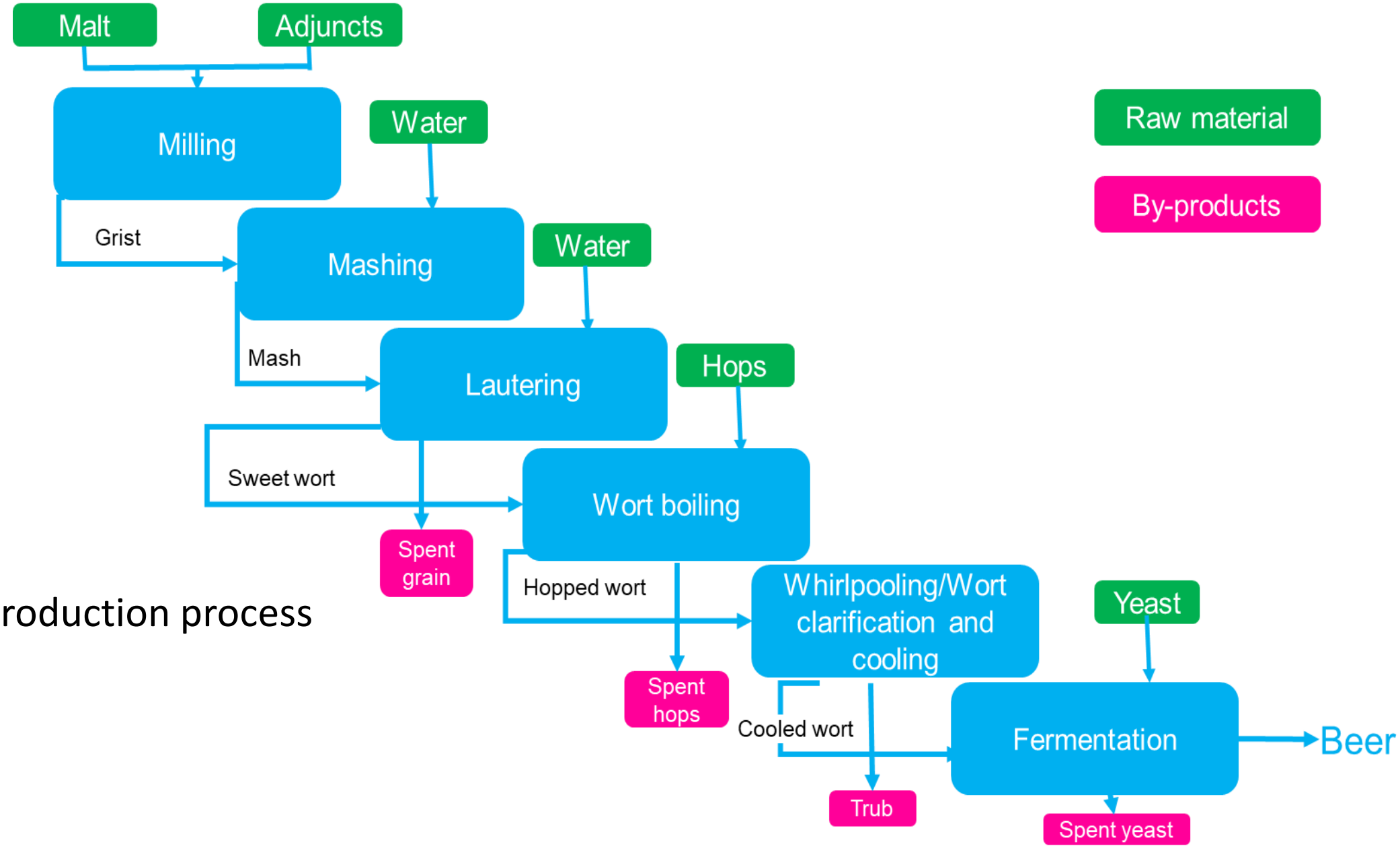
Fate of pesticide residues in beer and its by-products

Joint EURLs/NRLs Workshop for Pesticide Residues-2023
Stuttgart-Germany

Elena Hakme- elehak@food.dtu.dk
Assistant Professor
Denmark Technical University
EURL-CF

The beer production process

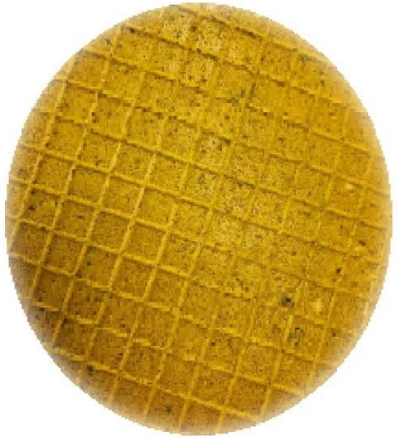


Why is important to understand the fate of pesticide residues in beer by-products?

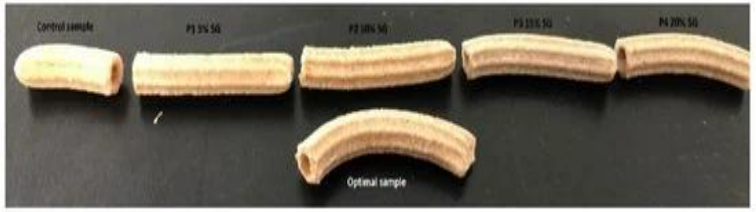
Spent grain vegan yogurt

Spent grain bread

Spent grain chips



Spent grain wafers

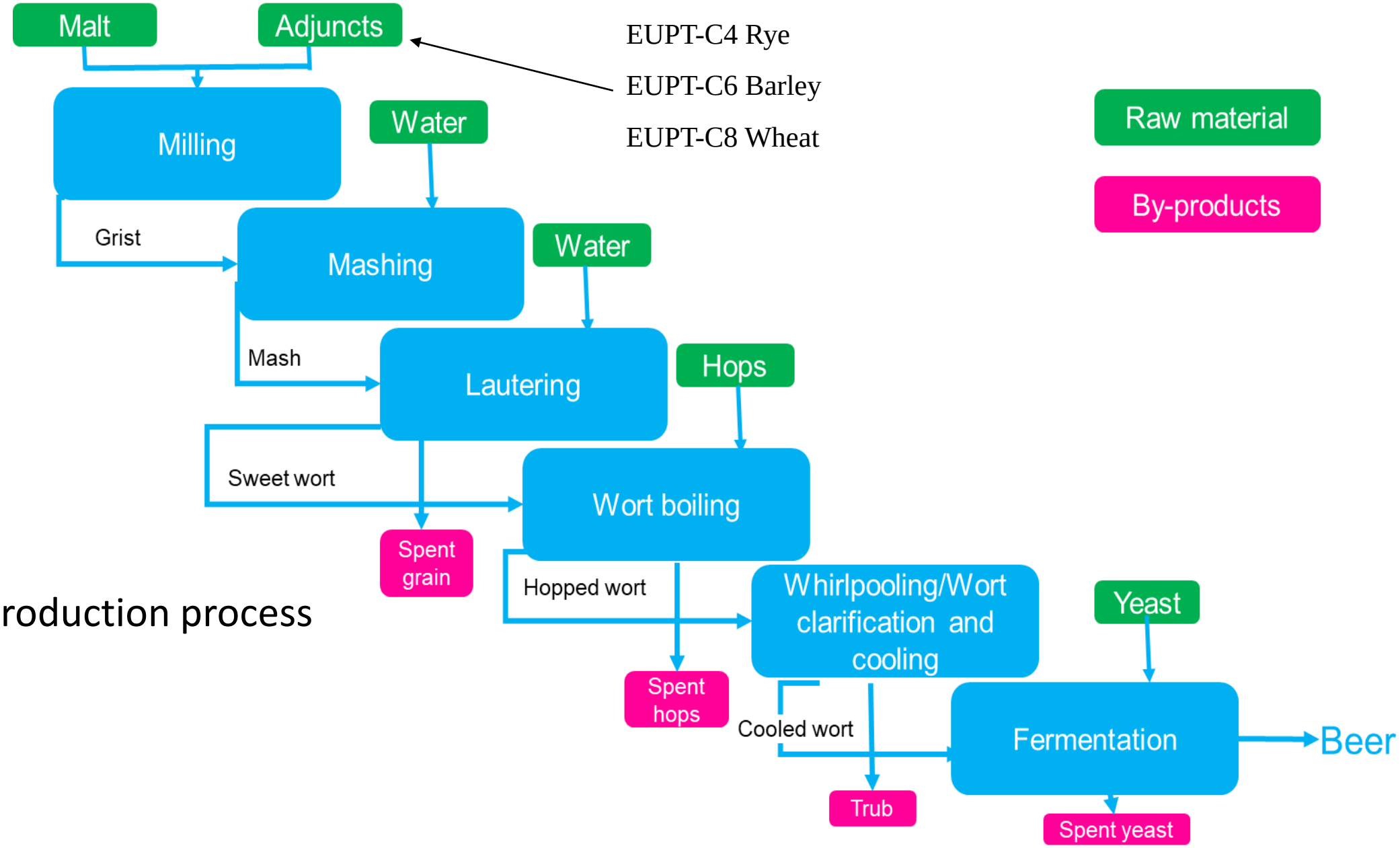


Spent grain pasta

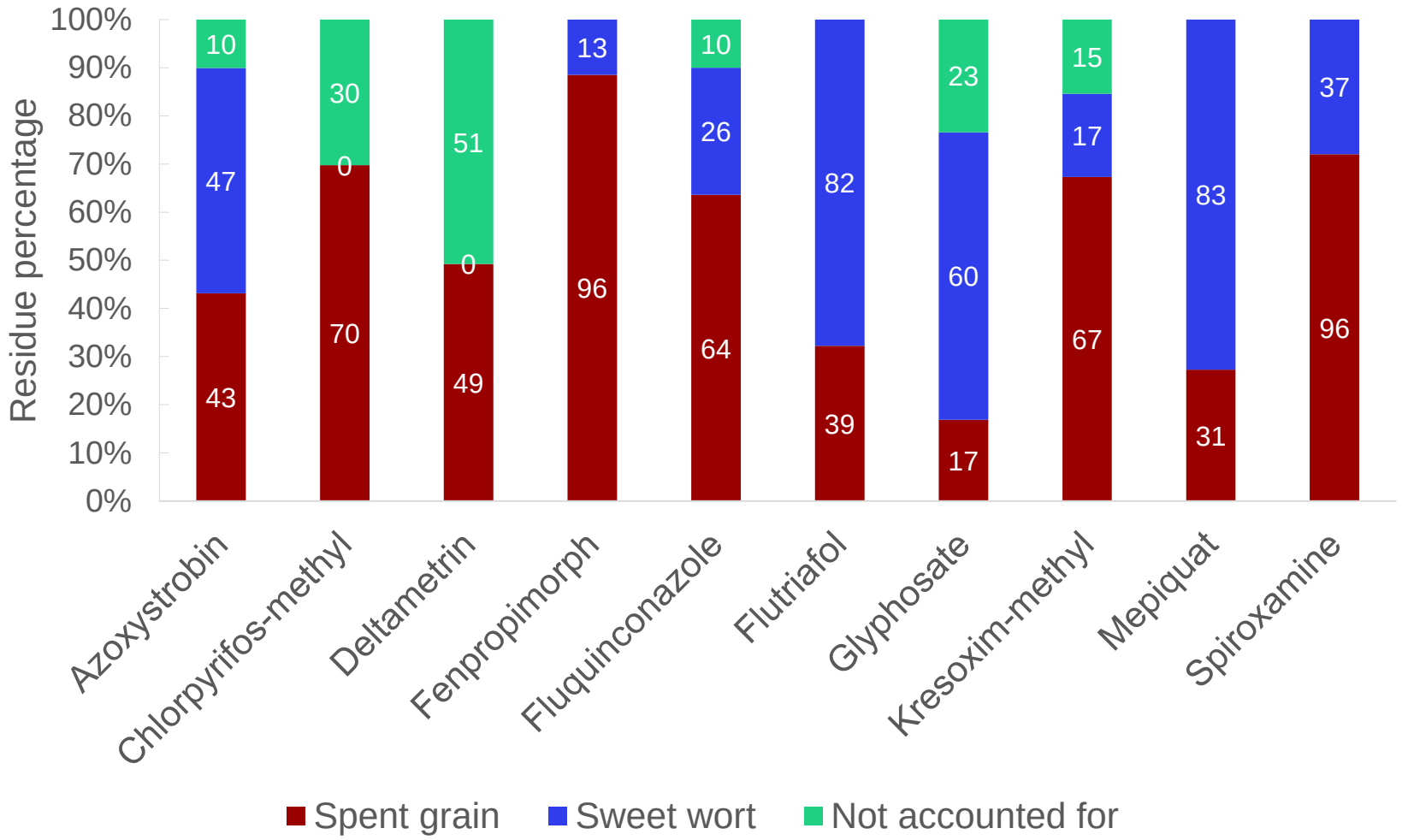
Spent grain cookies

https://doi.org/10.3390/foods12071533

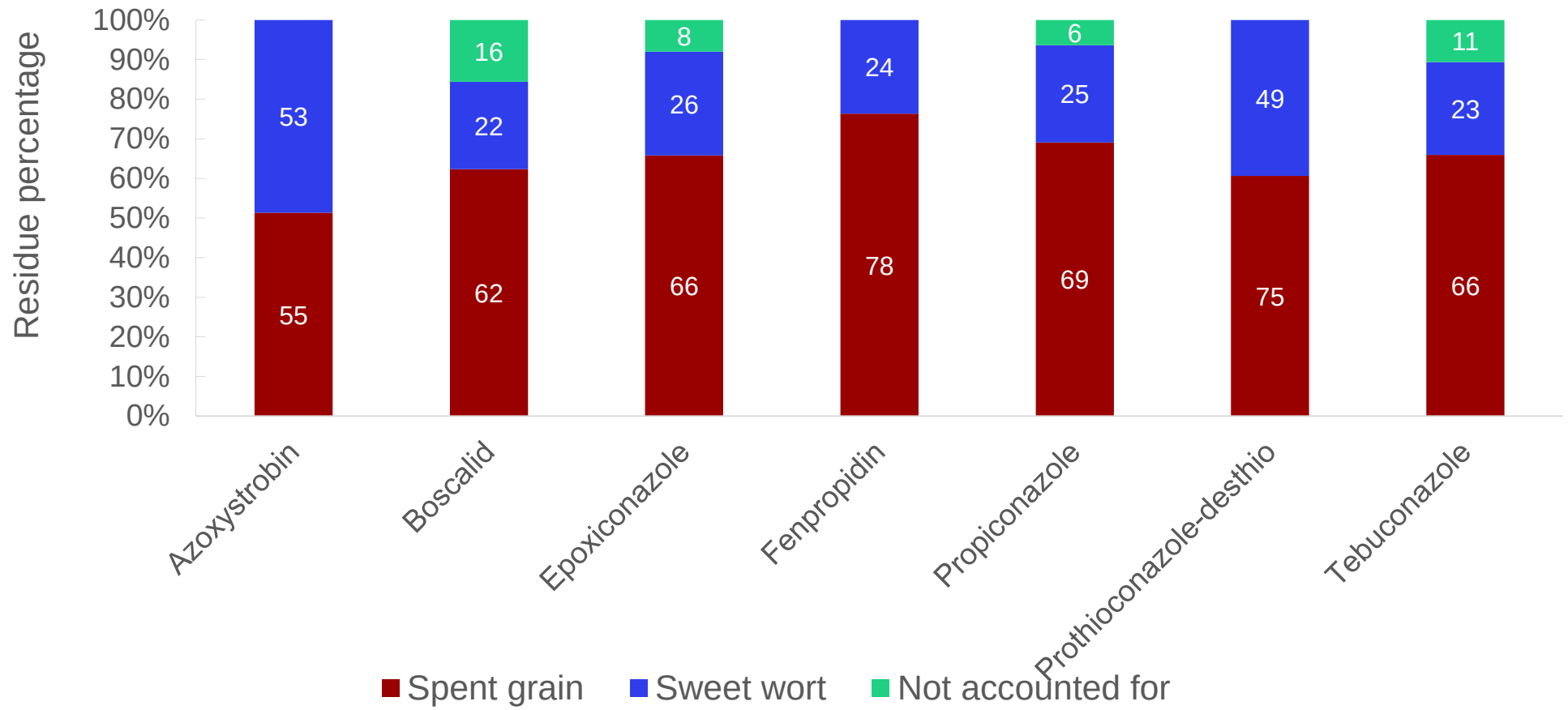
The beer production process



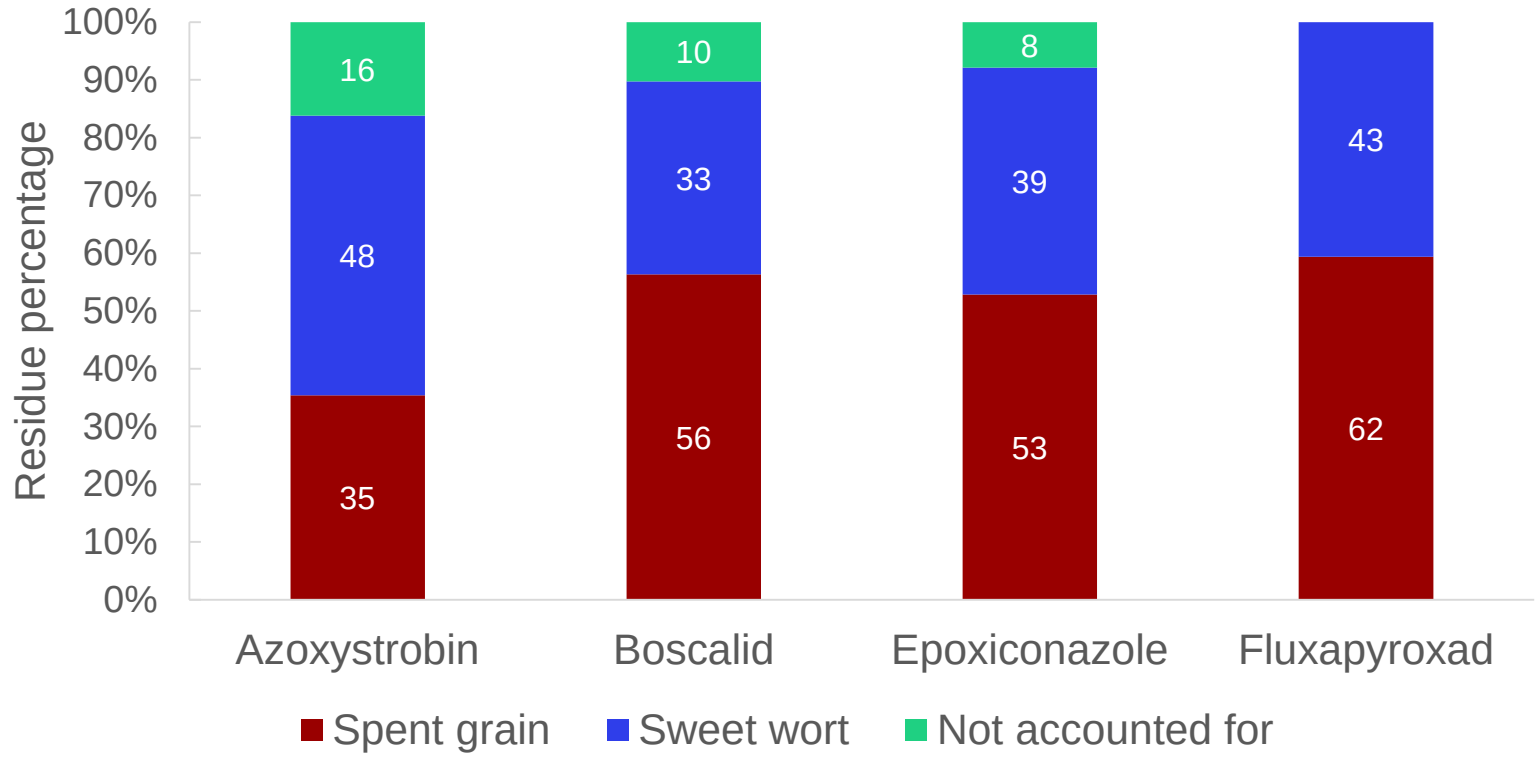
The distribution of pesticide residues in brewer's spent grain and sweet wort with **rye** used as adjunct



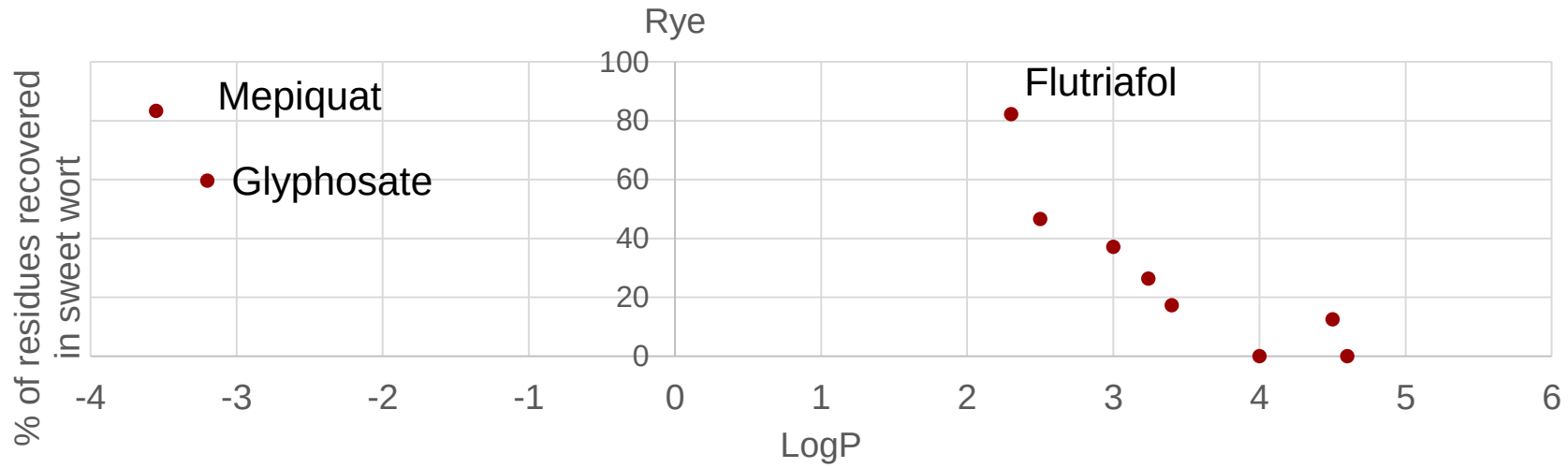
The distribution of pesticide residues in brewer's spent grain and sweet wort with **barley** used as adjunct

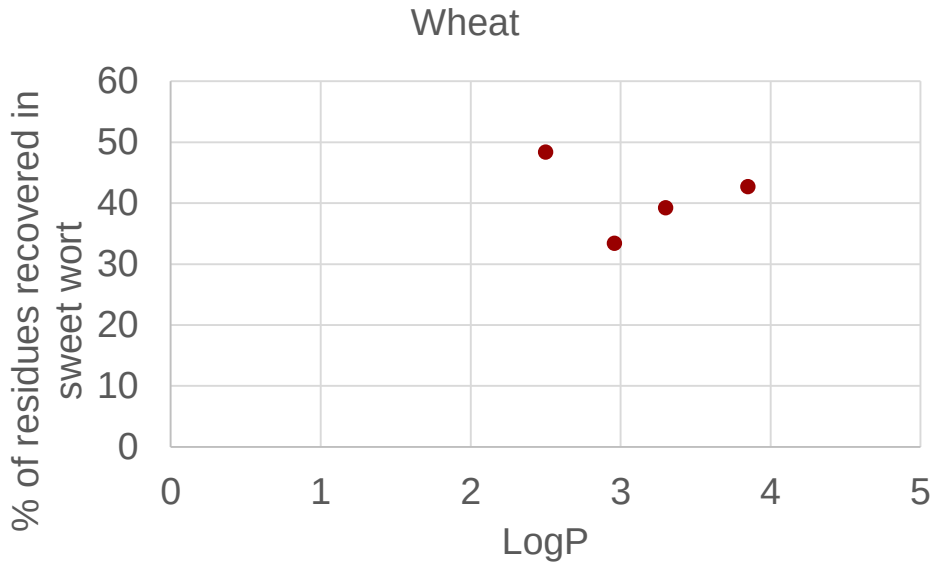


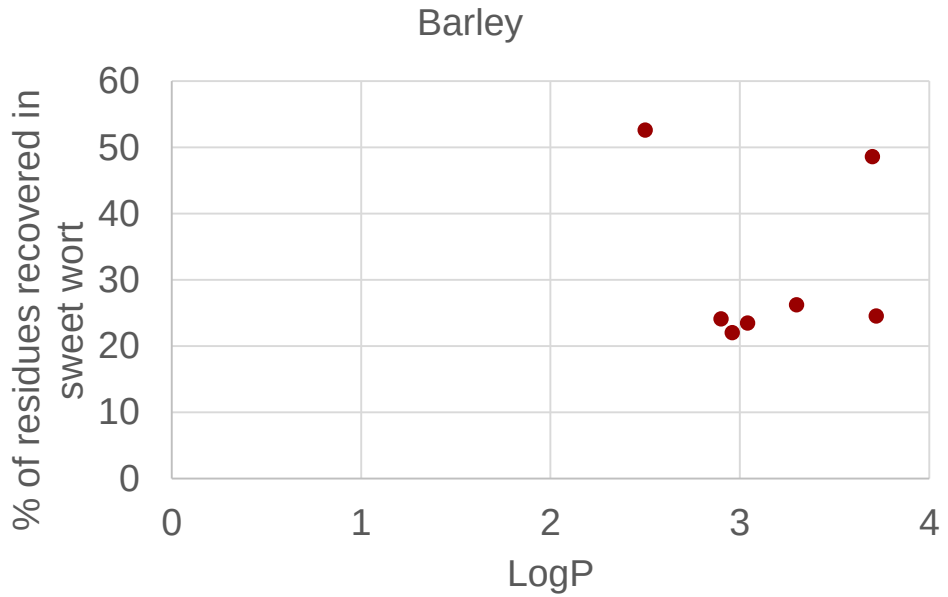
The distribution of pesticide residues in brewer's spent grain and sweet wort with **wheat** used as adjunct



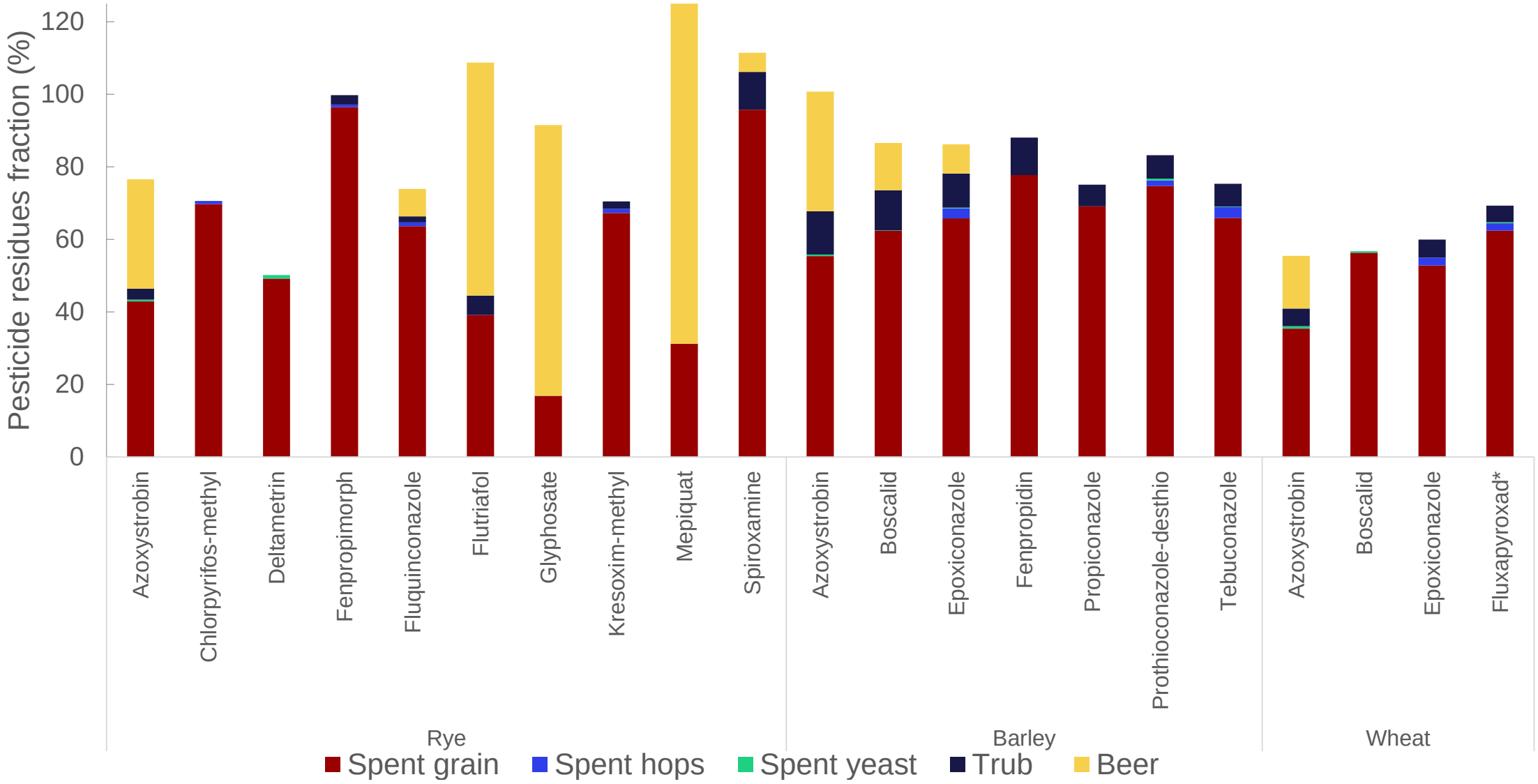
Is logP a good indicator of pesticides recovery in beer?



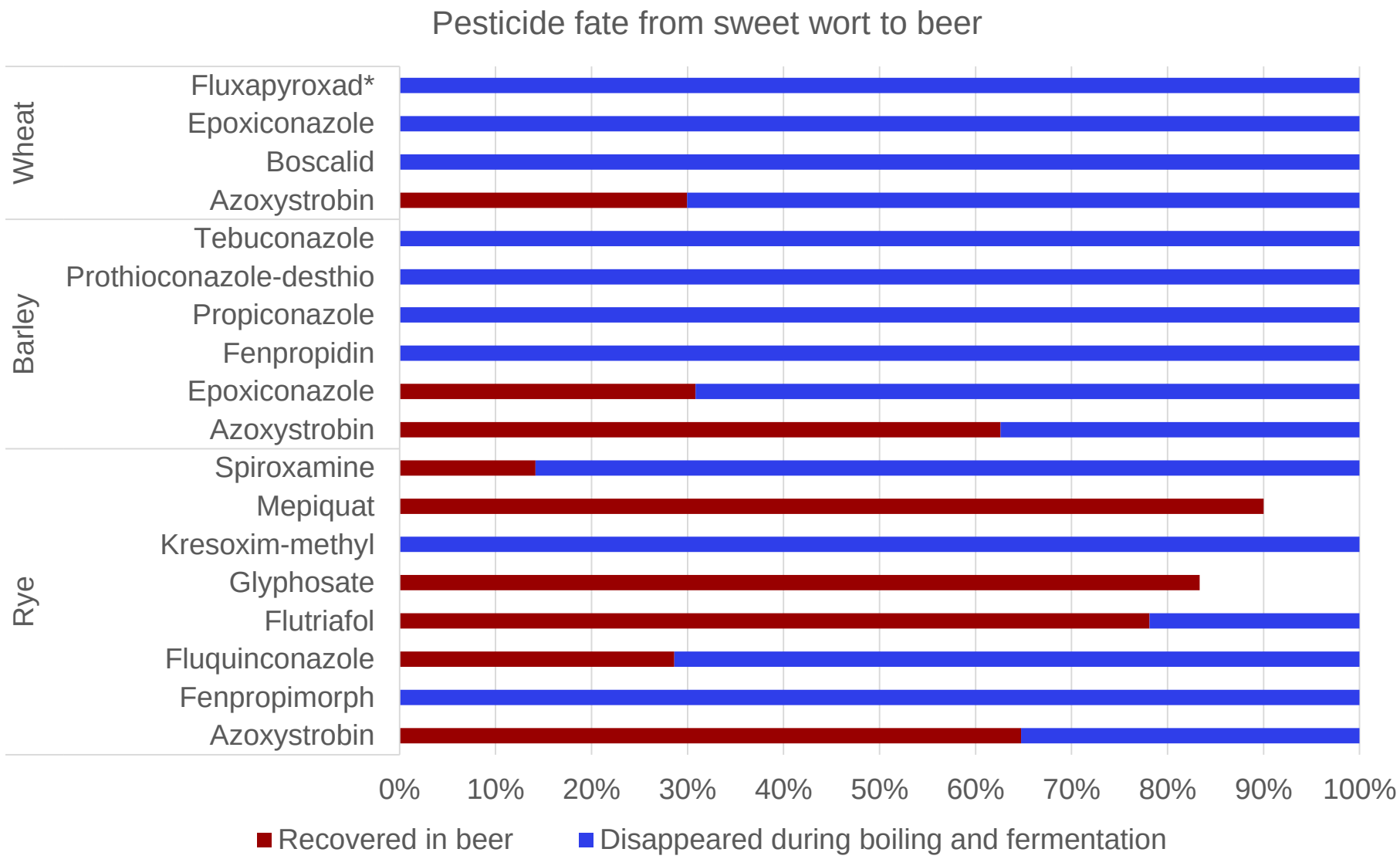




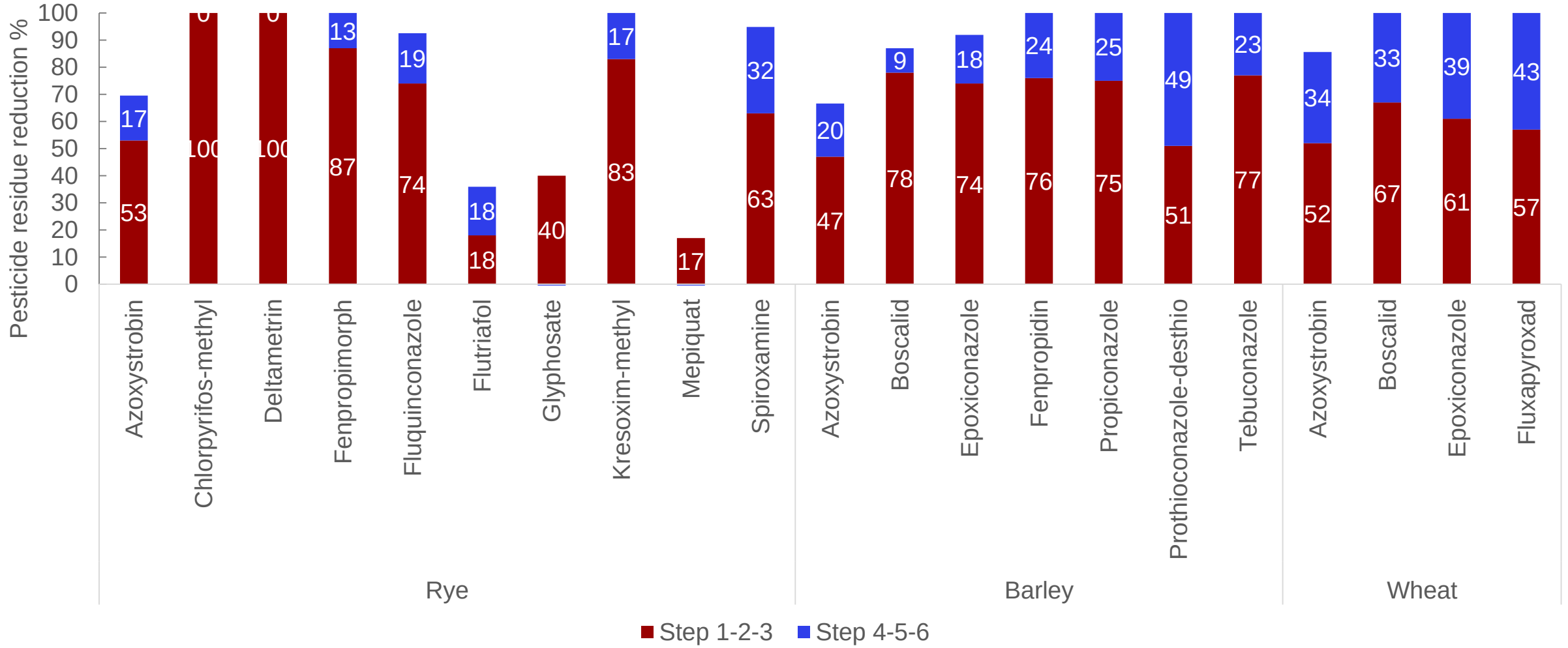
Pesticide residue fraction in the beer and the 4 by-products of spent grain, spent hops, spent yeast, and trub



Pesticide residues recovery/ reduction from sweet wort to beer



Pesticide residues reduction in step 1-2-3 (milling, mashing, and lautering), and step 4-5-6 (wort boiling, wort clarification and fermentation)



PFs of pesticide residues from rye, wheat, and barley to spent grain, sweet wort, spent hops, trub, and beer.

Type of adjunct	Pesticide	PF from adjunct to spent grain	PF from adjunct to sweet wort	PF from adjunct to spent hops	PF from adjunct to spent yeast	PF from adjunct to trub	PF from adjunct to beer
Rye	Azoxystrobin	0.11	0.04	**0**	0.05	0.02	0.03
	Fenpropimorph	**0.26**	**0.01**	0.06	**0**	0.02	**0**
	Fluquinconazole	0.17	0.02	0.09	0	**0.01**	0.01
	Flutriafol	0.10	0.07	0	0	0.04	0.06
	Glyphosate	**0.05**	0.05				**0.07**
	Kresoxim-methyl	0.18	0.01	0.09	0	0.02	**0**
	Mepiquat	0.08	**0.07**				0.08
	Spiroxamine	0.26	0.03	0	0	0.08	0
Barley	Azoxystrobin	0.15	0.04	0	0.04	**0.10**	0.03
	Boscalid	0.17	0.02	0	0.02	0.09	0.01
	Epoxiconazole	0.18	0.02	0.22	0.02	0.08	0.01
	Fenpropidin	0.21	0.02	0	0	0.08	0
	Propiconazole	0.18	0.02	0	0	0.05	0
	Prothioconazole-desthio	0.20	0.04	0.12	0.05	0.05	0
	Tebuconazole	0.18	0.02	**0.24**	0.01	0.05	0
Wheat	Azoxystrobin	0.09	0.04	0	**0.07**	0.04	0.01
	Boscalid	0.15	0.03	0	0.04	0.00	0
	Epoxiconazole	0.14	0.03	0.17	0	0.04	0

PF = Residue level in processed fraction (mg kg) /Residue level in RAC (mg kg)

Conclusions

- LogP is a good indicator of pesticides recovery in beer and its by-products. The majority of medium and highly non-polar pesticides are adsorbed to spent grain, while very polar compounds are mostly recovered in sweet wort.
- On average, the fraction of pesticide residues retrieved in beer is 9%, by-products combined (58%), and 33% is eliminated during the process by evaporation, or degradation.
- On average, pesticide residues tend to accumulate in spent grains (53%) >trub (4%)> spent hops (1%)> spent yeast (less than 1%)
- Thorough consideration should be taken by a range of food industries currently utilizing, or potentially considering the use of spent grain in innovative food applications, with a focus on monitoring this medium polar and non-polar pesticides in the spent grain.
- These finding could also provide guidance for individuals responsible for establishing food safety criteria for utilizing brewery by-products as new food ingredients.
- The generated PFs can be used to estimate the initial concentration of pesticide residues in raw products used for beer production to ensure compliance of beer and its by-products to the EU regulations.

Thank you!

Elena Hakme, Ida Kallehauge Nielsen, Jennifer Fermina Madsen, L
Munch Storkehave, Mette Skjold Elmelund Pedersen, Benjamin Luke S
Mette Erecius Poulsen, Timothy John Hobley, Lene Duedahl-Olesen