Introduction

Artemisia annua is an alternative option for malaria treatment. Artemisinin, a sesquiterpen lactone, is one of its various active agents and is effective against drug-resistant plasmodium strains. It is part of the World Health Organisation (WHO) artemisinin based combination therapy (ACT), recommended since 2001. A treatment with tea based on artemisia leaves has also proved to be successful in 80% of treated cases according to ANAMED (Action for Natural Medicine). For quality control a rapid method to detect artemisinin content is highly desired as artemisinin content strongly varies within the plant and among varieties. In the past various methods have been developed. Most of them need an extraction or derivation of the compound artemisinin which is both time and cost consuming.

This study tested the quantification of artemisinin with Fourier transform mid infrared reflectance spectroscopy (FT MIRS), a method measuring the intensity of light absorption by a sample.

Objectives

- Identification of significant peak areas for artemisinin,
- Development of a quantification model with MIRS,
- Testing the reliability of MIRS for quantifying artemisinin content in A. annua.

Material and Methods

**Thin layer chromatography (TLC)**

- **Mid Infrared Spectroscopy (MIRS)**
  - DRIFTS chamber
  - Bruker Tensor T27

Set up of TLC and MIRS methodology

**Conclusions**

- Artemisinin can be identified by a significant peak at wavenumber 1760 cm$^{-1}$, the lactone peak.
- A reliable prediction model based on 41 leaf samples was developed ($R^2$ = 86%, 92%).
- It is recommended to increase the sample number was developed (R$^2$ = 86%; 92%).
- Artemisinin detection below values of 0.24% is not possible by using TLC, therefore an alternative method suitable at lower ranges is recommended to improve the OPUS QUANT prediction model.

Results

**Prediction model 1 using all values**

<table>
<thead>
<tr>
<th>Spectral range</th>
<th>Rank</th>
<th>RPD</th>
<th>RMSECV</th>
<th>$R^2$</th>
<th>Preprocessing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1754.9 - 943</td>
<td>3</td>
<td>3.62</td>
<td>0.085</td>
<td>92.37</td>
<td>second derivation</td>
</tr>
<tr>
<td>1754.9 - 943</td>
<td>4</td>
<td>3.57</td>
<td>0.0862</td>
<td>92.03</td>
<td>second derivation</td>
</tr>
<tr>
<td>3018.1 - 2821.4</td>
<td>7</td>
<td>3.37</td>
<td>0.0915</td>
<td>91.16</td>
<td>min/max normalization</td>
</tr>
<tr>
<td>3018.1 - 2821.4</td>
<td>6</td>
<td>2.95</td>
<td>0.104</td>
<td>88.53</td>
<td>no preprocessing</td>
</tr>
</tbody>
</table>

- Based on these results, a prediction model by using OPUS Quant (Bruker Optics, Germany) was developed to determine leaf artemisinin content.
- FT-MIRS was carried at Hohenheim University by using a Bruker Tensor T27 with a Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) chamber.
- TLC was done by Midplant, Couthey, Switzerland.