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Changes in Glycoalkaloid Composition During Potato Processing:

Simple and Reliable Quality Control via HPTLC

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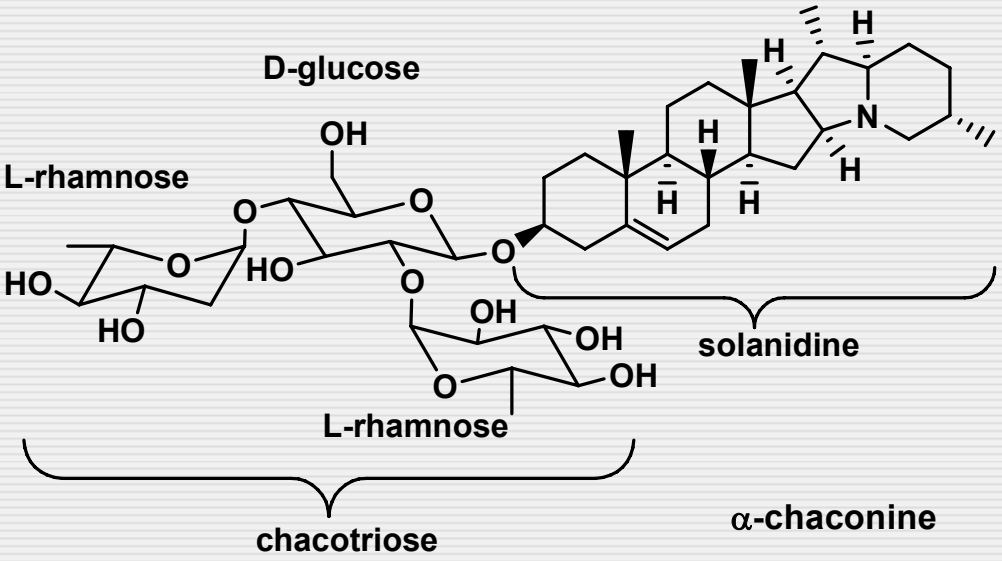
Introduction and Outline

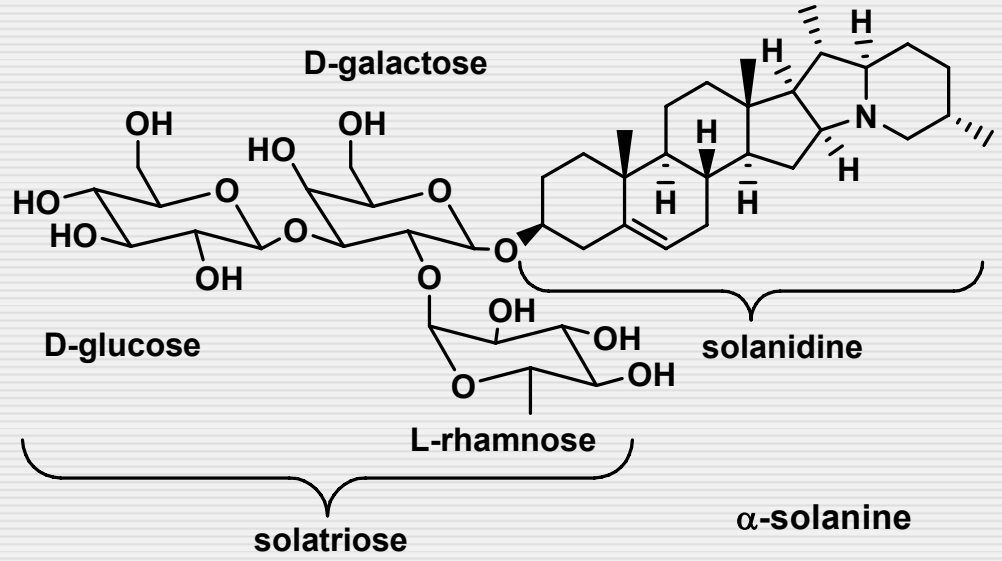
- Glycoalkaloids: Structure, Occurrence and Toxicity
- Commercial Potato Processing
- Objectives and Methods
  - Extraction Procedure for Potato Glycoalkaloids
  - Parameters incl. Chromatography, Derivatisation, Densitometry
- Results
  - Knowledge about Fate and Behaviour of Glycoalkaloids During Potato Processing
  - Risk Assessment for Potato Processing Industry
  - Glycoalkaloids vs. Phenolic Compounds vs. Vitamins

Glycoalkaloids (GA)

- Alkaloids: one of the biggest classes of natural products, > 20.000 compounds
- Glycoalkaloids (GA), toxic bioactive compounds in *Solanaceous* plants (nightshade): tomato, potato, jimson weed, eggplant, pepper, etc.
- Serve as natural defenses against plant phytopatogens (fungi, viruses, bacteria, insects and worms)
- Solanine was isolated by Desfosses (1820) from black nightshade (*Solanum ptycanthum)* berries

Potato Glycoalkaloids





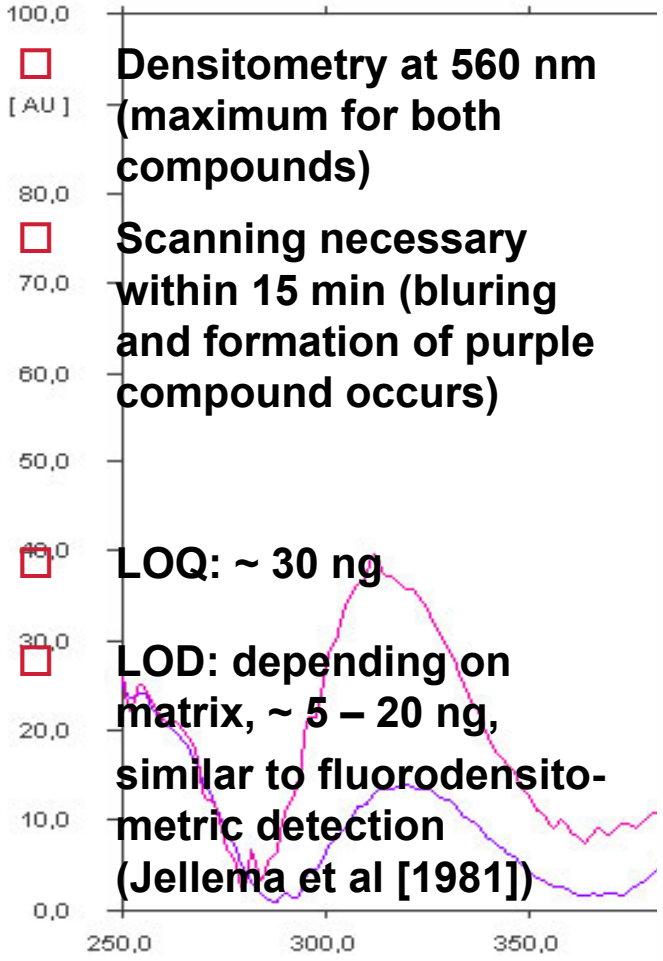
- Potato GA: solanine and chaconine. Contribution to flavour of potatoes (bitterness).
- 95 % are α- compounds
- Bioactivity (toxicity): α > β > γ- compounds
- Toxicity (humans), WHO:
  - 1 – 2 mg/kg weight p.o.
  - leathal: 3 – 6 mg/kg weight
  - < 200 ppm in food: safe
  - whole potatoes: 3 – 440 ppm
  - Europe: no regulatory limit
- Gastrointestinal irritation, headache, nausea, fatigue, vomiting, abdominal pain, diarrhea, spasm, (respiratory) paralysis

Method-Development

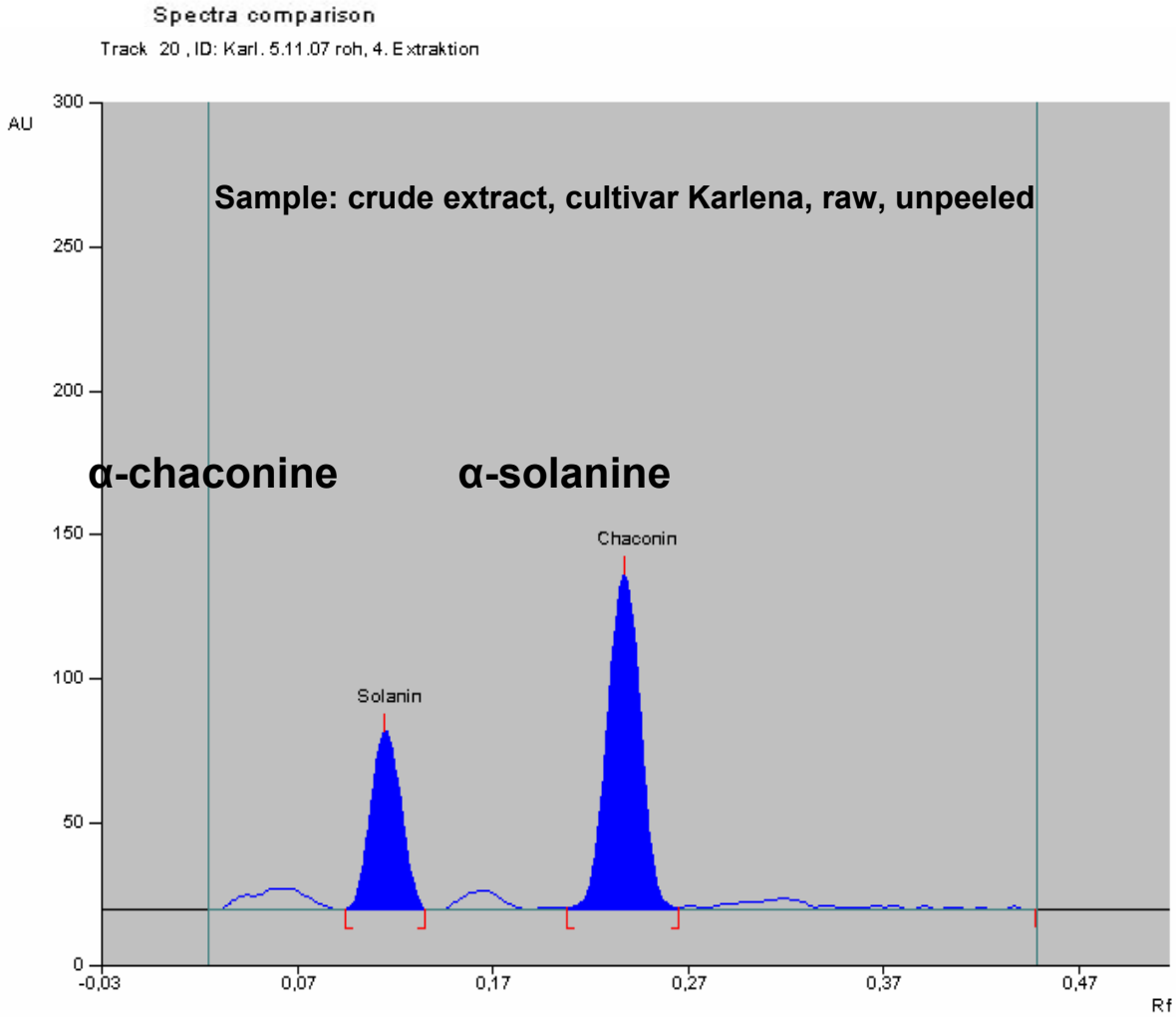
- Method modified from Bodart et al [2000]
- Sampling during industrial processing, cultivar-mix or single cultivar
- Dehydration via vacuum drying (80 °C) or lyophilisation
- Grinding
- Extraction: MeOH/HAc 95/5 or 98/2 (v/v)
  - Temperature: boiling = 66 – 70 °C
  - 3 x Ultra-Turrax (5 min) or shaking water bath (30 min), centrifugation
- No clean-up
- Solvent evaporation under vacuum (50 °C)
- Fill up with MeOH/HAc 99/1 (v/v)
- Filtration
- Sample application
- Chromatography:
  - Mobile phase: CH_2Cl_2/ MeOH/ NH_3 (2,5%)
    70 + 30 + 4,4 (v/v/v)
  - Horizontal developing chamber
  - Preconditioning with mobile phase, 10 min (tank configuration, chamber saturation)
  - Solvent front: 85 mm

Post Chromatography: Detection and Determination

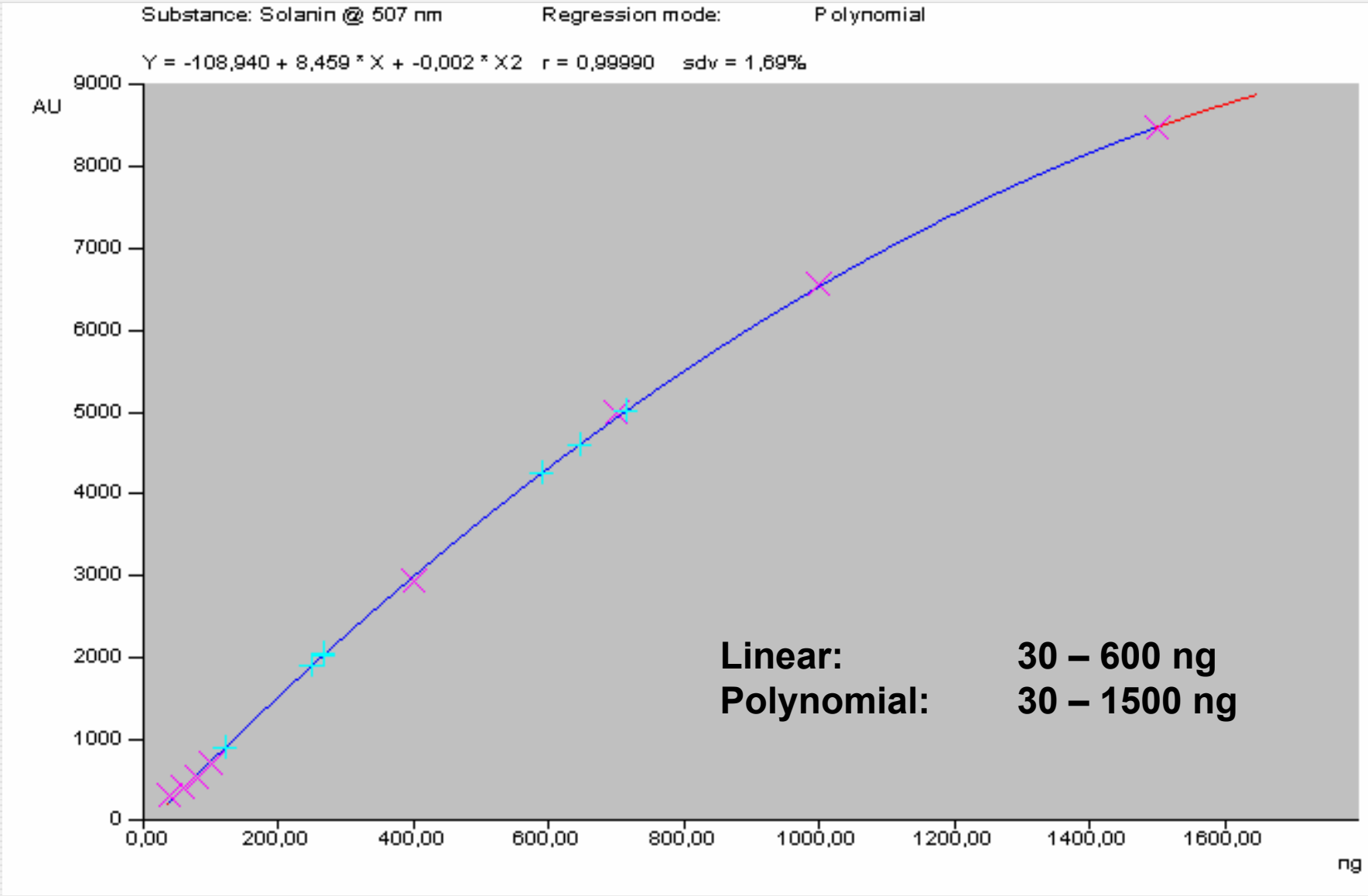
- Air-drying (5 min) under hood followed by air oven (20 min)
- 2 x dipping in modif. Carr-Price-Reagt: 25 % $SbCl_3$ in $CHCl_3$/HAc, (3+1, v/v), heating: 5 min, 110° C, $SbCl_3$ reacts with steroidal double bond: red compound, specific and sensitive



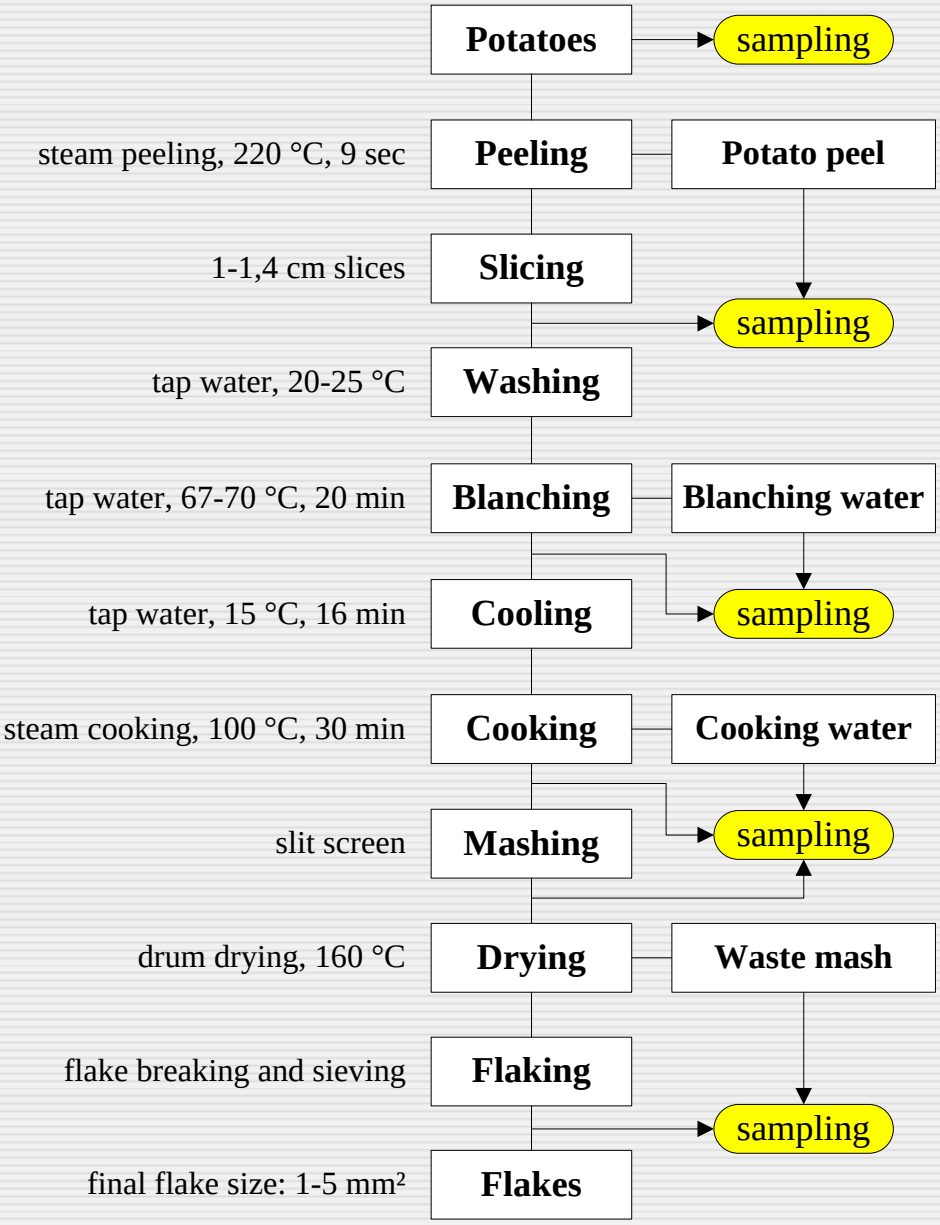
- Densitometry at 560 nm (maximum for both compounds)
- Scanning necessary within 15 min (bluring and formation of purple compound occurs)
- LOQ: ~ 30 ng
- LOD: depending on matrix, ~ 5 – 20 ng, similar to fluorodensito-metric detection (Jellema et al [1981])



Calibration

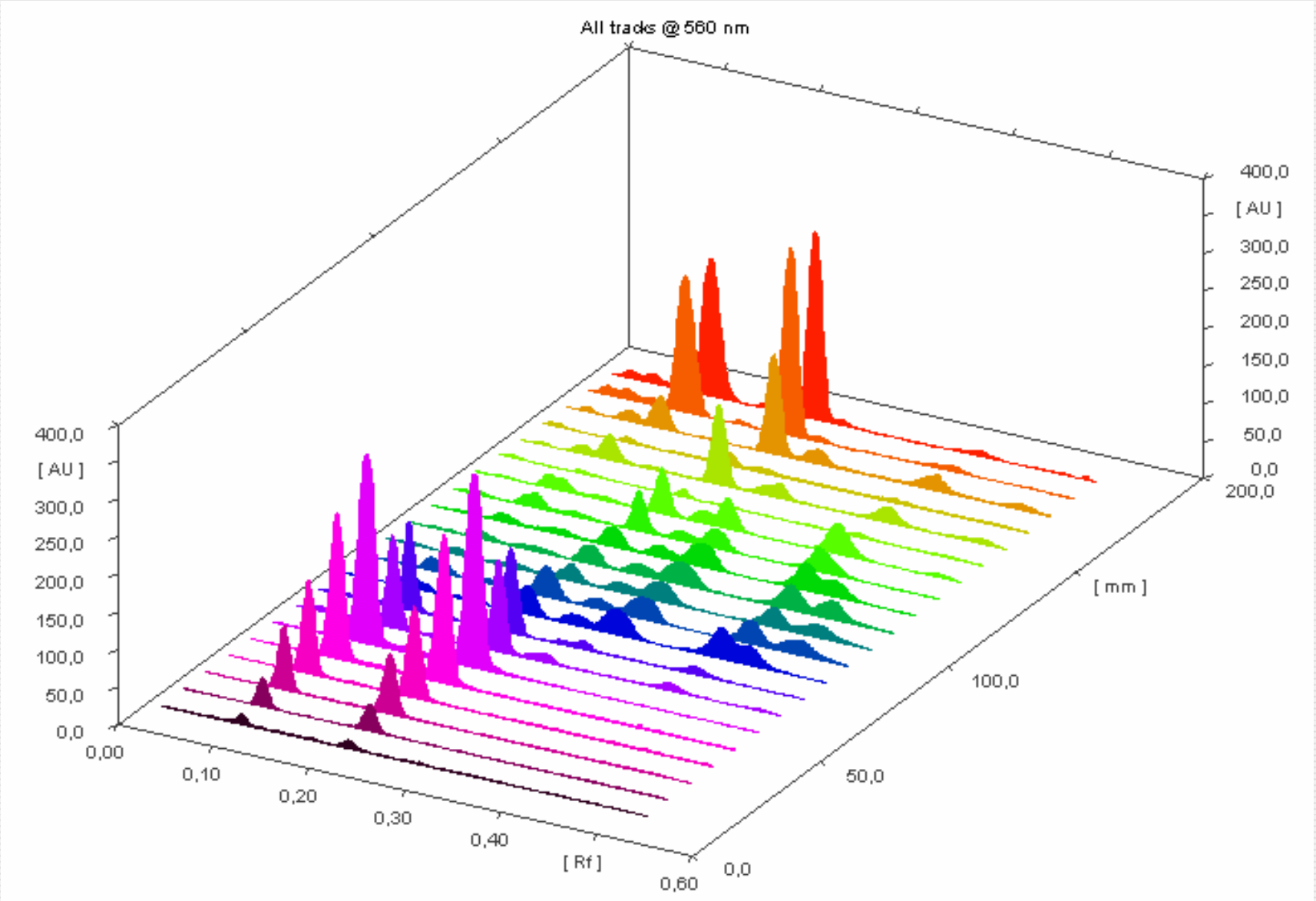


Potato Processing and Glycoalkaloids

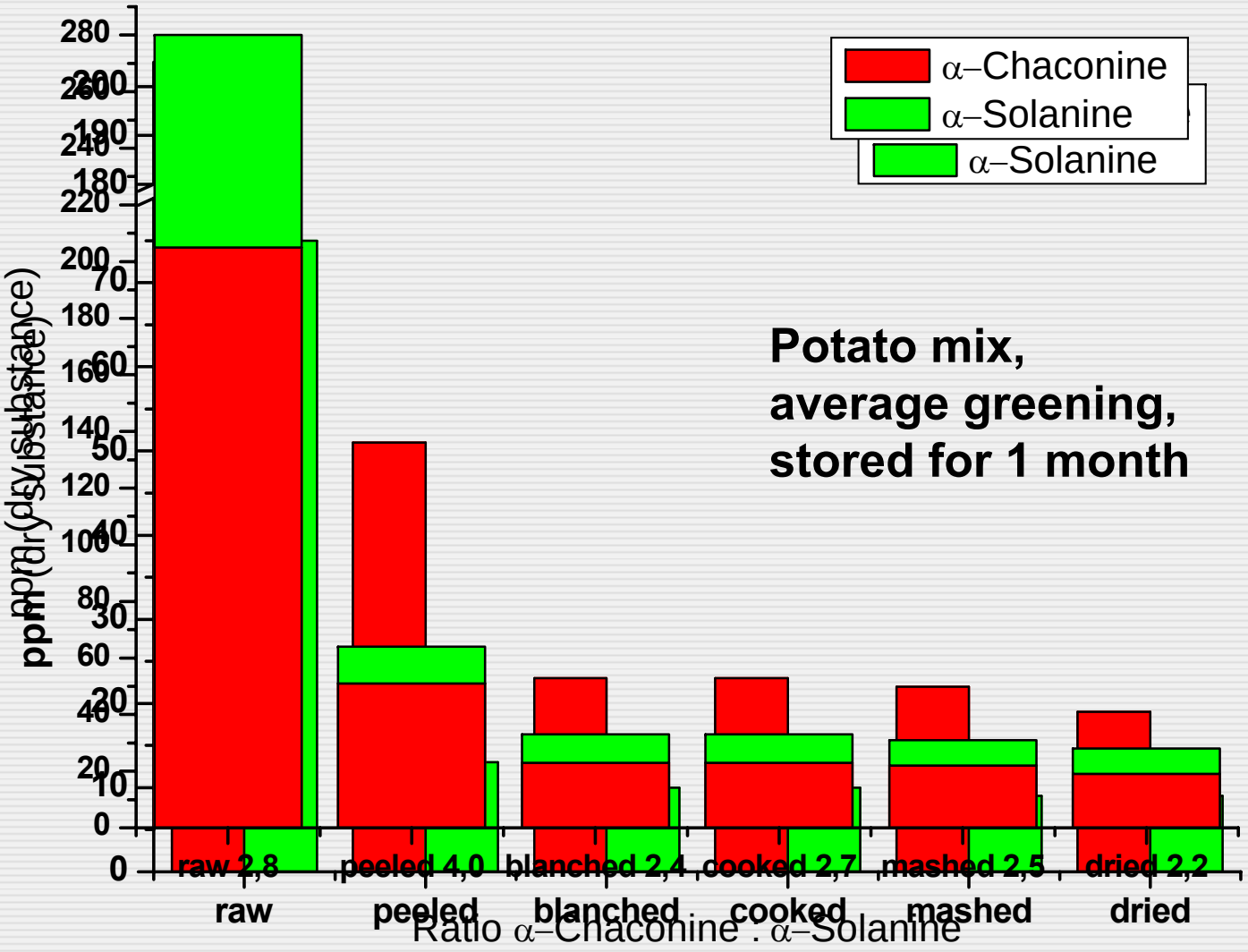


- Potato growers and processors are important part of the food chain („from farm to fork“- policy)
- Quality management systems demand food tracebility and safety
- Automatic sorting of green and damaged potatoes is possible (e.g. spectral imaging), but high investment costs
- Challenge: Simple determination of GA in raw and stored potatoes and all processing steps: < 200 ppm GA
- GA - risk assesment for potato growers and processors possible?
- - Ratio chaconine/solanine?
  - GA concentrations in peels, byproducts and sidestreams?
  - β- and γ- compounds detectable?

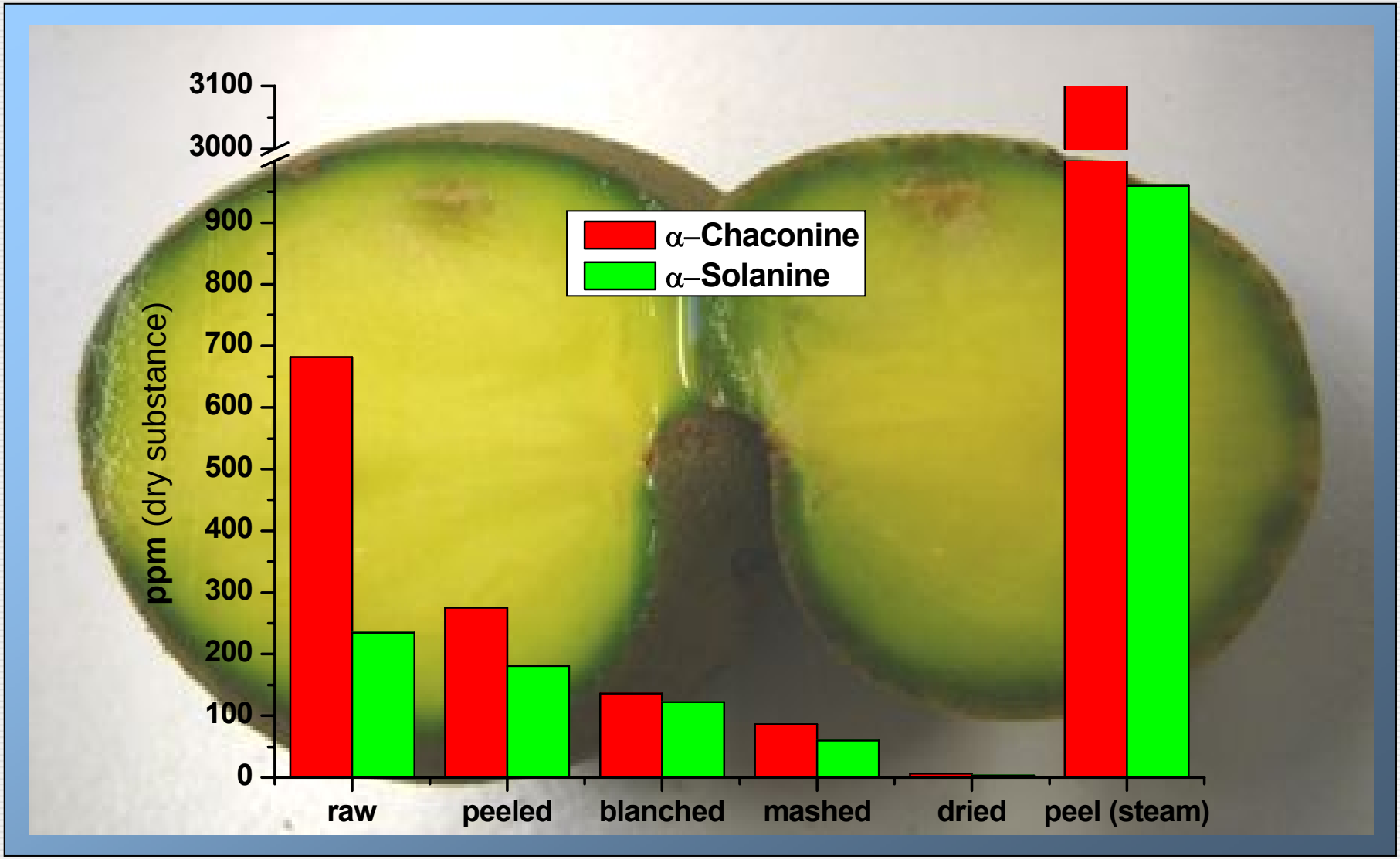
Densitogram (560 nm)



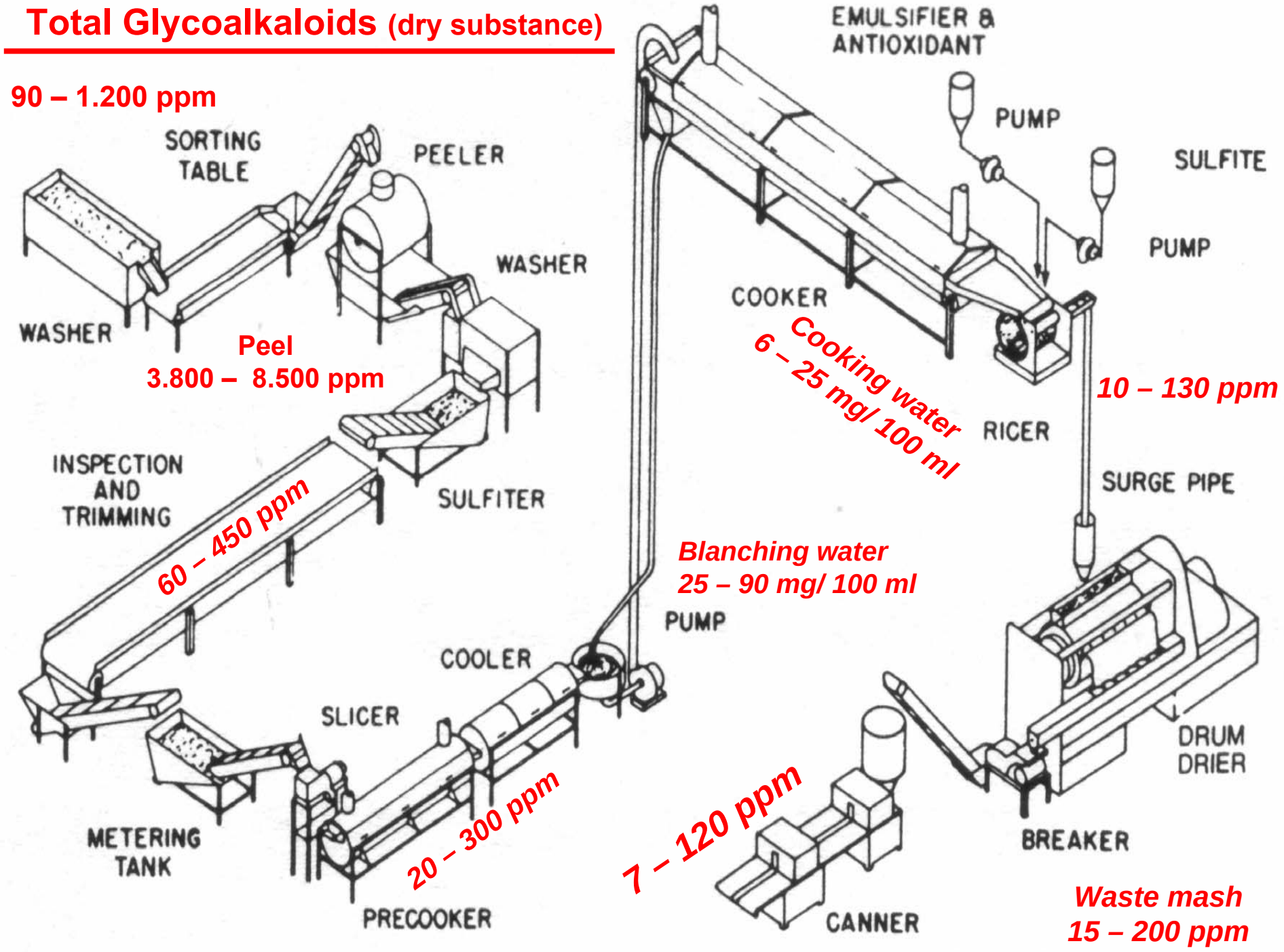
Results (average green)



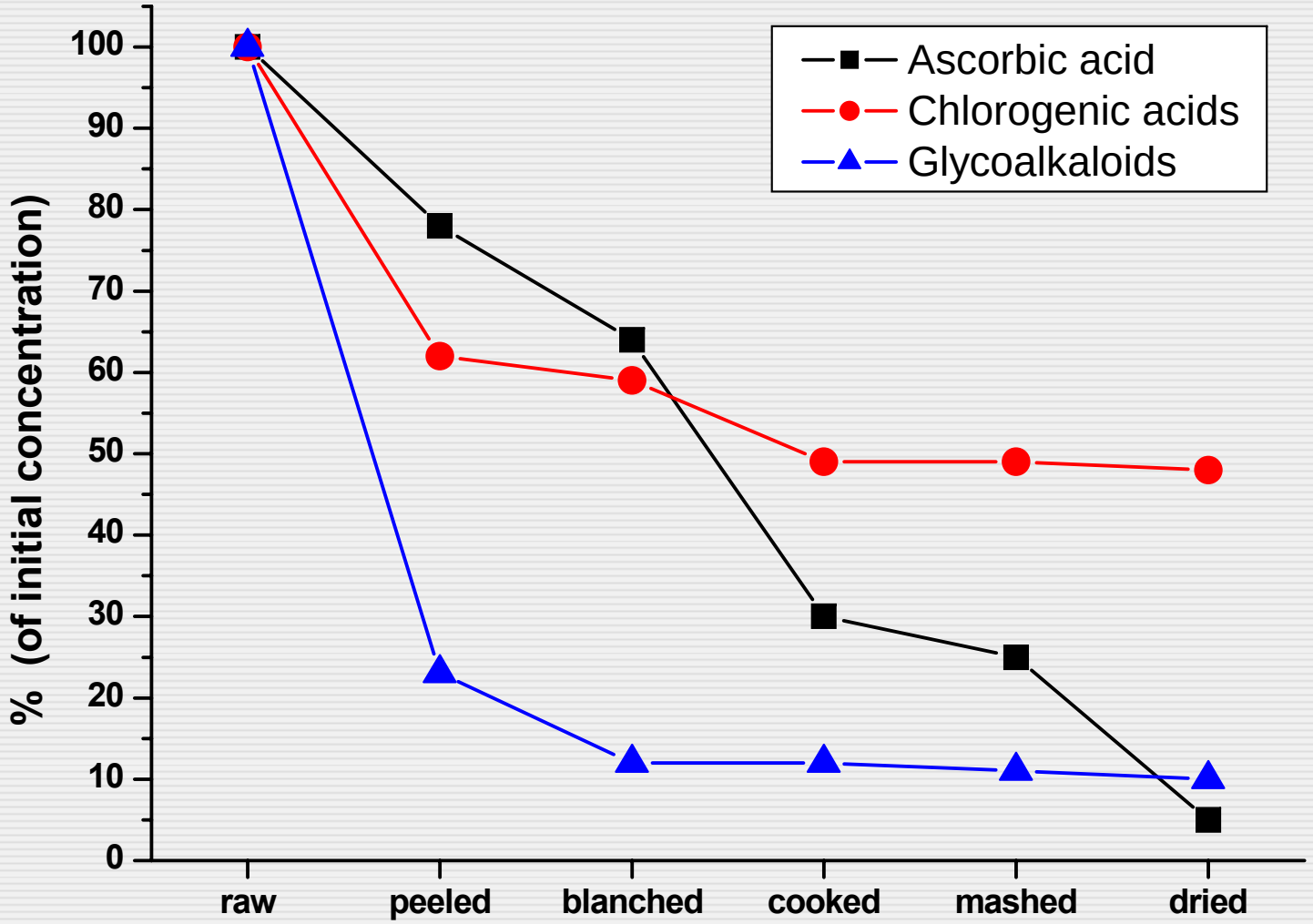
Results (green potatoes)



Total Glycoalkaloids (dry substance)



Losses During Potato Processing



Conclusion

- Green: < 150 ppm GA in potato flakes = < 30 ppm in reconstituted mashed potatoes
- Average: ~ 7 – 50 ppm GA in flakes = 1,4 – 10 ppm in reconstituted mashed potatoes
- Especially peeling and blanching are responsible for GA-losses (70 – 90 %)

- Advantages of HPTLC in this special application:
  - Post chromatographic derivatisation leads to specific peaks for GA (red)
  - Simultaneous quantification of 15 samples on one plate (20 x 10 cm)
  - No clean-up necessary

- Impact to potato processing industry:
  - Industrial potato flakes can be regarded as safe for consumption due to GA-losses during processing (and blending of different batches)
  - Waste mash is safe as animal feed, peel should not be solely used as fodder

Acknowledgement

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THANK YOU FOR YOUR ATTENTION!