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Indonesian indigenous plants as a source of antioxidants to treat gastrointestinal disorders

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Abstract

Gastrointestinal disorders are the most common illnesses that affect people nowadays. Its prevalence and incidence have increased over the last decades. The majority of the people in Indonesia are still using indigenous plants as medicine to treat these infections or diseases. This study was aimed to determine the potential of Indonesian indigenous plants in treating gastrointestinal disorders. The plants were inventoried through searching articles such as Google Scholar, PubMed, ScienceDirect and Indonesian medicinal plants books. The keyword search term used was "gastrointestinal," "Indonesian," "medicinal plants," "antioxidant activity," and "phenolic compound,". A total of fifty-one species of indigenous Indonesian plants of 32 families were recorded as being used by the Indonesian population to treat gastrointestinal disorders. Gastrointestinal disorders that heavily utilize indigenous plants are diarrhoea, constipation, gastric ulcer and gastritis. Indonesian indigenous plants containing bioactive compounds such as alkaloids, flavonoids, saponins, tannins, steroids, terpenoids and phenolics that can serve as a source of antioxidants to treat gastrointestinal disorders. There were five Indonesian indigenous plants with the most potential as a source of antioxidants to cope with gastrointestinal disorders: *Zingiber officinale L, Annona muricata, Phyllanthus niruri, Curcuma longa* and *Curcuma xanthorrizha.*

1. Introduction

Traditional plants medicine has been known for a long time and used by the people of Indonesia. This process has been passed down from generation to generation, especially with the concept of back to nature make traditional medicine more desirable. Indonesian indigenous plants are Indonesian native plants from certain regions/ecosystems, including introduced species from other geographic areas but have evolved with the climate and geographic region of Indonesia (Andarwulan, 2012). Most people think that plants can be used as a traditional medicine because it has a lower side effect than chemical drugs. The original plant is widely used as an alternative medicine for an exogenous antioxidant that has been proven effective for treating a variety of ailments including indigestion (Madikizela *et al*., 2012). The ability of plants to treat gastrointestinal disorders because of their antioxidant compounds such as flavonoids, polyphenols, saponins, alkaloids, and terpenoids. Flavonoids and polyphenol compounds are antioxidants, antidiabetic, anticancer, anti-inflammatory and antiseptic, while alkaloids have strong antineoplastic properties also inhibits the growth of cancer cells (Saxena *et al.*, 2012; Xu *et al.*, 2017).

Gastrointestinal disorders are diseases that affect the digestive tract function, such as food and fluid absorption, digestion or excretion. The disorder causes pain, morbidity and can lead to death. Diseases caused by gastrointestinal disorders including 10 major killer diseases in the world. In terms of mortality, causes of death for all age groups diarrheal was 3.5%, ranks 13th out of 22 causes of death, both communicable and non-communicable diseases. WHO (2007) conducted a review of the eight countries in the world, shows that the percentage of occurrences due to gastritis in America by 47%, followed by India at 43% and Indonesia amounted

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to 40.85%, gastrointestinal disorders are abdominal or stomach pain, dysentery, gastroenteritis, constipation and vomiting.

The study of Indonesian plants as medicine gastrointestinal disorders have been conducted, but no studies have inventoried the plant as a drug used to treat gastrointestinal disorders. Therefore, this study aimed to identify the Indonesian indigenous plants with traditional benefits in alleviating types of diseases, used parts of the plants and their phytochemical contents. In addition, potential plants as a source of antioxidants in the treatment of gastrointestinal disorders were determined. Plant inventory and determination of potential levels are expected to institutionalize traditional medicine and alternative pharmaceutical preparations.

2. Material and methods

2.1 Inventory of plants

Literature reviews published in journals, reports and books dealing with traditional uses of medicinal plants in Indonesia to treat various gastrointestinal disorders were obtained. Different online databases were used PubMed, Science Direct, Scopus, and Google Scholar with specific search terms such as 'medicinal plants', 'Indonesian plants AND gastrointestinal', phytochemical AND phenolic content AND antioxidant activity from each Indonesian plant were have inventoried. The articles obtained are filtered by title, abstract and full text. Articles that are not relevant to the research topic was issued, while the elected subsequently evaluated using inclusion and exclusion criteria for the study. The inclusion criteria used in this review were articles published in the year 2009 - 2019, Indonesian plants, gastrointestinal, ethanol extract, total phenolic content (TPC) expressed in mg GAE/g extract, total flavonoid content (TFC) expressed in mg QE/g extract and antioxidant activity using DPPH (2,2-diphenyl-1 picrylhydrazyl) method expressed in IC_{50} with ascorbic acid comparison compound (AEAC) from each of these Indonesian indigenous plants. The term 'Indonesian plants' was used to limit the geographical scope of the search. Selection of ethanol extract and DPPH method because many of these are found in this literature search.

2.2 Phenolic content and antioxidant activity

Total phenolic content and antioxidant activity were used to determine the potential of Indonesian indigenous plants in treating gastrointestinal disorders. The method used is to compare the phenolic content (TPC) with antioxidant activity. Units of data synchronized with the assumption that the ethanol extract of these plants has the same density (ml extract = g of extract). Plants that have the highest potential level value is expressed as the plant with the most potential as a source of antioxidants to treat gastrointestinal disorders.

2.3 Analysis data

The analysis data consisted of qualitative and quantitative data. Qualitative data includes the results of an inventory of indigenous Indonesian plants such as species names, local names, families, parts used, and types of gastrointestinal disorders that can be treated using these plants. The results of an inventory of the types of gastrointestinal disorders are categorized based on abnormalities or physiological effects of the plant. This categorizing aims to determine the number of plants that can be used for disorders of the gastrointestinal tract. In addition, qualitative data have also used the presence of bioactive compounds such as phenolic, alkaloids, flavonoids, tannins, saponins, terpenoids and steroids.

Quantitative data is used to express the percentage of the number of plants that can be used to treat gastrointestinal disorders. Determine if the potential level of each plant species were analyzed using the XLSTAT program.

3. Result and discussion

3.1 Potential indigenous Indonesian plants

The results of the literature search obtained 97 plants that are known to treat gastrointestinal disorders. Then the articles were selected based on title, abstract and availability of the full-text article. Indonesia's inventory of indigenous plants that can treat gastrointestinal disorders is presented in Table 1. Data in Table 1 shows that 51 species are consisting of 32 plant families that are commonly used to treat gastrointestinal disorders. The most dominant family with respect to a number of species used to treat gastrointestinal disorders is *Zingiberaceae* (ten species) followed by *Apiaceae* (three species), *Solanaceae, Fabaceae, Piperaceae, Annonaceae, Arecaceae, Punicaceae, Acanthaceae, basellaceae* and *Myrtaceae* (2 species) whereas other plants 1 species.

To determine the number of plants that can be used to treat gastrointestinal disorders, the types of gastrointestinal disorders are categorized based on abnormalities similar or physiological effects of these plants such as constipation/laxative/constipation, gastritis/gastric ulcer/stomach pain/carminative/ flatulence and emetic/nausea/vomiting. Types of gastrointestinal disorders are divided into 13 categories (Table 2). Types of gastrointestinal disorders that can be treated with indigenous Indonesian plants are gastritis (24%), followed by diarrhoea (15.4%), digestive disorders (15.4%), constipation (11.5%), colitis (8.7%),

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Table 1. Identified Indonesian indigenous plants in alleviating gastrointestinal disorders

Name	Family	Local name	Parts of Plants Studied	Traditional Uses	Mode of application	References
Acorus calamus	*Acoraceae*	Jeringau	Leaf	Carminative, cholic, constipation, gastritis, diarrhea	Infusion	Mulyani *et al.* (2017)
Aloe Vera Linn.	*Liliaceae*	Lidah buaya	Leaf	Gastritis	Extract, juice	Darwis (2012)
Alpinia galanga	*Zingiberaceae*	Lengkuas	Rhizome	Diarrhea	Extract, powder	Darwis (2012)
Amomum compactum	*Zingiberaceae*	Kapulaga	Leaf	Constipation, gastritis, indigestion	Extract, powder	Asra *et al.* (2019)
Andrographis paniculata Ness.	*Acanthaceae*	Sambiloto	Leaf	Dysentry, gastric ulcer, sprue	Infusion, extract, powder	Solikhah (2016)
Annona muricata L.	*Annonaceae*	Sirsak	Fruit	Diarrhea, gastritis	Juice, eat	Abdu (2018)
Annona squamosa L	*Annonaceae*	Srikaya	Fruit	Indigestion, gastric ulcer	Juice, eat	Rianto *et al.* (2015)
Anredera cordifolia	*Basellaceae*	Binahong	Leaf	Dysentery	Infusion, extract	Purwasih *et al.* (2017)
Areca catechu	*Arecaceae*	Pinang	Fruit	Indigestion, constipation	Infusion, eat	Darwis (2012)
Averrhoa bilimbi L	*Oxalidaceae*	Belimbing	Fruit	Indigestion, gastric ulcer	Juice, eat	Darwis (2012)
Caesalpinia sappan L	*Caesalpiniaceae*	Secang	Stem	Diarrhea	Extract	Widowati (2011)
Camellia sinensis (L.) Kuntze	*Theaceae*	Teh	Leaf	Diarrhea	Extract	Bedrood *et al.* (2018)
Carica papaya L.	*Caricaceae*	Papaya	Fruit	Constipation, gastric ulcer	Juice, eat	Yusro *et al.* (2019)
Cassia alata L.	*Leguminosae*	Ketepeng Cina	Leaf	Constipation	Extract, eat	Darwis (2012)
Centella asiatica	*Apiaceae*	Pegagan	Leaf	Gastritis, carminative	Extract	Darwis (2012)
Cinnamomum cassia Presl	*Lauracea*	Kayu manis	Stem	Stomach ache, indigestion	Infusion, extract	Kumar *et al.* (2019)
Citrus limon	*Rutaceae*	Lemon	Fruit	Carminative, cholic, constipation, diarrhea, gastric, stomachache, nausea	Juice, eat	Rokaya *et al.* (2014)
Clitoria ternatea Linn	*Fabaceae*	Telang	Flower	Stomach ache,	Infusion, extract	Manjula *et al.* (2013)
Cosmos caudatus	*Asteraceae*	Kenikir	Leaf	Gastric	Decoction, juice, eat	Cheng *et al.* (2016)
Curcuma aeruginosa Roxb	*Zingiberaceae*	Temuireng	Rhizome	Stomach ache	Extract, powder	Suparni (2012)
Curcuma heyneana	*Zingiberaceae*	Temugiring	Rhizome	Dysentry, constipation	Extract, powder	Subositi and Wahyono (2019)
Curcuma longa	*Zingiberaceae*	Kunyit	Rhizome	Diarrhea , gastritis, gastric ulcer	Extract, powder	Darwis (2012)
Curcuma xanthorrizha	*Zingiberaceae*	Temulawak	Rhizome	Gastritis, diarrhea, dysentery, constipation, gastric ulcer, appetizer	Extract, powder	Darwis (2012)
Curcuma zedoaria	*Zingiberaceae*	Kunyit putih	Rhizome	Carminative, indigestion, anthelmintic, gastric ulcer, gastritis	Extract, powder	Darwis (2012)
Cyclea barbata	*Menispermaceae*	Cincau	Leaf	Indigestion, diarrhea, gastritis, ulcer	Extract, gel	Darwis (2012)
Foeniculum vulgare L	*Apiaceae*	Adas	Fruit	Gastritis	Extract, powder	Darwis (2012)
Guazuma ulmifolia	*Malvaceae*	Jati Belanda	Leaf	Gastritis	Decoction	Patil and Biradar (2013)

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Table 1(Cont.). Identified Indonesian indigenous plants in alleviating gastrointestinal disorders

Name	Family	Local name	Parts of Plants Studied	Traditional Uses	Mode of application	References
Hibiscus sabdariffa L	*Malvaceae*	Rosella	Flower	Indigestion, gastric ulcer	Decoction	Suzery *et al.* (2010)
Jatropha curcas L	*Euphorbiaceae*	Jarak	Leaf	Gastritis	Oil, poultice	Abdelgadir and Staden (2013)
Kaempferia galanga	*Zingiberaceae*	Kencur	Rhizome	Stomach ache	Extract, powder	Rao and Kaladhar (2014)
Momordica charantia	*Curcubitaceae*	Pare	Fruit	Indigestion	Juice, eat	Septiningsih *et al.* (2017)
Morinda citrifolia L	*Rubiaceae*	Mengkudu	Fruit	constipation	Extract, juice	Surya *et al.* (2009)
Moringa oleifera	*Moringaceae*	Kelor	Leaf	Gastritis, indigestion	Infusion, juice, eat	Sulastri *et al.* (2018)
Myristica fragrans	*Myristicaceae*	Pala	Fruit	Indigestion, diarrhea	Juice, eat	Mulyani *et al.* (2017)
Nigella sativa	*Apiaceae*	Jinten hitam	Seed, leaf	Gastric ulcer, indigestion, diarrhea, nausea	Extract, powder	Mulyani *et al.* (2017)
Ocimum sanctum L.	*Ocinaceae*	Kemangi	Leaf	Gastritis, gastric ulcer	Infusion, juice, eat	Sopianti dan Sary (2018)
Phyllanthus niruri	*Phyllanthaceae*	Meniran	Leaf	Gastric ulcer	Extract	Darwis (2012)
Piper crocatum	*Piperraceae*	Sirih merah	Leaf	Sprue, gastric ulcer	Extract, eat	Prayitno *et al.* (2016)
Piper nigrum L.	*Piperaceae*	Merica	Seed,	Indigestion, appetizer, gastric	Extract, powder	Akbar *et al.* (2014)
Plectranthus amboinicus	*Labialae*	Torbangun	Leaf	Gastritis	Extract, juice	Patel *et al.* (2010)
Pluchea indica (L)	*Compositae*	Beluntas	Leaf	Gastritis, dysentery, cholic	Infusion, eat	Darwis (2012)
Psidium guajava	*Myrtaceae*	Jambu biji	Leaf	Diarrhea, dysentery	Juice, eat	Fratiwi (2015)
Punica granatum L.	*Lythraceae*	Delima	Fruit, Seed	Stomach, diarrhea, dysentery, peptic ulcer	Juice, eat	Darwis (2012)
Salaca edulis	*Arecaceae*	Salak	Fruit	Diarrhea	Juice, eat	Fitrianingsih *et al.* (2015)
Solanum torvum Swartz	*Solanaceae*	Takokak	Fruit	Gastric ulcer, stomach ache, gastritis	Extract	Mardiani *et al.* (2016)
Strobilanthes crispus Bl.	*Acanthaceae*	Keji Beling	Leaf	Constipation	Decoction	Darwis (2012)
Syzygium polyantum	*Myrtaceae*	Salam	Leaf	Gastritis, diarrhea	Extract	Darwis (2012)
Tamarindus indica	*Fabaceae*	Asam jawa	Fruit	Indigestion, laxative, diarrhea, dysentery, peptic ulcer, constipation	Paste, poultice	Mulyani *et al. (*2017)
Zingiber cassumanar	*Zingiberaceae*	Bangle	Rhizome	Constipation, diarrhea	Extract	Mulyani *et al.* (2017)
Zingiber officinale L	*Zingiberaceae*	Jahe	Rhizome	Indigestion, nausea, diarrhea, gastritis	Extract, juice, powder	Pairul *et al.* (2018)
Zingiber zerumbet	*Zingiberaceae*	Lempuyang	Rhizome	Gastritis, diarrhea, dysentery	Extract, juice, powder	Darwis (2012)

Table 2. Number of plants used to treat gastrointestinal disorders

Types of gastrointestinal disorders	Abbreviation	Number of Plants	Percentage (%)
Gastritis / stomach pain / gastric ulcer	Gas	25	24.0
Diarrhea	Dia	16	15.4
Indigestion	Ind	16	15.4
Constipation/laxative	Con lax	12	11.5
Ulcer	Ulc	9	8.7
Stomachache	Sto	7	6.7
Dysentery	Dis	6	5.8
Appetizer	App	3	2.9
Colic	Col	3	2.9
Emetic/vomit	EmeVom	2	1.9
Carminative	Car	2	1.9
Other disease	Oth dis	2	1.9
Anthelmintic	Ant	1	1.0

abdominal pain (6.7%) and dysentery (5.8%). Some are used to increase appetite, overcome stomach ulcers, nausea, and flatulence.

The results of the literature search also showed that leaves were the most widely used part of the plant with 24 species (44.4%), followed by 13 species of fruit (24.1%), 9 species of rhizomes (16.7%), 3 seeds and flowers each. species (5.6%) and stems of 2 species (3.7%) as can be seen in Figure 1.

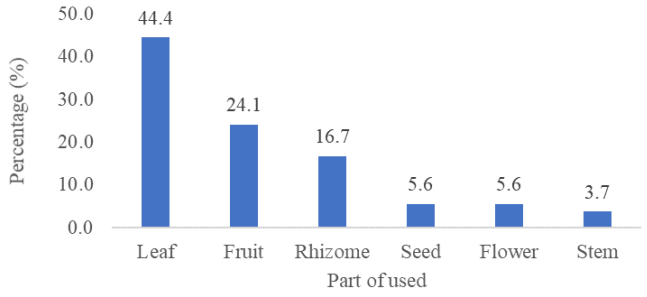

Figure 1. Percentage of plant parts used to treat gastrointestinal disorders

Indigenous Indonesian plants have many bioactive compounds such as phenolic, flavonoids, terpenoids, alkaloids, tannin, terpenoids, saponins and steroids so it can be used to treat several common diseases including gastrointestinal disease. Data bioactive compounds in each plant were extracted using ethanol can be seen in Table 3.

3.2 Phenolic content, flavonoid content and antioxidant activity of identified indigenous Indonesian plants

The results of the literature search on phenolic content (TPC), flavonoid content (TFC) and antioxidant activity are presented in Table 4. Data in Table 4 shows that *Zingiber officinale* is a plant that has the highest potential level as a source of antioxidant to treat gastrointestinal disorders followed by *Annona muricata*, *Phylanthus niruri*, *Curcuma longa* and *Curcuma xanthorrizha*.

4. Conclusion

This study clearly shows the potential of Indonesian indigenous plants as antioxidant agents to treat gastrointestinal disorders. Pharmacological studies reveal that a diverse group of naturally occurring chemical substances derived from the plants show promising antioxidant activity such as *Zingiber officinale, Annona muricata, Curcuma longa* and others. Therefore, further research should be carried out on the bioactive compounds present in the particular plants which have the potential as an antioxidant agent, especially to treat gastrointestinal disorders.

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Table 3. Phytochemical content of Indonesian indigenous plants

Types of plants	Alkaloids	Flavonoids	Tannins	Saponins	Terpenoids	Steroid	Phenolic	References
Aloe Vera Linn	+	+	+	+	+	+	+	Jha *et al.* (2018)
Alpinia galanga	+	+	-	+	+	+	++	Agustina *et al.* (2016)
Amomum compactum	+	+	-	+	+	+	+	Silalahi (2017)
Andrographis paniculata Ness	+	+	+	+	NA	NA	+	Rajalakshmi and Cathrine (2016)
Annona muricata	+	+	+	+	+	+	+	Ojezele *et al.* (2016)
Annona squamosa	+	+	NA	+	+	+	+	Mulyani *et al.* (2013)
Averrhoa bilimbi L	++	++	+++	+++	-	+++	+	Hasim *et al.* (2019)
Caesalpinia sappan	+	+	-	+	+	-	++	Widowati (2011)
Camellia sinensis (L.) Kuntze	+	+	+	+	+	+	+	Martono and Setiyono (2014)
Carica papaya	+	+	+	-	NA	+	+	Zahra *et al.* (2017)
Cinnamomum cassia Presl	+	+	+	+	+	+	+	Kumar *et al.* (2019)
Citrus limon	+	+	+	-	NA	+	+	Mayasari and Laoli (2018)
Clitoria ternatea Linn	+	+	+	-	+	-	-	Manjula *et al*. (2013)
Cosmos caudatus	+++	+		+++	+	+	+	Liliwirianis *et al.* (2011)
Curcuma aeruginosa Roxb	-	+	-	++	+	-		Nurcholis (2017)
Curcuma heyneana	++	++	++	+	+	-	++	Ghasemzadeh *et al.* (2016)
Curcuma longa	+	+	+	+	+	+	+	Agustina *et al.* (2016)
Curcuma xanthorrizha	+	+	-	-	-	-	+	Agustina *et al.* (2016)
Curcuma zedoaria	+	+	-	+	+	+	+	Sumathi *et al.* (2013)
Cyclea barbata	-	+	NA	+	+	+	+	Mentari *et al.* (2019)
Foeniculum vulgare L	+	+	+	+	-	+	+	Effendi *et al.* (2015)
Hibiscus sabdariffa L	++	++	++	+++		++	++	Alaga *et al.* (2014)
Kaempferia rhizoma	+	+	+	-	-	NA		Hayati *et al.* (2015)
Momordica Charantia	+	+	+	-	NA	+	+	Septiningsih *et al.* (2017)
Morinda citrifolia	+	++	+	+	++	++	+	Kumar *et al.* (2014)
Moringa oleifera	+	+	+	+	NA	NA	+	Sulastri *et al.* (2018)
Myristica fragrans	+	+	+	+	NA	+	+	Gupta *et al.* (2014)
Nigella sativa	+++	+++	++	-	NA	++	+++	Zarai *et al.* (2013)
Ocimum sanctum L.	+	+	+	+	+	NA	+	Sopianti and Sary (2018)
Phyllanthus niruri	+	+	+	+	+	NA	++	Ramandeep *et al.* (2017)
Piper crocatum Ruiz & Pav	++	++	++	++	NA	-	++	Prayitno *et al.* (2016)
Piper nigrum Linn	+++	++	++	-	+	++	+	Nahak and Sahu (2011)
Psidium guajava	+	+	+	-	-	+	+	Agustina *et al.* (2016)
Punica granatum L	-	+	+	+	-	+	+	Agustina *et al.* (2016)
Salaca edulis	+	+	+	NA	+	-	+	Fitrianingsih *et al.* (2015)
Solanum torvum	+	+	+	+	NA	NA	NA	Rahman *et al.* (2013)

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Table 3. Phytochemical content of Indonesian indigenous plants

Types of plants	Alkaloids	Flavonoids	Tannins	Saponins	Terpenoids	Steroid	Phenolic	References
Syzygium polyantum	+	+	+	-	-	+	+	Agustina *et al.* (2016)
Tamarindus indica	-	+	+	+	-	NA	+	Buanasari *et al.* (2018)
Zingiber cassumanar	+	+	+	+	+	-	+	Buldani *et al.* (2017)
Zingiber officinale	+	+	-	+	+	+	+	Agustina *et al.* (2016)

NA, Not available.

Table 4. Total phenolic content (TPC), antioxidant activity and potential levels of indigenous Indonesian plants

Plant species	Total Phenolic Content (TPC) (mg GAE/g extract)	Total Flavonoid Content (TFC) (mg QE/g extract)	Antioxidant Activity (AA) (IC_{50}) µg/mL	Potential level (TPC/AA)	References
Aloe vera Linn	7.99	9.17	45.6	175.22	Vidic *et al.* (2014)
Alpinia galanga	37.84	NA	93.27	405.70	Da'i *et al.* (2013)
Annona muricata	195.05	64.25	21.03	9274.85	Yen *et al.* (2019)
Avorrhoa bilimbi L	39.03	97.28	16.99	2297.23	Hasim *et al.* (2019)
Camellia sinensis	31.6	23.2	7.30	4328.77	Bizuayebu *et al.* (2016)
Cosmos caudatus	149.33	214.00	166.25	898.23	Noriham *et al.* (2015)
Curcuma aeruginosa Roxb	51.49	33.36	406.52	126.66	Kumar *et al.* (2013)
Curcuma longa	6.15	4.28	1.08	5694.81	Wandita and Musfiroh (2018)
Curcuma xanthorrizha	205.86	NA	36.96	5569.81	Amelinda *et al.* (2018)
Curcuma zedoaria	84.15	NA	210.12	400.49	Marliani *et al.* (2017)
Foeniculum vulgare	5.8	16.8	2.409	2407.64	Martati and Akmalina (2018)
Hibiscus sabdariffa L	48.42	2.075	281.78	171.85	Jung *et al.* (2013)
Kaempferia galanga	23.85	NA	13.07	1824.79	Latifah (2015)
Morinda citrifolia	88.03	1.56	398.99	22.06	Kumar *et al.* (2014)
Moringa oleifera	30.0	96.0	134.5	223.05	Sulastri *et al.* (2018)
Myristica fragrans	37.26	51.97	770	48.39	Liu *et al.* (2008)
Nigella sativa	31.15	110.5	53.90	577.83	Zarai *et al.* (2013)
Ocimum sanctum L.	148.9	18.27	52.68	2826.50	Erviana *et al.* (2011)
Phyllanthus niruri	61.36	54.72	10.53	5827.16	Ramandeep *et al.* (2015)
Piper crocatum	182.68	197.95	82.71	2208.68	Prayitno *et al.* (2016)
Piper nigrum Linn	174.92	62.73	448.20	390.27	Nahak and Sahu (2011)
Plectranthus amboinicus	11.6	1.612	247.94	46.79	Patel *et al.* (2010)
Solanum torvum	16.15	1.41	124	130.24	Abdulkadir *et al.* (2016)
Syzygium polyantum	69.76	270	35.057	1989.73	Verawati *et al.* (2017)
Tamarindus indica	71.68	NA	98.30	729.20	Yeasmen and Islam (2015)
Zingiber cassumunar	27.1	NA	142.7	189.91	Marliani *et al.* (2015)
Zingiber officinale L	400.2	268.2	39.6	10106.06	Yesiloglu *et al.* (2012)

Value of the potential level is calculated assuming the density of the extract for each plant is the same.

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