



WORKSHOP

2 0 2 1

BIOBASED MATERIALS RESEARCH: ADVANCES FROM ECOFUNCO AND BIONTOP EUROPEAN PROJECTS

ecofunco

biontop



Bio-based Industries
Consortium





Proteins as bio based coatings for packaging





Agenda

- **Fraunhofer IVV introduction**
- Challenges faced with packaging today – approaches to improve sustainability of packaging
- Protein based coatings as possible solution
 - Properties of protein coatings
- Micellar lupin protein in Ecofunco
 - Properties of micellar lupin protein
 - Further developments



Fraunhofer IVV – Locations Freising and Dresden

Institute Head Fraunhofer IVV: Prof. Dr. Andrea Büttner | Prof. Dr.-Ing. Jens-Peter Majschak



Total budget	€ 30,4 million	Total workforce	325
External contracts	€ 26,9 million	Scientists and graduates	184
Institutional funding	€ 3,5 million	Postgraduate students	41

(Status April 2021)



Our Business Fields – Synergies for Your Success



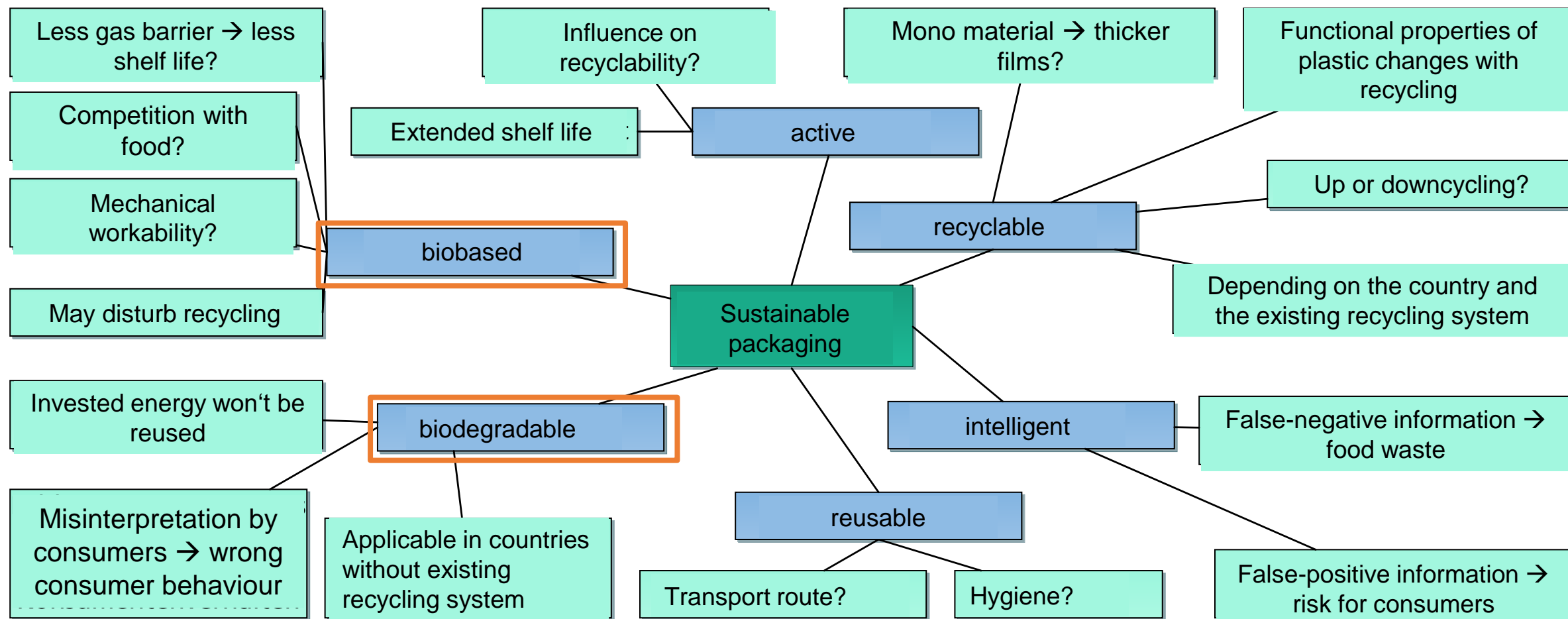


Agenda

- Fraunhofer IVV introduction
- **Challenges faced with packaging today – approaches to improve sustainability of packaging**
- Protein based coatings as possible solution
 - Properties of protein coatings
- Micellar lupin protein in Ecofunco
 - Properties of micellar lupin protein
 - Further developments



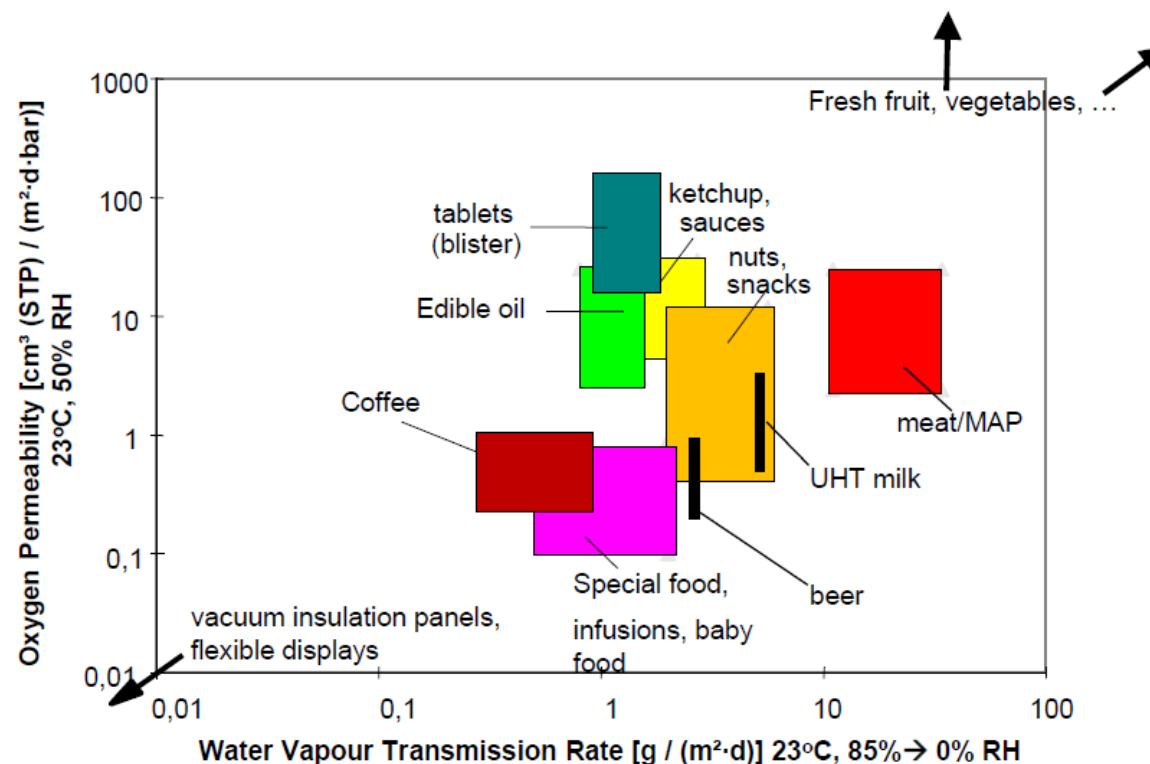
Challenges faced with packaging today – approaches to improve sustainability of packaging





Challenges faced with packaging today – approaches to improve sustainability of packaging

- Packaging material permeation requirements for sensitive food, pharmaceutical and technical products
- Some demands can be met through protein based coatings



Source: Langowski, H.-C. (2008): Permeation durch Lebensmittelverpackungen – Anwendungsbeispiele. Seminar: Permeation durch Packstoffe, Fraunhofer IVV



Agenda

- Fraunhofer IVV introduction
- Challenges faced with packaging today – approaches to improve sustainability of packaging
- **Protein based coatings as possible solution**
 - Properties of protein coatings
- Micellar lupin protein in Ecofunco
 - Properties of micellar lupin protein
 - Further developments



Protein based coatings as possible solution – properties of protein coatings

Need

Barrier material as substitute for EVOH based on renewable raw materials

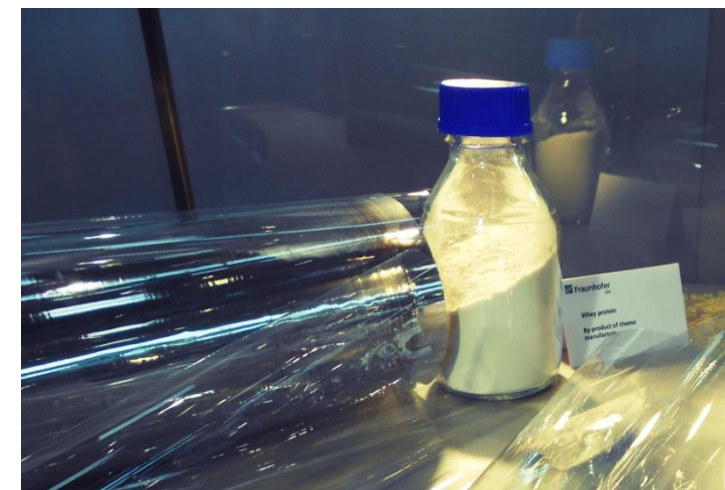
Use of residual material: e.g. Whey protein

Result

- OTR: $Q_{100} = 1-2 \text{ [cm}^3(\text{STP})/(\text{m}^2 \text{ d bar})]$
- Substitution of EVOH by thermoformable Wheyprotein layers
- Competitive to EVOH: 7-10 €/kg for WheyLayer®-formulation

Benefit

- Sustainable alternative to EVOH
- Applicable in industrial scale
- Market launch by LAJOVIC TUBAembalaža d.o.o.

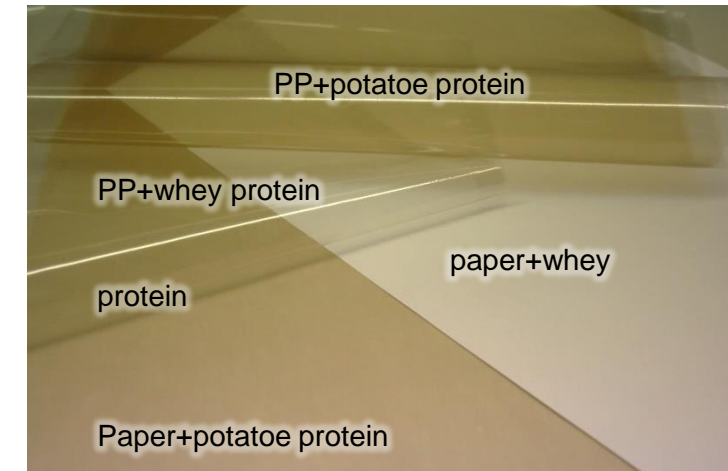
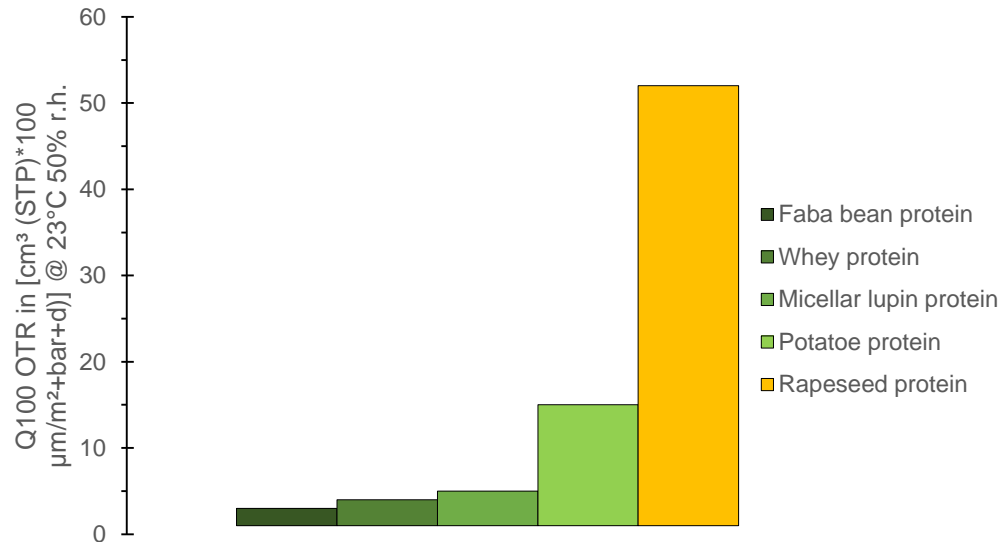


Projecttitel: WheyLayer². Barrier biopolymers for sustainable packaging



Protein based coatings as possible solution – properties of protein coatings

Typical oxygen barriers of different protein types





Agenda

- Fraunhofer IVV introduction
- Challenges faced with packaging today – approaches to improve sustainability of packaging
- Protein based coatings as possible solution
 - Properties of protein coatings
- **Micellar lupin protein in Ecofunco**
 - **Properties of micellar lupin protein**
 - Further developments



Micellar lupin protein in Ecofunco – Properties of micellar lupin protein

- Lupines are mostly used as green manure → protein rich seeds are not valorised to a large extent
- Protein can be extracted by a specific extraction method which includes a combination of salting-in and dilution precipitation → micellar lupin protein
 - Alteration in the tertiary structure → hydrophobic groups become exposed
 - Influence on the protein properties:
 - Low water solubility
 - High stickiness
 - Fat like structure
 - Structure-viscous behaviour
- Combination of two properties (oxygen barrier + adhesive properties) in a single layer → reducing the amount of material used while improving biodegradability and recyclability

Stand der Technik

Papier bedruckt 60 g/m ²
Haftvermittler 1 g/m ²
Polyethylen 20 g/m ²
Haftvermittler 1 g/m ²
Barrierschicht (EVOH) 3 g/m ²
Haftvermittler 1 g/m ²
Polyethylen 20 g/m ²



Ziel: Mizellen-Konzept

Papier bedruckt
Mizellenprotein- Klebstoff
Polyethylen

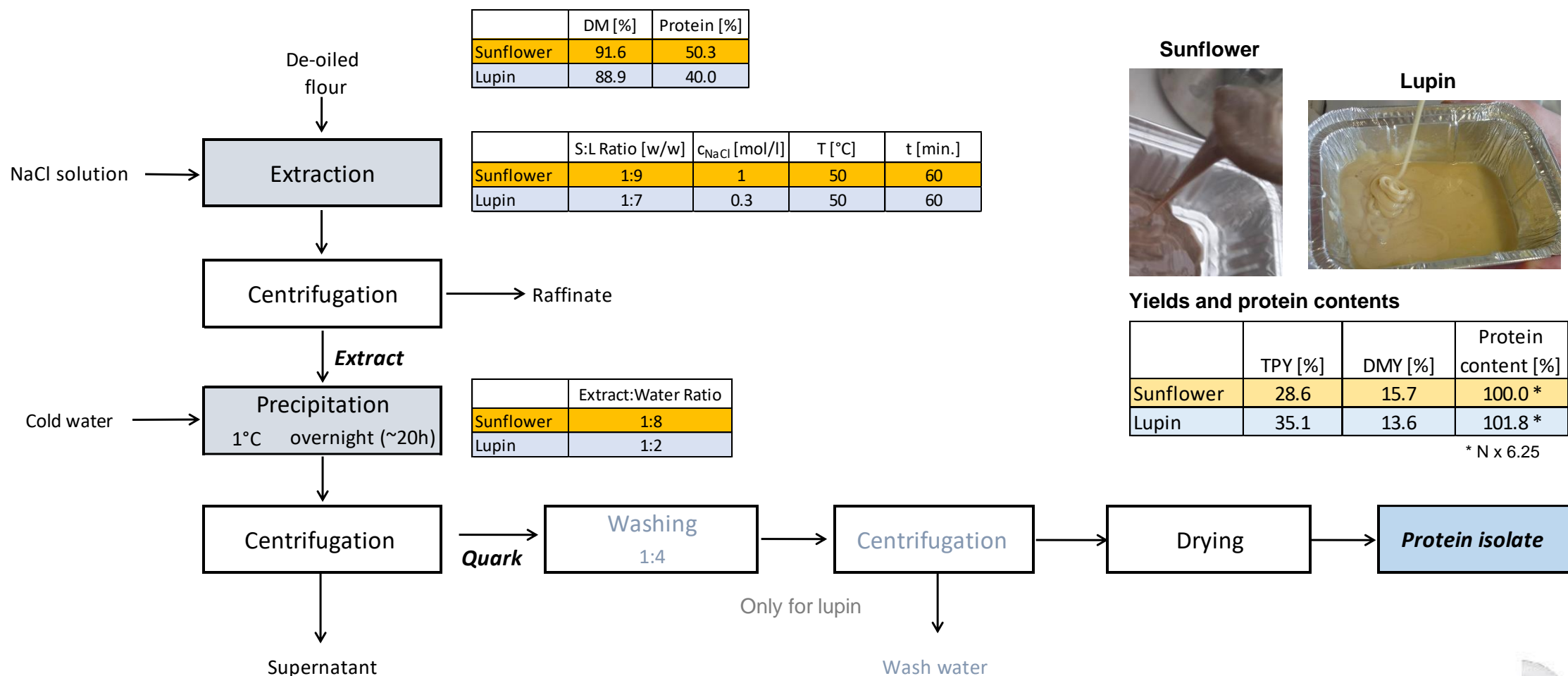
Aus
Mizellenkleberprojekt

Quelle: Fraunhofer IVV



Micellar lupin protein in Ecofunco – Properties of micellar lupin protein

Production of micellar protein isolates – scale-up trials





Agenda

- Fraunhofer IVV introduction
- Challenges faced with packaging today – approaches to improve sustainability of packaging
- Protein based coatings as possible solution
 - Properties of protein coatings
- **Micellar lupin protein in Ecofunco**
 - Properties of micellar lupin protein
 - **Further developments**



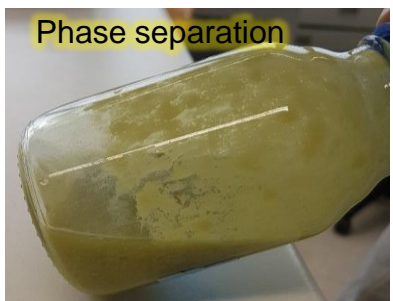
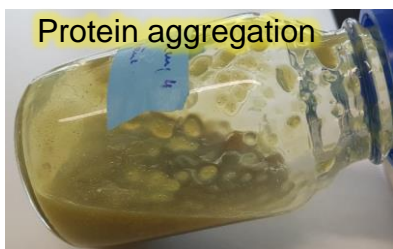
Micellar lupin protein in Ecofunco – Further developments

- Up until now: water based formulation
- Drawbacks:
 - When polymer/polymer structures are coated, water can't evaporate → remaining water has a negative influence on bond strength and oxygen barrier
 - Formulation needs to be adapted without destroying the micelle and therefore changing the properties
 - Testing different combinations of solvents, tensides and plasticizers were tested



Micellar lupin protein in Ecofunco – Further developments

Development of a solvent system suitable for micellar proteins



Results

+ Essential for protein stability

+ High vapor pressure
+ Non-Toxic and environmental friendly
+ Low flammability
+ Low viscosity

+ Suspendability improving effect on MLP
+ No impact on micellar structure

water

+

Ethanol or ethyl acetate

+

Triethanol amine (TEA) or diethanol amine (DEA)

– Low vapor pressure

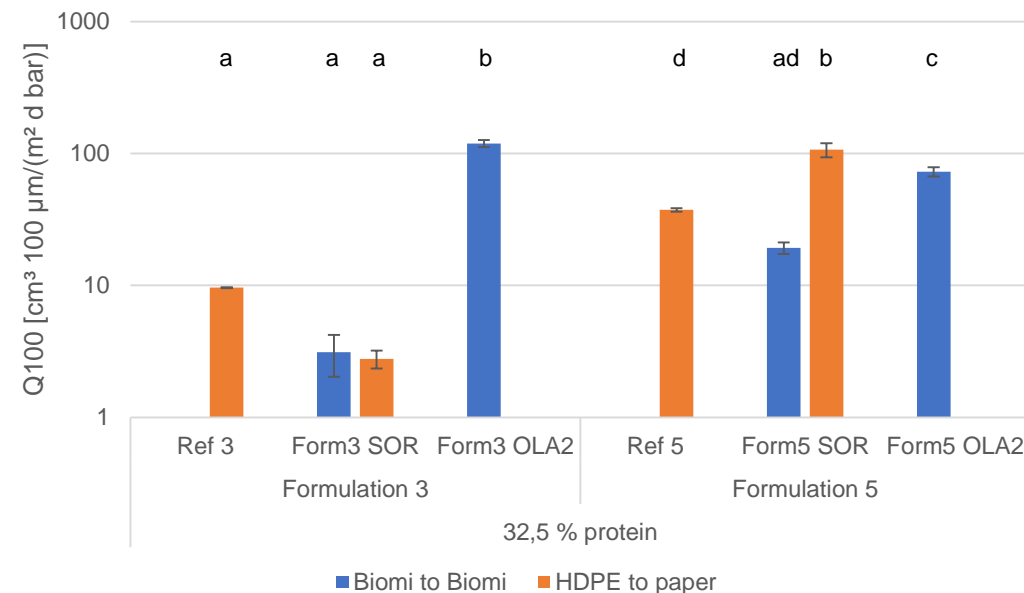
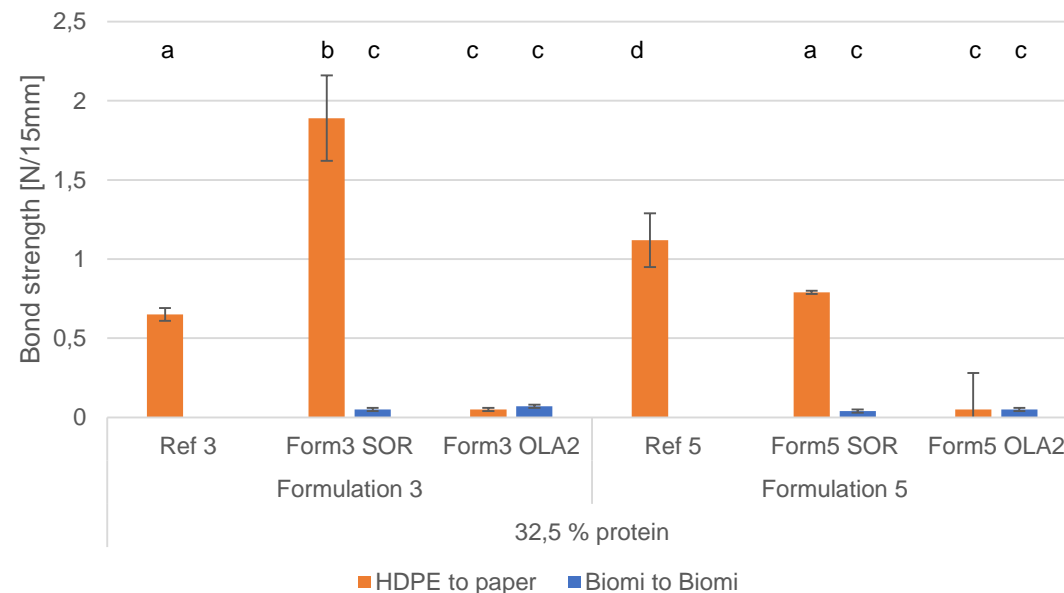
– Reducing effect on suspendability of MLP in water
– Can lead to protein aggregates

– High viscosity
– low vapor pressure
– Can lead to phase separation

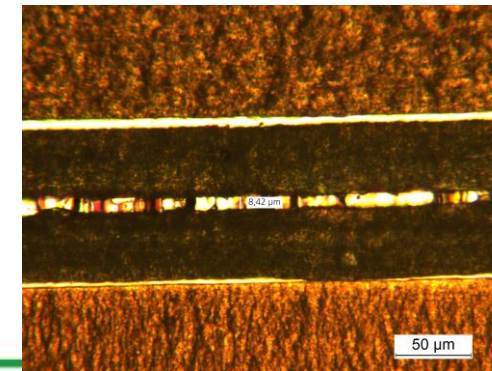
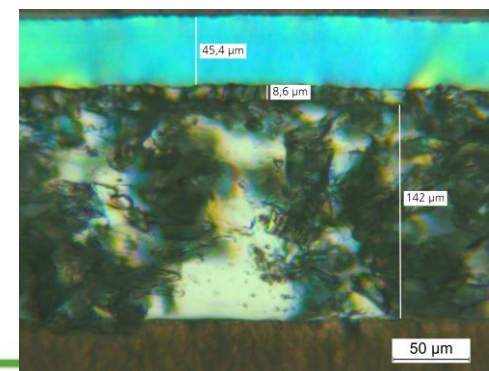


Micellar lupin protein in Ecofunco – Further developments

Influence of solvent mixtures and plasticizers on Bond strength and oxygen barrier



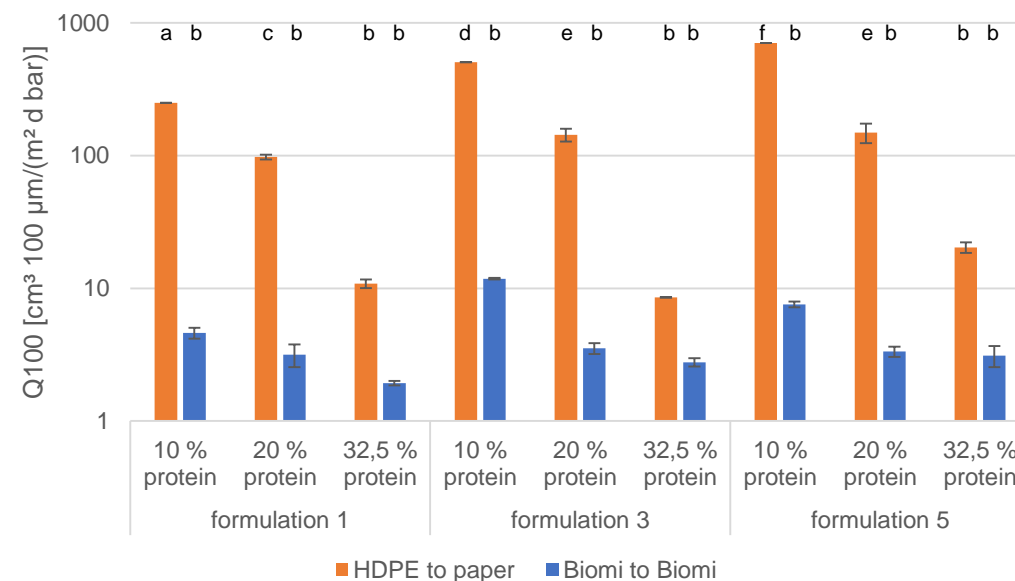
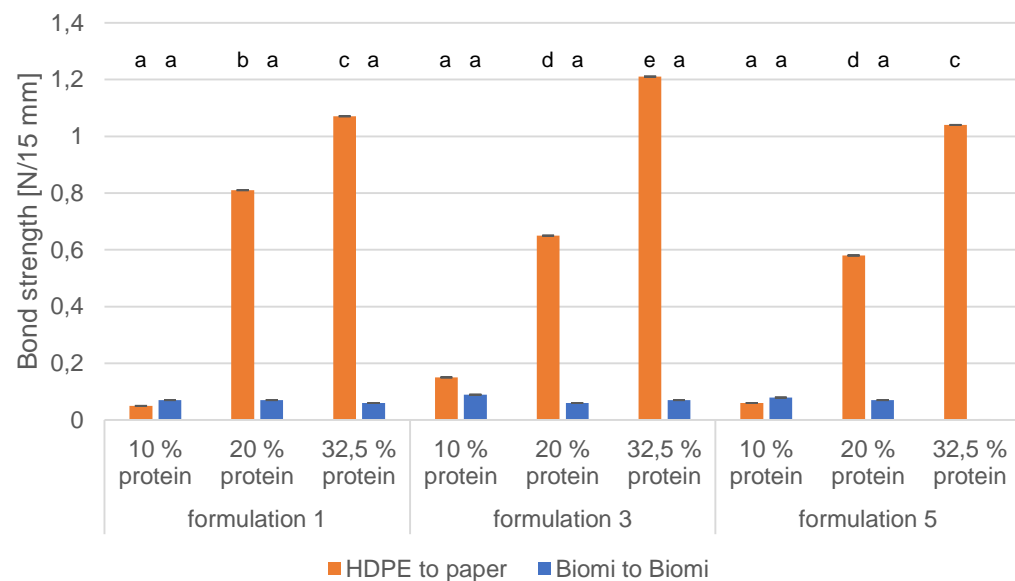
- Different plasticizers were tested like polyols or oligolactic acid
- Plasticizers have a big influence on the performance of the protein formulation
- Protein structure has to be compatible with the protein network





Micellar lupin protein in Ecofunco – Further developments

Influence of protein concentration on Bond strength and oxygen barrier



- OTR and Bond strength improve the higher the protein concentration is
- less moisture has to evaporate when the protein concentration is higher
- Keep protein concentration as high as possible while not exceeding a certain viscosity



Conclusion

- Protein based coatings can fulfil barrier requirements while being biobased and biodegradable
- MLP has specific properties because of its structure
- MLP can combine two properties (oxygen barrier + adhesive properties) in a single layer and therefore reducing the amount of material used
- MLP-Formulation needs to be adapted when a polymer/polymer structure is supposed to be coated
- Adaptations can have a major influence on the MLP properties and need therefore be done wisely



Thank you!



Paula Goderbauer
**Fraunhofer Institute for Process
Engineering and Packaging IVV**
Giggenhauser Straße 35
85356 Freising
Germany
Paula.goderbauer@ivv.fraunhofer.de