Phytochemical and infra-radiation test of Mangkokan leaf (Nothophanax scutellarum merr.)

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Abstract. Mangkokan (Nothophanax scutellarum merr.) is an ornamental plant that can be used to treat disease. Generally, the leaves are used as a lactant, diuretic or medicine to treat breast inflammation, swelling, hair loss, fever, headaches and constipation. The research objective was to identify the active compound content via Fourier Transform Infrared Radiation (FTIR) in Mangkokan leaf extract. This study used n-hexane, ethyl acetate, methanol and ethanol as solvents. The yield was 2.4% with 2.4 g n-hexane extract, a yield of 3.39% with 3.39 g of ethyl acetate extract, a yield of 17.39% with 17.39 g of methanol extract, and a yield of 19.55% with 19.55 g ethanol extract. The secondary metabolite test obtained positive n-hexane extract results containing steroids, positive ethyl acetate extract containing alkaloids (using Dragendorff’s, Mayer’s and Wagner’s reagents), steroids and phenols. In contrast, methanol and ethanol extracts had the same content, namely alkaloids (confirmed via Dragendorff’s, Mayer’s and Wagner’s reagents), flavonoids, steroids, tannins, phenols and saponins. FTIR analyzed functional groups for each extract through radiation at different wavelengths.

1. Introduction

Nothophanax scutellarium merr. known as Mangkokan is a shrub with ornamental functions that belongs to the Araliaceae family [1], [2]. The roots and leaves of Mangkokan plants are used for medicine. The leaves act as a diuretic and lactant that can also treat breast inflammation, swelling and hair loss [1]-[3], fever, headaches [4], and constipation [5]. Population in Indonesia also use Mangkokan leaves for cooking as a curry with coconut milk or as fresh vegetable dish. The chemical content of Mangkokan leaves includes alkaloids, coumarin, saponins, tannins, flavonoids and polyphenols [1], [6]. There are still few people who know the medical uses of these decorative plants,
even though many diseases can be cured with Mangkokan leaves. Thus this study identifies active compounds and performs FTIR test Mangkokan leaves (Nothopanax scutellarium merr.).

2. Material and methods

2.1. Sampling of plant

This sample used 3 kg dark green Mangkokan leaves (Nothopanax scutellarium merr.), not young and not old. They were, obtained from Neusu Aceh village, Baiturrahman sub-district, Banda Aceh city at coordinates 5°32'10" N and 95°19'3" E with a height of 4 m above sea level (asl). The identification of herbarium samples was conducted at the Biology Laboratory of the Faculty of Mathematics and Natural Sciences, Syiah Kuala University, Banda Aceh with number B/365/UN11.1.8.4/TA.00.01/2020. The coordinates of the Neusu villages and Mangkokan sampling can be seen in Figure 1 and Figure 2.

2.2. Materials and instruments

2.2.1. Material. Mangkokan leaves (Nothopanax scutellarium merr.), N-hexane, ethyl acetate, methanol, ethanol and specific reagents were used to test phytochemical extracts.

2.2.2. Instruments. Analytical scales, maceration containers, filter paper, rotary vacuum evaporators, test tubes, porcelain glasses, stirrers, drop pipettes and other supporting tools.

2.3. Procedure

2.3.1. Maceration and extraction. The leaves of Mangkokan (Nothopanax scutellarium merr.) were cleaned, then air-dried and pulverized into a powder using a blender. Powder samples were weighed as data for yield calculations. Each sample weighed 100 g for maceration with n-hexane, ethyl acetate, methanol and ethanol for seven days. Then filtering was carried out until the macerate was obtained. It was then steamed using a rotary evaporator until a thick extract was obtained. The dense extracts of n-hexane, ethyl acetate, methanol and ethanol were weighed, then tested for phytochemicals and FTIR.

2.3.2. Phytochemical test. There were several tests of compounds, as follows:

1. Identification of alkaloid compounds
   1 ml of 2N HCl was added to the 2 ml extract solution and then separated into four test tubes. With tube 1 as a control Dragendorff’s reagent was added to tube 2, Mayer’s reagent was added to tube 3 and Wagner's reagent was added to tube 4. Positive results were indicated by red brick deposit with the Dragendorff’s reagent, white with Mayer’s reagent, and brown with Wagner’s reagent [6].

2. Identification of flavonoid compounds
Magnesium powder was added to the extract solution, followed by 3-4 drops of concentrated HCl. The formation of red or orange color indicated the presence of flavonoids [6].

3. Identification of steroid compounds
10 ml of chloroform were added to 2 ml of extract solution, followed by 1 ml of anhydrous acetic acid and 2-3 drops of concentrated sulfuric acid. Green discoloration indicated the presence of steroids [7], [8].

4. Identification of triterpenoid compounds
Identification for triterpenoids followed the procedure for steroid testing. The appearance of red or purple discoloration indicated the presence of triterpenoids [7], [8].

5. Identification of tannin compounds
A 1% gelatin solution containing NaCl was added to the extract. The formation of a white precipitate indicated the presence of tannins [7], [8].

6. Identification of phenol compounds
The extract was dissolved with a few drops of FeCl3 solution. The formation of a bluish-black colour indicated the presence of phenol [6].

7. Identification of saponin compounds
9 ml of distilled water was added to 1 ml of extract and shaken vigorously for 15 seconds. The presence of saponins was indicated by retaining the resulting foam for ten minutes [7], [8].

2.3.3. FTIR test. Fourier Transform-Infra Red Spectroscopy (FTIR) is an analytical method used to analyze organic and inorganic compounds' chemical structure. This is achieved by analyzing the resulting spectra according to the peaks formed by a functional group, as these compounds absorb electromagnetic radiation in the infrared region [9].

3. Result and discussion
3.1. Extract yield calculation
The yield value of Mangkohan leaves extract was calculated, indicating the lowest yield (2.4%) was obtained from n-hexane extract with an extract weight of 2.4 g. The highest yield value(19.55%) was ethanol extract at an extract weight of 19.55 g, illustrated in Table 1.

| No | Sample          | Extract weight (g) | Yield weight (%) |
|----|-----------------|--------------------|-----------------|
| 1  | Thick extract n-hexane | 2.4 g             | 2.4%            |
| 2  | Thick extract ethyl acetate | 3.39 g        | 3.39 %          |
| 3  | Thick extract methanol     | 17.39 g           | 17.39%          |
| 4  | Thick extract ethanol      | 19.55 g           | 19.55%          |

Note: 100 g dried simplicia of Mangkohan leaves (% extract = weight of extract / weight of sample)x100).

3.2. Phytochemical test
As seen in Table 2, the results showed that n-hexane extract contained steroids. Furthermore, positive ethyl acetate extract using Dragendorff’s reagent, Mayer’s and Wagner’s indicated the presence of alkaloids, steroids and phenols. Positive methanol and ethanol extracts using Dragendorff’s, Mayer’s and Wagner’s reagent contained alkaloids, flavonoids, steroids, tannins, phenols, and saponins.
Table 2. Secondary metabolites of Mangkolan leaf extract.

| Secondary Metabolites | n-hexane extract | Ethyl acetate extract | Methanol Extract | Ethanol extract |
|-----------------------|-------------------|-----------------------|------------------|-----------------|
| Alkaloid              | -                 | +                     | +                | +               |
| Mayer’s               | -                 | +                     | +                | +               |
| Dragendorff’s         | -                 | +                     | +                | +               |
| Wagner’s              | -                 | +                     | +                | +               |
| Flavonoid             | -                 | -                     | +                | +               |
| Steroid               | *                 | +                     | +                | +               |
| Terpenoid             | -                 | -                     | -                | -               |
| Tannins               | -                 | -                     | +                | +               |
| Phenol                | -                 | +                     | +                | +               |
| Saponin               | -                 | -                     | +                | +               |

(+) Present, (-) Absent

3.3. FTIR test

As shown in Figure 3 and Table 3. FTIR data of a fraction of Mangkolan leaves n-hexane extract showed uptake in the 3762.32 cm⁻¹ area with a broadband, indicating OH and NH groups’ presence in the fraction. OH and NH groups produce a broad absorption peak in the area 3800-2700 cm⁻¹. Also, there is a sharp band with strong intensity in the area of 2966.65 cm⁻¹, which indicated an aromatic CH group in the absorption area range (3030 cm⁻¹). Additionally, the alkane (CH) group is also found in the 2873.09 cm⁻¹ band. In the 1757.23 cm⁻¹ area, there is a sharp band with strong intensity, indicating an acyl halide functional group (> CO), in the absorption area range 1755-1850 cm⁻¹ [10]. There is a sharp band in the 1472.71 cm⁻¹ area and a broadband in the 1406.17 cm⁻¹ area, signaling an aromatic nitro group (-C [NO₂]) in the 1300 -1570 cm⁻¹ absorption area. In the area of 1082.11 cm⁻¹, 1190.13 cm⁻¹, 1248.96cm⁻¹ and 1298.15 cm⁻¹, there are ether (C-O-C) functional groups with an absorption of 1053-1333 cm⁻¹. In the area of 462.94 cm⁻¹, 546.84 cm⁻¹, 743.59 cm⁻¹, 851.61 cm⁻¹ and 901.76 cm⁻¹, there are functional groups of other compounds and - (CH₂)n at 666 absorption -900 cm⁻¹.

Figure 3. FTIR test on n-hexane extract of Mangkolan leaves (*Nothopanax scutellarium* merr.).
Table 3. FTIR test results on n-hexane extract of Mangokan leaves (Notopanax scutellarium merr.).

| No | Wavenumber (cm⁻¹) | Peak extract n-Hexane | Peak shape | Interpretation of functional groups |
|----|------------------|-----------------------|------------|------------------------------------|
| 1  | 743.59 cm⁻¹      | 650-900 cm⁻¹          | taper      | C-H (Aliphatic)                    |
| 2  | 798.56 cm⁻¹      |                       | taper      | C-H (Aliphatic)                    |
| 3  | 851.61 cm⁻¹      |                       | taper      | C-H (Aliphatic)                    |
| 4  | 901.76 cm⁻¹      |                       | taper      | C-H (Aliphatic)                    |
| 5  | 1030.03 cm⁻¹     | 1000-1250 cm⁻¹        | taper      | C-N (Amide)                        |
| 6  | 1082.11 cm⁻¹     |                       | taper      | C-O-C (Ether)                      |
| 7  | 1190.13 cm⁻¹     | 1053-1333 cm⁻¹        | sharp      | C=O (Esther)                       |
| 8  | 1248.96 cm⁻¹     |                       | taper      | C-N2 (Aromatic Nitro)              |
| 9  | 1298.15 cm⁻¹     |                       | taper      | C-N2 (Aromatic Nitro)              |
| 10 | 1406.17 cm⁻¹     | 1300-1570 cm⁻¹        | taper      | C-N (Amide)                        |
| 11 | 1472.71 cm⁻¹     | 1500-1900 cm⁻¹        | taper      | C=C (Alkenes)                      |
| 12 | 1575.91 cm⁻¹     |                       | sharp      | C=O (Esther)                       |
| 13 | 1646.32 cm⁻¹     | 2000-2300 cm⁻¹        | sharp      | C=O (Esther)                       |
| 14 | 1757.23 cm⁻¹     | 2853-2962 cm⁻¹        | sharp      | C-H (Alkanes)                      |
| 15 | 2382.19 cm⁻¹     | 2700-3000 cm⁻¹        | widen      | C=O (Esther)                       |
| 16 | 2873.09 cm⁻¹     |                       | taper      | C-H (Alkanes)                      |
| 17 | 2966.65 cm⁻¹     |                       | taper      | C-H (Alkanes)                      |
| 18 | 3579.07 cm⁻¹     |                       | taper      | C-H (Alkanes)                      |
| 19 | 3762.32 cm⁻¹     |                       | taper      | C-H (Alkanes)                      |

As shown in Figure 4 and Table 4, FTIR spectrum data of ethyl acetate extract showed the presence of phenol groups, supported by the presence of OH groups in the widening absorption band at the wavenumbers 3297.45 cm⁻¹, 3638.87 cm⁻¹, and 3762.32 cm⁻¹. At wave numbers 2872.13 cm⁻¹ and 2872.13 cm⁻¹ a sharp band shape indicates the presence of an alkane group in the form of CH, while at wavenumbers 2029.20 cm⁻¹, 2146.86 cm⁻¹, 2258.74 cm⁻¹ and 2382.19 cm⁻¹ a sharp absorption band indicates the presence of C = O ester compound. There is also a C = C alkene group with a sharp band absorption at wave number 1761.08 cm⁻¹ and a taper absorption band at wave number 1643.42 cm⁻¹. Additionally, there is an aromatic group, nitro aromatic C-N2 shown at 1407.13 cm⁻¹, 1476.57 cm⁻¹, and 1568.19 cm⁻¹. The C-O-C ether group shows absorption in a sharp band at wavenumber 1192.06 cm⁻¹, while the wave numbers 1085.97 cm⁻¹ and 1253.78 cm⁻¹ show a sharp absorption band. Wave numbers 621.11 cm⁻¹, 745.52 cm⁻¹, 796.64 cm⁻¹, and 849.68 cm⁻¹ indicate aliphatic C-H groups’ presence.
Figure 4. FTIR testing from ethyl acetate extract of Mangokan leaves (Nothopanax scutellarium merr.).

Table 4. FTIR test results from ethyl acetate extract of Mangokan leaves (Nothopanax scutellarium merr.).

| No | Wavenumber (cm⁻¹) | Peak shape | Interpretation of functional groups |
|----|------------------|------------|-------------------------------------|
|    | Peak extract Ethyl Acetate | Library | | |
| 1  | 621.11 cm⁻¹ | taper | C-H (Aliphatic) |
| 2  | 745.52 cm⁻¹ | sharppaper | |
| 3  | 796.64 cm⁻¹ | paper | |
| 4  | 849.68 cm⁻¹ | taper | |
| 5  | 1085.97 cm⁻¹ | taper | |
| 6  | 1192.06 cm⁻¹ | sharppaper | |
| 7  | 1253.78 cm⁻¹ | taper | |
| 8  | 1407.13 cm⁻¹ | taper | |
| 9  | 1476.57 cm⁻¹ | sharppaper | |
| 10 | 1568.19 cm⁻¹ | taper | C-NO₂ (Aromatic Nitro) |
| 11 | 1643.42 cm⁻¹ | taper | |
| 12 | 1761.08 cm⁻¹ | papewiden | |
| 13 | 2029.20 cm⁻¹ | c | |
| 14 | 2146.86 cm⁻¹ | sharppaper | |
| 15 | 2258.74 cm⁻¹ | paper | |
| 16 | 2382.19 cm⁻¹ | paper | |
| 17 | 2872.13 cm⁻¹ | paper | |
| 18 | 2872.13 cm⁻¹ | paper | |
| 19 | 3297.45 cm⁻¹ | paper | |
| 20 | 3638.87 cm⁻¹ | paper | |
| 21 | 3762.32 cm⁻¹ | paper | |

As shown in Figure 5 and Table 5, the FTIR spectrum data of methanol extract showed the presence of phenol groups, supported by the presence of the OH group in the widening absorption band at wavenumbers 3620.54 cm⁻¹, 3757.49 cm⁻¹, and 3826.94 cm⁻¹. At wave numbers 2874.06 cm⁻¹ and 2965.68 cm⁻¹ a sharp band shape indicates an alkane group's presence in the form of CH, while at wave number 2387.98 cm⁻¹ a sharp band absorption suggests the presence of a compound C = O ester.
There is also a C = C alkene group with a sharp absorption band at wave numbers 1653.07 cm\(^{-1}\) and 1756.26 cm\(^{-1}\). In addition, nitro aromatic C-NO\(_2\) group is indicated by a sharp absorption band at wavenumber 1418, 71 cm\(^{-1}\) and a sharp absorption band at wavenumber at 1473.68 cm\(^{-1}\). The C-O-C ether group shows wavenumber at 1108.15 cm\(^{-1}\), 1186.27 cm\(^{-1}\), and 1250.89 cm\(^{-1}\), indicated by a sharp absorption band. Wave numbers 742.63 cm\(^{-1}\) and 796.64 cm\(^{-1}\) the presence of an aliphatic C-H group.

![Figure 5. FTIR test on methanol extract of Mangkakan leaves (Nothopanax scutellarium merr.).](image-url)

**Table 5. FTIR test results on methanol extract of Mangkakan leaves (Nothopanax scutellarium merr.).**

| No | Wavenumber (cm\(^{-1}\)) | Peak shape | Interpretation of functional groups |
|----|---------------------------|------------|-----------------------------------|
| 1  | 742.63 cm\(^{-1}\)        | taper      | C-H (Aliphatic)                   |
| 2  | 796.64 cm\(^{-1}\)        | taper      |                                   |
| 3  | 1108.15 cm\(^{-1}\)       | taper      | C-O-C (Ether)                     |
| 4  | 1186.27 cm\(^{-1}\)       | taper      |                                   |
| 5  | 1250.89 cm\(^{-1}\)       | taper      |                                   |
| 6  | 1418.71 cm\(^{-1}\)       | taper      |                                   |
| 7  | 1473.68 cm\(^{-1}\)       | taper      | C-NO\(_2\) (Aromatic Nitro)       |
| 8  | 1653.07 cm\(^{-1}\)       | sharp      | C=C (Alkenes)                     |
| 9  | 1756.26 cm\(^{-1}\)       | sharp      | C=O (Esther)                      |
| 10 | 2387.98 cm\(^{-1}\)       | sharp      |                                   |
| 11 | 2874.06 cm\(^{-1}\)       | sharp      |                                   |
| 12 | 2965.68 cm\(^{-1}\)       | sharp      |                                   |
| 13 | 3620.54 cm\(^{-1}\)       | widen      |                                   |
| 14 | 3757.49 cm\(^{-1}\)       | sharp      | O-H (Phenol)                      |
| 15 | 3826.94 cm\(^{-1}\)       | taper      |                                   |

As shown in Figure 6 and Table 6, the FTIR spectrum data of ethanol extract showed the presence of phenol content, supported by the presence of the OH group indicated by a broad absorption band at wavenumbers 3583.89 cm\(^{-1}\), 3759.42 cm\(^{-1}\), and 3882.87 cm\(^{-1}\). At wave numbers 2875.99 cm\(^{-1}\) and 2969.54 cm\(^{-1}\), a sharp band shape indicates the presence of an alkane group in the form of CH, while at wavenumbers 2389.91 cm\(^{-1}\) a sharp absorption band suggests the presence of C = O ester group. There is also a C = C alkene group with a sharp band absorption at wavenumbers 1662.71 cm\(^{-1}\) and 1753.37 cm\(^{-1}\). A nitro aromatic C-NO\(_2\) group is signaled by sharp band absorption at wavenumbers 1426.42 cm\(^{-1}\) and 1473.68 cm\(^{-1}\).
cm\(^{-1}\) and a sharp absorption band at wavenumber at 1470.79 cm\(^{-1}\). The C-O-C ether group shows at wavenumbers 1116.83 cm\(^{-1}\), 1179.52 cm\(^{-1}\), 1245.10 cm\(^{-1}\), and 1292.96 cm\(^{-1}\), indicated by a sharp absorption band. Wave numbers, 774.55 cm\(^{-1}\), 801.46 cm\(^{-1}\), and 843.89 cm\(^{-1}\) indicate the presence of an aliphatic C-H group.

Figure 6. FTIR test on ethanol extract of Mangkokan leaves (Nothopanax scutellarium merr.).

Table 6. FTIR test results on ethanol extract of Mangkokan leaves (Nothopanax scutellarium merr.).

| No | Wavenumber (cm\(^{-1}\)) | Peak shape | Interpretation of functional groups |
|----|--------------------------|------------|------------------------------------|
| 1  | 774.55 cm\(^{-1}\)       | taper      | C-H (Aliphatic)                    |
| 2  | 801.46 cm\(^{-1}\)       | taper      | C-O-C (Ether)                      |
| 3  | 843.89 cm\(^{-1}\)       | taper      | C-O (Ester)                        |
| 4  | 1116.83 cm\(^{-1}\)      | sharp      | C-H (Aliphatic)                    |
| 5  | 1179.52 cm\(^{-1}\)      | taper      | C-O-C (Ether)                      |
| 6  | 1245.10 cm\(^{-1}\)      | taper      | C-H (Aliphatic)                    |
| 7  | 1292.96 cm\(^{-1}\)      | taper      | C-O-C (Ether)                      |
| 8  | 1426.42 cm\(^{-1}\)      | taper      | C-H (Aliphatic)                    |
| 9  | 1470.79 cm\(^{-1}\)      | taper      | C-H (Aliphatic)                    |
| 10 | 1662.71 cm\(^{-1}\)      | taper      | C=O (Alkenes)                      |
| 11 | 1753.37 cm\(^{-1}\)      | taper      | C=O (Alkenes)                      |
| 12 | 2389.91 cm\(^{-1}\)      | sharp      | C=O (Alkenes)                      |
| 13 | 2875.99 cm\(^{-1}\)      | taper      | C=O (Alkenes)                      |
| 14 | 2969.54 cm\(^{-1}\)      | taper      | C=O (Alkenes)                      |
| 15 | 3583.89 cm\(^{-1}\)      | taper      | O-H (Phenol)                       |
| 16 | 3759.42 cm\(^{-1}\)      | taper      | O-H (Phenol)                       |
| 17 | 3882.87 cm\(^{-1}\)      | taper      | O-H (Phenol)                       |

4. Conclusion
Based on the data analysis and discussion, it is concluded that the secondary metabolites contained in Mangkokan leaf extract are alkaloids, flavonoids, steroids, tannins, phenols, and saponins. FTIR analysis showed the presence of functional groups CH (Aliphatic), COC (Ether), C-NO\(_2\) (Nitro Aromatic), C = C (Alkenes), C = O (Esters), CH (Alkanes) and OH (Phenol), and CN (Amide).

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