



# Releasing the potential of feathers

UNLOCK project solutions



Bio-based Industries  
Consortium



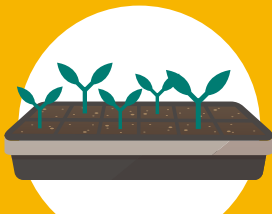
This project has received funding from the Bio-based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement N° 101023306.

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# The UNLOCK project

The European poultry sector produces **3.6 million tonnes of waste feathers** annually, mainly valorised in low added value products. In line with the **EU Bioeconomy Strategy**, the UNLOCK project aims to transform this waste into a valuable raw material to create a new sustainable value chain.

The initiative will create bio-based products for agriculture, such as:



**Forest and seed trays**



**Mulch films**



**Hydroponic foams**



**Nonwoven geotextiles**

UNLOCK uses three different technologies for feather treatment based on the desired end-product: mechanical grinding, steam explosion and microbial fermentation.

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**3** different technologies for feather treatment

Since feathers are nearly **90% keratin**, these materials offer additional benefits: they are designed to be zero waste, biodegradable, and enrich soils with organic nitrogen.

Feathers contain nearly

**90%**  
Keratin

From storage to treatment efficiency, product performance to market readiness, **UNLOCK finds solutions to every hurdle along the value chain to create a feather-based bioeconomy.**



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# Poultry sector analysis by Farrelly and Mitchell

## Feather Waste Sources and Management in the EU

In 2020, the EU poultry sector produced 13.6 million tonnes of meat, with 67% coming from **France, Germany, Italy, Poland, and Spain**. These target countries generated approximately **480,000 tonnes of feathers annually, out of 620,000 tonnes across the EU**.



**620,000 ton**  
of waste feathers  
generated annually  
across the EU

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A limited number of licensed establishments (0.5-3.98%) currently manage feathers or feather-related products, underscoring the **need** for more specialised **entities to handle poultry feather waste and support a bio-based economy**.

## Challenges in the Feather-Based Economy

Key **hurdles** in feather value chains include maintaining feather quality, developing the infrastructure required for the novel value chain, and logistics.

Eliminating moisture content and contamination in the feathers through incentivising processors to invest in additional processes will be key to **advancing the novel value chains**.

**Keratin-based bioplastics** will face competition in the market, and developing product differentiation and consumer acceptance will be critical.



# Solutions for Supply Chain Challenges

UNLOCK proposes **innovative solutions**, including additional feather management processes and developing focussed business strategies to address the various potential hurdles.



## Find out more:



Analysis of Feather Waste Sources and Management in the EU



EUs Feather-based Economy: The Challenges Ahead



Supply chain solutions for the main scenarios detected in the target countries



# Feather treatment technologies



## Mechanical grinding

### What is it?

The physical process to mechanically reduce feather size.

### Purpose

It is used to produce feather fibers for UNLOCK geotextiles and to feed other technologies such as **Steam Explosion processes** to homogenise the size of the material.

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**A demo-scale mechanical grinding plant with a capacity of 200 kg/h is under construction in Kutno (Poland).**

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Sanitised feathers



Ground feathers



## Steam explosion

### What is it?

A physical process that uses temperature and pressure to treat feathers.

### Purpose

To break down feather structure. It is used to produce **biodegradable plastics** for agriculture (mulch films, seed trays and hydroponic foams).

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**In the continuous reactor at the Biorefinery Demo Plant in Sweden, it was possible to produce 20 kg/h of treated feathers.**

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Steam explosion  
continuous reactor



Steam explosion  
treated feathers



## Microbial fermentation

### What is it?

A bioprocess whereby some bacteria are able to produce feather-digesting enzymes that will fractionate keratin.

### Purpose

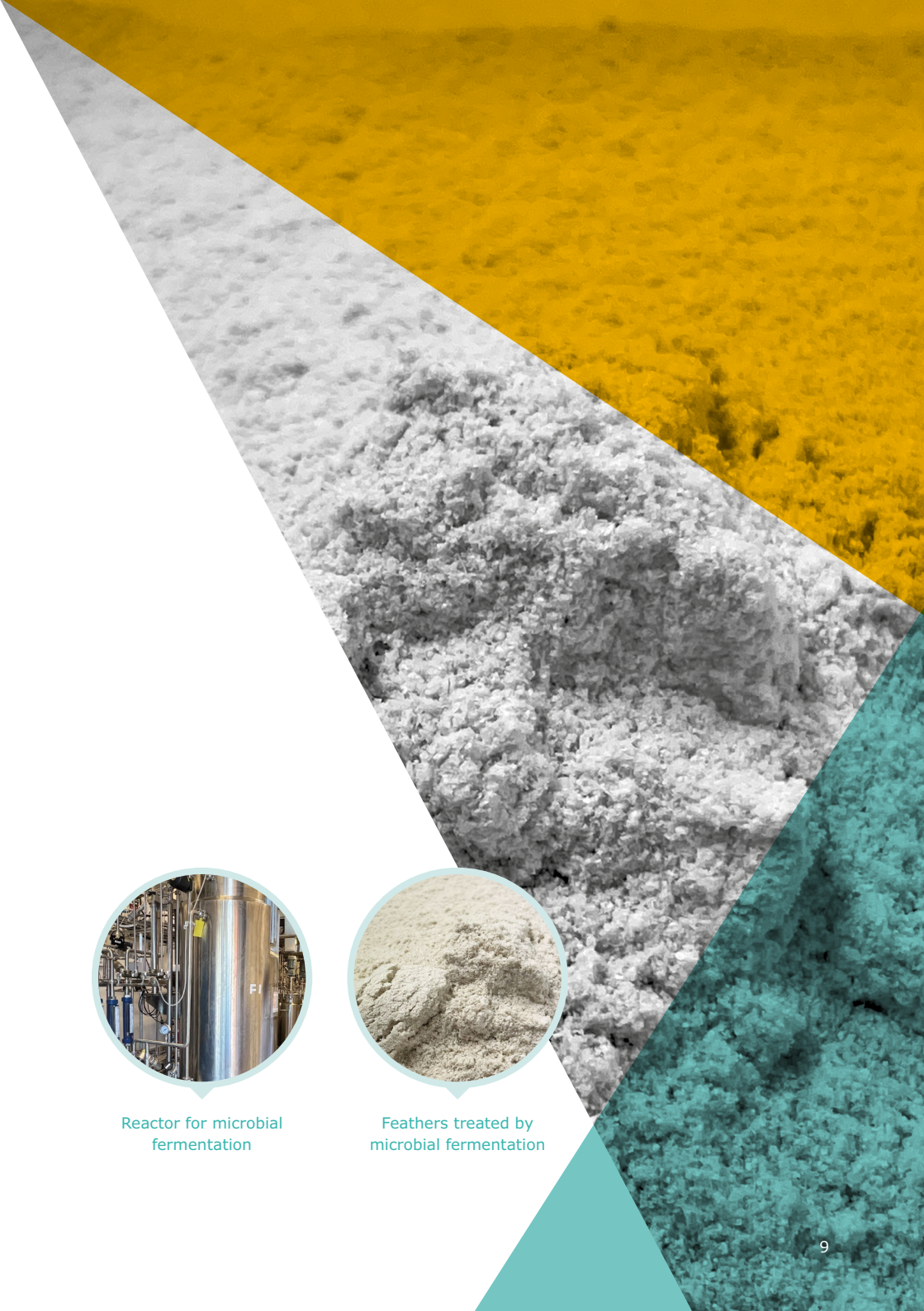
To obtain keratin fibers for the production of **hydroponic foams**.

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**Demo plant is also located in Sweden with a reached capacity of 600L of batch production.**

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Reactor for microbial fermentation



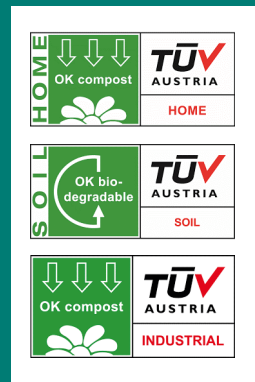
Feathers treated by microbial fermentation

# Products based on treated feathers for agricultural applications

Plastics used in agriculture are not sufficiently recycled due to contamination at use phase, and so far biodegradable alternatives are not widely used.

To replace conventional non-biodegradable agricultural plastics, UNLOCK will demonstrate the production of sustainable keratin-based end-products with tailored biodegradability properties at the end-of-life.

All project end-products biodegradability under different conditions is being tested by NORMEC OWS.



## Maximising the impact of UNLOCK's results





## Seed trays

### Composition

Blend of biodegradable plastics with steam explosion treated feathers.

### Application

Containers for greenhouse growth of plant materials.

### Advantages

Compostable in industrial conditions and input of Nitrogen to soil. Under development biodegradable in soil materials.

### Production process



CEDROB

Feather collection and sanitation



RISE PROCESSUM

Treated feathers: Steam explosion



CIDETEC/BIOMI

Compounding



BIOMI

Extruded sheets



ACUDAM

Thermoforming



## Mulch films

### Composition

Blend of biodegradable plastics with steam explosion treated feathers.

### Application

Soil protection in different crops (prevents the growth of weeds, loss of moisture, etc.).  
Replaces polyethylene (PE) film.

### Advantages

Biodegradable in soil, input of Nitrogen to soil.

### Production process



CEDROB

Feather collection and sanitation



RISE PROCESSUM

Treated feathers: Steam explosion



CIDETEC/BIOMI

Compounding



TECNOPACKAGING

Blow extrusion







## Non-woven geotextiles

### Composition

Biodegradable fibers (synthetic and natural) combined with mechanically ground feathers.

### Application

Crop protection, avoiding soil erosion, weed growth prevention. It replaces polypropylene geotextiles.

### Advantages

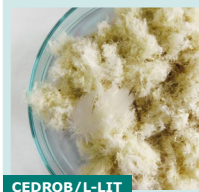
Compostable in industrial conditions and input of Nitrogen to soil.

### Production process



CEDROB

Feather collection and sanitation



CEDROB/L-LIT

Treated feathers: mechanical griding



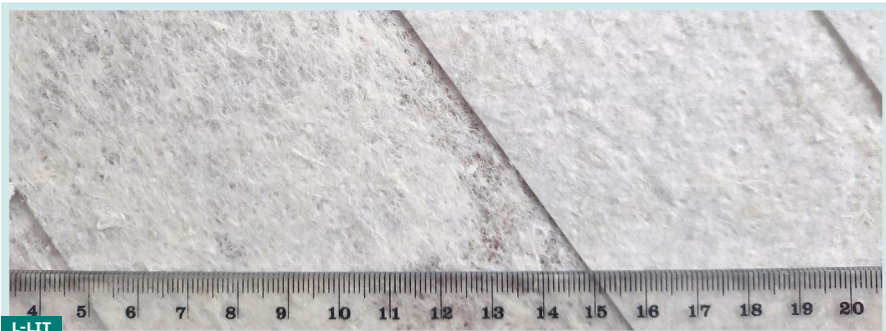
L-LIT

Nonwoven needling



L-LIT

Calender



L-LIT



# Biodegradable Foams for Hydroponic Crops – Keratin pebbles

## Composition

Foamed biodegradable plastic with treated feathers (microbial fermentation and/or steam explosion treated feathers).

## Application

Substrate for hydroponic crops. It replaces clay pebbles current substrates.

## Advantages

Depending on the formulation, foams with different types of end-of-life are obtained: compostable in industrial conditions or biodegradable in soil.

## Production process



CEDROB

Feather collection and sanitation



RISE PROCESSUM



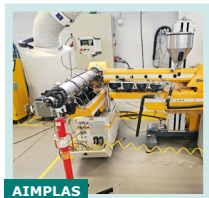
BIOEXTRAX

Treated feathers: Steam explosion/ microbial fermentation



BIOMI/AIMPLAS

Compounding



AIMPLAS

Foaming by extrusion



TERRA AQUATICA



AIMPLAS

# Partners



## Contact

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