# Detection of pyrrolizidine alkaloids using hyperspectral imaging in the short-wave infrared

Julius Krause[1], Nanina Tron[2], Georg Maier[1], Robin Gruna[1], and Andrea Krähmer[2]

[1] Fraunhofer IOSB Institute for Optronics System Technologies and Image Exploitation, Fraunhoferstraße 1, 76131 Karlsruhe, Germany

[2] Julius Kühn-Institut, Federal Research Centre of Cultivated Plants, Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection, Königin-Luise-Straße 19, 14195 Berlin

**Abstract:**

Pyrrolizindine alkaloids (PAs) are secondary plant compounds that are liver and genotoxic. In recent years, PAs have increasingly come into focus, as unwanted contaminations, especially in organic or health teas were found. Optical spectroscopy in near and short-wave infrared is particularly suitable for the detection and differentiation of organic products. Using hyperspectral camera systems, material streams can be monitored and foreign substances can be separated after detection.

To this, the present study investigates the detection and separation of unwanted groundsel from common nettle, peppermint, and lemon balm. For this purpose, a hyperspectral camera with a resolution of 256 bands in the wavelength range of 1100-2200 nm was used. This measuring range includes absorptions by CH-molecule bonds, which can be produced e.g. by ethereal oils in tea herbs. Furthermore, absorptions by NH-bonds are in the measuring range of the hyperspectral camera, these are, among others, part of PA molecules.

The data evaluation was performed using the *AnniNet*, a convolutional neural net (CNN) architecture designed at Fraunhofer IOSB for the analysis of near infrared spectral data. The *AnniNet* architecture is implemented in python and uses the framework Tensorflow 2.0.

The trained models showed a good differentiation of the individual plants. A sensitivity analysis of the models showed a strong weighting of spectral ranges assigned to absorptions by CH- and NH-molecule bonds.

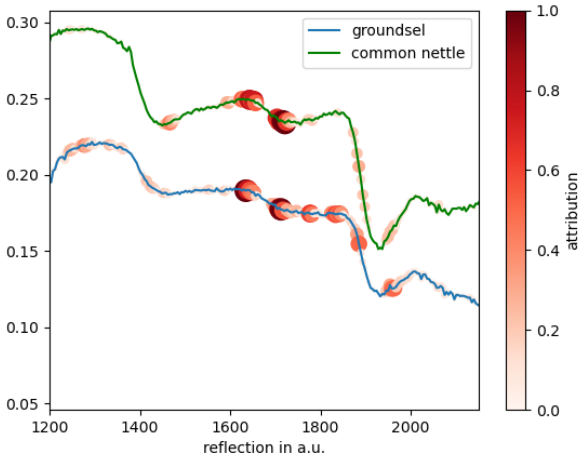


*Figure 1: Spectral data from common nettle and groundsel. A sensitivity analysis of the classification model showed a strong weighting of spectral ranges assigned to CH-molecule bonds. This could be caused by the flavonoid which is significant for common nettle.*

**Keywords:**

Hyperspectral Imaging, convolutional neural network, Pyrrolizindine alkaloids