernández e Hijos (La Loma)	Pedro Guillén	Almond
Lobrot	Prosur	Faroliva
Eurocaviar	Frutas de Librilla	Runakay Plus
Paqui Alemán	Manuel López Fernández Envases Metálicos S.L.	Caprichos del Paladar
Supermercados GranBBio	José Rodríguez Pastor	

## Annex II. Test at the demonstration plant - regional companies (action B3)

	Date	Company	Sector	Test description (citrus residues processed)
1	February 2017	Cítricos de Murcia	Lemon	Citrus puree production (50kg)
2	April 2017	Membrillo Emily	Jam, jellies and canned goods	Use of the citrus puree in a quince jelly recipe
3	May 2017	Coato	Jam, jellies and canned goods	Use of citrus puree in a vegetal drink recipe
4, 5	June 2017			
6	July 2017			
7	August 2017	Cítricos de Murcia	Lemon	Citrus puree production (450kg)
8	September 2017			
9	September 2017	Fruit Tech Natural	Lemon	Citrus puree production (180kg)
10	November 2017	Coato	Jam, jellies and canned goods	Use of citrus puree in a vegetal drink recipe
11	November 2017	Mocitos-Frucomur	Other citrus and fruits	Citrus puree production (116kg)
12	December 2017	Toñifruit	Lemon	Citrus puree production (300kg)
13	January 2018	Hortimur	Other citrus and fruits	Citrus puree production (200kg)
14	February 2018	Manuel García Campoy	Jam, jellies and canned goods	Use of citrus puree in a citrus jam recipe
15	February 2018	Mocitos-Frucomur	Other citrus and fruits	Citrus puree production (200kg)
16	February 2018	Coato	Jam, jellies and canned goods	Use of citrus puree in a vegetal drink recipe
17	May 2018			
18	May 2018	Toñifruit	Lemon	Ecological citrus puree production (200kg)
19	May 2018	Supermercados GranBiBio	Jam, jellies and canned goods	Use of citrus puree in a strawberry jam recipe
20	May 2018	Juan Alarcón	Other citrus and fruits	Citrus puree production (300kg)
21		González		Use of citrus puree in a jam recipe
22	May 2018	Eurocaviar	Jam, jellies and canned goods	Use of the citrus puree in a citrus spherifications recipe
23	June 2018	Hero España	Jam, jellies and canned goods	Use of the citrus puree in a strawberry jam recipe
24	June 2018	Frutas de Librilla	Other citrus and fruits	Use of the citrus puree in a blackberry jam recipe
25	July 2018	Frutas de Librilla	Other citrus and fruits	Ecological citrus puree production (200kg)
26	July 2018	Milco SAT	Other citrus and fruits	Use of the citrus puree in a peach jam production
27	July 2018	FTN	Other citrus and fruits	Citrus puree production (400kg)

**Annex III. National and international companies and relevant associations contacted in Action B4**

Albafruits	Novasanco
Perales y Ferrer	Manipulados Hortícolas San Andrés
Vitalgrana	Agriconsa
Agrisol	Agrofresh Export Consortium
Art-Fruits Group	Asociación Naranja de Valencia
Asso Fruit Italia	Best Fruit
Brio Fruits	Bruño
Cañamas Hermanos	Cinatur Group
Citriber	Cítricos Cox
Copal	Exquisite Fruits
Fontestad (Mayoristas de Cítricos en Madrid)	Torres Hermanos y Sucesores
Benihort - Coop. Agrícola San Isidro de Benicarló	García Ballester
Frutas Tono	Mediterranean Fresh Fruit & Vegetable Exporters' Association
Agroinver Zapata	Explotaciones Agrarias La Jaira
Explotaciones Agrícolas de Cítricos	Finca Carmina, Explotaciones y Servicios
Gil Rodríguez, David	Gimeno Pérez, Eloy
Martínez García, Francisco Isidoro	Mateo Torres, María de los Remedios
Velasco Callau, María Carmen	Cítricos Ferisan
Citrimogi	Agrumaria Corleone
AIIPA Association	Orange Fiber
Giuliano	EON
Nico Fruit	Gruppo Villari
Valdiverdura	Frutta Sana
Pannitteri	Azienda Trombino
Azienda Sava Agri	Consorzio COA Export
Cooperativa GOEL	Confagricoltura
Zuegg	Polengui Group
Agriconsulting	Grupo Ferrer - Interquim
Surinver	Cítricos el Túnel

**Annex IV. Test at the demonstration plant – national and international citrus juice and oil industries, fresh producers and marketers (action B4)**

	Date	Company	Sector	Test description (citrus residues processed)
1	February 2018	Cítricos el Túnel	Other citrus and fruits	Citrus puree production (50kg)
2				Citrus puree production (150kg)
3	March 2018	Grupo Ferrer-Interquim	Other citrus and fruits	Citrus puree production (300kg)
4	June 2018			Citrus puree production (300kg)



**Annex V. National al international companies and relevant associations contacted in Action B5**

ANTONIO Y PURI TORRES	SEAM START-UP	SANT'ORSOLA SPA
AGRICOLA FORESTAL DE NERPIO	INSTITUTO DE SOSTENIBILIDAD	ENEA (BIOAG DEPT.)
LORUSSO Y SAEZ, S.L.	MAPAMA-DGIA (SERVICIO DE CALIDAD INDUSTRIAL. SUBDIRECCIÓN GENERAL DE FOMENTO INDUSTRIAL E INNOVACIÓN. DIRECCIÓN GENERAL DE LA INDUSTRIA ALIMENTARIA. MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE)	RO.NA. FOODTECH CONSULTING
AGROINDUSTRIAS TROPICALES	AINIA	ITALCANDITI SPA
DULCESOL (JUAN Y JUAN)	ANICAV ASSOCIATION	POLENGHI GROUP
AGRICOLA ROCAMORA	AIPA ASSOCIATION	AGRICONSULTING SPA
ENCURTIDOS EL ZALAO	AZ AGRICOLA CAPPELLINO	ORDINE DEI TECNOLOGI ALIMENTARI CAMPANIA E LAZIO
CASA RUFINO S.L	UNINDUSTRIA CALABRIA CROTONE	ACEITUNAS CAZORLA
JUMEL ALIMENTARIA S.A	UNINDUSTRIA CALABRIA CATANZARO	MEMBRILLO EL QUIJOTE
MULTIFRUTICOS LA BODEGA	UNINDUSTRIA CALABRIA VIBO VALENTIA	PULPI EYA
OPEN COOK 2010	UNINDUSTRIA CALABRIA COSENZA	GALLINA BLANCA
POLGRI	UNINDUSTRIA CALABRIA REGGIO CALABRIA	EURECAT
HUERTO GOURMET	CONFINDUSTRIA RAGUSA	UNIVERSIDAD DE ALICANTE
UNIVERSIDAD DE GRANADA	CONFINDUSTRIA PALERMO	FUNDACIÓN CENTRO DE INVESTIGACIÓN Y DESARROLLO DEL ALIMENTO FUNCIONAL (GRANADA)
CNTA	CONFINDUSTRIA CATANIA	FUNDACIÓN PARQUE CIENTÍFICO DE MADRID
LINK-IDI	CONSORZIO APEO SICILIA	ASINCAR
BIOPLAT	CONFINDUSTRIA SALERNO	UNIVAR

TEPRO AGRÍCOLAS	CONSULTORES	CONFINDUSTRIA NAPOLI	INNOFOOD I+D+I
LEITAT		IAMB - CIHEAM BARI	DOMCA
CDTI		DNV GL	DERETIL
XARTA		CLUSTER DARE APULIA	SITRA
BETELGEUX, S.L.		FRESH PLAZA JOURNAL	IRCONFORT
PONS IP		ASSITOL	FIAB
AVES MATACHÍN	NOBLES-CASA	ASSOLOMBARDA	
ACCIONA SERVICE		ZUEGG SPA	

**Associations contacted through FIAB:**

Name	Description	Number of associated companies
ANFABRA	Association of soft drinks	20
FENAVAL	National federation of associations of processed vegetables and processed foods	227
AGRUCON	Spanish grouping of canned vegetable manufacturers	8
ASEVEC	Spanish association of manufacturers of frozen vegetables	12
AFEPADI	Association of dietetics and food supplements companies	90
PRODULCE	Spanish sweet association	62
AEFH	Spanish association of ice cream manufacturers	5
AME	Multi-sector association of food and beverage companies	25
ASEFAPRE	Spanish Association of manufacturers of ready meals	14
AEFSCP	Spanish association of manufacturers of sauces, broths and soups	9
ASOZUMOS	National association of juice manufacturers	18
ASEMAC	Spanish Association of manufacturers of bakery and pastry	32
ASPRIME	Spanish Association of manufacturers of raw materials and additives for bakery, pastry and ice cream	9

**Annex VI. Test at the demonstration plant – national and international jam, jellies and canned goods companies (action B5)**

	Date	Company	Sector	Test description (citrus residues processed)
1	January 2018	Dulcesol	Jam, jellies and canned goods	Use of the citrus puree in a sponge cake recipe
2				Use of the citrus puree in a fruit filling recipe
3	April 2018	Lorusso y Saez S.L.	Jam, jellies and canned goods	Use of the citrus puree in a strawberry jam recipe
4	July 2018	Membrillo el Quijote S.A.	Jam, jellies and canned goods	Use of the citrus puree in a strawberry jam recipe

