



UNIVERSITY
OF LATVIA



Assessment of bio-valorisation of by-products from food industry in Europe

Raimonda Solooha, *M.Sc., PhD student*

Liva Kristiana Lukasa, *M.Sc.*

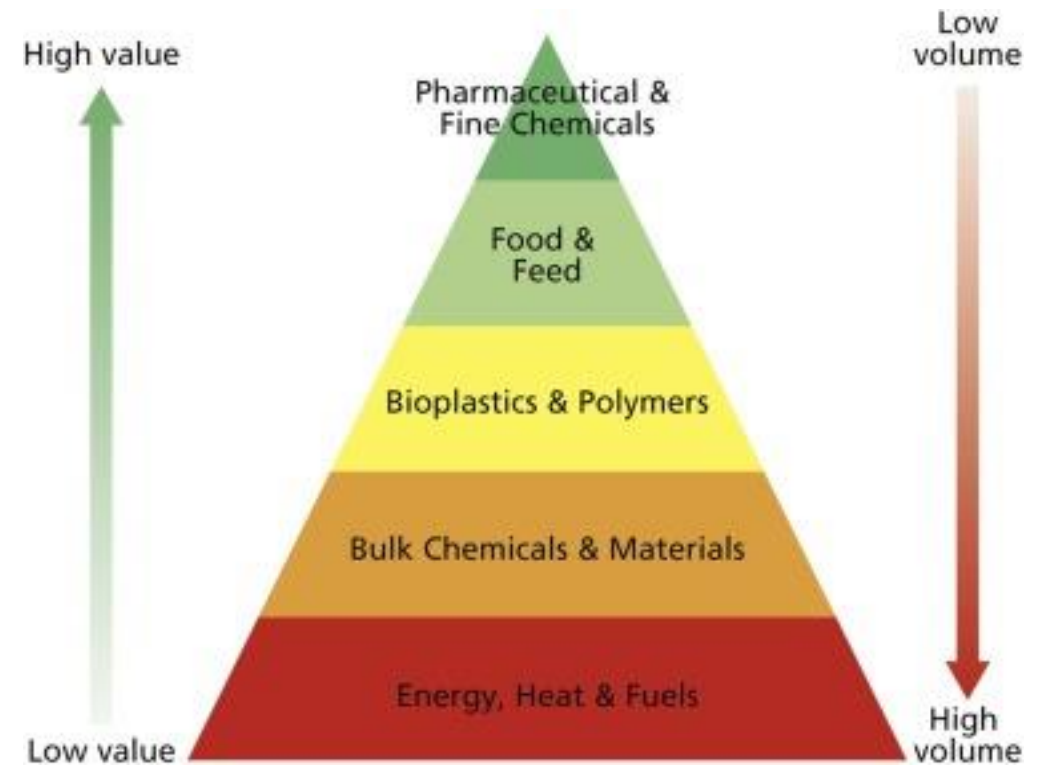
Elina Dace, *Dr.sc.ing.*

Session IX: The LIFE CIRCforBIO project

TOPICALITY

- **Circular bioeconomy strategy** – to add value to secondary bio-resources¹.
- **Resource quantification** – to identify secondary bioresources
- **Value-added products** – to contribute to circular regional development

Bioresource (secondary bioresource) > Fossil fuels



Bio-based value pyramid²

¹EC (2018) A sustainable bioeconomy for Europe – Strengthening the connection between economy, society and the environment. <https://data.europa.eu/doi/10.2777/792130>.

²Stegmann et al. (2020) The circular bioeconomy: its elements and role in European bioeconomy clusters. <https://doi.org/10.1016/j.rcrx.2019.100029>

CURRENT STATE

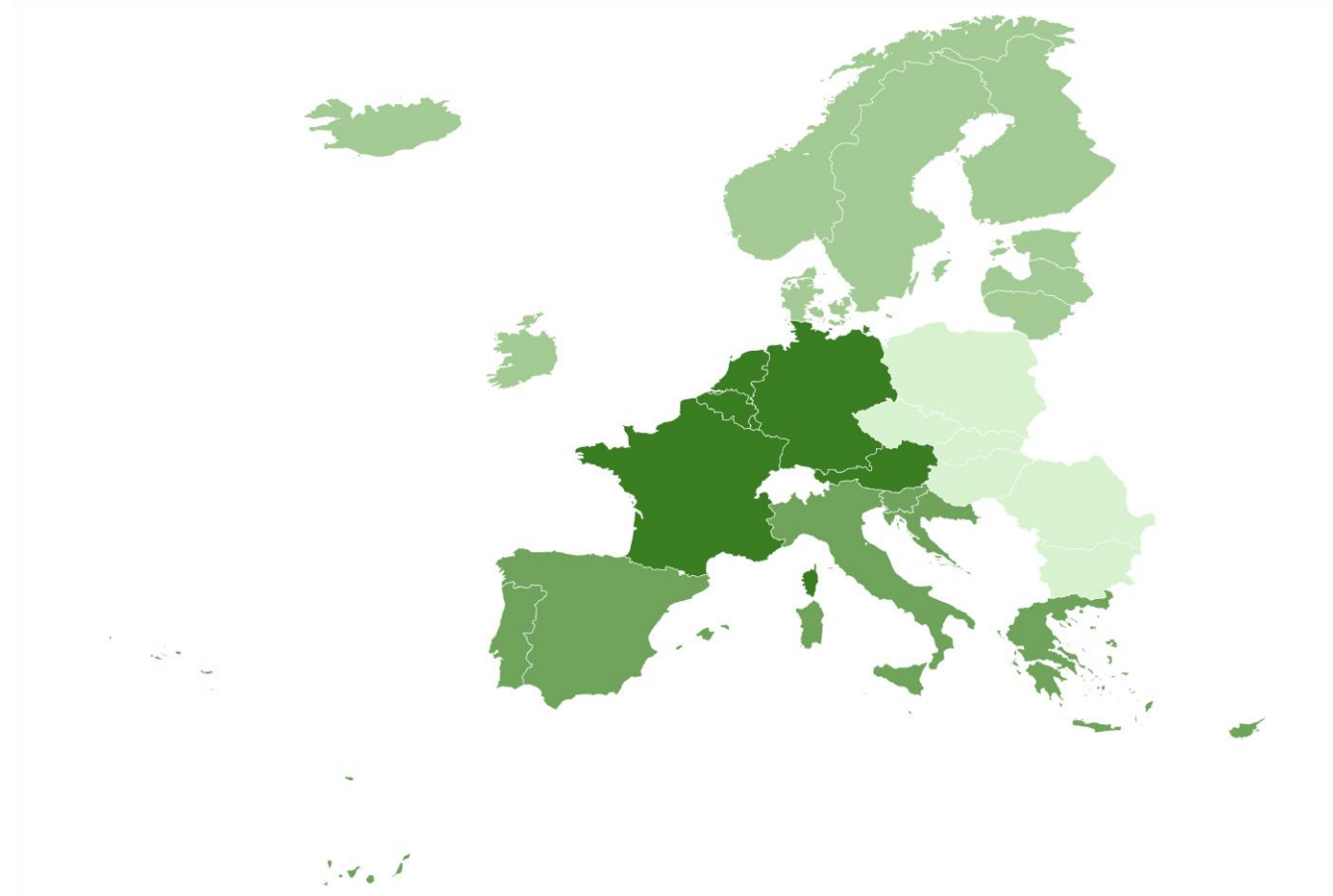
- No obligation for reporting by-products and their utilisation pathways
- Inconsistently and sporadically reported data on by-product formation
- Limited information on valorisation pathways in policy documents



- Hindered use of secondary bioresources in circular bioeconomy
- Inefficient policy decision making for circular bioeconomy development

OBJECTIVES OF THE STUDY

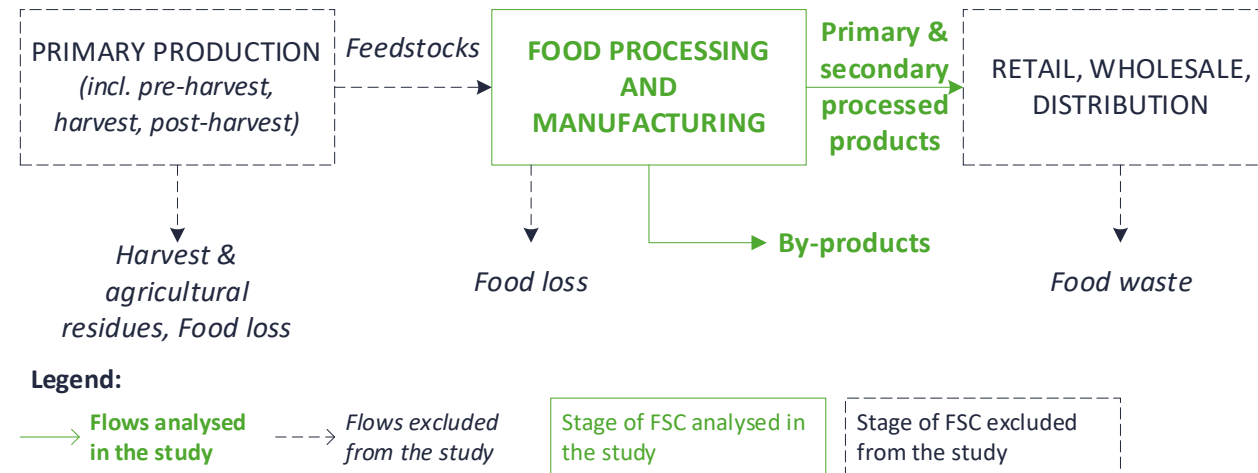
1. To estimate the quantities of food industry **by-products** in 4 different European regions;
2. To identify **value-added products** of biological valorisation;



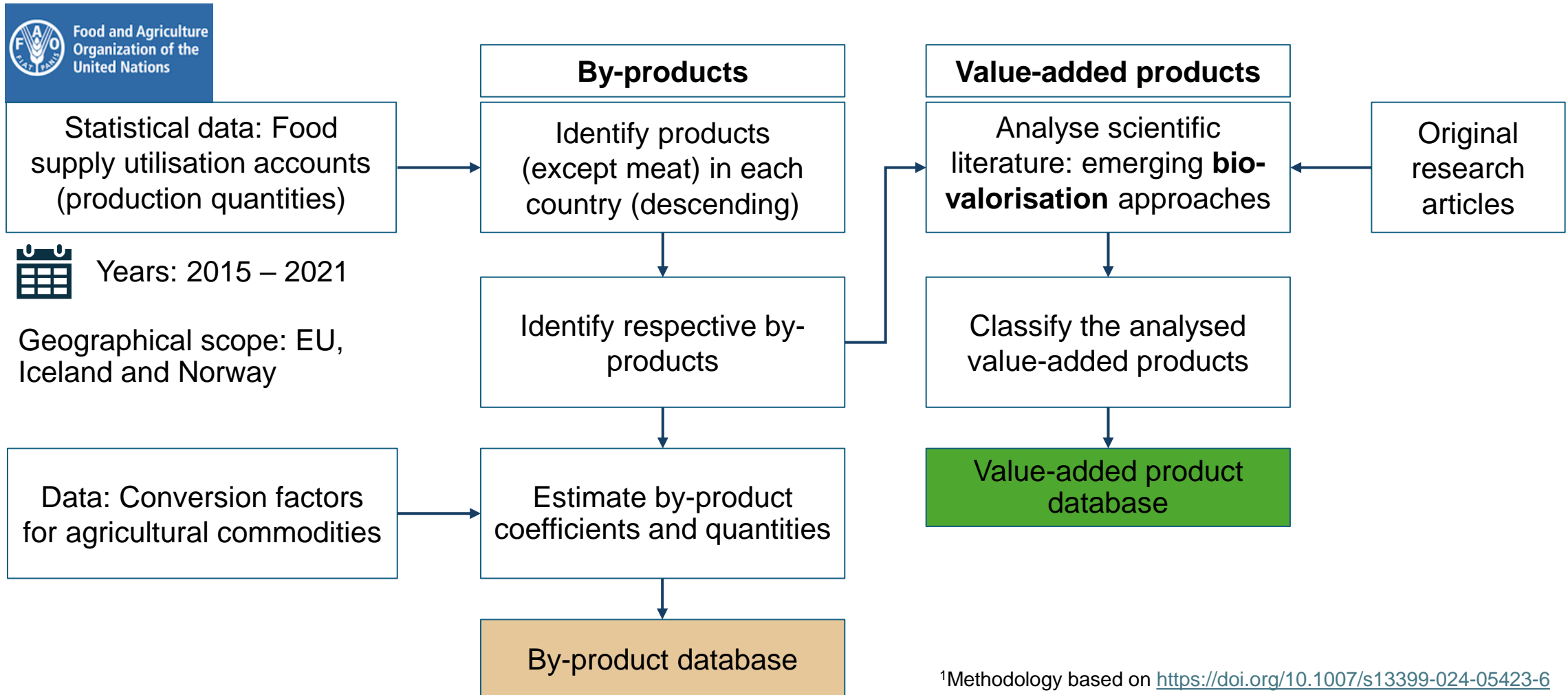
¹Study based on <https://doi.org/10.1007/s13399-024-05423-6>

DEFINITIONS

- **By-product** – a product that is formed as an unavoidable side product in the production of food (coefficients estimated based on wet weight)
- **Value added product** – a product produced by microorganisms (bacteria, fungi) through a process of biological valorisation, using a food industry by-product as the main substrate




RESEARCH METHODOLOGY¹



Product	By-product 1	By-product 2	Product group
Beer of barley, malted	Brewer's spent grain	Brewery spent yeast	Brewery and Winery
Wine	Marc of grapes		Brewery and Winery
Barley, pearled	Barley flour and grits		Cereals
Pot barley	Bran of barley	Barley hulls	Cereals
Flour of maize	Bran of maize	Germ of maize	Cereals
Flour of rye	Bran of rye		Cereals
Oats, rolled	Bran of oats	Oat hulls	Cereals
Husked rice	Rice hulls		Cereals
Rice, milled (husked)	Bran of rice		Cereals
Starch of maize	Maize gluten		Cereals
Starch of wheat	Wheat gluten		Cereals
Wheat and meslin flour	Bran of wheat	Germ of wheat	Cereals
Cheese from milk of goats	Whey, fresh		Dairy
Cheese from whole cow milk	Whey, fresh		Dairy
Cheese from milk of sheep	Whey, fresh		Dairy
Eggs, liquid	Eggshells		Eggs
Apple juice	Apple pulp		Fruit and vegetables
Orange juice	Fruit pulp for feed		Fruit and vegetables
Raw cane or beet sugar	Molasses	Sugar beet pulp, wet	Fruit and vegetables
Paste of tomatoes	Tomato pulp		Fruit and vegetables
Tomato juice	Tomato pulp		Fruit and vegetables
Grape juice	Grape pomace		Fruit and vegetables
Cotton seed	Cotton lint	Cotton waste	Oils and Fats
Oil of linseed	Linseed cake		Oils and Fats
Rapeseed or canola oil, crude	Rapeseed cake		Oils and Fats
Soya bean oil	Soybean cake		Oils and Fats
Sunflower-seed oil, crude	Sunflower cake		Oils and Fats
Oil of maize	Maize cake		Oils and Fats
Cottonseed oil	Cottonseed cake	Cotton linters	Oils and Fats
Olive oil	Olive pomace		Oils and Fats
Groundnuts, shelled	Groundnut shells		Pulses, nuts and oilseeds
Potato flour	Potato peels		Roots and Tubers
Potatoes, frozen	Potato peels		Roots and Tubers
Starch of potatoes	Potato pulp, wet		Roots and Tubers
Cocoa paste not defatted	Cocoa husks and shells		Stimulants
Coffee, decaffeinated or roasted	Coffee silverskin		Stimulants

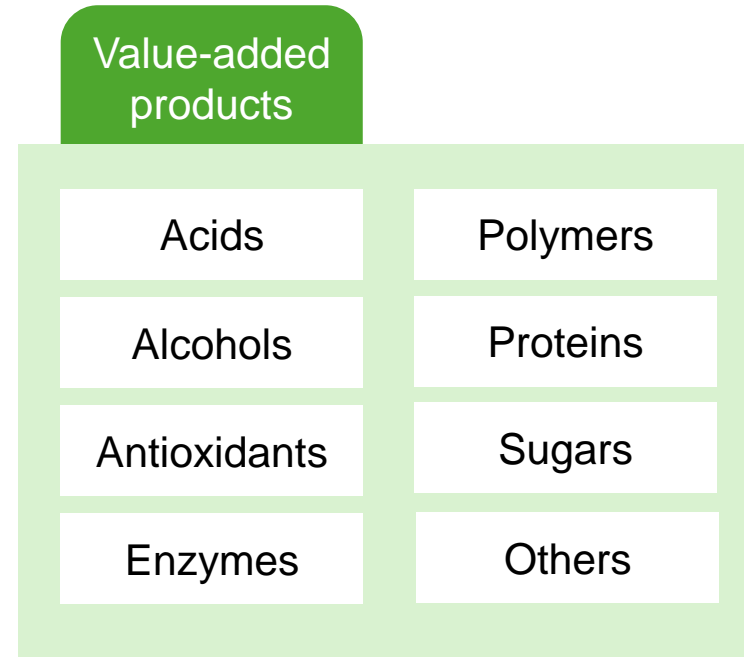
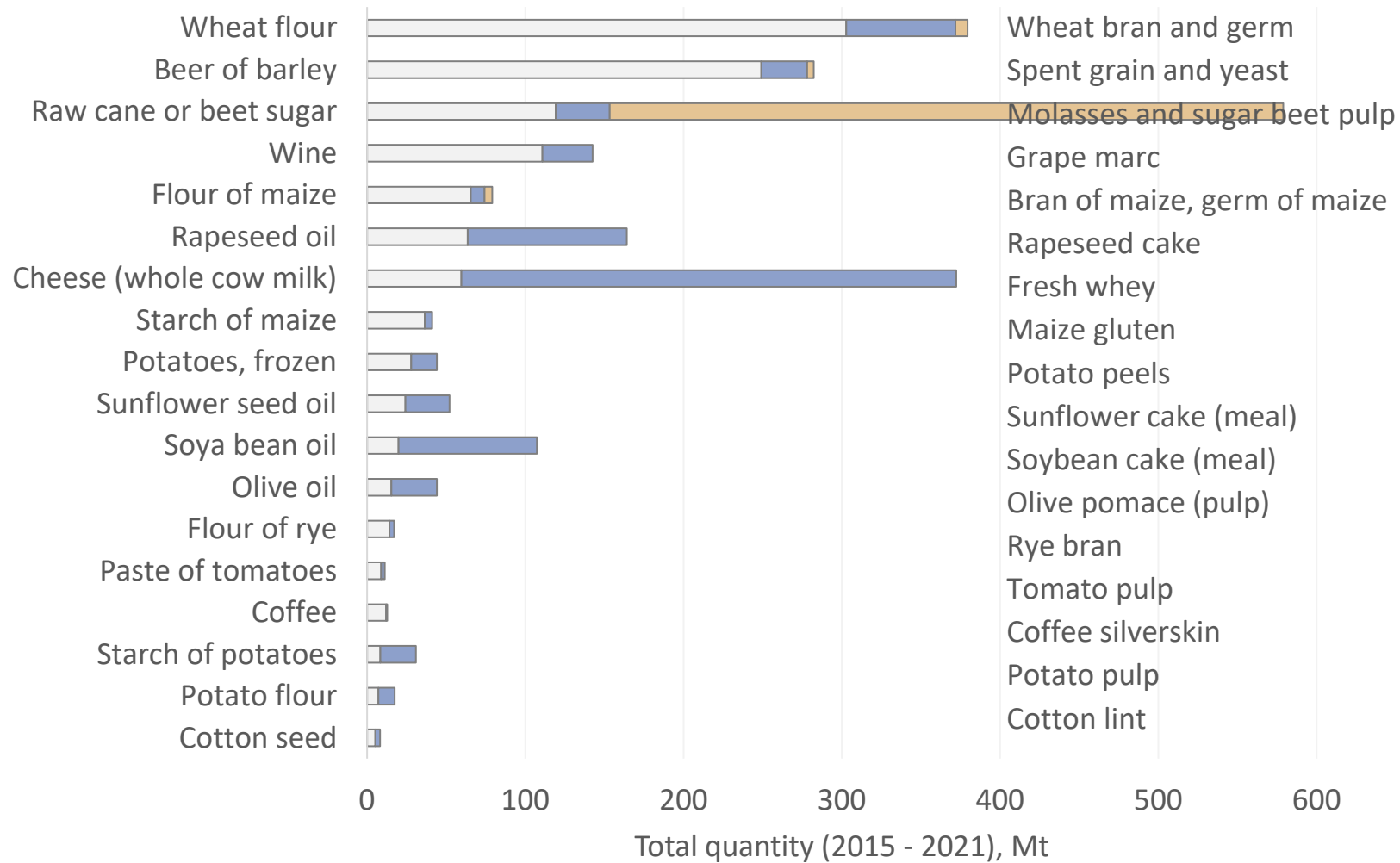
OVERVIEW OF PRODUCTS (kt/year)

Product, kt/year	Northern Europe	Western Europe	Eastern Europe	Southern Europe
Wheat flour	260	2772	1644	1803
Beer of barley	336	2748	1528	866
Raw cane or beet sugar	191	2340	682	219
Wine	4	1020	172	1407
Flour of maize	22	765	432	369
Rapeseed oil	70	1268	323	33
Cheese from whole cow milk	123	939	205	211
Potatoes, frozen	1	957	151	0.4
Starch of maize	7	434	243	260
Starch of wheat	45	463	205	38
Sunflower-seed oil	2	157	285	161
Soya bean oil	15	309	17	246
Flour of rye	39	142	152	10
Starch of potatoes	75	225	32	0.1
Olive oil	0	4	0	274
Coffee, decaffeinated or roasted	30	127	25	85
Cotton seed	0	0	2	376
Potato flour	66	135	15	1

 Top 10 product in the respective region (based on average value between 2015 - 2021), kt/year

 Products primarily produced in a specific region

BY-PRODUCTS AND VALUE-ADDED PRODUCTS

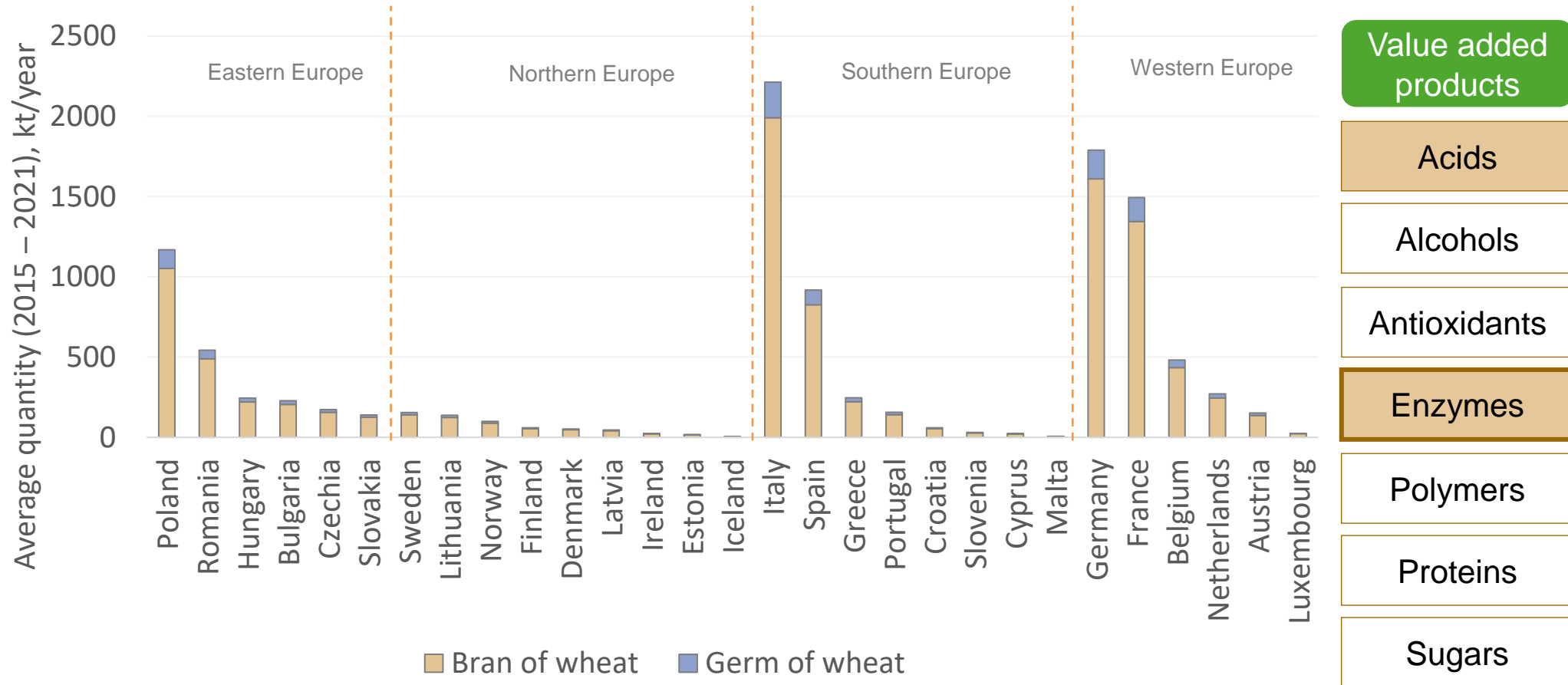


Biological valorisation (bio-valorisation) – application of microorganisms

- Product
- By-product 1
- By-product 2

The quantity of food products and their respective direct by-products

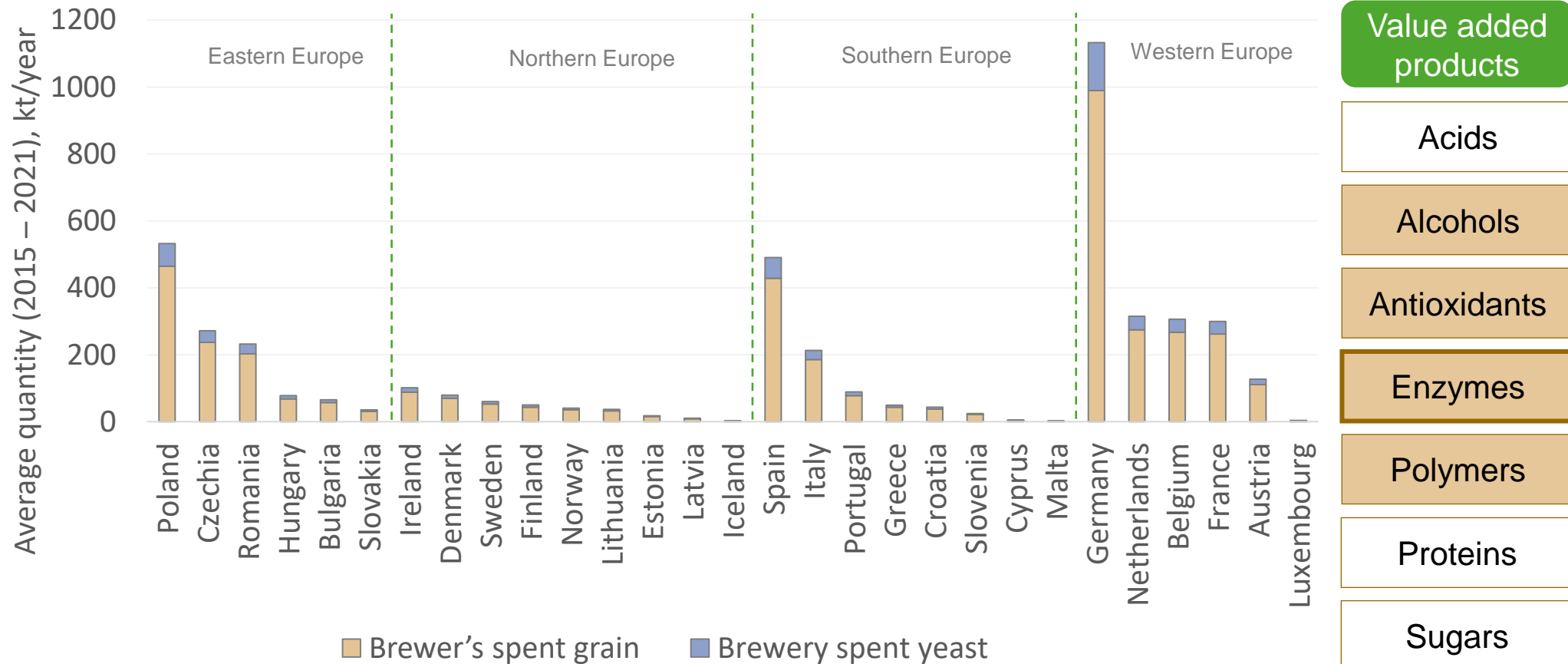
BY-PRODUCTS OF WHEAT FLOUR PRODUCTION



The quantity of **wheat flour** and its by-products **wheat bran** and **wheat germ**

On average 0.23 t of wheat bran and 0.03 t of wheat germ per 1 t of wheat flour

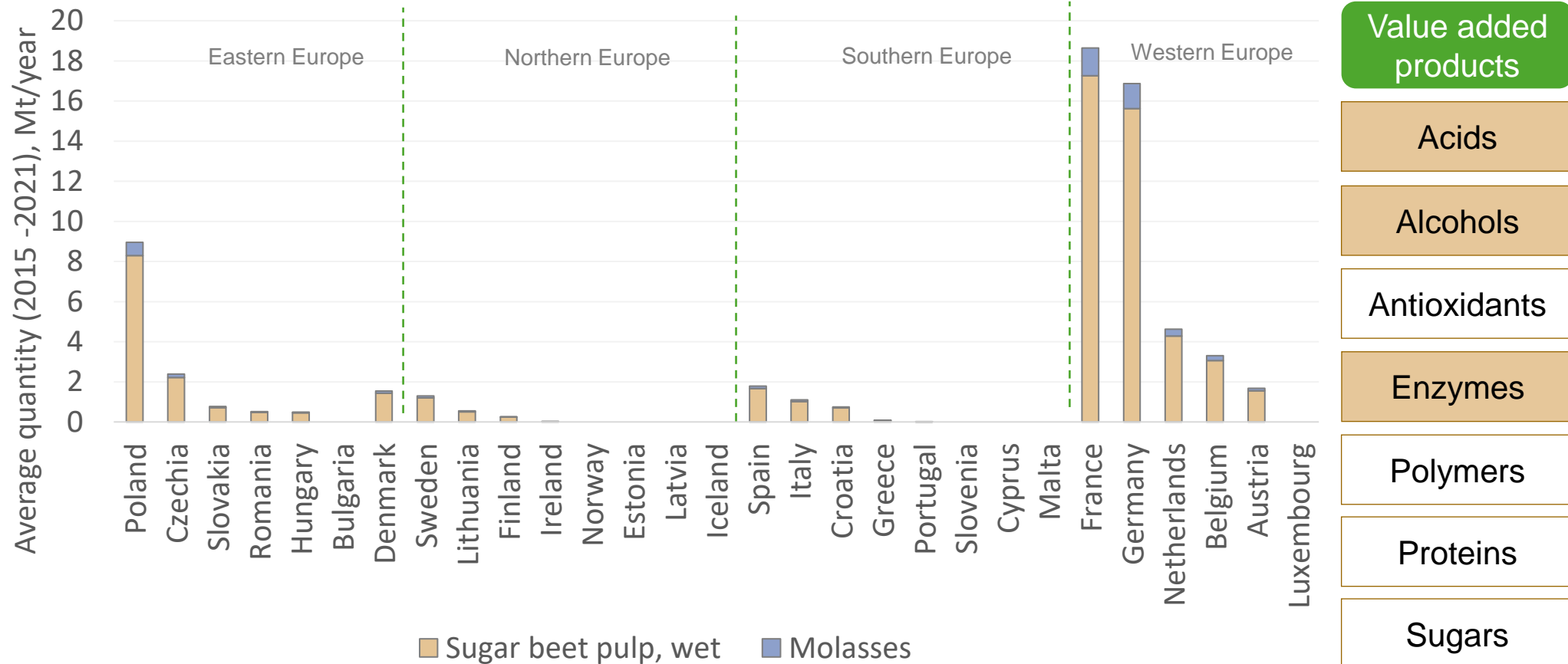
BY-PRODUCTS OF BEER PRODUCTION



The quantity of **beer** and its by-products: **brewer's spent grain** and **spent yeast**

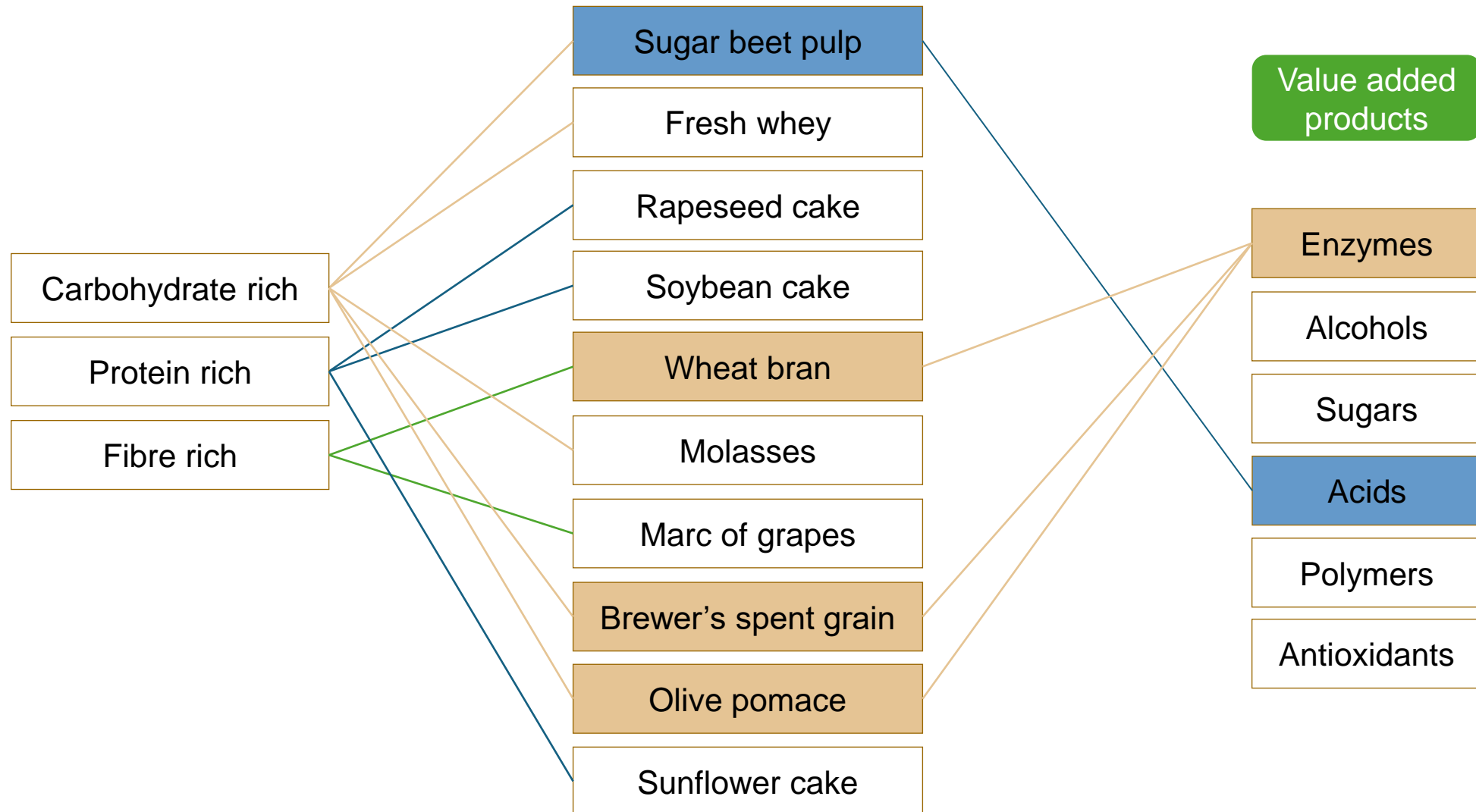
On average 0.12 t of spent grain and 0.02 t of spent yeast per 1 t of beer

RESULTS: SUGAR PRODUCTION



The quantity of **sugar** and its by-products **sugar beet pulp** and **molasses**
 On average 3.57 t of sugar beet pulp and 0.29 t of molasses per 1 t of sugar.

VALUE-ADDED PRODUCTS



CONCLUSIONS: LIMITATIONS

- **By-products:**
 - limited quantitative data on by-product formation;
 - difficult to quantify ranges;
 - uniform coefficients applied to all countries not considering technological nuances
- **Value-added products:**
 - low technology readiness, primarily lab-scale experiments;
 - hard to estimate potential product quantities based on by-product availability

CONCLUSIONS: STRENGTHS

- Uniform method applied with a possibility of extending the geographical scope, products and quantifiable resource flows;
- Improved data comparability and clarity on by-products
- A comprehensive overview of by-product coefficient estimates and value-added products using bio-valorisation

FURTHER OUTLOOK

- Increase the understanding of **by-product formation** and **conventional utilisation pathways**
- Evaluate **by-product suitability** for producing value-added products using biological valorisation methods.
- Enable **comparison** of bio-based products with fossil fuel-based products considering **environmental impacts**¹.

¹EC (2024) Boosting Biotechnology and Biomanufacturing in the EU.



UNIVERSITY
OF LATVIA



Assessment of bio-valorisation of by-products from food industry in Europe

Raimonda Soloha, *M.Sc.* , raimonda.soloha@lu.lv

<https://orcid.org/0000-0003-3358-8261>

Liva Kristiana Lukasa, *B.Sc.*

Elina Dace, *Dr.sc.ing.*

Session IX: The LIFE CIRCforBIO project

REFERENCES

1. EC (2018) A sustainable bioeconomy for Europe – Strengthening the connection between economy, society and the environment. <https://data.europa.eu/doi/10.2777/792130>.
2. Stegmann et al. (2020) The circular bioeconomy: its elements and role in European bioeconomy clusters. <https://doi.org/10.1016/j.rcrx.2019.100029>.
3. EC (2024) Boosting Biotechnology and Biomanufacturing in the EU.
4. Soloha, R., Lukasa, L.K. & Dace, E. (2024) Estimation and bio-valorisation of food industry by-products in Northern Europe. <https://doi.org/10.1007/s13399-024-05423-6>.

METHODOLOGICAL CONSIDERATIONS

- Product inclusion based on:
 - Product average quantity (tons) during the analysed period (2015 – 2021)
 - Product among top 20 products in the analysed country
 - By-products for product can be identified
 - By-product conversion factors and quantities estimated
 - Intermediate products further used in food production (i.e. buttermilk) not included as by-products
- By-product quantification
 - Value estimates based on wet weight basis
 - Water losses and water addition not separately quantified