The potential of *Macaranga* plants as skincare cosmetic ingredients: A review

Enih Rosamah1, Muhammad Taufiq Haqiqi1 Agmi Sinta Putri1, Harlinda Kuspradini1, Irawan Wijaya Kusuma1, Rudianto Amirta1, Yuliansyah Yuliansyah1, Wiwin Suwinarti1, Swandari Paramita2, Rico Ramadhan3, Didi Tarmadi4, Maya Ismayati5, Harits Atika Ariyanta5, Widyas Patriasari5, Aswandi Aswandi5, Cut Rizlani Kholibrina5, Nur Izyan Wan Azelee6, Yong-unh Kim7, Enos Tangke Arung1*

1Faculty of Forestry, Mulawarman University, Samarinda, Indonesia.
2Faculty of Medicine, Mulawarman University, Samarinda, Indonesia.
3Department of Chemistry, Faculty of Science and Technology, Airlangga University, Surabaya, Indonesia.
5Research Center for Biomass and Bioproducts, National Research and Innovation Agency, Bogor, Indonesia.
6Institute of Bioproduct Development (IBD), Universiti Teknologi Malaysia, UTM Skudai, Johor, Malaysia.
7Department of Pharmaceutical Engineering, College of Cosmetics and Pharmaceuticals, Daegu Haany University, Gyeongsangbuk-do, South Korea.

ARTICLE INFO

Received on: 04/12/2022
Accepted on: 11/04/2023
Available Online: 04/07/2023

Key words: Cosmetics, fast-growing plant, industrial product, *Macaranga*, skincare.

ABSTRACT

The application of bioactive ingredients extracted from plants utilized as additives in various cosmetic products has gained popularity, since they are safe, with low adverse effects when applied properly, and are environmentally friendly. Moreover, the awareness of healthier cosmetic products has rapidly increased so that the exploration of screened plants with appropriate properties has attracted significant attention worldwide. This review discusses the potential of one of the fastest-growing tropical plants, *Macaranga*, applied in skincare cosmetics. Their interesting characteristics, such as being anti-inflammatory, antioxidant, and antimicrobial, and their tyrosinase inhibitory effect have been comprehensively summarized. Various scientific literature works have further proven ethnopharmacological studies that explore the traditional use of *Macaranga* species by local people in the tropics for medicinal and skincare purposes. Therefore, we believe this will allow *Macaranga* to become a promising material in the future for large-scale industrial skincare cosmetics.

INTRODUCTION

The largest organ on the outside of the human body, the skin, is a barrier to shield interior organs from dehydration, microbial infection, and UV exposure. Besides these important functions, it is well known that a better skin appearance is also responsible for an individual’s awareness of looking more beautiful. Hence, various companies have attempted to pursue improving their innovative products in skincare cosmetics. The business sector in this area has been recognized as one of the most promising ones, with an annual revenue worth of billions of dollars (Kouassi et al., 2022). Currently, a phenomenon in healthy lifestyles contributes to shifting from synthetic skincare cosmetics to green ones, since synthetic materials reportedly have harmful side effects, such as low absorption ability and allergic reactions (irritation) (Morais et al., 2021). A previous study also indicated their negative influences on the environment (Amberg and Fogarassi, 2019). On the other hand, green technology offers several advantages, including safety, nontoxicity, having no adverse effects when used correctly, and biodegradability. These products are generally fabricated by incorporating bioactive compounds obtained from plants.

*Corresponding Author
Enos Tangke Arung, Faculty of Forestry, Mulawarman University, Samarinda, Indonesia.
E-mail: tangkearung@yahoo.com

© 2023 Enih Rosamah et al. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/).
Therefore, this trend motivates scientists worldwide to explore plant materials with appropriate properties, particularly those used in skincare cosmetics.

Euphorbiaceae is considered to be one of the largest families among flowering plants, with 218 genera and 5,735 species (Zixi et al., 2016). According to ethnobotanical studies, most plants in this family are frequently utilized in local medicine and skincare (Zahidin et al., 2017). Macaranga is a genus of Euphorbiaceae, which consists of more than 300 species, and it is widely distributed across tropical and subtropical countries in Africa, Asia, Australasia, and the Pacific (Huonga et al., 2019). Nevertheless, its distribution center has been recorded in tropical Asia (Syah and Ghisalberti, 2015). This fast-growing tree species, also known as the highest genus in the Euphorbiaceae, can be found in gaps between the forest canopy, disturbed forests, and open areas (Tanjung et al., 2018). Due to the change in light conditions after logging activities or forest fires, some Macaranga species are usually found with high dominance as pioneer species. The presence of Macaranga can be a reliable bioindicator of deforestation (Zapanta et al., 2019). Its rapid growth has been recorded to significantly influence the composition of the forest vegetation community during the secondary succession stage (Susanto et al., 2018). In Indonesia, its wide distribution has been found in Sumatera and on Kalimantan Island (Tanjung et al., 2018).

Considering its ability to cover land quickly and attract wildlife, it is also becoming popular as a species to promote revegetation after coal mining in this country (Amirta and Candra, 2016). The leaves of several species from this genus are often utilized in traditional medicine and have the potential for use as antipyretics, antitussives, and anti-inflammatories (Pailee et al., 2015). Due to its good adaptation to various types of land, even with low available nutrient status, combined with its interesting properties, further domestication of Macaranga will allow the use of these plant species in various applications, including sustainable raw materials for additives in skincare production.

Nowadays, the practice of using direct herbal products for skincare purposes has been declining, since various modern skincare products containing bioactive ingredients with simpler usage have been introduced to the market (Milito et al., 2021). As a result, valuable information about crude extraction and isolated compounds, including those obtained from Macaranga, will need to be collected, as several authors have reported its remarkable bioactivity (Di et al., 2020; Hashim et al., 2022; Minarti et al., 2021). This review presents a comprehensive summary of the chemical and pharmacological studies on Macaranga spp. in terms of their suitability for use as skincare cosmetic products. Furthermore, the range of their potential application in large-scale industrial skincare products is also considered.

**METHODOLOGY**

The current review was conducted based on a number of publications, specifically, plant extracts and bioactive constituents of various Macaranga plants, which can be used as skincare cosmetic ingredients. Other potential applications of Macaranga’s bioactive constituents are also presented. There is no limitation on the year of publication. Exhaustive searches were performed on four electronic databases: PubMed, ScienceDirect, Scopus, and Google Scholar. Various keywords, such as Macaranga plant, Macaranga genus and species, chemical compounds of Macaranga, bioactivity of Macaranga, anti-inflammatory activity, antioxidant activity, antimicrobial activity, and antityrosinase activity, were employed to find appropriate data and articles.

**Bioactive constituents of Macaranga plants**

An earlier work summarized the chemical investigations of 25 species of Macaranga (Magadula, 2014). In this study, the phytochemical characterization has been updated to include 40 species. They are identified as M. adenantha, M. allorobinsonii, M. alnifolia, M. balansae, M. barteri, M. bicolour, M. conglomererata, M. confiera, M. constricta, M. deheiculata, M. denticulata, M. gigantea, M. giganitifolia, M. hemsleyana, M. heyrei, M. hosei, M. hurfolia, M. hypoleuca, M. indica, M. javanica, M. kurzii, M. lowii, M. magna, M. mappa, M. monandra, M. peltata, M. pleiostemona, M. pruinosa, M. pustulata, M. recurvata, M. rhizoides, M. rubiginosa, M. sampsonii, M. schweinfurthii, M. siamensis, M. sinensis, M. tanarius, M. trichocarpa, M. triloba, and M. vedeliana. This list reveals, however, that only a small percentage of species (less than 15%) have been further chemically investigated, despite the fact that there are more than 300 species of Macaranga available in the world.

Each plant species is distinctive regarding its bioactive constituents. Based on the previous study by Mai et al. (2020), it has been discovered that some Macaranga species are rich in phenolic compounds, particularly flavonoid and stilbene derivatives. Yang et al. (2015a, 2015b) reported the presence of two novel stilbenes, denticulatains A and B, and flavonoid derivatives, including denticulatain C, D, and E from M. denticulata fronds. C-methylated and isoprenylated chalcone derivatives, denticulalcones A, B, and C, were also discovered in related species. According to Pailee et al. (2015), macasiamenenes A-U, macasiamenin A, macasiamenone A, and macasiamenols A and B, were isolated from M. siamensis leaves and twigs. Furthermore, secondary metabolites in the class of tannins, terpenes, coumarins, steroids, and many other compounds were also detected. The most prevalent of these is scopoletin, a coumarins that is present in six different species of Macaranga: M. barteri, M. conglomererata, M. denticulata, M. kurzii, M. magna, and M. triloba. The number of compounds isolated from M. tanarius has been reported as the highest, with 98 compounds collected from its leaves, stem bark, and fruits. Mostly, the compounds in Macaranga are stilbenes and flavonoids, as shown in Figure 1. A list of all summarized constituents is presented in Table 1.

**Application of Macaranga in cosmetics**

**Anti-inflammatory activity**

Inflammation is the response of body to any kind of disturbance caused by irritation, injury, or bacteria. Anti-inflammatory products work by blocking the body response to this skin disorder by inhibiting the effects of certain enzymes that contribute to swelling and inflammation (Attiq et al., 2018). In terms of both skin appearance and health, dealing with inflammation is a major issue. Preventing the impact of skin inflammation is essential for a youthful appearance and avoiding the development of chronic or acute skin diseases.
In general, anti-inflammatory skincare products contain antioxidants, which help the body fight damaging free radicals. Antioxidants prevent collagen breakdown and skin DNA damage (Lin et al., 2018). An earlier study found that dichloromethane extracts of *M. siamensis* leaves and twigs had a strong anti-inflammatory effect, with Macasiamenene F isolated from these extracts reducing tumor necrosis factor (TNF) alpha by 20% after 24 hours (Leláková et al., 2020). *M. barteri* methanol extract had a strong anti-inflammatory effect with potential compounds such as macabarterin, 3-O-methylellagic acid, 4-O-b-D-xylopyranoside, ellagic acid, 3-O-methylellagic acid, and gallic acid (Ngoumfo et al., 2008). Moreover, an assay on rats with carrageenan-induced edema showed that hydroalcoholic *M. barteri* bark extract reduced inflammation and skin hyperalgesia. This report also confirmed the traditional application of *M. barteri*’s bark to treat pain and inflammation, acting as an analgesic (Asante-Kwatia et al., 2019). *M. tanarius* demonstrated high inhibition of protein (albumin) denaturation with IC$_{50}$ values of 0.26–1.02 mm with some bioactive compounds such as nymphaeol A, nymphaeol B, nymphaeol C, isonymphaeol B, and 3’-geranyl-naringenin (Shahinozzaman et al., 2021). Nymphaeol B of this species strongly inhibits acetylcholinesterase (Ache) at 50 µg/ml (Amir Rawa et al., 2022). Another study reported that *M. hurifolia* extract from Nigeria has an inflammatory effect (69.6%) at a dose of 300 mg/kg (Segun et al., 2019a).

**Antioxidant activity**

Natural antioxidants are used in the cosmetics industry for their capacity to reduce oxidative stress on the skin and protect products from oxidative deterioration (He et al., 2021; Hoang et al., 2021). Due to the natural aging process as well as extrinsic causes including UV radiation, air pollution, and pathogenic microorganisms, oxidative stress is the main factor accelerating skin aging (Farage et al., 2008; Rees, 2004). Antioxidant molecules prevent radical chain reactions, which inhibit reactive oxidants’ formation; as a result, they can also be used to cure cancer. In cosmetic products, including serums and creams, antioxidants can be employed to stabilize ingredients and prevent the rancidity of...
<table>
<thead>
<tr>
<th>No.</th>
<th>Plant species</th>
<th>Location</th>
<th>Plant part</th>
<th>Constituents</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>M. adenantha</em></td>
<td>China</td>
<td>Twigs</td>
<td>Macadenanthin A, macadenanthin B, macadenanthin C, glyasperin A, broussoflavonol F, and macarangin</td>
<td>Yang et al. (2015c)</td>
</tr>
<tr>
<td>2</td>
<td><em>M. allorobinsonii</em></td>
<td>Indonesia</td>
<td>Leaves</td>
<td>Gallic acid, and methyl gallate</td>
<td>Darmawan et al. (2012)</td>
</tr>
<tr>
<td>4</td>
<td><em>M. balansae</em></td>
<td>Vietnam</td>
<td>Fruit</td>
<td>4'-methyl-8-prenyltaxifolin, 6,8-diprenyl-4'-methyl-naringenin, and 4'</td>
<td>Mai et al. (2020)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cameroon</td>
<td>Stem bark</td>
<td>Macabarterin, scopoletin, 3-O-methyllellagic acid 4-O-β-D-xylopyranoside, Ellagic acid, 3-O-Methyllellagic acid, Gallic acid, and Methyl gallate</td>
<td>Ngoumfo et al. (2008)</td>
</tr>
<tr>
<td>5</td>
<td><em>M. barteri</em></td>
<td>Nigeria</td>
<td>Leaves</td>
<td>Benzamide, 2,2-Bis(4-nitrobenzyl)-1-phenylbutane-1,3-dione, 2-Acetophenone, 1,2,3-Trimethylbenzene, 1,2-Diacetoxypropane, 3-Hydroxy-1-phenyl-4-hexen-1-one, Methyl vinyl carbinol, 2-Hydroxyl-3-methylfur, acetyl tetrahydrofuran, isopropenyl dodecanoate, 2-hydroxy-2-methyl propanoic acid, undecane, Caryophyllene, aromadendrene, a-humulene, 3-Hydroxy-4(3H)-quinolinone, Caryophylla-2,6-dien-5-one, Germaenene B, Germaene D, nerolidol, Spalthelenol, tetradecane, b-elemene, N-acetylbamidam, a-Linalool-2-penten-4-one, Caryophyllene oxide, N-phenylacrylamide, 2,12-Epoxycaryophyll-5-ene, 4-Methyl-1,3-oxathiolone, Methyl ethyl carbol, n-octodecane, Neophytadiene, Citronellyl propionate, trans-Phytol, 4-Methylpentanoic acid, n-Hexadecanoic acid, 2-Hexyl-2-decanal, Ethyl ester hexadecanoic acid, n-docosane, Citronellyl butyrate, cycloedecene, 2,5,8-Heptadecatren-1-1, dodecanedialdehyde, 9,12,15-Octadecatrien-1-ol, Ethyl Hept-6-enoate, 2-Keto-butry-acid, Pentadecan-1,1-Aza-4-thiopentane, 2-Ethoxycarbonyloxy-1-phenyl-2-nonen, mappain, vedelianin, schweinfurth H</td>
<td>Ogundajo et al. (2017); Segun et al. (2019a); Segun et al. (2021)</td>
</tr>
<tr>
<td>6</td>
<td><em>M. bicolour</em></td>
<td>Philippines</td>
<td>Leaves</td>
<td>(2S)-5,7-Dihydroxy-4'-methoxy-8-(3''-methylbut-2''-enyl) flavanone, (2S)-5,7,4'-Trihydroxy-8-(3''-methylbut-2''-enyl) flavanone, and (2S)-5,7,4'-Trihydroxy-6,8-(3'',8''-dimethyl-2''-dienyl) flavanone</td>
<td>Versian et al. (2011)</td>
</tr>
<tr>
<td>7</td>
<td><em>M. conglomerata</em></td>
<td>Kenya</td>
<td>Stem bark</td>
<td>-dimethoxy ellagic acid</td>
<td>Hashim et al. (2022)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-acetylaleuritolic acid, 2a-hydroxyaleuritolic acid-3-p-hydroxybenzoate, and scopoletin</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td><em>M. conifera</em></td>
<td>Indonesia and China</td>
<td>Leaves</td>
<td>5-Hydroxy-4'-methoxy-2''-2''-dimethoxy-3'-methylbutylpyran-(7,8,6'') flavanone, 5,4'-Dihydroxy-[2''-(1-hydroxy-1-methyl) dihydrofururan]-[7,8,5',4'] flavanone, 5,7-Dihydroxy-4'-methoxy-8-(3-methylbut-2'-enyl) flavanone, Lonchocarpol</td>
<td>Jang et al. (2004); Versian et al. (2011)</td>
</tr>
<tr>
<td>9</td>
<td><em>M. constricta</em></td>
<td>Malaysia</td>
<td>Leaves</td>
<td>Taraxerone, taraxerol, and β-amyrin</td>
<td>Salleh et al. (2017)</td>
</tr>
<tr>
<td>No.</td>
<td>Plant species</td>
<td>Location</td>
<td>Plant part</td>
<td>Constituents</td>
<td>Sources</td>
</tr>
<tr>
<td>-----</td>
<td>---------------</td>
<td>----------</td>
<td>------------</td>
<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>11</td>
<td><em>M. denticulata</em></td>
<td>Vietnam</td>
<td>Fruit</td>
<td>6-(8'-hydroxy-3',8'-trimethyl-oct-2'-enyl)-kaempferol, 3'-dehydro-solpholinenol C, denticulatadin B, bonannione A, diplacol, macarangin, 3-O-methylmacarangin, 5,7,3',4'-tetrahydroxy-3-methoxy-6-geranylflavone, 3,5,7,3',4'-pentahydroxy-6-geranylflavonol, macarhizinoidin A, robipseudin A, denticulatadin E, 8-dimethylallylisosakuranetin, 4'-deprenylmappain, deheiculatin H, poilaneic acid, derivative phaseic acid, taraxerone, and epitaraxerol</td>
<td>Le et al. (2021)</td>
</tr>
<tr>
<td>12</td>
<td><em>M. gigantea</em></td>
<td>Indonesia</td>
<td>Leaves</td>
<td>Macdentichalcone, scopoletin, macarangin, 3-O-methylmacarangin, denticulaflavonol, sophoraflavanone B</td>
<td>Suthivaiyakit (2002); Lei et al. (2016)</td>
</tr>
<tr>
<td>13</td>
<td><em>M. gigantifolia</em></td>
<td>Indonesia</td>
<td>Leaves</td>
<td>5,7-dihydroxycoumarin</td>
<td>Tanjung et al. (2009)</td>
</tr>
<tr>
<td>14</td>
<td><em>M. hemsleyana</em></td>
<td>China</td>
<td>Fronds</td>
<td>3[1]-O-acetyl aleuritolic acid, canophyllol, β-Sitosterol, Stigmast-4-en-3-one, and Stigmast-4-en-3,6-dione</td>
<td>Wang et al. (2008)</td>
</tr>
<tr>
<td>15</td>
<td><em>M. heynei</em></td>
<td>Malaysia</td>
<td>Leaves</td>
<td>Macagigantin, Glyasperin A, and Apigenin</td>
<td>Darmawan et al. (2012)</td>
</tr>
<tr>
<td>16</td>
<td><em>M. hosei</em></td>
<td>Malaysia and Indonesia</td>
<td>Leaves</td>
<td>Lupenone, β-sitostenone, 5-hydroxy-7,4'-dimethoxyflavone, 5-hydroxy-6,7,4'-trimethoxyflavone, 4'-O-methyl-8-isoprenyl eriodictyol, and 6-isoprenyl eriodictyol</td>
<td>Salleh et al. (2017); Marliana et al. (2018a)</td>
</tr>
<tr>
<td>17</td>
<td><em>M. hurfroja</em></td>
<td>Cameroon</td>
<td>Fruit</td>
<td>Macaflavone I and macaflavones B</td>
<td>Pagna et al. (2022)</td>
</tr>
<tr>
<td>18</td>
<td><em>M. hypoleuca</em></td>
<td>Indonesia</td>
<td>Sap</td>
<td>Terakseron and Alpha-Beta-D-mannoside</td>
<td>Gusmailina and Saputra (2021)</td>
</tr>
<tr>
<td>19</td>
<td><em>M. indica</em></td>
<td>India and Vietnam</td>
<td>Leaves</td>
<td>2-propenial, isouegenol, 1-(4-Hidroksi-3-MET), 4-Metil-2,5-Dimetoksibenzenaldehid, Asam homovanillic, acetasoyringone, and guaiacol</td>
<td>Sultana and Ilyas (1986); Vu et al. (2021); Huonga et al. (2019)</td>
</tr>
</tbody>
</table>

Continued
<table>
<thead>
<tr>
<th>No.</th>
<th>Plant species</th>
<th>Location</th>
<th>Plant part</th>
<th>Constituents</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td><em>M. lowii</em></td>
<td>Indonesia</td>
<td>Leaves</td>
<td>macalowiinin, 4'-O-methyl-8-isoprenylnaringenin, 4'-O-methyl-5,7,4'-trihydroxy flavone</td>
<td>Agustina et al. (2012)</td>
</tr>
<tr>
<td>23</td>
<td><em>M. magna</em></td>
<td>Indonesia</td>
<td>Leaves</td>
<td>scopoletin, apigenin, and gallic acid</td>
<td>Minarti et al. (2021)</td>
</tr>
<tr>
<td>24</td>
<td><em>M. mappa</em></td>
<td>Hawaii</td>
<td>Leaves</td>
<td>Mappain</td>
<td>Van Der Kaaden et al. (2001)</td>
</tr>
<tr>
<td>25</td>
<td><em>M. monandra</em></td>
<td>Cameroon</td>
<td>Stem bark</td>
<td>Kolavenic acid and 2-Oxo-kolavenic acid</td>
<td>Salah (2003)</td>
</tr>
<tr>
<td>26</td>
<td><em>M. peltata</em></td>
<td>India</td>
<td>Stem bark</td>
<td>β-Sitosterol, bergenin, 8,10-di-O-methyl ether, and Tri-O-methyl ether</td>
<td>Ramaiah et al. (1979)</td>
</tr>
<tr>
<td>30</td>
<td><em>M. recurvata</em></td>
<td>Indonesia</td>
<td>Leaves</td>
<td>Macarecurvatin A, macarecurvatin B, Di isoprenyl aromadendrin, Glyasperin A, broussoflavonol F, flavestin K, flavestin B, flavestin G, 4-O-methyl-8-isoprenyl-naringeninin, and 8-isoprenyl-5,7-dihydroxyflavanone</td>
<td>Tanjug et al. (2012); Tjahjandarie et al. (2019)</td>
</tr>
<tr>
<td>31</td>
<td><em>M. rhizinoides</em></td>
<td>Indonesia</td>
<td>Leaves</td>
<td>Macarhizinoidin A, Macarhizinoidin B, and Methyl 4-isoprenyl-oxy-cinnaminate</td>
<td>Tanjug et al. (2012)</td>
</tr>
<tr>
<td>33</td>
<td><em>M. sampsonii</em></td>
<td>China</td>
<td>Leaves</td>
<td>Macaranone A, macaranone B, macaranone C, and macaranone D</td>
<td>Li et al. (2009)</td>
</tr>
<tr>
<td>34</td>
<td><em>M. Schweinfurthii</em></td>
<td>Cameroon</td>
<td>Leaves</td>
<td>Schweinfurthin A, schwefinurthin B, schwefinurthin C, schwefinurthin I, and schwefinurthin J</td>
<td>Beutler et al. (1998); Klausmeyer et al. (2010)</td>
</tr>
</tbody>
</table>
Table 1: Constituents of Macarangia species

<table>
<thead>
<tr>
<th>No.</th>
<th>Plant species</th>
<th>Location</th>
<th>Plant part</th>
<th>Constituents</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td><em>M. tanarius</em></td>
<td>Taiwan, Thailand, Japan, Indonesia, Malaysia</td>
<td>Leaves</td>
<td>Macarangivane A, tanariflavanone B, (-)-nymphaeol C, tanariflavanone C, Tanariflavanone D, nymphaeol A, nymphaeol B, nymphaeol C, Macarangivane A, macatrichocarpin A, macatrichocarpin B, macatrichocarpin C, macatrichocarpin D, Macarangiosides E, Macarangiosides F, licoflavanon, flavokawain C, and helichrysetin</td>
<td>Tseng et al. (2001); Phrommart et al. (2005); Kawakami et al. (2008); Gunawan-Puteri and Kawabata (2010); Lin et al. (1990); Matsunami et al. (2009); Yoshimura et al. (2017); Matsunami and Otsuka (2018); Mariliana et al. (2018b); Rawa et al. (2022)</td>
</tr>
<tr>
<td>39</td>
<td><em>M. triloba</em></td>
<td>Malaysia</td>
<td>Flowers</td>
<td>6-Prenyl-3′-methoxy-eriodictyol, nymphaeol C, nymphaeol C, 6-Farnesy1-3′, 4,5,7-tetrahydroflavone, 4,5-dihydro-5′-a-hydroxy-4′-a-methoxy-6′a,12-dehydro-a-tocicario, (+)-Clovan-2β,9β-diol, Ferulic acid, absicic acid, 1β,6α-dihydroxy-4(15)-eudesmen, 3β-hydroxy-24-ethylcholest-5-en-7-one, loliolide, tanarifuranonol, 5,7-dihydroxycomarum, and malaysianone A</td>
<td>Zakaria et al. (2010, 2012)</td>
</tr>
<tr>
<td>40</td>
<td><em>M. vedeliana</em></td>
<td>New Caledonia</td>
<td>Leaves</td>
<td>Macarangin</td>
<td>Hnawia et al. (1990)</td>
</tr>
</tbody>
</table>

lipids (Leopoldini et al., 2011). Antioxidants inhibit lipid oxidation by reacting with lipids and peroxy radicals and converting them into more stable nonradical products (Lin et al., 2018; Petruk et al., 2018). Furthermore, antioxidants also help in overcoming inflammation.

Gundjajo and Ashafa (2019) reported that the methanol extract of a popular traditional medicinal plant in west Africa, M. barteri, demonstrated a high antiradical effect against 1,1-diphenyl-2-picrylhydrazyl (DPPH) and nitric oxide (NO) with values of 0.47 and 1.68 mg/ml, respectively. M. tanarius fruit extracts exhibited strong antioxidant activity due to the presence of prenylflavonoids in the seed, pericarp, glandular trichome, and leaf (Kumazawa et al., 2014; Kumazawa et al., 2008). Chien et al. (2022) also reported that M. tanarius new and mature fruit extracts exhibited stronger free radical-scavenging activity and possessed lower IC50 than Taiwanese green propolis extract. Ethyl acetate extract of M. triloba leaves from Central Kalimantan, Indonesia, exhibited a strong ability to neutralize free radicals DPPH (Ardany et al., 2018). Kamarozaman et al. (2019) reported that new dihydrostilbenes isolated from M. heynei showed some antioxidant activity.
Antimicrobial activity

In cosmetic goods, antimicrobial compounds are used to both inhibit the growth of unfavorable microorganisms in skincare products and increase the shelf life of products (Nowak et al., 2021). The skin is the largest organ in the body, and it is exposed to the environment, making it an ideal location for bacteria, viruses, or fungi to grow. In order to protect consumers and stabilize shelf life, especially against potentially harmful bacteria, the formulation of cosmetic products (water based vs. oil based) has considered multifunctional antimicrobial ingredients (Hoang et al., 2021). This is in line with rising consumer awareness and demands for clean beauty and avoiding artificial ingredients, especially preservatives. It is realized that the use of conventional antimicrobial agents, which are usually loaded with preservatives, has disturbed the balance of skin microflora, so the skin is vulnerable to exposure to harmful microorganisms (Nowak et al., 2021).

Methanolic extract of M. barteri leaves grown in Nigeria has been reported to inhibit Pseudomonas aeruginosa, Enterococci faecalis, and Cryptococcus neoformans (>80% inhibition (Obigbo et al., 2018). Parayil et al. (2019) used a combination solvent, chloroform, and water (1:10) to extract from the leaves of M. peltata, which resulted in a clearance zone of the well diffusion method against Staphylococcus aureus. Panda et al. (2017) tested acetone, water, and ethanol solvents to extract from M. peltata leaves, which had antimicrobial activity against Escherichia coli, S. aureus, and Candida albicans. As described in another report, both the leaves and stem bark of M. peltata also had positive activity against four bacterial strains: E. coli, P. aeruginosa, Bacillus subtilis, and S. aureus (Verma et al., 2009).

Bradacs et al. (2010) reported that the inner bark extract of Macaranga dioica, commonly used as traditional medicine in the South Pacific Archipelago of Vanuatu, exhibited moderate activity against C. albicans. Ogundajo et al. (2017) extracted hexane, ethyl acetate, and methanol from M. barteri leaves. They found that methanolic extract had the best antibacterial activity against S. aureus, Bacillus pumilus, Streptococcus faecalis, Listeria sp., P. aeruginosa, Plesiomonas shigelloides, Aeromonas hydrophila, Shigella sonnei, Salmonella typhi, Salmonella typhimurium, E. coli, Proteus vulgaris, Proteus vulgaris, Enterobacter faecalis, and Klebsiella pneumoniae. The authors also discovered that a hexane extract of the plant was effective against fungi such as Candida neofomans, Trichophyton mucoides, and Candida albicans. Lee et al. (2019) isolated five propolins from M. tanarius. Among them, propolin D showed the highest inhibition of biofilm formation by strains of S. aureus, Staphylococcus epidermidis, and C. albicans, with MICs of 10–50 μg/ml. Isolated prenylated kaempferol and conglomeratin, from M. conglomerata, reportedly showed significant permeation of P. aeruginosa (MIC = 7.8 mg/ml) and moderate activity against S. aureus, E. coli, and Klebsiella pneumoniae (MIC = 62.5 mg/ml) (Hashim et al., 2022).

Tyrosinase inhibitory effect

An antimelanogenesis activity is one of the most important criteria for determining the suitability of plant compounds for use in skincare agents. It was previously reported by Arung et al. (2019) that they isolated glyasperin A, a prenylated flavonoid isolated from M. pruinosa that greatly inhibited melanin in B16 melanoma. Another report from Mazlan et al. (2013) demonstrated that they had extracted M. denticulata, M. pruinosa, and M. gigantea using methanol to assess their tyrosinase inhibitory activity. Among them, methanolic extract of M. denticulata bark showed the highest inhibition (68.7%). Methanol extract from the leaves and stem bark of M. hufufola has been tested to show their application in tyrosinase inhibition, in which they found appropriate activity with values of 159.42 [mg Kojic acid equivalent (KAE)/g] and 160.95 (mg KAE/g), respectively (Sadeer et al., 2019). Lim et al. (2009) screened the bioactivity of methanolic extracts of M. gigantea, M. pruinosa, M. tanarius, and M. triloba, which resulted in the best tyrosinase inhibition activity obtained by M. pruinosa among all the Macaranga tested. KAE values and quercetin equivalent were 6.8 and 20.7 mg/g, respectively.

Limitations of natural ingredient in cosmetics

Macaranga extract contains antioxidant, anti-inflammatory, and antimicrobial compounds. Some of these compounds have potential as topical cosmetic preparations. However, it is acknowledged that not all of these natural ingredients are safe because they may be associated with carcinogenic, mutagenic, and reprotoxic chemicals (Hoang et al., 2021). As a result, their application as skincare products that protect the integrity of cosmetics and the skin at the same time must be considered wisely. Furthermore, despite their promising effects, validation with clinical results is required. Due to a lack of clinical data and the limited relevance of data, some of the practical significance of the effects mentioned has not been adequately proven. However, these data provide interesting points for dermatologists to consider in the application of natural ingredients in relation to topical therapies (Hoang et al., 2021).

Although uncommon, skin contact with cosmetics containing plant extracts can result in allergic responses, contact dermatitis, erythema multiforme, and xanthomatous reactions (Hoang et al., 2021). It is possible, due to the lack of separation techniques, that many plant extracts have not been investigated for their compounds (Zorzi et al., 2016). Antioxidants may also have a variety of adverse effects, including acute toxicity, skin and eye irritation, skin sensitization, and photosensitization (Hoang et al., 2021; Mujtaba et al., 2021). In light of this, the application of natural ingredients requires that they are applied in safe concentrations; for instance, the application of essential oils is only recommended at 0.1–0.8%, or diluting with carrier oils (Guzmán and Lucia, 2021; Vostinaru et al., 2020). The use of some natural extracts, such as polyphenols, in cosmetics is constrained due to their low stability and sensitivity to heat and light (Hoang et al., 2021). Due to this condition, some cosmetic products that contain furocoumarins, compounds that are also present in Macaranga extract, should only be applied at night. Sun exposure has phototoxicity effects, causing skin damage.

Natural antioxidants are susceptible to deterioration, and their bioavailability is limited by low absorption. The use of active phytomolecules with the application of nanotechnology in cosmetics has drawn a lot of attention since it can boost absorption by the skin (Salvioni et al., 2021). Various types of nanoemulsions, nanoparticles, liposomes, niosomes, and dendrimers have influenced the formulation of cosmetic products (Musthaba et al., 2009). According to test results, the application
of nano formulations can minimize hematological toxic effects, boost bioavailability, and lessen other side effects, such as alopecia, nausea, vomiting, diarrhea, exhaustion, and skin rashes (Hoang et al., 2021; Saklani and Katty, 2008; Salvioni et al., 2021; Zorzi et al., 2016). Recently, major concerns regarding its safety have been raised, and much more exploration is needed to determine its efficacy in delivering active ingredients into the skin. New regulations established by the European Union have passed amendments in its (new regulations) cosmetics directory for safer nanocosmetics to enter the market, safeguarding the beauty and health of consumers (Hoang et al., 2021; Musthaba et al., 2009). Natural antioxidants are more expensive than synthetic ones in cosmetics, despite the fact that these molecules are safer than synthetic antioxidants.

Other potential uses of Macaranga plants

Hendra et al. (2017) reported that the extract of M. tanarius exhibited positive antihyperlipidemic and hepatoprotective effects. Some active compounds isolated from ethyl acetate extract of M. tanarius leaves, i.e., mallotinic acid, corilagin, chebulagic acid, macactannins A and B, can be developed for diabetes treatment agents (Gunawan-Puteri and Kawabata, 2010). Another Macaranga species, M. hurifolia extract from Nigeria, showed potential for anti-inflammatory and antidiabetic effects (Segun et al., 2019b). Ehile et al. (2018) reported that the aqueous extract of M. barteri exhibited a gastric antilulcer effect at doses ranging from 62.5 to 500 mg/kg b.w. This extract has been reported to be safe for oral medicine due to major toxic anthropometric and hematological effects not being present in tested rats, despite the fact that biochemical and histological studies are needed to ensure safe use of the extract (Ehile et al., 2018). Furthermore, as reported earlier, Macaranga spp. contains rich prenylated flavonoids (Shahinozzaman et al., 2021). These exhibited several potential effects: antivirus activity (Feng et al., 2010), antiallergic activity (Quan et al., 2008), and larvicidal activity against the fourth-instar larvae of Aedes albopictus and Culex pipiens quinquefasciatus (Niu et al., 2010). Muhaimin et al. (2019) reported that ethanolic extract of M. gigantea exhibited antiplasmodial activity and can be developed as an alternative agent for controlling malaria. The study also confirmed that M. denticulata leaf extract has antinociceptive activity. At doses of 200 and 400 mg/kg, it demonstrated dose-dependent and statistically significant antinociceptive activity in acetic and formalin tests. Furthermore, among six major M. denticulata compounds, Macaranga had the best fitness score of 5.81 with the COX-1 enzyme (Hasanat et al., 2017).

CONCLUSIONS

A comprehensive review of the potential of Macaranga plants as skincare cosmetics ingredients has been conducted. Macaranga plants contain bioactive compounds which have anti-inflammatory, antioxidant, antibacterial, and tyrosinase inhibitory activity. Therefore, Macaranga plants have the potential to be used as skincare cosmetic ingredients.

AUTHORS’ CONTRIBUTIONS


FUNDING

This research received funding from the Deputy of Research and Innovation, National Research and Innovation Agency (BRIN) for “Pusat Kolaboratif Riset Kosmetik Berteknologi Nano Berbasis Bio-massa” in the Fiscal Year 2022 (grant number: 398/II/FR/3/2022).

CONFLICTS OF INTEREST

The authors have no relevant financial or nonfinancial interests to disclose.

ETHICAL APPROVAL

This study does not involve experiments on animals or human subjects.

DATA AVAILABILITY

All data generated and analyzed are included within this review article.

PUBLISHER’S NOTE

This journal remains neutral with regard to jurisdictional claims in published institutional affiliations.

REFERENCES

Atiq A, Jalil J, Hussain K, Ahmad W. Raging the war against inflammation with natural products. Front Pharmacol, 2018; 9:976.
Chien YH, Yu YH, Ye SR, Chen YW. Antibacterial and antioxidant activity of the fruit of Macaranga tanarius, the plant origin of Taiwanese green propolis. Antioxidants, 2022; 11(7):1242.


