Determination of artemisinin content in *Artemisia annua* leaves powder using Near-infrared spectroscopy (NIRS)

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With the scientific support of:
Aims

Search of a fast, easy, reliable and cheap method of analysis for artemisinin.

NIRS ?
NIRS in brief

[Diagram showing different types of radiation and electromagnetic spectrum]

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1. Light energy emitted (780-2500 nm)

2. Molecular overtone and combination vibration
Spectral data

Chemometric analysis
Exemples of application in food industry

Applications
• Fat content
• Protein
• Lactose
• Somatic cell count

Applications
• Moisture content
• Fat content
• Protein content
• Sensory (firmness / hardness / texture)

Applications
• Phenolic compounds content (M3G, tanins as catechin hydrate)
• Quality attributes (pH, Reducing sugar, lactic acid, tonality, total sulphur dioxyd)

Applications
• Identification of tea
• Caffein content
• Polyphenol content
• Free amino acids
• Total antioxidat capacity

Applications
• Total sugar, glucose, fructose, succrose
• Citric, tartric acid in orange juices
• Organic acid in Japanese apricots
• Bayberry juice internal quality

Applications
• Body Fat
• Water
• Proteins

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Lab devices

Hand-held and portable

On-line

On-site
Determination of artemisinin (AC) and moisture content (MC)

Phasir™ Handheld Near-Infrared Analyser
(Polychromix, Inc.; model 1018)

- Weight: 1.8 kg
- Dimensions: 254 * 292 * 152 mm
- Wavelength ranges: 1000 – 1800 nm
- Measurement time: typical 1-2 seconds
- Internal data storage: all readings stored in internal memory and can be offloaded to PC
- Batteries: exchangeable, up to 5-8 hours of continued use
- Operating conditions: temperature range 5 to 45 °C
Sample preparation → dried powders
Reference method: TLC (Gaudin and Simonnet, 2002)
Calibration: 100 samples
Direct spectral acquisition
External Validation: 40 samples
Chemometric analysis: PLS regression
Determination of AC

Calibration & Cross-validation
- SNV + PLS regression
- RMSEC : 0.07%, R:0.94
- RMSECV: 0.09%, R: 0.90
- λ range: 1040 nm – 1723 nm
- RPD : 2.31 → RPD_{cor.} = 2.32

→ Acceptable for screening and breeding program (Williams and Sobering 1993, Delwiche et al., 1998).

External Validation
→ RMSEP: 0.1%
Determination of MC

Calibration & Cross-validation
- SNV+ 2nd der.+ PLS regression
  - RMSEC : 0.7%, R:0.99
  - RMSECV: 0.8%, R: 0.99
  - λ range: 957 nm – 1616 nm
- RPD : 7.47

→ OK for screening and useful in quality control

External Validation
→ RMSEP: 0.7%
Conclusions

- NIRS application to artemisinin content and moisture content with *Artemisia annua* dry powder is a success. Models are correct for breeding, ...
- Fast and easy (6 min/sample, crushing included)
- Cheap (~3 euros/samples; labor+consumable)
- Solvent free
- Non destructive
- No lab infrastructure needed

**But**

- Price of the device
- Reference method needed for calibration
- Robustness needs to be further improved (more samples)
- Standard sample preparation (dry material, powder)
- Method for quantification only (not suitable to identify molecules)

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