
PLA4COFFEE
THE NEW
GENERATION
CAPSULES
Life
LIFE14 ENV/IT/000744

BACKGROUND OF THE PROJECT

Coffee capsule global market has reached the number of 48 million units sold in 2016.

Western European countries and North America are the biggest markets accounting for up to 70% of global production.

Beside aluminum, plastic, thanks to its easy processability and low cost, is the material of reference for coffee capsule manufacture.

More than 70% of coffee capsule are currently made with convention plastics such as Polypropylene and PBT.

Coffee capsules on their different parts can be made with very several materials together such as metal, plastic and ground coffee powder. After use, since there is no way to separate the metal or plastic materials from the exhausted organic coffee powder, coffee capsules and the single or multiple portion's wrapping material is brought to landfill creating huge environmental issues.
The introduction of a bio-compostable material (PLA) for the manufacturing of compostable coffee capsules is a viable solution to the growing environmental issue.
As known, neat PLA resin features appreciable elastic modulus and tensile strength, not far from petroleum-based polymers. Nonetheless, PLA resin is usually pretty brittle, featuring limited thermal resistance, toughness and resiliency unless blending with other polymers and/or inclusion of appropriate rigid nanofillers are made.
From the capsule production process to the recovery stage the ideal alternative bio-compostable material fulfill a series of challenging features such as:

During capsules production

1. Guarantee easy processability
2. Allow for short cycle times
3. Be used in the same equipment as used for standard polypropylene, changing only the shrinking

During capsule filling and closing

4. Use the same packaging equipment, with the same:

a) Feeding
b) Filling
c) Closing

5. The format size will be changed
6. The temperature, the pressure and recipe will change

As food packaging

7. Preserve coffee powder, and other product like tea and soluble drinks, organoleptic properties
8. Guarantee far better oxygen/water vapour barrier to provide shelf life
9. Comply with food contact (FDA & EU 10-2011) regulation
10. Comply with global & specific migration

In the coffee machine

11. Guarantee dimensional stability
12. Offer resistance to coffee dispencing conditions (temperature from 85 to 100°C / pressure 10 to 20 bar, brewing time from 20 to 50 seconds depending on machine / coffee)

During disposal

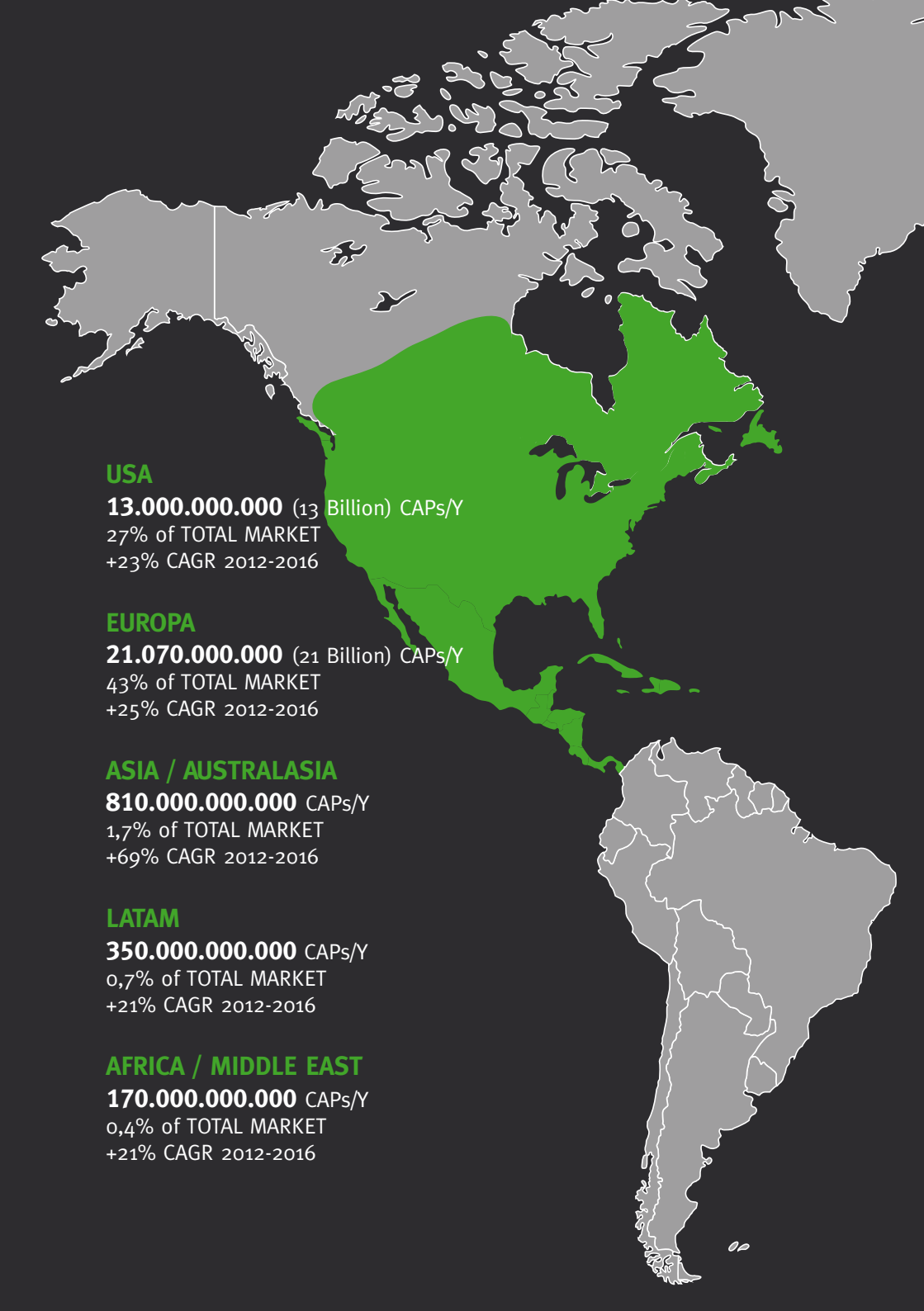
13. Be environmentally friendly

In this frame, with the contribution of the LIFE Program of the European Union, the Project LIFE4COFFE was aimed to validate the use of a new PLA based formulation on a preindustrial scale by refining the material already tested in laboratory and adapting existing plants employed for the production of coffee capsules.

48.000.000.000
CAPSULE/YEAR*

METAL: 13 Billion (27%
PLASTIC:35,4 Billion (73%)

* AMI Consulting
SINGLE SERVE BEVERAGE CAPSULES | August 2016



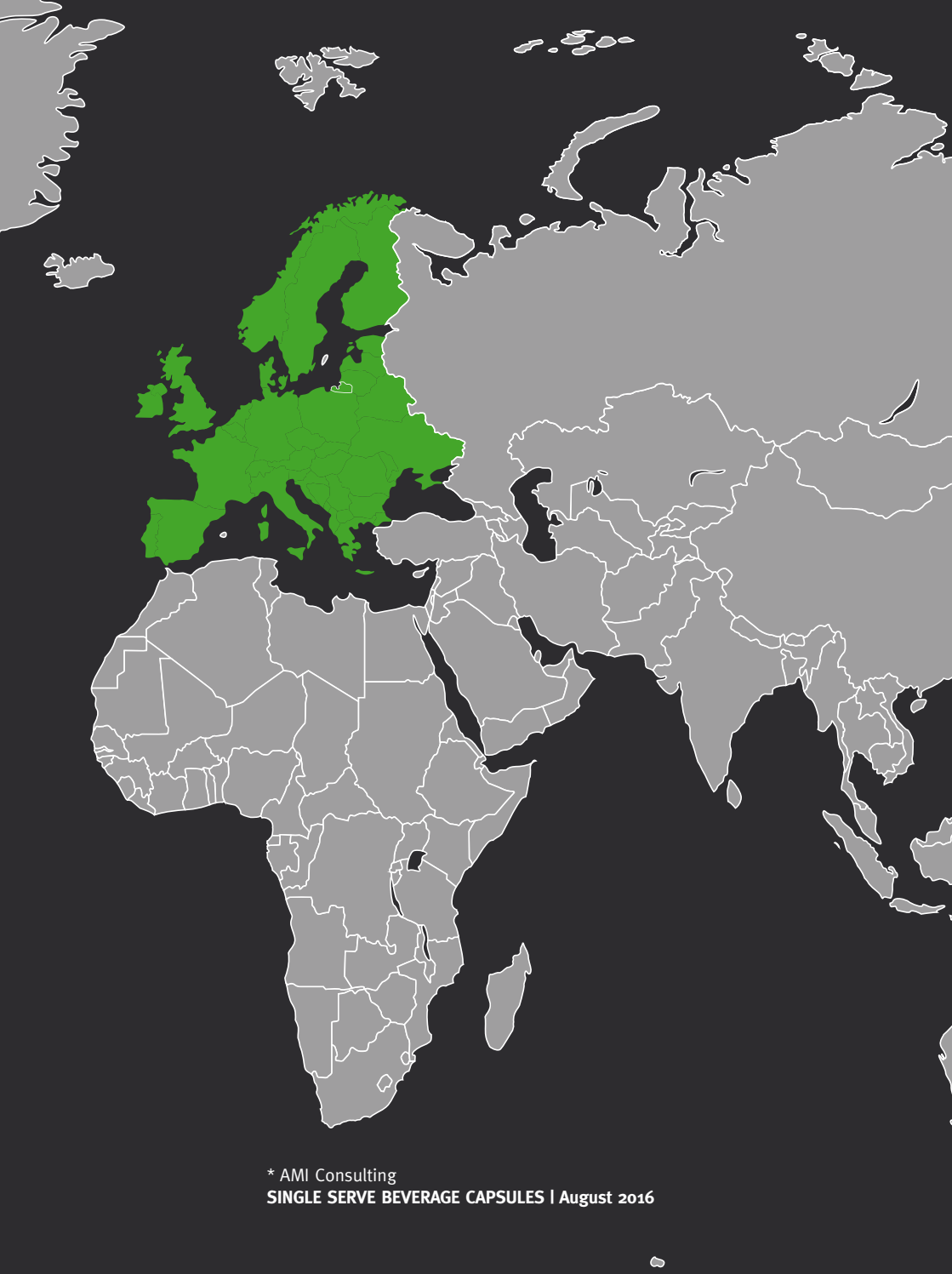
USA
13.000.000.000 (13 Billion) CAPs/Y
27% of TOTAL MARKET
+23% CAGR 2012-2016

EUROPA
21.070.000.000 (21 Billion) CAPs/Y
43% of TOTAL MARKET
+25% CAGR 2012-2016

ASIA / AUSTRALASIA
810.000.000.000 CAPs/Y
1,7% of TOTAL MARKET
+69% CAGR 2012-2016

LATAM
350.000.000.000 CAPs/Y
0,7% of TOTAL MARKET
+21% CAGR 2012-2016

AFRICA / MIDDLE EAST
170.000.000.000 CAPs/Y
0,4% of TOTAL MARKET
+21% CAGR 2012-2016



* AMI Consulting
SINGLE SERVE BEVERAGE CAPSULES | August 2016

316 MILLION US Population
13% are using single cup

15 BILLION COFFEE CAPS/YEAR
(Assumes that each person only makes one cup a day & Caps weigh roughly 12 grams)

200,000 TONS
of coffee caps per year

Equivalent of throwing away about
1231.5 Boing 747

OBJECTIVES

The project, with the contribution of the LIFE Programme of the European Union, was mainly aimed to:

- Demonstrate the suitability of innovative eco-friendly materials to meet the technical specifications of the coffee industrial field;

- Convince the stakeholders that it is possible to ensure new productions with reduced environmental impact while safeguarding economic growth.

One of the main issue resolved is to move the HDT (heat deflection temperature) from about 100 °C 150 °C, avoiding transportations summertime crystallizations and softening problems once the capsule is inserted inside the brewer machine.
One specific characteristic of the capsule, the oxygen barrier, has been tremendously improved. Even if not foreseen within PLA4COFFE program, we always aimed to resolve or improve the barrier properties offered from this new capsule to oxygen. This value is directly proportional to the expected shelf life. We started from a value of 35 (means 35 times worse than the aluminum capsule), versus a 75 for plastic itself. The latest tests shows a 1,5 outstanding result. This brings the expected shelf life to a foreseen 15-20 months.
This result is a combination of the new recipe formula, the refined extruding process and the improved injection and compression process.

Fig.1

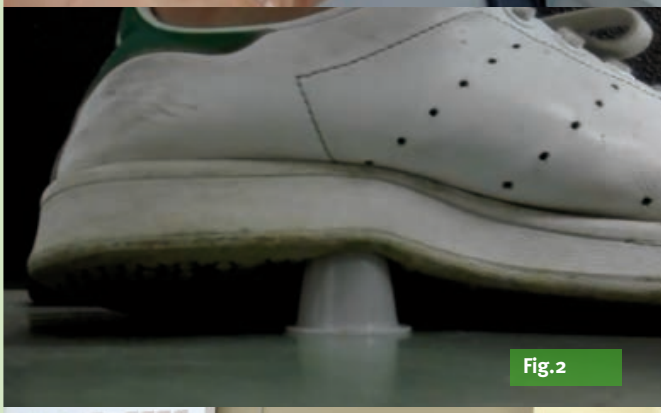


Fig.2

Fig.3

Fig.4

METHODOLOGY USED

LIFE-PLA4COFFEE project n. ENV/IT/000744 validated the industrial use of new poly(lactic acid) (PLA) based formulations for the production of compostable coffee capsules.

For this purpose, the project divided in three stages:

PHASE 1 - Scale-up of the new PLA material and the coffee production process by the refinement of selected PLA formulations and a specific development of the pre-industrial compounding plant.

PHASE 2 - Demonstration of the new material and the adapted process by testing prototypes: activities supported through life cycle and socioeconomic impact assessments.

PHASE 3 - Dissemination of project results trough the website, participation in relevant events such as fairs, workshops, international conferences as well as publications on international refereed journals and specific trade imagazines.

Fig.1. Non-engineered PLA Coffee Capsules
Fig.2. PLA Coffee Capsule - Weight of the person 85 kg
Fig.3. MID Term Workshop held at TOV
Fig.4. Final Workshop a HOST 2017

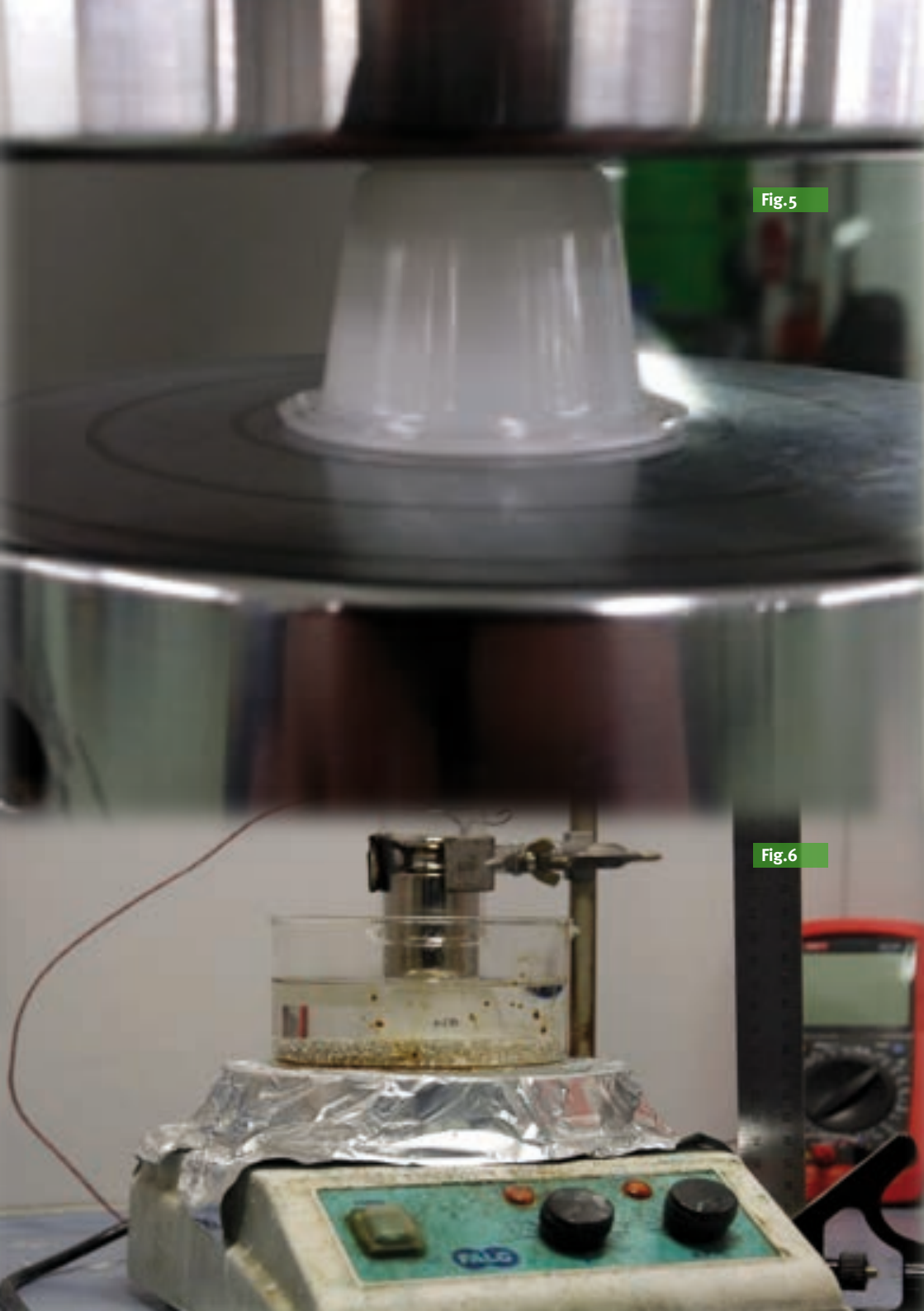


Fig.5

Fig.6

RESULTS

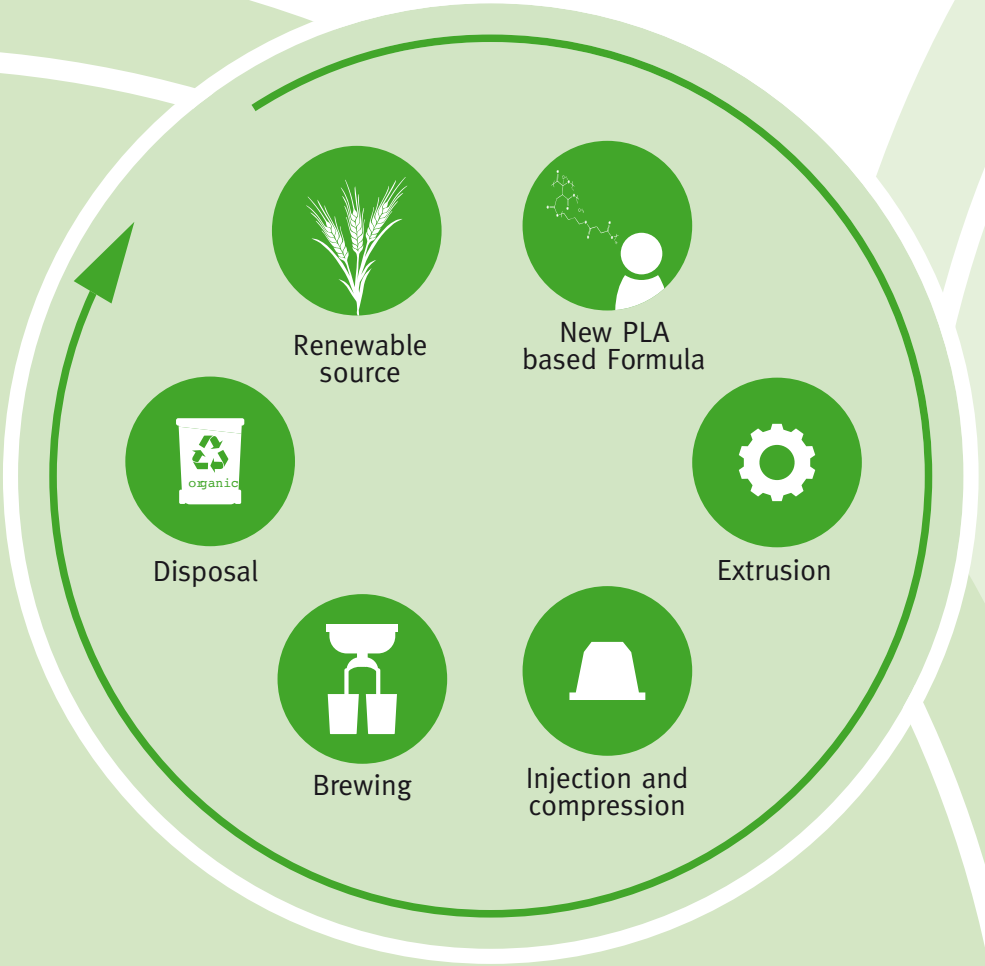
Technical results achieved within the two years of project can be summarized as follow:

- **Realization** of compostable formulations able to meet product requirements and ensure good processability by compression and injection molding.
- **Realization** of prototypes of bio-based and compostable coffee capsules on pre-industrial scale by injection and compression molding.
- **Optimization** of molding process parameters in order to maximize the production efficiency without prejudicing the quality standard of the molded items, and demonstrating that the proposed innovation is a concrete alternative to the current plastic materials.
- **Fine tuning** of the final recipe in order to reduce overall costs of the raw materials and improve the compounding process.
- **Progressive** and stress resins tests to ensure that all of the parameters have been fully addressed - test progressivi e continui di stress sulle resine al fine di verificare l'inalterabilità di ogni parametro

Fig.5. Compression test: Test speed 0.2-5-10-50-100 mm/min
Fig.6. Thermal Stability test: Temperatures 90-110-130-150 °C Load 0.5 Kg

- **Brewing** tests to finalize the very last step of a good coffee experience - test di erogazione del caffè per verificarne la qualità e l'aroma

- **Definition** of the compounding line at preindustrial scale, including a new and fast quality control of the pellets (via FT-NIR spectroscopy).



LONG-TERM ENVIRONMENTAL BENEFITS AND/OR SOCIO-ECONOMIC IMPACTS

Being able to finalize Pla4coffe gives us all big chances to go on with this path towards reducing plastic consumptions and introduce new resins for other projects.

Just thinking to single serve market trend, we confirm the possibility to start improving pla based resins towards plastic ones.
Costs have been reduced by at least 20%, while performances have been maintained equal (mechanical properties) or dramatically improved by a 20 times factor (oxygen barrier).

Other new formulations and tests are undergoing to further improve these values.

The resins formulation is also suitable to be implemented in different new projects just like wine or milk bottle, because, given its weight, it could also have a greater impact on the alimentary market.

PROJECT DETAILS

Title: **LIFE PLA4COFFEE**
Reference Number: **LIFE14 ENV/IT/000744**

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ADMINISTRATIVE DATA

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EU Contribution: 1˙501˙610 Euro
Website: https://pla4coffee.wordpress.com/