Applicability of a Handheld NIR spectrometer to determine the quality of maritime pine resin (*Pinus pinaster*) *in situ* forest

Morandise Rubini1\*, Lisa Feuillerat1, Thomas Cabaret1, Bertrand Charrier1

1 CNRS / Université de Pau & des Pays de l’Adour, Institut des Sciences Analytiques et de Physico-Chimie pour l’Environnement et les Matériaux - Xylomat, UMR5254, 40004, Mont-de-Marsan, France

\* [morandise.rubini@univ-pau.fr](mailto:morandise.rubini@univ-pau.fr)

Maritime pine *(Pinus pinaster)* tapping was developed through the vast areas of the south of France, whose, the largest forest is in *Landes de Gascogne*, a single-species forest massif with more than 1.3 million hectares of maritime pine (Rosa, Soares and Tomé, 2018). Maritime pine (*Pinus pinaster*) tapping was undergo at a large scale until 1970. Then, industrial production has disappeared due its low competitiveness at an international level. The objective is to promote tapping in this area by providing to companies a rapid and non-destructive analysis tool to enable them to determine the quality of tinned resin directly in the forest field. Indeed, after the tree was tapped, the collected resin can be distilled, in the laboratory, into two substances: turpentine, composed of monoterpenes, and rosin, mainly composed of diterpenes, also called resinic acids.

Researches were focused on a miniaturized spectrometer (molecular sensor SCiO ™) developed by Consumer Physics. This lightweight spectrometer (about 35 grams) covers a spectral range between 780 and 1110 nm. It allows observation of electronic transitions, harmonics and combination bands of the molecules present in the resin. The studied quality include chemical proportion (rate of turpentine) and composition (α-pinene, β-pinene, δ-3-carene, ɣ-terpinene, dehydroacetic acid, levopimaric acid, abietic acid, neoabietic acid). Parameters were correlated to the spectra in order to build predictive models using Partial Least Squares (Wold, Sjöström and Eriksson, 2001), Independent Component Analysis (Gustafsson, 2005) and Least Squares-Support Vector Machines (Chauchard et al., 2004) regressions methods.

Computed models gave good results regarding almost of all the parameters. Although the study is still underway to try to improve the predictive models, results of this exploratory study are promising and confirming that handheld NIR spectrometer could be a good alternative for screening quality parameters of pine resin directly in the field.

**Keywords:** quality, analyse in-situ forest, maritime pine *(Pinus pinaster)* resin, predictive models, NIRs

**Acknowledgements:** The authors warmly acknowledge the financial support from the Nouvelle Aquitaine regional council, the Landes departmental council, the Agence Nationale de la Recherche (National Agency for Research), Xyloforest (ANR-10-EQPX-16), and Holiste.

REFERENCES

Chauchard, F. et al. (2004) ‘Application of LS-SVM to non-linear phenomena in NIR spectroscopy: Development of a robust and portable sensor for acidity prediction in grapes’, Chemometrics and Intelligent Laboratory Systems, 71(2), pp. 141–150. doi: 10.1016/j.chemolab.2004.01.003.

Gustafsson, M. G. (2005) ‘Independent Component Analysis Yields Chemically Interpretable Latent Variables in Multivariate Regression’, Journal of Chemical Information and Modeling. American Chemical Society , 45(5), pp. 1244–1255. doi: 10.1021/ci050146n.

Rosa, R., Soares, P. and Tomé, M. (2018) ‘Evaluating the Economic Potential of Uneven-aged Maritime Pine Forests’, Ecological Economics. Elsevier B.V., 143, pp. 210–217. doi: 10.1016/j.ecolecon.2017.07.009.

Wold, S., Sjöström, M. and Eriksson, L. (2001) ‘PLS-regression: A basic tool of chemometrics’, in Chemometrics and Intelligent Laboratory Systems, pp. 109–130. doi: 10.1016/S0169-7439(01)00155-1.