

## Faecal predictions by near infrared spectroscopy for Ibex: overcoming the problem of sample quantities

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### Introduction

The difficulty of direct observation and the protected status of some mountain wild and domestic ungulate species such as *Capra ibex ibex* (European mountain goat), *Rupicapra rupicapra* (Chamois) and *Ovis aries* (domestic sheep) require the use of faecal indices when studying foraging behaviour, as the chemical composition of faeces can provide information on quality and quantity of the animal's diet [1, 2].

However, the quantity of an individual sample can be limited by the faeces available. Sometimes it is too small to allow reference chemical analyses to measure important parameters like nitrogen, fibre or mineral content. Near infrared (NIR) spectroscopy has the potential to be able to estimate the chemical composition in small samples.

### Materials and methods

Within the framework of a study on ungulate nutrition in the French Alps, a total 233 faecal samples were collected. Most of them, 191, came from *C. ibex ibex*, 10 came from *R. rupicapra* and 31 came from *O. aries*. Only 24 samples were of a sufficient size for chemical analysis, to develop a NIR spectroscopy calibration. It was therefore decided to apply the following procedure:

- (a) Take the spectra of all available samples.
- (b) Mix some of the samples that were too small to analyse individually in order to get a sufficient quantity for chemical analysis.
- (c) Build a calibration against the chemical analysis for the mixed samples plus the 24 individual samples with sufficient quantity for chemical analysis.
- (d) Apply the derived calibration to all individual samples.

All 233 samples were dried at 60°C and ground to pass through a 1 mm sieve. Spectra were collected in duplicate with two different cup fillings in reflectance mode using a Foss 6500 spin cell instrument (Foss NIRSystems, Silver Spring, MD, USA) and averaged.

A hierarchical unsupervised classification of samples was performed on the basis of spectral data, in SYSTAT software (SPSS Inc. Chicago, IL, USA). The first 20 principal components were used as classification variables. Faeces were not mixed between species to maintain a high variability in the calibration database.

Chemical analyses were performed on a total of 54 samples to measure crude protein (CP) by the Kjeldahl method, crude fibre (CF) by the Weende method, the Van Soest fibre fractions [3] of neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL), and ash content (mineral matter (MM)) by combustion at 550°C.

Calibration equations were built after mathematical pre-processing of data using the standard normal variate (SNV) and detrend procedure on the second derivative of the spectra. Visible wavelengths were discarded because they introduced instability into the models. That is they had a lower standard error of calibration (SEC) but a higher standard error of cross-validation (SECV). Partial least squares regression was found to be the most efficient method for calibration. It was processed with the modified partial least squares procedure of WinISI software (Win-ISI, Infrasoft International, Port Matilda, PA, USA).

## Results and discussion

The first important feature was to test if the mixed samples represented the variability of the total population. A principal component analysis was performed on the calibration database and the spectra of all the 233 individual samples projected on the principal component axes. Only 12% of samples from *C. i. ibex* had a Mahalanobis distance greater than 3. This confirmed that the selection of samples to be mixed and analysed was representative of the full data set.

Calibration equations had SECV values of 0.48%, 1.27%, 1.86%, 1.84%, 1.31% and 0.84%, for CP, CF, NDF, ADF, ADL and MM respectively. Although the accuracy for fibre fractions was not extremely high, these results allowed the prediction of the chemical composition of the whole database.

## Conclusion

The strategy of mixing faecal samples, combined with a procedure to ensure the minimal loss of variability, can help to overcome problems of insufficient quantity of matter for estimating their chemical analysis. In the present study, the use of this strategy produced a complete chemical profile of all samples collected. An additional benefit was the lower analytical cost associated with only measuring a subset of mixed samples compared with individually measuring all the samples in the sampled population.

## References

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