Antioxidant and Cytotoxic Activities of Various Meliaceae Plants Extract

Vera Permatasari[1], Muhammad Eka Prastya[1,3], Tjandrawati Mozef[1,3](✉), Gian Primahana[1,3], Wawan Sujarwo[2,3], and Sri Rahayu[2,3]

[1] Research Center for Pharmaceutical Ingredients and Traditional Medicine, The National Research and Innovation Agency (BRIN), Tangerang Selatan, Indonesia
tjan002@brin.go.id

[2] Research Center for Ecology and Ethnobiology, The National Research and Innovation Agency (BRIN), Bogor, Indonesia

[3] Research Center for Plant Conservation, Botanic Gardens, and Forestry, National Research and Innovation Agency (BRIN), Bogor, Indonesia

Abstract. *Meliaceae* plant is a large, evergreen plant which extracts are rich in natural promising compounds with numerous bioactivities including antioxidant, antimicrobial and cytotoxic properties. The aim of the present work was to evaluate the antioxidant activity of phenolic and flavonoid which were investigated using DPPH and ABTS methods. In addition, MCF7 cells were also used to assess the cytotoxic activities of 11 potential extracts derived from various *Meliaceae* plants family with MTT assay. Antioxidant activity as a scavenger of large DPPH free radicals is known to have a small IC_{50} value. The highest antioxidants are in *Toona ciliata* leaves extract with the IC_{50} value of 7.68 μg/mL, while the lowest DPPH antioxidants are in *Aglaia foveolata* twig with the IC_{50} value of 256.07 μg/mL. As for the ABTS antioxidant showed the highest value are in Aglaia tomentosa-Bengkulu with the IC_{50} value of 8.91 μg/mL, while the lowest is *Aglaia foveolata* leaves (IC_{50} of 1170.2 μg/mL). Moreover, MCF7 epithelial cells challenged with the extract showed a concentration dependent increase in cytotoxicity. Based on MCF7 inhibition, *Aglaia foveolata* leaves had enough active cytotoxic activity followed by *Dysoxylum parasiticum*-Jawa, *Dysoxylum parasiticum*-Sumatera, *Aglaia tomentosa*-Central Sulawesi and *Aglaia faveolata* stem bark. The IC_{50} value is focus on *Aglaia foveolata* i.e., leaves and stem bark part of plant, namely 72.4 and 103.2 μg/mL, respectively. In this study, the highest free radical scavenging activity and also antimicrobial activity was exhibited by the methanolic extract of *Toona ciliata* leaves. It suggests that *Toona ciliata* leaves extract may become a promising antioxidant of *Meliaceae*. Moreover, remarkable cytotoxic activity against MCF7 cell line was found for the methanolic extracts of *Aglaia foveolta* leaves. The phytochemical screening demonstrated the presence of different types of compounds like phenol, flavonoids, and others, which could be responsible for the obtained activities.

Keywords: Meliaceae · antioxidant · antimicrobial · cytotoxicity · *Toona ciliata* · *Aglaia foveolata*

I. Nurlaila et al. (Eds.): ICHR 2022, AHSR 56, pp. 300–311, 2023.
https://doi.org/10.2991/978-94-6463-112-8_29

1 Introduction

Herbal plants play an important role in preventing and treating human diseases. Plants are considered as a source of phytochemicals that have medicinal value [1]. Approximately 60–80% of the world's population still relies on traditional medicines for the treatment of common illnesses [2]. The World Health Organization (WHO) reports that 80% of the world's population uses herbal medicines for some aspects of primary health care. About 11% of the 252 essential medicinal components derived from plants [1]. The family *Meliaceae* has diverse phytochemistry with many bioactive compounds, and different species are used in the production of cosmetics, medicines, and poisons (such as insecticides) [3].

Several species from the *Meliaceae* family have been tested for their antioxidant activity [4–6]. The effects of natural antioxidants can be through a variety of different mechanisms therefore it is important to prove their activity [7]. Antioxidants can attenuate the damaging effects of reactive oxygen species (ROS) in vitro and delay many events that contribute to cellular aging [8]. ROS are formed as a natural product of normal cell activity. Elevated ROS levels have harmful effects on cell homeostasis, structure, and function and generate oxidative stress [9]. The antioxidants scavenge radicals and inhibit the chain initiation or break the chain propagation [7].

Antimicrobial activity in this family has also been tested [6]. Misuse and mishandling of antibiotics has resulted in the emergence of groups of microorganisms that are not only resistant to antibiotics but also more tolerant to several ways of processing and preserving food, so that the use of natural antimicrobial compounds in food has received a lot of attention [10].

Cancer is one of the most dangerous diseases that cause death in humans. Breast and cervical cancer are the two most common causes of cancer in women worldwide [11]. Cytotoxic activity in several species of the *Meliaceae* family in the MCF7 cell line has been tested such as in *Chisocheton patens Blume* [12] and *Chisocheton penandrus* [13]. This paper reports the cytotoxic activity of the methanolic extracts of *Aglaia foveolta* leaves and stem bark against MCF7 cell line.

Phenolic and flavonoids compounds are such of the major antioxidants [7]. They have been shown to exert antioxidant, antimicrobial, cytotoxic, anti-aging, anti-inflammatory, antiviral, antihypertensive, anti-atherosclerosis, cardioprotective, anti-ulcerogenic, anti-neoplastic, anti-diabetic, anti-hepatotoxic, hypolipidemic, antiplatelet, neuroprotective and anticonvulsant activities [14].

In this study, we analyzed the antioxidant, antimicrobial and cytotoxic activities of eleven methanol extract derived from *Meliaceae* plant family, which were collected from Indonesia regions (Bogor and Bali Botanic Gardens). There are still limited reports in regards with these activities of *Toona ciliata* and *Aglaia foveolata* and some other plants species of *Meliaceae* family. Therefore, our objective in this study were to investigate the activity derived from species of *Meliaceae* family.

2 Materials and Methods

2.1 Preparation of Plant Materials

Plants sample belonging to the family of *Meliaceae* were collected from Bogor Botanic Gardens, West Java, Indonesia (GPS location: -6.597330508308246, 106.80191943070704) and Bali Botanic Gardens, Bali, Indonesia (GPS location: -8.281292339592786, 115.15658800044008). Each sample was identified by botanists from both locations on the basis of standard plant identification. Further, plant samples were dried and cut to the size of 0.5–1 cm. These samples were kept in the freezer and protected from light.

Extraction was conducted using maceration with methanol as a solvent. Briefly, samples were placed onto macerated with the ratio of 1:5 (samples: macerated): 50 gr sample on 250 mL methanol and placed at the room temperature for 48 h. Subsequently, solvent was separated and evaporated to obtain crude methanol extracts. The extraction process was carried out 3 times to each sample to optimize the amount of the corresponding extract. The plants used in the current study were: *Cipadessa baccifera* (leaves), *Aglaia tomentosa* (leaves, from Bengkulu province), *Aglaia tomentosa* (leaves, from Central Sulawesi Province), *Aglaia foveolata* (twig, leaves, stem bark), *Dysoxylum parasiticum* (leaves –from Sumatra Island), *Dysoxylum parasiticum* (leaves –from Java Island), *Toona sureni* (leaves), *Toona ciliata* (leaves), and *Sandoricum koetjape* (leaves).

2.2 Determination of Phenolic and Flavonoid Content

Calculation of total phenol and total flavonoid was carried out using the standard *Folin-Ciocalteu* Reagent (FCR) method and standard quercetin, respectively. The total phenolic and flavonoid content was determined using a standard describes elsewhere with slight modifications [15].

2.3 Antioxidant Assay (DPPH and ABTS Radical Scavenging Activity)

Antioxidant assay briefly was determined using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid (ABTS) solution. DPPH antioxidant test was carried out by dissolving the sample in methanol. The ABTS antioxidant test was carried out by oxidizing ABTS using potassium peroxydisulfate ($K_2S_2O_8$). The DPPH and ABTS value were determined using the method as describes elsewhere with slight modifications [16–18]. The inhibition value was regressed in the linear regression equation to obtain the 50% Inhibitory Capacity (IC_{50}) antioxidant capacity of each sample. The percentage of inhibitory activity was calculated using the equation:

$$\%\text{Inhibition} = \frac{\text{Absorbance control} - \text{Absorbance sample}}{\text{Absorbance control}} \times 100\%$$

2.4 Antimicrobial Assay (Determination of MIC and MBC)

Antimicrobial activity was determined using the standard serially microdilution method as describes elsewhere with slight modifications [19]. In this study, we used 2 common microbial tested collecting from Laboratory of Microbiology and Biochemistry, Research center for Pharmaceutical Ingredients and Traditional Medicine (BRIN). The microba are *Citrobacter freundii* (DSM30039) type of gram-negative bacteria and *Pichia anomala* (DSM6766) type of fungi. Minimum Inhibitory concentration (MIC) value was examined using a standard micro-dilution assay with some modifications [20].

2.5 Cytotoxicity Assay (Methyl Thiazolyl Tetrazolium Method)

The breast cancer (MCF7) cells were cultured in Dulbecco's Modified Eagle's Medium (DMEM) supplemented with 10% Fetal Bovine Serum (FBS) and Antibiotic-antimycotic. Incubation was carried out at 37 °C with an atmosphere of 5% CO_2. MCF7 cell line seeded (1 x 104 cells/mL) in 96-well plate containing DMEM + 10% FBS + Antibiotic-mycotic. After 24 h incubation in CO_2 incubator, the cells were added by various concentration of extracts (100, 50, 25, 12,5, 6,25, 3,175, 1,587 and 0,79 μg/mL). The extracts used were methanol extract. Each treatment had 2 replicates. After 48 h incubation, 10 μL of 3-(4,5-dimethylthiazol-2-yl)-2,5 diphenyl tetrazolium bromide (MTT) solution (5 mg/mL in D-Hank's) was added into each well, then incubated for 4 h at 37 °C. The media was carefully removed and the cells were dissolved in 200 μL DMSO. The absorbance was measured with an automated spectrophotometric microtiter plate reader at 570 nm wavelength. The 50% cell-inhibitory concentration (IC_{50}) was determined.

3 Results

Our results demonstrated that on the preliminary screening for antioxidant activity via DPPH radicals with concentration of 300 ppm. Each extract has a different total inhibition value ranging from 18.2 to 91.58% DPPH inhibition activity on the antioxidant tested (Table 1). The highest value indicating strong activity showed by *T. ciliata* leaves extract with the total inhibition of 91.58%, follow by *S. koetjape* 87.07%, *A. tomentosa*-Bengkulu 85.26%, *A. foveolta* stem bark 77.44%, *C. baccifera* 75.34%, *A. foveolta* twig 58.12%, and *A. foveolta* leaves 51.32%. For values above 50%, we focus on continuing to calculate the levels of phenols and flavonoids and IC_{50} of DPPH and ABTS. There are significantly different between *A. foveolta* - Bengkulu (85,26%) and *A. foveolta* – Sulawesi (29.32%), these results indicate that the compounds present in plants are strongly affected by the geographical location where they grow.

3.1 Total Phenolic and Total Flavonoid Content

Phenolic and flavonoid content was measured using the *Folin–Ciocalteu* reagent and quercetin standard with aluminum chloride method, respectively. The various concentrations (10–100 μg/mL) were used to construct standard curves. Total phenol and flavonoid

Table 1. Screening for antioxidant activity via DPPH radicals*

No	Samples	DPPH Inhibition activity (%)
1	*Cipadessa baccifera*	75.34
2	*Aglaia tomentosa, Bengkulu*	85.26
3	*Aglaia tomentosa, Central Sulawesi*	29.32
4	*Aglaia foveolate twig*	58.12
5	*Aglaia foveolata leaves*	51.32
6	*Aglaia foveolata stem bark*	77.44
7	*Dysoxylum parasiticum, Sumatera*	18.20
8	*Dysoxylum parasiticum, Jawa*	26.92
9	*Toona sureni*	48.57
10	*Toona ciliata*	91.58
11	*Sandoricum koetjape*	87.07

*concentration of 300 ppm.

were calculated based on the equivalent number of mg gallic acid (GAE)/g sample and mg quercetin/g extract, respectively (Table 2). The content of phenolic compounds in the methanol extract represented an approximate five-fold variation, ranging from 6.44 to 1.13 mg GAE/g extract. *A. tomentosa*-Bengkulu and *T. ciliata* and had the greatest phenolic contents (6.44 ± 0.33 and 6.11 ± 0.51 mg GAE/g extract, respectively), while the smallest phenolic contents were found in *A. foveolata* leaves and *C. baccifera* (1.13 ± 0.01 and 1.89 ± 0.02 mg GAE/g, respectively). The flavonoid content in methanol extracts ranged from 14.93 to 2.25 mg QE/g extract, representing an approximate six-fold variation. *T. ciliata* had the greatest flavonoid content (14.93 ± 0.71 mg QE/g extract), while the smallest amounts of flavonoids were found in *A. foveolta* stem bark, *C. baccifera* and *S. koetjapi* (2.25 ± 0.08, 2.25 ± 0.01 and 2.62 ± 0.02 mg QE/g extract respectively).

3.2 DPPH and ABTS Radical Scavenging Activity

The DPPH radical scavenging activities of selected medicinal plants are presented in Fig. 1. All plant extracts exhibited concentration-dependent increases in radical scavenging capacity. The greatest DPPH radical scavenging potency of with a minimum IC_{50} value was recorded for *T. ciliata* (7.68 ± 0.41 μg/mL), *A. tomentosa* – Bengkulu (31.94 ± 1.39 μg/mL), *S. koetjape* (40.73 ± 1.5 μg/mL), *A. foveolta* stem bark (95.35 ± 0.79 μg/mL), *C. baccifera* (109.18 ± 7.81 μg/mL), *A. foveolta* leaves (208.85 ± 5.3279 μg/mL), and *A. foveolta* twig (256.07 ± 1.34 79 μg/mL). These extracts exhibit a remarkable antioxidant effect at low concentrations. All data were compared with the IC_{50} value of ascorbic acid and standard quercetin (4.71 ± 0.69 and 2.71 ± 0.86 μg/mL, respectively) as showed in Table 2.

Table 2. Total phenolic and flavonoid contents of selected Meliaceae plants and DPPH and ABTS Radical Scavenging Activity

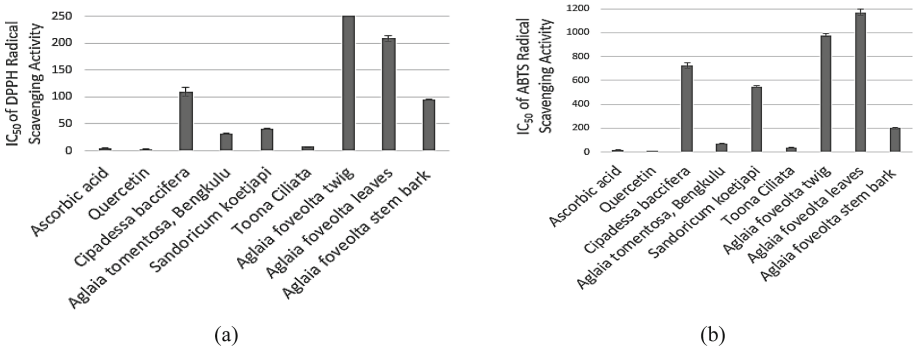
Plant Sample	TPC (mg GAE/ g extract)	TFC (mg QE/g extract)	DPPH radical scavenging activity, IC_{50} value (ppm)	ABTS radical scavenging activity, IC_{50} value (ppm)
Ascorbic acid	-	-	4.71 ± 0.69	19.55 ± 0.20
Quercetin	-	-	2.71 ± 0.86	8.69 ± 0.23
Cipadessa baccifera	1.89 ± 0.02	2.25 ± 0.01	109.18 ± 7.81	723 ± 22.83
Aglaia tomentosa-Bengkulu	6.11 ± 0.51	5.16 ± 0.11	31.94 ± 1.39	71.07 ± 0.61
Sandoricum koetjapi	2.21 ± 0.04	2.62 ± 0.02	40.73 ± 1.5	549.66 ± 8.51
Toona ciliata	6.44 ± 0.33	14.93 ± 0.71	7.68 ± 0.41	37.85 ± 0.23
Aglaia foveolta twig	2.11 ± 0.09	6.25 ± 1.79	256.07 ± 1.34	977.75 ± 11.89
Aglaia foveolta leaves	1.13 ± 0.01	5.75 ± 0.17	208.85 ± 5.32	1170.2 ± 25.83
Aglaia foveolta stem bark	3.13 ± 0.06	2.25 ± 0.08	95.35 ± 0.79	199.89 ± 6.31

TPC: total phenol content; TFC: total flavonoid content; GAE: gallic acid equivalents; QE: quercetin equivalents

Figure 1 shows the radical scavenging activity of ABTS from selected medicinal plants. All plant extracts exhibited a concentration-dependent increase in radical scavenging capacity. The greatest ABTS radical scavenging potency with a minimum IC_{50} value was recorded for *T. ciliata* (37.85 ± 0.23μg/mL), *A. tomentosa*–Bengkulu (71.07 ± 0.61μg/mL), *A. foveolata* stem bark (199.89 ± 6.31 μg/mL), *S. koetjape* (549.66 ± 8.51 μg/mL), *C. baccifera* (723 ± 22.83 μg/mL), *A. foveolata* twig (977.75 ± 11.89 μg/mL), and *Aglaia foveolata* leaves (1170.2 ± 25.83μg/mL). All data were compared with the IC_{50} value of standard quercetin and ascorbic acid (2.71 ± 0.86 and 4.71 ± 0.69 ppm, respectively), as shown in Table 2.

3.3 MIC and MBC

Each extract has the different total inhibition value ranging from 7.81 to 1,000 μg/mL on the microbial tested (Table 3). The lowest value indicating strong activity showed by *T. ciliata* leaves extract against *C. freundii* with the total inhibition of 7.81 μg/mL but low activity against *P. anomala* (1,000 μg/mL). From this screening, *T. ciliata* has the best antimicrobial activity among other plants. In the next stage, we investigate the MIC and MBC values. From the MIC and MBC tests, it was also seen that the smallest value for both *C. freundii* and *P. anomala* was shown by *T. ciliata* plants, which means that *T. ciliata* had the best antimicrobial activity among plants that had previously been screened.



(a) (b)

Fig. 1. (a) Comparison of DPPH• scavenging activity of ascorbic acid, quercetin and selected *Meliaceae* plants. (b) Comparison of ABTS• scavenging activity of ascorbic acid, quercetin and selected *Meliaceae* plants.

Table 3. Antimicrobial activity of Meliaceae-derived extracts against *C. freundii* and *P. anomala* and the MIC and MBC values

Plant Samples	**MIC (μg/mL)**		**MBC (μg/mL)**	
	Citrobacter freundii	***Pichia anomala***	***Citrobacter freundii***	***Pichia anomala***
Tetracycline	31.25	ND	31.25	ND
Streptomycin	ND	31.25	ND	31.25
Cipadessa baccifera	1000	-	>1000	-
Aglaia tomentosa, Bengkulu	500	-	750	-
Sandoricum koetjape	500	250	750	250
Toona ciliata	62.5	125	62.5	125
Aglaia foveolta, twig	-	-	-	-
Aglaia foveolta, leaves	-	1000	-	1000
Aglaia foveolta, stem bark	250	-	500	-

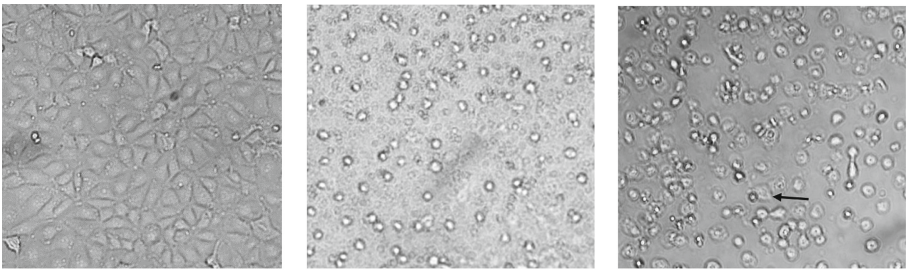
"-": not active at 1000 ppm; MIC more than 1000 ppm. "ND": Not Determine

3.4 Cytotoxicity (MTT)

Antioxidant screening has been carried out. High levels of inhibition or above 50% were taken to be tested for further antioxidant activity, while those with low levels of inhibition were selected to be tested for cytotoxic activity. The cytotoxic effect on the MCF7 cell line was evaluated using a standard MTT assay. From the 11 plants, 6 plants were taken to be tested for their cytotoxic activity on the MCF7 cell line as shown in Table 4. The best cytotoxic activity was seen in *A. foveolta* leaves, which was 95.80 ± 0.49 μg/mL. Then, it was decided to look for IC_{50} on both *A. foveolata* leaves and stem bark i.e. 72.4 and 103.2 μg/mL, respectively.

Table 4. Screening of potential cytotoxic inhibition and IC_{50} value of *A. foveolata* stem bark and leaves

Samples	**Mean ± SD (µg/mL) % inhibition at a concentration of 100 ppm**	**IC_{50} (ppm)**
Untreated MCF7 cell line	28.74 ± 13.41	-
Doxorubicin	75.29 ± 9.35	-
Dysoxylum parasiticum - Sumatera	88.85 ± 5.93	-
Aglaia tomentosa - Central Sulawesi	80.40 ± 12.84	-
Dysoxylum parasiticum - Jawa	94.31 ± 1.46	-
Toona sureni	47.36 ± 18.94	-
Aglaia foveolata stem bark	60.40 ± 5.62	103.2
Aglaia foveolata leaves	95.80 ± 0.49	72.4



(a) (b) (c)

Fig. 2. (a) untreated MCF7 cell line (b) MCF7 cell line after *A. foveolata* leaves treatment. (c) MCF7 cell line after *A. foveolata* stem bark treatment.

Figure 2 panel a shows confluent untreated breast cancer while panel b depicts dying morphology of the cancer cells after *A. foveolata* leaves treatment. Panel c demonstrates the cancer cells post *A. foveolata* stem bark treatment. Unlike in Panel b where cells are mostly dying, in Panel b cells are seen to be alive although they are not in a close contact to each other. This suggests that *A. foveolata* stem bark has a lower level of toxicity than *A. foveolata* leaves.

4 Discussion

Solvent and extraction procedures are of essential variable for dissolving plant endogenous compounds. Phenolic compounds are more soluble in polar organic solvents due to the presence of hydroxyl groups, so methanol was chosen as the extraction solvent. Flavonoids are secondary metabolites which antioxidant activity and potency depend on the number and position of free OH groups [18]. The highest phenol and flavonoid content of the 7 extractions in this study was *T. ciliata*. Hossain et al. reported in 2014 that *T.*

ciliata also have high total phenolic and flavonoid content (239.2 ± 2.53 mg/g gallic acid and 98.36 ± 1.07 mg/g quercetin equivalent) [5]. The value of phenolic content in this study is different compared to the literature. This may be due to the presence of different amounts of sugars, carotenoids or ascorbic acid, or the duration, geographical variation or methods of extraction. Genetic diversity and biological, environmental, seasonal, and year-to-year variations significantly also can affect the flavonoid content of vegetables [18].

DPPH assay is use to evaluate the radical scavenging potency of plant extracts. It is based on reduction of the violet DPPH radical by the antioxidant via a hydrogen atom transfer mechanism to cause a change in the color to stable pale-yellow DPPH molecules [18, 21]. ABTS can be oxidized by manganese dioxide or potassium persulfate. The ABTS radical (ABTS• +) was formed by losing an electron by the nitrogen atom of ABTS. In the presence of Trolox, the nitrogen atom quenched the hydrogen atom, yielding the solution decolorization, and the absorbance at 743nm was decreased [22]. Aerobic metabolism in most cells is important for the production of energy, which in this process generates free oxygen radicals or reactive oxygen species (ROS). Excessive ROS production can cause oxidative chain reactions resulting in an imbalance of oxidants and antioxidants in the body which can cause molecular damage and changes in several health conditions. Antioxidants can delay or inhibit oxidative reactions, thus limiting oxidative damage [23].

The highest antioxidant activity from DPPH and ABTS assay is at *T. ciliata*. The result is close to the reference value of ascorbic acid. Comparing the Vinodhini's study, the crude methanol of their extracts has shown maximal percentage inhibition 67.87 ± 0.24. The percentage inhibition of ascorbic acid which was used as the standard drug was 98.09 ± 0.05 [6] and study from Kavitha upon evaluation of antioxidant activity using DPPH and ABTS method showed IC_{50} value ranging from 100–150 μg/mL and 80–150 μg/mL respectively with different test solvent extracts [4]. All the tested samples show antioxidant activity but less than the standard. The results of this assay indicated that T. ciliata might be responsible for this scavenging activity due to the presence of flavonoids, terpenoids and phenolic compounds [6].

T. ciliata had the best antimicrobial activity among plants that had previously been screened. This is in line with Ayitso's research which showed that *T. ciliata* (one of the vegetation studied) had a significant antimicrobial effect when tested on *C. freundii* (one of the microbes in this study) indicated by the length of its zone of inhibition [24]. The high content of flavonoids can affect the antimicrobial activity. Flavonoids are reported to be involved in the inhibition of nucleic acid biosynthesis and other metabolic processes and inhibit the germination of plant pathogenic spores [25]. Phenolic and flavonoid compounds have been reported previously as antimicrobials in other microbial strains.

The cytotoxic activity of plant extracts is shown to increase the death of various tumor cell lines through different mechanisms such as apoptosis, necrosis and autophagy. Apoptosis using the mitochondrial pathway can be caused by the strong cytotoxic activity of flavonoids which are derivatives of catechin and quercetin [26]. Very potent in vitro cytotoxic activity against several human cancer cell lines was discovered by Kim in 2007 in the fruit and twigs of A. foveolata which showed the presence of silvestrol content [27]. Base on Salim study about constituents of the leaves and stem bark of *A. foveolata*

in 2007, they isolated new compound and tested against a panel of cancer cell lines, and found the cytotoxic compound was the first member of cyclopenta benzopyran class which also showed significant NF-κB inhibitory activity [28].

5 Conclusion

The results of our screening assays confirmed the use of the investigated *Meliaceae* family plants. It is the first report about antioxidant, antimicrobial, and cytotoxic effects of *A. tomentosa*-Bengkulu, *A. tomentosa*-Central Sulawesi, specific part of *A. foveolata* (twig, stem bark, and leaves). Whereas other plants like *C. baccifera*, *A. foveolta*, and *T. ciliata* have been partially investigated. From this study, *A. foveolata* (leaves) elicited both antioxidant and antimicrobial activities. This aspires for more discoveries on Meliaceae plants that might be promising to be harnessed as antioxidant, antimicrobial and cytotoxic simultaneously.

Acknowledgement. This work was supported by the grant of research collaborative program with Leibniz University of Hannover, Germany under "SILVIR Project" 2020.

References

1. A.K. Shakya, *Medicinal plants: Future source of new drugs* (Int. J. Herb. Med, India, 2016) vol. 4, pp. 59–64
2. R. A. A. Mothana and S. A. A. Abdo, *Antimicrobial, antioxidant and cytotoxic activities and phytochemical screening of some yemeni medicinal plants* (Hindawi, London, 2008) vol. 7 no. 3, pp. 323–330
3. M. Heads, *Biogeography and ecology in a pantropical family, the Meliaceae* (Gard. Bull., Singapore, 2019) vol. 71, pp. 335–461
4. H. Hossain and P. N. Akbar, *In Vivo Anti-Inflammatory and in Vitro Antioxidant Activities of Toona Ciliata Leaves Native to Bangladesh.* (Glob. Journals Inc, USA, 2014). vol. 14. Online ISSN: 2249-461
5. V. Vinodhini and T. S. Lokeswari, *Antioxidant activity of the isolated compounds, methanolic and hexane extracts of Toona ciliata leaves* (Int. J. Eng. Technol, UK, 2014) Vol.4 no. 3. ISSN 2049-3444
6. K. S. Kavitha and S. Satish *Evaluation of antimicrobial and antioxidant activities from Toona ciliata Roemer* (J. Anal. Sci. Technol, Korea, 2013) vol. 4 no. 1, pp. 1–7
7. I. Seck and A. Hosu, *Phytochemicals content, screening and antioxidant/pro-oxidant activities of Carapa procera (barks)(Meliaceae)* (South African J of Botany, Southern Africa, 2021). pp 369-376
8. B. Poljsak and D. Šuput, *Achieving the balance between ROS and antioxidants: When to use the synthetic antioxidants* (Oxid. Med. Cell. Longev. Volume 2013). 11 pages
9. A. V. Snezhkina and A. V. Kudryavtseva, *ROS generation and antioxidant defense systems in normal and malignant cells* (Oxid. Med. Cell. Longev, Hindawi, London, 2019). vol. 2019 17 pages
10. R. Gyawali and S. S. Ibrahim, *Natural products as antimicrobial agents* (Food Control, Science Direct, 2014) vol 46, pp 412–429

11. E. A. Elsayed and M. A. Sharaf-Eldin, *In vitro Evaluation of Cytotoxic Activities of Essential Oil from Moringa oleifera Seeds on HeLa, HepG2, MCF-7, CACO-2 and L929 Cell Lines* (Asian Pacific J. Cancer Prev., China, 2015) vol. 16, no. 11, pp. 4671–4675
12. U. Supratman and W. Naibaho, *Cytotoxic Triterpenoids from the Bark of Chisocheton patens Blume (Meliaceae)* (Phytochem. Lett., UK, 2019). vol. 30, pp. 81–87
13. Supriatno and Nurlaelasari, *A new limonoid from stem bark of Chisocheton pentandrus (Meliaceae)* (Nat. Prod. Res., UK, 2018) vol. 32, no. 21, pp. 2610–2616
14. N. S. Jaafar and M. N. Hamad, *Qualitative phytochemical comparison between flavonoids and phenolic acids contents of leaves and fruits of melia azedarach (Family: Meliaceae) cultivated in Iraq by HPLC and HPTLC* (Int. Journal Phar and Parmaceutical Sci, Canada, 2016). vol.8, ISSN 0975-1941
15. F. Ghafar and T. N. Nadzirah, *Total phenolic content and total flavonoid content in moringa oleifera seed* (Sci Heritage Journal, UK, 2017) vol. 1, no. 1, pp. 23–25
16. M. E. Prastya and R. I. Astuti, *Bacillus sp. SAB E-41-derived extract shows antiaging properties via ctt1-mediated oxidative stress tolerance response in yeast Schizosaccharomyces pombe* (Asian Pac. J. Trop. Biomed, China, 2021). vol. 8, no. 11, p. 533–539
17. R. Re and N. Pellegrini, *Antioxidant activity applying an improved ABTS radical cation decolorization assay* (Free Radic. Biol. Med., 1999) vol. 26, 12 pages
18. S. Aryal and M. K. Baniya, *Total Phenolic Content, Flavonoid Content and Antioxidant Potential of Wild Vegetables from Western Nepal* (Plants, Switzerland, 2019) vol. 8, no. 4
19. F. Blando and R. Russo, *Antimicrobial and Antibiofilm Activity against Staphylococcus aureus of Opuntia ficus-indica (L.) Mill. Cladode Polyphenolic Extracts* (Antioxidants, Switzerland, 2019), vol. 8, Page 117
20. N. C. for C. L. S. NCCLS. *Performance standards for antimicrobial disk susceptibility tests. Methods for dilution antimicrobial susceptibility tests for bacteria that grow aerobically*. (2020)
21. K. Sirivibulkovit and S. Nouanthavong, *Paper-based DPPH Assay for Antioxidant Activity Analysis* (Anal. Sci. 2018) vol. 34, no. 7, pp. 795–800
22. F. Xiao and T. Xu, *Guidelines for antioxidant assays for food components* (Food Front, China, 2020) pp. 60–69
23. K. -X. Zhou and M. S. Braun, *Antioxidant, Cytotoxic, and Antimicrobial Activities of Glycyrrhiza glabra L., Paeonia lactiflora Pall., and Eriobotrya japonica (Thunb.) Lindl. Extracts* (Medicines 2019) vol. 6, p. 43
24. A. Ayitso and D. M. Onyango, *Antimicrobial Activities of Microorganisms Obtained from the gut of Macrotermes michaelseni in Maseno, Kenya* (J. Appl. Biol. Biotechnol. 2015) vol. 3, no. 06, pp. 48–052
25. S. A. Baba and S. A. Malik, *Determination of total phenolic and flavonoid content, antimicrobial and antioxidant activity of a root extract of Arisaema jacquemontii Blume* (J. Taibah Univ. Sci., 2015). vol. 9, no.4, pp. 449–454
26. U. P. Santos and J. F. Campos, *Antioxidant, Antimicrobial and Cytotoxic Properties as Well as the Phenolic Content of the Extract from Hancornia speciosa Gomes* (PLoS One, 2016). vol. 11, no. 12, p. e0167531
27. S. Kim and B. Y. Hwang, *Silvestrol, a Potential Anticancer Rocaglate Derivative from Aglaia foveolata, Induces Apoptosis in LNCaP Cells through the Mitochondrial/Apoptosome Pathway without Activation of Executioner Caspase-3 or -7* (Anticancer Res., 2007). vol. 27, no. 4B 2175–2183
28. A. A. Salim and H. B. Chai, *Constituents of the leaves and stem bark of Aglaia foveolata* (Tetrahedron, 2007) vol. 63, no. 33, pp. 7926–7934