# The realisation of sustainable food systems by valorisation of agri-food wastes and by-products in support of circular bioeconomy concepts

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ValorTech
ERA Chair for Food (By-) Products
Valorisation Technologies







**Tartu city, Estonia, EU**

**European capital of Culture, 2024**

# ABOUT ERA-CHAIR in VALORTECH

Eesti Maaülikool
Estonian University of Life Sciences

The ERA (European Research Area) Chair, funded by the **EU Horizon 2020** program, was launched in 2018:

**Aim**: To create a new chair focusing on the **application of advanced technologies for minimum waste generation & maximum utilisation of by-products (valorisation) for value addition**.

**Brings together know-how and technological base from 2 EMU Institutes:**

- **Institute of Agricultural and Environmental Sciences**
- **Institute of Veterinary Medicine and Animal Sciences**

The **broader vision** related to the creation of the ERA Chair in VALORTECH: **This Chair will develop into a leading centre of research excellence & as a strong partner for local industries** offering practical values to increase efficiency, reduce waste and **explore new business opportunities**.

# Contribution of ERA-Chair in **VALORTECH** to the academia, research & industry

# Valorization of Food Industrial Wastes & By-products

Fruits & Vegetable processing industry:

Bioactive compounds, natural food colourants, Compost, Biogas, etc.

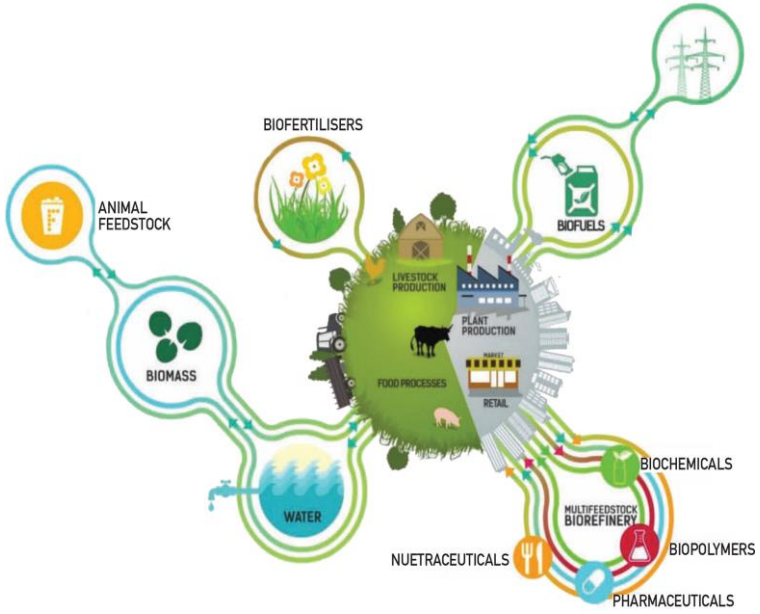
Dairy industry: Colostrum, Whey

Fish industry: Fish wastes (Gelatin, oils, fertilizer)

Poultry Wastes: Feather, skin, eggshell, excreta (Fertilizer, bio-fuel, bioplastic)

Meat Industry: Bones, skin, blood, etc

Opportunities: Many side-streams remains underexplored




Zero wastes, Taste the Waste, Waste to Wealth concepts & Technological innovations….

# Raw materials explored:









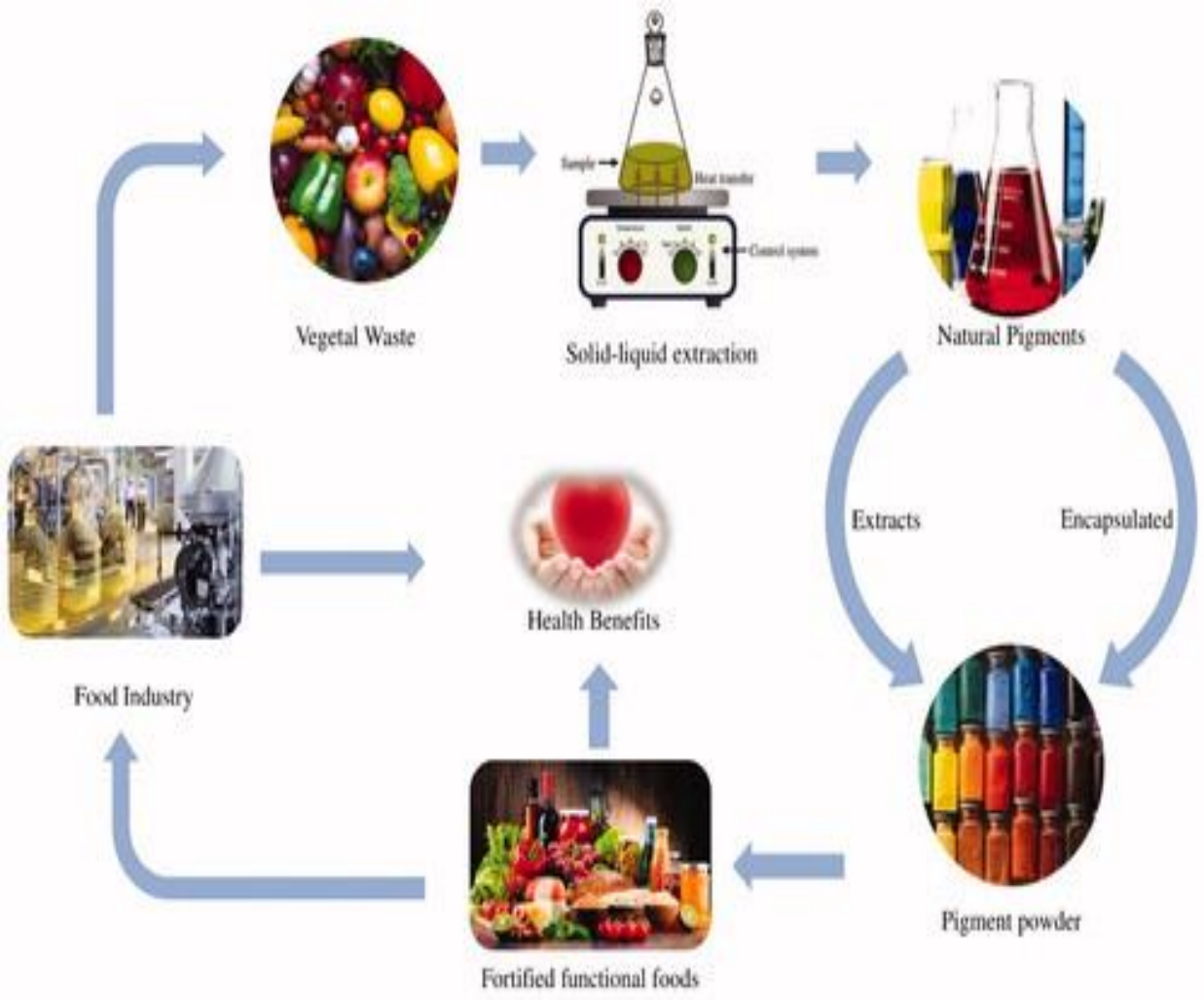

# Applications: Food, Cosmetics & Pharmaceutical industries:

High value-added components:

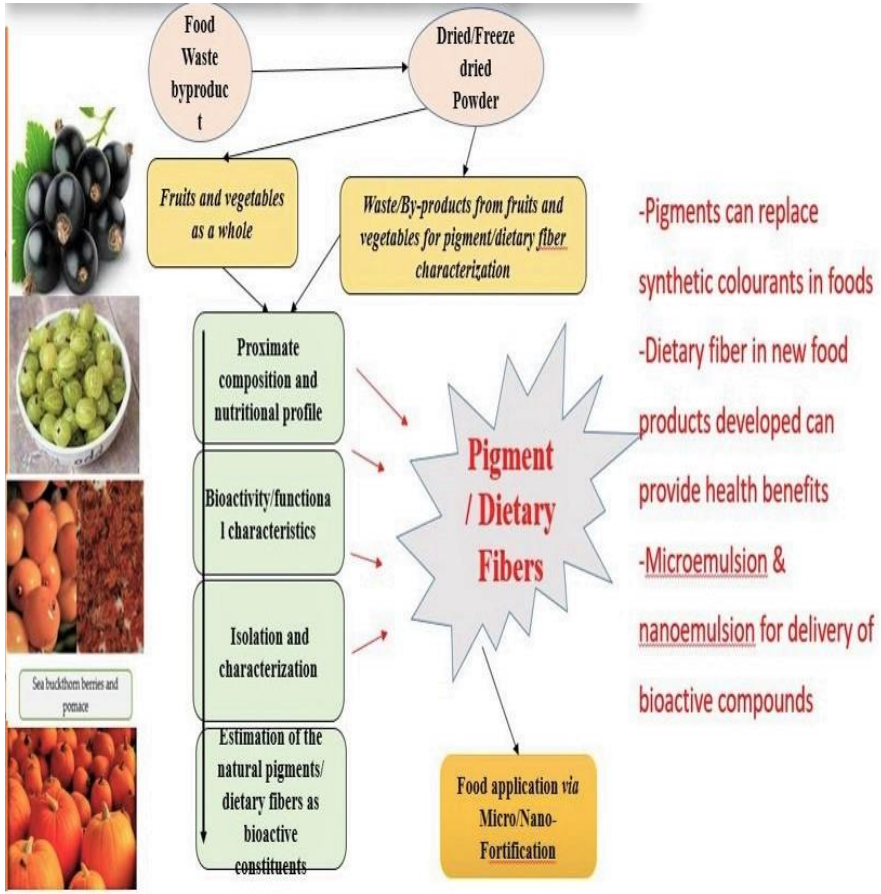
- Functional foods

Supplements (dietary fiber)

- Nutraceutical products
- Food preservatives (Antioxidant compounds)
- Natural colorants (Pigments)
- Livestock feed
- Bioplastics
- Plant Ev's in the medical field




**Source**: Sharma et al. 2020; https://doi.org/10.1080/07388551.2021.1873240




-Pigments can replace synthetic colourants in foods

-Dietary fiber in new food products developed can provide health benefits

-Microemulsion & nanoemulsion for delivery of bioactive compounds

Review Articles

## Valorization of fruits and vegetable wastes and by-products to produce natural pigments

Minaxi Sharma, Zeba Usmani, Vijai Kumar Gupta & Rajeev Bhat

Pages 535-563 | Received 05 Jan 2021, Accepted 05 Jan 2021, Published online: 26 Feb 2021

Download citation https://doi.org/10.1080/07388551.2021.1873240 Check for updates

Open Access Article

## Extraction of Carotenoids from Pumpkin Peel and Pulp: Comparison between Innovative Green Extraction Technologies (Ultrasonic and Microwave-Assisted Extractions Using Corn Oil)

by Minaxi Sharma * and Rajeev Bhat

Open Access Article

## Valorisation of Sea Buckthorn Pomace by Optimization of Ultrasonic-Assisted Extraction of Soluble Dietary Fibre Using Response Surface Methodology

by Shehzad Hussain *, Minaxi Sharma and Rajeev Bhat

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* Author to whom correspondence should be addressed.

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Current Research in Food Science
Volume 7, 2023, 100629

## Natural pigments (anthocyanins and chlorophyll) and antioxidants profiling of European red and green gooseberry (*Ribes uva-crispa* L.) extracted using green techniques (UAE-citric acid-mediated extraction)

Shehzad Hussain [a], Minaxi Sharma [a], Tatsiana Jarg [b], Riina Aav [b], Rajeev Bhat [a]

# Winery wastes:

- Effect of cultivation & growth factors on phytoconstituents
- Optimizing extraction techniques for recovery of targeted bioactive compounds
- Chemometric assessment, polyphenolic content and antioxidant activity of bioactive compounds
- Flavonols (quercetin), Stilbenoids (ε-viniferin)

*Recommendations for sustainable food production*

*antioxidants* MDPI

*Article*

**Recovery of Polyphenols from Vineyard Pruning Wastes—Shoots and Cane of Hybrid Grapevine (*Vitis* sp.) Cultivars**

Reelika Rätsep [1,2,*], Kadri Karp [3], Mariana Maante-Kuljus [3], Alar Aluvee [2], Hedi Kaldmäe [2] and Rajeev Bhat [1]

Open Access Article

**Polyphenols and Resveratrol from Discarded Leaf Biomass of Grapevine (*Vitis* sp.): Effect of Cultivar and Viticultural Practices in Estonia**

by Reelika Rätsep [1,2,*], Kadri Karp [3], Mariana Maante-Kuljus [3], Alar Aluvee [2] and Rajeev Bhat [1]

# Valorisation of different genotypes (17 cultivars) of underutilised rowan berries as functional food ingredients

- The addition of rowanberry pomace extracts & defatted pomace to meat products would give extra value to these products in terms of their shelf-life & additional fibre content.
- The lipophilic components obtained from SC-CO2 fractionation of rowanberry pomace can be used as nutraceuticals due to their high content of **beta-carotene and PUFAs**
- Rowanberry pomace could **replace artificial preservatives** (meat preservatives)

ELSEVIER

Food Chemistry: X

Volume 19, 30 October 2023, 100761

**Untargeted metabolomics and conventional quality characterization of rowanberry pomace ingredients in meatballs**

Viive Sarv [a b], Kristi Kerner [b c g], Petras Rimantas Venskutonis [a c], Gabriele Rocchetti [d], Pier Paolo Becchi [e], Luigi Lucini [e], Alo Tänavots [f g], Rajeev Bhat [b]

Open Access Article

**Antioxidants Characterization of the Fruit, Juice, and Pomace of Sweet Rowanberry (*Sorbus aucuparia* L.) Cultivated in Estonia**

by Viive Sarv [1,2,*], Petras Rimantas Venskutonis [1,3], Reelika Rätsep [1,2], Alar Aluvee [1], Rita Kazernavičiūtė [3] and Rajeev Bhat [2]

Open Access Review

**The *Sorbus* spp.—Underutilised Plants for Foods and Nutraceuticals: Review on Polyphenolic Phytochemicals and Antioxidant Potential**

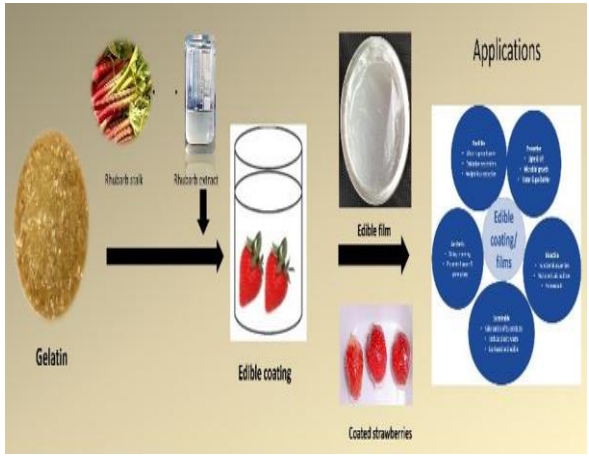
by Viive Sarv [1,2,*], Petras Rimantas Venskutonis [1,3] and Rajeev Bhat [1]

# Bioplastics production from oil industry & fish industry wastes/by-products:

- Improve mechanical properties (thickness, tensile strength, elongation at break), gas permeability, water vapour permeability, moisture and water barrier properties
- Biodegradability in compost, soil and aquatic environment)
- Gelatin-based edible coating and films with rhubarb extract for preserving the quality of food products

Rapeseed husk


Fish wastes

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Sustainable Chemistry and Pharmacy
Volume 18, December 2020, 100326

## Valorization of food processing wastes and by-products for bioplastic production

Katrin Jõgi, Rajeev Bhat

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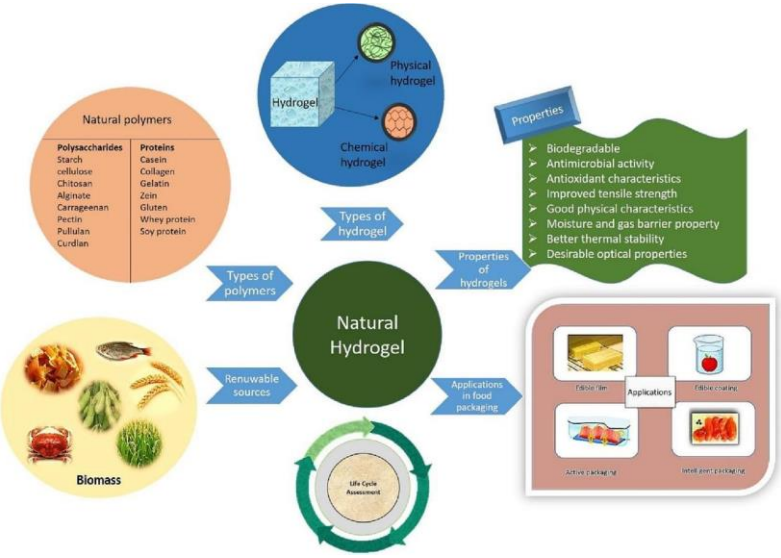
International Journal of Biological Macromolecules
Volume 248, 1 September 2023, 125845

Review

## Sustainable polysaccharide and protein hydrogel-based packaging materials for food products: A review

Surya Sudheer [a], Smarak Bandyopadhyay [b], Rajeev Bhat [a]




**Possibility to replace petroleum based plastics**

# Development of livestock feed:

## Hempseed hull & sea buckthorn pomace

- Composition, amino acids, minerals, fatty acids, antioxidant compounds, *in vitro* digestibility, *in vitro* gas production (in cooperation with SLU)
- Feed analyses & marketing

*Agronomy Research* **18**(S3), 1760–1795, 2020
https://doi.org/10.15159/AR.20.086

**Review article: Current research trends in fruit and vegetables wastes and by-products management-Scope and opportunities in the Estonian context**

D. Malenica* and R. Bhat

Estonian University of Life Sciences, Insitute of Veterinary Medicine and Animal Siences, Kreutzwaldi 56/5, EE51006, Tartu, Estonia

*sustainability* MDPI

*Review*

**Sustainable Management and Valorization of Agri-Food Industrial Wastes and By-Products as Animal Feed: For Ruminants, Non-Ruminants and as Poultry Feed**

Dunja Malenica [1], Marko Kass [2] and Rajeev Bhat [1,*]

**Major outcome:**
Sustainable production of livestock feed that is expected to tackle environmental pollution & feed shortage in the future

**Low cost, nutritious livestock feed can be developed**

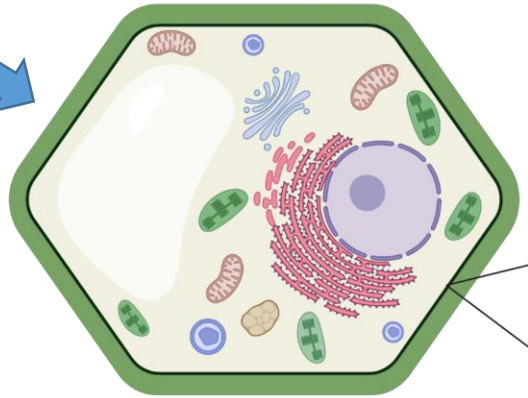
# Purification and characterization of Extracellular vesicles:

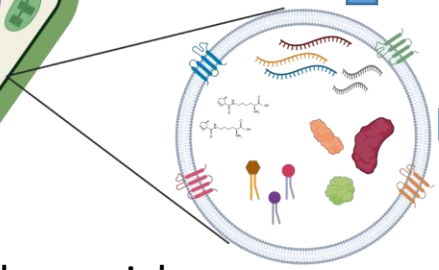
Agri-food industries

Waste/ byproduct

Bioactive compounds

- Apoplastic fluid
- Plant cell cultures
- Plant tissues





Plant derived Extracellular vesicles

Optimize plant EV isolation and characterization

Effect of plant based EV on mammalians

Potential applications

- Food additives
- Cosmetics
- Pharmaceuticals

**Hypothesis :** Fruit and vegetable wastes have functional EVs capable of affecting mammalian tissue & cell function.

# Academia (Teaching):

- (I) - Specialty teaching module is offered for Masters students: *Subject code VL.1331 Valorisation of Agri-food By-products*:
- (ii) Sustainable Bioplastics and Circular Economy (*Subject code: VL.1339*)
- - Both Estonian & and Erasmus students are taking the course.

# Training activities & reaching out to public:

- (i) International lecture sessions with the sub-theme focusing on '*Biomass Valorization and Bioprocessing Technologies*' & 'Green extraction technologies' were introduced
- (ii) A series of Webinars related to '*Food Wastes and by-products valorization*' were introduced
- (iii) Summer and Winter Schools have been completed
- (iv) Seminars, webinars, and hands on training completed

# **Industry:** Collaboration efforts:

- (i) Innovation cluster MTÜ Liivimaa Lihaveis - in cooperation with the cluster our researcher is carrying out product development tests for the production of meat products enriched with plant additives.
- (ii) Scanola Baltic AS, Baltimere Invest AS - Ensuring the supply of by-products from oil & protein concentrate production, used for Valortech PhD students (research experiments).
- (iii) Valortech researchers are working in cooperation with the representative of Estonian Chamber of Agriculture and Commerce
- (iv) Estonia's well-established food company Estonian Bread Industry (Eesti Leivatööstus AS) in Tartu
- (v) Murimäe winery: Understanding the Nordic viticulture system and various agronomic practices involved in the sustainable production of wine
- (vi) 'Anu Ait OÜ: opportunities for collaboration, solutions for livestock feed production in the local market

# Future prospects:

- What new innovations can be expected?
- What all sectors are affected and benefitted?

✓ New market opportunities in Estonia and beyond?

✓Economic benefits for local industries?

✓Life Cycle Analysis (LCA) being undertaken

✓Suggestions for policy-makers?

✓Knowledge transfer of lab-generated data

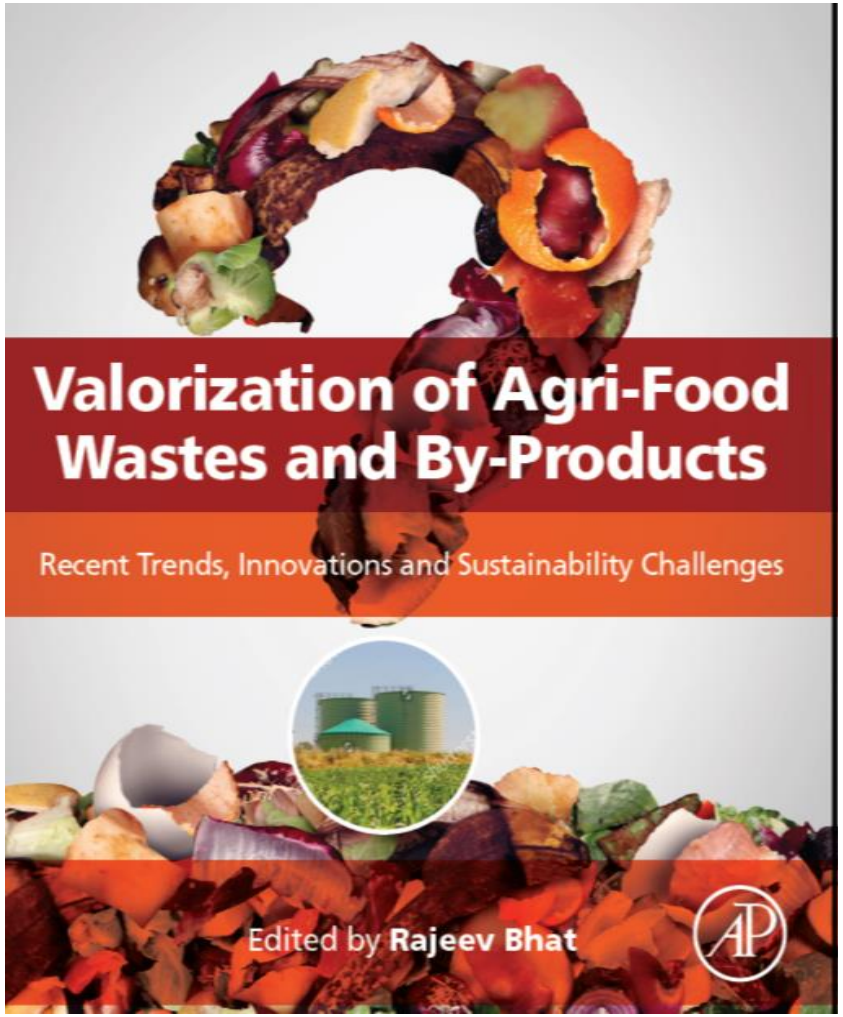
✓Support for new start-ups

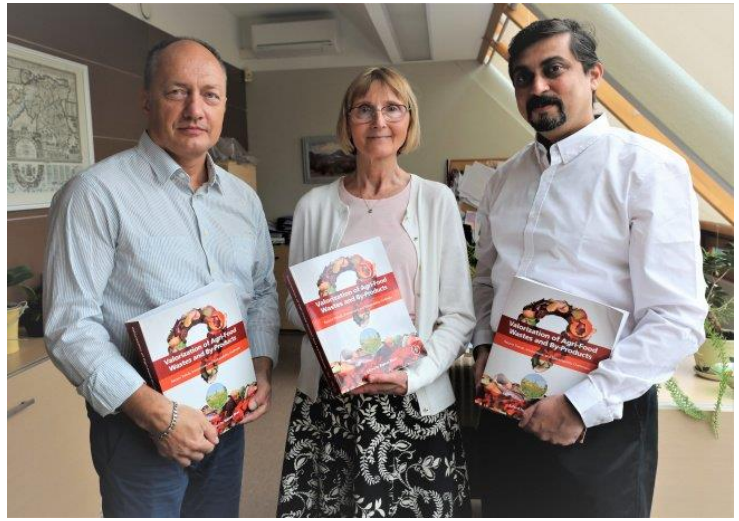
✓Inputs for policy makers

# Valorization of Agri-Food Wastes and By-Products: Recent Trends, Innovations and Sustainability Challenges

Ed.: Rajeev Bhat

- 1st Edition: **Paperback**
  **ISBN:** 9780128240441
- **Imprint:** Academic Press/Elsevier
- **Published Date:** 1st September 2021
- Page Count: 994



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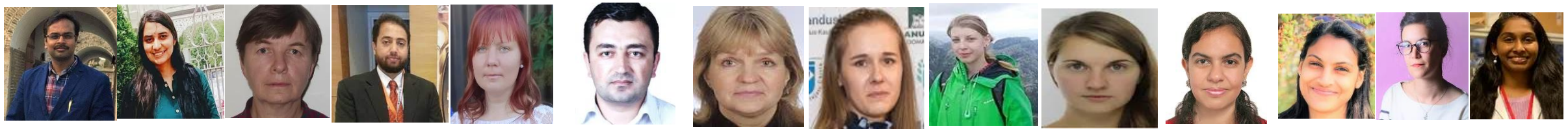
# Acknowledgements:


- Organizers of this conference and FoodWaStop COST Action CA22134
- VALORTECH's funding by the European Union's Horizon 2020 research and innovation programme under grant agreement No. 810630.
- To all the research collaborators and staff of VALORTECH
- All the VALORTECH Council and Board members

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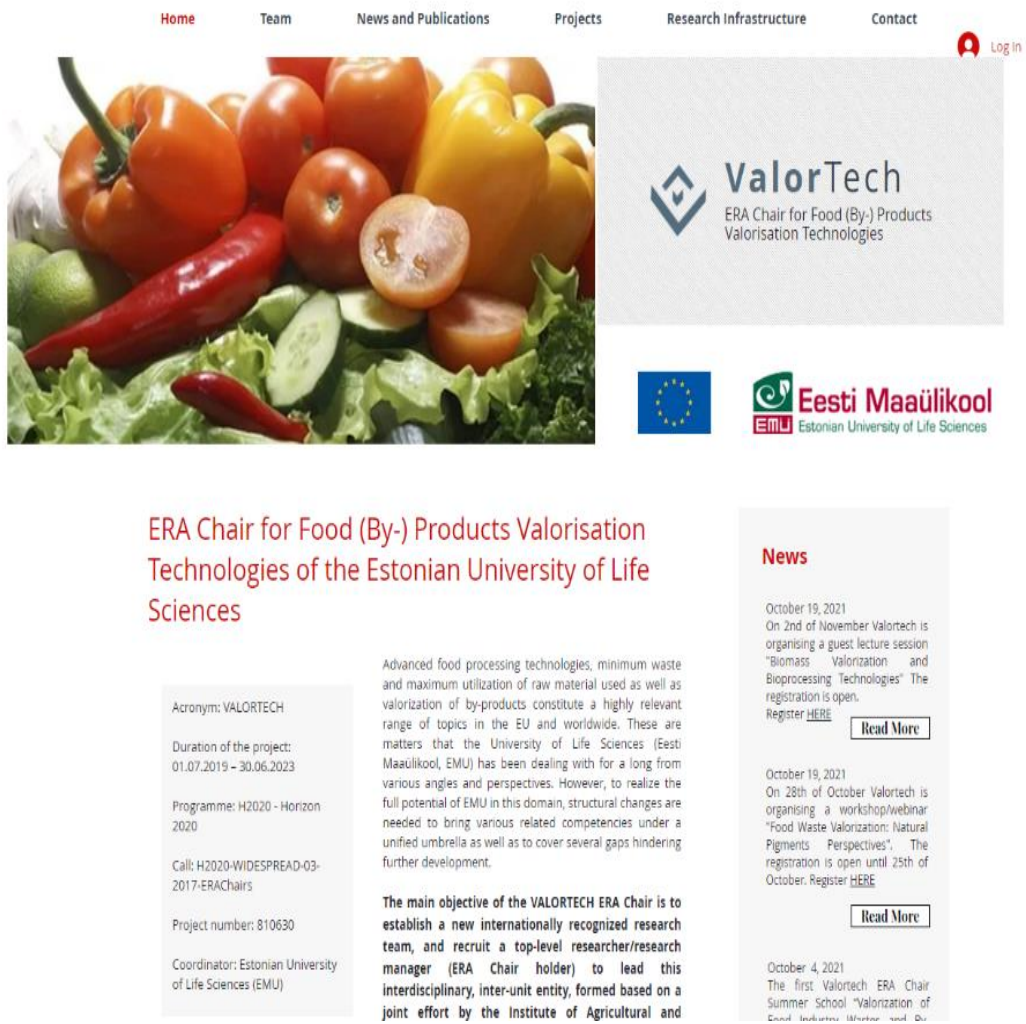


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