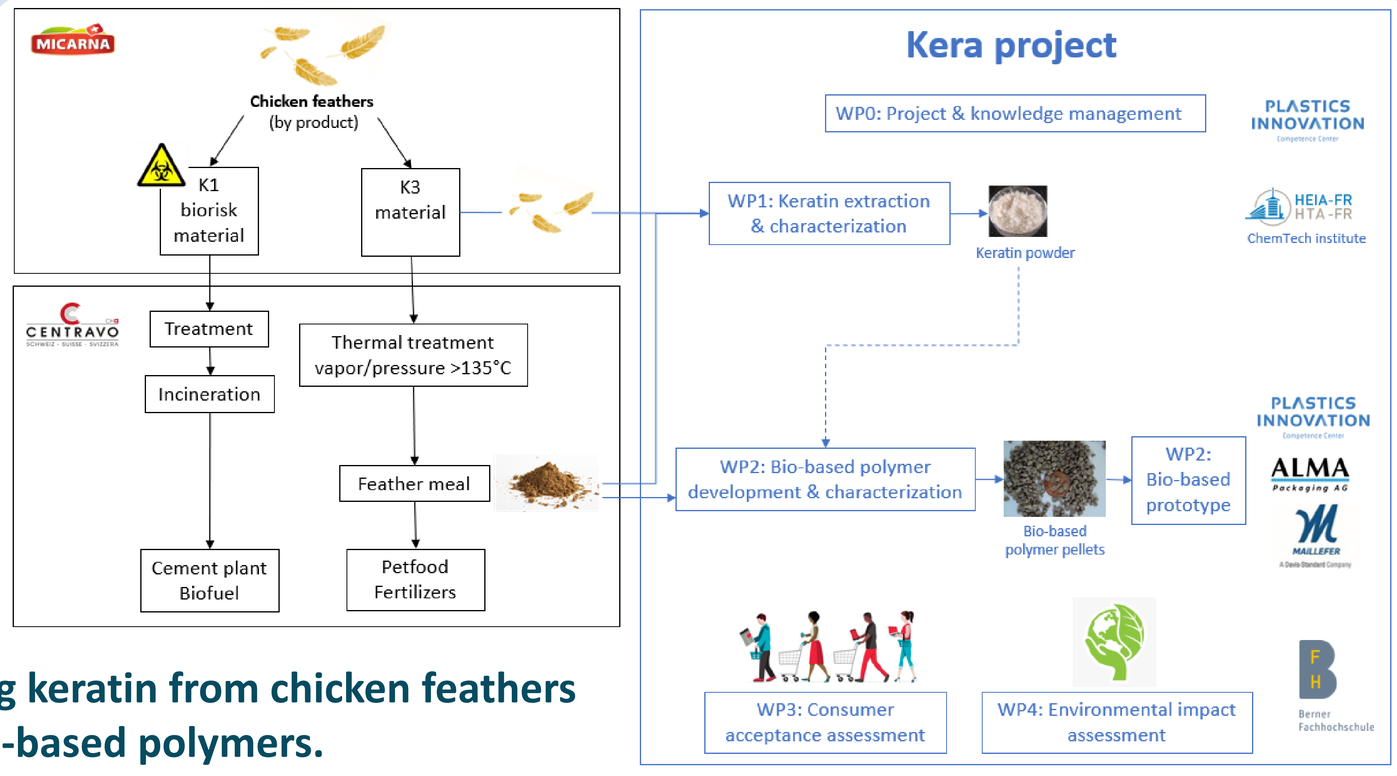
# KERA

Collaborative Project funded by npr Nouvelle politique régionale — State of Fribourg / Etat de Fribourg / Staat Freiburg: Development Agency FDA, Promotion économique PromFR, Wirtschaftsförderung WiF — Fribourg, the place to grow!

# Valorization of chicken feathers keratin as new bio-based polymers

## Context & Objectives

In the European Union, around 15 million tons of poultry meat are transformed each year and this consumption is expected to increase in the coming years.
Unfortunately, poultry industry generates huge amounts of waste (40% per chicken, including feathers) resulting in approximatively 3 to 4 million tons of feather waste generated only in the European countries.
This by-product is typically either converted into low-nutritional value animal feed, fertilizer or incinerated. Not only are these options unsustainable but they also miss an opportunity to contribute to the circular economy.
With about 90% protein content, poultry feathers are potentially a rich and renewable source of polymeric protein (keratin).




**KERA project evaluated the feasibility of using keratin from chicken feathers for the development of new bio-based polymers.**

## Results

### Keratin extraction & characterization

Extraction of keratin from chicken feathers and chicken feather meal was tested using three different approaches:

1. ionic liquid 1-butyl-3-methylimidazolium chloride → dissolution problems and no precipitation of keratin.
2. N-methylmorpholine N-oxyde → low yield extraction (25-30%).
3. L-cysteine method → promising results in terms of yield (26% for feathers, 39% for feather meal). The method was scaled-up on a 5L reactor (yield 43%) and on a 15L reactor (yield 22%). The extracts were used for characterization and polymer development.

FT-IR deconvolution of keratin samples were performed showing that keratin extracted is composed mainly from beta-sheet and random coils (65-70%) followed by alpha-helix (20-25%) and turns (2-5%). TGA measurements showed at first a loss of water and a decomposition of the samples at 200°C. SDS-PAGE measurements did not produce accurate results and improvement or modification of the method should be performed.

### Bio-based polymer development

The development of a polymer based on feather meal was carried out in three stages.

1. Use of feather meal as is and compound it into pellets for plastic injection or extrusion. The material can be extruded (3 mm diameter).

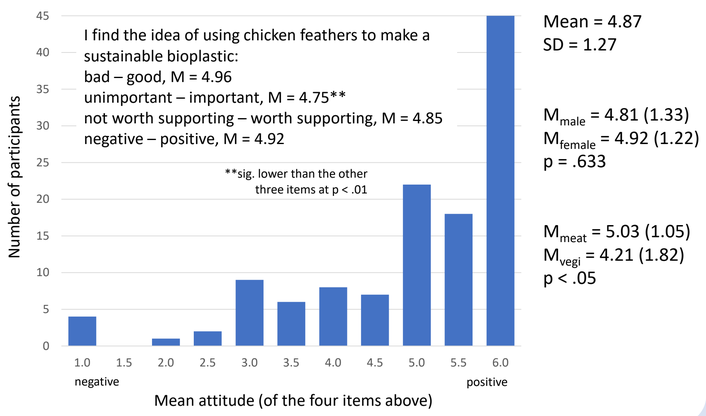
2. Use of feather meal as a filler with 2 types of compostable polymers of KD Fedderson (M-VERA GP1037 with 30% cleaned feather meal, M-VERA B5029 with 50% cleaned feather meal). Both blends are injectable with industrial molding machines.

3. Use of extracted keratin to prepare a gel that can be compressed into a film. This experiment provides proof of principle that a keratin film can be made.

### Consumer perception

An online survey was conducted in spring 2021 in German and French-speaking Switzerland with 122 consumers. The results show that consumers like the idea of using the whole animal in general, and making a plastic out of chicken feathers specifically. If the importance of this endeavor would be stressed, one can expect to even increase further the positive attitude.

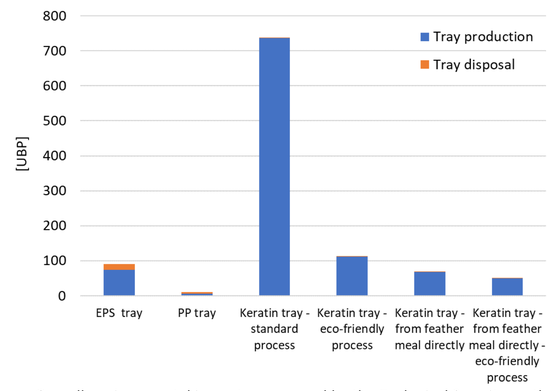
Consumers are willing to pay a small premium price and the new plastic should be introduced as a plastic made from natural material that is safe, especially regarding component's migration.
In summary, consumers would welcome such a packaging.




### Sustainability assessment

Environmental impacts of different production scenarios for a keratin-based packaging device (tray) were evaluated and compared with analogous packaging devices made from expanded polystyrene (EPS) and polypropylene (PP) using life cycle assessment (LCA). Life cycle stages covered production and disposal.

Environmental impacts of keratin-based packaging may be lower than for EPS packaging when mitigation measures in the production process are implemented (renewable energy use, recovery of acetone, use of urea in agriculture) and/or the keratin-based material is produced from feather meal directly. However, even in the best-case impacts are higher than for PP packaging.




Overall environmental impact as assessed by the Ecological Scarcity method for different production scenarios.

**Keratin from feathers is a viable biopolymer as an alternative to fossil-fuel based plastics for developing $CO_2$ neutral applications that befit the circular economy.**

## Project partners

MICARNA · CENTRAVO CH SCHWEIZ · SUISSE · SVIZZERA · ALMA Packaging AG · MAILLEFER · PLASTICS INNOVATION Competence Center · HEIA-FR HTA-FR · Berner Fachhochschule Haute école spécialisée bernoise

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