

QTL-mapping of kaempferols and sinapic acid esters and correlations with other seed quality traits in oilseed rape

Jasmin Vettel ¹, Christoph Walser², Hanna Schilbert³, Bernd Weisshaar³, Corinna Dawid², Christian Möllers¹

¹ Georg-August University Göttingen, Göttingen, Germany

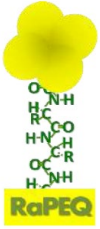
² Technical University of Munich, Freising, Germany

³ Bielefeld University, Bielefeld, Germany

 jasmin.vettel@uni-goettingen.de



Own photo



Oilseed rape as a protein crop?

Challenges

- About 30 times the phenolic acid ester content of soybeans, especially bitter tasting **sinapic acid esters**^{1, 2}
- Contains another major bitter compound, **kaempferol 3-O-(2'''-O-sinapoyl- β -sophorosid) (K3OSS)**³

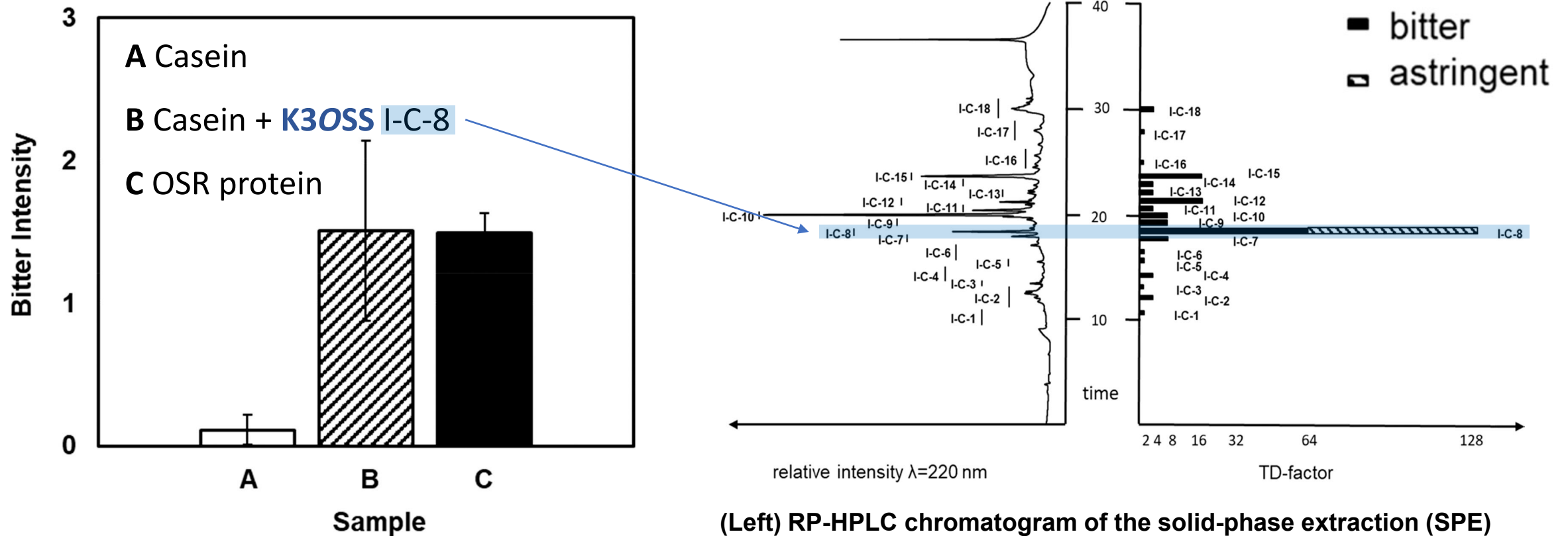
Breeding Objective:

The goal is not only to increase the protein content in the seeds but also to enhance the protein quality!

¹ Kozłowska et al. 1990, Van Nostrand Reinhold, New York, pp. 193-210 ² Milkowski et al. 2004, Plant J . 2004 Apr;38(1):80-92

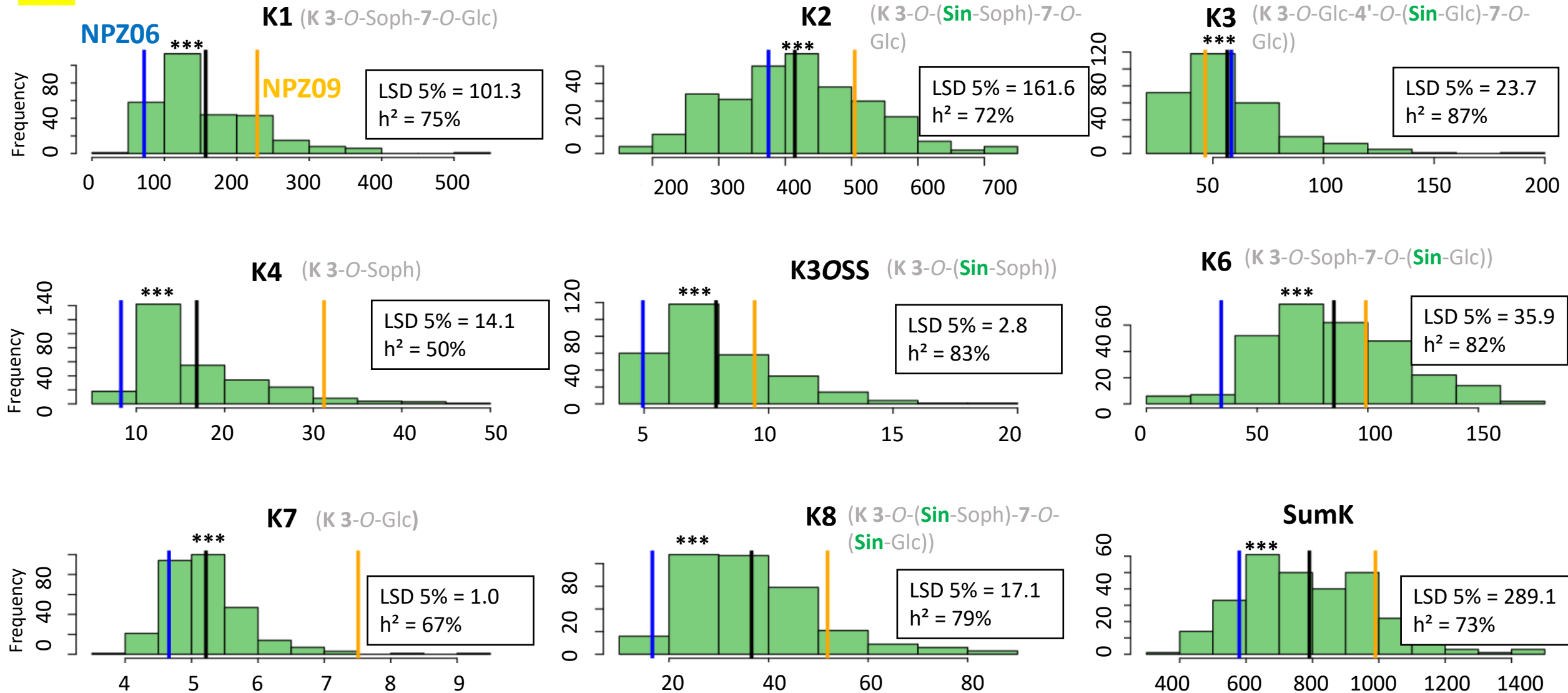
³ Hald et al. 2019, J. Agric. Food Chem. 2019, 67, 1, 372-378

Taste dilution analysis (TDA)



(Left) RP-HPLC chromatogram of the solid-phase extraction (SPE) fraction I-C and (right) taste dilution analysis (TDA).

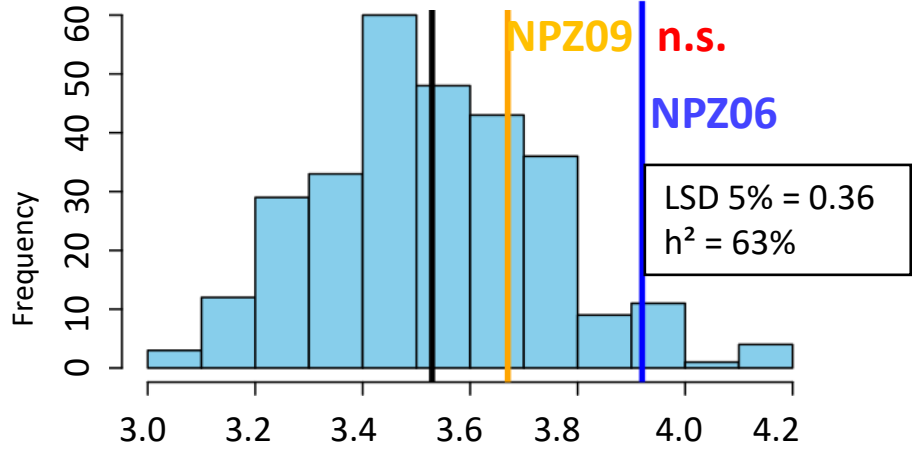
Genetic variation of kaempferol glycosides ($\mu\text{g/g}$ seeds)



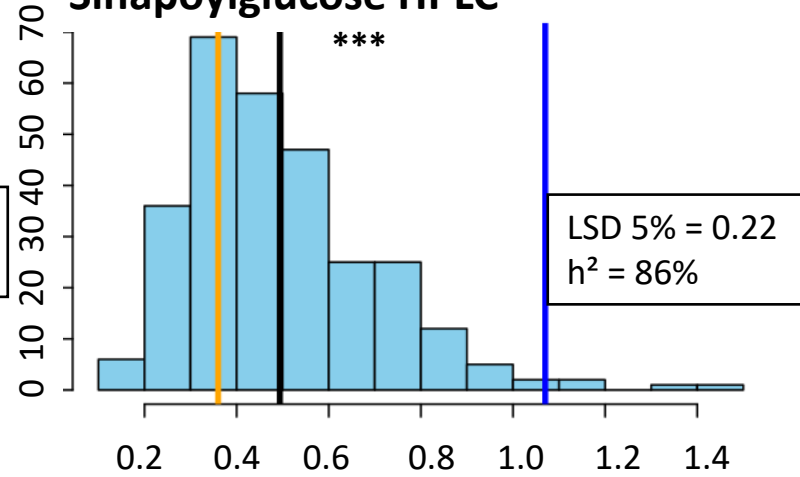
*** indicates significance at a $p \leq 0.01$ between parents using a two-tailed T-test

Genetic variation of sinapic acid esters (mg/g seeds)

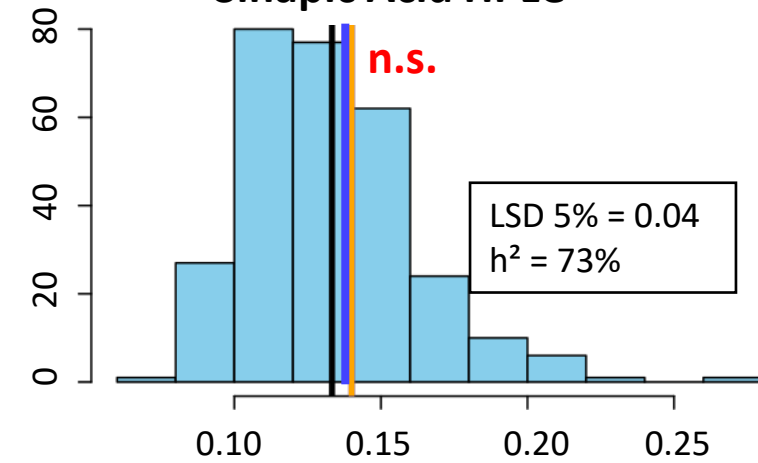
Sinapine HPLC



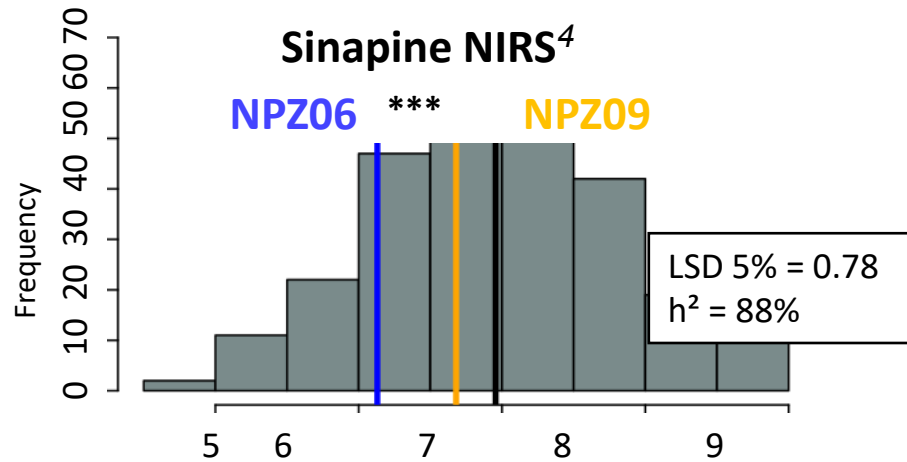
Sinapoylglucose HPLC



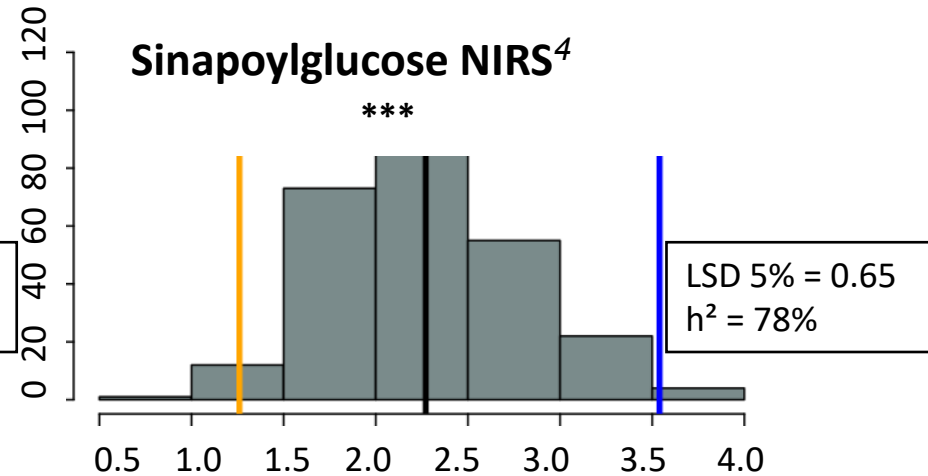
Sinapic Acid HPLC



Sinapine NIRS⁴

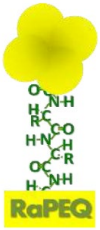


Sinapoylglucose NIRS⁴



*** indicates significance at a $p \leq 0.01$ between parents using a two-tailed T-test; n.s. = not significant

⁴ Zum Felde et al. 2007, *Plant Breeding* 126:291–296

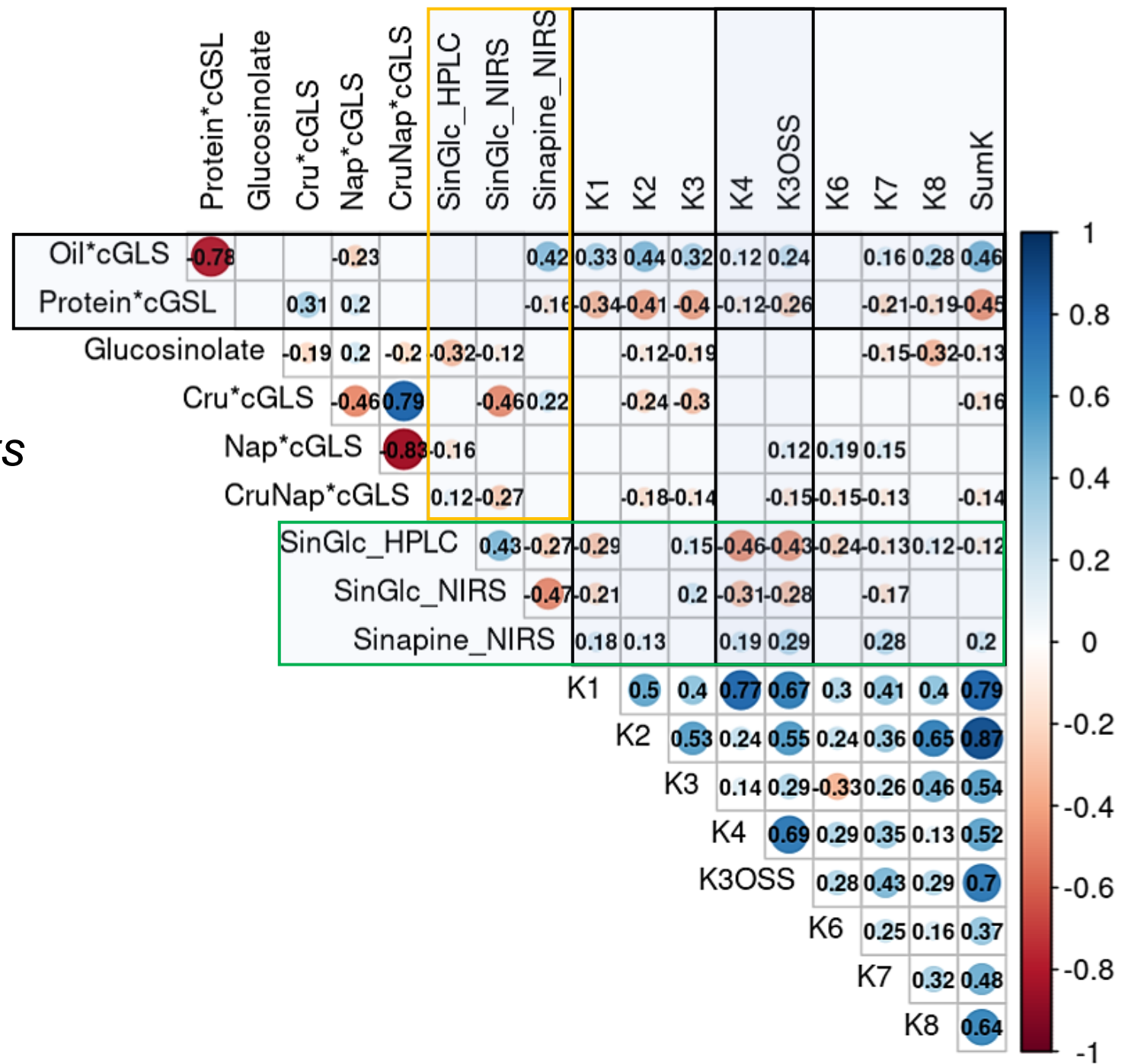


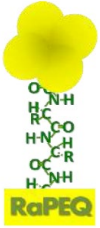
Correlations

DH Population NPZ06 x NPZ09

2 field years, 6 environments
2020-2022

Spearman rank correlation
coefficients





Major co-localized QTL on C6

C6

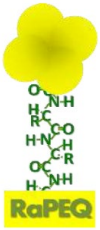
~ 7 - 25 cM

(Total: 125cM)

	K3OSS	Sum of Kaempferols	K1	K4	K7	Sinapine (NIRS)	SinGlc (NIRS)	SinGlc (HPLC)
LOD score ($p \leq 0.01$)	36.41	20.73	22.87	24.98	13.87	16.25	14.98	25.23
Phenotypic variance explained by each QTL	29%	15%	25%	27%	10%	17%	12%	17%
Additive effect	1.42	84.21	34.77	3.31	0.16	0.34	-0.18	-0.09
Phenotypic variance explained by all QTL	63%, 7 QTL	63%, 7 QTL	43%, 4 QTL	46%, 5 QTL	58%, 9 QTL	43%, 6 QTL	56%, 8 QTL	65%, 10 QTL

▪ A candidate gene was identified which is related to an *A. thaliana* gene encoding a flavonol glycosyltransferase (*FGT*) with activity towards the 3-O and 7-O-position of flavonols

➤ Differentially expressed between the parents (log2FC: -1.82)



Major co-localized QTL on A6

A6

~ 70 – 75 cM

(Total: 113 cM)

	K3OSS	Sum of Kaempferols	K1	K2	K8
LOD score ($p \leq 0.01$)	17.67	32.88	15.64	32.59	26.65
Phenotypic variance explained by each QTL	12.03	25.65	16.12	22.60	25.83
Additive effect	0.78	99.51	26.87	52.39	6.51
Phenotypic variance explained by all QTL	63%, 7 QTL	63%, 7 QTL	43%, 4 QTL	67%, 14 QTL	51%, 6 QTL

- **MYB transcription factor candidate gene** recently identified as **flavonol regulator**⁴
- **Differentially expressed** between the parents (**log₂FC: -2.61**)
- **QTL was confirmed** in a **second independent DH population**⁵

⁴ Schilbert and Glover 2022, *BMC Genomics* 23:604

⁵ Pers. Comm. Nils Stolte

Summary

- ✓ **Major and minor QTL for individual and total kaempferol glycosides, including K3OSS, and sinapic acid esters were identified**
- ✓ **Metabolic interactions between K3OSS, as well as its putative precursor kaempferol 3-O-(sophoroside) (K4), with sinapic acid esters were found**
- ✓ **Oil and protein content showed a significant positive and negative correlation with kaempferol glycosides and sinapine, respectively**
- ✓ **A MYB transcription factor gene and a *FGT* gene were identified as loci controlling the kaempferol biosynthesis**

Thank you for your
Attention!



Jasmin Vettel

Georg-August-Universität Göttingen,
Department Crop Sciences, Division
of Crop Plant Genetics

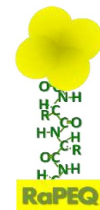


jasmin.vettel@uni-goettingen.de

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GEFÖRDERT VOM



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