BIOPOL

With the contribution of the LIFE Programme of the European Union

LAYMAN'S REPORT

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CONTENT

SCENARIO

The leather industry is a high water and chemical consumption industry.

The chemicals normally used in the leather manufacturing are based on petrochemistry, due to the easy fossil raw materials availability and their chemical stability.

In accordance with the European Dangerous Substances Directive (67/548/CEE) almost 31% of the volume of the chemicals used by the European leather Industry are Hazardous Substances: 62% of those are used in Italy.

BREF (Best Available Techniques Reference document) and IPPC UE Directive of 2008 highly recommend the reduction of water consumption in the leather making process and look towards the identification of efficient and sustainable alternatives to guarantee the reduction of environmental impacts in the leather making process.

THE PROJECT

LIFE BIOPOL is a project co-financed by the European Union as part of the LIFE 2014-2020 programme.

The project involves five partners: CODYECO, chemical company responsible for project coordination, DERCOSA and INPELSA tanneries, the UNIVERSITY CA' FOSCARI OF VENICE and ILSA, a company specialized in plant nutrition.

The LIFE BIOPOL main target is the synthesis of a new class of products, named biopolymers, which represent innovative and eco-friendly alternatives to traditional petrochemical products used in the leather making process. The biopolymers are produced using as raw materials some industrial low or no value industrial side streams in order to enhance the circular economy between different industrial sectors.

The project intends to valorize wastes and by-products from agricultural and leather industry, modifying these resources into raw material to synthetize products with re-tanning and fat liquoring characteristics.
LIFE BIOPOL also satisfies many aspects considered highly relevant by the European legislation, in particular: the improvement of the water management, the reduction of hazardous substances and pullutants as well as the decreasing of the carbon footprint of chemicals.

The development of the new products started at pilot scale and it was performed into an industrial prototype plant specifically designed and built up for scaling up the new technology.

The scale up of biopolymers allowed the investigation of their performances in tannery on bovine, sheep, goat and split suede leathers.

The whole project was inspected through a Life Cycle Assessment study in order to minimize and calculate the environmental footprint of the new technology.

OBJECTIVES

1 Design and build up an industrial prototype plant able to produce the biopolymers.

2 Valorization of industrial side-streams through the development of safe and eco-friendly products.

3 Enhance the circular economy between different industrial sectors.

4 Prove that the new products have equal or better performances than petrochemical agents through the application in the leather making process.

5 Reduce the pollution load of re-tanning effluents and water consumption.

6 Verify that the Product Environmental Footprint (PEF) of the biopolymers is lower than conventional leather making chemicals.

PARTNERS

CODYECO
a smit & zoon company

Codyeco was established in 1976 in Santa Croce Sull'Arno (Pisa), one of Italy's most important tanning districts.

The company was set up to provide the tanning industry with a range of high quality chemical products and dyes, distinguished from their competitors by the addition of a strong technical service component with support from a technical testing laboratory.

These features quickly build Codyeco's reputation on the reference market and soon lead to the opening of new branches in other important Italian tanning districts, Solofra (Avellino) and Arzignano (Vicenza), providing these with independent technical laboratories.

ILSA
The green evolution

Since 1956 ILSA has been producing and selling organic and organo-mineral fertilizers, biostimulants and products with specific action. It has a full range of different product lines, for both conventional and organic farming. Its mission is to best meet the needs of today's farming, which is becoming increasingly specialized and focused on environmental issues.

The company's research center and technological innovation epitomize the company's will to always improve; they allow ILSA to be one of the leading companies in the field of biotechnologies for plant nutrition and biostimulation. The company owns three production plants, two in Italy (Arzignano, Molfetta) and one in Brazil (Porto Alegre).

DERCOSA

Founded in 1972, DERCOSA was created with the intention of generating value with the by-products of the meat and leather industry.

It was originally intended to be a collagen processing plant for the cosmetic industry, but the already established know-how in leather production of its founding group tipped the scale towards making it a split suede manufacturer.

Over 40 years later, DERCOSA is an established and significant bovine split suede specialist with respectable international clientele and a vast product range.

INPELSA

INPELSA is a Spanish tannery dedicated to the tanning and dyeing for clothing sheep leathers, with the main items the Duble-Face, the Napa and Nubuck and in recent years has expanded its range product for the leather footwear.

INPELSA was founded in January 1973, it competes in the first line of quality, in the leather market for clothing, and today is inserted into the main brands of footwear and leather industry, mainly using Spanish material.

Università Ca'Foscari Venezia

Ca'Foscari University of Venice is recognized as one of the best universities in the country offering its students ample study programs in a broad range of areas. Ca' Foscari University pursues the goal to achieve research excellence.

Research and teaching at DSMN are focused on basic and applied chemistry, such as organic, inorganic, industrial, analytical, nanosciences and molecular biology.

Fundamental and applied research are carried out with emphasis on sustainability and environmental safeguard and on new materials. The Department interacts with public and private institutions and companies, at the local, national and international level.

FROM TRASH TO TREASURE

The LIFE BIOPOL project is fully focused on the re–use of agricultural and leather industry's side streams.

ILSA has selected the following biomasses for the biopolymer synthesis:

- **PLANT DERIVED MATRICES: LEGUMINOUS CROP, CEREALS, SUGAR CANE AND SUGAR BEET**
- **ANIMAL DERIVED MATRICES: HIDES AND SKINS FROM TANNERY (WET BLUE)**

Vegetable biomasses are suitable sources of compounds of the carbohydrates family, whereas animal biomasses have a high protein content.

The by-products valorized within the project are such complex materials and need pretreatments in order to be reused. Therefore, the biomasses are treated through the enzymatic hydrolysis by ILSA.

The enzymatic hydrolysis brings many advantages, involving enzymes able to carry out a much more selective and less polluting recycling process in comparison with the traditional ones.

According to bibliography, several studies were carried out to investigate the effects of various processing conditions and different enzymes.

Therefore, several enzymatic hydrolyses were performed choosing enzymes in relation with their specific activity, application and industrial market availability.

The hydrolyzed biomasses produced by ILSA were provided to CODYECO in order to produce the leather making biopolymers.

FROM BIOMASSES TO INDUSTRIAL PERFORMANCE PRODUCTS

The low molecular weight hydrolysates were used as biological raw materials to produce biopolymers for re-tanning and fat-liquoring. CODYECO took advantage of its know-how on the leather chemicals in order to modify the starting hydrolyzed biomasses, making them suitable for the application on leather.

A multi-disciplinary approach was followed taking into account the chemistry of the biological starting materials and performances to achieve in application on leather.

New chemical protocols were developed and optimized through specific characterizations carried out by the UNIVERSITY OF VENICE, which allowed the synthesis of multi-functional bio-based products.

The use of the biological raw materials is the main strategy to obtain biopolymers with:

- **NON HAZARDOUS SUBSTANCES**
- **LESS ENVIRONMENTAL IMPACTS**

The biopolymers were produced at lab scale and then, scaled up at industrial scale.

The scale-up of the new technology was made into a prototype plant specifically designed and built up: the new plant is equipped with the latest generation technologies, which give the opportunity to perform a new range of chemical reactions.

Moreover, special sensors installed into the plant are able to monitor the environmental impacts of the manufacturing of the new products with the aim of producing chemicals with a certain value of environmental footprint.

APPLICATION ON DIFFERENT TYPES OF LEATHER

The performances of the new biopolymers were investigated in tannery by DERCOSA and INPELSA.

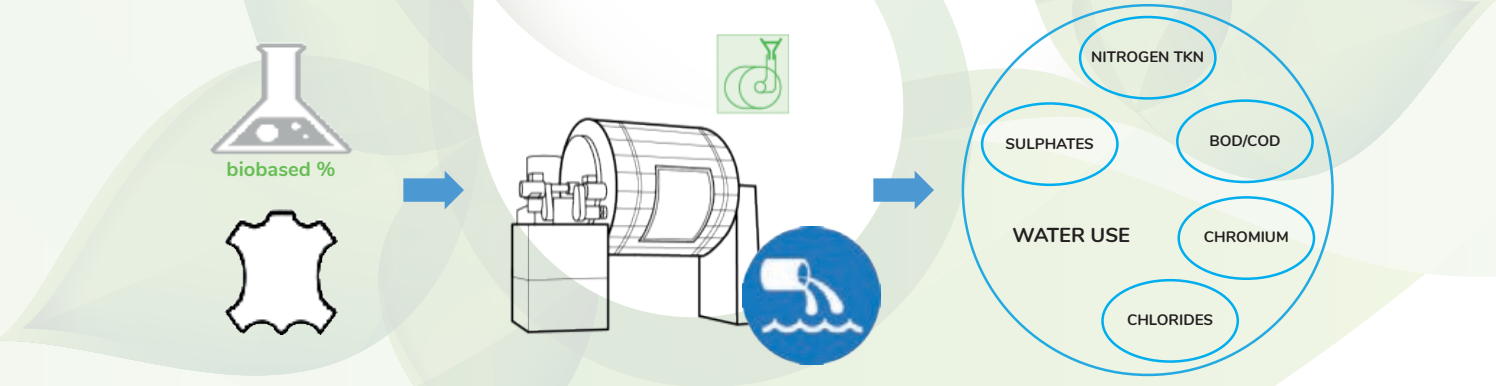
The two tanneries, specialized in production of split-suede and goat/sheep leathers, started to use the BIOPOL products in their application recipes. The aim of this activity was the replacement of conventional chemicals in order to make a range of leather articles comparable to the ones produced through traditional processes.

In the same way, CODYECO evaluated the performances of the new products on bovine, developing leather articles using bio-based application recipes.

Leather articles that have been fully developed are:

- SHOE UPPER COWS
- LEATHER BAGS COWS
- SPLIT SUEDE FOOTWEAR
- SHEEP FOR GARMENT, SHOES AND BAGS
- DOUBLE FACE LAMB SKINS

During these activities, the quality of the wastewaters was monitored through the inspection of specific parameters such as COD, BOD, Total Nitrogen and salts in order to evaluate the environmental benefits of the new technology.



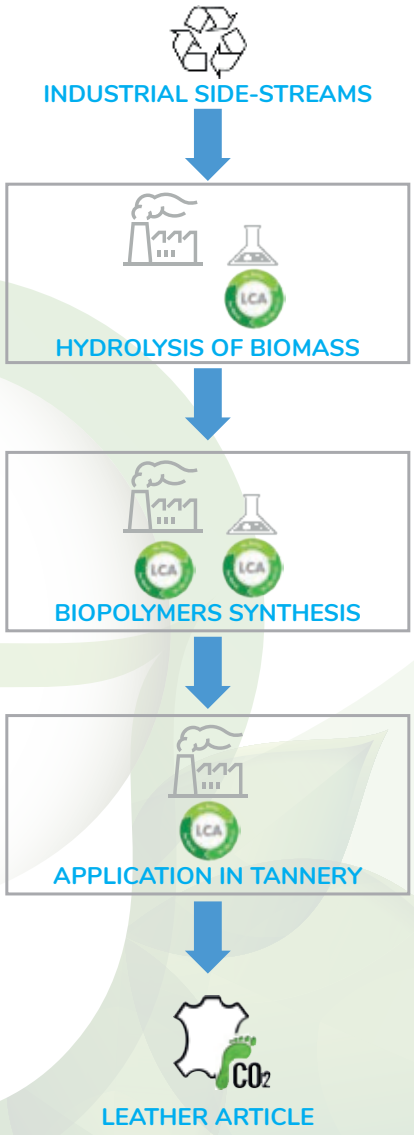
LIFE CYCLE ASSESSMENT (LCA)

The evaluation of the environmental footprint of the biopolymers was made through a Life Cycle Assessment study in according to the PEFCR document (Leather) in order to calculate:

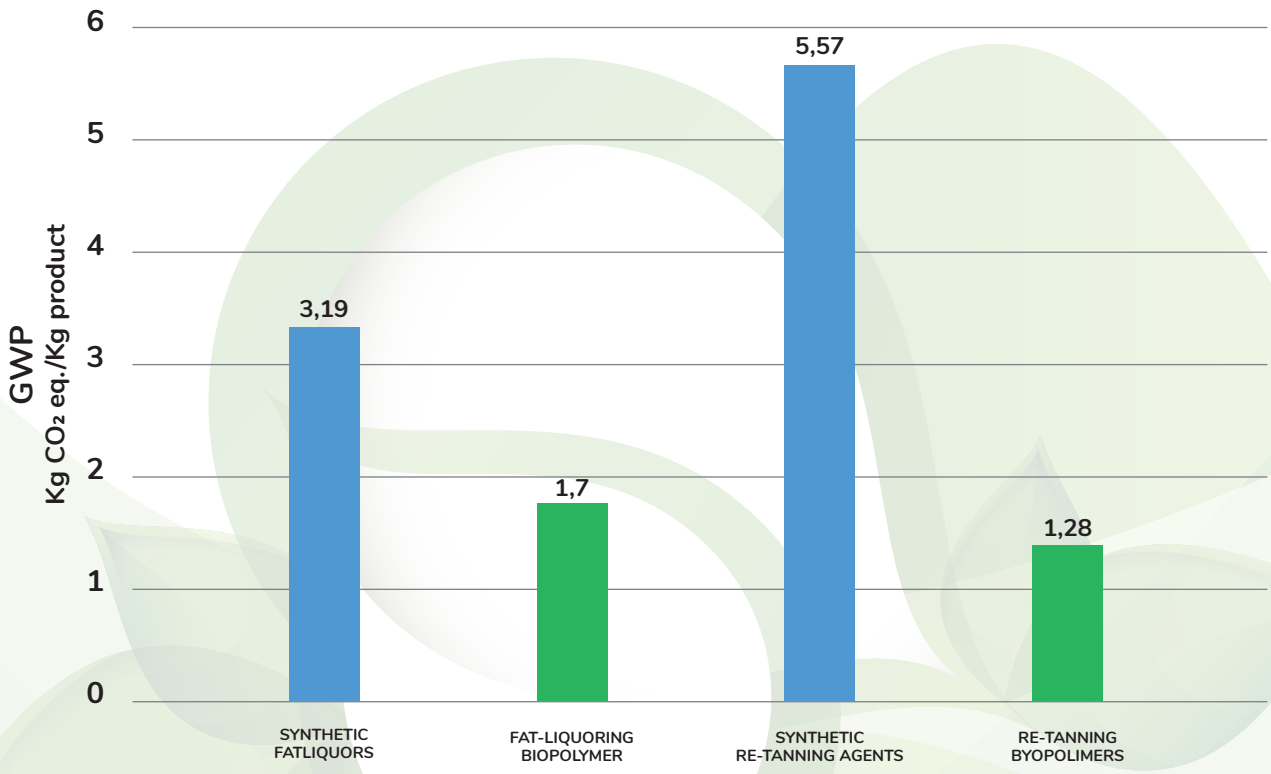
- **PRODUCT ENVIRONMENTAL FOOTPRINT (Kg CO_2 eq./ Kg product)**
- **CARBON FOOTPRINT FOR MAKING LEATHER ARTICLES (Kg CO_2 eq./ m^2 leather)**

The LCA study concerned every LIFE BIOPOL activity in order to create and test an innovative approach for leather chemicals, with the aim of evaluating the environmental benefits of the selected starting materials and processes.

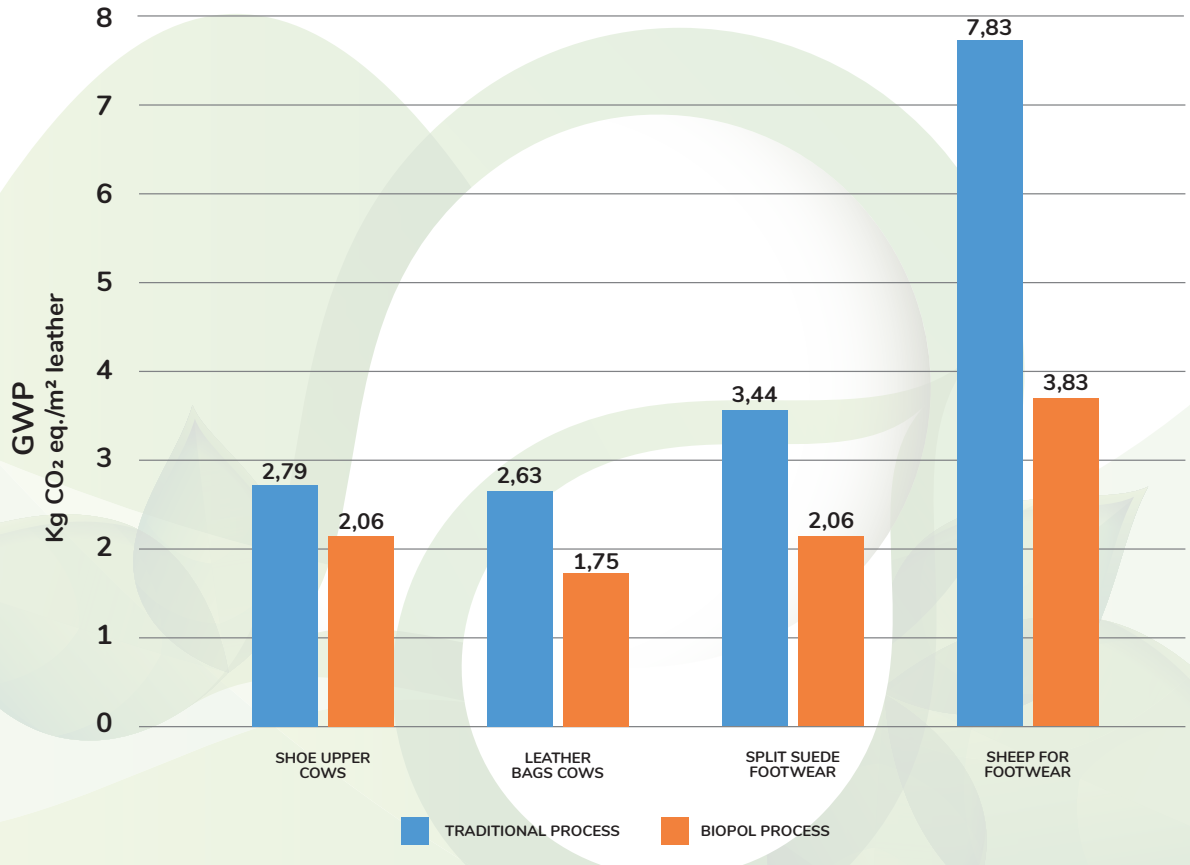
Furthermore, the study was extended to the application of biopolymers in the leather making process.



PRODUCT ENVIRONMENTAL FOOTPRINT



ENVIRONMENTAL IMPACT OF THE LEATHER ARTICLE



MAIN RESULTS

PERFORMANCES

1. Consistent leather quality achieved with the new technology
2. Good Light Fastness and Heat Yellowing
3. Goog Fogging Performances
4. More brilliant color and deeper shade than standard crusts

CIRCULAR ECONOMY

1. Higher bio-based content against traditional petro-based chemicals
2. Good biodegradability
3. Product Environmental Footprint up to 77% less than conventional chemicals used in the retanning phase
4. Carbon Footprint to produce the leather article up to 51% less than traditional processes

WASTE MANAGEMENT

1. Chlorides (15%), Sulphates (98%) and Total Nitrogen (57%) reduction is a constant of all tests performed using biopolymers
2. Reduction up to 25% of water used in the re-tanning phase
3. No chrome salts addition in re-tanning

CONCLUSION

- Valorization of wastes and by-products from the leather and agricultural industry is confirmed.
- Characterization data confirm that interactions among reagents lead to the desired biopolymers during the synthesis.
- The biopolymers show good performances on different types of leather and can be used to produce a broad range of leather articles.
- By the use of the new technology a decreasing of the pollution load in the re-tanning effluents is achievable.
- The biopolymer based products have lower PEFs (Kg CO_2 eq./Kg product) than conventional petro-based chemicals used in similar processing step.

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