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LETTER TO THE EDITOR

Molecules and Indoor Atmosphere Effect of Rosewood: Dalbergia Latifolia

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The purpose of our research is to determine the chemical composition of the DLR heartwood and evaluate th e applications and functions of the compounds to establish the uses of this valuable material. In this study, w e used five methods to detect and analyze the chemical components, including TG and GC-MS, Py-GC/MS, TD-GC/MS. The major chemical compounds were phenols, alcohols, acids, and ethers in addition to cellulose, hemicellulose, and lignin. The main chemical compounds present in the extractives were elemicin, β-eudesmo l, 2,6-dimethoxy-4-allylphenol, catechol, for mononetin, and 7-hydroxy-3-(4-methoxyphenyl)-2H-chromen-2-one.

Dalbergia latifolia; Chemical composition; FT-IR; Py-GC/MS; TD-GC/MS

I Introduction

Dalbergia latifolia Roxb (DLR) is a type of rosewood that belongs to the family of Leguminosae (subfamily Papilionoideae). It is native to India and Java in Indonesia. Because the wood of DLR has good physical and mechanical properties, its heartwood is rot-resistant, and it has a natural color and texture, the tree species has become popular for furniture and building. However, large-scale felling of the trees to meet the high demand has resulted in a significant decline in the species. Therefore, it is important that the DLR resources are used sustainably with little waste.

Wood is an organic substance formed by natural growth and contains small amounts of other components in addition to cellulose, hemicellulose, and lignin. These components are called extractives. Research studies have shown that wood extractives commonly contain tannins, resins, gums, essential oils, pigments, alkaloids, and more than 700 types of chemical compounds. Some of these components are important raw materials for medicines and are used in the chemical and industrial fields; they also have economic value.

In this study, we used DLR heartwood as the raw material. After the extraction experiments, we detected the compounds using thermogravimetric (TG) analysis, Fourier-transform infrared spectroscopy (FT-IR), gas chromatography-mass spectrometry (GC-MS), pyrolysis-gas chromatography-mass spectrometry (Py-GC/MS), and thermal desorption-gas chromatography-mass spectrometry (TD-GC/MS).Subsequently, we researched the applications and functions of these compounds.

II Material and Methods

Experimental Materials

The location for this experiment was the Central South University of Forestry and Technology in Changsha in the Hunan province in China (Changsha city is located at 28°11' N and 112°58' E in a subtropical monsoon climate). The raw material of our study is the DLR heartwood. First, we placed the raw material into a micro plant grinder to obtain the wood powder, which was then divided into four parts; three parts were used for the extraction experiment and one part was left untreated. (Gao et al. 2017) In the extraction experiment, we used three types of solvents: ethanol, a mixture of ethanol and methanol, and a mixture of ethanol and benzene. The samples consisted of three liquid groups and four solid groups, which represented the residual wood powder after the extractions and the untreated wood powder. The details of the samples are shown in Table 1.

Table 1 Samples for the extraction experiment.

	Solvent	Solid	Liquid
Untreated	-	S_0	-
Extractive	Ethanol	S_1	L_1
	Ethanol/Methanol	S_2	L_2
	Ethanol/Benzene	S_3	L_3

Experimental Methods

TG Analysis was carried according to the References (Ge et al. 2015, Chen et al. 2017, Lou et al. 2018, Li et al. 2017, 2016, Peng et al. 2011, Peng et al. 2012, Peng et al. 2013).

FT-IR Analysis was carried according to the References (Ge et al. 2015, Lou et al. 2018, Al-Tameme et al. 2015, Peng et al. 2017a, Li et al. 2015a, 2015b, Awaad et al. 2017, Popiolek and Biernasiuk 2017).

GC-MS Analysis was carried according to the References (Ge et al. 2015, Chen et al. 2017, Lou et al. 2018, Li et al. 2013, Peng et al. 2011, Peng et al. 2012, Peng et al. 2013 Li et al. 2015a, 2015b, Awaad et al. 2017, Popiolek and Biernasiuk 2017).

Py-GC/MS Analysis was carried according to the References (Ge et al. 2015, Chen et al. 2017, Lou et al. 2018, Li et al. 2013, Peng et al. 2011, Peng et al. 2012, Peng et al. 2013).

TD-GC/MS Analysis was carried according to the References (Ge et al. 2015, Chen et al. 2017, Lou et al. 2018, Li et al. 2013, Peng et al. 2011, Peng et al. 2012, Peng et al. 2013).

III Experimental Results and Discussion

TG results

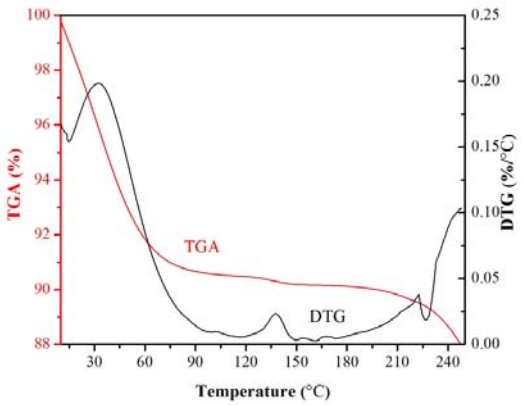

Figure 1 TGA/DTG curves of the DLR raw wood powder

Figure 1 shows that the TG analysis (TGA) and derivative TG (DTG) curves decrease significantly as the TG temperature increases to 90°C. This occurred because of the water evaporation in the plant cells. At

temperatures > 90℃ and < 180℃, the sample weight remains stable (Jin and Mi 2019). During this stage, an endothermic process occurs and the samples do not lose mass. Among the three organic ingredients of wood, hemicellulose has the low estthermal stability. The hemicellulose began to pyrolyze at temperatures s > 200℃ (Brebu et al. 2013). This resulted in an increase in the DTG curve at temperatures s > 180℃. The DTG curve exhibits slight fluctuations during the endothermic stage, which may be due to the impurities in the sample (Liu et al. 2008).

FT-IR results

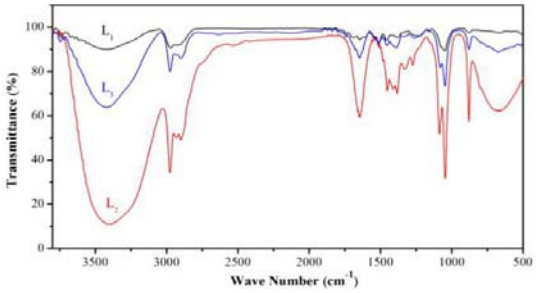

Figure 2 FT-IR spectra of the liquid extracts

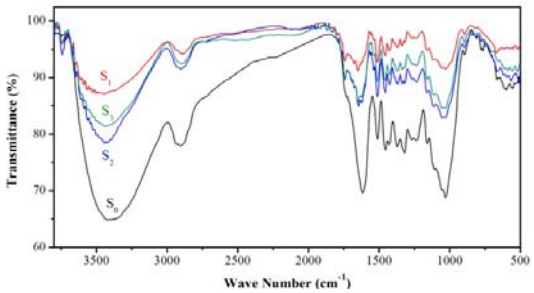

Figure 3 FT-IR spectra of the DLR wood

Figure 2 and Figure 3 shows that the FT-IR analysis demonstrated that the major chemical compounds in the DLR heartwood were phenols, alcohols, acids, and ethers in addition to cellulose, hemicelluloses, and lignin. These chemical compounds were extracted most effectively by the mixture of the ethanol and methanol, whereas the use of only ethanol as a solvent had a limited effect. The ranking of the effectiveness of the solvent to extract the compounds from the DLR heartwood was methanol s > benzene s > ethanol based on the FT-IR analysis. The mixture of the solvents also had auxo-action to extraction of chemical compositions.

GC-MS results

The GC-MS analysis showed that 10 chemical compounds were detected using the three types of solvent s. The GC-MS results of L_1showedthat 15 peaks were detected and only 2 compounds were detected in the DLR heartwood powder, representing 3.92% of the total peak areas. The compounds were phenol, 4-methyl-2-[5-(2-thienyl)pyrazol-3-yl]- (3.16%) and elemicin (0.76%).

The results forL_2showedthat 62 peaks and 4 compounds were detected, representing 3.64% of the total p eak areas. The compounds were 2,3,6-trimethoxy-10,11-dihydrodibenzo[b,f]oxepin-10-ol (1.96%), elemicin (1.29%), β-eudesmol (0.25%), and 2-methoxyhydroquinone (0.14%).

The results forL_3indicatedthat 54 peaks and5compounds were detected, representing 11.11% of the total p eak areas. The compounds were 7-hydroxy-3-(4-methoxyphenyl)-2H-chromen-2-one (4.44%), for mononetin (3.09%), maackiain (1.85%), 3,3,4,5,5,8-Hexamethyl-2,3,5,6-tetrahydro-s-indacene-1,7-dione (1.51%), and 1,3-Dimethoxy-5-[(E)-2-phenylvinyl]benzene (0.22%).

The major compounds were alcohols, phenols, ketones, and flavonoids.

Py-GC/MS results

The Py-GC/MS results showed that 40 peaks and 10 compounds were detected in the DLR heartwood powder, representing 25.02% of the total peak areas. The compounds were 2,6-dimethoxy-4-allylphenol (5.79%), catechol (5.76%), hydroxyacetone (3.21%), guaiacol (2.99%), methyl pyruvate (2.17%), 4-ethylguaiacol (1.31%), 5-methyl furfural (1.17%), 3-methoxycatechol (0.95%), 2(5H)-furanone (0.93%), and 2H-pyran-2,6(3H)-dione (0.74%). The major obtained compounds were phenols, ketone, esters, and aldehydes.

TD-GC/MS results

The TD-GC/MS results showed that 40 peaks and 10 compounds were detected in the DLR heartwood powder,

representing25.82% of the total peak areas. They were diisobutyl phthalate (9.42%), elemicin (7.26%), β-eudesmol (3.09%), 2-(2-butoxyethoxy)ethyl acetate (2.13%), 2,2,4-trimethyl-1,3-pentanedioldiisobutyrate (1.17%), α-bisabolol (1.11%), 3-hydroxy-2,2,4-trimethylpentylisobutyrate (0.70%), cedrol (0.52%), dimethyl phthalate (0.24%), and 1-(2-butoxyethoxy)ethanol (0.18%).The major compounds were esters, alcohols, and phenols.

IV Compound functions

Elemicin appeared to be effective in treating Campylobacter infections. β-eudesmol represented a key compound for potentiating neuronal functions (Obara et al. 2002). Maackiain mixed with medicarpinexhibited very good larvicidal activity (4th instar larvae of *Aedesaegypti*) (Bezerra-Silva et al. 2015, Mizuguchi et al. 2015). Formononetin was a phytoestrogen (Chen et al. 2011, Mu et al. 2009). Guaiacol can be used in medicines, dyes, and for thesynthesis of spices (Mageroy et al. 2012). Cedrol not only enhanced fibroblast proliferation but also increased the production of elastin and type I collagen. Cedrolstimulatesthe extracellular matrix production (Dayawans 2003, Kagawa et al. 2003). 2,2,4-Trimethyl-1,3-pentanedioldiisobutyrate can be used as an indirect food additive in food packaging (Astill et al. 1972). Hydroxyacetone can be used for the synthesis of renewable diesel or jet fuel range branched alkanes with 2-methylfuran (Li et al. 2013).

V Conclusion

The TG analysis indicated that the chemical components of the DLR heartwood did not change at temperatures s > 90℃ and < 180℃. At temperatures s > 180℃, the weight of the samples decreased because of the pyrolysis of the hemicellulose, cellulose, and lignin. We detected 28 compounds using GC-MS, Py-GC/MS, and TD-GC/MS. They included elemicin, phenol; 4-methyl-2-[5-(2-thienyl)pyrazol-3-yl]-, 2-methoxyhydroquinone, etc. These chemical compounds areused for the synthesis of dyes, spices, and chemicals, as well as in medicine and bioscience.

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