Can a single wavelength be a proxy for lipid content in plant samples of Mediterranean shrublands ?

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In the framework of studies on the nutritiional value of rangeland plants, it can sometimes be useful to have an indication of the lipid content of samples, although it is not a major component of plant vegetative parts. Heterogeneous databases gathering very diverse plants or plant parts require a very large number (several hundreds) of chemical analyses for calibration of chemical composition, so that lipids are generally not considered in such databases. The present study intends to seek for a proxy of lipid content as a single wavelength in the NIR spectrum. The objective is not to predict lipid content accurately, but to be able to rank the plants according to their lipid content.

Materials and methods

The study was based on samples from a study on Mediterranean shrubby rangelands ("garrigue"), grazed by sheep in the spring, with mixed vegetation: grasses, shrubs, trees (*Silué et al., 2016*). About 250 samples from 60 species were collected in may 2015 in Corconne (southern France). Samples were dried mildly (55°C) and ground (1mm sieve).

Spectra were collected on a FOSS NIRSYSTEM 5000 spectrometer with a wavelength range 1100-2500nm (2mm step). Then 30 samples were selected to represent the botanical diversity and the expected range of lipids. Lipid content was assessed by crude fat analysis by extraction with petroleum ether on Soxhlet.

The approach was to correlate lipid content with absorption at individual wavelength, in order to identify wavelengths better representing lipids. This analysis was performed on raw spectra as well as on spectra pretreated with different derivation orders and smoothing options.

Results and discussion

Lipid content ranged from 1.1 to 11.0%DM. However for low values the results have to be considered with care due to the analytical uncertainty. Average spectra of plants with high or low lipid content have differences at various wavelengths (Figure 1), but these differences are not due to lipids only since other constituents also vary between samples.

The correlograms showing R^2 between lipid content and absorbance at individual wavelengths are shown on Figure 2, for the various derivation orders. The highest correlations were 0.04 (at 1402nm) for raw spectra, 0.29 (at 1760nm) for 1st derivative, 0.63 (at 1772nm) for 2nd derivative, 0.64 (at 1782nm) for 3rd derivative. An illustration of the relationship between lipid content and absorbance at a selected wavelength is shown on Figure 3 (3rd derivative with SNV).

Figure 1. Spectra of samples with high (green) or low (blue) lipid content, and difference between spectra

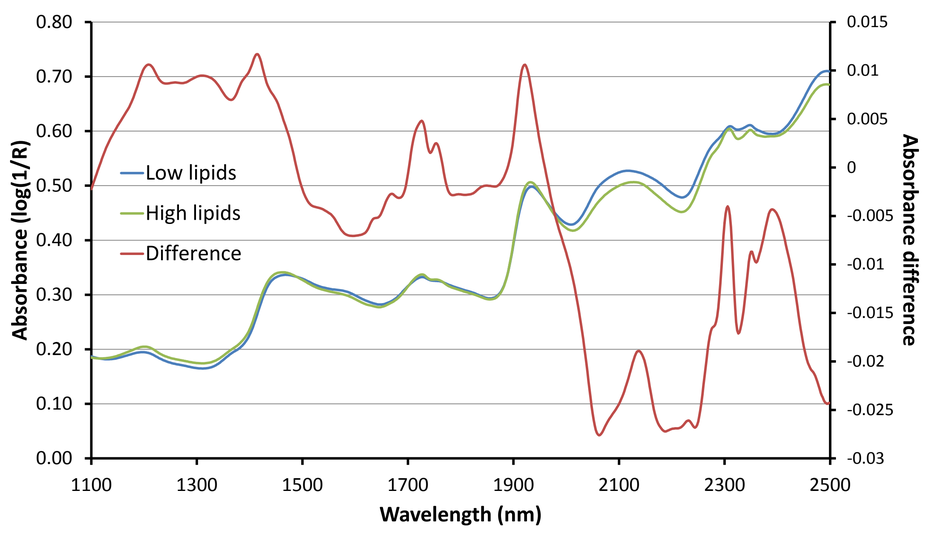
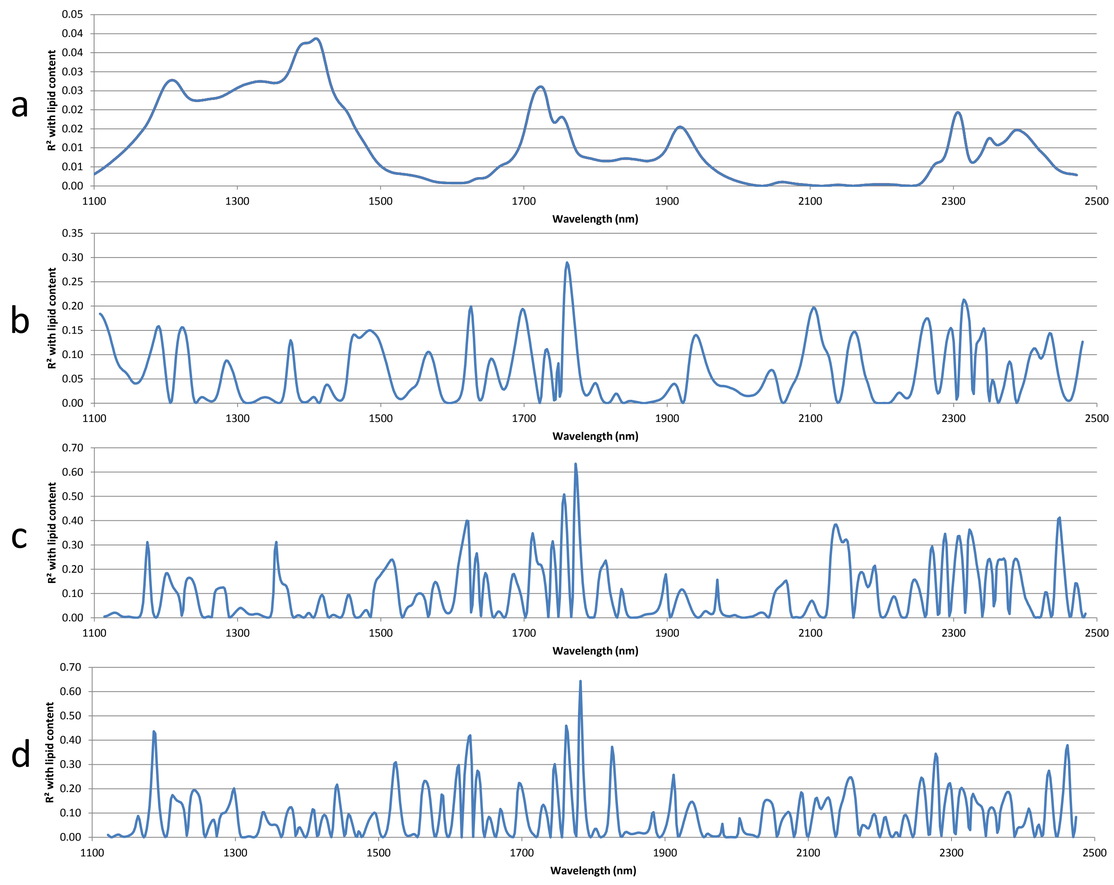


Figure 2. Correlation (R^2) between lipid content and individual wavelengths

(a) Raw spectra, (b) 1st derivative, (c) 2nd derivative, (d) 3rd derivative



The wavelengths with best correlation with lipids were not those which are often the more linked to oil content (around 2300-2350nm). The correlation with wavelengths in the 1760-1780nm region is high enough to provide a useful information on lipid content. When applied to the whole database (380 spectra, including 135 new samples from 2016), the lipid ranking identified the plants high in lipids (genera : *Juniperus, Erica, Pinus, Rosmarinus, Asparagus, Dorycnium*…) or low in lipids (*Arbutus, Cistus, Asphodelus, Rubia, Hedera, Rhamnus* …). However a proper validation with additional reference analyses has to be done.

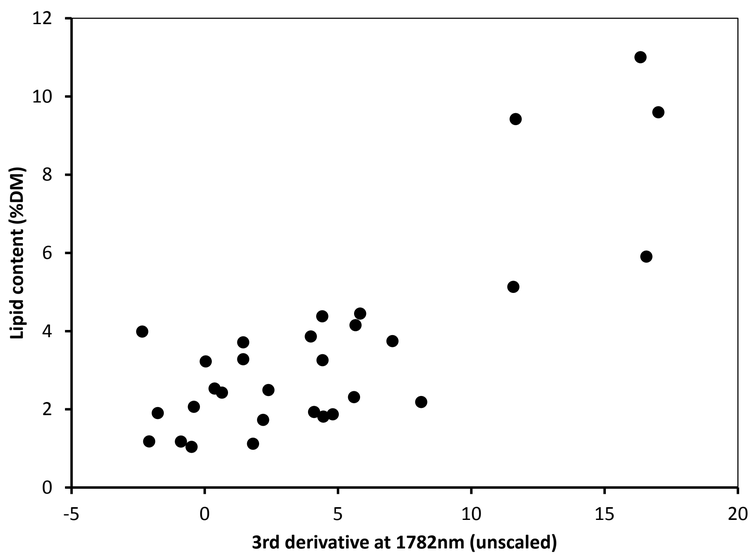
Perspectives

The high correlations with individual wavelengths suggest that a calibration of lipid content in such a database would be possible. However it would require many analyses, which is not relevant on the short term because accurate prediction of lipid content is not required.

The proxy can help identifying the low / intermediate / high lipid plant parts, and can contribute to explain the feeding behavior of animals. It can also help for the selection of samples to be analyzed in the laboratory.

A similar approach will be tested on fresh samples, since all samples were also scanned before drying: at this stage the volatile essential oils are still present in the samples and will provide more accurate information on secondary compounds present in the fresh plants.

Figure 3. Relationship between absorbance at 1782nm (3rd derivative) and lipid content



***Reference**: Silué N., Bastianelli D., Meuret M., Hassoun P., Jouven M., 2016. Functional classification by NIRS of plant parts selected by sheep on a shrubby rangeland. Options Méditerranéennes series A, n°114. 71-74*