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In vitro Antimicrobial and Antioxidant Activity of Meliaceae Plants Collection of Eka Karya Bali Botanic Garden

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ABSTRACT. Meliaceae are popularly used to produce terpenoid and limonoid compounds. These compounds have the potential as antioxidants, antimicrobials, insecticides, antipyretics, and anthelmintics. This research aims to determine the antioxidant and antimicrobial activity of Meliaceae leaves extract of Eka Karya Bali Botanic Garden plants collection. The dried leaves of 15 species of Meliaceae were extracted by methanol. *In vitro* antimicrobial tests were carried out on agar media inoculated by selected microbe. On the other hand, the antioxidant activity was assayed by 1,1-diphenyl-2-picryl hydrazyl (DPPH) radical scavenging. As a result, *Aphanamixis polystachya* against *Aspergillus niger* (35.21 mm) and *Cladosporium* sp. (46.21), *Toona hexandra* against *Fusarium solani* (37.31 mm), *Dysoxylum cauliflorum* against *Candida albicans* (38.19 mm), *Chisocheton pentandrus* against *Salmonella typhimurium* (39.53 mm), *Sandoricum koetjape* against *Staphylococcus aureus* (50.07 mm), and *Toona hexandra* against *Streptococcus nutans* (42.25 mm) exhibited the strongest inhibitory effect. Furthermore, the antioxidant screening showed that *Cipadessa baccifera*, *C. pentandrus*, and *Sandoricum koetjape* exhibited strong antioxidant activity, while *T. ciliata* showed a very strong antioxidant activity with IC_{50} 33.64 μg/mL. This study reveals an initial screening of the potential of various types of Meliaceae as a source of antioxidants and antibacterials. Furthermore, this information can be used as a new alternative for pharmaceutical companies and the industrial sector in the development of new products.

Keywords: antibacteria, antifungal, DPPH, methanol leaves extract, *Toona ciliata*

INTRODUCTION

Meliaceae is a flowering plant, mostly formed in trees and shrubs. Meliaceae are widely distributed in various habitats in tropical and subtropical regions. The main characteristic of Meliaceae is alternate leaves, usually pinnate without stipules. Leaves in spirals, very rarely opposite. Leaflets opposite, sub opposite, or alternate. Leaflet blades with oblique base, entire margin, rarely lobed or serrate (Yadav et al., 2015). Among hundreds of Meliaceae species around the world, Eka Karya Bali Botanic Garden (Eka Karya BBG) has been collected 32 species from various regions in Indonesia, such as *Aglaia angustifolia*, *Aphanamixis polystachya*, *Chisocheton pentandrus*, *Cipadessa baccifera*, *Dysoxylum cauliflorum*, *Lansium parasiticum*, *Melia azedarach*, *Sandoricum koetjape*, *Swietenia macrophylla*, and *Toona ciliata*.

The plant species of Meliaceae are popularly used to produce terpenoid and limonoid compounds. These compounds have the potential as antioxidants, antimicrobials, insecticides, antipyretics, and anthelmintics (Prijono et al., 2001; Yadav et al., 2015). *Pseudocedrela kotschyi* leaves extract demonstrated strong antioxidant, antidiarrheal and antimotility properties, and actively reduce intestinal fluid secretion (Essiet et al., 2016). Previously, Dongmo et al., (2009) reported that stem bark extract of *Turraeanthus africanus* has interesting antioxidant and vasorelaxant properties and represents a potential source of medicine for the treatment of cardiovascular diseases.

Studies on the identification of active ingredients and biological properties of Meliaceae have been widely reported. Several secondary metabolites such as flavonoids, tannins, saponins, alkaloids, terpenoids and polyphenols have been reported to have antibacterial and antioxidant properties (Manjari et al., 2017; Melsadalam et al., 2019; Katja, 2020). However, there are still many Meliaceae species collected at Eka Karya BBG with unknown potential. So, it is important to explore the potential of Indonesian flora that is beneficial to humans, such as antimicrobial activity tests and screening for antioxidant potential. Nathan and Cars (2014) reported that the increasing number of bacterial infections worldwide has become a serious problem, with the emergence of new pathogens that have the potential for rapid global spread, such as *Staphylococcus* spp., *Mycobacterium, tuberculosis* and

Streptococcus spp. This problem is exacerbated by the emergence of bacterial resistance to certain antibiotics (WHO, 2014), which requires the discovery and development of new antimicrobial agents from various sources, including those from higher plants, to combat microbial resistance (Strobel & Daisy, 2015). On the other hand, antioxidants function to ward off free radicals that trigger various diseases. Therefore, this study aims to determine the antioxidant and antimicrobial activity of Meliaceae leaves extract of Eka Karya BBG plants collection.

EXPERIMENTAL SECTION

Fiveteen samples of Meliaceae were taken from the plant collection of Eka Karya BBG, while the preparation of extracts and screening for antimicrobial and antioxidant activities were carried out at the Applied Botany Laboratory, Eka Karya BBG, from February to June 2021. Fifteen Meliaceae species that have been identified by the Registration Unit of Eka Karya BBG were used in this study, there are *Aglaia argentea* Blume, *A. elliptica* (C.DC.) Blume, *A. eximia* Miq., *A. lawii* (Wight) C.J.Saldanha, *A. silvestris* (M.Roem.) Merr., *Aphanamixis polystachya* (Wall.) R.Parker, *Cipadessa baccifera* (Roxb. ex Roth) Miq., *Chisocheton pentandrus* (Blanco) Merr., *Dysoxylum cauliflorum* Hiern, *D. excelsum* Blume, *D. gaudichaudianum* (A.Juss.) Miq., *D. nutans* (Blume) Miq., *Sandoricum koetjape* (Burm.f.) Merr., *Toona ciliata* M.Roem., and *T. sureni* (Blume) Merr.

Leaves Extract Preparation

The extraction of Meliaceae is based on Tiwari et al. (2011). The plant samples obtained from the field were cut into thin pieces and dried for seven days. A total of 100 g of dried leaves samples were then immersed in an erlenmeyer containing 1000 mL of methanol for seven days. After that, the samples were filtered using filter paper. The filter results were evaporated in IKA RV10 vacuum rotary evaporator to obtain the crude extracts.

Antimicrobial Assay

A modified disk-diffusion method by Chung et al. (2004) was used to assay the antimicrobial activity of Meliaceae extracts. To assay their antimicrobial activities, the methanolic leaves extracts were tested against four fungi species (*Aspergillus niger*, *Cladosporium* sp., *Fusarium solani*, *Candida albicans*) and three bacteria species (*Salmonella typhimurium*, *Staphylococcus aureus*, *Streptococcus nutans*).

Microbial culture on agar media was taken using ose and transferred to a tube containing sterile distilled water, then homogenized until all spores were immersed. A total of 100 µL of liquid microbial culture stock was put into a sterile Petri dish. Furthermore, 10 mL of molten agar was added, then homogenized to ensure that the microbes were evenly distributed throughout the media, then leave until the media were solidifies.

After the inoculated media was set, a sterile filter paper was then placed in the centre. A total of 50 µL of plant extract was dropped on the filter paper, and then incubated at room temperature at 22 ºC for 3 days. The antimicrobial activity of the extract was indicated by the formation of a clear zone. Data were analyzed by the Analysis of Variance (ANOVA) at a significant rate of 95%, followed by Duncan new multiple range test (DNMRT) at alpha 0.05 using SPSS 15 software.

Antioxidant Assay

As Kedare and Singh (2011) stated, antioxidant activity of 15 Meliaceae leaves methanolic extracts can be monitored using the scavenging effect of radicals on DPPH. Fifteen species of Meliaceae leaf extract were tested at 5 and 7 different concentration levels (**Table 1**). The absorbance of the solutions was screened at 517 nm by a spectrophotometer to calculate radical scavenging activity. The inhibition percentage of each concentration was then plotted to obtain IC_{50} values.

RESULTS AND DISCUSSION

Meliaceae is an ethnobotanically important family with a very common neem tree, which is being used from ancient times till date. In recent years, some studies were also reported the biological properties of other Meliaceae species. The present study was aimed to screen the antimicrobial and antioxidant activity of methanolic leaves extract of 15 Meliaceae species collection of Eka Karya BBG.

In vitro Antimicrobial Activity

The antimicrobial activities of the extracts were indicated by the formation of a clear zone as shown in **Figure 1**. The clear zone indicates the presence of antagonistic metabolites produced by plant extracts, thereby inhibiting the microbial growth. Among 15 extracts, only *A. polystachya*, *D. gaudichaudianum,* and *D. cauliflorum* inhibited the growth of *A. niger* (**Figure 2A**). Similarly, *D. gaudichaudianum* and *D. excelsum* were also strongly inhibited the growth of *Cladosporium* sp. (**Figure 2B**). Those two extracts showed stronger inhibition than *A. silvestris* against *Cladosporium* sp. Previously, Praptiwi and Harapini (2005) found that antibacterial test of 20% methanol extract of *D. gaudichaudianum* showed an inhibition to the growth of *S. aureus* (Praptiwi & Harapini, 2005). Not only in *D. gaudichaudianum*, studies conducted by Chung et al. (2004) on methanol extract of leaves and bark of other *Dysoxylum* species such as *D. ramiflorum* and *D. rugulosum* showed an inhibition toward *S. aureus* growth.

On the other hand, the growth of *F. solani* was only inhibited by *C. pentandrus* and *T. ciliata* (**Figure 2C**). Meanwhile, *C. albicans* was inhibited by *A. lawii, A. silvestris, C. bacciifera*, and *D. cauliflorum* (**Figure 2D**). Among four extracts that exhibited inhibitory activity against *C. albicans*, the lowest inhibitory effect was

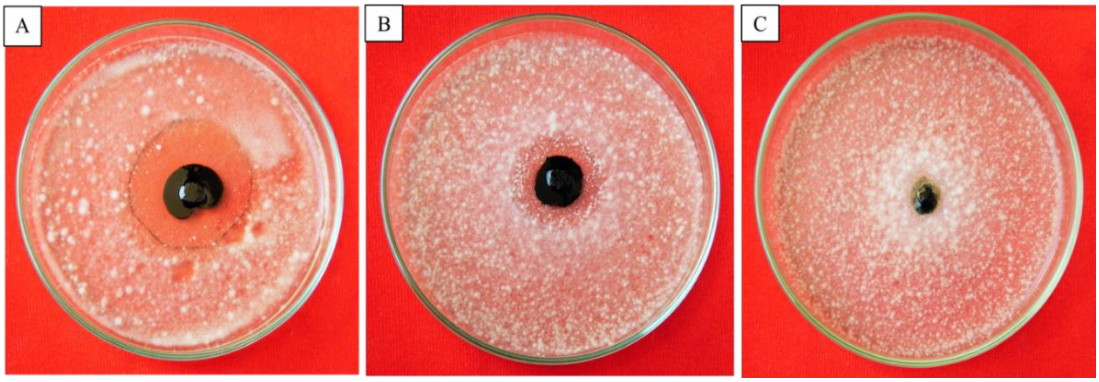

Figure 1. The confontration assay of A: *Aphanamixis polystachya*, B: *Dysoxylum cauliflorum*, and C: *Chisocheton pentandrus* against *Aspergillus niger* at 3 days post treatment. The clear zone formed on the media indicates inhibitory effect of plant extract toward microbial growth.

documented on *C. bacciifera* and *A. silvestris* with 20.96 and 24.38 mm of the inhibitory zone, respectively. However, the inhibitory zone caused by *C. bacciifera* was stronger than the previous study by Bhakshu et al. (2016). They reported that petroleum ether and ethyl acetate leaves extract of *C. bacciifera* were able to inhibit the growth *C. albicans* by 18- and 12- mm zone of inhibition, respectively. Previously, Bokhari et al. (2015) found that among the various extracts, stem-bark and leaf methanol extract, followed by stem-bark and leaf chloroform extract of *C. bacciifera* showed the best antifungal activity. Similarly, methanol extracts of *Walsura trifoliata* also exhibit significant activity against *S. aureus*, *B. cereus*, and moderate inhibition on *B. coagulans* and *C. albicans* than petroleum ether, and benzene extracts (Murthy & Kandimalla, 2008). Thus, we found that methanol appears to be the best solvent to increase the antimicrobial effect of plant extract. Moreover, Agustina et al. (2018) stated that methanol has universal properties in acting as a solvent, which can dissolve analytes with polar and nonpolar properties. In addition, methanol can attract analytes in alkaloids, steroids, saponins, and flavonoids derived from plants.

Among seven microbes used in this study, most extracts showed an inhibitory effect on *S. typhimurium*. Six out of 15 extracts (*A. eximia*, *A. elliptica*, *T. sureni*, *D. excelsum*, *A. lawii*, and *C. pentandrus*) exhibited their anti-*S. typhimurium in vitro* (**Figure 2E**). Above all, *C. pentandrus* showed the strongest inhibitory effect by 39.53 mm inhibitory zone. Previously, Chung et al. (2004) tested 30 plant families for antimicrobial screening using selected human pathogenic microorganisms. They reported that methanol extract of *C. macranthus* leaves as well as *C. erythrocarpus* and *C. petrandus* bark had antibacterial activity against *S. aureus*, even *C. macranthus* leaf extract showed the strongest inhibitory effect with 10.0 to 14.9 mm of clear zone compared to *C. erythrocarpus* and *C. petrandus* bark with less than 9 mm of the inhibitory zone. That result is lower than another study conducted by Melsadalam et al. (2019) which found that methanol extract of *Chisocheton* leaves had an inhibition zone of 29 mm against *S. aureus* and 23.75 mm against *E. coli*.

On the contrary, only *S. koetjape* and *T. ciliata* inhibited the growth of *S. aureus* (**Figure 2F**) and *S. nutans* (**Figure 2G**), respectively. Identically, Hardika et al. (2013) was also found that methanol leaves extract of *S. koetjape* has antibacterial activity against *S. aureus* and *E.coli*, even its aqueous leaves extract inhibited the growth of those bacteria (Rina & Eff, 2019). Moreover, methanol extract of *S. koetjape* bark showed antifungal activity against *C. albicans* (Warsinah et al., 2011), while its fruits extract exhibited antibacterial activity toward *Pseudomonas aeruginosa, E. coli, Acinetobacter baumannii, Enterococcus faecalis*, and *S. aureus* (Toobpeng et al., 2017). In other words, we demonstrated that *T. ciliata* showed the inhibitory effect toward *F. solani* (**Figure 2C**) and *S. nutans* (**Figure 2G**), while *T. sureni* has only inhibit the growth of *S. typhimurium* (**Figure 2E**). Other studies showed that not only the leaf, but also stem and root extracts of *T. ciliata* exhibited strong antimicrobial activities toward a wide spectrum of human and plant pathogenic fungi and bacteria, such as *S. aureus*, *Streptococcus pyogenes*, and *Salmonella typhii* (Chowdhury et al., 2003; Bibi et al., 2011; Kiladi, 2012; Kavitha & Satish, 2013). Furthermore, Bokhari et al. (2015) found that stem bark and leaf extracts exhibited the highest antifungal properties than the fruit. Comparatively, *T. sureni* leaves extract and its essential oil effectively inhibited the growth of *E. coli, S. aureus*, and *Bacillus subtilis* (Ekaprasada et al., 2009; Ekaprasada et al., 2015).

In summary, only *A. argentea, D. cytobotryum*, and *D. nutans* were not shown antimicrobial properties. Among 4 *Aglaia* species assayed, only *A. argentea* did not exhibited antimicrobial activity. Likewise, Chung et al. (2004) documented that *A. argentea* was not exhibited antimicrobial activity as well, while other *Aglaia* such *A. affinis, A. rivularis*, and *A. shawiana* inhibit the growth of *S. aureus*. This condition may be

caused by secondary metabolites of *Aglaia argentea* found in other plant parts. Previous studies reported the presence of triterpenoid compounds from *n*-hexane extract stems of *Aglaia argentea* (Farabi et al., 2017; Hidayat et al., 2018). The rocaglate type compound identified as methyl rocaglat from the stem of *Aglaia argentea* was first reported by (Hidayat et al., 2017) which showed cytotoxic activity with IC_{50} value <0.1 g/mL. Still, we found that *A. elliptica, A. eximia*, and *A. lawii* exhibited antimicrobial properties against *C. albicans* and *S. typhimurium*. Correspondingly, acetone and ethanol extracts of *A. lawii* leaves were showed significant activity against *S. aureus* and *B. cereus* (Lavate et al., 2012). Previous studies showed that other *Aglaia* species such as *A. malabarica, A. forbesii, A. silvestris*, and *A. odorata* were also possessed strong antimicrobial properties on human and phytopathogens (Praptiwi, 2007; Joycharat et al., 2010; Vu et al., 2016; Ravindran & Thoppil, 2018).

In vitro Antioxidant Activity

To assess the antioxidant activity, a DPPH scavenging activity test was conducted to each Meliaceae extracts. The ability of each extract to inhibit free radicals is grouped into four categories based on Molyneux (2004); very strong (IC_{50}< 50 ppm), strong (IC_{50} 50-100 ppm), moderate (IC_{50} 100-150 ppm), and weak (IC_{50} 150-200 ppm).

As presented in **Table 1**, only *T. ciliata* leaves extract exhibited a very strong antioxidant activity with IC_{50} of 33.638 ppm, while other *Toona* species tested in this study, *T. sureni*, showed a weak antioxidant activity. This is not surprising since *T. ciliata* are widely known as a potential traditional medicine to cure dysentry, leprosy, fever, headache, blood complaints, cardiotonic, aphrodisiac, ulcer, and menstrual disorders (Divakar & Ratan 2017). Previously, Ekaprasada et al., (2009a) found an antioxidant compound isolated from *T. ciliata* named methyl gallate exhibited stronger IC_{50} (1.02 ppm) compared to our finding. Additionally, the antioxidant activity of *T. ciliata* tends to be stable in all solvents as Kavitha and Satish (2013) found that its extracts in petroleum ether, chloroform, ethyl acetate, and methanol solvents showed high inhibition percentage toward DPPH free radicals.

Out of 15 Meliacae species, *C. baccifera, C. pentandrus*, and *S. koetjape* exhibited strong antioxidant activity by IC_{50} 65.258, 62.823, and 62.064 ppm, respectively. Previously, Lubis et al., (2021) found that *C. baccifera* methanolic extract exhibited stronger antioxidant (IC_{50} 33.19 ppm) than ours. They also found 39.84% xanthine oxidase inhibitory activity, which came from many flavonoid compounds in the extract. *C. baccifera* extracted in ethanol and methanol showed the presence of alkaloids, flavonoids, saponins, terpenoids, tannins, and phenolic compounds (Lubis et al., 2021; Murkute & Shinde 2018). Methanol extract of stem and stem bark of *C. baccifera* also showed the content of secondary metabolites of tannins, phenols, and flavonoids (Patel et al., 2020). As antioxidants are chemical compounds that serves to inhibit the formation of free radicals so it can prevent various diseases (Li'aini et al., 2021). Kindo et al. (2014) stated that *C. baccifera* is potential antioxidant source to prevent oxidative stress and other diseases.

Not many studies have tested the antioxidant activity of *C. pentandrus*. However, Katja (2020) found that methanol extract of *Chisocheton* sp. leaves showed a weak IC_{50} (216.73 ppm). However, some compounds that have potential as antioxidants, such as alkaloids, saponins, steroids, flavonoids, and tannins also found in the methanol extract of the leaves of *Chisocheton* sp. (Melsadalama et al., 2019; Katja, 2020).

Similar to *T. ciliata*, antioxidant activity of *S. koetjape* was also stable in all solvents. Hamzah et al. (2020) found that the extract of *S. koetjape* in n-hexane, ethyl acetate, n-butanol, and water solvent showed a high percentage of inhibition against DPPH free radicals. Furthermore, they find that *S. koetjape* leaf extract contains several secondary metabolites such as flavonoids, tannins, steroids, saponins, and alkaloids. Not only leaves, another study showed that the methanol extract of *S. koetjape* fruit also showed high antioxidant activity (Bayani, 2016). Recently, Saadah and Tulandi (2020) also found alkaloids, flavonoids, quinones, triterpenoids, and tannins in the methanol extract of the stem of *S. koetjape*.

All *Aglaia* and *Dysoxylum* species tested in this study were categorized as weak antioxidant activity. This result is quite different from some previous studies. Saefudin & Basri (2016) and Li'aini et al., (2021) found that the difference antioxidant value could be caused by differences in plant age, habitat, plant parts used, solvent polarity, and extraction methods. The low antioxidant activity of *Aglaia* species in this study might be due to the part we used is the leaves. Several studies reported that antioxidant activity of *Aglaia* stem bark showed a stronger IC_{50} than other plant parts. Sianturi et al., (2016) found the antioxidant compounds were isolated from the bark of *A. eximia* named kaempferol exhibited a much stronger antioxidant activity by IC_{50} 1.18 ppm. Moreover, Kaja et al., (2014) reported the antioxidant activity of the methanol extract of *A. odoratissima* stem bark (IC_{50} 36.32 ppm) was much stronger than the leaf (IC_{50} 844 ppm). Similiarly, Manjari et al., (2017) found the antioxidant activity of bark extract of *A. elaeagnoidea* using various solvents such chloroform, ethanol, methanol, petroleum ether, and water was stronger than the leaf. Furthermore, they also found that ethanol extract of the bark showed high levels of alkaloids, tannins, anthraquinones, saponins, and polyphenols and flavonoids. Meanwhile, the leaves extract showed low levels of alkaloids, polyphenols, flavonoid, tannins, and no anthraquinones and saponins were detected.

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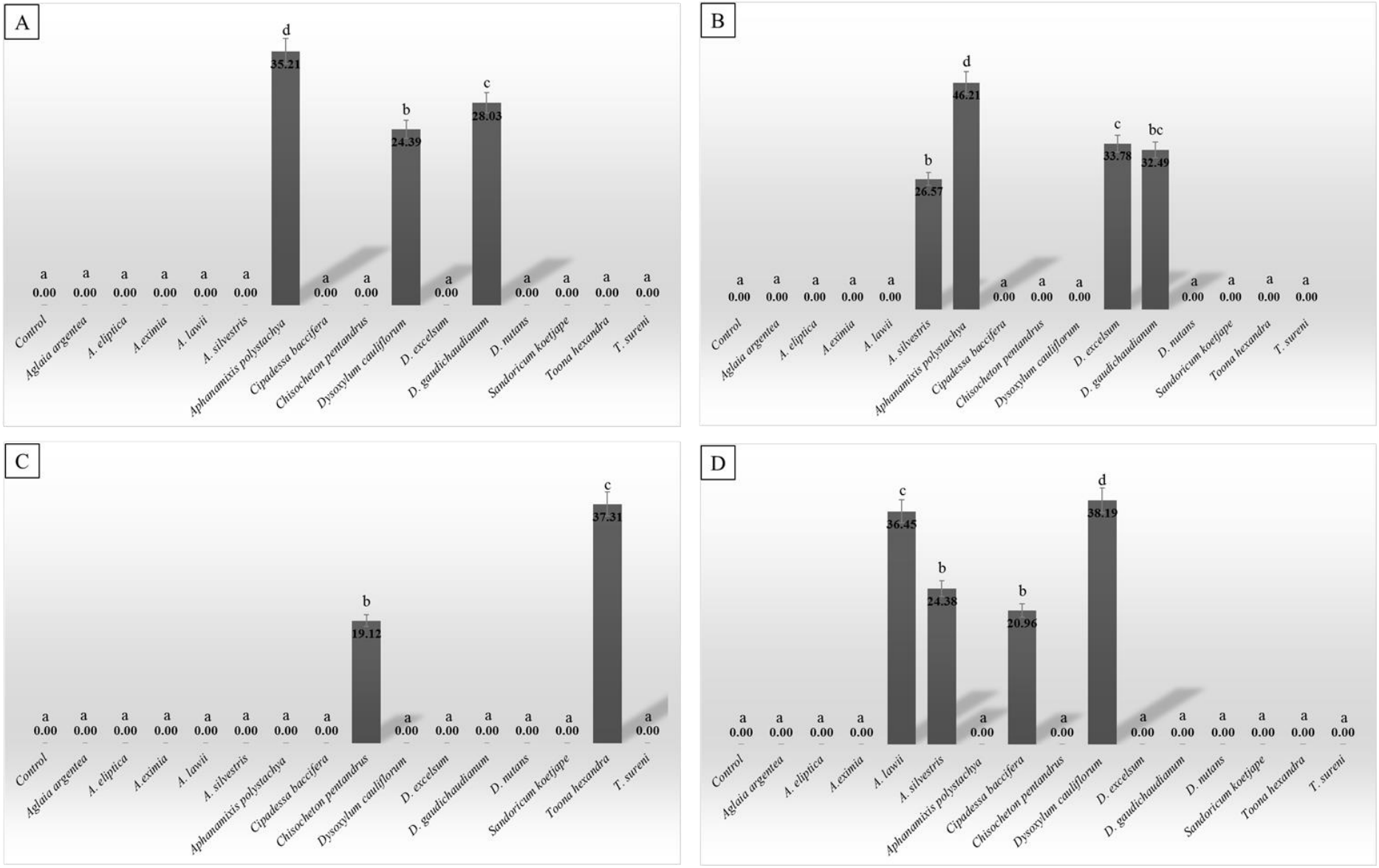
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a 0.00
a 0.00
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a 0.00
a 0.00
d 35.21
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b 24.39
a 0.00
c 28.03
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Control
Aglaia argentea
A. eliptica
A.eximia
A. lawii
A. silvestris
Aphanamixis polystachya
Cipadessa baccifera
Chisocheton pentandrus
Dysoxylum cauliflorum
D. excelsum
D. gaudichaudianum
D. nutans
Sandoricum koetjape
Toona hexandra
T. sureni
B
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c 37.31
a 0.00
D
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c 36.45
b 24.38
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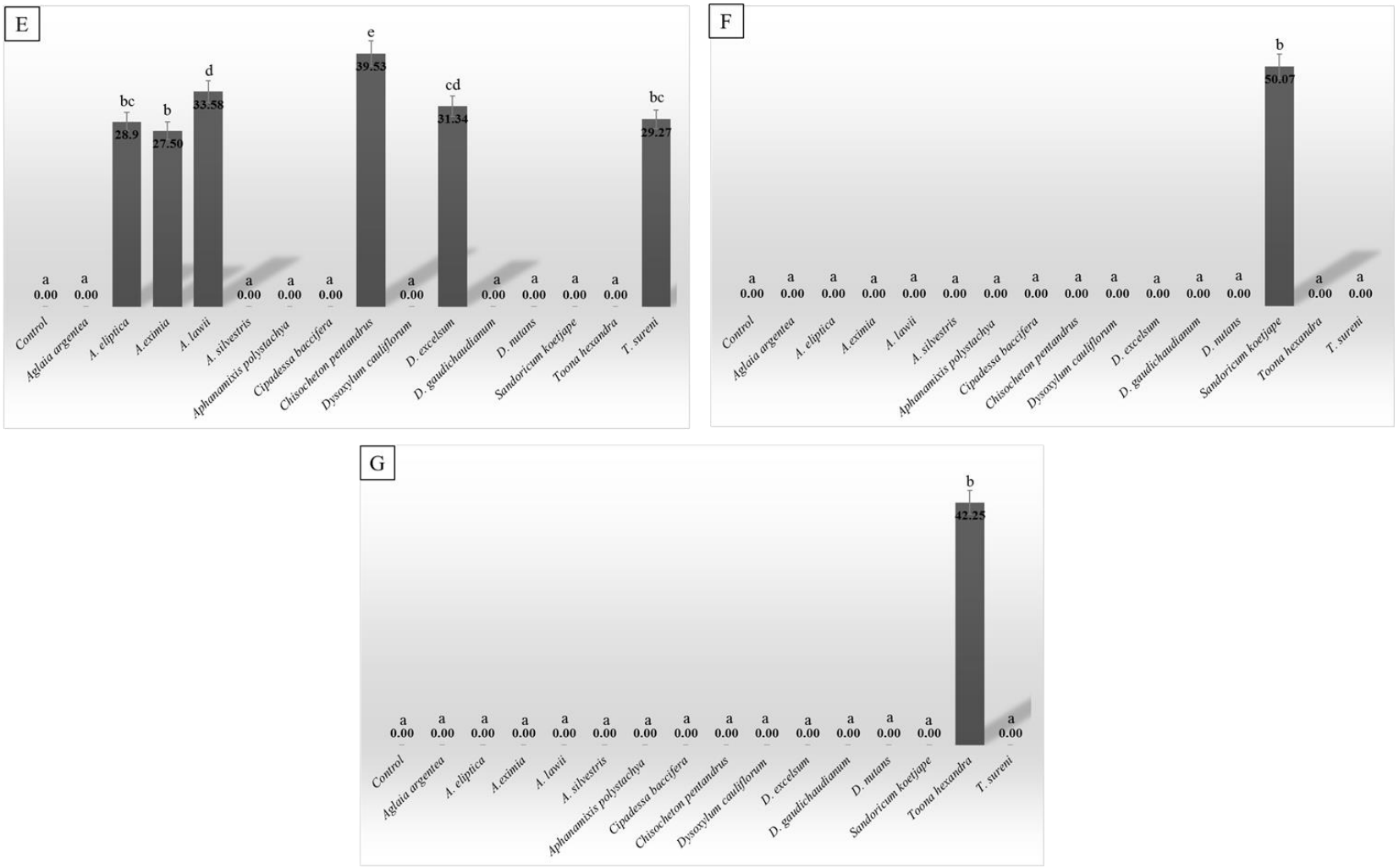

Figure 2. Inhibitory effect of Meliaceae leaves extract against **A**: *Aspergillus niger*, **B**: *Cladosporium* sp., **C**: *Fusarium solani*, **D**: *Candida albicans*, **E**: *Salmonella typhimurium*, **F**: *Staphylococcus aureus*, and **G**: *Streptococcus nutans*. The bar indicates inhibitory zone (in mm) formed at 3 days post treatment. Different letter above the bar indicates significantly different according to Duncan test ($p < 0.05$).

Table 1. Antioxidant activity of Meliaceae leaves extracts toward free radical

Species	Concentration (ppm)	Inhibition percentage (%)	IC_{50} (ppm)	Category
Aglaia				
Aglaia argentea Blume	100	11.003	555.366	Weak
	200	19.359		
	300	28.691		
	400	38.022		
	500	45.543		
	600	52.925		
	700	62.117		
Aglaia elliptica (C.DC.) Blume	100	11.783	581.406	Weak
	200	21.815		
	300	30.414		
	400	39.331		
	500	47.293		
	600	50.955		
	700	55.255		
Aglaia eximia Miq.	100	7.419	707.876	Weak
	200	18.083		
	300	25.193		
	400	30.294		
	500	37.249		
	600	43.895		
	700	47.141		
Aglaia lawii (Wight) C.J.Saldanha	100	13.306	421.423	Weak
	200	27.023		
	300	38.272		
	400	49.794		
	500	60.494		
	600	69.273		
	700	75.995		
Aglaia silvestris (M.Roem.) Merr.	100	9.841	598.532	Weak
	200	17.511		
	300	26.918		
	400	35.022		
	500	42.981		
	600	50.217		
	700	57.019		
Aphanamixis				
Aphanamixis polystachya (Wall.) R.Parker	100	5.362	916.378	Weak
	200	11.662		
	300	16.220		
	400	20.375		
	500	27.614		
	600	32.172		
	700	38.740		
Cipadessa				
Cipadessa baccifera (Roxb. ex Roth) Miq.	100	46.131	65.258	Strong
	200	77.997		
	300	86.950		
	400	87.709		
	500	86.798		
	600	85.129		
	700	84.674		
Chisocheton				
Chisocheton pentandrus (Blanco) Merr.	100	52.174	62.823	Strong
	200	82.889		

	300	87.377		
	400	87.097		
	500	85.975		
	600	84.572		
	700	83.310		
Dysoxylum				
Dysoxylum cauliflorum Hiern	100	12.500	650.672	Weak
	200	20.115		
	300	31.466		
	400	35.489		
	500	41.954		
	600	45.977		
	700	51.006		
Dysoxylum excelsum (Spreng.) Blume ex G.Don	100	13.424	414.558	Weak
	200	32.428		
	300	39.216		
	400	50.679		
	500	61.086		
	600	68.024		
	700	75.113		
Dysoxylum gaudichaudianum (A.Juss.) Miq.	100	18.704	500.265	Weak
	200	32.990		
	300	37.408		
	400	44.477		
	500	50.221		
	600	55.965		
	700	62.445		
Dysoxylum nutans (Blume) Miq.	100	2.101	1441.394	Weak
	200	6.303		
	300	10.924		
	400	11.765		
	500	18.067		
	600	21.148		
	700	21.849		
Sandoricum				
Sandoricum koetjape (Burm.f.) Merr.	5	5.048	62.064	Strong
	10	10.641		
	20	21.555		
	40	36.426		
	80	59.891		
Toona				
Toona ciliata M.Roem.	5	11.030	33.638	Very strong
	10	20.029		
	20	35.559		
	40	74.020		
	80	94.485		
Toona sureni (Blume) Merr.	100	23.053	202.725	Weak
	200	59.190		
	300	74.766		
	400	77.259		
	500	77.882		
	600	76.168		
	700	71.651		

As for *Dysoxylum*, the ethyl acetate extract of *D. cauliflorum* leaves conducted by Ting et al. (2011) exhibited very strong antioxidant activity (IC_{50} 19 ppm), much stronger than our results. Thus, it can be suggested to use ethyl acetate to extract *Dysoxylum* for the DPPH radical scavenging assay, which might show better results.

Similarly, *A. polystachya* were also showed weak antioxidant activity by 916.378 ppm of IC_{50}. Sultana et al. (2009) also found that bark methanol extract of

A. polystachya revealed maximum free radical scavenging activity (IC_{50} 5.36 ppm) was much stronger than our results using leaf extract (IC_{50} 916.378 ppm). In line with Krishnaraju et al. (2009), *A. polystachya* bark extracts exhibited better efficacies toward free radical agent compared to vitamin C. This is in accordance with Paul et al. (2021) which found that bark extracts offer more antioxidative activity than leaves extracts.

CONCLUSIONS

It can be concluded that Meliaceae group of Eka Karya Bali Botanic Garden has the potential as antimicrobial and antioxidant. Out of the 15 extracts, 14 extracts such *Aglaia eximia*, *A. lawii*, *A. silvestris*, *Aphanamixis polystachya*, *Cipadessa baccifera*, *Chisocheton pentandrus*, *Dysoxylum cauliflorum*, *D. excelsum*, *D. gaudichaudianum*, *D. nutans*, *Sandoricum koetjape*, *Toona ciliata*, and *T. sureni* were able to inhibit the growth of selected microbes. *S. koetjape* showed the strongest inhibitory effect by 50.07 mm against *Staphylococcus aureus*. Morever, this species also showed a very strong antioxidant activity by 33.638 ppm of IC_{50}. Three other Meliaceae species, *C. baccifera, C. pentandrus*, and *S. koetjape*, exhibited strong antioxidant activity by IC_{50} 65.258, 62.823, and 62.064 μg/mL, respectively, while *T. ciliata* showed a very strong antioxidant activity (33.638 μg/mL). The strong antioxidant properties of the plant extract might be helpful in the development of drugs or functional foods. However, a further study is needed to intensify the antioxidant and antimicrobial activity of Meliaceae.

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