Impact of natural ageing of five Guyanese wood residues on their extractive's chemical composition and anti-termite activity

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Keywords: Anti-termite activity, Chemical composition, Extractives, French Guiana, Natural ageing, Woody residues.

Context and objective

The valorization of Amazonian wood residues into active chemical compounds could be an eco-friendly, cost effective and valuable way to develop wood preservatives formulations (Isman and Machial 2006). The supply chain and storage of wood residues can be complex, especially in tropical areas, and can therefore lead to degradation or changes in the chemical composition, chemical structure and thus properties of ligneous biomass (De Freitas Homem De Faria et al 2021).

The present research aims to assess the impact of 4-years natural ageing in indoor conditions (20 ± 2 °C and 65 ± 5 % RH) of 5 Guyanese's wood by-products [Angelique (*Dicorynia guianensis*, Fabaceae), Wapa (*Eperua spp.*, Fabaceae), Wacapou (*Vouacapoua americana*, Fabaceae), Grigon franc (*Sextonia rubra*, Lauraceae), Gonfolo (*Qualeae spp.*, Vochysiaceae)], on their extractive content, chemical composition and anti-termite activity). The five wood species were selected according to their ability (based on their extractive yield and natural durability) to provide a large quantity of industrial by-products with a high number of extractive compounds and potential bioactivity properties (Fig. 1).

Materials and methods

For each wood species, heartwood residues were collected in 2018 and 2022, at the Kourou's sawmill (Kourou, French Guiana), and then extracted by maceration process using ethyl acetate, in 2022 (Kieny et al 2024). Yields of each extractives fraction were determined and their chemical composition were analyzed by FT-IR, GC-MS (Bopenga Bopenga et al 2019) and LC-MS (Heim et al 2022). In line, the anti-termite activity of all extractive's fractions was evaluated against European subterranean termite species (*Reticulitermes flavipes*) by laboratory screening tests. The termite screening tests consisted to impregnate cellulosic papers with the extractive's solutions (with different concentrations), and to expose them against 20 termite workers. After 17 days, the termite survival rate (TSR%) was determined and the relative

degraded area of each paper (Sterm. %) was evaluated by image analysis method (Boer et al 2024).

Fig. 1: Repartition of major Guyanese wood species according to their decay resistance to 6-months soil bed test, extractive yield (using ethyl alcohol/benzene) and annual harvested volume in 2020. The species surrounded by a dotted circle correspond to the selected wood for this study: AG is Angelique, GF is Grignon, WAC is Wacapou, WAP is Wapa and GFLR is Gonfolo. Data for harvested volumes are provided by ONF (ONF 2022). Data concerning the wood mass loss after soil bed tested come from the database of wood properties from specimens of the French Guiana wood collection (Beauchêne et al 2021). Data from wood extractive yields come from the Chemical CIRAD database (Gérard et al 2019).

Preliminary results

Natural ageing of wood residues undergoes a loss of their extractive compounds, for all wood species except for Wapa (Fig.2). Indeed, the extractive loss, after 4 years of indoor natural ageing, were 56.3%, 43.9%, 29.5 %, 9.9 % and -10.8 % for Angelique, Wacapou, Grignon, Gonfolo and Wapa, respectively.

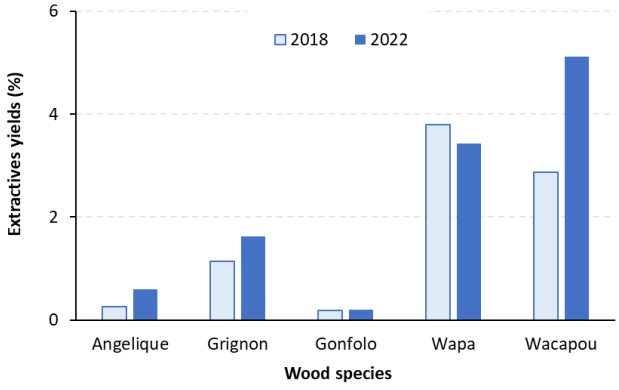

Fig. 2: Extractives yields from the 5 wood by-products maceration processes using ethyl acetate, according to the year of wood by-products harvesting.

For all wood species, GC-MS and LC-MS confirmed that the natural ageing of wood undergoes a modification in the composition of their respective extractive fraction, mainly due to the volatilization or oxidation reactions occurred on some chemical compounds.

This results in a very significant impact on the anti-termite activity level of extractives, with the extractives from 2022 samples which are significantly more effective than those of extractives from 2018 samples (Fig. 3).

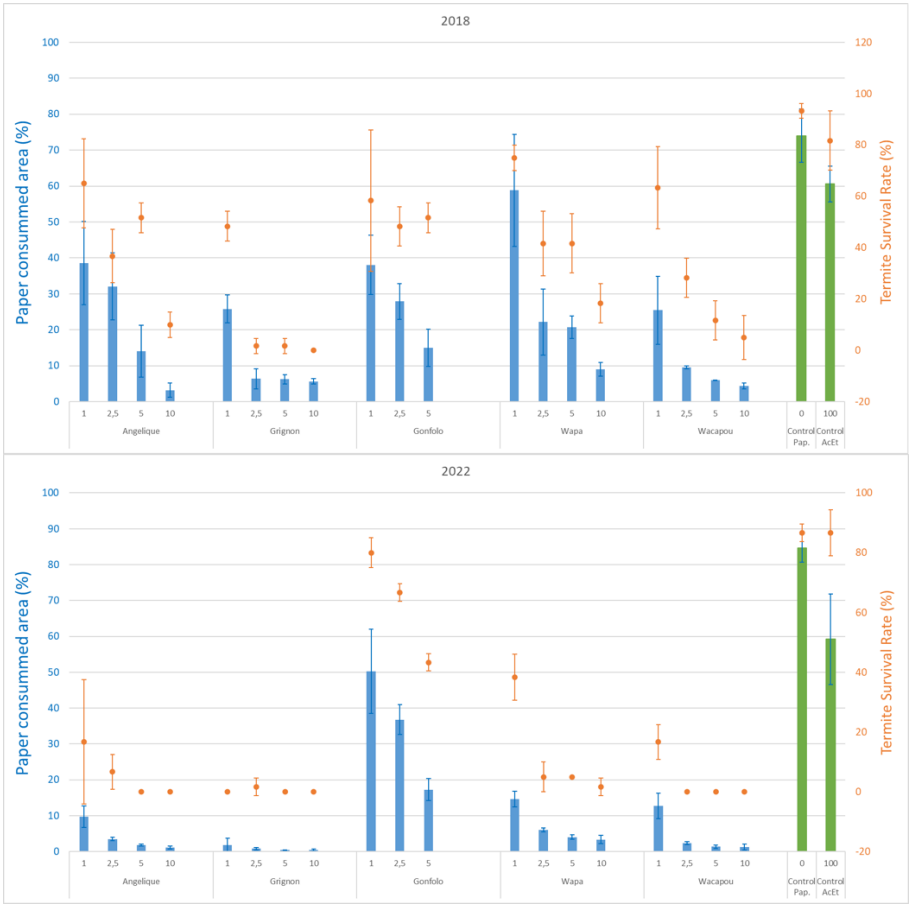

Fig. 3: Average values of the percentage of paper loss area (histogram) and termite survival rates (line), according to the concentration of the different wood extractives (from ethyl acetate maceration) solution, and the year of wood by-products harvesting.

This anti-termite activity of wood extractives was mainly due to the presence of major active chemical compounds such as cassane-type diterpenoids for Wacapou (Kieny et al 2024); catechin and epicatechin for Angelique (Anouhe et al. 2018); eperuic acid, catechin, epicatechin, rhamnopyranosyl and dihydrokaempferol for Wapa (Royer et al 2010); and Rubrynolide and rubrenolide for Grignon franc (Houël et al 2017) (Fig. 4).

Conclusion and perspectives

The extractive fraction (obtained by ethyl acetate maceration) from Guyanese wood, except from Gonfolo, possess a high anti-termite activity against *Reticulitermes flavipes*. This antitermite activities was reduced by the natural ageing process of the raw wood residue before extraction step. These preliminary results highlight the importance of harvesting, storage and conditioning of wood by-products to optimize the quality of chemical compounds to be extracted and valorized.

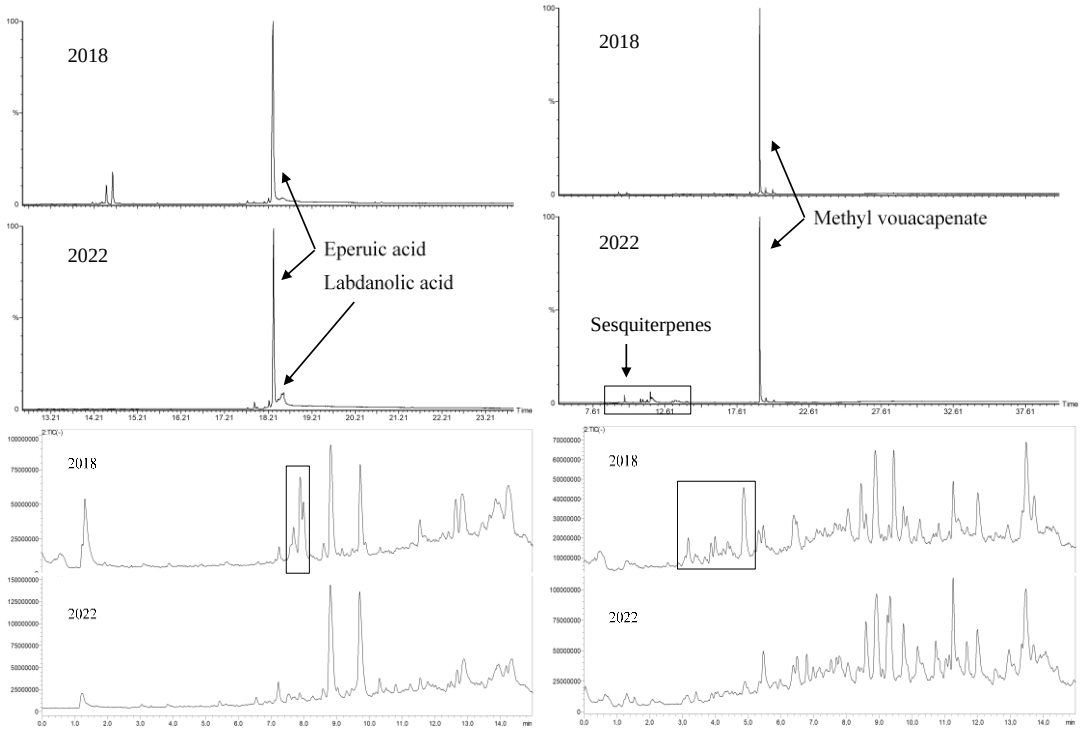

Fig. 4; chromatograms: (a) GC-MS chromatograms of Wapa extracts. (b) GC-MS chromatograms of Wacapou extracts. The major compound was methyl vouacapenate. Sesquiterpenes detected between 8.0 and 13.0 min in 2022 sample were not present in 2018 sample. (c) LC-MS (ESI-) chromatograms of Grignon extracts. The major compounds at 8.8 and 9.8 min exhibited masses corresponding to rubrynolide and rubrenolide respectively when important peaks observed around 8.0 min in 2018 sample seemed to correspond to oxidated forms of these 2 compounds with molecular masses increased by 16 Da. (d) LC-MS (ESI-) chromatograms of Gonfolo extracts. Chromatographic profiles comparison showed the appearance of peaks between 3.0 and 5.0 min for 2018 sample which could be due to highly oxygenated compounds.

Acknowledgments

This work was conducted in the framework of the PhD thesis of Emma Kieny, which is financially supported by Ademe (Environmental and Energy Management Agency) and CIRAD. These researches take part from the project PROTEXTWOOD (ID 2202-102) funded through LabEx AGRO ANR-10-LABX-0001-01 (under I-Site Université de Montpellier framework) and the project PANTHER2-Guyane funded through Agence Nationale de la Recherche (ANR-22-CE43-0019). In addition, this work has benefited from an "Investissement d'Avenir" grant managed by Agence Nationale de la Recherche (CEBA, ref. ANR-10-LABX-25-01), and it was also supported by the FEADER (European Regional Development Fund) research project "EcovaloBois" (Project number: GY0015430), and by the CNRS peps INSIS 2018 research project "GuyavaloFibres".

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