Microbial resistant of building plants of *Gigantochloa apus*

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Abstract. The plant of *Gigantochloa apus*, has been traditionally used as a material for building houses, floor, roof top, fence and bamboo-crafts. In practice, beside the strength and elasticity, stability towards microbial also becomes an important consideration. This paper reports the chemical composition of the *Gigantochloa apus* and its resistance to bacterial growth. It was found that *Gigantochloa apus* contained alkaloids and phenolic tannins which are predicted to deter microbes. The ability to resist bacterial growth was evaluated in two common model microbes; i.e. *Escherichia coli* and *Staphylococcus aureus*. The chemicals afforded from *Gigantochloa apus* have capability to inhibit bacterial growth eight times stronger than the reference compound.

1. Introduction

Plant species of *Gigantochloa apus* have been widely used by locals for building houses [1, 2] over several decades such as for particle board materials [3, 4], and furniture [5]. Recently, many handcraft products [4–6] were also developed and marketed by using *Gigantochloa apus* as the main material (Fig 1). *Gigantochloa apus* material composed of cellulose which is responsible for the strength and elasticity of its products [1, 2, 7, 8]. However, other chemicals also exist in the *Gigantochloa apus* which are known to be responsible for its stability and durability [9–11] towards microbial decomposition [12]. Many reports have indicated that secondary metabolites contained in the *Gigantochloa apus* are responsible for this property [13, 14]. So far, many strategies have been developed to improve this activity [15–17]. Other species of *Gigantochloa apus* have been reported for their activity in different extraction solvents and conditions [14]. Phenolics [14], saponins, tannins and alkaloids from secondary metabolite groups [11, 12, 18] were detected in the extract. This paper reveals chemicals composition in the *Gigantochloa apus* that are responsible for the capability to inhibit decomposition by microbial.

2. Experimental procedure

2.1. Extract preparation

The *Gigantochloa apus* is determined as *Gigantochloa apus* (Schult.) Kurz in UPT Herbal Laboratory of Materia Medica Batu, Indonesia. The sample was bought from a local market in Batu as a young shoot. It was further dried in oven and then powdered. The extraction was done using a fast pressurized solvent extraction (Buchi, Switzerland) in ethanol. A 5 g of sample was extracted with a 25 mL of ethanol 96%. Preheating at 60 °C was conducted and repeated in three cycles to afford the ethanol solution of the extract. It was further concentrated under reduced pressure using a rotary evaporator (Buchi, Switzerland). The dried extract was obtained as a brown-semi solid extract. Several
concentrations were also prepared from 50 mg/mL of stock solution of the dried extract into 1.25 mg/mL, 2.5 mg/mL and 5.0 mg/mL.

2.2. Chemical analysis
The procedure to analyze the chemicals composed of the extract of *Gigantochloa apus* was derived from a reference reported by [19].

2.2.1. Flavonoid analysis. The dried extract was dissolved in distilled water and a 1.0 mL of sample was heated for 5 minutes. A 10 mg of magnesium was added followed by dropwise addition of 38% hydrochloric acid solution. The positive flavonoid was detected due to change of color in the solution from orange to red.

2.2.2. Alkaloid analysis. The dried extract was dissolved in distilled water. A 1.0 mL of sample in a reaction tube was added with Meyer reagent. The different tubes were also prepared and added with Dragendorf reagent and Bouchard reagent. The formation of precipitate indicated alkaloid presence in the sample.

2.2.3. Saponin analysis. The dried extract was dissolved in distilled water. A 1.0 mL of sample in reaction tube was added with 1.0 mL of hot water and 3 drops of 35% hydrochloric acid solution. The formation of stable foam indicated the presence of triterpenoid saponin.

2.2.4. Tannin analysis. The dried extract was dissolved in distilled water. A 1.0 mL of sample was heated for 5 minutes and a 1.0% of iron(III) chloride solution was added. The change of color to greenish brown or blackish blue indicated the presence of tannin.

2.3. Microbial-growth inhibition evaluation
Growth inhibition of the extract was analyzed following the Kirby-Bauer disk diffusion susceptibility test [20]. Bacteria species of *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923 were used as model. The paper disk was immersed in the extract sample (concentration 1.25 mg/mL; 2.5 mg/mL and 5.0 mg/mL), gentamicin 40 mg/mL, and sterilized water. Then, the disks were placed into inoculated bacteria. Further incubation was conducted at 37 °C for 2 x 24 hours. The growth inhibition activity was determined from the clear zones around the paper disk.

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**Figure 1.** Materials characteristic of *Gigantochloa apus* for handicrafts.
3. Results and discussion

3.1. Chemical analysis
Cellulose and lignin are found as the main chemicals of *Gigantchloa apus*. Both chemicals were identified from the fresh and dried samples (Table 1). They are also used as the main backbone for preparing handcraft product materials. The other organic extract (4.64-4.88%) was isolated from ethanol/toluene as solvent [21].

| Sample condition | Cellulose (%) [21] | Lignin (%) [21] | Organic extract (%) [21] |
|------------------|-------------------|----------------|-------------------------|
| Dried            | 72.65             | 22.71          | 4.64                    |
| Fresh            | 69.73             | 25.39          | 4.88                    |

Table 1. Chemical composition of *Gigantochloa apus*.

Secondary metabolite | Leaf [22] | Dried [12] | This study |
----------------------|-----------|------------|------------|
Flavonoid             | -         | -          | -          |
Alkaloid              | +         | -          | +          |
Saponin               | +         | -          | -          |
Tannin                | -         | +          | +          |
Terpenoid             | +         | -          | -          |

Identification of the composition of the organic extract was previously reported to contain alkaloid and saponin in the leaf [22]. Meanwhile, tannin is detected from the dried sample [12]. Our investigation found alkaloid and tannin as the main chemical composition of the organic extract (Fig. 2). These compounds are predicted to be responsible for stabilizing the materials of *Gigantochloa apus* against destruction by microbes.

3.2. Bacterial growth inhibition evaluation
The Kirby-Bauer method is applied to analyze activity of chemicals composed in the *Gigantochloa apus*. In all concentrations, the extract is active for decrease in bacterial development. The activity is higher than gentamicin in both bacterial models, *Escherichia coli* and *Staphylococcus aureus* (Table 2).
Table 2. Growth inhibition activity of chemicals from *Gigantochloa apus*.

| Evaluated sample                  | Bacterial growth inhibition capability (mm) |
|-----------------------------------|--------------------------------------------|
|                                   | *E. coli* | *S. aureus* |
| Control (water)                   | 0         | 0           |
| *G. apus* extract (1.25 mg/mL)    | 1.71      | 7.72        |
| *G. apus* extract (2.50 mg/mL)    | 2.45      | 8.60        |
| *G. apus* extract (5.00 mg/mL)    | 3.94      | 10.52       |
| Gentamicin (40.0 mg/mL)           | 2.58      | 6.00        |

The visual appearance for bacterial growth inhibition is shown in Fig 3. The extract concentration of 5.0 mg/mL shows a wider and clear zone around the paper disk. The bacteria are inhibited from growing in this zone.

![Figure 3](image)

**Figure 3.** Photograph growth inhibition of *Gigantochloa apus* extract in *Staphylococcus aureus* (A) and *Escherichia coli* (B). Control only contain water (5) and sample in variation concentration (1-3), and gentamicin (4).

4. Conclusion

The *Gigantochloa apus* contains cellulose and lignin as main chemicals with the minor organic extract composed of alkaloids and tannins. These compounds belong to the class of secondary metabolites. They are predicted to be responsible for the stability and ability to inhibit the deterioration of *Gigantochloa apus*-based materials for handicraft.

References

[1] Lee, C. H., Chung, M. J., Lin, C. H., and Yang, T.H. (2012). Effects of layered structure on the physical and mechanical properties of laminated moso bamboo (Phyllosachys edulis) flooring. *Construction and Building Materials, 28*(1), 31–35.

[2] Nugroho, N., and Bahtiar, E. T. (2017). Structural grading of Gigantochloa apus bamboo based on its flexural properties. *Construction and Building Materials, 157*, 1173–1189.

[3] Qisheng, Z., Shenxue, J., and Yongyu, T. (2002). Industrial utilization on bamboo. International network for bamboo and rattan.

[4] Sujarwo, W., and Keim, A. P. (2017). Ethnobotanical Study of Traditional Building Materials from the Island of Bali, Indonesia. *Economic Botany, 71*(3), 224–240.

[5] Sofiana, Y., Sylvia, C. O., and Purbasari, M. (2017). Potential of bamboo as material for furniture in rural area in Indonesia. *Advanced Science Letters, 23*(1), 263–266.

[6] Borah, E. D., Pathak, K., Deka, B., Neog, D., and Borah, K. (2006). Utilization aspects of Bamboo and its market value. *The Indian Forester, 423–427.*
[7] Sugesty, S., Kardiansyah, T., and Hardiani, H. (2015). Bamboo as raw materials for dissolving pulp with environmental friendly technology for rayon fiber. Procedia Chemistry, 17, 194–199.

[8] Iswanto, A. (2018). Oriented particleboard made from tali bamboo (Gigantochloa Apus): effect of particle length on physical and mechanical properties (Vol. 309, p. 012038). Presented at the IOP Conference Series: Materials Science and Engineering, IOP Publishing.

[9] Suprapti, S. (2010). Decay resistance of five Indonesian bamboo species against fungi. Journal of Tropical Forest Science, 22(3), 287–294.

[10] Subekti, N., Widiyaningrum, P., Yoshimura, T., and Fibriana, F. (2018). The strength and termite resistance characteristics of fiberboards produced from the renewable bamboo biomass. Wood research, 63(3), 409–418.

[11] Subekti, N., Yoshimura, T., Rokhman, F., and Mastur, Z. (2015). Potential for Subterranean Termite Attack against Five Bamboo Species in Correlation with Chemical Components. Procedia Environmental Sciences, 28, 783–788.

[12] Santoso, A., Hadi, Y. S., and Malik, J. (2012). Tannin resorcinol formaldehyde as potential glue for the manufacture of plybamboo. Indonesian Journal of Forestry Research, 9(1), 10–15.

[13] Scheffer, T. C. (1966). Natural resistance of wood to microbial deterioration. Annual review of Phytopathology, 4(1), 147–168.

[14] Mori, Y., Kuwano, Y., Tomokiyo, S., Kuroyanagi, N., and Odahara, K. (2019). Inhibitory effects of Moso bamboo (Phyllostachys heterocycla f. pubescens) extracts on phytopathogenic bacterial and fungal growth. Wood Science and Technology, 53(1), 135–150.

[15] Masruri, M., Baihaqi, M. A., Riyanto, S., and Srihardyastutie, A. (2017). Improving antibacterial activity of Spathodea campanulata Beauv’s water extract with copper nanoparticle on Staphylococcus aureus (Vol. 1823, p. 020015). Presented at the AIP Conference Proceedings, AIP Publishing.

[16] Azkiya, N., Masruri, M., and Ulfā, S. (2018). Green Synthesis of Silver Nanoparticles using Extract of Pinus merkusii Jungh and De Vriese Cone Flower (Vol. 299, p. 012070). Presented at the IOP Conference Series: Materials Science and Engineering, IOP Publishing.

[17] Masruri, M., Pangestin, D. N., Ulfā, S. M., Riyanto, S., Srihardyastutie, A., and Rahman, M. F. (2018). A Potent Staphylococcus Aureus Growth Inhibitor of A Dried Flower Extract Of Pinus Merkusii Jungh and De Vriese And Copper Nanoparticle (Vol. 299, p. 012072). Presented at the IOP Conference Series: Materials Science and Engineering, IOP Publishing.

[18] Mulyono, N., Lay, B. W., Rahayu, S., and Yaprianti, I. (2012). Antibacterial activity of petung bamboo (Dendrocalamus asper) leaf extract against pathogenic Escherichia coli and their chemical identification. International Journal of Pharmaceutical Biological Archive, 3(4), 770–778.

[19] Harborne, A. (1998). Phytochemical methods a guide to modern techniques of plant analysis. springer science and business media, Germany.

[20] Biemer, J. J. (1973). Antimicrobial susceptibility testing by the Kirby-Bauer disc diffusion method. Annals of Clinical and Laboratory Science, 3(2), 135–140.

[21] Widyorini, R., Umemura, K., Isnan, R., Putra, D. R., Awaludin, A., and Prayitno, T. A. (2016). Manufacture and properties of citric acid-bonded particleboard made from bamboo materials. European journal of wood and wood products, 74(1), 57–65.

[22] Supriyatin, S. R., and Sukmawati, D. (2014). Phytochemical analysis of manggong bamboo leaf extract. Presented at the Proceeding of International Conference on Research, Implementation and Education. B-165.