Pharmacological activities and phytochemical constituents of *Phyllanthus reticulates* Poir. – A review

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Abstract—Phyllanthus reticulatus Poir. (Phyllanthaceae) is a shrub distributed in Australia, Asia, and Africa. Various parts of this plant species are employed to cure a variety of illnesses in ethnomedicines such as urine infection, malaria, headache, dysmenorrhea, abscess, anemia, asthma, diarrhea, smallpox, syphilis, inflammation, rheumatism, sores, and envenomation. So far, there is no systematic comprehensive review has been published to analyze, summarize, and document the scientific finding of phytochemistry and pharmacological activities of this plant species. Hence, this work aims to present a comprehensive review to offer a base and encourage to carry out further phytochemical and pharmacological researches of *P. reticulatus*. The Web of Science was utilized to identify the appropriate published articles from 1900 to September 2020. Compounds including astragalin, corilagin, isoquercitrin, taraxerone, pinoresinol, friedelin, reticulate side A, and sitosterol been identified in this plant species. So far, only *in vitro* and *in vivo* scientific evidence are available for the pharmacological activities of various parts of *P. reticulatus* and more investigations involved *in vitro* bioassays. Researches show that *P. reticulatus* contains analgesic, antibacterial, antidiabetic, antifungal, anti-human immunodeficiency virus-1, antihypercholesterolemic, anti-inflammatory, antioxidant, antiplasmodial, and hepatoprotective activities. Further, none of the pharmacologically active compound has been recognized in this plant species. Hence, additional pharmacological activities and phytochemical analysis studies should be performed to deliver more scientific evidence for ethnomedicinal uses of this plant species. This work summarized the available phytochemical and pharmacological activities findings of *P. reticulatus* and also delivers a foundation for additional phytochemical and pharmacological activities investigations of *P. reticulatus.*

Keywords – Phyllanthus reticulatus, Phyllanthaceae, Sri Lanka, Siddha Medicine, Ayurveda

I. INTRODUCTION

*Phyllanthusreticulatus*Poir.is a shrub that belongs to the family Phyllanthaceae. This plant species is found in Australia, Asia, and Africa (Conservatoire et Jardin botaniques & South African National Biodiversity Institute, 2012). Also, it is called (Neerppoola) in Tamil. *P. reticulatus* is used for many purposes including food, medicine, and others. Fruits are consumed as food in Sierra Leone and East Africa(Lewis, 1986). Various parts of this plant species are used to treat various disorders in traditional medicines like urine infection, bleeding gums, genital ulcer, burns, suppuration, malaria, muscle spasms, hookworm, headache, dysmenorrhea, abscess, sore eyes, anemia, gastrointestinal bleeding, asthma, diarrhea, blood disorders, smallpox, syphilis, inflammation, rheumatism, constipation, colic, fever, sores, chafes, envenomation, and venereal sores in Africa and Asia (Chhabra *et al*., 1984; Hedberg *et al*., 1983; Ilham *et al*., 1995; Jayaweera, 1982; Lewis, 1986; Panthong *et al*., 1986; Selvanayagam *et al*., 1995; The Institute of Ayurveda and Alternative Medicine, 2020). Notably, its bark and tender leaf are used to treat diabetes in Sri Lankan Siddha Medicine (Sathasivampillai *et al*., 2017).

P. reticulatus has many applications to heal several diseases in traditional medicines as mentioned above. Anyway, only some of the traditional medicinal uses have been proved by scientific studies. Also, no systematic comprehensive review has been published to analyze, summarize, and document the scientific finding of phytochemistry and pharmacological activities of this plant species. Hence, this work aims to present a comprehensive review to offer a base and encourage to carry out further phytochemical and pharmacological researches of *P. reticulatus*.

A literature review was performed using the Web of Science to find the appropriate published articles of *P. reticulatus* from 1900 to September 2020. *Phyllanthus reticulatus* was used as a search term and only phytochemical and pharmacological activities related to published articles were considered in this study.

II. PHYTOCHEMICAL CONSTITUENTS

More information like part used, extract, identified compound, and reference is listed in Table 1. Compounds have been identified in leaf, root, stem, and whole plant of this plant species. However, the greatest number of compounds have been discovered in the whole plant. Compounds including astragalin, corilagin, ellagic acid, isoquercitrin, and kaempferol 3-rutinoside have been isolated from leaves (Lam *et al*., 2007; Neves and Neves, 1966; Pojchaijongdee *et al*., 2010). Also, taraxerone is found in the root (Joshi *et al*., 1981) and pinoresinol, betulinic acid, 3,4,3′-tri-O-methylellagic acid, 21α+hydroxyfriedel-4(23)-en-3-one, and 21α-hydroxyfriedelan-3-one have been identified in the stem (Hui *et al*., 1976; Pojchaijongdee *et al*., 2010; Sangkasila, 1998). However, friedelin and sitosterol, etc. have been isolated from both stem and leaves (Hui *et al*., 1976). Compounds like hovetrichoside A, isotachioside, mananthoside I, phyllanthusmin C, and reticulateside A have

been identified in the whole plant (Lan *et al*., 2010; Ma *et al*., 2012). Ethanol extracts contain the majority of the compounds. More phytochemical studies should be conducted to isolate more natural compounds from various parts of this plant species which might be novel and have many pharmacological activities.

I. PHARMACOLOGICAL ACTIVITIES

Hitherto, only *in vitro* and *in vivo* scientific evidence are available for the pharmacological activities of various parts of *P. reticulatus.* Anyhow, more researches have been conducted using *in vitro* bioassays. More information including the level of scientific evidence, pharmacological activity, part used, extract, bioassay/model, dose/concentration, duration, and reference are listed in Table 2. Leaf, aerial, root, and stem have exhibited a variety of pharmacological activities like analgesic(Saha *et al*., 2007), antibacterial (Direkbusarakom *et al*., 1998; Eldeen *et al*., 2011), antidiabetic(Kumar *et al*., 2008), antifungal(Chellappandian *et al*., 2018), anti-human immunodeficiency virus-1 (HIV-1) (Eldeen *et al*., 2011; Tai *et al*., 2011), antihypercholesterolemic (Maruthappan and Shree, 2010), anti-inflammatory (Saha *et al*., 2007), antioxidant (Chellappandian *et al*., 2018; Eldeen *et al*., 2011), antiplasmodial (Omulokoli *et al*., 1997), and hepatoprotective (Das *et al*., 2008)activities. The antifungal activity has a larger number of investigations and leaves have been used in a greater number of pharmacological studies.

Leaves possess antibacterial, antidiabetic, antifungal, anti-Human immunodeficiency virus-1, antioxidant, and antiplasmodial activities. Furthermore, methanol extract was utilized in the majority of the studies and it exhibited pharmacological activities including antibacterial, anti-human immunodeficiency virus-1, anti-inflammatory, antioxidant, and antiplasmodial activities. On the other hand, none of the pharmacologically active compound has been identified in this plant species. Hence, further pharmacological activities and phytochemical analysis correlated investigations should be performed to identify the active compounds. It seems that the ethnomedicinal applications to treat diseases like malaria, inflammation, rheumatism, muscle spasms, diabetes, and abscess have been evidenced by reported analgesic, antibacterial, antidiabetic, antifungal, anti-inflammatory, and antiplasmodial activities. Anyhow, there is no existing scientific evidence for healing including hookworm, headache, smallpox, syphilis, and asthma. Thus, future researches should be carried out to provide more scientific evidence for ethnomedicinal uses of this plant species.

Table 1: Compounds identified in *P. reticulatus*

Part used	Extract	Identified compound	Reference
Leaf	Methanol	(5R*,6R*)-4,6-Dimethoxycarbonyl-5-[2′,3′,4′-trihydroxy-6′-(methoxycarbonyl) phenyl]-5,6-dihydro-2H-pyran-2-one, 2,7-di-O-methylellagic acid, astragalin, corilagin, ellagic acid, isoquercitrin, kaempferol 3-rutinoside, methyl gallate, methylbrevifolincarboxylate, quercitrin, rutin, stigmasterol-3-O-β-glucoside, β-Sitosterol-3-O-β-glucoside, 3,4,3′-tri-O-methylellagic acid	Lam *et al*. (2007); Neves and Neves (1966); Pojchaijongdee *et al*. (2010)
Leaf	Petroleum ether	Friedelin, sitosterol	Hui *et al*. (1976)
Root	NS	Taraxerone	Joshi *et al*. (1981)
Stem	Ethanol	Betulinic acid	Hui *et al*. (1976)
Stem	Methanol	3,4,3′-tri-O-methylellagic acid	Pojchaijongdee *et al*. (2010); Sangkasila (1998)
Stem	Petroleum ether	Friedelin, friedelan-3βol, glochidonol, sitosterol, 21α+hydroxyfriedel-4(23)-en-3-one, 21α-hydroxyfriedelan-3-one	Hui *et al*. (1976)
Stem	NS	Pinoresinol	Sangkasila (1998)
Whole plant	Ethanol	(-)-epigallocatechin, 19-hydroxyspruceanol 19-O-b-d-glucopyranoside, 3-(3-methylbut-2-en-1-yl) isoguanine, 3,4-dihydroxyphenylpropanol 3-O-b-d-glucopyranoside, carthamoside B_5, hovetrichoside A, isotachioside, mananthoside I, turpenionosides A, turpenionosides B	Lan *et al*. (2010)
Whole plant	Ethanol (95%)	(+)-lyoniresinol, (3S,5R,6S,9R)-megastigman-3,9-diol 3-O-α-L-arabinofuranosyl-(1->6)-β-D-glucopyranoside, 7-megastigmen-3-ol-9-one 3-O-α-L-arabinofuranosyl-(1->6)-β-D-glucopyranoside, cleistanthol, phyllanthusmin B, phyllanthusmin C, reticulatuside A, reticulatuside B, spruceanol, syringaresinol	Ma *et al*. (2012)
NS	NS	Epi-friedelanol, p-coumaric acid, pyrogallic acid	Chandler and Hooper (1979); Neves and Neves (1966)

Abbreviation - NS: Not stated

Table 3: Pharmacological activities of *P. reticulatus*

Level of scientific evidence	Pharmacological activity	Part used	Extract	Bioassay / model	Dose / concentration	Duration	Reference
In vitro	Antibacterial	NS	Ethanol	*Aeromonas hydrophila* assay	2.5 mg/ml (MIC)	NA	Direkbusarakom *et al*. (1998)
		NS	Ethanol	*Vibrio harveyi* assay, *Vibrio parahaemolyticus* assay	5 mg/ml (MIC)	NA	
In vitro	Antibacterial	Leaf	Methanol (80%)	*Bacillus licheniformis* assay	164 µg/ml	NA	Eldeen *et al*. (2011)
		Leaf	Methanol (80%)	*Pseudomonas stutzeri* assay	180 µg/ml	NA	
		Leaf	Methanol (80%)	*Escherichia coli* assay, *Klebsiella pneumoniae* assay	312 µg/ml	NA	
		Leaf	Methanol (80%)	*Staphylococcus aureus* assay	79 µg/ml	NA	
		Leaf	Methanol (80%)	*Bacillus spizizenii* assay	84 µg/ml	NA	
In vitro	Antifungal	Leaf	Ethanol	*Trichophyton simii* assay	1000 µg/ml (MFC)	NA	Chellappandian *et al*. (2018)
		Leaf	Ethanol	*Trichophyton rubrum* (CI-1) assay, *Trichophyton rubrum* (CI-2) assay, *Trichophyton mentagrophytes* (CI-1) assay, *Microsporum gypseum* assay	125 µg/ml (MIC)	NA	
		Leaf	Ethanol	*Trichophyton tonsurans* assay, *Trichophyton simii* assay, *Trichophyton mentagrophytes* (CI-2) assay	250 µg/ml (MFC)	NA	
		Leaf	Ethanol	*Trichophyton rubrum* (CI-1) assay, *Trichophyton rubrum* (CI-2) assay, *Trichophyton mentagrophytes* (CI-1) assay, *Microsporum gypseum* assay	500 µg/ml (MFC)	NA	

Level of scientific evidence	Pharmacological activity	Part used	Extract	Bioassay / model	Dose / concentration	Duration	Reference
		Leaf	Ethanol	*Trichophyton mentagrophytes* (CI-2) assay, *Trichophyton tonsurans* assay	62.5 µg/ml (MIC)	NA	
In vitro	Anti-Human immunodeficiency virus-1	Leaf, Stem	Methanol	Ribonuclease H inhibitory assay	50 µg/ml	NA	Tai *et al*. (2011)
		Leaf	Methanol	Human immunodeficiency virus-1 cytopathic assay	5.6 µg/ml (EC_{50})	NA	
		Stem	Methanol	Human immunodeficiency virus-1 cytopathic assay	20.8 µg/ml (IC_{50})	NA	
		Leaf	Methanol	Human immunodeficiency virus-1 cytopathic assay	6.3 µg/ml (IC_{50})	NA	
In vitro	Anti-Human immunodeficiency virus-1 reverse transcriptase	Leaf	Methanol (80%)	Human immunodeficiency virus-1 reverse transcriptase assay	131 µg/ml (IC_{50})	NA	Eldeen *et al*. (2011)
In vitro	Antioxidant	Leaf	Ethanol	2, 2-diphenyl-1-picrylhydrazil free radical scavenging assay	NS	NA	Chellappandian *et al*. (2018)
In vitro	Antioxidant	Leaf	Methanol (80%)	2, 2-diphenyl-1-picrylhydrazil free radical scavenging assay	10.8 µg/ml (IC_{50})	NA	Eldeen *et al*. (2011)

Level of scientific evidence	Pharmacological activity	Part used	Extract	Bioassay / model	Dose / concentration	Duration	Reference
In vitro	Antiplasmodial	Leaf	Methanol	Chloroquine-sensitive (K67) *Plasmodium falciparum* assay	1.7 µg/ml (IC_{50})	NA	Omulokoli *et al*. (1997)
		Leaf	Methanol	Chloroquine-resistant (ENT36) *Plasmodium falciparum* assay	10 µg/ml (IC_{50})	NA	
		Root	Methanol	Chloroquine-resistant (ENT36) *Plasmodium falciparum* assay	159.8 µg/ml (IC_{50})	NA	
		Root	Methanol	Chloroquine-sensitive (K67) *Plasmodium falciparum* assay	165.1 µg/ml (IC_{50})	NA	
		Stem	Methanol	Chloroquine-resistant (ENT36) *Plasmodium falciparum* assay	23.9 µg/ml (IC_{50})	NA	
		Stem	Methanol	Chloroquine-sensitive (K67) *Plasmodium falciparum* assay	7.7 µg/ml (IC_{50})	NA	
In vivo	Analgesic	Aerial	Ethyl acetate, Methanol	Radiant heat tail-flick method	300 mg/kg	1 h	Saha *et al*. (2007)
		Aerial	Ethyl acetate	acetic acid-induced writhing inhibition method	150 mg/kg	10 min	

Level of scientific evidence	Pharmacological activity	Part used	Extract	Bioassay / model	Dose / concentration	Duration	Reference
In vivo	Antidiabetic	Leaf	Ethanol, Petroleum ether	Alloxan-induced diabetic mouse	500 mg/kg	21 d	Kumar *et al*. (2008)
In vivo	Antihypercholesterolemic	Aerial	Aqueous	Atherogenic diet-induced hypercholesterolemic rat	250 mg/kg	45 d	Maruthappan and Shree (2010)
In vivo	Anti-inflammatory	Aerial	Ethyl acetate, Methanol	Carrageenan-induced rat hind paw edema model	150 mg/kg	1 h	Saha *et al*. (2007)
In vivo	Hepatoprotective	Aerial	Ethanol (95%)	Carbon tetrachloride-induced liver damaged rat	200 mg/kg	15 d	Das *et al*. (2008)

Abbreviations
HIV: Human Immunodeficiency Virus, EC_{50}: Half maximal effective concentration, IC_{50}: Half maximal inhibitory concentration, MFC: Minimal Fungicidal Concentrations, MIC: minimum inhibitory concentration, NA: Not Applicable, NS: Not Stated

A. In vitro studies

Antibacterial (Direkbusarakom *et al*., 1998; Eldeen *et al*., 2011), antifungal (Chellappandian *et al*., 2018), anti-human immunodeficiency virus-1 (Eldeen *et al*., 2011; Tai et al., 2011), antioxidant (Chellappandian *et al*., 2018; Eldeen *et al*., 2011), and antiplasmodial (Omulokoli *et al*., 1997) activities possess *in vitro* level of scientific evidence of *P. reticulatus.* The majority of the studies have been carried out to study the antifungal activity. The most efficient (based on the lowest extract concentration used) *in vitro* investigation was conducted by Omulokoli *et al*. (1997). In this study, leaf methanol extract (IC_{50} 1.7 µg/ml) revealed antiplasmodial activity in chloroquine-sensitive (K67) *Plasmodium falciparum* assay. Thus, it is recommended that conducting further *in vivo* and clinical trial researches for the studies exposed more efficient consequences in *in vitro* bioassays.

B.In vivo studies

Until now, analgesic (Saha *et al*., 2007), antidiabetic(Kumar *et al*., 2008), antihypercholesterolemic (Maruthappan and Shree, 2010), anti-inflammatory (Saha *et al*., 2007), and hepatoprotective (Das *et al*., 2008) activities have been reported in *in vivo* evidence. The majority of the *in vivo* evidence is available for analgesic activity. A study implemented by Saha *et al*. (2007) seems the best study (based on the lowest dose and duration of the study) among the reported *in vivo* studies. Aerial ethyl acetate extract (150 mg/kg) orally administered to acetic acid-induced writhing rat model exhibited the analgesic activity after 10 minutes. Henceforth, it is suggested that to carry out clinical trials for the reported *in vivo* studies.

II. CONCLUSION

Several compounds have been identified in *P. reticulatus*and this plant species contains several pharmacological activities. Also, it has a wide range of ethnomedical uses. Hence, further phytochemical studies should be conducted to identify the pharmacologically active compound in *P. reticulatus.* Moreover, further *in vitro, in vivo*, and clinical trial investigations should be performed for various extracts and discovered compounds in *P. reticulatus* to provide more scientific evidence for its ethnopharmacological applications. This work summarized the available phytochemical and pharmacological activities findings of *P. reticulatus.* This work also delivers a foundation for additional phytochemical and pharmacological activities investigations of *P. reticulatus.*

III. REFERENCES

Chandler, R. F., and Hooper, S. N. (1979).Friedelin and associated triterpenoids.*Phytochemistry*, *18*(5), 711–724.

Chellappandian, M., Saravanan, M., Pandikumar, P., Harikrishnan, P., Thirugnanasambantham, K., Subramanian, S., and Ignacimuthu, S. (2018). Traditionally practiced medicinal plant extracts inhibit the ergosterol biosynthesis of clinically isolated dermatophytic pathogens. *Journal de MycologieMedicale*, *28*(1), 143–149.

Chhabra, S. C., Uiso, F. C., and Mshiu, E. N. (1984).Phytochemical screening of Tanzanian medicinal plants. I. *Journal of Ethnopharmacology*, *11*(2), 157–179.

Conservatoire etJardinbotaniques& South African National Biodiversity Institute. (2012). African Plant Database. Retrieved October 13, 2020, from https://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php

Das, B. K., Bepary, S., Datta, B. K., Chowdhury, A. K., Ali, M. S., and Rouf, A. S. S. (2008).Hepatoprotective activity of *Phyllanthusreticulatus*.*Pakistan Journal of Pharmaceutical Sciences*, *21*(4).

Direkbusarakom, S., Ezura, Y., Yoshimizu, M., and Herunsalee, A. (1998). Efficacy of Thai traditional herb extracts against fish and shrimp pathogenic bacteria. *Fish Pathology*, *33*(4), 437–441.

Eldeen, I. M. S., Seow, E. M., Abdullah, R., and Sulaiman, S. F. (2011).*In vitro* antibacterial, antioxidant, total phenolic contents and anti-HIV-1 reverse transcriptase activities of extracts of seven *Phyllanthus* sp. *South African Journal of Botany*, *77*(1), 75–79.

Hedberg, I., Hedberg, O., Madat, P. J., Mshigeni, K. E., Mshiu, E. N., and Samuelsson, G. (1983). Inventory of plants used in traditional medicine in Tanzania. II. Plants of the families Dilleniaceae—Opiliaceae. *Journal of Ethnopharmacology*, *9*(1), 105–127.

Hui, W.H., Li, M.M., and Wong, K.M. (1976).A new compound, 21α-hydroxyfriedel-4 (23)-en-3-one and other triterpenoids from *Phyllanthusreticulatus*.*Phytochemistry*, *15*(5), 797–798.

Ilham, M., Yaday, M., and Norhanom, A. W. (1995).Tumour promoting activity of plants used in Malaysian traditional medicine.*Natural Product Sciences*, *1*(1), 31–42.

Jayaweera, D. M. A. (1982). Medicinal Plants (indigenous and Exotic) Used in Ceylon: Magndaceae-Rubiaceae. National Science Council of Sri Lanka.

Kumar, S., Kumar, D., Deshmukh, R. R., Lokhande, P. D., More, S. N., and Rangari, V. D. (2008). Antidiabetic potential of *Phyllanthusreticulatus* in Alloxan-induced diabetic mice.*Fitoterapia*, *79*(1), 21–23.

Lam, S.H., Wang, C.Y., Chen, C.K., and Lee, S.S. (2007). Chemical investigation of *Phyllanthusreticulatus* by HPLC-SPE-NMR and conventional methods.*Phytochemical*

Analysis: An International Journal of Plant Chemical and Biochemical Techniques, *18*(3), 251–255.

Lan, M.S., Ma, J.X., Tan, C.H., Wei, S., and Zhu, D.Y. (2010). Chemical Constituents of *Phyllanthusreticulatus*.*Helvetica ChimicaActa*, *93*(11), 2276–2280. Lewis, W. H. (1986). The Useful Plants of West Tropical Africa.*Economic Botany*, *40*(2), 176–176.

Ma, J.X., Lan, M.S., Qu, S.J., Tan, J.J., Luo, H.F., Tan, C.H., and Zhu, D.Y. (2012).Arylnaphthalenelignan glycosides and other constituents from *Phyllanthusreticulatus*. *Journal of Asian Natural Products Research*, *14*(11), 1073–1077.

Maruthappan, V., and Shree, K. S. (2010).Effects of *Phyllanthusreticulatus* on lipid profile and oxidative stress in hypercholesterolemic albino rats.*Indian Journal of Pharmacology*, *42*(6), 388.

Neves, A. C., and Neves, M. T. C. (1966).Some determinations on the leaves of *Phyllanthusreticulatus*Poir.Of Mozambique.*Bol Esc Farm Univ Coimbra*, *25*, 22.

Omulokoli, E., Khan, B., and Chhabra, S. C. (1997).Antiplasmodial activity of four Kenyan medicinal plants.*Journal of Ethnopharmacology*, *56*(2), 133–137.

Panthong, A., Kanjanapothi, D., and Taylor, W. C. (1986).Ethnobotanical review of medicinal plants from Thai traditional books, Part I: Plants with anti-inflammatory, anti-asthmatic and antihypertensive properties. *Journal of Ethnopharmacology*, *18*(3), 213–228.

Pojchaijongdee, N., Sotanaphun, U., Limsirichaikul, S., and Poobrasert, O. (2010). Geraniinic acid derivative from the leaves of *Phyllanthusreticulatus*.*Pharmaceutical Biology*, *48*(7), 740–744.

Saha, A., Masud, M. A., Bachar, S. C., Kundu, J. K., Datta, B. K., Nahar, L., and Sarker, S. D. (2007). The Analgesic and Anti-Inflammatory Activities of the Extracts of *Phyllanthusreticulatus*.In Mice Model.*Pharmaceutical Biology*, *45*(5), 355–359.

Sangkasila, R. (1998). Chemical constituents and some bioactivities of stem of *Phyllanthusreticulatus*Poir (PhD Thesis). MS Thesis. Bangkok, Ramkhamhaeng University.

Sathasivampillai, S. V., Rajamanoharan, P. R. S., Munday, M., and Heinrich, M. (2017). Plants used to treat diabetes in Sri Lankan Siddha Medicine – An ethnopharmacological review of historical and modern sources. *Journal of Ethnopharmacology*, *198*, 531–599.

Selvanayagam, Z. E., Gnanavendhan, S. G., Balakrishna, K., and Rao, R. B. (1995).Antisnake venom botanicals from ethnomedicine.*Journal of Herbs, Spices & Medicinal Plants*, *2*(4), 45–100.

Tai, B. H., Nhut, N. D., Nhiem, N. X., Quang, T. H., ThanhNgan, N. T., ThuyLuyen, B. T., and Ban, N. K. (2011). An evaluation of the RNase H inhibitory effects of Vietnamese medicinal plant extracts and natural compounds.*Pharmaceutical Biology*, *49*(10), 1046–1051.

The Institute of Ayurveda and Alternative Medicine. (2020). Ayurvedic Plants of Sri Lanka: Plants Details. Retrieved October 13, 2020, from Ayurvedic plants database—*Phyllanthusreticulatus* website: http://www.instituteofayurveda.org/plants/plants_detail.php?i=536&s=local_name