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ORIGINAL ARTICLE

In vitro Antioxidant and Antidiabetic Activities of Leaf and Flower Extracts from *Bombax ceiba*

Nurarat Kriintong, Teeraporn Katisart

Department of Biology, Faculty of Science, Mahasarakham University, Kantharawichai, Maha Sarakham, Thailand

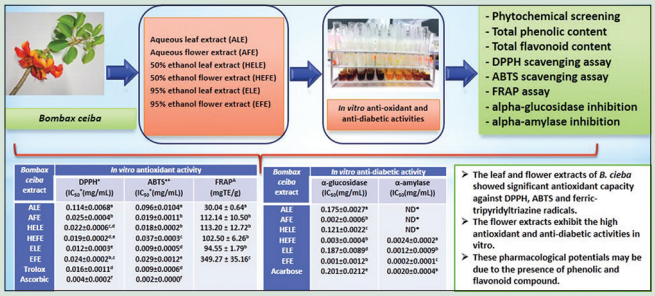
ABSTRACT

Context: *Bombax ceiba* is belonging to the family *Bombacaceae*. Dried stamen of this plant is used as vegetable and food ingredients for people in the Northern part of Thailand. There are very few reports on the biological activities in this plant, especially the flower parts. **Objectives:** The present study aimed to demonstrate the phytochemical screening and *in vitro* antioxidant and antidiabetic activities of crude extracts from *B. ceiba*. **Materials and Methods:** The leaf and flower part of *B. ceiba* were extracted using different solvents including water, 50% ethanol, and 95% ethanol. The phytochemical constituents were determined using standard qualitative methods. Total phenolic content (TPC) and total flavonoid content (TFC) were analyzed by colorimetric methods. 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay, 2,2-azino-bis-(3-ethylbenzothaizoline-6-sulphonate (ABTS) assay, and ferric reducing antioxidant power (FRAP) assay were used to investigate the *in vitro* antioxidant and antidiabetic activities of the extracts. For *in vitro* antidiabetic activities, α-glucosidase and α-amylase inhibitory effects were tested. **Results:** Phytochemical screening indicated the presence of alkaloids, flavonoids, coumarins, saponins, tannins, terpenoids, and cardiac glycosides in this plant. The highest TPC and TFC were found in 95% ethanol flower extract (2.73 ± 0.064 mg gallic acid equivalent/g and 28.25 ± 2.33 mg quercetin equivalent/g, respectively.). However, the highest antioxidant activity (DPPH and ABTS + assay) was found in 95% ethanol leaf extract (0.012 ± 0.0003, 0.009 ± 0.0005 mg/mL, respectively.) and FRAP assay was found in 95% ethanol flower extract (349.27 ± 35.16 mg trolox equivalent/g). The highest α-glucosidase and α-amylase inhibitory activities were found in 95% ethanol flower extract (0.001 ± 0.0012 and 0.0002 ± 0.0001 mg/mL, respectively). **Conclusion:** The crude extracts from *B. ceiba* showed the potent *in vitro* antioxidant and antidiabetic activities, especially the flower extracts. These findings confirm the ethnobotanical uses of *B. ceiba* as food and medicinal plants. Further studies on biological and pharmacological activities of this plant in the animal model and clinical trials must be carried out to confirm the use in medical aspects.

Key words: *Bombax ceiba* leaf and flower extracts, *in vitro* antidiabetic inhibitory activity, *in vitro* antioxidant activity, phytochemical screening

SUMMARY

- Phytochemical constituents revealed the presence of alkaloids, flavonoids, coumarins, saponins, tannins, terpenoids, and cardiac glycosides in *Bombax ceiba* extracts. The highest total phenolic content and total flavonoid content were found in 95% ethanol flower extract. The highest antioxidant activity (2,2-diphenyl-1-picrylhydrazyl and 2,2-azinobis-(3-ethylbenzothaizoline-6-sulphonate + assay) was found in 95% ethanol leaf extract and ferric reducing antioxidant power assay was found 95% ethanol flower extract. The highest α-glucosidase and α-amylase inhibitory activities were found in 95% ethanol flower extract. The crude extracts from *B. ceiba* showed the potent *in vitro* antioxidant and antidiabetic activities, especially the flower extracts. These findings confirm the ethnobotanical uses of *B. ceiba* as food and medicinal plants. Further studies on biological and pharmacological activities of this plant in the animal model and clinical trials must be carried out to confirm the use of this plant in medical aspects.



Abbreviations used: ALE: Aqueous leaf extract; AFE: Aqueous flower extract; HELE: 50% ethanol leaf extract; HEFE: 50% ethanol flower extract; ELE: 95% ethanol leaf extract; EFE: 95% ethanol flower extract; DPPH: 2,2-diphenyl-1-picrylhydrazyl; ABTS: 2,2-azino-bis-(3-ethylbenzothaizoline-6-sulphonate; FRAP: Ferric reducing antioxidant power; TPC: Total phenolic content; TFC: Total flavonoid content.

Correspondence:
Dr. Teeraporn Katisart,
Department of Biology, Faculty of Science,
Mahasarakham University, Talat, Maha Sarakham,
44150, Thailand.
E-mail: tkatisart@gmail.com
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INTRODUCTION

Bombax ceiba (*Bombacaceae*), also known as Ngui (in Thai), is found and grown in Africa, Australia, and Asia including Thailand.[1] The pharmacological studies in this plant provided the information that *B. ceiba* exhibits various biological activities such as astringent, cooling, stimulant, diuretic, aphrodisiac, demulcent, and tonic activities.[2]

It was found that the young roots of *B. ceiba* have hypoglycemic, hypolipidemic, and hepatoprotective activities and confirm the traditional uses of this plant to manage diabetes and its associated liver toxicity.[3] In addition, the male rat treated with young root extracts of this plant has improved sexual performances and behaviors.[4]

The methanolic stem bark extract of this plant has excellent anti-obesity activity in rats induced by a high-fat diet.[5] Bark and seeds powder has hyperlipidemic activity with a reduction in serum and tissue lipid profiles.[6] The lupeol from stem bark exhibits the inhibitory effect on human umbilical venous endothelial cells (HUVEC) tube formation without affecting the growth of tumor cell lines.[7] It is reported that there are triterpenoid compounds in the stem bark extract, which could be responsible for lowering blood glucose levels.[8]

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The leaf extracts displayed significant wound healing activity.[9] They also showed a remarkable hypoglycemic and hypolipidemic activity which is related to Type 2 diabetes. Moreover, the antidiabetic activity of *B. ceiba* leaf extracts may due to the antioxidant activity and pancreatic β-cell histology improvement.[10] The mangiferin in leaf extracts improved the diabetic complications in the kidney and decreased free radicals in meningeal cells.[11] In addition, the leaf extracts exhibit the antianxiety activity.[12] The leaf extracts of this plant improved the stress behaviors in animal models. The leaf extracts also increased the antioxidant values in brain tissues of rats.[13]

It is reported that the flower extract has an excellent antioxidant activities.[14] The methanolic flower extract of *B. ceiba* has the protective effects against cytotoxicity in the cell line.[15] The flowers of this plant also could improve liver function in the animal model which may due to its antioxidant potential.[16] The aqueous flower extract prevents against cardiotoxicity.[17] The flower extracts possess a protective effect on the gastric injury.[18] The flower extracts also showed the inhibitory effects on renal cancer cell lines. The biological activity of *B. ceiba* flower extracts may relate to the presence of ß-sitosterol and fatty acids.[19] The aqueous methanol flower extract exhibits the hepatoprotective activity.[20]

The fruit of *B. ceiba* possesses the lithotriptic activity confirming the use in the treatment of urolithiasis.[21] The fruit extracts also have diuretic activity.[22] The leaf and flower extracts of *B. malabaricum* which is a synonym of *B. ceiba* possess significant antipyretic[23] and antioxidant activities, respectively.[24]

The phytochemical screening revealed that flower extracts of this plant consist of three xanthones and nine flavonoids.[25] Another study found that the flowers comprise ten flavonoids, quercetin, four coumarins, and seven other compounds.[26]

For ethnobotanical uses, it was found that androecium of this plant is used as a food ingredient for Indian people.[27] Some parts of this plant are edible that is famous in the Northern part Thailand. People use flowers to cook as curry soup, called "Nam Ngiao" served with rice noodles.[28] However, there are a few scientific reports on the biological activities of leaf and flower of *B. ceiba*. Therefore, this study was carried out to study the *in vitro* antioxidant and antidiabetic activities of *B. ceiba* leaf and flower extracts.

MATERIALS AND METHODS

Plant preparation and extraction

Leaf and flower parts of *B. ceiba* were used for extractions. They were collected from the cultivation area in Phichit Province, Northern part of Thailand. They were washed by running through tap water and then dried in a hot air oven at 40°C for 18 h. Then, they were ground as fine power using an electrical grinder. The aqueous extracts were prepared by added 100 g of dry powder of leaf and flower into 1000 mL of distilled water and boiled at 100°C 10 min for three times. The 50% and 95% ethanol extracts were prepared by adding 100 g of dry powder of leaf and flower in 400 mL of 50% and 95% ethanol and macerated for 7 days. The crude residues were filtered using filter paper Whatman No. 1. The filtrates were obtained by removing the solvents in a rotary evaporator and then freeze-dried as a fine powder and kept at −20°C until used.

Phytochemical screening

The leaf and flower extracts of *B. ceiba* were screened for the presence of alkaloids, flavonoids, coumarins, anthraquinones, saponins, tannins, terpenoids, steroids, and cardiac glycosides. The experiment was performed using standard qualitative methods described by Wadood *et al.*[29] with some modifications.

Determination of total phenolic content

The total phenolic content (TPC) was investigated by Folin Ciocalteu's method and described by Singleton *et al.*[30] with some modifications. Briefly, 100 µL of the gallic acid solution (standard) and samples was prepared in a 10 mL test tube. Five hundred microliter of the Folin–Ciocalteu's reagent was added and mixed. One hundred microliter distilled water was used as a blank. After that, 400 µL of 7.5% Na_2CO_3 solution was added in each tube and mixed well. The samples were left to react at 25°C for 30 min in the dark room. Ultraviolet–visible (UV-Vis) spectrophotometer was used to measure the absorbance at 765 nm. Five replications were performed in each treatment. The TPC value was expressed as mg gallic acid equivalents (GAE) per g sample.

Determination of total flavonoid content

The total flavonoid content (TFC) was investigated by a colorimetric method and described by Zhishen *et al.*[31] with some modifications. One hundred microliter of the quercetin solution and samples was prepared in a 10 mL test tube. Four hundred micro liter of 2.5% $NaNO_2$ was added and mixed. The blank used 100 µL distilled water instead of the standard solution and samples. Thereafter, 500 µL of 5% $AlCl_3$ solution and 2000 µL of distilled water were added. The samples were allowed to react at 25°C for 10 min. The absorbance was measured using UV-Vis spectrophotometer at 415 nm. The experiments were repeated five times. The TFC value was expressed as mg quercetin equivalents (QEs) in per g sample.

Determination of *in vitro* antioxidant activity

2,2-diphenyl-1-picrylhydrazyl radical scavenging assay

2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay was carried out by the modified method described by Brand-Williams *et al.*[32] One millimeter DPPH was dissolved in distilled water. One hundred microliter of the standard solution and samples was prepared. Nine hundred microliter of 1 mM DPPH solution was added and allowed to react for 30 min at 25°C. The absorbance was measured at 515 nm to determine the DPPH radical inhibitory activity of the extracts. The experiments were repeated five times. In the present study, the positive controls were ascorbic acid and trolox. The results were expressed as a percentage inhibition of DPPH calculated from the following formula.

% radical inhibition = $([A_0 - A_1]/A_0) \times 100$

Whereas, A_0 = Absorbance of blank, A_1 = Absorbance of sample

Half-maximal inhibitory concentration (IC_{50}) was calculated from the calibration curve by linear regression.

2,2-azinobis-(3-ethylbenzothaizoline-6-sulphonate radical scavenging assay

The procedure described by Re *et al.*[33] was followed. Seven millimeter of 2,2-azinobis-(3-ethylbenzothaizoline-6-sulphonate (ABTS) was dissolved in $K_2S_2O_8$ solution with pH 7.4. The ABTS solution was left at 25°C for 16 h in the dark and then dilute ABTS solution by distilled water in ratio 1:50, respectively. Aliquots of 100 µL of the standard solution and samples were prepared in a 10 mL test tube and 900 µl of ABTS solution was added and allowed to react 25°C for 6 min. The ABTS inhibition was measured by the reduction in absorbance at 734 nm. The positive control was ascorbic acid and trolox, while distilled water was used as a negative control and as blank. IC_{50} was determined from the standard curve.

Ferric reducing antioxidant power radical scavenging assay

Ferric reducing antioxidant power (FRAP) assay was adapted from Benzie and Strain[34] with some modifications. The FRAP reagent containing 2.5 mL of a 10 mM 2,4,6-tripyridy-s-triazine solution was prepared in 40 mM HCl plus 2.5 mL of 20 mM $FeCl_3$ and 25 mL of 0.3 mM acetate buffer, pH 3.6. The reagent was prepared freshly and

incubated at 37°C for 60 min. One hundred microliter of the standard solution and samples was prepared. 900 µL of FRAP solution was added and allowed to react 25°C for 5 min. The experiments were repeated five times. Trolox was used as a positive control. The absorbance was measured at 593 nm. The inhibition of a ferric-tripyridyltriazine value was expressed as mg trolox equivalents (TEs) per g sample.

Determination of *in vitro* antidiabetic activities

α-Glucosidase inhibition assay

The ability of *B. ceiba* extract to inhibit α-glucosidase that was performed using the colorimetric methods was described in Dong *et al.*'s study[35] with some modifications. One hundred microliter of the standard solution and samples was prepared. One hundred microliter of 1 unit/mL α-glucosidase in 0.1 M potassium phosphate buffer (pH 6.8) was prepared. After incubation at 37°C for 20 min, 100 µL of 2 mM pNP-G in the buffer was added; then, the solution was incubated at 37°C for 20 min. Three hundred and twenty microliter of 1 mM Na_2CO_3 in the buffer was added to stop the reaction. The absorbance was measured at 405 nm. Acarbose was used as a positive control, while a 0.1 M potassium phosphate buffer was used as a negative control. IC_{50} was calculated from the standard curve. The results were expressed as percentage inhibition of α-glucosidase compared to the controls.

% inhibition = ([A0 − A1]/A0) ×100

Whereas, A_0 = Absorbance of blank, A_1 = Absorbance of sample

IC_{50} values were calculated with a standard curve plotted by inhibition percentage against the concentration.

α-Amylase inhibition assay

The α-amylase inhibition protocol was adapted from the method described by Akkarachaiyasit.[36] α-Amylase was dissolved in sodium phosphate buffer pH 6.9 to adjust a concentration of 3 unit/mL solution. Rice starch (1% w/v) was dissolved in hot water. The α-amylase 150 µL, leaf and flower extract of *B. ceiba* or acarbose (standard) 20 µL, 180 µL of sodium phosphate buffer pH 6.9, and 150 µL of starch solution were added. The solution was incubated at 37°C for 10 min. Then, 1% 3,5-dinitrosalicylic acid (DNS) 500 µL was added. Thereafter, the solution was decocted for 10 min. Five hundred microliter sodium potassium tartrate was added. The inhibition of α-amylase activity was measured at a wavelength of 540 nm. Acarbose was used as a positive control and 0.1 M potassium phosphate buffer as a negative control and as blank. IC_{50} was determined from the standard curve.

Statistical analysis

All data were expressed as mean ± standard error of mean with $n = 5$. The difference among means was tested using one-way analysis of variance followed by Duncan multiple range test. $P < 0.05$ was considered statistically significance. Statistical analysis was carried out using SPSS Statistics version 23.0 (IBM; New Orchard Road, Armonk, New York, United States).

RESULTS

Phytochemical constituents

Qualitative phytochemical screening of leaf and flower extract of *B. ceiba* demonstrated that the extracts contain alkaloids, flavonoids, glycosides, and coumarins. However, there are no anthraquinone and steroid in this plant [Table 1].

Total phenolic and flavonoid content

EFE of *B. ceiba* obviously showed the highest TPC and TFC (2.73 ± 0.064 mg GAE/g, 28.25 ± 2.33 mg QE/g, respectively), while ALE showed the lowest TPC and TFC (0.09 ± 0.002 mg GAE/g, 1.34 ± 0.09 mg QE/g, respectively) compared with other extracts [Table 2].

In vitro antioxidant activities

2,2-diphenyl-1-picrylhydrazyl radical scavenging activity

The DPPH radical scavenging activities of *B. ceiba* (IC_{50} values) are shown in Table 3. It was found that both leaf extracts (95% ethanol leaf extract [ELE]) (IC_{50} = 0.012 ± 0.0003 mg/mL) and flower extracts (50% ethanol flower extract [HEFE]) (IC_{50} = 0.019 ± 0.0002 mg/mL) exhibited strong radical scavenging activity compared to those of the standard trolox (IC_{50} = 0.016 ± 0.0011 mg/mL). However, the extracts had the less potent antioxidant activity than those of the standard ascorbic acid (IC_{50} = 0.004 ± 0.0002 mg/mL).

2,2-azinobis-(3-ethylbenzothaizoline-6-sulphonate radical scavenging activity

The result indicated that the plants extracts inhibited the ABTS + radicals; the lowest IC_{50} values were found in ELE (0.009 ± 0.0005 mg/mL), while highest IC_{50} values were found in AFE (0.197 ± 0.0011 mg/mL), as shown in Table 3. However IC_{50} values of ELE were almost similar to those of the standard trolox (0.009 ± 0.0006 mg/mL).

Ferric reducing antioxidant power radical scavenging activity

The reducing power of the extracts of different solutions is shown in Table 3. EFE obviously showed the highest ability to reduce Fe^{2+} (349.27 ± 35.16 mg TE/g), while ALE (30.04 ± 0.64 mg TE/g) showed the lowest compared to other extracts ($P < 0.05$).

In vitro antidiabetic activities

α-Glucosidase inhibitory activity

The IC_{50} values of α-glucosidase inhibition of EFE, AFE, and HEFE were 0.001 ± 0.0012, 0.002 ± 0.0006, and 0.003 ± 0.0004 mg/mL, respectively. The high IC_{50} values of α-glucosidase inhibition of HELE, ALE, and ELE of *B. ceiba* leaves were 0.121 ± 0.0022, 0.175 ± 0.0027, and 0.187 ± 0.0089 mg/mL, respectively, as shown in Table 4.

α-Amylase inhibitory activity

In this study, the IC_{50} value of α-amylase inhibition of EFE was

Table 1: Phytochemical constituent's different solvent of *Bombax ceiba* extracts

Bombax ceiba extract	Alkaloid	Flavonoid	Anthra quinone	Coumarin	Saponin	Tannin	Terpenoid	Steroid	Cardiac glycoside
ALE	+	+	−	+	−	+	−	−	+
AFE	−	+	−	+	−	−	−	−	−
HELE	+	+	−	+	+	+	−	−	+
HEFE	+	+	−	+	−	−	−	−	−
ELE	+	+	−	+	+	+	−	−	+
EFE	+	+	−	−	−	−	+	−	−

−: Absence; +: Presence; ALE: Aqueous leaf extract; AFE: Aqueous flower extract; HELE: 50% ethanol leaf extract; HEFE: 50% ethanol flower extract; ELE: 95% ethanol leaf extract; EFE: 95% ethanol flower extract

Table 2: Total phenolic content and total flavonoid content of *Bombax ceiba* extracts

Bombax ceiba extract	TPC[A] (mg GAE/g)	TFC[B] (mg QE/g)
ALE	0.09±0.002[a]	1.34±0.09[a]
AFE	0.82±0.014[b]	8.71±0.59[b]
HELE	1.01±0.013[c]	13.22±3.15[c]
HEFE	1.15±0.023[d]	16.33±0.49[d]
ELE	1.67±0.026[e]	16.87±2.67[d]
EFE	2.73±0.064[f]	28.25±2.33[e]

[a-f]Different letters in the same row indicate significance (P<0.05); [A]Results were expressed as mean±SD (n=5) and as mg GAE in 1 g sample; [B]Results were expressed as mean±SD (n=5) and as mg QE in 1 g sample. TPC: Total phenolic content; TFC: Total flavonoid content; ALE: Aqueous leaf extract; AFE: Aqueous flower extract; HELE: 50% ethanol leaf extract; HEFE: 50% ethanol flower extract; ELE: 95% ethanol leaf extract; EFE: 95% ethanol flower extract; SD: Standard deviation

Table 3: *In vitro* antioxidant activities of *Bombax ceiba* extracts

Bombax ceiba extract	Antioxidant activity		
	DPPH (IC_{50}, mg/mL)	ABTS (IC_{50}, mg/mL)	FRAP (mg TE/g)
ALE	0.114±0.0068[a]	0.096±0.0104[a]	30.04±0.64[a]
AFE	0.025±0.0004[b]	0.019±0.0011[b]	112.14±10.50[b]
HELE	0.022±0.0006[c,d]	0.018±0.0002[b]	113.20±12.72[b]
HEFE	0.019±0.0002[d,e]	0.037±0.0003[c]	102.50±6.26[b]
ELE	0.012±0.0003[e]	0.009±0.0005[d]	94.55±1.79[b]
EFE	0.024±0.0002[b,c]	0.029±0.0012[e]	349.27±35.16[c]
Trolox	0.016±0.0011[d]	0.009±0.0006[d]	
Ascorbic	0.004±0.0002[f]	0.002±0.0000[f]	

[a-g]Different letters in the same row indicate significance (P<0.05); Results were expressed as mean±SD (n=5) and as mg TE in 1 g sample. Results were expressed as mean±SD (n=5). IC_{50}: Half-maximal inhibitory concentration; ALE: Aqueous leaf extract; AFE: Aqueous flower extract; HELE: 50% ethanol leaf extract; HEFE: 50% ethanol flower extract; ELE: 95% ethanol leaf extract; EFE: 95% ethanol flower extract; DPPH: 2,2-diphenyl-1-picrylhydrazyl; ABTS: 2,2-azinobis-(3-ethylbenzothaizoline-6-sulphonate; FRAP: Ferric reducing antioxidant power; SD: Standard deviation

Table 4: α-Glucosidase and α-amylase inhibitory activities of *Bombax ceiba* extracts

Bombax ceiba extract	Antidiabetic activity	
	α-glucosidase (IC_{50}, mg/mL)	α-amylase (IC_{50}, mg/mL)
ALE	0.175±0.0027a	ND
AFE	0.002±0.0006b	ND
HELE	0.121±0.0022c	ND
HEFE	0.003±0.0004b	0.0024±0.0002a
ELE	0.187±0.0089d	0.0012±0.0009b
EFE	0.001±0.0012b	0.0002±0.0001c
Acarbose	0.201±0.0212e	0.0020±0.0004a

[a-d]Different letters in the same row indicate significance (P<0.05). Results were expressed as mean±SD (n=5). IC_{50}: Half-maximal inhibitory concentration; ALE: Aqueous leaf extract; AFE: Aqueous flower extract; HELE: 50% ethanol leaf extract; HEFE: 50% ethanol flower extract; ELE: 95% ethanol leaf extract; EFE: 95% ethanol flower extract; ND: Not determined; SD: Standard deviation

0.0002 ± 0.0001 mg/mL followed by ELE (0.0012 ± 0.0009 mg/mL) and HEFE (0.0024 ± 0.0002 mg/mL), as shown in Table 4.

DISCUSSION

B. ceiba extracts possess various biological activities such as antioxidant, anti-inflammatory, and antimicrobial activities. In addition, the extracts from this plant exhibit their medicinal values in the treatment of diabetes and hyperglycemia.[37] Flower parts of *B. ceiba* have been used as a food ingredient among Thai people. However, there are a few scientific reports on their biological and pharmacological activities. In this present study, it was found that leaf and flower extracts of *B. ceiba* contain phytochemicals including alkaloids, flavonoids, coumarins, saponins, tannins, terpenoids, and cardiac glycosides. Moreover, the high total phenolic and flavonoid contents were found in flower extracts. The flower extracts also exhibit the high antioxidant and antidiabetic activities *in vitro*. It was reported that there are phytochemical constituents including isovanillic acid, mangiferin, protocatechuic acid, rutin, quercetin, and apigenin in this plant.[15] However, the TPCs of aqueous and HEFEs in the present study are less than those in the flower extracts from *B. malabaricum* which is claimed to be a synonym of *B. ceiba*. This demonstrates that the flowers of *B. malabaricum* have remarkable antioxidant activity.[24] In the present study, it was found that AFE and HEFE has higher inhibitory activity against DPPH and ABTS free radical than those of ALE and HELE. However, EFE has lower antioxidant activity than those of ELE. Due to the solvent's ability with different polarity, ethanol may be a suitable solvent for the extraction of polyphenol and less toxic to human health.[38] ABTS scavenging activity of *B. ceiba* suggests that the phytochemicals within the extracts donate electron/hydrogen resulting in the reduction of oxidative stress.[39] The reducing power of the extracts to reduce Fe^{2+} is strong, and it depends on total phenolic and flavonoid contents. This result is similar to the previous study that flavonoid compound is secondary natural product metabolites responses for the antioxidant ability.[40] In terms of *in vitro* antidiabetic activities, *B. ceiba* flower extracts have higher α-glucosidase and α-amylase inhibitory activity than those of the standard acarbose. This suggests that the extracts are rich in flavonoids and phenolics which can inhibit α-glucosidase and α-amylase activity and potential to contribute to the management of diabetes.[41] These results are similar to previous report that 50% ethanolic extract of stem bark and flowers of *B. ceiba* possesses hypoglycemic activity and mangiferin is responsible for the lowering of fasting blood glucose level.[42]

CONCLUSION

The leaf and flower extracts of *B. ceiba* showed a significant antioxidant capacity against DPPH, $ABTS^{+}$, and ferric-tripyridyltriazine radicals. The flower extracts exhibit high antioxidant and antidiabetic activities *in vitro*. These pharmacological potentials may be due to the presence of phenolic and flavonoid compound. These findings confirm the benefit of ethnobotanical uses of this plant.

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Conflicts of interest

There are no conflicts of interest.

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