# Research Journal of Pharmaceutical, Biological and Chemical Sciences

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ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

# Isoflavone from *Artocarpus integer* (Thunb.) Merr. and the bioactivity of antioxidants.

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**ABSTRACT**

Isolation of secondary metabolites heartwood of *Artocarpus integer* (Thunb.) Merr. (Moraceae) by maceration, fractionation, and purification stage have been conducted. The molecular structure of isolated compounds was determined by UV spectroscopy, IR, $^{1}$H-NMR, $^{13}$C-NMR, HSQC, and HMBC. The compounds were tested antioxidant activity by DPPH method using spectrophotometer UV-Vis at $\lambda_{max}$ 500 nm with $IC_{50}$ values: artocarpanone (1) (29.88 µg/ml), cudraflavone C (2) (3.35 µg/ml), artocarpin (3) (4.70 µg/ml), tephrosin (4) (55.58 µg/ml), norartocarpetin (5) (2.83 µg/ml), and ascorbic acid (2.79 µg/ml) as a comparison. Tephrosin is a compound that first time discovered in this plant.
**Keywords:** Moraceae, *Artocarpus integer*, flavonoids, antioxidant

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ISSN: 0975-8585

## INTRODUCTION

*Artocarpus* consists of about 50 species and spread in Indonesia, particularly in Sumatra, Java, Kalimantan, and Sulawesi. The plant also found in South Asia, Papua New Guinea and the South Pacific [1]. In Indonesia, *Artocarpus* plant known as "nangka-nangkaan" [2]. *Artocarpus* generally have characteristic are: hight tree, gummy white in all part, somewhat hard sheets and arranged leaves alternate, fleshy fruit with small to large sizes, large woody and taproot [3]. Some parts of *Artocarpus* genus used as building materials [4,5] and traditional medicine [6,7]. The root of *A. heterophyllus* used to treat fever, dysentery, and malaria, the seeds for diarrhea, and leaves for medicine ulcers, fever, sores, and skin diseases [3]. *A. elasticus* bark infusion used as a contraceptive, the gum used as a cure dysentery and fever reliever [3].

In general, plants of the *Artocarpus* contain phenol compound derivatives [8,9,10] and nonphenolic [11,12]. *Artocarpus* most abundant of flavonoid group compounds compared to other [9,11]. These compounds have diverse biological activities, including anti-malarial [13,14], anti-tumor [15] and antioxidant [16,17,18].

Development of science and technology has changed the pattern of human life which impact the emergence of a wide range of degenerative diseases [19]. Air pollution and fast food can be a source of free radicals in our body. Free radicals are very unstable because they have one or more unpaired electrons that are harmful to health. In fact, the body has an enzyme superoxide dismutase (SOD) and glutathione peroxidase, but if the body's defenses down, the enzyme cannot ward of the free radical attack [6,10].

Compound that can reduce free radicals in the body is an antioxidant. The synthetic antioxidants such as butyl hydroxy toluene (BHT), butylhydroxyanisole (BHA), propyl gallate (PG) and tert-butyl hydroquinone (TBHQ) has high efficacy, but these coumpounds will stimulated carcinogenesis [20]. Based on this condition needed antioxidant compounds derived from natural ingredients including vitamins C and E, curcumin, curcuminoid, phenolic and flavonoids [21,22].

## MATERIALS AND METHODS

### Plant material

The heartwood of *Artocarpus integer* (Thunb.) Merr. was collected from North Luwu, South Sulawesi, Indonesia in 2015. The voucher specimen of the plant has been kept in the Bogoriense herbarium, Research Center for Biology, Indonesian Institute of Sciences (LIPI), Bogor, Indonesia. The plant specimens stored as collections in Bogoriense herbarium with registration number BO-1936238.

### General experimental procedures

Melting points were determined on a micro-melting point apparatus and are uncorrected. UV spectra using Hewlett Packard 8543 Agilent Technologies and IR spectra were measured with Shimadzu Prestige-21. $^{1}H$ and $^{13}C$ NMR spectra were recorded with a Bruker AM 500 spectrometer, operating at 500 MHz ($^{1}H$) and 125 MHz ($^{13}C$). TLC analysis on precoated Si gel plates (Merck Kieselgel 60 F, 0.25 mm), VLC was carried out using Merck Si gel 60 GF, and radial chromatography with Merck Si gel 60 PF 254.

### Extraction and isolation

The heartwood samples were dried, shredded and pollinated. *Artocarpus integer* heartwood powder (3.8 kg) was macerated with methanol for 72 hours, filtered and evaporated using rotary evaporator to get crude methanol extract (350 g) was obtained. The methanol extract was partitioned to obtain a fraction of n-hexane (7.63 g), chloroform (94.75 g), ethyl acetate (7.33 g), and methanol (43.69 g). Subsequently, chloroform fraction (20 g) was fractionated by vacuum liquid chromatography, eluent n-hexane/ethyl acetate rasio are 10:0, 7:3, 6:4, 5:5 and 3:7 produced 16 major fractions.

ISSN: 0975-8585

Main fraction number 10 (100 mg) was further separated by radial chromatography/centrifugal planar chromatography (KR1), eluted with chloroform:/ethyl acetate in ratio 9:1 enhanced by polarity gradually yielding 8 subfractions. The fraction of 10 was carried out by radial chromatography 4 times until a mass of 133 g was obtained and then fractionated again yielding 10 subfractions. The subfraction was grouped by TLC (Thin layer chromatography) analysis resulted in 5 fractions.

**Antioxidant Test**

A total of 9.9 mg of DPPH was dissolved with methanol p.a. to a volume of 10 ml to obtain 0.4 mM DPPH solution. Furthermore 1.00 mg of Artocarpanone compound (1) was dissolved with methanol p.a. to a volume of 5 ml, obtained a concentration of 5000 ppm as a mother liquor. From the mother liquor pipette 1µl, 2 µl, 3 µl, 4 µl, and 5 µl ar added with 1 ml of DPPH 0.4 mM, then it was added to volume of 5 ml in order to obtain a concentration of 1 µg/ml, 2 µg/ml, 3 µg/ml, 4 µg/ml, and 5 µg/ml. The solution is shaken and stored at room temperature in the dark room for 30 minutes. Then measured the absorbance $\lambda_{max}$ 500 nm wavelength. The same treatment was performed for cudraflavone C (2), artocarpin (3), tephrosin (4), and norartocarpetin (5).

## RESULTS AND DISCUSSION

Based on the TLC result by three eluent systems, showed subfraction 108.4-6 with single and similar stains, so that after the analyzed using UV, IR, NMR, generates artocarpanone (1) (14.1 mg). With the same fractionation technique 1010.3-6 subduction was obtained cudraflavone C (2) (19.6 mg), subfraction 313.5-8 artocarpin (3) (67.4 mg), substraction 1018.2 tephrosin (4) (3.9 mg), and substraction 1217.5 norartocarpetin (5 ) (11.6 mg).

**Spectral measurements**

Artocarpanone (1): white powder, mp 208-210 °C. UV (MeOH) $\lambda_{max}$ (nm) (log ε): 335, 287. IR (KBr) $\nu_{max}$ ($cm^{-1}$): 3425 (OH), 2924 dan 2852 (CH aliphatic), 1637 (C=O), 1517 (C=C aromatic), 1462 ($CH_2$), 1381 ($CH_3$), 1157 (C-O). $^1$H NMR (500 MHz, acetone-$d_6$) (ppm): 5.72 (1H, *dd*, *J* = 2.8; 13.2 Hz, H-2); 3.19 (1H, *dd*, *J* = 13.2; 17.1 Hz, $H_{ax}$-3); 2.74 (1H, *dd*, *J* = 2.9; 17.1 Hz, $H_{eq}$-3); 12.15 (1H, *s*, 5-OH); 6.04 (1H, *d*, *J* = 2,2 Hz, H-6); 6.02 (1H, *J* = 2.2 Hz, H-8); 6.46 (1H, *d*, *J* = 2.2 Hz, H-3'); 6.42 (1H, *dd*, *J* = 8.4 Hz, H-5'); 7.30 (1H, *d*, *J* = 8.4 Hz, H-6'); 3.83 (3H, *s*, 7-OMe). $^{13}$C NMR (125 MHz, acetone-$d_6$) (ppm): 75.4 (CH, C-2); 42.6 ($CH_2$, C-3); 198.0 (C=O, C-4); 103.6 (C, C-4a); 159.5 (C-OH, C-5); 94.4 (C-6); 168.7 (C, C-7); 95.3 (CH, C-8); 164.6 (C, C-8a); 117.2 (C, C-1'); 156.3 (C-OH, C-2'); 103.4 (CH, C-3'); 159.5 (C-OH, C-4'); 107.8 (CH, C-5'); 128.9 (CH, C-6'); 56.14 ($OCH_3$).

Cudraflavone C (2): orange powder, mp 97-100 °C. UV (MeOH) $\lambda_{max}$ (nm) (log ε): 313, 263. IR (KBr) $\nu_{max}$ ($cm^{-1}$): 3419 (OH), 2962 dan 2920 (CH aliphatic), 1649 (C=O), 1622 (C=C aromatic), 1462 ($CH_2$), 1359 ($CH_3$), 1166 (C-O). $^1$H NMR (500 MHz, acetone-$d_6$) (ppm): 13.43 (1H, *s*, 5-OH); 6.35 (1H, *s*, H-8); 6.54 (1H, *d*, *J* = 2.3 Hz, H-3'); 6.50 (1H, *dd*, *J* = 2.3; 8.3 Hz, H-5'); 7.17 (1H, *d*, *J* = 8.3 Hz, H-6'); 3.09 (2H, *d*, *J* = 6.9 Hz, H-9); 5.11 (1H, *m*, H-10); 1.42 (3H, *s*, 12); 1.56 (3H, *s*, H-13); 3.35 (2H, *d*, *J* = 7.2 Hz, H-14); 5.27 (1H, *m*, H-15); 1.77 (3H, *s*, H-17); 1.64 (3H, *s*, H-18). $^{13}$C NMR (125 MHz, acetone-$d_6$) (ppm): 160.0 (C, C-2); 121.5 (C, C-3); 183.0 (C=O, C-4); 105.0 (C, C-4a); 162.0 (C-OH, C-5); 111.7 (C, C-6); 162.3 (C, C-7); 93.4 (CH, C-8); 156.9 (C, C-8a); 113.0 (C, C-1'); 161.3 (C-OH, C-2'); 103.8 (CH, C-3'); 157.0 (C-OH, C-4'); 108.0 (CH, C-5'); 132.2 (CH, C-6'); 24.6 ($CH_2$, C-9); 122.7 (CH, C-10); 131.9 (C, C-11); 17.6 ($CH_3$, C-12); 25.8 ($CH_3$, C-13); 21.9 ($CH_2$, C-14); 123.3 (CH, C-15); 131.4 (C, C-16); 17.8 ($CH_3$, C-17); 25.7 ($CH_3$, C-18).

Artocarpin (3): yellow powder, mp 174-177 °C. UV (MeOH) $\lambda_{max}$ (nm) (log ε): 323, 280. IR (KBr) $\nu_{max}$ ($cm^{-1}$): 3396 (OH), 3041 (CH aromatic), 2958 dan 2824 (CH aliphatic), 1651 (C=O), 1618 dan 1479 (C=C aromatic), 1454 ($CH_2$), 1352 ($CH_3$), 1142 (C-O). $^1$H NMR (500 MHz, acetone-$d_6$) (ppm): 13.97 (1H, *s*, 5-OH); 6.54 (1H, *s*, H-8); 6.57 (1H, *d*, *J* = 2.3 Hz, H-3'); 6.53 (1H, *dd*, *J* = 2.3; 8.4 Hz, H-5'); 7.22 (1H, *d*, *J* = 8.3 Hz, H-6'); 3.14 (2H, *d*, *J* = 7.0 H 11-9); 5.14 (1H, *d*, *J* = 7.0 Hz, H-10); 1.44 (3H, *s*, H-12); 1.58 (3H, *s*, H-13); 6.60 (1H, *d*, *J* = 17.5 Hz, H-14); 6.70 (1H, *dd*, *J* = 7.1; 16.2 Hz, H-15); 2.44 (1H, *m*, H-16); 1.09 (3H, *d*, *J* = 6.8 Hz, H-17); 1.09 (3H, *d*, *J* = 6.8 Hz, H-18). $^{13}$C NMR (125 MHz, acetone-$d_6$) (ppm): 162.4 (C, C-2); 121.9 (C, C-3); 183.3 (C=O, C-4); 105.5 (C, C-4a); 159.7 (C-OH, C-5); 109.7 (C, C-6); 163.7 (C, C,-7); 90.4 (CH, C-8); 157.3 (C, C-8a); 112.8 (C, C-1'); 157.2 (C-OH, C-2'); 103.8 (CH, C-3'); 161.4 (C-OH, C-4'); 108.0 (CH, C-5'); 132.3 (CH, C-6'); 24.6 ($CH_2$, C-9); 122.5 (CH, C-

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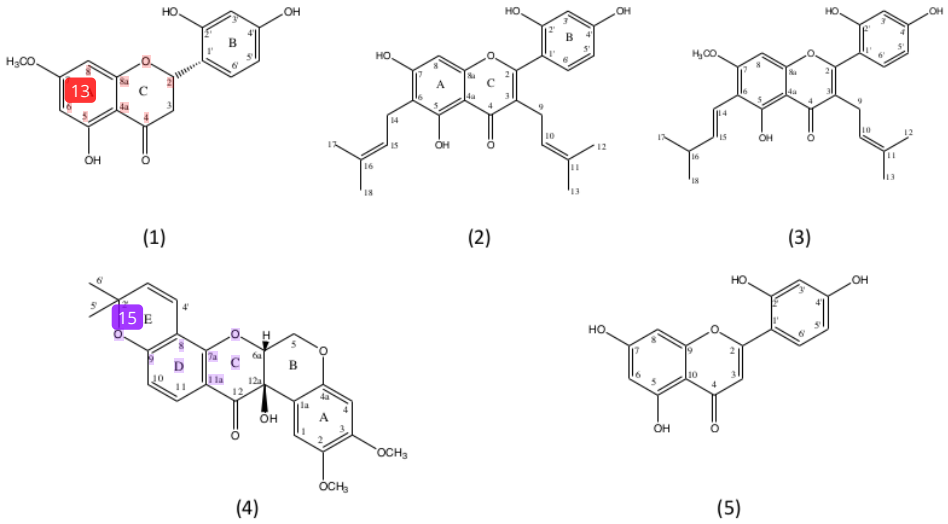
10); 132.2 (C, C-11); 25.8 ($CH_3$, C-12); 17.6 ($CH_3$, C-13); 116.9 (CH, C-14); 142.1 (CH, C-15); 33.9 (CH, C-16); 23.1($CH_3$, C-17/18).

Tephrosin (4): yellow powder, mp 194-198 °C. UV (MeOH) $\lambda_{max}$ (nm) (log ε): 312, 270. IR (KBr) $\nu_{max}$ ($cm^{-1}$): 3444 (OH), 3072 (CH aromatic), 2964 dan 2929 (CH aliphatic), 1674 (C=O), 1596 dan 1516 (C=C aromatic), 1452 ($CH_2$), 1377 ($CH_3$), 1217 (C-O). $^1$H NMR (500 MHz, chloroform-d) (ppm): 6.55 (1H, *s*, H-1); 6.48 (1H, *s*, H-4); 4.49 (1H, *dd*, *J* = 2.3; 12.6, H-6); 4.63 (1H, *dd*, *J* = 2.3; 12.1, H-6); 4.57 (1H, *dd*, *J* = 1.4; 2.4, H-2); 6.47 (1H, *d*, *J* = 8.9, H-10); 7.72 (1H, *d*, *J* = 8.7, H-11); 6.60 (1H, *d*, *J* = 10.0, H-4'); 5.55 (1H, *d*, *J* = 10.1, H-5'); 1.38 (3H, *s*, H-7'); 1.44 (3H, *s*, H-8'). $^{13}$C NMR (125 MHz, chloroform-d) (ppm): 108.7 (C, C-1a); 109.3 (CH, C-1); 144.1 (C, C-2); 151.2 (C, C-3); 101.2 (CH, C-4); 148.5 (C, C-4a); 64.0 ($CH_2$, C-6); 76.4 (CH, C-6a); 156.8 (C, C-7a); 109.4 (C, C-8); 160.9 (C, C-9); 114.1 (CH, C-10); 128.7 (CH, C-11); 111.2 (C, C-11a); 191.5 (C, C-12); 67.6 (C-OH, C-12a); 115.5 (CH, C-4'); 128.9 (CH, C-5'); 78.1 (C, C-6'); 28.4 ($CH_3$, C-7'); 28.7 ($CH_3$, C-8'); 56.0 ($OCH_{3(1)}$); 56.5 ($OCH_{3(2)}$).

Norartocarpetin (5): yellow powder, mp 244-248 °C. UV (MeOH) $\lambda_{max}$ (nm) (log ε): 338, 287, 264. IR (KBr) $\nu_{max}$ ($cm^{-1}$): 3361 (OH), 2960 dan 2924 (CH aliphatic), 1616 dan 1510 (C=C aromatic), 1454 ($CH_2$), 1359 ($CH_3$), 1163 (C-O). $^1$H NMR (500 MHz, acetone-$d_6$) (ppm): 13.11 (1H, *s*, 5-OH); 7.07 (1H, *s*, H-3); 6.23 (1H, *d*, *J* = 2.0 Hz, H-6); 6.50 (1H, *d*, *J* = 2.0 Hz, H-8); 6.60 (1H, *d*, *J* = 2.3 Hz, H-3'); 6.57 (1H, *dd*, *J* = 2.3; 8.7 Hz, H-5'); 7.84 (1H, *d*, *J* = 8.7 Hz, H-6'). $^{13}$C NMR (125 MHz, acetone-$d_6$) (ppm): 161.9 (C, C-2); 107.6 (CH, C-3); 182.5 (C=O, C-4); 104.3 (C, C-4a); 162.4 (C-OH, C-5); 98.5 (CH, C-6); 163.8 (C-OH, C-7); 93.6 (CH, C-8); 157.9 (C, C-8a); 109.8 (C, C-1'); 158.4 (C-OH, C-2'); 103.4 (CH, C-3'); 161.6 (C-OH, C-4'); 108.2 (CH, C-5'); 130.0 (CH, C-6').



(1) (2) (3) (4) (5)

**Figure 1. Isolated compounds from heartwood *Artocarpus integer* (Thunb.) Merr.**

**Antioxidant Activity**

The antioxidant activity test by spectrophotometer method was done by reacting the sample with DPPH solution. The DPPH radicals scavenging activity was calculated according equation [23]:

$$\text{Scavenging activity} = [(A_0 - A_1 / A_0) \times 100]$$

$A_0$ is the absorbance of the control (blank, without sample) and $A_1$ is the absorbance in the presence of the sample.

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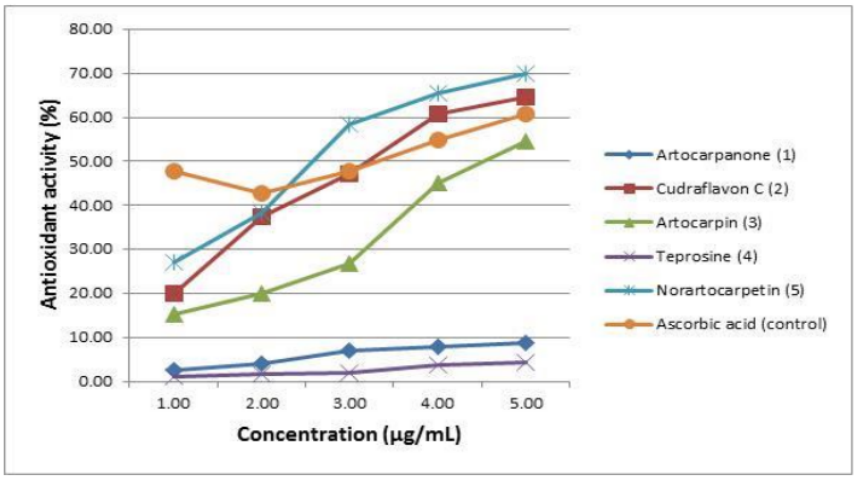


**Figure 1. Graph antioxidant activity of isolated compounds heartwood of *Artocarpus integer* (Thunb.) Merr. and ascorbic acid**

**Table 1. $IC_{50}$ value of compounds heartwood of *Artocarpus integer* (Thunb.) Merr.**

| Compound | The linear regression equation | $IC_{50}$ Value (µg/mL) |
|---|---|---|
| Artocarpanone (1) | y = 1.6352x - 1.1321<br>$R^2$ = 0.9562 | 29.88 |
| Cudraflavone C (2) | y = 7.8981x + 8.9172<br>$R^2$ = 0,559-0 | 5.20 |
| Artocarpin (3) | y = 10.3870x + 1.1613<br>$R^2$ = 0.9510 | 4.70 |
| Tephrosin (4) | y = 0.9034x + 0.2181<br>$R^2$ = 0.9344 | 55.58 |
| Norartocarpetin (5) | y = 11.3250x + 17.8860<br>$R^2$ = 0,9426 | 2.83 |
| Ascorbic acid (positive control) | y = 3.7869x + 39.4260<br>$R^2$ = 0.7238 | 2.79 |

Categories ability of antioxidant level is: strong ($IC_{50}$<50 µg/ml), active ($IC_{50}$ 50-100 µg/ml), medium ($IC_{50}$ 101-250 µg/ml), low ($IC_{50}$ 250-500 µg/ml), and inactive ($IC_{50}$>500 µg/ml) [24].

All the compounds found in the heartwood of Artocarpus integer (Thunb.) Merr. is flavonoids group. Composition content compounds is artocarpanone (1) derivatived of flavanone; while cudraflavone C (2), artocarpin (3), norartocarpetin (5) derivatived of flavon; and tephrosin (4) derivatived of isoflavon. The structure of these compounds shown in Figure 1. Tephrosin (4) was first time discovered in this plant, but often found in family Pabaceae [25].

The antioxidant activity of isolation compound shows that artocarpanone (1), cudraflavone C (2), artocarpin (3), norartocarpetin (5) respectively have strong antioxidant category level, while and tephrosin (4) have active category.

## CONCLUSIONS

Five flavonoid derived compounds have been found from *Artocarpus integer* (Thunb.) Merr. and tested antioxidant activity. $IC_{50}$ value resulted are: artocarpanone (1) (29.88 µg/ml), cudraflavone C (2) (3.35 µg/ml), artocarpin (3) (4.70 µg/ml), tephrosin (4) ( 55.58 µg/ml), norartocarpetin (5) (2.83 µg/ml) and ascorbic acid (2.79 µg/ml) as a comparison.

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**ACKNOWLEDGEMENTS**

We thank the Herbarium Bogoriense, Bogor, Indonesia, for identification of the plant specimen. NMR Laboratory, Department of Chemistry, Bandung Institute of Technology for identification of compound structure, and Biochemistry Laboratory, Department of Chemistry, Hasanuddin University for antioxidant test.

**REFERENCES**

[1] Lemmens RHMJ., Soerianegara I., Wong WC. Minor Commercial Timbers 1995; 2: 59-70.
[2] Musthapa I., Hakim EH., Juliawaty LD., Syah YM., Achmad SA. International Journal of Phytomedicines and Related Industries 2010; 2: 157-160.
[3] Heyne K. *The useful Indonesian plants*, Sarana Wana Jaya Foundation Jakarta, 1987, pp. 668.
[4] Kochummen KM., Go R. Moraceae. *In Tree Flora Sabah and Sarawak*: Ampang Press: Kuala Lumpur, Malaysia 3, 2000, pp. 181–212.
[5] Hakim EH., Achmad SA., Juliawaty LD., Makmur L., Syah Y., Aimi N., Kitajima M., Takayama H., Ghisalberti EL. J. Nat Med. 2006; 60: 161–184.
[6] Su BN., Cuendet M., Hawthorne ME., Kardono LBS., Riswan S., Fong HHS., Mehta RG., Pezzuto JM., Kinghorn AD. J. Nat. Prod. 2002; 65: 163–169.
[7] Boonla KC., Oonanant W., Kongsaeree P., Kitta KP., Tanticharoen M., Thebtaranonth Y. Phytochemistry 2000; 54: 415–417.
[8] Venkataraman K. Phytochemistry 1972; 11(5): 1571-1586.
[9] Nomura T., HanoY., Aida M. Heterocycles 1998; 47: 1179-1205.
[10] Hakim EH. Biodiversity as a Source of Unique Molecular Diversity and Potential For Bioindustry. Bandung Institute of Technology, Bandung 2007.
[11] Achmad SA., Hakim EH., Juliawaty LD., Makmur L, Suyatno., Aimi N., Ghisalberty EL. Journal of Natural Product 1996; 59: 878-879.
[12] Altman LJ., Sito SW. Phytochemistry 1976; 15: 829-830.
[13] Widyawaruyanti AS., Kalauni SK., Awale S., Nindatu M., Zaini NC., Syafruddin D., Asih PBS., Tezuka Y., Kadota S. Journal of Natural Medicines 2007; 61: 410-413.
[14] Rahmani M., Hashim NH., Sukari MA., Ali AM., Alitheen NB., Go R., Journal of Medicinal and Aromatic of Science 2008; 31: 142-146.
[15] Pedro M., Ferreira MM., Cidade H., Kijjoa A., Elsa R., Nascimento MSJ. Life Sciences 2005; 77: 293-311.
[16] Nasution H., Rahmah M. Sains Dasar 2014; 3(2): 137-141.
[17] Ajiboye BO., Ojo OA., Adeyonu O., Imiere O., Olayide I., FadakaA., Oyinloye BE. Journal of Acute Disease 2016; 5(5): 423-429.
[18] Panthong K., Tohdee K., TowatanaNH., Voravuthikunchai SP., Chusri S. J Braz Chem Soc. 2013; 24(10): 1656-1661.
[19] Adaramoye OA., Akanni OO. Advances in Pharmacological Sciences 2014; 1-11.
[20] Amarowicz R., Troszyńska A., Shahidi F. Journal of Food Lipids 2005; 11: 278–286.
[21] Bors W., Michel C., Stettmaier K. Packer L Ed, Academic Press: London, UK 2001; 166–180.
[22] Dangles O., Dufour C., Manach C., Morand C., Remesy C. Packer L Ed, Academic Press: London, UK 2001; 319–333.
[23] Loizzo MR., Menichini F., Conforti F., Tundis R., Bonesi M., Saab AM., Statti GA., Cindio BD., Houghton PJ., Menichini F., Frega NG. Food Chem. 2009; 117: 174–180.
[24] Jun MHY., Fong J., Wan X., Yang CS., Ho CT. Journal Food Science Institute of Technologist 2003; 68: 2117-2122.
[25] Vasconcelos JN., Santiago GMP., Lima JQ., Arriaga AMC., Sobrinho DC. Quim Nova 2012, 35: 1097-1100.

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