



Sposób wykorzystania
odpadowej biomasy i
strumieni pobocznych do
wytwarzania surowców oraz
kompozycji kosmetycznych

**Method of utilizing waste biomass
and side streams to produce raw materials
and cosmetic compositions**

PAT 2795 Application No.: P.455335 (PUT, Symbiosis)

From Waste to Beauty

An innovative method for processing apple pomace into cosmetic raw materials

Connecting the food and cosmetic industries through a circular economy model.



LESS WASTE
MORE OPPORTUNITIES
A MORE BEAUTIFUL
TOMORROW

THE CHALLENGE

Poland is one of the world's largest producers of apples and concentrated apple juice, generating an average of

2,5 million tonnes
of waste per year
(apple pomace).

This represents a huge logistical and environmental challenge for the food sector.



HOW DOES THE TECHNOLOGY WORK?

Apple pomace is processed through a sequence of operations:



WHAT DO WE GET?

The obtained fractions are used to create ready-made, eco-friendly cosmetic formulas:



Cosmetic raw materials from apple pomace: pectin, polyphenols, fruit water and other valuable ingredients.

KEY ADVANTAGES OF THE INVENTION



**ZERO-WASTE
AND FULL VALORIZATION
OF PROCESS STREAMS**

Membrane concentration enables environmentally friendly recovery of pectin from waste apple pomace while utilizing all side streams.



**HIGH MARKET
POTENTIAL
(UPCYCLING)**

Transformation of cheap, problematic food waste into sought-after, high-value cosmetic raw materials "eco-friendly".



**APPLICATION SYNERGY
OF RAW MATERIALS**

Isolated ingredients allow the creation of a complete cosmetic (from the water base, through the thickener, to active and conditioning substances) derived from a single waste source.



**REDUCTION OF CARBON
AND WATER FOOTPRINT**

Lower consumption of technological water in cosmetic production by using water recovered from fruits (Upycled Water).



NATURE
INSPIRES
SCIENCE
CREATES
POSSIBILITIES



INTELLECTUAL PROPERTY PROTECTION

Patent application number: P. 455335 (Poznań University of Technology, Symbiosis Sp. z o.o.)

PAT 2795: A method for the extraction, concentration and recovery of pectin from waste apple pomace using membrane processes, with the use of side streams as cosmetic raw materials, cosmetic compositions based on them and a set of cosmetic products, as well as a non-medicinal cosmetic method for skin regeneration and improving its appearance.



TECHNOLOGY READINESS LEVEL
TRL 7/8



SUSTAINABLE DEVELOPMENT
REAL BENEFITS
FOR PEOPLE AND THE PLANET



PAT 2795 Application No.: P.455335 (PUT, Symbiosis)

1. Introduction

Poland is one of the world's largest producers of apples and concentrated apple juice, generating an average of 2.5 million tonnes of waste per year, which poses a huge logistical and environmental (organic waste) challenge for the domestic food sector.

The apple pomace processing method presented in this invention solves this problem through a revolutionary, cross-industry circular economy model. This technology connects the food and cosmetics industries, transforming waste streams remaining after industrial pectin extraction into innovative, high-value cosmetic raw materials. At the heart of the technology is an advanced membrane filtration process, which allows for the effective concentration and recovery of valuable biomass resources, including pectin, polyphenols, and water.

2. Technical Description

The technology is based on the processing of the byproduct (apple pomace) using a sequence of processes: extraction, filtration, ultrafiltration (UF), and precipitation. The use of membrane processes significantly reduces the costs associated with the energy-intensive solvent evaporation step. Simultaneously, the presented method utilizes the resulting byproduct streams as cosmetic raw materials and bases for chemical peels. The extracted fractions are used to create ready-made, eco-friendly cosmetic formulas: gels, emulsions, and advanced serums and chemical peels.



PAT 2795 Application No.: P.455335 (PUT, Symbiosis)

3. Advantages of the Invention

- **Zero-Waste and full valorization of process streams:** Thanks to the use of membrane concentration, it is possible to recover pectin from waste apple pomace in an environmentally friendly way while simultaneously managing side streams.
- **High Market Potential (Upcycling):** Transformation of cheap, troublesome food waste into sought-after, expensive and consumer-desired "eco-friendly" cosmetic raw materials.
- **Application synergy of raw materials:** Isolated ingredients allow the creation of a complete cosmetic (from the water base, through the thickener, to the active and conditioning substances) derived from a single waste source.
- **Reduction of Carbon and Water Footprint:** Reduction of technological water consumption in the production of cosmetics in favor of water recovered from fruits (Upcycled Water).

4. Intellectual Property (IP) Protection

- **Patent application number:** P. 455335 (Poznan University of Technology, Symbiosis Sp. z o.o.)
- **PAT 2795:** Method for extraction, concentration and recovery of pectin from waste apple pomace using membrane processes with the use of side streams as cosmetic raw materials, cosmetic compositions based thereon and a set of cosmetic products, as well as a non-therapeutic, cosmetic method for regeneration and improvement of skin appearance.

5. Technology Readiness Level (TRL)

TRL 7 / TRL 8 (Technology Readiness Level)

PAT 2737 Application No.: P.453421 (PUT, PULS, Symbiosis)

From Biodiesel Waste to Beauty Solutions

Biotechnological conversion of crude glycerol into advanced cosmetic ingredients

Innovative technology combining microbial bioproduction of organic acids with membrane separation, enabling full valorization of process streams in a circular economy.



THE CHALLENGE



Biodiesel production generates large amounts of crude, contaminated glycerol, posing significant environmental and economic challenges for the fuel industry.

MILLIONS OF TONNES

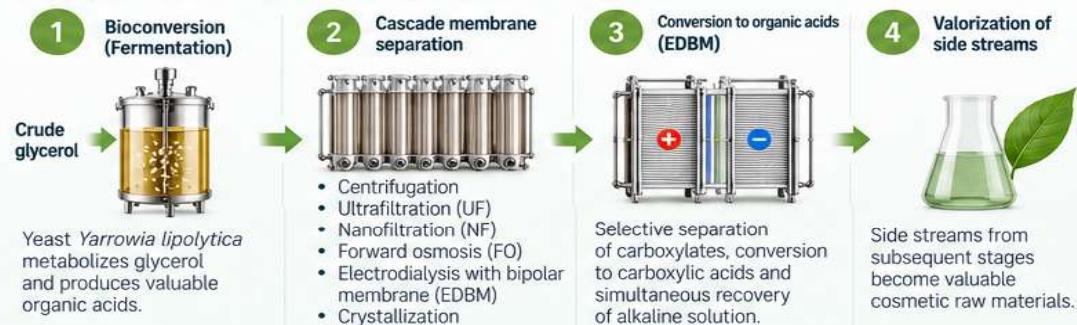
of crude glycerol are generated globally each year.

This represents a major environmental burden and high disposal costs.



HOW DOES THE TECHNOLOGY WORK?

An integrated bio-refinery in a closed-loop production cycle:



OUR FINAL PRODUCTS

Four standardized, high-value cosmetic ingredients:



Alpha-ketoglutaric acid (AKG)
High-purity functional ingredient with anti-aging properties.



Pyruvic acid
Strong exfoliating and brightening active ingredient.



Postbiotic from *Yarrowia lipolytica*
Rich in yeast lysates, amino acids and vitamins. Supports the skin microbiome.



Fermentation water (NF permeate/concentrate)
Upcycled water – a natural, green solvent for cosmetic formulations.

KEY ADVANTAGES OF THE INVENTION



ZERO-WASTE & FULL VALORIZATION

Complete utilization of all process streams. No secondary waste – even yeast biomass becomes a valuable postbiotic, and purified water is used in cosmetics.



HIGH BIOCOMPATIBILITY & ACTIVITY

Organic acids produced biotechnologically ensure natural origin and excellent skin compatibility. AKG – a valued anti-aging ingredient, pyruvic acid – strong exfoliating and brightening effects.



INNOVATIVE SEPARATION METHODS

Forward osmosis (FO) and EDBM enable efficient, low-energy concentration of carboxylic acids and conversion of their salts to the acid form, with simultaneous recovery of the alkaline solution.



POSTBIOTIC FOR SKIN MICROBIOME

A response to the key market trend – supporting the natural skin barrier and microbiome.



HIGH MARKET POTENTIAL (UPCYCLING)

Transformation of a low-value industrial waste into luxurious, high-value active ingredients for face and body care.

BIOTECHNOLOGY CREATES VALUE PEOPLE AND PLANET BENEFIT

CIRCULAR SOLUTIONS
REAL CHANGE



INTELLECTUAL PROPERTY PROTECTION

Patent application number: **P. 455655**

(Poznań University of Technology, Poznań University of Life Sciences, Symbiosis Sp. z o.o.)

PAT 2737: A method for the simultaneous bioproduction of alpha-ketoglutaric acid and pyruvic acid and their separation with simultaneous valorization of side streams.



TECHNOLOGY READINESS LEVEL

TRL 7/8



SUSTAINABLE DEVELOPMENT
TANGIBLE BENEFITS
FOR PEOPLE AND THE PLANET



PAT 2737 Application No.: P.453421 (PUT, PULS, Symbiosis)

1. Introduction

Biodiesel production generates large quantities of crude, contaminated glycerol (so-called crude glycerol), creating a significant environmental and economic challenge for the fuel industry. This solution transforms this low-value industrial by-product into high-value, advanced raw materials for the cosmetics industry through innovative biotechnological processes.

By combining microbial synthesis of carboxylic acids using selected strains of *Yarrowia lipolytica* with an innovative membrane-based separation and concentration process, the technology integrates bioproduction with the recovery and reuse of process components, contributing to the closure of material loops. The project aligns with the principles of the circular economy, in which each side stream generated during the subsequent processing of the fermentation broth is valorized and transformed into a commercially valuable ingredient for use in skincare products.



PAT 2737 Application No.: P.453421 (PUT, PULS, Symbiosis)

2. Technical Description

The technological process functions as an integrated bio-refinery divided into three critical phases:

- **Bioconversion (Fermentation):** Glycerol is used as the main carbon source (nutrient) in an aerated bioreactor where the yeast *Yarrowia lipolytica* metabolizes it, producing valuable organic acids.
- **Cascade membrane separation:** The raw fermentation fluid is subjected to subsequent separation and concentration steps in the following sequence: centrifugation, ultrafiltration (UF), nanofiltration (NF), forward osmosis (FO), electrodialysis with a bipolar membrane (EDBM), crystallization.
- **Bipolar membrane electrodialysis (EDBM):** The EDBM process enables selective separation of carboxylates, their conversion to the corresponding carboxylic acids and simultaneous recovery of the alkaline solution.
- **Obtaining cosmetic raw materials:** Side streams generated in subsequent stages of membrane filtration constitute raw materials for use in cosmetic masses.

As a result of multi-stage separation, four final, standardized products are obtained:

- **Alpha-ketoglutaric acid (AKG) and pyruvic acid** – Highly pure functional ingredients.
- **Postbiotic ingredient** – obtained from the post-fermentation fraction (centrifugation/ultrafiltration), rich in yeast lysates, amino acids and vitamins, dedicated to the protection of the skin microbiome.
- **Upcycled fermentation water (NF Permeate)** – Fermentation water (Permeate/Concentrate NF) – upcycling water, acting as an ecological green solvent in ready-made cosmetic masses.



PAT 2737 Application No.: P.453421 (PUT, PULS, Symbiosis)

3. Advantages of the Invention

- **Zero-Waste and full valorization of process streams:** Complete elimination of secondary waste. Even yeast cell fractions become sought-after postbiotics, while purified water from the bioreactor becomes a cosmetic base.
- **High biocompatibility and activity:** The biotechnological production of organic acids (rather than chemical synthesis) guarantees their natural origin and excellent skin absorption. AKG is a valued anti-aging ingredient, while pyruvic acid exhibits strong exfoliating and brightening effects.
- **Application of innovative separation methods:** Through the use of forward osmosis (FO) and bipolar membrane electrodialysis (EDBM), efficient, environmentally friendly, and low-energy concentration of carboxylic acids is possible, as well as the conversion of alpha-ketoglutaric acid and pyruvic acid salts into their acidic forms with simultaneous recovery of the base.
- **Innovative postbiotic for the microbiome:** The postbiotic fraction addresses one of the strongest market trends in cosmetics – supporting the skin's natural protective barrier and bacterial flora.
- **High-margin upcycling:** Transforming a worthless, contaminated waste stream from biofuel production into luxurious and high-value active ingredients for face and body care.

4. Intellectual Property (IP) Protection

Patent application number: P.455655 (Poznan University of Technology, Poznan University of Life Sciences, Symbiosis Sp. z o.o.)

PAT 2737: Method for simultaneous bioproduction of alpha-ketoglutaric acid and pyruvic acid and their separation with simultaneous management of side streams.

5. Technology Readiness Level (TRL)

TRL 7 / TRL 8 (Technology Readiness Level)

PAT 2819 Application No.: P.455655 (PUT, Symbiosis)

CosmeoDES

Green Solvent Technology for Sustainable Cosmetics

Patented Deep Eutectic Solvents (DESs) for zero-waste plant extraction and low-energy manufacturing.

**SAME
INGREDIENTS.
MORE
POSSIBILITIES.**



THE CHALLENGE

The modern cosmetic industry aims to eliminate volatile organic solvents and simplify production processes in line with Green Chemistry.

2.5 million tonnes

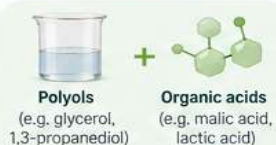
of apple pomace are generated annually in Poland, creating a major logistical and environmental challenge for the food sector.



HOW DOES CosmeoDES WORK?

A simple, integrated process in a closed production cycle:

1 Preparation of DESs



Thermal mixing of a hydrogen bond donor and acceptor (cosmetic raw materials) forms a stable deep eutectic solvent.

2 Low-energy extraction



DES selectively extracts and stabilizes polyphenols from apple pomace under mild temperature conditions.

3 Multifunctional extract ready for formulation



CosmeoDES Apple Pomace Extract – a final product that goes 100% into cosmetic formulations (without the need for solvent evaporation or waste disposal).

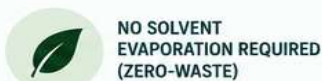
A MULTIFUNCTIONAL INGREDIENT

The extract becomes a valuable component of a wide range of cosmetic products:



Nature's potential fully utilized – from extraction to final cosmetic.

KEY ADVANTAGES OF THE INVENTION



**NO SOLVENT
EVAPORATION REQUIRED
(ZERO-WASTE)**

The entire extractant remains in the product as a valuable ingredient. No chemical wastewater and no energy consumption for distillation.



**LOW-ENERGY
PRODUCTION
(COLD PROCESS)**

Enables the creation of cosmetics using a cold process, significantly reducing the carbon footprint.



**5 in 1 TRUE
MULTIFUNCTIONALITY
(ALL-IN-ONE)**

One ingredient performs five functions: antioxidant (polyphenols), humectant (polyols), pH regulator (organic acids), formula stabilizer and enhancer of active ingredient penetration into the skin.



**SAFETY AND
GREEN CHEMISTRY**

Elimination of petrochemical solvents in favor of green, cosmetic-safe solvents.



**HIGH MARKET
POTENTIAL
(UPCYCLING)**

Transformation of a cheap, problematic food waste into sought-after, high-value cosmetic raw materials.

**SUSTAINABLE
INGREDIENTS
REAL BEAUTY
REAL IMPACT**



INTELLECTUAL PROPERTY PROTECTION

Patent application number: **P.455655** (Poznań University of Technology, Symbiosis Sp. z o.o.)

PAT 2819: Method for preparing deep eutectic solvents based on polyhydric alcohols and organic acids, their use as extractants of active compounds from apple pomace, and cosmetic compositions based on them.



**TECHNOLOGY READINESS LEVEL
TRL 7/8**



**SUSTAINABLE DEVELOPMENT
TANGIBLE BENEFITS
FOR PEOPLE AND THE PLANET**



1. Introduction

The modern cosmetic industry strives to eliminate volatile organic solvents and maximize the simplification of production processes in accordance with the principles of Green Chemistry. The "CosmeoDES" project revolutionizes the classic approach to plant extraction by introducing a patented technology of deep eutectic solvents (DESs) created exclusively from safe cosmetic raw materials. This technology allows for low-cost and highly selective extraction of valuable polyphenols from biomass (apple pomace). A significant breakthrough is the fact that the obtained extract does not require energy-intensive solvent evaporation – the extractant becomes a multifunctional component of the finished cosmetic formulation.

2. Short Description of the Technology

The technological process consists of two main, integrated stages carried out in a closed production cycle: (1) Preparation of DESs. Thermal mixing of a hydrogen bond donor and acceptor, both being cosmetic raw materials, is carried out in a reactor. Example systems include: 1,2,3-propanetriol + malic acid or 1,3-propanediol + lactic acid. As a result of intermolecular interactions, the melting point of the mixture is lowered, forming a stable eutectic liquid. (2) Low-energy extraction. The DES is transferred to an extraction reactor/evaporator containing biomass (apple pomace). Under mild temperature conditions, the solvent selectively captures and stabilizes polyphenols. The result of the process is Multifunctional CosmeoDES Apple Pomace Extract – a final product that goes 100% into cosmetic formulations (without the need for liquid phase separation or disposal of post-reaction waste).



PAT 2819 Application No.: P.455655 (PUT, Symbiosis)

3. Advantages of the Invention

- **No solvent evaporation required (Zero-Waste Technology):** The entire volume of the extractant remains in the product as a valuable cosmetic ingredient. This eliminates the issue of generating chemical wastewater and energy consumption for distillation.
- **Low-energy cosmetic manufacturing (Cold Process):** Due to the presence of polyols and acids, the extract facilitates the formulation of cosmetics using the "cold process" method, which significantly reduces the carbon footprint of cosmetic production.
- **True multifunctionality (All-in-One):** A single raw material serves 5 roles simultaneously in the final cosmetic: antioxidant (polyphenols), humectant (polyols), pH regulator (organic acids), formula stabilizer, and penetration enhancer for active ingredients into the skin.
- **Safety and Green Chemistry:** Elimination of petrochemical solvents in favor of green solvents that are safe for use in cosmetic formulations.

4. Form of Intellectual Property Protection

Patent application number: P.455655 (Poznan University of Technology, Symbiosis Sp. z o.o.)

PAT 2819: Method for obtaining deep eutectic solvents based on polyhydric alcohols and organic acids, their use as extractants of active compounds from apple pomace, and cosmetic compositions based on them.

5. Technology Readiness Level (TRL)

TRL 7 / TRL 8 (Technology Readiness Level)