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Research Article

Pharmacological Activities and Phytochemical Compounds: Overview of Pouteria Genus

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ABSTRACT

Species of Pouteria are widely spread in various countries. Pouteria is one of the genus that have diverse pharmacological activities. This review includes an overview of the species from Pouteria, phytochemical methods used in isolation of compounds from Pouteria, and their pharmacological activities. The trends in the pharmacological activity of Pouteria is antioxidant activity, antidiabetic and antimicrobial activities. However, information on its use as a traditional medicine from Pouteria was poor. Chemical compounds that have been widely isolated from Pouteria genus included phenolic acid, other phenolics non flavonoid, flavonoids, and terpenoids derivative. The most widely reported chemical compounds from Pouteria are terpenoid derivatives. Further research is needed for the mechanism of action based on the pharmacological activites of chemical compounds.

Key words: Pouteria genus, Pharmacological activities, Phytochemical compound.

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INTRODUCTION

Pouteria genus in one of the 53 genus.[1] Sapotaceae family, which has 325 species[2] and distributed in tropical and subtropical region.[3] Some species of Pouteria were used as traditional medicine. The experiment of pharmacological activities can be based on a report the use of these plants as traditional medicine and chemical content. Information regarding pharmacological activities and phytochemical compounds of Pouteria genus were needed for developing Pouteria genus uses in pharmacy industries. Therefore, this article reported information concerning pharmacological activities, phytochemical method and chemical compounds of Pouteria genus.

METHOD

The data was collected through PubMed. There are 71 journals in PubMed with keyword Pouteria. Journals that used as literature for this review are classified based on international journals indexed by Scopus, quartile 1-4.

RESULTS

The uses of Pouteria genus as traditional medicine can be shown in Table-1. Several species of Pouteria genus were used as food material. The fruits of Pouteria was often consumed directly[4,5] and used as an additional ingredient in food such as in pudding.[6,7] In traditional medicine, *P. ramiflora* as antihyperlipidemic,[8,9] *P. campechiana*, was used for heart disease, liver, epilepsy, stomach diseases, and skin disruption.[10] Other species of Pouteria genus was applied for inflammation, diabetes, indigestion,[3,11] diarrhea,[12] nausea, throw up and relieve back pain.[13] Based on the taxonomy of Pouteria, the most studied species is *P. campechiana*, and it can be seen the order and total species studies in term of pharmacological activity and the compounds isolated in Figure 1.

Phytochemical Compounds of *Pouteria Genus*

Secondary metabolites in plants are generally produced through the pathway of shikimic and acetic acid. Secondary metabolites from shikimic pathway are phenylpropanoid, simple phenolic compound and polyphenols including flavonoids. Whereas from the acetic acid pathway it is derivative of terpenoids, sterols and derivative of volatile compounds. In this review, information regarding phytochemical compounds of Pouteria genus up to 2019, was presented in Table 2 and Figure 2. Flavonoid, phenolic compounds and terpenoid were secondary metabolite isolated from Pouteria genus.

Other terpenoid compounds that have isolated included α-amyrin and lupeol. These compounds were found in *P. torta* fruits and flower[19,20] and *P. caimito* fruits.[21] Alpha-amyrin acetate and β-amyrin were presented from stem bark extract of *P. tomentosa*,[22] *P. Torta*[23] and *P. gardneri* leaves extract.[24] Beta-amyrin acetate and betulinic acid were isolated from methanol leaves extract of *P. torta*[23] and *P. tomentosa*.[22] Ursolic acid was reported from several species of Pouteria, included *P. venosa* extract,[11] *P. gardnerii* extract[24] and *P.tomentosa* extract.[22] Taraxerol was reported in *P. caimito* extract,[21,25] and *P. venosa* extract.[11] While carotenoids were found in *P. cambodiana* extract.[12]

The other phenolic groups which were isolated from Pouteria, included gallic acid, (+)-gallocatechin, (+)-catechin, (-)-epicatechin, (+)-catechin-3-O-gallate epicatechin, and myricitrin from *P. campechiana*, *P. sapota* and *P. viridis* extracts.[3] Myricitrin have been also isolated from *P. torta* extract.[20] Stilbenes and *protocatechuic acid* have

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Table 1: The use of Pouteria genus as traditional medicine.

Species	Part of	Uses as traditional medicine	Ref.
Pouteria caimito	Leaves	for antimalaria, reduce pain, and wound healing	14
	Flesh of fruit	to relieve cough, bronchitis, and other lung disorders	15
	Latex	as a laxative	
Pouteria cambodiana (Pierre ex Dubard) Baehni	Stem bark	decoction of stem bark to facilitate breast milk	16
Pouteria ramiflora (Mart.) Radlk	Other parts	for nausea, vomiting, fever and relieve back pain	8,9
	Fruits and root	as anthelmintic, dysentery, and inflammation	
Pouteria campechiana (Kunth) Baehni	Stem bark	antipyretic and for healing injured skin	15, 10, 17
	Peel of fruits	fever reducing medication	
	Leaves	decoction of leaves for diarrhea	
Pouteria sapota (Jacq.) H. E. Moore & Stern	Seed and seed oil	to reduce pain in the ear, to treat kidney stones, rheumatism, and digestive disorder	18

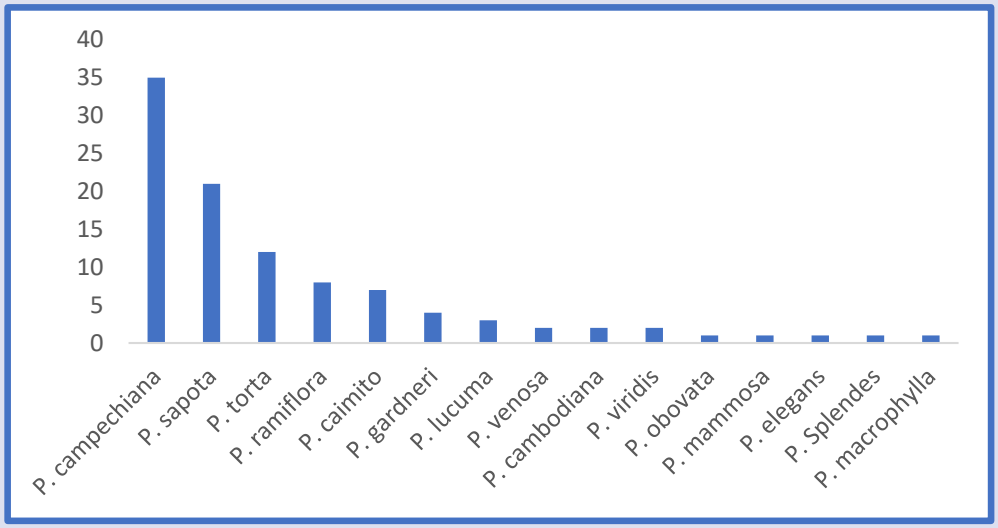

Figure 1: Total species studies in term of pharmacological activity and the compounds isolated.

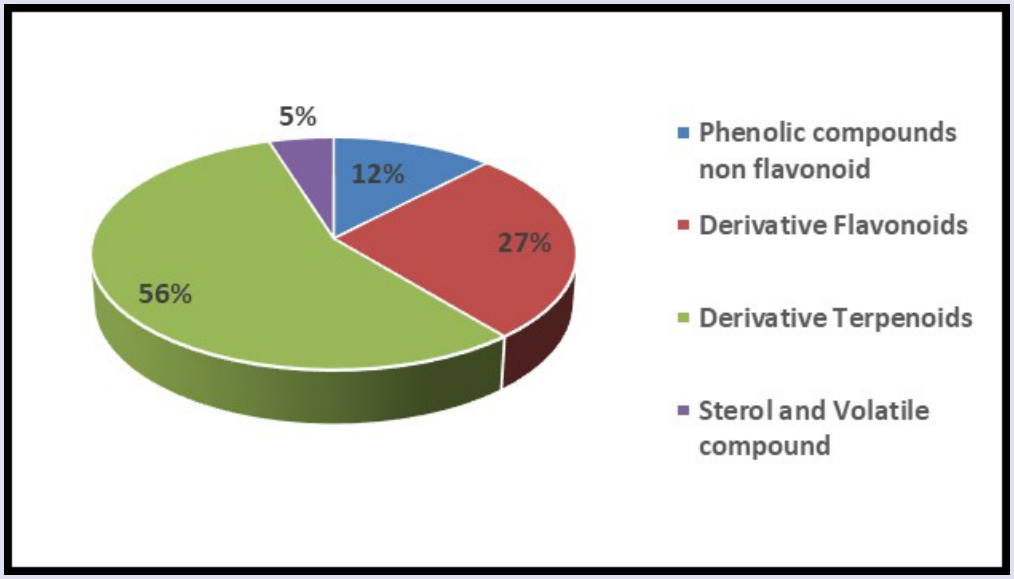

Figure 2: Compounds that have been isolated from Pouteria based on secondary metabolite.

Table 2: Phytochemical compounds of Pouteria up to 2019.

Phytochemical compounds	Species	Part used	Extraction method	Solvent	Ref.
Flavonoid					
Myricetin	*P. campechiana*	Leaves and seed	Maceration	EtOH 70%	27
	P. torta	Leaves	Percolation	EtOH-Water (7:3)	28
Myricetin-3-O-β-galactoside Myricetin-3-O-α-L-rhamnoside	*P. campechiana*	Leaves and seed	Maceration	EtOH 70%	27
Quercetin	*P. sapota*	Fruits	Soxhlet	EtOH 99%	29
	P. campechiana	Leaves; Seed	Maceration	EtOH 70%	27
Quercetin 3-O-α-L-rhamnopyranoside Quercetin 3-O-β-arabinopyranoside Taxifolin 3-O-α-arabinofuranoside Trans-taxifolin 3-O-α-arabinopyranoside Taxifolin 3-O-α-rhamnopyranoside	*P. campechiana*	Leaves	Maceration	Methanol	30
Phenolic ompound					
Gallat acid	*P. campechiana*	Leaves and Seed	Maceration	Ethanol 70%	27
Terpenoid					
a. Neoxanthin; b. (9'Z)-Neoxanthin c. Capsoneoxanthin	*P. sapota*	Ripe Fruit	Homogenized with acetone	Acetone	31
a. α- and β- amyrin b. Lupeol c. α-amyrin acetate d. Ψ-taraxasterol acetate	*P. gardneri*	Leaves	Maceration	n-Hexane	32
a. ursolic b. oleanolic acid	*P. gardneri*	Leaves	Maceration	Ethanol	
Monoterpene (α-Pinene)	*P. elegans*	Ripe fruits	HS-SPME technique		33
a. sapotexanthin 5,6-epoxide b. sapotexanthin 5,8-epoxide c. cryptocapsin d. capsanthin 5,6-epoxide	*P. sapota*	Ripe fruits	Homogenized in mortar	Acetone	34
a. Friedelin b. *Epi*-friedelanol	*P. ramiflora*	Leaves	Maceration	n-Hexane	35
Taraxerol	*P. ramiflora*	Leaves	Maceration	n-Hexane	
	P. venosa	Leaves; bark; stem bark	Maceration	Ethanol	11
a. Spinasterol; b. Three triterpenes fatty acid ester	*P. campechiana*	Stem bark	Maceration	Ethyl acetate	36
a. β-cryptoxanthin-5,6-epoxide; b. β-cryptoxanthin-5′,6′-epoxide; c. 3′ Deoxycapsanthi d. Cryptocapsin	*P. sapota*	Fruits	Homoge-nized with $NaHCO_3$	Acetone	37
a. Cryptocapsin-5,6-epoxide; b. 3′-deoxycapsanthin-5,6 epoxide; c. cryptocapsin-5,8-epoxides	*P. sapota*	Fruits	Homoge-nized with $NaHCO_3$	Acetone	38
a. 3'-deoxycapsorubin b. 3,3'-dideoxycapsorubin	*P. sapota*	Fruit	Homoge-nized with $NaHCO_3$	Acetone	39
Sapotexanthin (all-E,5'R)-β,κ-caroten-6'-one	*P. sapota*	Fruit	Homoge-nized with $NaHCO_3$	Acetone	40

been isolated from *P. cambodiana* extract.[13,16] Besides that, four of dihydroflavonols (dihydrokaemferol glycosides) were isolated from methanol-water (80:20) extract of *P. obovate*.[26]

Pharmacological activities

The pharmacological activities research of Pouteria varied widely. The pharmacological activity trends under study can be seen in the Figure 3 and in Table 3.

Antioxidant activity

Antioxidant activity was the most reported from Pouteria genus. Some extracts and fractions of Pouteria active as antioxidant. Many species of Pouteria have antioxidant activities included methanol extract of stem bark *P. cambodiana* with IC_{50} against DPPH 0.24 mg/ml,[16] acetone extract, methanol and acetone fractions of *P. campechiana* fruit,[3] ethanol and water extracts of *P. campechiana* fruits with different level maturity of 4, 8, 12, 16, 20 and 24 weeks as antioxidant against DPPH,

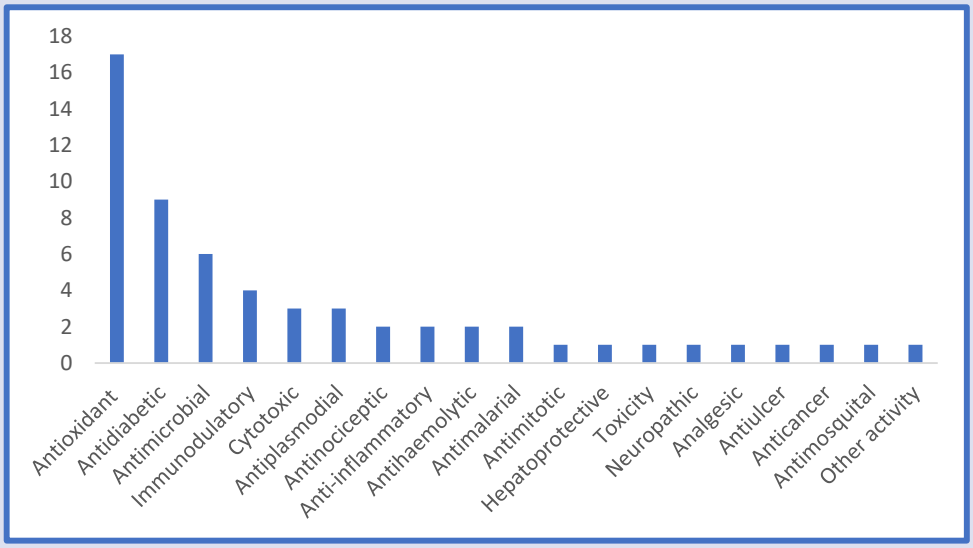

Figure 3: Total species studies in term of pharmacological activity and the compounds isolated.

Table 3: Pharmacological activities of Pouteria genus.

Species	Part Used							Pharmacological activities	Ref.
	R	RB	F	S	St	StB	L		
P. torta	+		+	+	+	+	+	a. Leaves: cytotoxic effect on *Artemia salina*, breast tumor cell, antimutagenic, antiplasmodial, active to α-glucosidase and α-amylase. b. Stem and root: active as antiplasmodial c. Fruits: active to α-glucosidase d. Stem bark: active to α-glucosidase and α-amilase	4; 12; 28; 51; 53; 54; 55
P. ramiflora	+	+	+	+	+	+	+	a. Root extract: active as antinosiseptic, antiinflammation and antiplasmodial b. Leaves extract: active to α-glucosidase, α-amilase, as antioxidant, antinosiseptic, antiinflammation, and antiplasmodial c. Stem and stem bark: active as antiplasmodial	4; 8; 35; 51
P. gardneri		+					+	a. Root bark: active as antileishmanial and trypanocidal b. Leaves: active to α-glucosidase and α-amilase	51; 55
P. caimito			+		+		+	a. Leaves: active as antioxidant, α-glucosidase and α-amilase, antimicroba for *Pseudomonas aeruginosa*, *Bacillus cereus,* and *Candida albicans* b. Fruits: active to acetylcholinesterase, and antimicroba for *C. albicans, S. aureus, B. cereus, E. coli, S. typhimurium* and toxicity effect to *Artemia salina*	5; 14; 45; 51; 56; 57
P. lucuma			+	+				a. Seed: active as antioxidant and gastroprotective b. Fruit: active as antioxidant and to α-amylase.	58; 59
P. macrophylla			+					Gallic acid in water extract fruit active as antioxidant	60
P. venosa					+	+	+	Leaves, stem and stem bark active as antioxidant, antimalaria and anticholinesterase and active as antimycrobial	11; 61
P. reticulata						+		Stem bark extract can inhibit to *Mycobacterium tuberculosis*	61
P. cambodiana						+		Water extract of stem bark active as immunomodulatory	13
P.campechiana			+	+	+	+	+	a. Fruits extract as antioxidant and hepatoprotective b. Stem bark as antioxidant and antihaemolytic c. Seed extract active as antiinflammation, analgesic, and antiulcer d. Leaves extract as antioxidant, antimytosis, antiinflammation, analgesic, antiulcer, antinocyceptic, antihyperalgesic and toxic to *Aedes aegypti* and *Culex quinquefasciatu*	10; 27; 28; 36; 44; 63; 64; 65: 66; 67; 68; 69
P. mammosa					+			Toxicity effect to irritation of eye and skin	70
P. sapota			+					Extract methanol- acetate acid (85:15) active as antioxidant to DPPH, and lipophilic and hydrophilic extract as an antioxidant to DPPH and FRAP	43; 71; 72

R: root, RB: root bark, F: fruit, S: seed, St: stem, StB: stem bark

FRAP and ABTS with variation inhibition.[41] Besides that, leaves extract of *P. ramiflora*[8] and *P. venosa*,[11] *P. viridis* fruits extract[3] and *P. splendens* leaves[42] had antioxidant activity. Antioxidant activity of *P. caimito* leaves extract had the smallest IC_{50} of 36.1 µg/ml compared to n-hexane and ethanol extracts.[14] The phenolic group can contribute to antioxidant activity. Phenolic compound of methanol-acetic acid (85:15) fruit extract of *P. sapota* showed antioxidant activity.[35] Beside the phenolic group, the carotenoid group can also contribute to antioxidant activity. Ethanol extracts of *P.campechiana* fruits that were stored for 2, 4, 6, 8, 10 and 12 days gave increasing in total carotenoid content and followed by increasing in antioxidant activity.[43]

Other pharmacological activies

Methanol extracts of *Pouteria cambodiana* stem bark[16] and *P. campechiana* leaves[44] was reported to have immunomodulatory activity. *P. gardnerii*, *P. ramiflora* dan *P. torta* extracts did not show active against *Aedes aegypti*, *Rhodnius milesi* and *Dipetalogaster maxi*.[20] N-hexane-ethyl acetate (1:1) fraction of *P. venosa* active against *A.aegypti*.[11]

P. ramiflora water extract and fraction of the ethanol extract of *P. torta* leaves[12] and methanol extract of *P. torta* leaves[42] revealed to possess toxicity effect towards *Artemia salina*. While stem bark, lignum and root of *P. guianensis* have no toxicity effect towards *Artemia franciscana*.[45,46] Pouterin compound from *P. torta* showed insecticidal effect against *Callosobruchus maculatus*, also has the ability to agglomerate erythrocytes in humans, rabbits and mice.[47] The other researches stated that stem extract of *P. sapota* active as antiplasmodium[48] and leaves extract of *P. venosa* as antimalarial.[11] Hydroethanol of stem and stem bark extracts of *P. guianensis* active as anti-termite against Nasutitermes sp.[49]

Wood root extract of *P.torta* have cytotoxicity effect against HCT-8 (human colon carcinoma) with IC_{50} 37.9 µg/ml, HL-60 (leukemia) with IC_{50} 31.7 µg/ml, SF-295 (Brain) with IC_{50} 30.2 µg/ml and MDA-MB-435 (melanoma) with IC_{50} 21 µg/ml.[4] Methanol leaves extract of *P. viridis* active as anti-HIV.[50] N-hexane leaves extract of *P. torta* active as antagonist estrogen at estrogen beta (ER_{β}) receptor.[51]

P. gardnerii, P. ramiflora, P. torta, and *P. caimito* have been tested for as inhibitor tyrosinase. Water leaves extract of *P. torta* and *P. caimito* active as an inhibitor of tyrosinase with IC_{50} 30.01 µg/ml and 50.01 µg/ml and ethanol leaves extract of *P. ramiflora* and *P. torta* showed IC_{50} 249.83 µg/ml and 104.34 µg/ml.[52]

DISCUSSION

Pouteria is a genus that has many types. The plant part of the Pouteria species can be used as food ingredients and have pharmacological activities. The part of the plant which often used as food material is a fruit. The peel of fruit, leaves, branch, and stem bark were reported to have more potential in term of pharmacological activity.

Phytochemical compound in plants is generally produced through the pathway of shikimic and acetic acid. Phytochemical compounds are important components in plants. It can be isolated from the initial extraction step. The extraction method and solvent used will affect the resulting.[73] The extraction method can be influenced by the type and amount of phytochemical compounds which was isolated. In addition, factors of kinship in the taxonomy of a plant can affect the type of chemical compounds. Among the types of Pouteria have a kinship, namely one genus. Therefore, several types of Pouteria have the same chemical compounds.

Trends in pharmacological activity of Pouteria are antioxidant and antimicrobial activity. The pharmacological activity of a plant can be caused by the presence of chemical compounds. The type of chemical compound and the concentration of chemical compounds in a plant can affect the type of pharmacological activity or the strength of the pharmacological activity. Antioxidant activity can be caused by the presence of the compounds from polyphenol group. Phenolic acids and flavonoids greatly contribute to antioxidant activity. The position of the OH group and the presence of double bonds on carbon atom no 2 and no 3 on flavonoids can affect the intensity of antioxidant activity. Antimicrobial activity can also be caused by the presence of compounds belonging to the polyphenol group and terpenoid derivatives. In Pouteria, many chemical compounds that have been isolated are phenol and polyphenol group and terpenoid derivatives.

CONCLUSIONS

Based on the literature, species of Pouteria which have presented to came from subtropical and tropical areas such as in North America, Central America, and Asia. *Pouteria campechiana* is the species most studied. Some pharmacological activities and phytochemical compounds of Pouteria genus have been widely stated. Extracts of Pouteria genus were demonstrated to have some pharmacological activities, however information concerning treatment the skin and other pharmacological activity of fraction and chemical compound of Pouteria genus was less. In addition, so far information on the mechanism of chemical compound from Pouteria genus guided by pharmacological activities has not been found.

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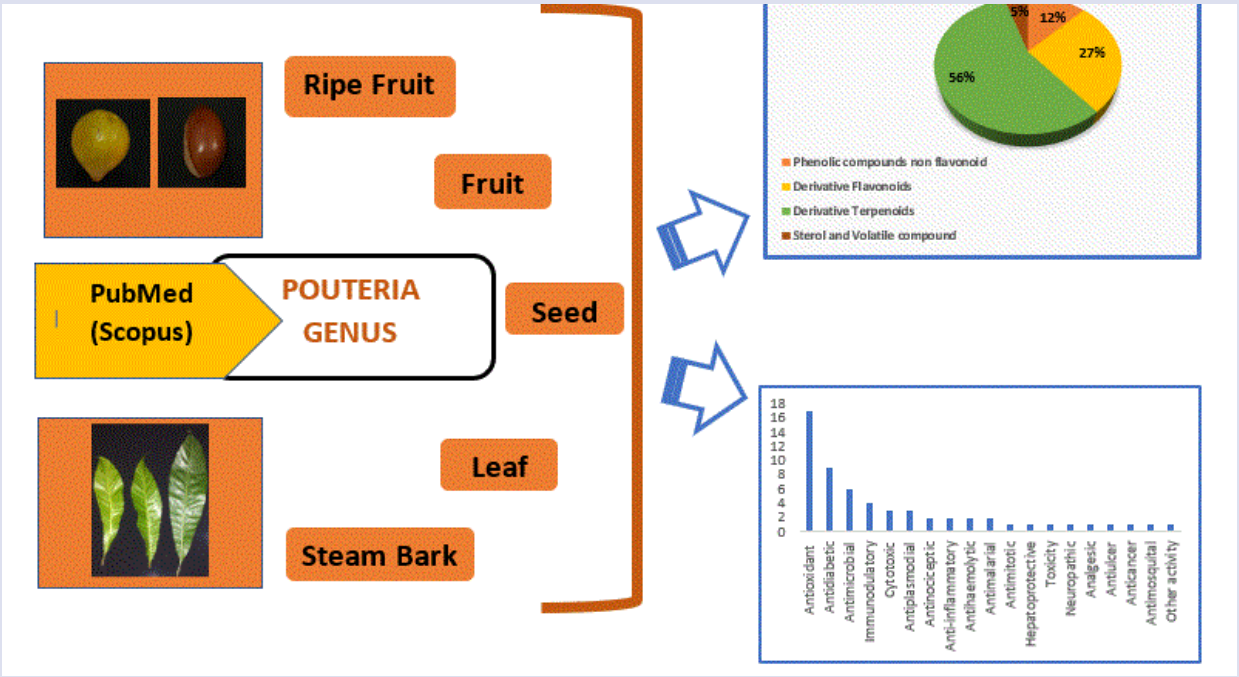
REFERENCES

1. Swenson U, Anderberg AA. Phylogeny, character evolution, and classification of Sapotaceae (Ericales). Cladistics 2005; 21: 101–130.
2. Triono T, Brown AHD, West JG and Crisp MDA. Phylogeny of Pouteria (Sapotaceae) from Malesia and Australasia. Aust. Syst. Bot 2007; 20(2): 107–118.
3. Ma M, Yang H, Basile MJ, Kennely EJ. Analysis of polyphenolic antioxidants from the fruits of three Pouteria species by selected ion monitoring liquid chromatography-mass spectrometry. J. Agric. Food Chem 2004; 52:5873-5878. https://doi.org/10.1021/jf049950k
4. Mesquita ML, Paula JE, Pessoa C, Moraes MO, Costa LV, Grougnet R, Michael S, Tillequin F, Espindola LS. Cytotoxic activity of Brazilian Cerrado plants used in traditional medicine against cancer cell lines. J. Ethnopharmacol 2009; 123(3): 439–445. https://doi.org/10.1016/j.jep.2009.03.018
5. Sousa LCR, Junior ARC, Carvalho MG, Silva TMS, Ferreira RO. UPLC-QTOF-MS analysis of extracts from the leaves of *Pouteria caimito* (Sapotaceae) and their antioxidant activity. Journal of Biosciences and Medicines 019; 07(03): 92–101. https://doi.org/10.4236/jbm.2019.73009
6. Lim TK. 2012. Edible medicinal and non-medicinal plants, p. 742. New York: Springer.
7. Awang KF, Bakar AMF. 2018. Canistel-*Pouteria campechiana* (Kunth) Baehni. Exotic Fruits Reference Guide, 107–111.
8. Fontes JEA, Souza PJC, Nascimento JLM, Santos SN, Espíndola LS, Ferreira VMM. Antinociceptive and antiinflammatory properties of the ethanolic extract of *Pouteria ramiflora* roots. Lat. Am. J. Pharm 2009; 28(6): 812–818. http://www.latamjpharm.org/trabajos/28/6/LAJOP_28_6_1_2_161P10Z8KJ
9. Silva MAB, Melo LVL, Ribeiro RV, Souza JPM, Lima JCS, Martins DTO, et al. Ethnobotanical survey of plants used as anti-hyperlipidemic and anorexigenic by the population of nova xavantina-MT, Brazil. Rev Bras Farmacogn 2010; 20(4): 549–562. https://doi.org/10.1590/S0102-695X2010000400014
10. Aseervatham GSB, Sivasudha T, Sasikumar JM, Christabel HP, Jeya D, Ananth AD. Antioxidant and hepatoprotective potential of *Pouteria campechiana* on acetaminophen-induced hepatic toxicity in rats. J. Physiol. Biochem 2014; (70): 1–14. https://doi.org/10.1007/s13105-013-0274-3

11. Montenegro LHM, Oliveira PES, Conserva LM, Rocha EMM, Brito AC, Arau RM et al. Terpenoids and evaluation of the antimalarial, larvicidal, anti-radicalar and anticholinesterase potential of *Pouteria venosa* (Sapotaceae). Rev Bras Farmacogn 2006; (16): 611–617. https://doi.org/10.1590/S0102-695X2006000500005
12. Perfeito JP, Santos ML, Lopez KSE, Paula JE, Silviera D. Characterization and biological properties of *Pouteria torta* extracts: a preliminary study. Rev. Bras. Farmacogn 2016; 15(3): 183-186. https://doi.org/10.1590/S0102-695X2005000300002
13. Manosroi A, Saraphanchotiwitthaya A, Manosroi J. Effects of *Pouteria cambodiana* extracts on in vitro immunomodulatory activity of mouse immune system. Fitoterapia 2006; 77(3): 189–193. https://doi.org/10.1016/j.fitote.2006.01.003
14. Franca CV, Perfeito JPS, Resck IS, Gomes SM, Fagg CW, Castro CFS, et al. Potential radical-scavenging activity of *Pouteria caimito* leaves extracts, J. App. Pharm. Sci 2016; 6(07): 184-188. https://doi.org/10.7324/JAPS.2016.60727
15. Morton JF. 1987. Canistel. In: Julia F.M (Ed). Fruit of Warm Climates, p.402-405. Miami
16. Manosroi A, Saraphanchotiwitthaya A and Manosroi J. In vitro immunomodulatory effect of *Pouteria cambodiana* (Pierre ex Dubard) Baehni extract. J. Ethnopharmacol 2005; 101: 90–94. https://doi.org/10.1016/j.jep.2005.03.031
17. Orwa C, Mutua A, Kindt R, Jamnadass R, Anthony S. 2009. Agroforestree database: a tree reference and selection guide version 4.0. World Agroforestry Centre, Kenya.
18. Tejacal IA, Villanueva AR, Pelayo ZC, Colinas LMT, Lopez MV, Bautista BS. Postharvest physiology and technology of sapote mamey fruit (*Pouteria sapota* (Jacq.) H.E. Moore & Stearn). Postharvest Biol Technol 2007; 45(3): 285–297. https://doi.org/10.1016/j.postharvbio.2006.12.024
19. David, V. 1993. Application of chromatographic techniques in the separation and determination of triterpenes and hydrocarbons present in the flowers, fruit of *Pouteria torta* Sao Carlos: Federal University, Dissertation.
20. Silva, CAM, Simeoni LA, Silveira D. Genus Pouteria: chemistry and biological activity. Rev. Bras. Farmacogn 2009; 19(2A): 501–509.
21. Pelliccari R, Ardon A, Bellavista V. Triterpenes from *Pouteria caimito*. Planta Med 1962; 22(2): 196–200.
22. Anjaneyulu, B. Chemical investigation of some Indian plants. Indian J. Chem 965; 3: 237-238.
23. Che CT, Koikhe K, Cordell GA, Fong HHS, Dobberstein H. Triterpenes of *Pouteria torta* (Sapotaceae). J. Nat. Prod 1980; 43(3): 420–421. https://doi.org/10.1021/np50009a016
24. Silva CAM. 2007. Contribution of chemical and biologycal activity of the *Pouteria gardnerii* (Mart. & Miq.). Brasilia: University of Brasilia, Dissertation
25. Maia JGS, Andrade EHA and Zoghbi MDGB. Volatiles from fruits of *Pouteria pariry* (Ducke) Baehni and *Pouteria caimito* (Ruiz and Pavon.) Radlk. Jeobp 2003; 6(2): 127–129. https://doi.org/ 10.1080/0972-060X.2003.10643339
26. Dini I. Flavonoid glycosides from *Pouteria obovata* (R. Br.) fruit flour. Food Chem 2011; 124(3): 884–888. https://doi.org/10.1016/j.foodchem.2010.07.013
27. Elsayed AM, El-tanbouly ND, Moustafa SF, Abdou RM, Awdan SAW. Chemical composition and biological activities of *Pouteria campechiana* (Kunth) Baehni, J. Med. Plant Res 2016; 10(16): 209–215. https://doi.org/10.5895/JMPR2015.6031
28. Costa DLMG, Rinaldo D, Varanda EA, Sousa JF, Nasser ALM, Silva ACZ, et al. Flavonoid detection in hydroethanolic extract of *Pouteria torta* (Sapotaceae) leaves by HPLC-DAD and the determination of its mutagenic activity. J. Med. Food 2014; 17(10): 1103–1112. https://doi.org/10.1089/jmf.2013.0116
29. Kamalakannan K, Rayar A, Megala L. Isolation of quercetin from *Pouteria sapota* and evaluation of its anti oxidant and cancer activities. World J. Pharm. Pharm. Sci 2016; 5(4): 1897–1910. https://doi.org/10.20959/wjpps20164-6527
30. Hernandez CLC, Villasenor IM, Joseph E, Tolliday N. Isolation and evaluation of antimitotic activity of phenolic compounds from *Pouteria campechiana* Baehni. Philipp J. Sci 2008; 137(1): 1–10.
31. Agocs A, Murillo E, Turcsi E, Beni S, Darcsi A, Szappanos A, et al. Isolation of allene carotenoids from mamey. J. Food Compos. Anal 2017; 65: 1–5. https://doi.org/10.1016/j.jfca.2017.04.004
32. Silva CAM, Melo RO, Resck IS, Silveira D. Triterpenes from *Pouteria gardneri* (Mart. & Miq.) Baehni extracts. J. Appl. Pharm. Sci 2016; 6(12): 197–201. https://doi.org/ 10.7324/JAPS.2016.601229
33. Aguiar JPL, Silva EP, Junior RCP, Nagahama D, Souza FCDA. Aromatic and nutritional profile of an Amazonian autochthonous species, caramuri *Pouteria elegans* (A.DC.) Baehni. Int. J. Food Prop 2019; 22(1): 1242–1249. https://doi.org/10.1080/10942912.2019.1640248
34. Murillo E, Turcsi E, Szabo I, Mosquera Y, Agocs A, Nagy V, et al. Carotenoid composition of the fruit of red mamey (*Pouteria sapota*). J. Agric. Food Chem 2016 :1–25. https://doi.org/10.1021/acs.jafc.5b01936
35. Rodrigues PM, Gomes JVD, Jamal CM, Neto AC, Santos ML, Fagg CW, et al. Triterpenes from *Pouteria ramiflora* (Mart.) Radlk. leaves (Sapotaceae). Food Chem Toxicol 2017; (xxx): 1-6. https://doi.org/10.1016/j.fct.2017.05.026
36. Ragasa CY, Labaclado LM, Rideout JA. Triterpenes and sterol from *Pouteria campechiana*. Philipp J. Sci 2011; 6(2): 1–7.
37. Turcsi E, Murillo E, Kurtan T, Szappanos A, Illye TZ, Fekete GG, et al. Isolation of β-cryptoxanthin-epoxides, precursors of cryptocapsin and 3′ -deoxycapsanthin, from red mamey (*Pouteria sapota*). J. Agric. Food Chem 2015; 63: 6059–6065. https://doi.org/10.1021/acs.jafc.5b01936
38. Fekete GG, Murillo E, Kurtan T, Papp T, Illyes TZ, Drahos L, et al. Cryptocapsinepoxide-type carotenoids from red mamey, *Pouteria sapota*. J. Nat. Prod 2013; 76(4): 607–614. https://doi.org/10.1021/np3007827
39. Murillo E, Mosquera Y, Kurtan T, Fekete GG, Nagy V, Deli J. Isolation and characterization of novel capsorubin-like carotenoids from the red mamey (*Pouteria sapota*). Helv. Chim. Acta 2012; 95: 983–988.
40. Murillo E, McLean R, Britton G, Agocs A, Nagy V, Deli J. Sapotexanthin, an A-provitamin carotenoid from red mamey (*Pouteria sapota*). J. Nat. Prod 2011; 74: 283–285. https://doi.org/ 10.1021/np1006982
41. Sunila AV, Murugan K. Variation in phenolics, flavonoids at different stages of fruit development of *Pouteria campechiana* (Kunth) Baehni. and its antioxidant activity. Int. J. Pharm. Pharm. 2017; 9(11): 70-75. https://doi.org/10.22159/ijpps.2017v9i11.20588
42. Alves TMA, Silva AF, Brandao M, Grandi TSM, Smania EFA, Smania, et al. Biological screening of Brazilian medicinal plants. Mem. Inst. Oswaldo Cruz 2000; 95(3): 67–373. https://doi.org/10.1590/S0074-02762000000300012
43. Hien TX, Huong HL, Thanh NT. Study on changes in chemical compositions and bioactive compounds in *Pouteria campechiana* fruit during storage. Vietnam J Sci Technol 2019; 57(3B): 17-25. Https://doi:10.15625/2525-2518/57/3B/14065
44. Zapata CI, Canul CJ, Fernandez MK, Martin QZ, Torres RJC, Lara RJC, et al. Immunomodulatory effects of the methanolic extract from *Pouteria campechiana* leaves in macrophage functions. Food Agr. Immunol 2018; 29(1): 386-3899. https://doi.org/10.1080/09540105.2017.1386163
45. Quignard ELJ, Pohlit AM, Nunomura SM, Pinto ACS, Santos EVM, Morais SKR, et al. Screening of plants found in Amazonas state for lethality towards brine shrimp. Acta Amaz 2003; 33(1): 93–104. https://doi.org/10.1590/1809-4392200331104
46. Libralato G, Losso C, Ghirardini AV. Toxicity of untreated wood leachates towards two saltwater organisms (*Crassostrea gigas* and *Artemia franciscana*). J. Hazard. Mater 2007; 144(1–2): 590–593. https://doi.org/10.1016/j.jhazmat.2006.10.082
47. Boleti APA, Freire MGM, Coelho MB, Silva W, Baldasso PA, Gomes VM, et al. Insecticidal and antifungal activity of a protein from *Pouteria torta* seeds with lectin-like properties. J. Agric. Food Chem 2007; 55(7): 2653–2658. https://doi.org/10.1021/jf0636317

48. Abe F, Nagafuji S, Yamauchi T, Okabe H, Maki J, Higo H, et al. Trypanocidal constituents in plants 1. Evaluation of some Mexican plants for their trypanocidal activity and active constituents in guaco, roots of Aistolochia taliscana. Biol. Pharm. Bull 2002; 25(9): 1188–1191. https://doi.org/10.1248/Bpb.25.1188
49. Barbosa AP, Nascimento CS, Morais JW. Studies of antitemitic properties of crude extracts of wood and bark from forest species in central amazon, brazil. Acta Amaz 2007; 37(2): 213–218. https://doi.org/10.1590/S0044-59672007000200006
50. Bedoya LM, Alvarez A, Bermejo M, Gonzalez N, Beltran M, Palominoa SS, et al. Guatemalan plants extracts as virucides against HIV-1 infection. Phytomedicine 2008; 15(6-7): 520-524. https://doi.org/10.1016/j.phymed.2007.10.006
51. Franzotti EM. 2004. Identification of nuclear receptor agonists and antagonists in herbal extract: *Morus nigra* L., *Plectranthus ornatus* Codd., *Ipomoea cairica* (L.) sweet, *Pouteria torta* (Mart.) Radlk. Brasilia: University of Brasilia, PhD, thesis.
52. Souza PM, Sales PM, Simeoni LA, Silva EC, Silviera D, Magalhaes PO. Inhibitory activity of α-amylase and α-glucosidase by plant extracts from the Brazilian Cerrado. Plos one 2012; 78(4): 393-399. https://doi.org/10.1055/s-0031-1280404
53. Mesquita ML, Grellier P, Mambu L, Paula JE, Espindola LS. In vitro antiplasmodial activity of Brazilian Cerrado plants used as traditional remedies. J. Ethnopharmacol 2007; 110(1): 165–170. https://doi.org/10.1016/j.jep.2006.09.015
54. Gouveia NM, Albuquerque CL, Espindola LS, Espindola FS. *Pouteria ramiflora* extract inhibits salivary amylolytic activity and decreases glycemic level in mice. An Acad. Bras. Cienc 2013; 85(3): 1141–1148. https://doi.org/10.1590/S0001-37652013000300016
55. Elias ST, Salles PM, Paula JE, Simeoni LA, Silveira D, Guerra ENS, et al. Cytotoxic effect of *Pouteria torta* leaf extracts on human oral and breast carcinomas cell lines. J. Cancer Res. Ther 2013; 9(4): 601–606. https://doi.org/10.4103/0973-1482.126454
56. Mesquita ML, Desrivot J, Bories C, Fournet A, Paula JE, Grellier P, et al. Antileishmanial and trypanocidal activity of Brazilian Cerrado plants. Memories of the Oswaldo Cruz Institute 2005; 100(7): 783–787. https://doi.org/10.1590/S0074-02762005000700019
57. Fernandez IM, Chagas EA, Maldonado SAS, Takahashi JA, Aleman RS, Filho AAM, et al. Antimicrobial activity and acetilcolinesterase inhibition of oils and Amazon fruit extracts. J. Med. Plant Res. 2020; 14(3): 88–97. https://doi.org/10.5897/JMPR2019.6790
58. Castillo GP, Reyes S, Robles J, Simirgiotis MJ, Sepulveda B, Burgos RF, et al. Biological activity and chemical characterization of *Pouteria lucuma* seeds: A possible use of an agricultural waste. J. Waste Manag 2019; (88): 319–327. https://doi.org/10.1016/j.wasman.2019.03.055
59. Fuentealba C, Galvez L, Cobos A, Olaeta JA, Defilippi BG, Chirinos R, et al. Characterization of main primary and secondary metabolites and in vitro antioxidant and antihyperglycemic properties in the mesocarp of three biotypes of *Pouteria lucuma*. Food Chem 2016; (190): 403-411. https://doi.org/10.1016/j.foodchem.2015.05.111
60. Silva BA, Gordon A, Jungfer E, Marx F, Mai JGS. Antioxidant capacity and phenolics of Pouteria macrophylla, an under-utilized fruit from Brazilian Amazon. Eur. Food Res. Technol, 2012; 234(5): 761–768. https://doi.org/10.1007/s00217-012-1684-0
61. Santos RFEP, Silva ISMS, Hendges EA, Silva ALL, Barbosa, AM, Santos KS, et al. 2014. Evaluation of antimicrobial potential and cytotoxic of *Pouteria venosa* species. Proceedings of from 5th Congress of the Brazilian Biotechnology Society (SBBIOTEC), p. 6. Brazil: Florianopolis.
62. Graham JG, Pendland SL, Prause JL, Danzinger LH, Vigo JS, Cabieses F, et al. Antimycobacterial evaluation of peruvian plants. Phytomedicine 2003; 10(6–7): 528–535. https://doi.org/10.1078/094471103322331502
63. Ikram EHK, Eng KHK, Jalil AMM, Ismail A, Idris S, Azlan A, et al. Antioxidant capacity and total phenolic content of Malaysian underutilized fruits. J. Food Compost. Anal 2009; 22(5): 388–393. https://doi.org/10.1016/j.jfca.2009.04.001
64. Kubola J, Siriamornpun S, Meeso N. Phytochemicals, vitamin C and sugar content of Thai wild fruits. Food Chem 2011; 126(3): 972–981. https://doi.org/10.1016/j.foodchem.2010.11.104
65. Mehraj H, Sikder RKK, Mayda U, Taufique T, Uddin AFMJ. Plant physiology and fruit secondary metabolites of canistel (*Pouteria campechiana*). World Appl. Sci. J 2015; 33(12):1908–1914. https://doi.org/10.5829/idosi.wasj.2015.33.12.15625
66. Adiyaman P, Kanchana S, Usharani T, Ilaiyaraja N, Kalaiselvan A, Kumar KRA. Identification and quantification of polyphenolic compounds in underutilized fruits (star fruit and egg fruit) using HPLC, Indian J. Tradit. Knowl 2016; 5(03): 487–493.
67. Campos DM, Ortiz AR, Sanchez RA, Flores GJS, Camacho RMA. Antinociceptive and antihyperalgesic activity of a traditional maya herbal preparation composed of *Pouteria campechiana*, *Chrysophyllum cainito*, *Citrus limonum*, and *Annona muricata*. Drug Dev. Res 2017; 78(2): 91–97. https://doi.org/10.1002/ddr.21378
68. Sangeetha R, Pratheeba T, Ragavendran C, Natarajan D. *Pouteria campechiana* leaf extract and its bioactive compound myricitrin are mosquitocidal against Aedes aegypti and Culex quinquefasciatus. Asian Pac. J. Trop. Med. 2019; 12(7): 321–328. https://doi.org/10.4103/1995-7645.262076
69. Aseervatham GSB, Manthra V, Ireen C, Thilagameena S, Akshaya S, Mary CA, et al. Free radical scavenging potential and antihaemolytic activity of methanolic extract of *Pouteria campechiana* (Kunth) Baehni. and *Tricosanthes tricuspidata* Linn. Biocatal. Agric. Biotechnol 2019: 18: 1-33. https://doi.org/10.1016/j.bcab.2019.101031
70. Dutok CMS, Rivas BCA, Leblanch RE, Jackson PL, Nunez CI, Arranz CJC, et al. 2015. Acute toxicity and dermal and eye irritation of the aqueous and hydroalcoholic extracts of the seeds of "zapote" *Pouteria mammosa* (L.) Cronquist. Sci. World J 2015: 1-7. https://doi.org/10.1155/2015/642906
71. Rodríguez TA, Moreno YS, Guadarrama SV, Tejacal IA. Soluble phenols and antioxidant activity in mamey sapote (*Pouteria sapota*) fruits in postharvest. Food Res Int 2011; 44(7): 1956–1961. https://doi.org/10.1016/j.foodres.2011.04.045
72. Yahia EM, Orozco GF, Leon CA. Phytochemical and antioxidant characterization of mamey (*Pouteria sapota* Jacq. H.E. Moore & Stearn) fruit. Food Rest. Int 2011; 44(7): 2175-2181. https://doi.org/10.1016/j.foodres.2010.11.029
73. Aulifa DL, Adnyana IK, Sukrasno, Levita J. Updates on 4-hydroxyderricin and xanthoangelol of Angelica plants. Extraction and pharmacological activities. Rasayan J. Chem 2020; 13(1): 11–17. https://doi.org/10.31788/RJC.2020.1315397

GRAPHICAL ABSTRACT



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