

# Recognition of the geographical origin and sex of Patagonian forests of *Araucaria araucana* through the analysis of leaves by FT-NIR: a methodological approach

Molina, J.G.A.<sup>1</sup>; Franco, M.P.<sup>2</sup>; Franzol, S.D.<sup>3</sup>; Moreno, C.<sup>1</sup>; Hadad, M.<sup>1</sup>; Tomazello Filho, M.<sup>3</sup>; Roig Juñet, F.A.<sup>1</sup>; Chaix, G.<sup>4</sup>

<sup>1</sup>Laboratorio de Dendrocronología e Historia Ambiental, IANIGLA, CCT-CONICET, Mendoza, Argentina

<sup>2</sup>USP - ESALQ - Forest Sciences, Piracicaba, Brazil

<sup>3</sup>USP ESALQ Forest Sciences, Piracicaba, Brazil

<sup>4</sup>CIRAD UMR AGAP USP ESALQ Forest Sciences, Piracicaba, Brazil



Contact: froig@mendoza-conicet.gob.ar

Plant physiology and growth vary along environmental gradients. Because tree species respond to climate variables and soil properties, these environmental gradients may reflect the chemical or structural leaf compounds. In face of the projected global warming, the extremes of these gradients may be involved in the promotion of particular physiological status of trees. To contribute to the discussion of this hypothesis we analyzed leaves of *Araucaria araucana*, an endemic conifer of northern Patagonia in Argentina (photo 1 and 2), through the technique of FT-NIR.

In the frame of this study, and because *Araucaria araucana* is a monoic tree species (photo 2 and 3), we try to use FT-NIR to detect signals in the spectrum related to both provenance (humid/xeric environments) and sex from direct lectures of NIR on leaves of adult trees.

## Experience

- Living leaves of *A. araucana* trees located at the extremes of a precipitation gradient were collected in different regions and forests. We grouped the samples in 3 groups according to the climate (from dry to humid conditions). For the adult trees we noted the sex of each tree when the flower and/or fruit were visible. Leaves were kept in cold and dry environment during the transport and were dehydrated by lyophilization in the lab. The absorbance spectra were obtained from Bruker MPA spectrometer by applying FT-NIR both by integration sphere (the leaves for each tree were putted in rotate cup) and with optic fiber (we measured one spectrum for each leave on inferior face). To verify and limit the anatomical and structural effects on NIR information, we compressed grounded leaves for each tree and we measured with integration sphere one spectrum for each pastille. We used the Unscrambler software 10.3 (Camo, AS, Norway) for NIR data analysis. Linear Discriminant Analysis (LDA) was used to classify leaf materials according their provenance and sex of the trees.

## Results and discussion

- For provenance discrimination for any type of material and/or measurement methodology, we obtained a good level of classification when using optic fibre, rotate cup or pastille samples, attaining 78, 95, and 88% respectively (Table I).
- For sex discrimination, the percentages of good classification were 75, 87, 81% when we used optic fibre, rotate cup (intact leaves) and pastille samples (grounded leaves), respectively (Table II). The best results were obtained using the integration sphere, because this methodological variant may result in a

mean value relative to the whole leaves for each tree with rotate cup. The restricted information due to the small surface measured by the optic fibre could explain the lower accuracy of the LDA model. The NIR data obtained from pastille samples, lacking information of the leaf structure and anatomy, gave intermediate results. However, the resulted good percentage confirmed our hypothesis on chemical differences due to region/forest provenances and sex of the trees. More sites should be included to confirm these preliminary results.

Table I: Results of LDA on NIR spectra analysis on provenance determination for *Araucaria araucana* based on different type of material with different designs.

			Climatic type			
Equipement type	Material		Humid	Inter.	Dry	Total/mean
Int. sphere/Rotate cup	All Leaves	N	31	35	31	97
Int. sphere/Rotate cup	All Leaves	Good classified	87%	97%	100%	95%
Optic fiber	Ind. leaves	N	109	124	117	350
Optic fiber	Ind. leaves	Good classified	76%	78%	79%	78%
Int. sphere	Pastille	N	58	68	62	188
Int. sphere	Pastille	Good classified	79%	85%	98%	88%

Table II: Results of LDA on NIR spectra analysis on sex determination for *Araucaria araucana* based on different type of material with different designs.

			Sexe		
Equipement type	Material		Female	Male	Total/mean
Int. sphere/Rotate cup	All Leaves	N	37	47	84
Int. sphere/Rotate cup	All Leaves	Good classified	95%	81%	87%
Optic fiber	Ind. leaves	N	135	167	302
Optic fiber	Ind. leaves	Good classified	90%	62%	75%
Int. sphere	Pastille	N	135	167	302
Int. sphere	Pastille	Good classified	90%	62%	75%

