Composition of Seed Oil and Leaf Essential Oil of *Swietenia mahagoni* (L) Jacq (Mahogani) by GC-MS Analysis

Thaung Sein¹, Saw Hla Myint²

Abstract

*Swietenia mahagoni* L. has folkloric and scientifically documented medicinally beneficial effects. The present work thus investigates the composition of seed oil and leaf essential oil of the plant. From the GC-MS analysis of the extracted essential oil from the leaf, 4-hydroxy-4-methyl hexa-5-enoic acid (RT 14.42 min), 2, 6, 10-trimethyltetradecane (RT 16.19 min), 3,5-dimethoxy cinnamic acid (RT 17.69 min) and methyl 4-(1,5- dioxolan-2-yl) benzoate (RT 17.69 min) were suggested in the essential oil. For the analysis of the seed oil, the fatty acid glycerides were first converted to fatty acid methyl esters (FAME) with MeOH/K₂CO₃ before GC-MS analysis. The average chain length (18 carbons) of the fatty acids in the oil has been estimated from to be 18 carbons from CH₂/CO peak intensity in the IR spectrum of FAME. GC-MS suggests the methyl esters of 2-hydroxy-4-methyl pentanoic acid (RT 14.37 min), (11 E, 14 E)-11,14-eicosadienoic acid (RT 15.80 min) and di- and mono- methyl esters of sebacic acid (RT 15.85 min). Phytochemical tests and proximate analysis of the seed and leaf have also been carried out. The knowledge of the compounds present in the seed oil and leaf essential oil as well as the kinds of phytoconstituents suggested by phytochemical tests in the plant is will contribute to further understanding of the medicinal value of mahogany.

**Keywords**: *Swietenia mahagoni* L., seed oil, leaf essential oil, phytoconstituents, GC-MS

1. Introduction

Traditional medicinal plants play a very important role in health care system of Myanmar because most of its population resides in the rural area and they have been using traditional medicine for centuries. The plant kingdom constitutes an invaluable source of chemical products which may be important due to their biological properties and their potential use in medicine. Mahogany is one of such plants. The earliest recorded use of *Swietenia mahagoni* was in 1514. Other records refer to the use of mahogani between 1521 and 1540, when Spanish explorers employed the wood for making canoes and for ship repair work in the West Indies. Mahogani's first major use in Spain and England was for ship building, and during the 18th century it was the chief wood employed in Europe for that purpose. Mahogani is a deciduous, erect tree growing to a height of 10 meters, with a heavy, dark-green, and dense crown. Bark is dark gray and ridged. The bark in younger specimens is smooth and grayish, becoming darker and furrowed with age (Figure 1). In the U.S. mahoganies are semi-deciduous, losing all or most of their leaves over winter or shedding at the flush of new growth in spring (Philippine Medicinal Plants, 2016). The bark contains tannin; limonoids and alkaloids, terpenoids, antraquinones, cardiac glycosides, saponins, phenols, flavonoids and long chain unsaturated acid (Mayur *et al.*, 2011). *Swietenia mahagoni* possess astringent, antipyretic, abortifacient, depurative, anticoagulant, antioxidant, antimicrobial, antidiabetic, antiprotozoal, anthelmintic, cytotoxic, gastroprotective, and hepatoprotective properties (Philippine Medicinal Plants, 2016). Crude methanolic seed extract yielded alkaloids, terpenoids, anthraquinones, cardiac glycosides, saponins, and volatile oils (Geethaa *et al.*, 2009). The present work deals with the investigation on the seed oil and the essential oil in the leaf of the plant.

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2. Materials and Methods

Sample Collection

The leaves and seeds of Mahogani were collected from East Dagon Township, Yangon Region, Myanmar. The collected plant samples were cleaned by washing with water and then were shade dried. The dried sample was ground into coarse powder. The dried powdered sample was stored in air tight container to prevent moisture changes and other contaminations.

Preliminary Phytochemical Tests

A few grams of sample powder were subjected to the tests of alkaloids, α-amino acids, anthraquinones, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch and tannins by the preliminary phytochemical test according to reported methods (Tin-Wa, 1972 and Trease and Evans, 1980).

Proximate Analysis

In the present study, some nutritional values such as moisture, ash, protein, fiber, fat, carbohydrate and energy values of *Swietenia mahagoni* (Mahogani) leaves and seeds were determined by AOAC methods (A.O.A.C, 2000).

Qualitative Elemental Analysis

Elemental analysis of *Swietenia mahagoni* (Mahogani) leaves and seeds were done by ED-XRF onEDX-8000.

Extraction of Essential Oil from Mahogani Leaves

The leaf sample was macerated with petroleum ether for two weeks shaking from time to time, filtered and the solvent evaporated. The obtained petroleum ether extract was mixed with some sand and submitted to steam distillation. The essential in the condensed oil-water mixture was then extracted by partition with petroleum ether. The petroleum extract was dried over anhydrous Na$_2$SO$_4$. Evaporation of the petroleum ether yields the essential oil for GC-MS analysis.

Extraction of Seed Oil

The seed sample was macerated with petroleum ether for two weeks shaking from time to time, filtered and the solvent evaporated to obtain seed oil. The constituting fatty acids in the
oil were obtained as their methyl esters by transesterification of the glycerides with MeOH/K$_2$CO$_3$ and separation on a silica gel column.

**Transesterification**

Seed oil (5 g), MeOH (1.5 mL) and K$_2$CO$_3$(0.3 g) were mixed in a 100 mL round bottom flask. The flask was fitted with a water cooled condenser that returned any vapourized methanol to the reacting mixture. The reaction temperature was maintained at 65°C using a sand bath, stirring continuously with a magnetic stirrer. After 25 min, 0.2 M A/A (4 mL) was added slowly to the mixture and stirred for a few minutes. The product mixture of fatty acid methyl esters (FAMEs) obtained as upper layer was removed using a separating funnel, and then dried over anhydrous MgSO$_4$. The dried FAME mixture (0.2 g) was purified by chromatography on a silica gel (7 g) column (diameter 1.2 cm) with PE : EtOAc (95 : 5) for further analysis by GC-MS. FAME average carbon chain length was also determined by FTIR.

The ratio of the peak intensities of CH$_2$ and CO, respectively, at 2922 and 1745 cm$^{-1}$ was calculated from the FT IR spectrum of FAME. Using the values thus obtained and the published curve of CH$_2$/CO ratio versus FAME carbon chain length, the average chain length of carbon in the fatty acids can be determined.

3. **Results and Discussion**

**Phytochemical Test by Using Test Tube Method**

The phytochemical tests were done on the leaf and seeds with a view to determine the presence of alkaloids, α-amino acids, carbohydrates, glycosides, phenolic compounds, reducing sugars, saponins and the absence of flavonoids, starch and tannins. The results were shown in Table 1.

**Proximate Analysis of S. mahagoni (Mahogani) Leaves and Seeds**

Some nutritional values such as moisture, ash, fiber, fat, protein, carbohydrates and energy values of the leaves and seeds of S. mahagoni (Mahogani) were summarized in Table 2. Fiber content (41.14 %) is predominant in the leaves sample and the fat content (28.77 %) is predominant in the seed sample.

<table>
<thead>
<tr>
<th>No.</th>
<th>Nutrients</th>
<th>Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Leaves</td>
</tr>
<tr>
<td>1</td>
<td>Moisture</td>
<td>18.20</td>
</tr>
<tr>
<td>2</td>
<td>Ash</td>
<td>6.54</td>
</tr>
<tr>
<td>3</td>
<td>Protein</td>
<td>8.42</td>
</tr>
<tr>
<td>4</td>
<td>Fiber</td>
<td>41.14</td>
</tr>
<tr>
<td>5</td>
<td>Fat</td>
<td>2.16</td>
</tr>
<tr>
<td>6</td>
<td>Carbohydrate</td>
<td>23.54</td>
</tr>
<tr>
<td></td>
<td>Energy Value (kcal/100g)</td>
<td>147.28</td>
</tr>
</tbody>
</table>

**Semi-Quantitative Elemental Analysis of the Leaves and Seeds of Mahogani by Energy Dispersive X-Ray Fluorescence**

The ED-XRF spectra and data of the leaves and seeds samples were shown in Figure 3 and Table 3. It can be seen that Ca (70.943 % and 45.431 %) and K (21.137 % and 86.871 %) in leaf and seed, respectively.
Extraction of Leaf Essential Oil and Analysis

Only very small amount of essential oil was obtained from the leaf by steam distillation. GC-MS analysis (Figure 3) of the essential oil suggests 4-hydroxy-4-methyl hexa-5-enoic acid (RT 14.42 min), 2,6,10-trimethyltetradecane (RT 16.19 min), 3,5-dimethoxy-cinnamic acid (RT 17.69 min) and methyl-4-(1,2-dioxolan-2-yl) benzoate (RT 17.69 min).
Extraction of Seed Oil and Analysis

After the transesterification reaction of the extracted seed oil, the product mixture was observed as two layers, FAME in the upper and glycerol in the lower layer. The purified FAME mixture from chromatography (Figure 8) was analysed by FT IR (Figure 9 and Table 3).
Figure 8. TLC monitoring of fractionated methylated seed oil

Figure 9. FTIR spectrum of the mixture of methyl esters of fatty acids (FAME) prepared from the extracted seed oil

Figure 10. CH2/CO peak intensity ratio versus chain length curve for fatty acid methyl esters

The average chain length of fatty acids in the oil can be estimated from the value (2.2) of the ratio of peak intensity for CH2 and CO stretching (Figure 9) and the CH2/CO intensity ratio versus chain length curve (Figure 10).

\[
\frac{\text{Intensity of } \text{CH}_2 \text{ peak at } 2922 \text{ cm}^{-1}}{\text{Intensity of } \text{CO} \text{ peak at } 1745 \text{ cm}^{-1}} = \frac{3.39 \text{ in}}{1.58 \text{ in}} = 2.2
\]

This indicates that the average chain length, i.e. the number of carbons in the chain in the constituent fatty acids is round about 18.
GC-MS analysis Figure 11. of the FAME mixture suggests 2-hydroxy-4-methyl pentanoate (RT 14.37 min), (11E, 14E)-11, 14-eicosadienoic acid (RT 15.80 min) and di and mono-methyl esters of sebacic acid (RT 15.85 min).

Figure 11. Gas Chromatogram of the mixture of methyl esters prepared from the seed oil

Figure 12. EI mass spectra (a) of eluted compound at RT 14.37 min and (b) methyl2-hydrox-4-methylpentanoate (database)

Figure 13. EI mass spectra of (a) eluted compound at RT 15.80 min and (b) methyl (11E, 14E)-11, 14-eicosadienoate (database)

Conclusion

From the results of preliminary phytochemical tests of leaf and seed samples of S.mahagoni, alkaloids, α-amino acids, carbohydrates, flavonoids, glycosides, phenolic compounds and saponins are present but reducing sugars, starch and tannins are absent.

Nutritional analyses showed that mahogany leaf and seed contained 18.10 % and 7.25 % of moisture, 6.54 % and 2.50 % of ash, 8.42 % and 17.49 % protein, 41.14 % and 22.23 % of fiber, 2.16 % and 28.77 % of fat, 23.54 % and 21.75 % of carbohydrate, respectively on the basis of dry samples. The energy value of the leaf and seed were observed to be 147.28 and 403.89 (kcal/100g) respectively.
Ca (70.943 %) was the most abundant element in the leaves sample followed by K, Si, Fe, S, Sr and Cu in relatively small quantities. But K (46.87 %) was the most abundant element in the seed sample. Ca (45.343 %) was nearly abundant as K, followed by S, Si, Fe, Cu and Zn in relatively small quantities in the seed sample. From the GC-MS analysis, 4-hydroxy-4-methylhexa-5-enoic acid (RT 14.42 min), 2,6,10-trimethyltetradecane (RT 16.19 min), 3,5-di methoxycinnamic acid (TR 17.69 min) and methyl 4-(1,5-dioxolan-2- yl) benzoate (RT 17.69 min) were suggested in the leaf essential oil and methyl esters of 2-hydroxy-4-methylpentanoic acid (RT 14.37 min) (11E, 14E)-11,14-eicosadienoic acid (RT 15.80 min ) and di and mono- methyl esters of sebacic acid (RT 15.85 min) were suggested in the FAMEs of seed oil.

It is hoped that the knowledge of the chemical compositions of the seed oil and the leaf essential oil of mahogany will make useful contribution to further understanding of the medicinal values of the plant.

References


