Qualitative and Quantitative Determination of Phenolic Acids During Commercial Potato Processing:

AMD-HPTLC as Powerful Tool

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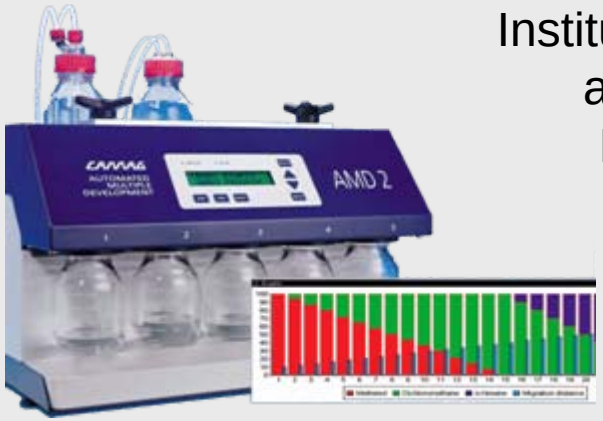


Introduction and Outline

- Phenolic Compounds in Potatoes
- Commercial Potato Processing
- Objectives
  - Optimal extraction procedures for phenolic compounds
  - AMD-HPTLC: method development
  - Is separation of all relevant phenolic compounds realisable?
  - Knowledge about fate and behaviour of phenolic compounds during potato processing
- Results

Phenolic components

Hydroxycinnamic acids C_6-C_3

Stilbenes C_6-C_2-C_6
(e.g. Resveratrol)

Flavonoids
Isoflavonoids
C_6-C_3-C_6

Lignans
Lignins
Tannin-derivatives
Others

Plant Phenolics

Xanthones C_6-C_1-C_6
(e.g. Mangiferin)

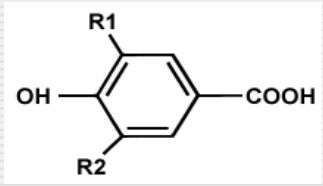
Naphtoquinones C_6-C_4
(e.g. Juglone)

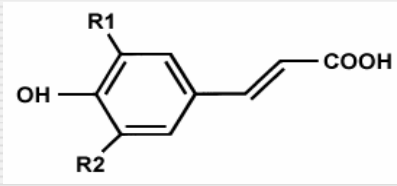
Hydroxybenzoic acids C_6-C_1

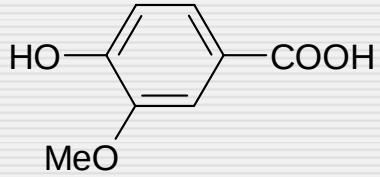
Coumarins
(e.g. Scopoline)

- „Phytochemicals“, part of sec. plant metabolites, > 8000 compounds
- Importance with regard to food quality
  - Anti-oxidative ⟶ health promoting effects: antimutagenic, anticarcinogenic, etc.
  - Anti-oxidative ⟶ food shelf-life, antiinflammatory, antiinfectious in case of bruising
  - Capacity with regard to brown-colouring (enzymatic and non-enzymatic reactions)
  - Taste induction
  - Complexation with proteins and other compounds (taste, turbidity,…)

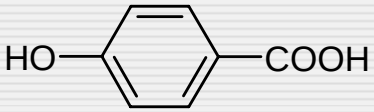
Phenolic compounds in potatoes



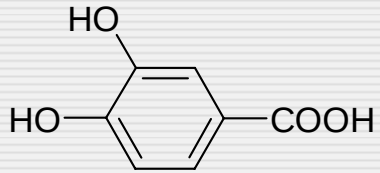




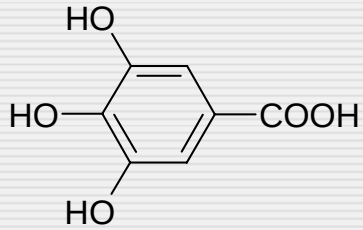
Vanillic acid ~ 1%



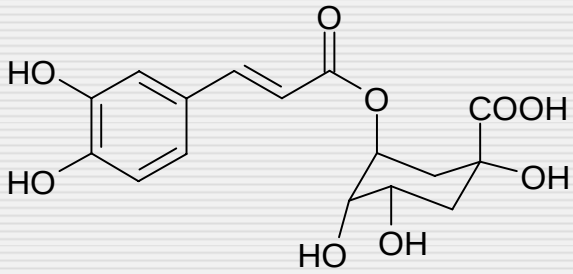
p-Hydroxybenzoic acid (PHB) < 1%



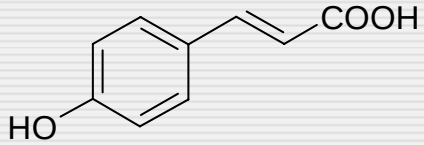
Protocatechuic acid < 1%



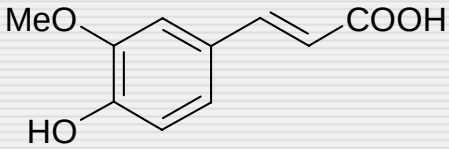
Gallic acid < 1%



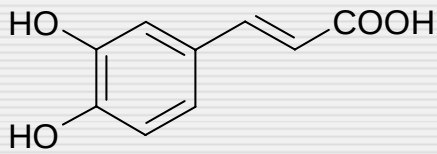
Chlorogenic acid ~ 75%



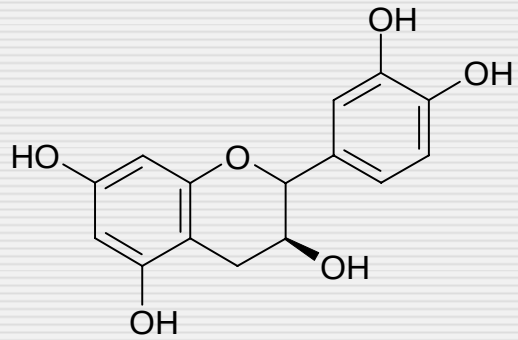
p-Coumaric acid ~ 1%



Ferulic acid ~ 4%

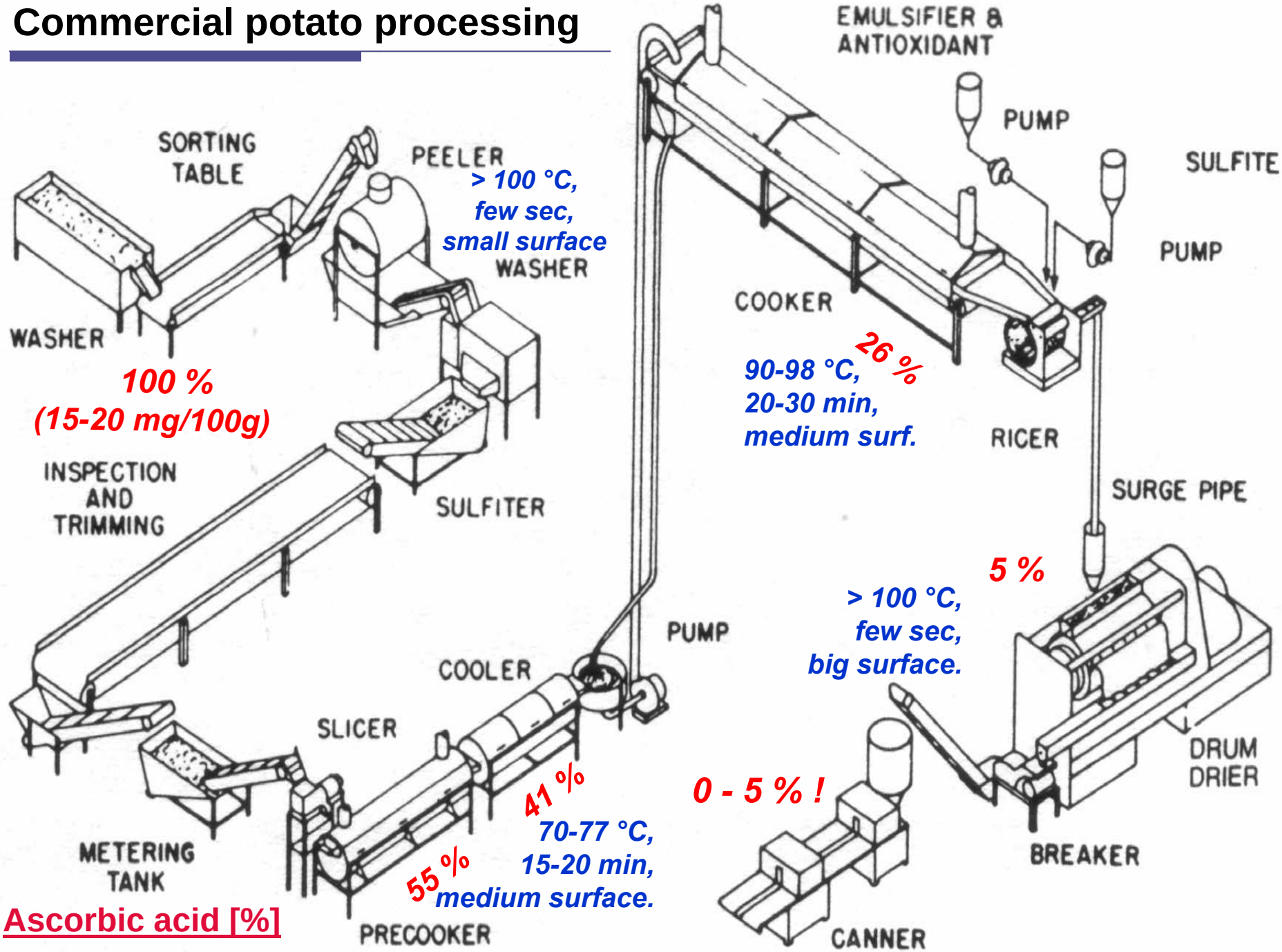


Caffeic acid ~ 14%



Catechol (Flavan-3-ol) ~ 2%

Commercial potato processing



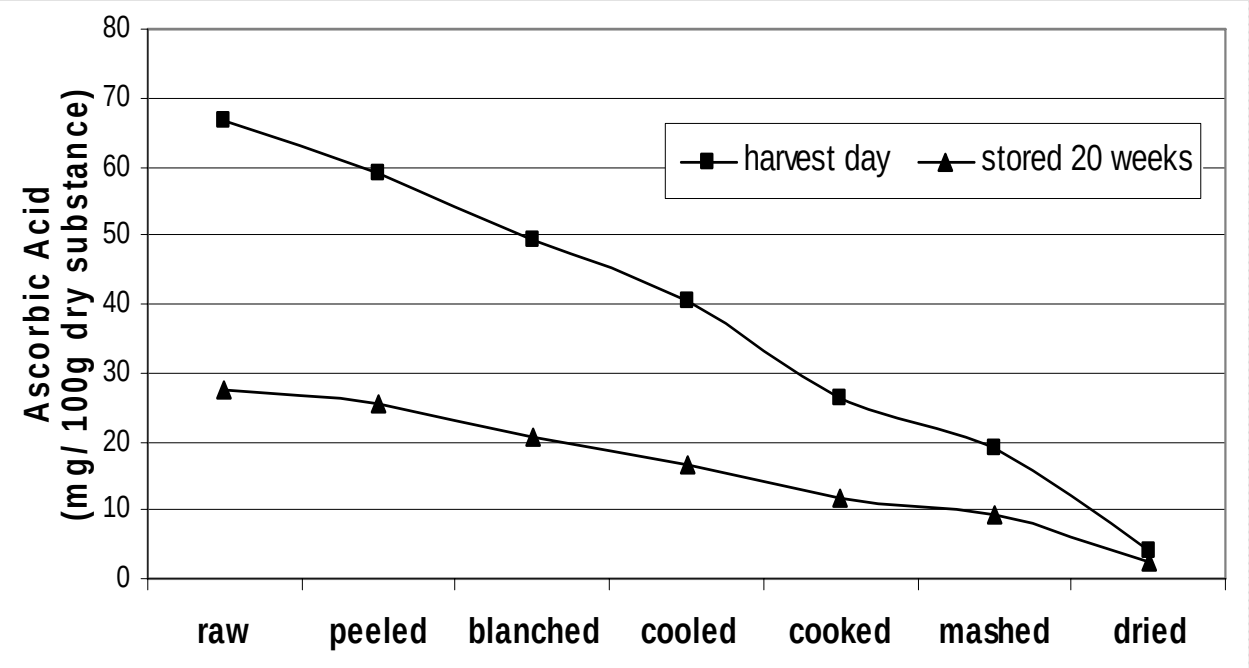
Previous results: Vitamins and Total Phenolics

- Total phenolics decrease during processing
- Light- and temperature-induced reduction of phenolic acids
- Reduction due to leaching

- Therefore: phenolic acid values are expected to decrease during processing

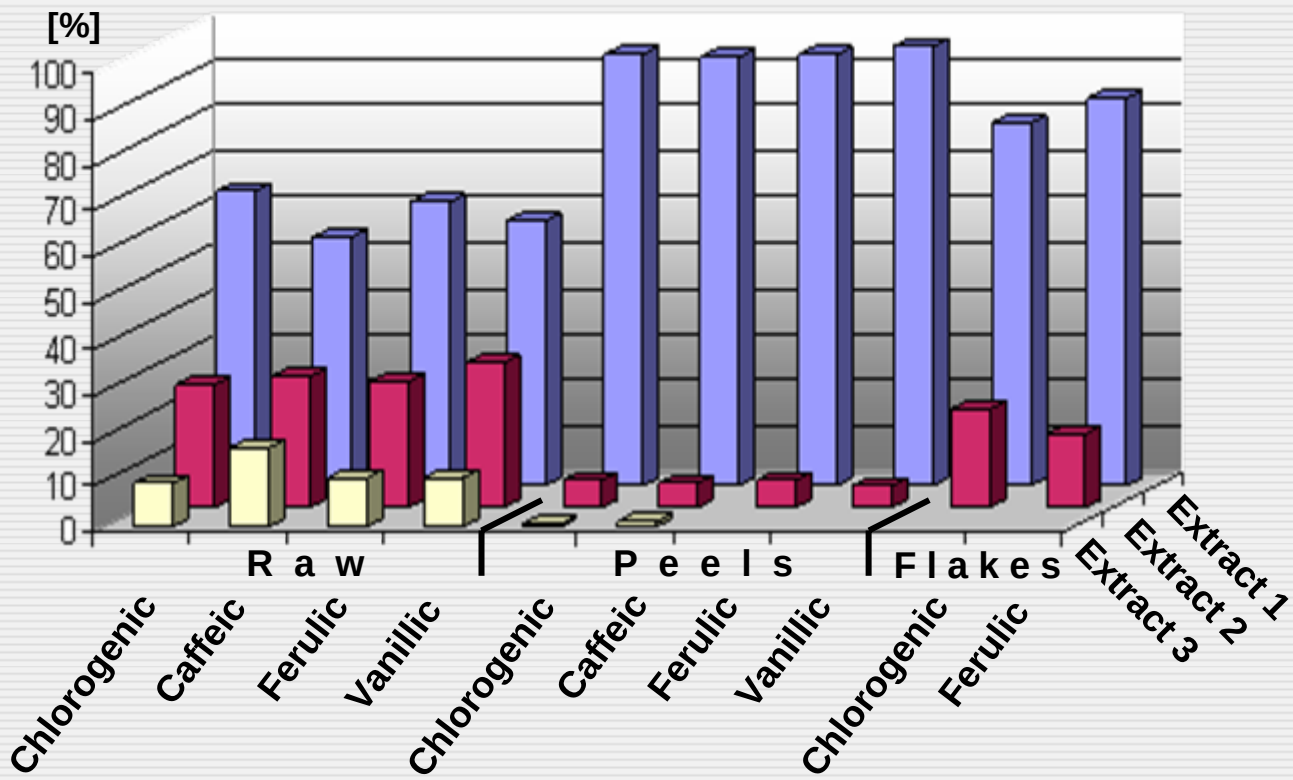
- Process waters?
- Sidestreams?
- Peels?

	raw	mashed	drum dried	peels (steam peeled)
mg of GAE/g dry substance	0,44	0,37	0,1	9,08



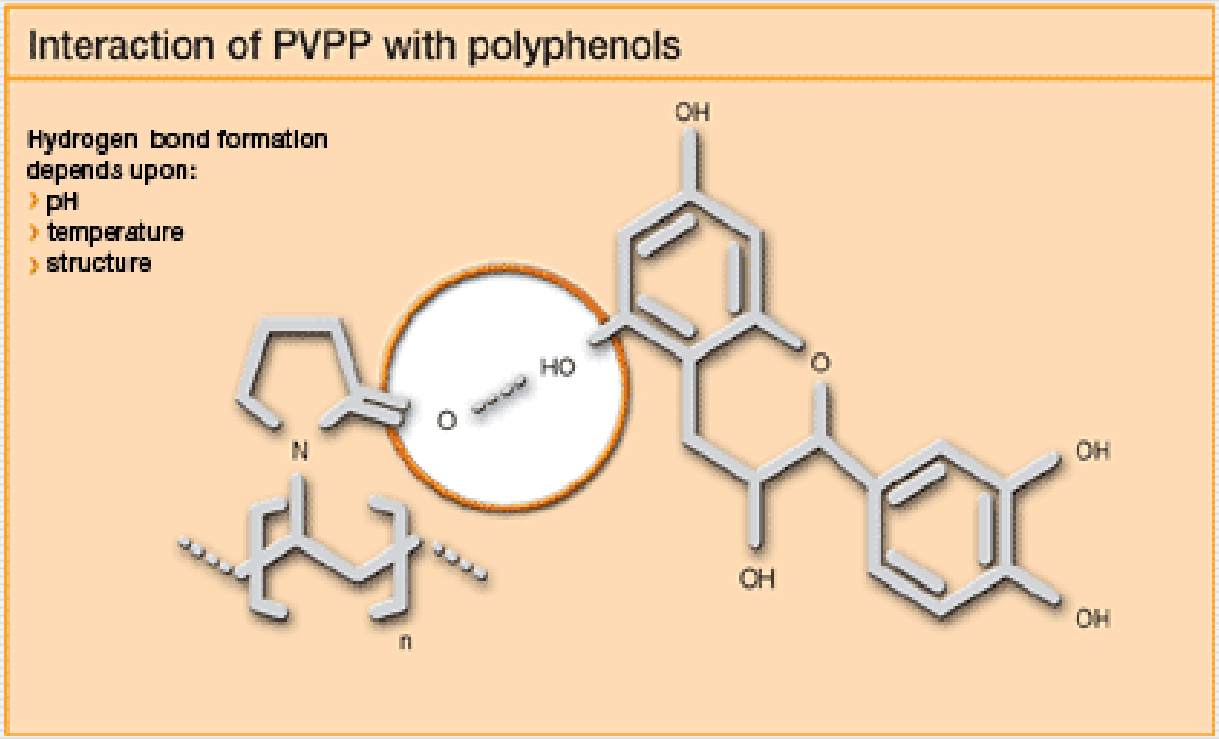
Method-development: Extraction optimization

- Extraction agent for phenolic acids: MeOH/H_2O 70/30 (v/v)
- Temperature: 70°C (cell disruption) but short time
- Ultra-Turrax/ Ultrasonic bath
- Clean-up by SPE or PVPP
- Alternative (best recovery): Accelerated-Solvent-Extraction (ASE)
  1.500 psi, 1-2 g sample, 75° C, 3 x 5 cycles



Method- and gradient-development

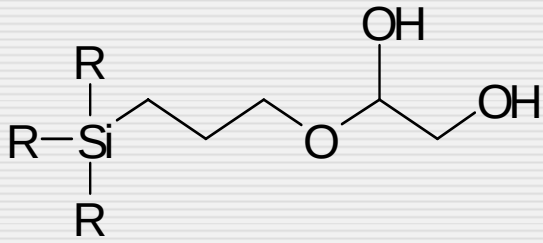
- TLC and HPTLC of phenolic compounds:
  Menziani [1991], Sharma [1998], Fecka [1999], Sherma [2000], Maleš [2001], Sawicka [2002], Gocan [2004] et al
- Trials with universal-gradients and different sorbents
- Separation of structural similar phenolics is difficult
- „Self-made“ plates with silica-PVPP layers: surface problems (crazing)

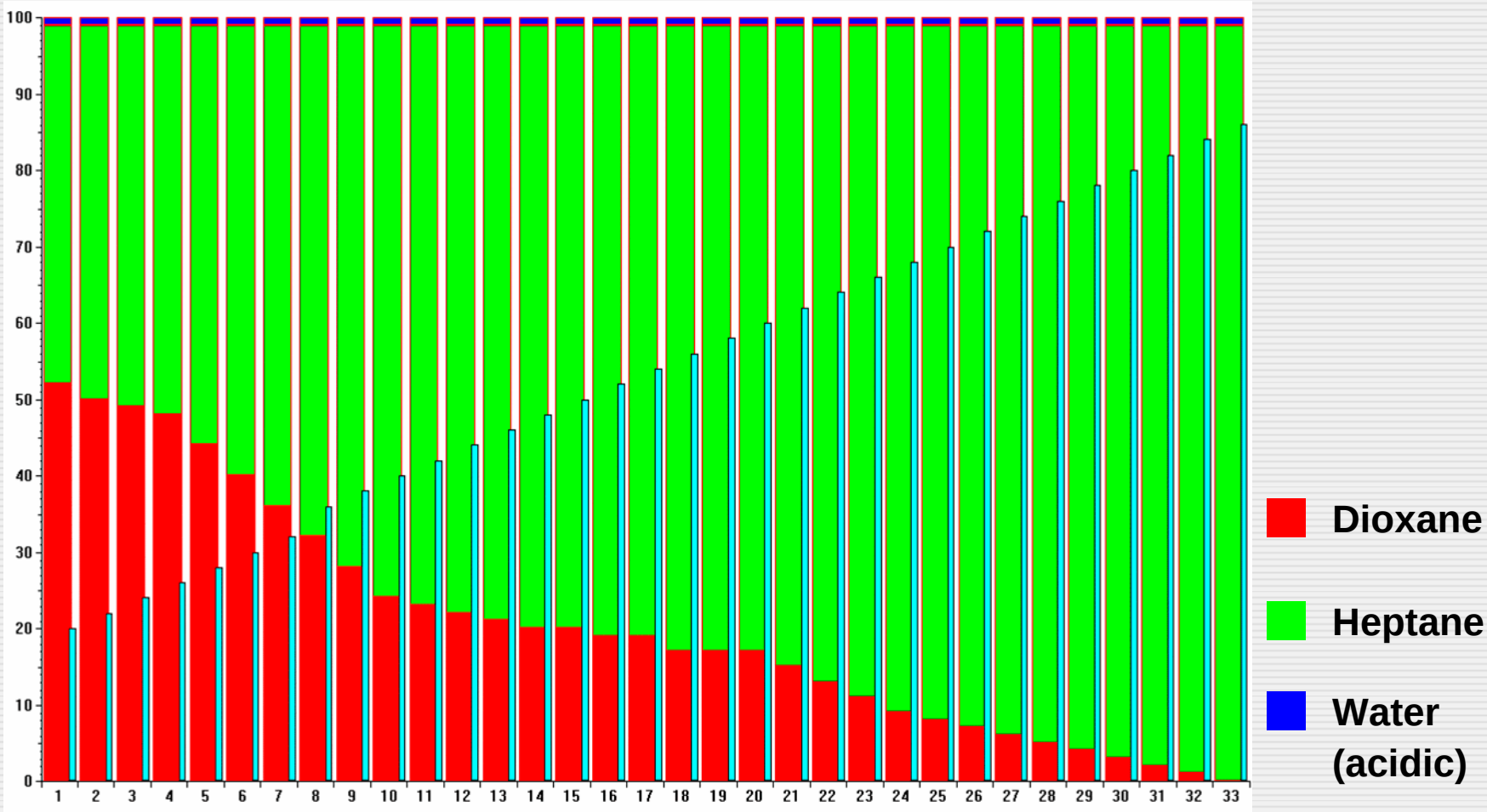


***Lodi [1991] and Soczewiński [1998]*:**
Diol-bonded silica as optimal stationary phase for separation of phenolic compounds (medium activity, excellent selectivity)

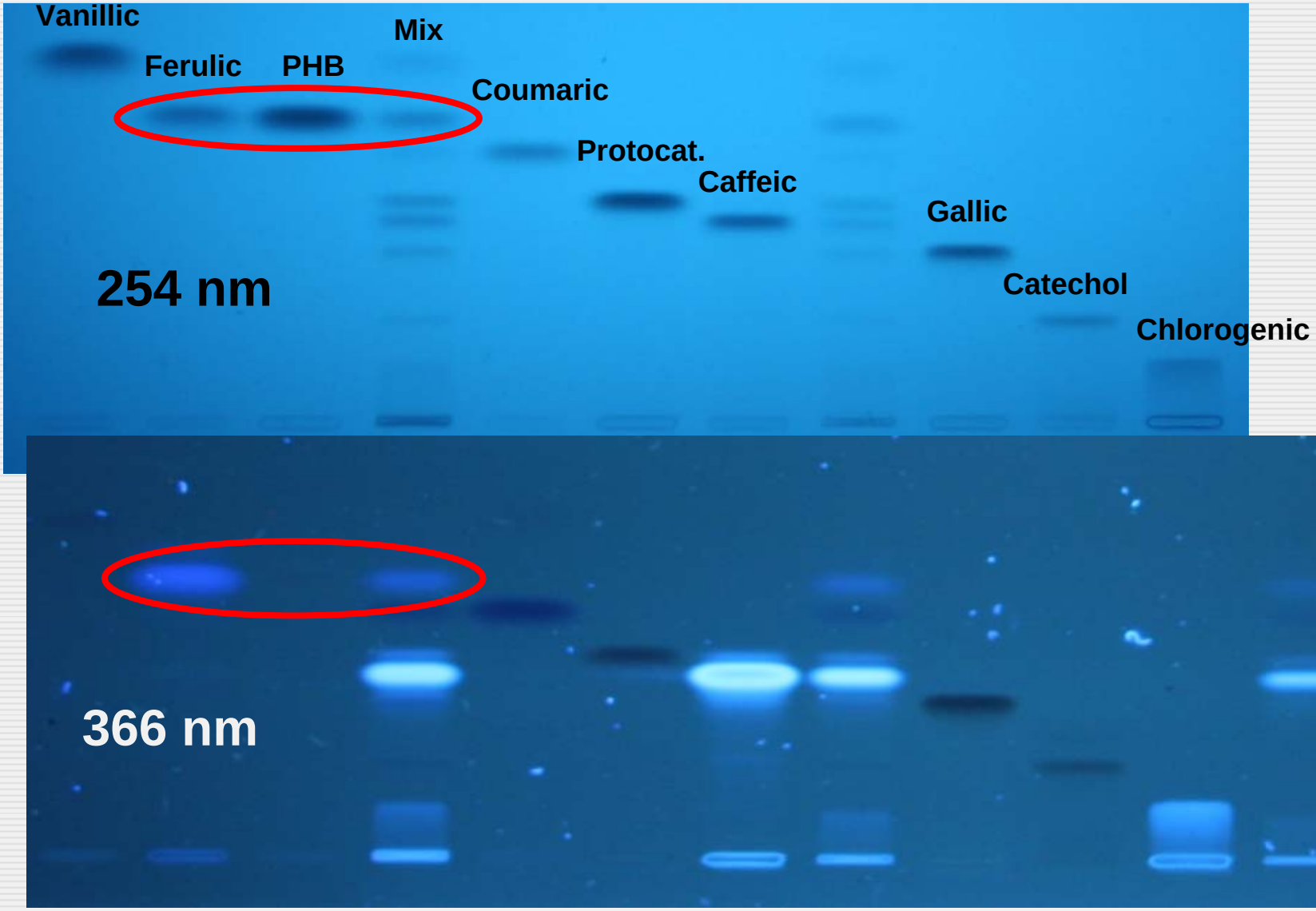
AMD with Diol-Phase

- Diol-Layer (no preconditioning or derivatization)
- 1,4-Dioxane/n-Heptane system
- 1 - 2 % H_2O (optionally acidic) → band shape

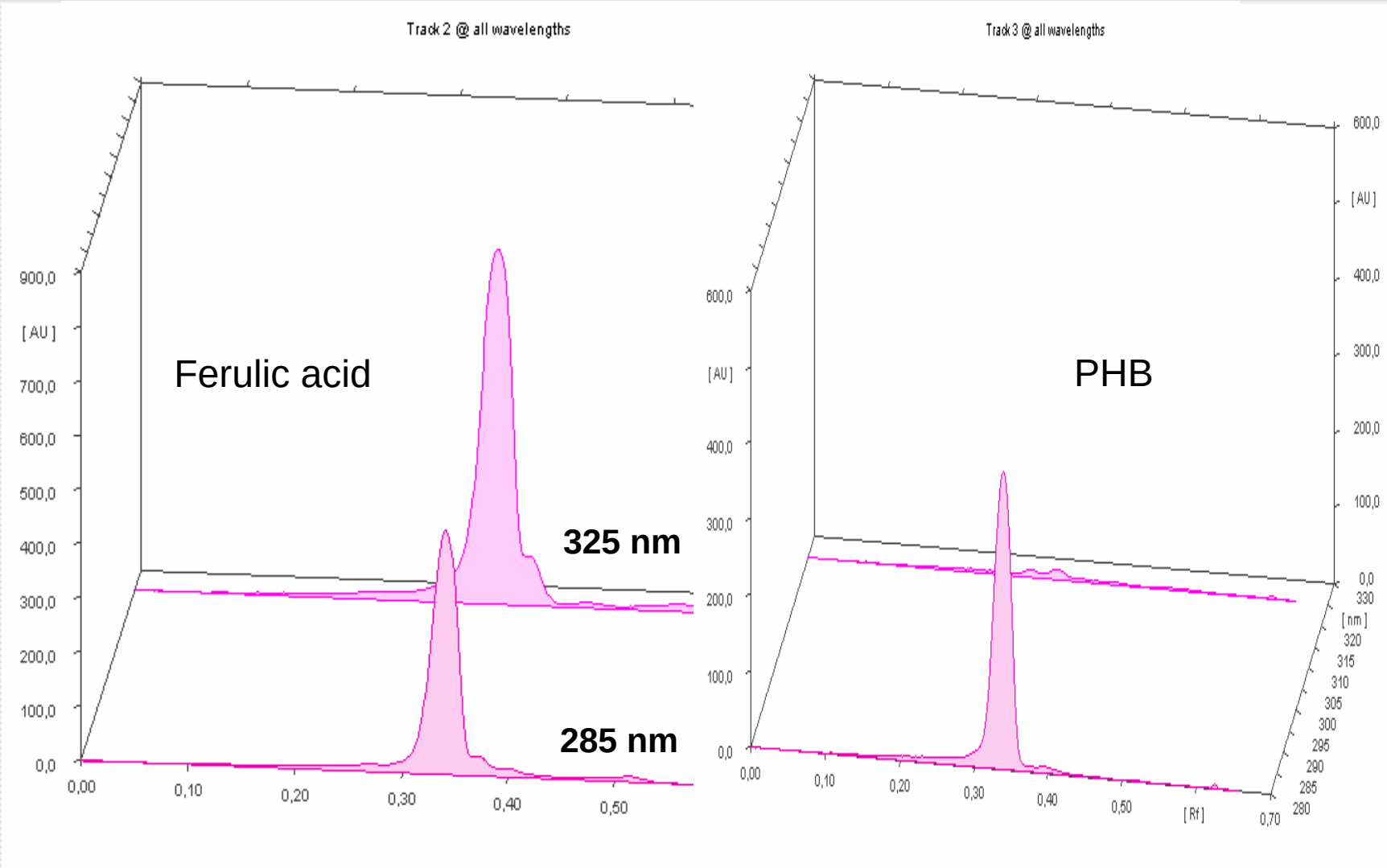




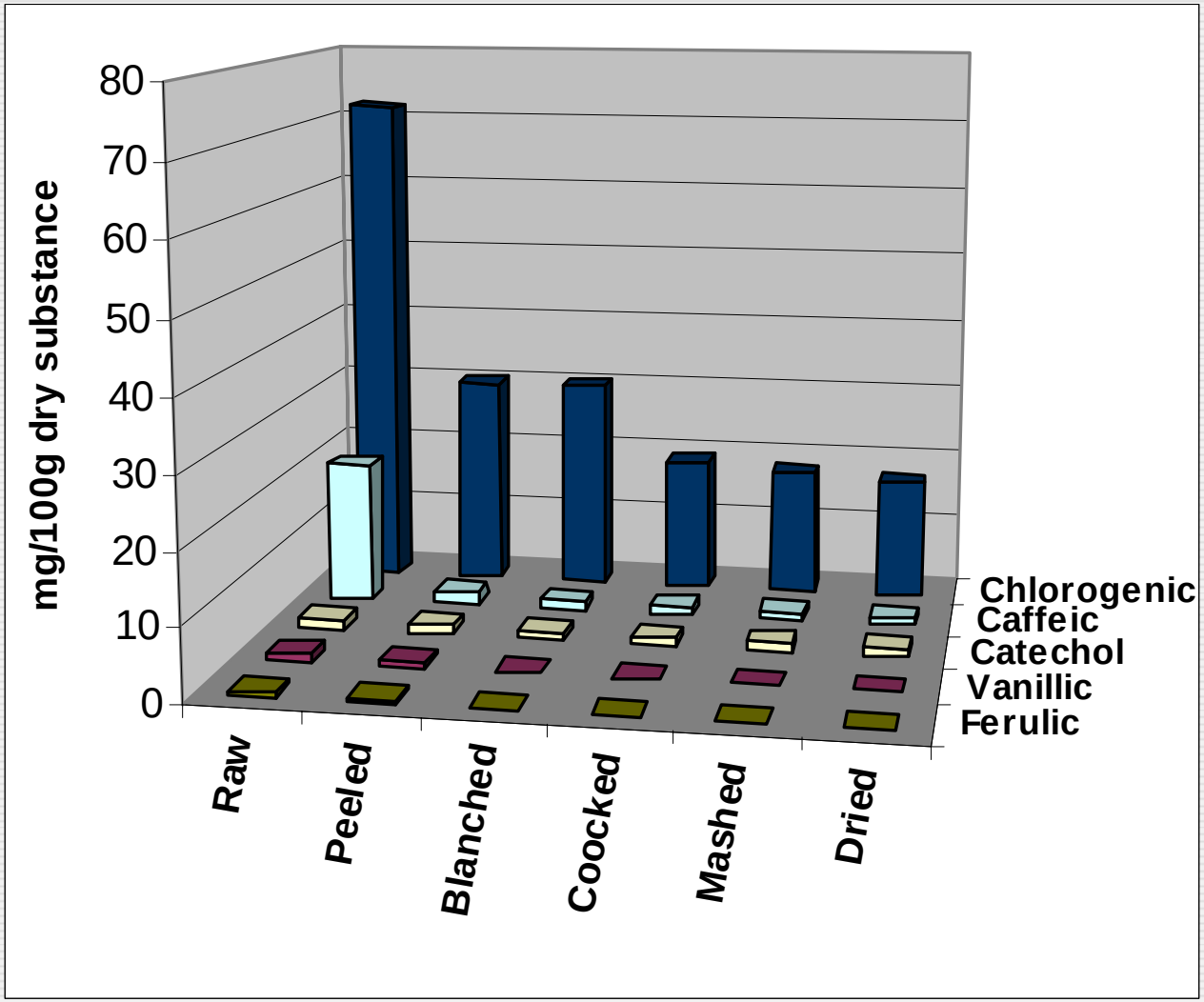
Detection


Vanillic
Ferulic
PHB
Mix
Coumaric
Protocat.
Caffeic
Gallic
Catechol
Chlorogenic
254 nm
366 nm

Densitogram (285 nm)



Results I: main phenolic acids

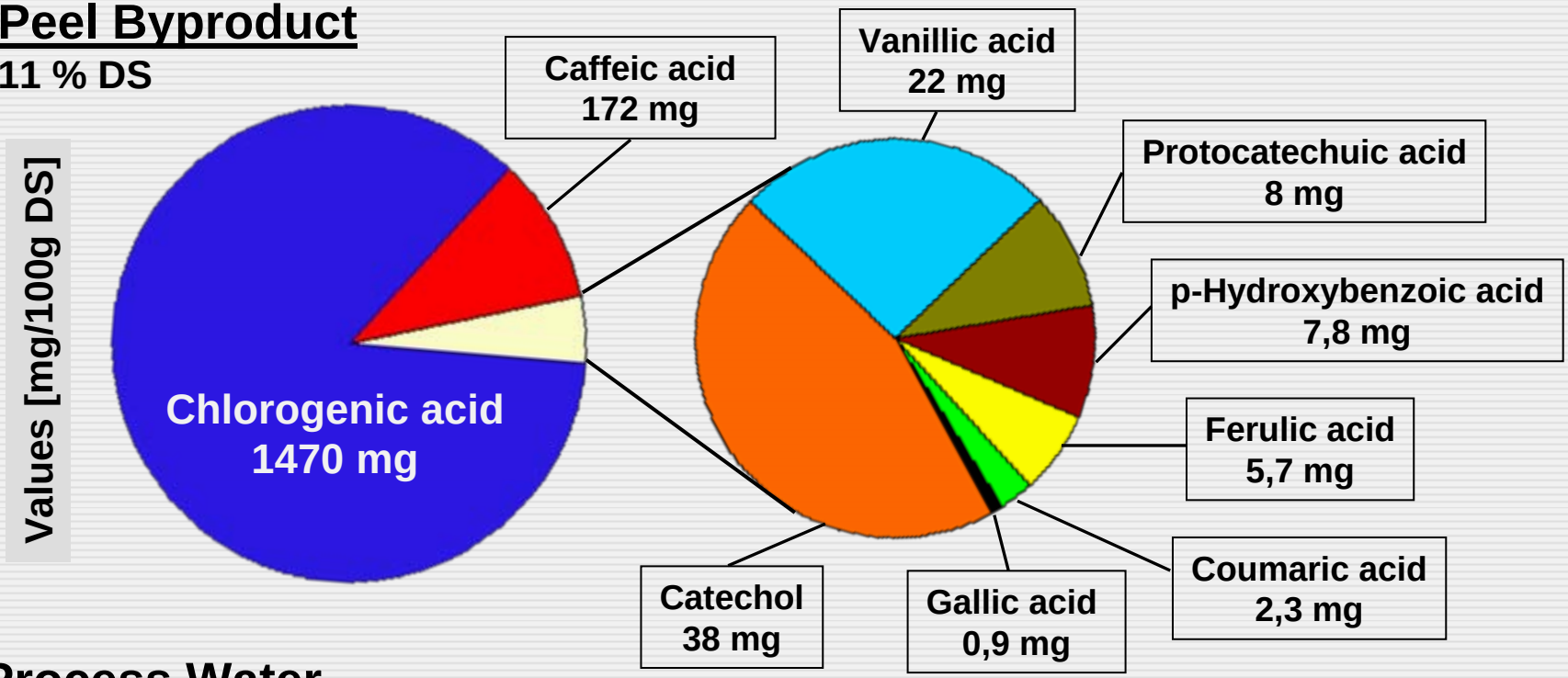


Traces of gallic acid, protocatechuic acid, p-hydroxy-benzoic acid and p-coumaric acid in raw potatoes

Results II: Sidestreams and Wastewater

Peel Byproduct

11 % DS

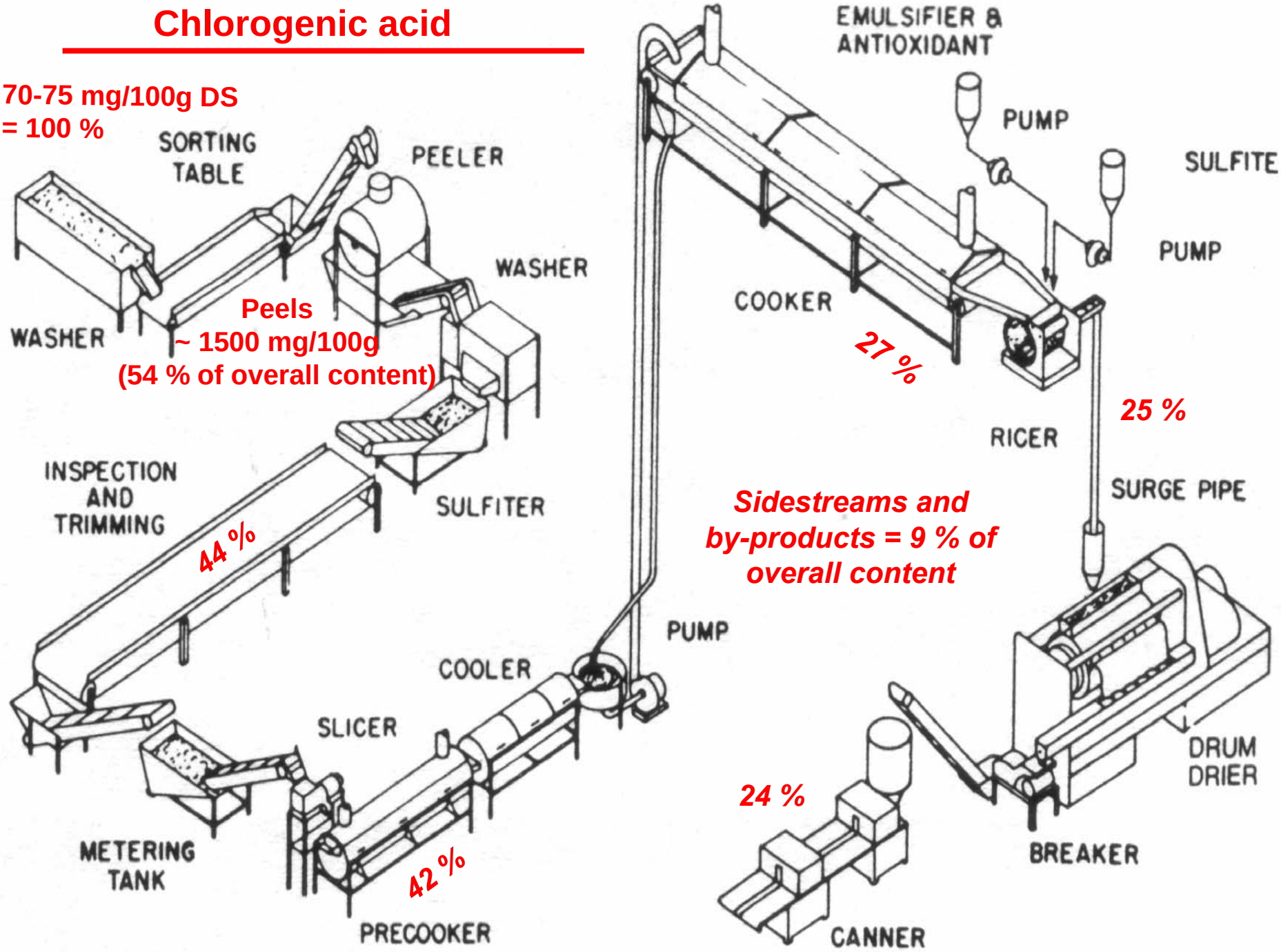


Process Water

[mg/100 ml]	Chlorogenic acid	Caffeic acid	Catechol	Vanillic acid	Ferulic acid	p-Coumaric acid
Blanching Water	6,4	0,27	0,24	0,1	0,04	0,01
Cooking Water	1,7	0,26	n.d.	0,04	0,03	0,01

Chlorogenic acid

70-75 mg/100g DS
= 100 %



Conclusion

- **Peels: Up to 20 x higher chlorogenic acid values and 10-20 x higher concentrations for other phenolic compounds**
- **Sidestreams and Wastewaters: Remarkable concentrations of Chlorogenic acid**
- **Total recovery of chlorogenic acid within all processing steps and sidestreams: 87 %**
- **Advantages of AMD-HPTLC in this special application:**
  - **Simultaneous quantification of 14 samples on one plate**
  - **No clean-up necessary**
  - **Linear correlation (~ 80 – 700 ng), polynomal regression applicable**
  - **Separation and quantification of 9 phenolics with satisfactory recoveries**
  - **Results comparable to HPLC, excellent combination of ASE and AMD-HPTLC**
- **Impact to potato processing industry:**
  - **Process optimization in order to retain important ingredients, e.g. vitamins and phenolics**
  - **Utilization of sidestreams is possible: extraction of phenolic compounds and regenerability for further use**
- **Perspective:**
  - **Separation of ferulic acid and p-hydroxybenzoic acid**
  - **Statistic analysis and method validation**

Acknowledgement

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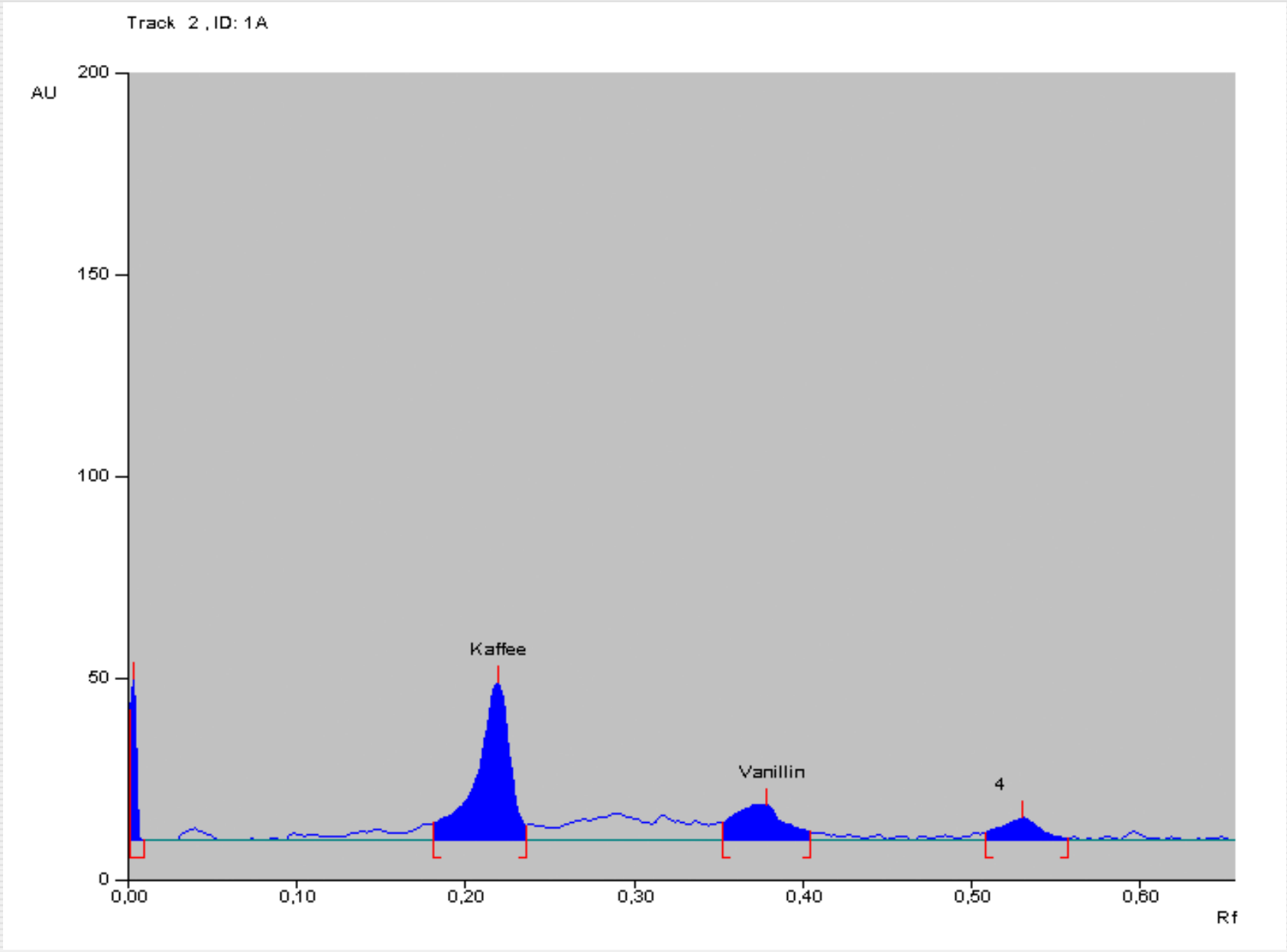
- Staff: Institute of Food Technology and Food Chemistry, Berlin
- GERCID GmbH, Berlin

THANK YOU FOR YOUR ATTENTION!


Track 2 , ID: 1A
AU
200
150
100
50
0
Kaffee
Vanillin
4
0,00
0,10
0,20
0,30
0,40
0,50
0,60
Rf