# Socio-economic and environmental performance of small-scale and mild fruit and vegetable processing technologies

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## Abstract

Food represents one of the most important commodities for human beings, but its production and processing can put pressure on the environment.

The technical and technological development has made possible to bring hundreds of millions of people out of hunger (although the problem of hunger in the world is still currently one of the main of challenges in the achievement of the Sustainable Development Goals SDGs for 2030) but the larger availability of food as a merely result of an economy-of-scale production and distribution raised several issues on its social and environmental sustainability.

In the framework of Horizon 2020, the FOX (Food processing in a Box) project will design, model and assess four innovative and flexible small-scaled food processing technologies in six European transnational regions.

## Introduction

In the recent years, with the advent of internet and with the so-called democratization of knowledge, consumers have became increasingly aware about the critical issues correlated with the current way to produce and process food (i.e. the transport of food over long distances, the overexploitation of resources and the exploitation of labor, the possible import of exotic diseases, the pressure on the environment, etc.) and because of that, a considerable amount of people began to take in consideration the environmental impacts of food products as one of the essential factor in purchasing a product.

Hence, the ethical and ecological awareness, starts to act as an essential compass when choosing a product with the consumers that indicate a preference for these products showing a better environmental performance.

As a consequence, consumers demand for locally grown and mild processed food products rose, resulting in new technological challenges for those companies involved in the food processing sector (i.e. producing food, in a profitable way, which is both mildly processed, safe and nutritious).

It appears that, until now, not many studies looked at mildly and minimally processed food (and at the related processing technologies and machineries). The few studies that exist looked at limited sustainability dimensions (without taking in consideration all the important aspects such as environmental and socioeconomic impact at the same time) and came with contrasting results.

Nevertheless, the new technologies are expected to permit the production of high quality and mildly processed food products with better nutritional characteristics in a more sustainable way.

## Methodology

A socio-economic and environmental impact assessment of these new technologies is being currently done.

The potential economic benefits are being assessed through the integration of economic data and business models in a so-called LCC (Life Cycle Costing) analysis. The analysis will include data regarding the commercialization in local markets of the products processed with the four new innovative and flexible technologies, data about investments and costs (direct, indirect, fixed, variable, opportunity, etc.) and data about potential business opportunities. For the social benefits, potential job creation and local workforce use in the six European transnational regional areas will be assessed.

In order to consider all the possible environmental aspects, impacts and issues and in compliance to both the ISO 14040 and ISO 14044 directives, an LCA (Life Cycle Analysis) is being carried out for all the four innovative technologies presented in FOX. The impact of the final products developed with the FOX processing technologies is being compared with the impact of some alternative products.

First, a Life Cycle Analysis regarding the identified alternative products has been carried out. For every food product, five stages of the supply chain have been identified and analyzed:

**Work Package 3 - AINIA**
Innovative quality analyses and sustainable packaging for fresh fruit and vegetable snacks

*Product: fresh cut ready to eat snack made of apricot, melon, cucumber, and snack peppers.*

| | |
|---|---|
| Healthier and more environmentally friendly options: *1) Fresh fruits locally produced* *2) Fresh vegetables locally produced* | Unhealthier but comparably environmentally friendly options: *1) Standard (not home-made) candy bars* *2) Standard (not home-made) cookies* |
| Comparably healthy but less environmentally friendly options: *1) Fresh tropical fruits not locally produced* *2) Fresh tropical vegetables not locally produced* | Unhealthier and less environmentally friendly options: *1) Standard (not home-made) candy bars with tropical fruit* *2) Standard (not home-made) cookies with tropical fruit* |

*Production stage* (agrochemicals, fertilizers transportation from the farm, water/ energy consumption).
*Processing stage* (packaging, transportation, water, fuels, and electricity consumption).
*Retailing stage* (transportation to the shops, secondary packaging, water, fuel, chemicals and electricity consumption).
*Consumption stage* (transportation, water/electricity consumption).
*Disposal stage* (waste collection and processing).

Then, a Life Cycle Analysis of the four innovative and flexible technologies intended for mild processing has been carried out in order to compare the two different environmental performances.

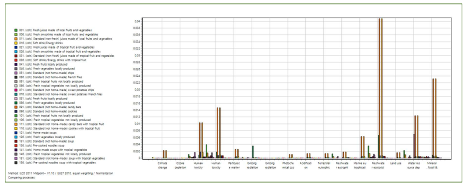
Data regarding the alternative products have been retrieved from the scientific literature while data regarding the case-study technologies have been collected from research partners which designed and which are currently developing the technologies. In order to do so, a proper protocol for data gathering has been developed:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Nº WP | | Component's name (i.e: pump, compressor, pipe, | | Weight in kg | kg | Expected maintenance (every how many months) | |
| Nº Doc. | | Function of the component | | % of the total weight | | Shortest expected lifespan (i.e: 5 years, 10 years, etc.) | |
| Volume | m³ | Cost of the component (In I, VAT excluded) | | Date / Place / Contact Person | | Country of assemblage | |

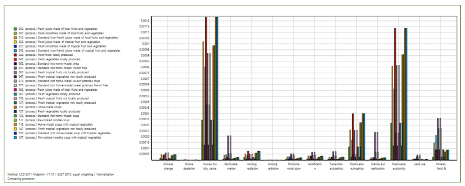
| Category | Sub-category | Characterization | Quantity | Unit of measure | Unit of measure | Info/notes/comments | Country | Recycled? Renew. |
|---|---|---|---|---|---|---|---|---|
| Metals and their alloys | | | | | | | | |
| Ferrous metals | | | | | | | | |
| Iron | | | 0 | kg | | | | |
| Total cast iron | | | 0 | kg | | | | |
| | Grey cast iron | Carbon (3% - 3.5%); Manganese (0.4% - 1%) Phosphorous (0.15% - 1%); Silicon (1% - 2.75%) | 0 | kg | | | | |
| | White cast iron | Carbon (1.75% - 2.3%); Manganese (0% - 0.4%) Phosphorous (0% - 0.2%); Silicon (0.85% - | 0 | kg | | | | |
| | Other cast iron (indicate) | | 0 | kg | | | | |
| Total steel | | | 0 | kg | | | | |

## Results

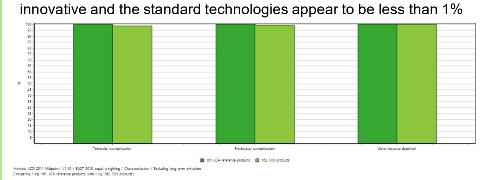
The final outcome will be a socio-economic and environmental impact assessment of the four innovative small-scaled food processing technologies. A preliminary life cycle assessment of all the alternative reference products has been already carried out



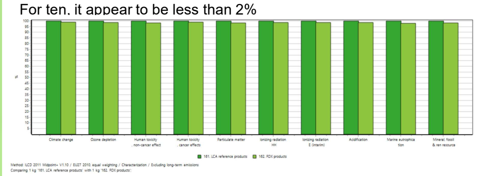
In the picture above, the results regarding the production stage of 32 alternative reference products are shown while in the picture below the results regarding the processing stage are shown.



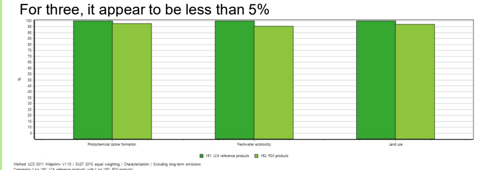
The first technology has been already compared with an alternative processing technology using some preliminary data. For three of the environmental impact categories, the difference between the innovative and the standard technologies appear to be less than 1%



For ten, it appear to be less than 2%



For three, it appear to be less than 5%



## Conclusion

The preliminary results regarding the comparison between the environmental performances of the first of the four technologies with a possible competitor already established on the market do not seem to show significant differences. For three categories of environmental impact out of sixteen, the difference is less than 1% (water resource depletion: 0.5%, freshwater eutrophication: 0.8%, terrestrial eutrophication: 0.8%). For ten categories of environmental impact out of sixteen, this difference is less than 2% (mineral, fossil and resource depletion: 1.8%, marine eutrophication: 1.9%, acidification: 1.3%, ionizing radiation E: 1.3%, ionizing radiation HH: 1.3%, particulate matter: 1.8%, human toxicity cancer effects: 1.1%, human toxicity non-cancer effects: 1.3%, ozone depletion: 1.5%, climate change: 1.3%). Finally, for three of the sixteen categories of environmental impact, a difference was found which, although more substantial, remains below 5% (photochemical ozone formation: 2.1%, land use change: 2.7%, freshwater ecotoxicity: 4.6% ).

Although these results suggest a not so significantly better environmental performance of mild processing technologies compared to standard processing technologies, it must be considered that:

A large number of data have not yet been taken into consideration (as at the moment not yet available). The weight (and the consequent effect on the overall environmental performance) that these parameters relating to these data possess is therefore still unknown at the moment.

The results relating to the environmental performance of the other three technologies could show totally different results.

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