



Research Article

Whitening Activity of Various Parts of Taiwanese Mahogany

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Abstract

This study aimed to evaluate the whitening potential of various parts of Taiwanese mahogany (*Swietenia macrophylla*) through both extracellular and intracellular assays. The inhibitory effects on tyrosinase activity and the impact on B16F10 melanoma cell viability and melanin content were systematically investigated using various extracts, including crude methanol extracts and partitioned fractions (ethyl acetate, n-butanol, and water). Extracellular results demonstrated that most large-leaf mahogany extracts at 100 ppm exhibited higher tyrosinase inhibition rates than the positive control, kojic acid (48.9%), particularly the hot water leaf (86.86%) and methanol peel (78.10%) extracts. Intracellularly, the n-butanol fraction of mahogany stones (50 ppm, 39.10%) and the water-soluble fraction (12.5-50 ppm, up to 50.13%) significantly reduced tyrosinase activity. Furthermore, methanol extracts from small-leaf mahogany leaves showed a superior ability to reduce cellular melanin content compared to large-leaf varieties. These findings suggest that specific parts and solvent fractions of Taiwanese mahogany possess significant whitening activities, supporting their potential application in cosmetic and therapeutic formulations.

Keywords

Tyrosine Activity, Antioxidant, Anti-inflammation, *Swietenia Macrophylla*

1. Introduction

Swietenia macrophylla, generally known as mahogany, is a species of plant in the Meliaceae family, *Swietenia* genus. Mahogany is the most well known and valuable tropical tree species in the international market. Native to Central and South America and the West Indies, the fruits are commonly known as "sky fruit" because the fruits seem to point up towards the sky when bearing [1]. Mahogany is commonly used as a traditional medicine in Malaysia and other Southeast Asian countries. The seeds are essentially used in commercial medical devices to improve blood circulation and better various skin conditions [2].

The main pharmacological effect comes from the activity of

terpenoids and limonoids, which have numerous health benefits to the human body, includes, but not limited to anti-diabetic [3], lowering blood pressure [1], anti-diarrhea [4], anti-inflammatory, anti-mutagenic [5], anti-microbial, anti-malaria [4, 6], antioxidant [7], analgesic [8], anti-tumor [9], anti-HIV activity [10], anti-dysentery, as well as alleviate anemia, malaria, chest pain, intestinal parasites, and anti-ulcer [4, 9, 11, 12]. The antibacterial activity comes from two compounds: 2-hydroxy-3-swietenolide and 2-hydroxy-3-O-tigloyl swietenoides, which both have antibacterial activities against the multidrug-resistant (MDR) bacteria [13]. Mahogany is also used to treat leishmaniasis [14] in eastern Africa and India [15].

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The leaves are largely used for medical persistence, such as antimicrobial, anti-oxidation [16], anti-dust mite [10], anti-coagulant [17], as well as non medical utilities like textile dye product [18]; whereas the bark is predominantly used as an astringent, leather softener [18], and anti-dust mite [10]. The wood part is largely used in construction, furniture, and paneling [19]. Additionally, the main component of the *Swietenia macrophylla* stem is 3-hydroxy caruilignan C, which could be used against the HIV virus while not cytotoxic to other cells [20].

2. Materials and Methods

2.1. Experimental Materials

The mahogany samples were taken from the Lianhuachi Research Center of Forestry Research Institute. The samples were classified into big-leaf, small-leaf, and middle-leaf; all drugs were purchased from Sigma-Aldrich Co., and cell culture media supplies were purchased from GIBCO and Ameresco.

2.2. Experiment Methods 1

Partition: Using solvents with opposite polarities to carry out partition, include ethyl acetate (EA), n-butanol (butanol), and water. The extracts of the sample are divided into EtOAc soluble fraction, BuOH soluble fraction, water-soluble fraction, and water-insoluble fraction.

2.3. Whitening Experimental Analysis

2.3.1. Extracellular Tyrosinase Inhibitory Activity Assay

Prepare samples with concentrations of 100, 50, 10, 5, and 1 ppm. Add the samples into a 96 well plate separately, then add 180 μ L of tyrosine solution and 1 μ L of tyrosinase into each well. Mix and place at 37 $^{\circ}$ C for an hour. Measure absorbance at 475nm using an ELISA reader. Negative control: 180 μ L tyrosine + 5 μ L tyrosinase. Positive control: 1000 μ L tyrosine.

2.3.2. Intracellular Tyrosinase Inhibitory Activity Assay

Implant cells (1×10^5 cells/ml) in a 24-well plate with 100 nM α -MSH. Incubate at 37 $^{\circ}$ C, 5% CO₂ for 24 hours. Add 45 μ L 1% Triton X-100-PBS lysed, then add 5 μ L of 2 mM L-DOPA or tyrosine. Incubate for an hour. Read OD at 492 nm and calculate the rate [21].

2.4. Quantitative Analysis of Melanin Content

Implant cells (1×10^5 cells/mL) with 100 nM α -MSH for 24

hours. Wash with PBS, freeze at -80 $^{\circ}$ C for 30 min, then room temperature for 30 min. Centrifuge at 12000 $\times$ g for 30 min, add 100 μ L of 1N NaOH at 60 $^{\circ}$ C for an hour. Measure absorbance at 405 nm [22].

3. Results

3.1. Analysis of Extracellular Tyrosinase Inhibitory Activity

The assay used mushroom tyrosinase (40 unit/mL) [23]. The legal limit of Kojic acid is 2% [24]. For safety, 200 ppm (below the cytotoxic level found by Japanese authorities) was chosen as a positive control. As shown in Figure 1, large-leaf mahoganies at 100 ppm are all greater than the inhibition rate of kojic acid (48.9%), except for hot water leaves (86.86%), EtOH (64.96%), MeOH peels (76.27% and 78.10%) and MeOH seeds (70.80%). However, at 50 and 100ppm, MeOH branches (8.03% and 3.65%), EtOH fruits (15.33% and 6.57%) and middle-leaf MeOH (8.03% and 8.76%) showed strong inhibitory rates.

As shown in Figure 2, both MeOH stones and seeds inhibited extracellular tyrosinase with butanol as the best (12.5-50 ppm: 9.12%, 8.03%, 0.73%), followed by Ethyl acetate (21.17%, 16.79%, 6.57%) and water (24.82%, 14.96%, 13.50%). Aspirin (< 4mM) cannot inhibit extracellular tyrosinase but reduces melanin content in mouse melanoma cells [25].

3.2. Effect on Viability Rate of Melanin Cells

MTT results suggest extracts are cytotoxic to B16F10 cells: crude large-leaf MeOH (67.51% and 57.15% at 50/100ppm) as shown in Figure 3, and soluble ethyl acetate (73.69%, 65.0%, 63.05% at 12.5/25/50ppm) as shown in Figure 4.

3.3. Analysis of Intracellular Tyrosinase Inhibitory Activity

Kojic acid inhibition rates were 19.36%, 36.60%, 43.36%, and 55.35% (12.5-100 ppm) as shown in Figure 5. Most large-leaf extracts inhibited cellular tyrosinase directly, with specified exceptions for branches, seeds, and small-leaf parts (rates 39.11%–87.29%). As shown in Figure 6, butanol stones (50 ppm, 39.10%), water stones (12.5-50 ppm, 50.13%, 31.42%, 25.24%), and soluble ethyl acetate/butanol seeds inhibited intracellular tyrosinase effectively.

3.4. Effect on the Content of Melanin in Cells

α -MSH stimulates melanin production [26, 27]. Kojic acid rates were 33.77%–27.94%. MeOH leaves at 100 ppm were most effective (1.26% melanin). As shown in Figure 7, small-

leaf MeOH (27.77%/23.30%) and EtOH (29.78%/27.84%) were more effective than large-leaf MeOH leaves. Large-leaf MeOH stones and seeds at 12.5-50 ppm inhibited synthesis,

with Ethyl acetate, butanol, and water performing best as shown in Figure 8.

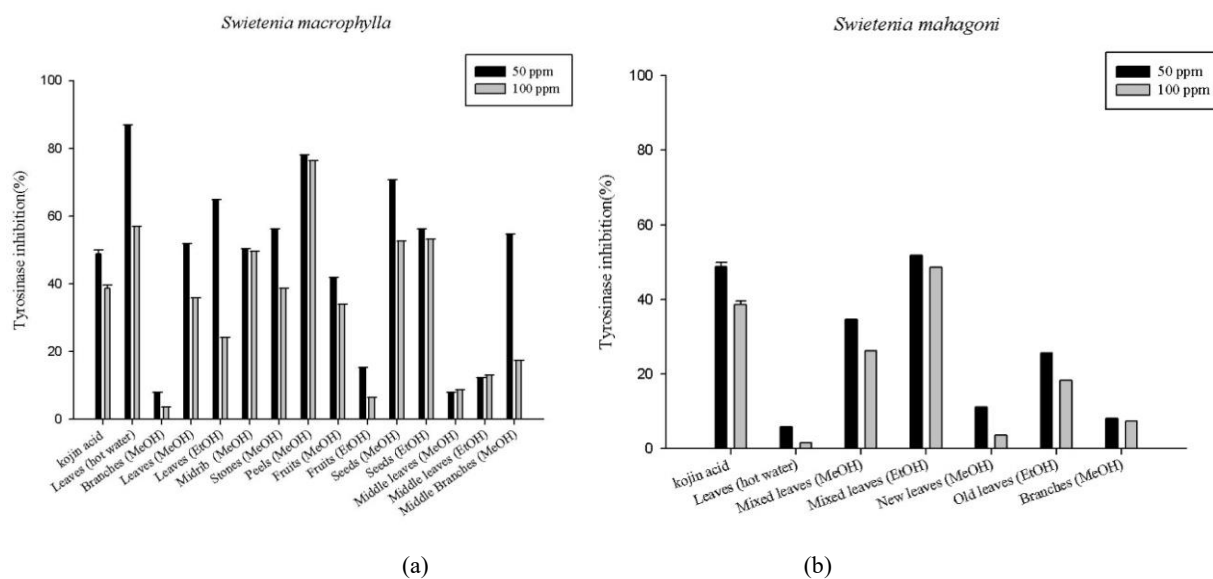


Figure 1. Analysis of the extracellular tyrosinase inhibitory activity in (a) crude large-leaf mahogany extract, and (b) crude small-leaf mahogany extract.

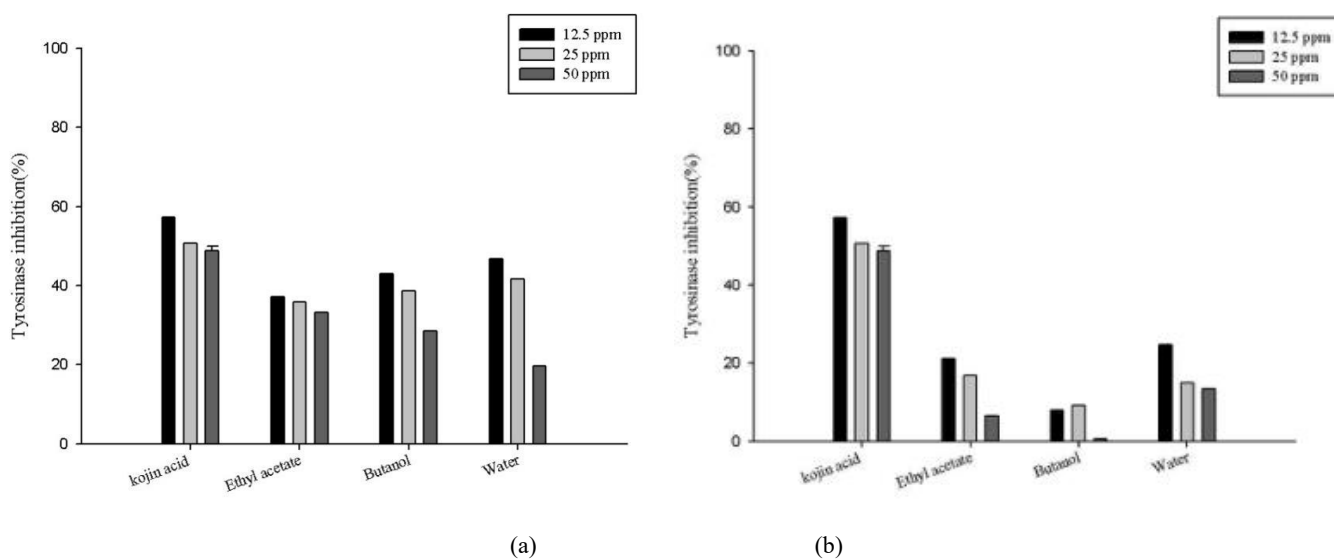


Figure 2. Analysis of the extracellular tyrosinase inhibitory activity in (a) stones and (b) seeds with different solubilities.

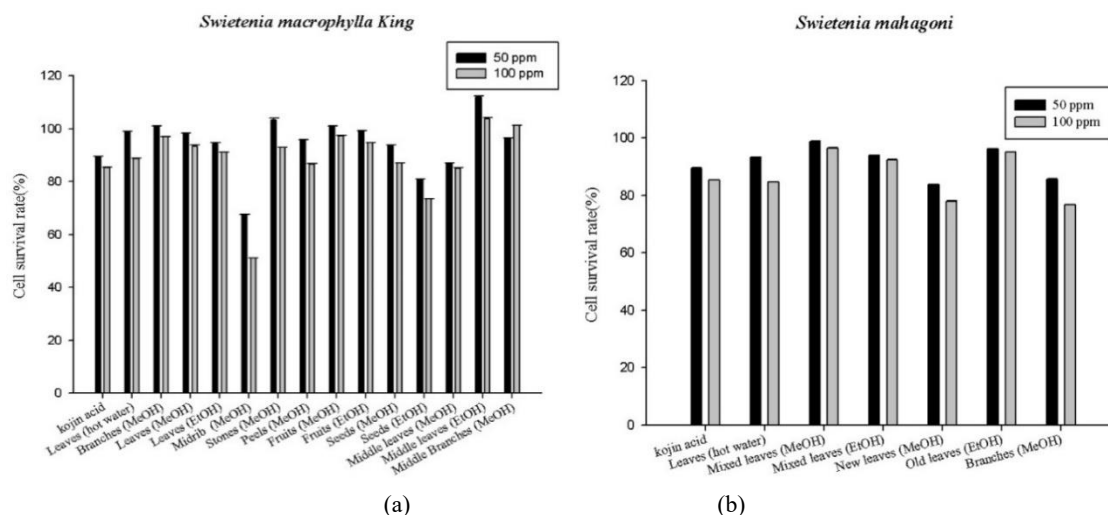


Figure 3. Viability rate of melanoma cells in different species and parts of crude mahogany extracts: (a) crude large-leaf, (b) crude small-leaf.

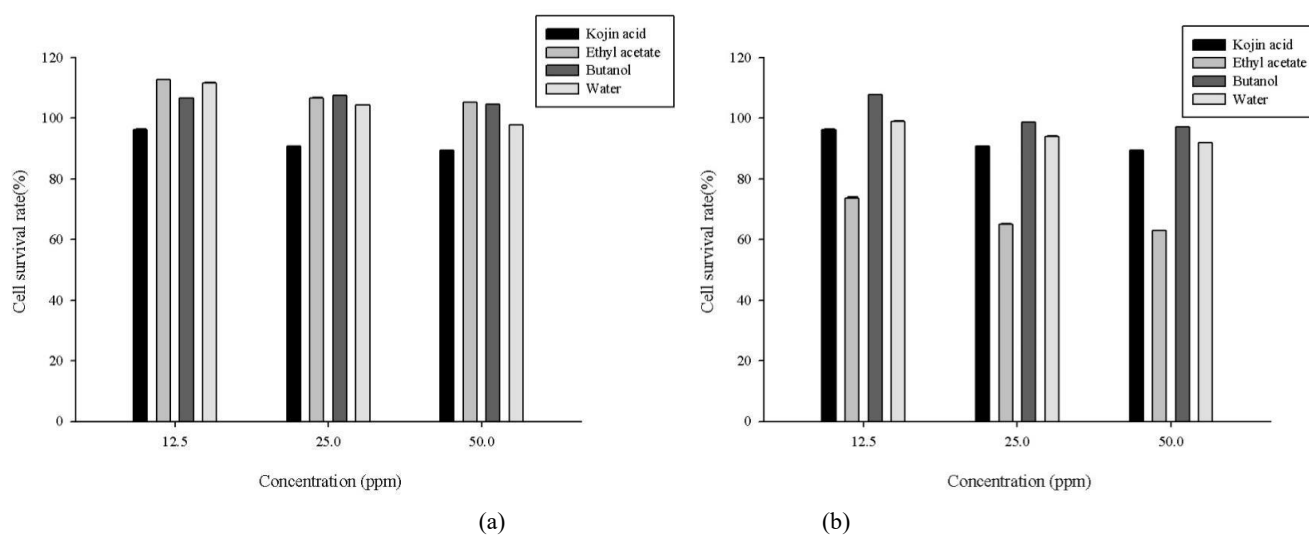


Figure 4. Viability rate of melanoma cells in (a) stones and (b) seeds with different solubilities.

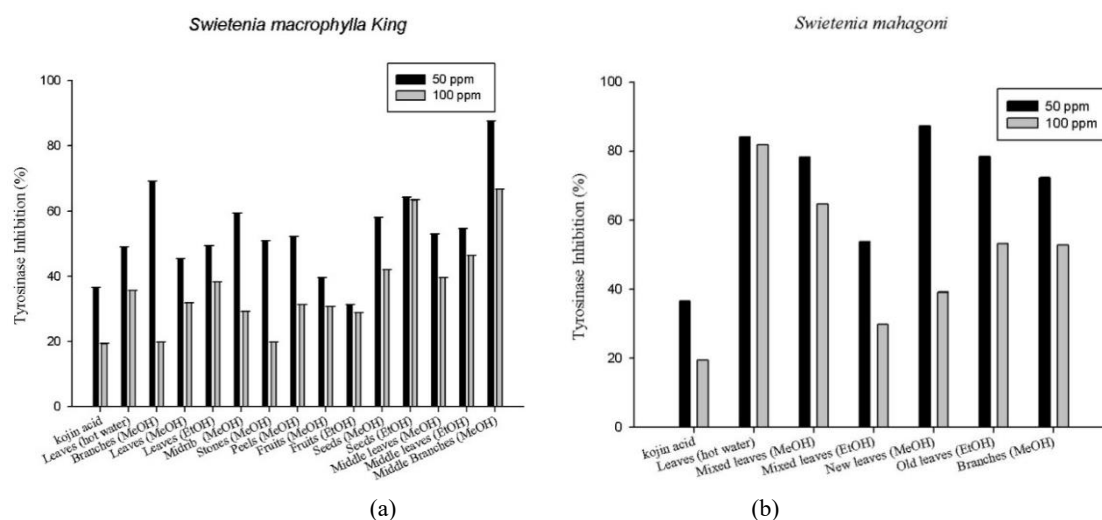


Figure 5. Intracellular tyrosinase inhibitory activity assay of crude large-leaf (a) and small-leaf (b) mahogany extracts.

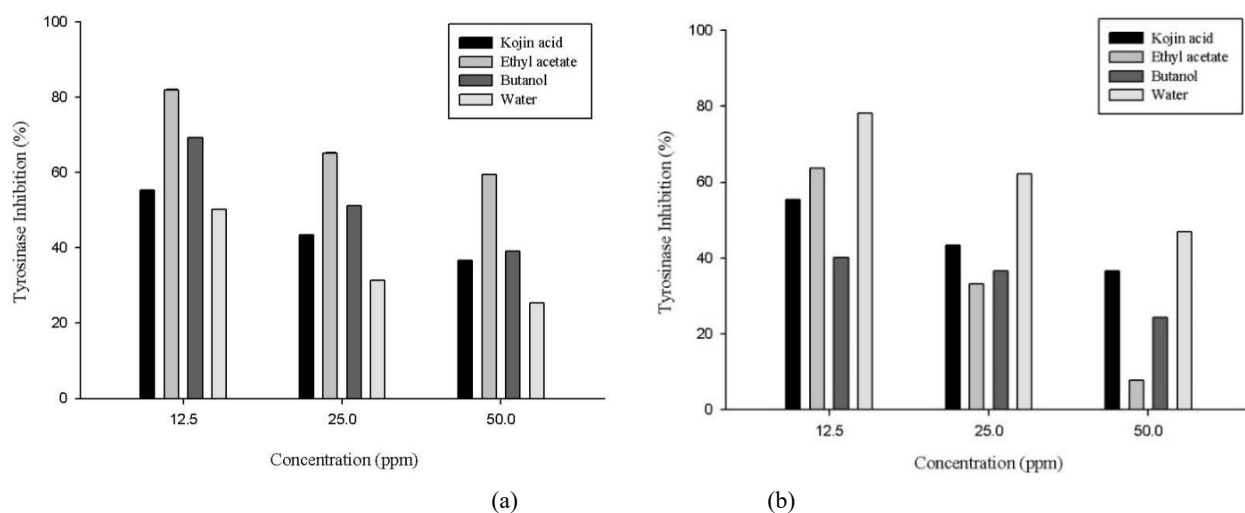


Figure 6. Intracellular tyrosinase inhibitory activity assay with different MeOHsolubilities in (a) mahogany stone and (b) seed.

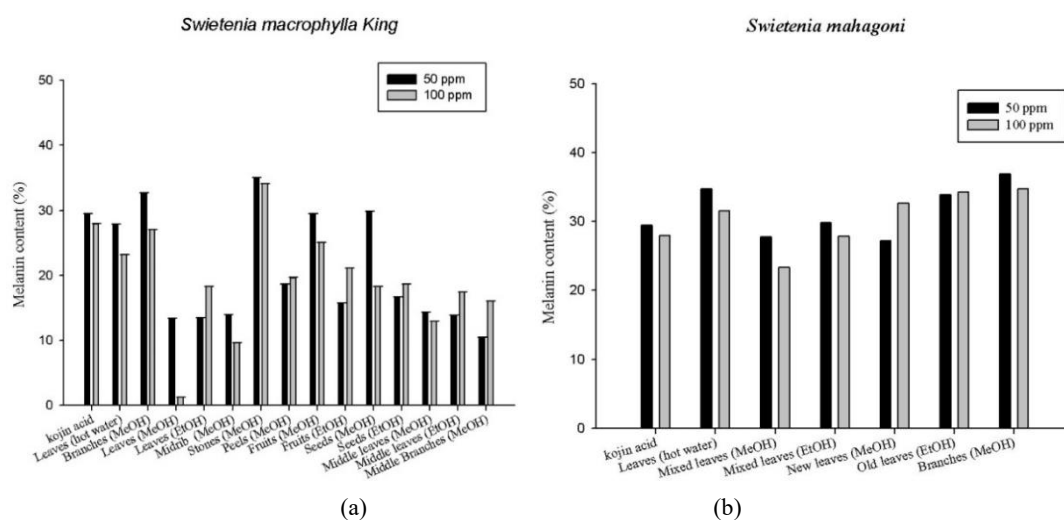


Figure 7. Intracellular melanin content assay: (a) crude large-leaf, (b) crude small-leaf mahogany extracts.

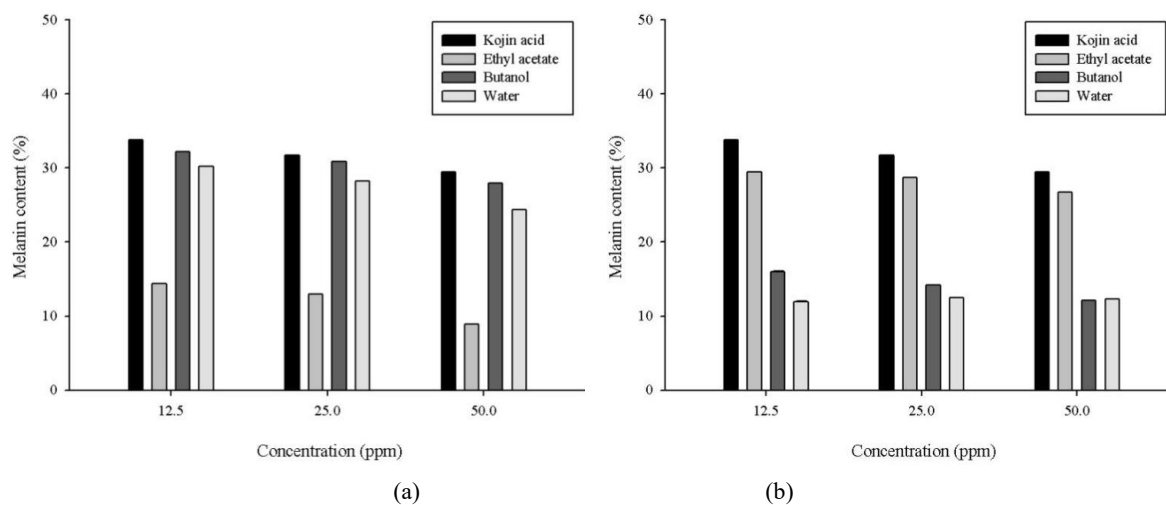


Figure 8. Intracellular melanin content assay with different MeOH solubilities in (a) mahogany stone and (b) seed.

4. Discussion

Swieteniamacrophylla seeds are traditionally used for cardiovascular diseases and diarrhea. This study found mahogany leaves have a higher antioxidant value compared to seeds [9]; while seeds have better anti-inflammatory and whitening effects.

Abbreviations

HIV	Human Immunodeficiency Virus
MDR	Multidrug Resistance
α -MSH	α -Melanocyte-Stimulating Hormone

Author Contributions

Kun-Yuan Hong: Conceptualization, Data curation, Writing – original draft, Project administration

Meng-Ling Wu: Supervision, Writing – review & editing

Hsin-Hui Wu: Methodology, Data curation, Validation

Conflicts of Interest

The authors declare no conflicts of interest.

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