A Review on Phenolic Compounds from Family Sapotaceae

Article · February 2016

CITATIONS
9

READS
264

6 authors, including:

Mostafa H. Baky
Egyptian Russian University
6 PUBLICATIONS **17** CITATIONS
SEE PROFILE

Mohamed R Elgindi
Egyptian Russian University
54 PUBLICATIONS **310** CITATIONS
SEE PROFILE

Eman G. Haggag
Helwan University
74 PUBLICATIONS **368** CITATIONS
SEE PROFILE

Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2016; 5(2): 280-287
Received: 27-01-2016
Accepted: 28-02-2016

Moustafa H Baky
Department of Pharmacognosy, Faculty of pharmacy, Egyptian Russian University.

Amal M Kamal
Department of Pharmacognosy, Faculty of pharmacy, Helwan University.

Mohamed R Elgindi
(A) Department of Pharmacognosy, Faculty of pharmacy, Egyptian Russian University.
(B) Department of Pharmacognosy, Faculty of pharmacy, Helwan University.

Eman G Haggag
Department of Pharmacognosy, Faculty of pharmacy, Helwan University.

Correspondence
Mohamed R Elgindi
(A) Department of Pharmacognosy, Faculty of pharmacy, Egyptian Russian University.
(B) Department of Pharmacognosy, Faculty of pharmacy, Helwan University.

A Review on Phenolic Compounds from Family Sapotaceae

Moustafa H Baky, Amal M Kamal, Mohamed R Elgindi, Eman G Haggag

Abstract
Sapotaceae is a family of flowering plants that known with wide range of chemical constituents like saponins, flavonoids and poly phenolic compounds. Phenolic compounds are widely distributed in plant kingdom and have several biological activities as anti-inflammatory, antioxidant, antibacterial, antifungal, antidiabetic and antiulcer. This review focuses on the phenolic compounds identified in different species of family sapotaceae and their biological activities.

Keywords: Sapotaceae, Phenolic compounds, Flavonoids, Anti-ulcer, Anti-inflammatory, Antidiabetic

Introduction
Phytochemicals are defined as the substances found in plants that exhibit a potential for modulating human metabolism in a manner beneficial for the prevention of chronic and degenerative diseases [1]. Phenolics are defined as a class of polyphenols which are important secondary metabolites present in plants [2] and are also responsible for their antioxidant action and various beneficial effects in a multitude of diseases [3, 4]. Sticky and often white latex is found in cuts of bark, branches, leaves and fruits, although it often appears slowly in species growing in dry conditions [5].
The Sapotaceae is a family of flowering plants, belonging to order Ericales and divided into five tribes with 53 genera and about 1250 species. It consists of trees or shrubs with a world-wide distribution, although the highest species diversity is found in the tropical and subtropical regions of Asia and South America [5, 6]. Several species produce edible fruits, with or without economic uses. Species noted for their edible fruits include *Manilkara* (Sapodilla, sapota), *Chrysophyllum cainito*, *Pouteria*, and *Planchonia careya*.

Phenolic Compounds isolated from different species
Manilkara zapota: is reported to contain phenolic compounds such as: Myricetin-*3-O-α-L*-rhaminopyranoside, Apigenin-7-O-α-L-rhamnopyranoside and Caffeic acid, which isolated from leaves [7], Quercetrin, (+)-catechin, (-)-epicatechin, (+)-gallocatechin, Gallic acid, dihydromyricetin, Methylchlorogenate, Methyl-*4-O*-galloyl chlorogenate, 4-O-galloylchlorogenic acid which isolated from fruits [8]. D-quercitol was reported in seeds and leaves [9]. Three phenolic compounds isolated from the fruits of *Manilkara zapota*; Leucodelphinidine, Leucocyanidine, Leucoperalgonidine [10].

***Argania spinosa*:** The phenolic compounds identified in *Argania spinosa* seed oil (Argan oil) are Myricetin-*3-O-β-D*-galactopyranoside, Myricitin, Quercetin, Myristrin, Quercetrin, Hesperidin, Rutin, (+)-Catechin, (-)-Epicatechin, Caffeic acid, Ferulic acid, p-hydroxybenzoic acid, Syringic acid, Vanillic acid, Veratric acid, Gallic acid, Naringenin-7-O-glucoside and Luteolin [11].

Pouteria torta: is a species of family sapotaceae, Myricetin-*3-O-α-L*-arabinopyranoside, Myricetin-*3-O-β-D*-galactopyranoside, and Myricetin-*3-O-α-L*-rhaminopyranoside were isolated from leaves [12].

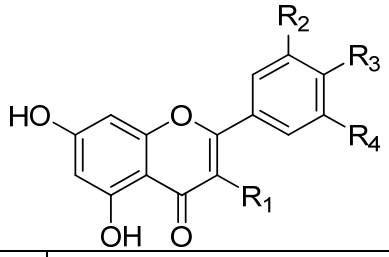
Pouteria campechiana: was studied for the phenolic contents of the leaves to identifiey; Myricetin-*3-O-α-L*-arabinopyranoside, Myricetin-*3-O-α-L*-rhaminopyranoside, Quercetin-3-O-α-L- rhamnopyranoside, Taxifolin-3-O-α-L-rhamnopyranoside, Trans-taxifolin-3-O-α-L-arabinopyranoside, Taxifolin-3-O-α-L-arabinofuranoside and Quercetin-3-O-β-

Arabinopyranoside [13].

***Pouteria sapota*:** (+)-Catechin, (-)-Epicatechin, Gallic acid catechin-3-O-gallate, and myricetin and Gallocatchin-3-O-gallate were isolated from the fruits of *Pouteria sapota* [14, 15].
The presence of dihydromyricetin and (+)-Catchin-3-O-gallate in three species of *Pouteria*; *Sapota*, *viridis* and *campechiana* were reported [16].
Pouteria obovata: fruits contain 2R,3R-4'-*O*-methyl dihydrokaempferol 7-O-[3''-O-acetyl]-β-D-glucopyranoside; 2R,3R-4'-*O*-methyl dihydrokaempferol 7-O-β-D-β-L-xylopyranosyl-(1'''→6'')-[3''-O-acetyl]-β-D-glucopyranoside and 2R,3R-4'-*O*-methyl dihydrokaempferol 3-O-β-D-β-L-xylopyranosyl-(1'''→6'')-[3''-O-acetyl]-β-D-glucopyranoside [17].
Stem bark of *Vitellaria paradoxa* contain quercetin, (+)-Catechin and (-)-Epicatechin [18].

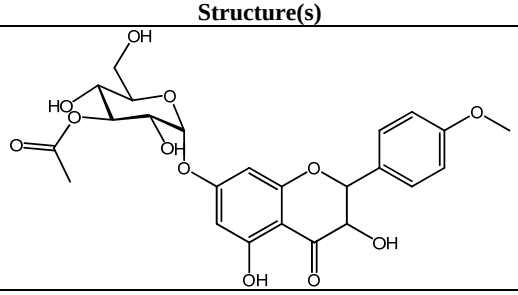
Other species of family Sapotaceae
Fruits and seeds of *Mimusops manilkara* studied for phenolic compounds, quercetin, dihydroquercetin [19].
Myricetin-*3-O-α-L*-rhaminopyranoside was reported in Chrysophyllum albidum [20].
Tridesmostemon omphalocarpoides reported the presence of (-)-Epicatechin and lichexanthone in stem wood [21].
Synsepalum dulcificum stem was reported to contain p-hydroxybenzoic acid, Syringic acid, Vanillic acid, Veratric acid, Gallic acid, trans-p-Coumaric acid and cis-p-Coumaric acid [22].
Gallic acid, quercetin and Kampferol were identified in *Mimusops elengi* flower [23].
3', 4'-dihydroxy-5, 2'-dimethoxy-6, 7-methylen dioxy Isoflavone was isolated from *Madhuca latifolia* fruits [24].

Table 1: Flavonoids compounds isolated from family Sapotaceae



Compound	Structure(s)				Species(s)
	R1	R2	R3	R4	
Myricetin-*3-O-α-L*-arabinopyranoside	O-ara	OH	OH	OH	*Pouteria torta* *Pouteria campechiana*
Myricetin-*3-O-β-D*-galactopyranoside	O-gal	OH	OH	OH	*Pouteria torta* *Argania Spinosa*
Myricetin-*3-O-α-L*-rhaminopyranoside	O-rha	OH	OH	OH	*Pouteria torta* Manilkara zapota Chrysophyllum albidum *Pouteria campechiana*
Myricitin	OH	OH	OH	OH	*Argania Spinosa*
Quercetin	OH	OH	OH	H	*Argania Spinosa* *Mimusops Manilkara* *Vitellaria paradoxa*
Myristrin	O-rha	OH	OH	OH	*Argania Spinosa* *Manilkara zapota*
Quercetin-3-O-α-L-rhamnopyranoside	O-rha	H	OH	OH	*Argania Spinosa* *Manilkara zapota* *Mimusops manilkara* *Pouteria campechiana*
Quercetin-3-O-β-arabinopyranoside	O-ara	H	OH	OH	*Pouteria campechiana*
Rutin	O-glu-rha	H	OH	OH	*Argania Spinosa*
Luteolin	H	OH	OH	H	*Argania Spinosa*

Table 2: Different groups of compound isolated from family Sapotaceae

Compound	Structure(s)	Species(s)
2R,3R-4'-*O*-methyl dihydrokaempferol 7-O-[3''-O-acetyl]-β-D-glucopyranoside		*Pouteria obovata*

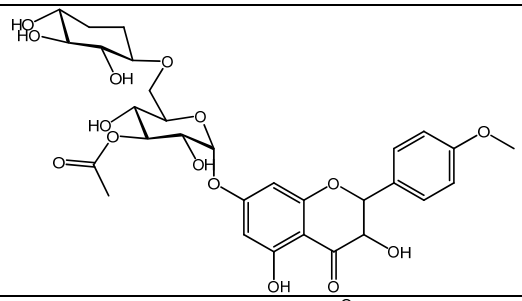
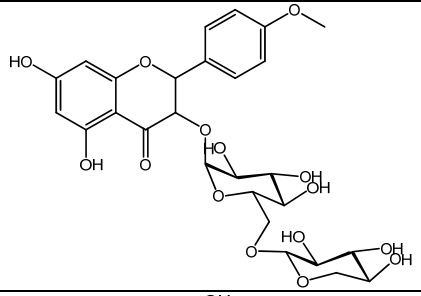
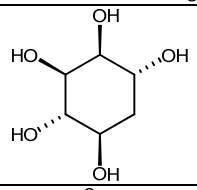
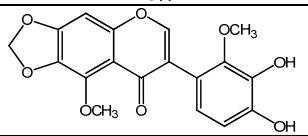
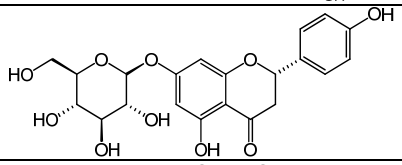
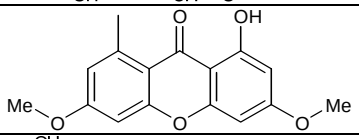
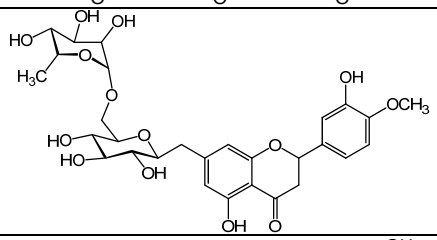
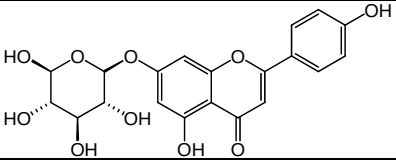
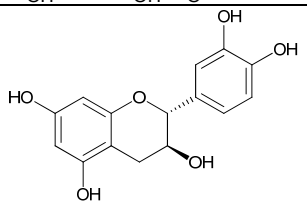
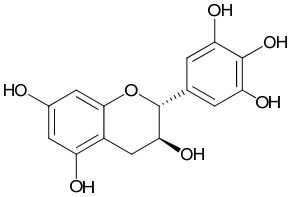
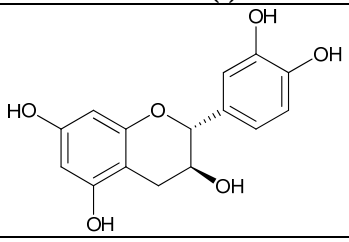
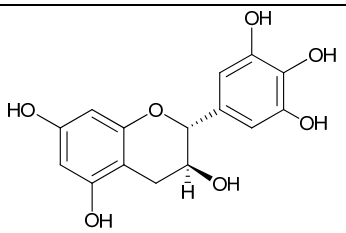
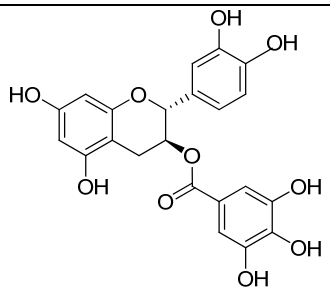
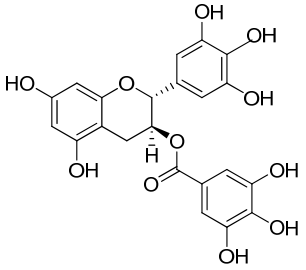
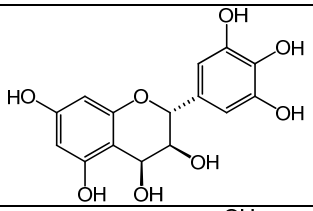
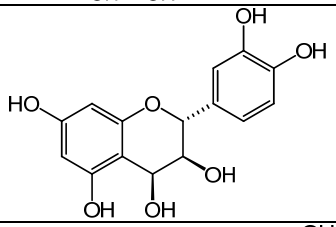
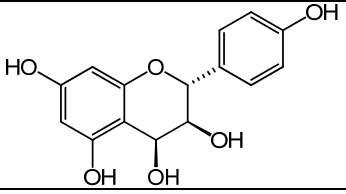
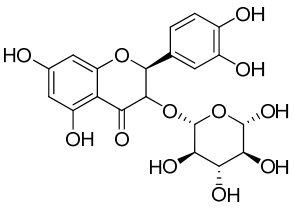
2R,3R-4'-*O*-methyl dihydrokaempferol 7-O-β-D-β-Lxylopyranosyl-(1'''→6'')-[3''-O-acetyl] -β-D-glucopyranoside		*Pouteria obovata*
2R,3R-4'-*O*-methyl dihydrokaempferol 3-O-β-D-β-L-xylopyranosyl-(1'''→6'')-[3''-O-acetyl]-β-D-glucopyranoside		*Pouteria obovata*
D-quercitol		*Manilkara zapota*
3',4'-dihydroxy-5,2'-dimethoxy-6,7-methylen dioxy Isoflavone		*Madhuca latifolia*
Naringenin-7-O-glucoside		*Argania Spinosa*
Lichexanthone		*Tridesmostemon omphalocarpoides*
Hesperidin		*Argania Spinosa*
Apigenin-7-O-α-L-rhamnoside		*Manilkara zapota*
Dihydroquercetin		*Mimusops Manilkara*
Dihydromyricetin		*Manilkara zapota Pouteria sapota*

Table 3: Phenolic compounds isolated from family Sapotaceae

Compound	Structure(s)	Species(s)
(+)-Catechin		*Argania Spinosa* *Manilkara zapota* *Pouteria sapota* *Vitellaria paradoxa*
(+)-gallocatechin		*Manilkara zapota*
(+)-Catchin-3-O-gallate		*Pouteria sapota* *P. viridis* *P. campechiana*
Gallocatchin-3-O-gallate		*Pouteria sapota*
Leucodelphinidine		*Manilkara zapota*
Leucocyanidine		
Leucoperalgonidine		
Taxifolin-3-O-α-L-rhamnopyranoside		*Pouteria campechiana*

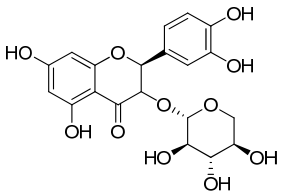
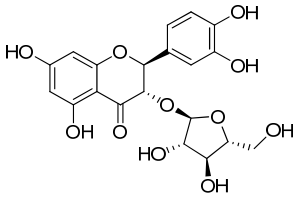
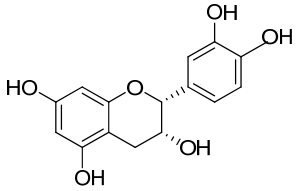
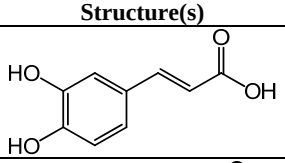
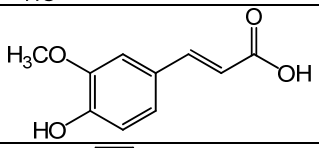
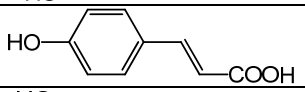
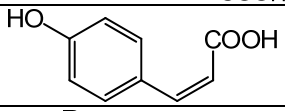
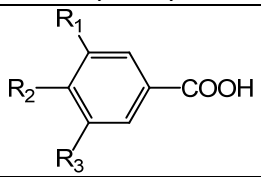
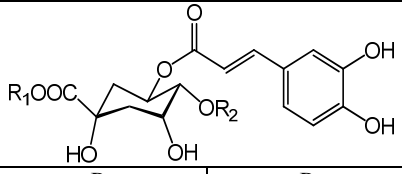
Trans-taxifolin-3-O-α-L-arabinopyranoside		*Pouteria campechiana*
Taxifolin-3-O-α-L-arabinofuranoside		*Pouteria campechiana*
(-)-Epicatechin		*Argania Spinosa* *Tridesmostemon omphalocarpoides* *Manilkara zapota* *Pouteria sapota* *Vitellaria paradoxa*

Table 4: Phenolic acids isolated from family Sapotaceae

Compound	**Structure(s)**			**Species(s)**
Caffeic acid				*Argania Spinosa* *Manilkara zapota*
Ferulic acid				*Argania Spinosa*
trans-p-Coumaric acid				*Synsepalum dulcificum Daniell*
cis-p-Coumaric acid				
				
	R1	R2	R3	
p-hydroxybenzoic acid	H	OH	H	*Argania Spinosa* *Synsepalum dulcificum Daniell*
Syringic acid	OMe	OH	OMe	
Vanillic acid	H	OH	OMe	
Veratric acid	H	OMe	OMe	
Gallic acid	OH	OH	OH	*Argania Spinosa* *Manilkara zapota* *Pouteria obovata* *Pouteria sapota*
				
	R_1	R_2		
Methylchlorogenate	CH_3	H		*Manilkara zapota*
Methyl *4-O*-galloylchlorogenate	CH_3	Gallic acid		
4-O-galloylchlorogenic acid	H	Gallic acid		

Biological activities

Anticancer and cytotoxic activity

The root bark of *Butyrospermum Parkii* showed cytotoxic activity against human breast adenocarcinoma (MDA-MB-231), malignant melanoma (A375), colon carcinoma (HCT116) and glioblastoma multiforme (T98G) cell lines [25].

Sideroxylon foetidissimum root extract showed greater cytotoxic activity towards the murine macrophage-like cell line RAW 264.7 cells [26].

The ethyl acetate extract of *Argania spinosa* fruits showed cytotoxic activity against human breast cancer cells (MCF7) [27].

Stem bark of *Manilkara zapota* showed potent cytotoxic activity against HL-60 and HT-29 cell lines [28].

Stem bark of *Manilkara zapota* showed antitumor activity against Ehrlich ascites carcinoma (EAC) in Swiss albino mice [29].

The MeOH extract defatted shea (*Vitellaria paradoxa*) showed anticancer activity [30].

Bark extract of *Chrysophyllum pruniforme* showed cytototoxic effect [31]. *Manilkara zapota* fruit extract showed antitumor activity [32].

Antioxidant activity

Butyrospermum parkii showed antioxidant activity against that of Troxol or butylated hydroxytoluene (BHT) against 2, 2-diphenyl-1-picryl hydrazyl (DPPH), oxygen and nitric oxide free radicals [25].

The alcoholic extract of *Mimusops elengi* leaves showed good antioxidant activity by peroxynitrite, superoxide and hydrochlorous acid scavenging activity [33].

The radical scavenging capacity of the methanolic extract of leaves in DPPH which showed that antioxidant capacity [34].

The MeOH extract of defatted *Vitellaria paradoxa* showed antioxidant activity [30].

The antioxidant capacity of the *Manilkara zapota* L. leaves extracts, obtained by sequential extraction with different polarities of solvents, was evaluated by four different *in vitro* methods: DPPH, superoxide and hydroxyl radical scavenging activity and reducing capacity assessment assay. The acetone extract showed best antioxidant activity [35].

Seeds extract of *Manilkara zapota* showed high antioxidant activity [36]. *Argania spinosa* showed antioxidant properties via protection against free radical-induced erythrocyte haemolysis and its ability to potentiate the antioxidant effect of Vitamin E [37].

Fruit extract of *Argania spinosa* showed potent antioxidant activity [27], Pouteria sapota fruit extract showed antioxidant activity [14, 38].

The extract of three parts; leaves,fruits and stem of *Pouteria campechiana* reported as antioxidant [13, 22, 39].

The antioxidant activity of phenolic compounds isolated from *Manilkara zapota* fruits was studied [8].

Leaves extract of *Manilkara hexandra* showed antioxidant activity [40].

Anti-inflammatory Activity

Mimusops elengi leaves extract showed anti-inflammatory activity [33]. *Manilkara bidentata* ethanolic extract showed to decrease IL-1β and IL-8 pro-inflammatory cytokines so the extract could be used as anti-inflammatory and anti-aging [41].

In evaluation of anti-inflammatory activity the crude ethanolic and ethyl acetate extract of *Manilkara zapota* leaves showed significant inhibition of paw edema in albino wistar rats so exhibit significant anti inflammatory activity [42].

Aqueous extract of *Elaeoluma nuda* was showed significant anti-inflammatory effect in rat adjuvant-induced arthritis [43].

The methanolic extract of defatted shea (*Vitellaria paradoxa*) showed anti-inflammatory activity [30].

Stem bark of *Vitellaria paradoxa* showed anti-inflammatory activity [18]. Acetone fraction of *Manilkara hexandra* seeds extract showed potent anti-inflammatory activity [44].

Antiulcer activity

The effect of bark alcoholic and petroleum ether extracts of *Mimusops elengi* was evaluated in rats. The alcoholic extract has significant antiulcer activity compare to petroleum ether extracts of bark [45].

The alcoholic extract of bark *Mimusops elengi* and its different fractions namely ethyl acetate, N-butanol, and methanol and aqueous against different ulcer models, and concluded that Ethyl acetate fraction possesses anti-ulcer activity against experimental gastric ulcers [46].

Stem bark of *Manilkara hexandra* (*Roxb*.) showed anti ulcer activity against ethanol-indomethacin and pylorus ligated gastric ulcer in experimental animals [47].

The antiulcer potential of aqueous extract of *Madhuca indica* was tested against naproxen induced gastric ulcer, omeprazole was used as a positive standard. Aqueous extract of plant of *M. indica* showed significant reduction in ulcerated area and ulcer index as compared to control group [48].

Antimicrobial Activity

Achras sapota showed antibacterial activity against Gram positive and Gram negative bacteria [49].

The methanolic extract and fractions from the stem bark of *Tridemostemon omphalocarpoides* showed significant anticandidal and antibacterial against two candida species and seven aerobic bacteria [50].

Four extracts of the root of *Pachystela brevipes* showed antibacterial and antifungal against tested microorganisms [51].

Different extracts of parts of *Mimusops elengi* were tested for anti microbial activity and showed antimicrobial activity [52-55].

The extract of stem bark of *Donella ubaguiensis* showed anti microbial activity against 10 tested microorganisms [56].

The methanolic extract of *Manilkara hexandra* leaves showed invitro antimicrobial activity against different types of microorganisms [57]. Antimicrobial activities of extracts of leaves, stem bark and fruits of *Butyrospermum paradoxum* [58].

Fruit extracts of *Mimusops elengi* and *Manilkara hexandra* showed antimicrobial activities [59].

Manilkara hexandra leaf extract showed antimicrobial activity reported [60].

Antidiabetic activity

Mimusops elengi bark was reported as antidiabetic [61, 62].

The anti diabetic activity of leaves extract of *Manilkara zapotaI* was studied [7].

Manilkara zapota seeds and leaves showed marked anti diabetic activity [63, 64]. Both extract of Manilkara hexandra Leaves and Bark showed hypoglycemic effect [60, 65].

Antihyperlipidemic and hypocholesterolemic effect

Argan oil obtained from the seeds of *Argania spinosa* L. showed beneficial effect in the treatment of the hyperlipidemia and hypercholesterolemia [66]. The ethanolic extract of *Mimusops elengi* L. showed significant antihyperlipidemic effect owing to its ability to reduce the levels of total

cholesterol, triglyceride and increasing the level of HDL [67].
The reported antihyperlipidemic effect of leaves of *Manilkara zapota* are described [7, 68].

Hepatoprotective effect
The ethanolic extract of *Madhuca longifolia bark* possesses hepatoprotective activity against D-galactosamine (d-GalN) induced hepatotoxicity in rats [69]. Leaf and bark extracts of Manilkara zapota showed hepatoprotective effect [70].

Immunomodulatory activity
The methanolic stem bark extract of *Pouteria cambodiana* extract was showed to have immumomodulatory activity [71].
The polysaccharides from *Manilkara hexandra* bark significantly stimulating the immune system function. This activity may be due to the stimulation of macrophage function which is a known action of botanical polysaccharides [72].
The ethanolic extract of *Madhuca longifolia* showing significant immunostimulatory activity [73].

Other biological activities
Manilkara zapota leaves showed analgesic and antipyretic activities [74, 75], gastroprotective effect [76], Antifungal activity [77, 78] and aqueous extract showed Acaricidal activity [79].
Ethyl acetate extract of *Argania spinosa* showed antimalarial activity [27]. Skin-whitening and chemopreventive [30].

References

1. Giammanco M. Food Chemistry, 2007; 104:466-479.
2. Slade D, Ferreira D, Marais JPJ. Phytochemistry, 2005; 66:2177-2215.
3. Hotta H, Nagano S, Ueda M, Tsujino Y, Koyama J, Osakai T. Biochimica et Biophysica Acta, 2002; 1572:123-132.
4. Williams RJ, Spencer JPE, Rice-Evans C, Free Radical Biology and Medicine, 2004; 36:838-849.
5. Swenson U, Anderberg AA. the international journal of the Willi Hennig Society. Cladistics. 2005; 21:101-130.
6. Govaerts R, Frodin DG, Pennington TD, World Checklist and Bibliography of Sapotaceae. Royal Botanic Gardens, Kew, UK, 2001.
7. Fayek NM, Abdel Monem AR, Mossa MY, Meselhy MR, Shazly AH, Pharmacognosy Research, 2012; 4(2):85-91.
8. Ma J, Luo X, Protiva P, Yang H, Ma C, Basile MI *et al*. J. Nat. Prod. 2003; 66:983-986.
9. Rao GV, Sahoo MR, Madhavi MSL, Mukhopadhyay T. Der Pharmacia letters, 2014; 6(2):69-73.
10. Miland P, Preeti, Int. J. Res. Pharm. 2015; 6(4):544-550.
11. Charrouf Z and Guillaume D, American Journal of Food Technology. 2007; 2(7):679-683.
12. Costa DLMG, Rinaldo D, Varanda EA, Sousa JF, Nasser ALM, Silva ACZ *et al.* J Med Food. 2014; 17(10):1-10.
13. Hernandez CLC, Villasenor IM, Joseph E, Tolliday N. Philippine Journal of Science. 2008; 137(1):1-10.
14. Torres-Rodríguez A, Salinas-Moreno Y, Valle-Guadarrama S, Alia-Tejacal I, Food Research International, 44,1956-1961.
15. Elhadi MY, Fabiola GO, Claudia AL. Phytochemical and antioxidant characterization of mamey (Pouteria sapotaJacq. H.E. Moore & Stearn) fruit Food Research International, 2011; 44(7):2175-2181.
16. Ma J, Yang H, Basile JM, Kennelly JE. Journal of Agricultural and Food Chemistry. 2004; 52:5873-5878.
17. Dini I. Food Chemistry, 2011; 124:884-888.
18. Eyong KO, Foyetb HS, Baïrysa G, Folefoc GN, Asongalem EA, Lagojda A *et al*. Journal of Ethnopharmacology. 2015; 174:277-286.
19. Misra G, Mitra CR. Phytochemistry, 1969; 8:249-252.
20. Adebayo AH, Abolaji AO, Kela R, Ayepola OO, Olorunfemi TB, Taiwo OS, J. Pharm. Sci. 2011; 24(4):545-551.
21. Fru CG, Sandjo LP, Kuete V, Liermann JC, Schollmeyer D, Yeboah SO *et al.* Phytochemistry Letters, 2013; 6:676-680.
22. Wang HM, Chou YT, Hong ZL, Chen H, Chang Y, Yang WL, Chang HC, Mai C, Chen CY, Journal of the Taiwan Institute of Chemical Engineers. 2011; 42:204-211.
23. Sunita S, Deepti G, Pharmacognosy Communications, 2015; 5(1):83-92.
24. Siddiqui BS, Khan S, Kardar MN, Natural Product Research, 2010; 24(1):76-80.
25. Tapondjou LA, Nyaa L, Tane P, Ricciutelli M, Quassinti L, Bramucci M *et al.* Carbohydrate Research, 2011; 346:2699-2704.
26. Sanchez-Medina A, Stevenson PC, Habtemariam S, Pena-Rodriguez LM, Corcoran O, Mallet AI *et al.* Phytochemistry, 2009; 70:765-772.
27. El Babili F, Bouajila J, Fouraste I, Valentin A, Mauret S, Moulis C. Phytomedicine, 2010; 17:157-160.
28. Awasare S, Bhujbal S, Nanda R, Asian J pharm cli Res. 2012; 5(4):183-188.
29. Osman MA, Rashid MM, Aziz MA, Habib MR, Karim MR. Asian Pac. J. Trop. Biomed. 2011b; 1:448-451.
30. Zhang J, Kurita M, Shinozaki T, Ukiya M, Yasukawa K, Shimizu N *et al.* Phytochemistry, 2014; 108:157-170.
31. Angone SA, Mewono L, Mounanga MB, Medzegue S, Ella Mendene HF, Mba Ndong JG *et al.* Pharmacognosy Research, 2013; 5(3):195-199.
32. Abdul Khalek M, Khatun Z, Habib MR, Karim MR. Biologija, 2015; 61(3-4):145-152.
33. Biswakanth Kar, Kumar RB, Karmakar I, Dola N, Bala A, Upal KM *et al.* Asian Pacific Journal of Tropical Biomedicine. 2012; 2:976-980.
34. Saha MR, Hasana SMR, Aktera R, Hossaina MM, Alamb MS, Alam MA. J Vet Med. 2008; 6(2):197-202.
35. Chanda SV, Nagani KV. Nature and Science, 2010; 8(10):260-266.
36. Shanmugapriya K, Saravana PS, Payal H, Mohammed P, Binnie W, Int J Pharm Pharm Sci. 2011; 3(5):256-260.
37. Amzal H, Alaoui K, Tok S, Errachidi A, Charof R, Cherrah Y *et al.* Fitoterpia, 2008; 79:337-344.
38. Yahia EM, Gutiérrez-Orozco F, Arvizu-de Leon C. Food Research International, 2011; 44:2175-2181.
39. Suda I, Oki T, Nishiba Y, Masuda M, Kobayashi M, Nagai S *et al.* J Jpn Soc Food Sci Technol. 2005; 52:462-471.
40. Dutta S, Ray S. International Journal of Pharmacy and Pharmaceutical Sciences. 2015; 7(10):296-301.
41. Rhourri-Frih B, Renimel I, Chaimbault P, André P, Herbette G, Lafosse M. Fitoterapia, 2013; 88:101-108.
42. Ganguly A, Al Mahmud Z, Nasir Uddin M, Abdur Rahman SM. Asian Pac J Trop Dis. 2013; 3(4):301-307.
43. Merini LR, Furtado SC, Oliveira MMB, Carneiro ALB, Boechat AL, Barcellos JFM, Cytokine, 2014; 65:231-235.
44. Eskander JY, Haggag EG, El-Gindi MR, Mohamedy MM. Med Chem Res, 2014; 23:717-724.
45. Prakash D, Koti BC, Vijay T, Chandrakala, Katagi MS, Int Res J Pham. 2011; 2(8):173-176.

46. Shah PJ, Gandhi MS, Shah MB, Goswami SS, Santani D. Journal of ethnopharmacology. 2003; 89:305-311.
47. Shah MB, Goswami SS, Santani DD. Phytother. Res, 2004; 18:814-818.
48. Mohod SM, Bodhankar SL, Journal of Acute Disease. 2013, 127-133.
49. Ahmed R, Rashid F, Ahmed VU, Nourwala M, Bibi N, Kazmi SU. Journal of Asian Natural Products Research. 2008; 10(1):7-16.
50. Kuete V, Tangmouo JG, Penlap Beng V, Ngounou FN, Lontsi D. Journal of Ethanopharmacology. 2006; 104:5-11.
51. Ezuruike IT, Aba OY, Habila JD, Ndukwe GI. Sch. Acad. J. Pharm. 2015; 4(1):35-41.
52. Prabhat, Ajaybhan, Navneet, Chauhan A. Report Opinion, 2010; 2(6):37-42.
53. Deshpande RR, Ruikar A, Panvalkar PS, Kulkarni AA, Khatiwora E, Adasul V. J Biomed Sci and Res. 2010; 2(3):151-154.
54. Rangama BNLD, Abayasekara CL, Panagoda GJ, Senanay ake MRDM. J Natn Sci. 2009; 37(2):139-145.
55. Ali MA, Mozid MA, Yeasmin S, Khan AM, Sayeed MA, Res J Agriculture and Biological Sci. 2008; 4(6):871-874.
56. Djoumessi AVB, Sandjo LP, Liermann JC, Schollmeyer D, Kuete V, Rincheval V *et al.* Tetrahedron, 2012; 68:4621-4627.
57. Chanda S, Parekh J. Phcog J, 2010; 2(12):448-455.
58. Ogunwande IA, Bello M, Olawore NO, Muili KA. Fitoterapia, 2001; 72(1):54-56.
59. Patel PR, Rao TVR. International Food Research Journal. 2012; 19(3):1227-1231.
60. Patel ED, Patel NJ. Advance Research in Pharmaceuticals and Biologicals, 2015; 5(2):863-867.
61. Ganu GP, Jadhav SS, Deshpande AD. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2010; 1:37-45.
62. Jerline M, Jothi G, Brindha P. Effect of Mimusops elengi Linn. Bark extract on alloxan induced hyperglycemia in albino rats. Journal of Cell and Tissue Research. 2009; 9:1985-1988.
63. Saradha S, Ruckmani A, Chokkalingam M, Maignanakumar R, Arunkumar R, Madhavi E *et al*. International Journal of Pharmacy and Pharmaceutical Sciences. 2014; 6(2):434-437.
64. Barbalho SM, Bueno PCD, Delazari DS, Guiguer EL, Coquerio DP, Araujo AC *et al.* Journal of Medicinal Food. 2015; 18(3):385-391.
65. Nimbekar TP, Katolkar PP, Patil AT. Research J. Pharm. and Tech. 2012; 5(3):367-368.
66. Berrougui H, Ettaib A, Gonzalez MD, Alvarez de Sotomayor M, Bennani-Kabchi N, Hmamouchi M. Journal of Ethanopharmacology. 2003; 89:15-18.
67. Ghaisas MM, Kadam AH, Kshirsagar BD, Dhote VV, Deshpande AD. J Natural Remedies. 2008; 8(2):132-137.
68. Barbalho SM, Bueno PCD, Delazari DS, Guiguer EL, Coquerio DP, Araujo AC *et al.* Journal of Medicinal Food. 2015; 18(3):385-391.
69. Roy SP, Kannadasan T, Gupta R. Biomedical Research, 2015; 26(2):365-369.
70. Milind P, Preeti. Int. J. Res. Ayurveda Pharm. 2015; 6(4):545-550.
71. Manosroi A, Saraphanchotiwitthaya A, Manosroi J. Journal of Ethnopharmacology. 2005; 101:90-94.
72. Gomathi P, Ganjeev kumar A, Prameela R, Kishore kumar K, Gnananath K. Int J Pharm Pharm Sci. 2012; 4(3):430-432.
73. Shrivastava M, Dhingra N, Dwivedi LK, International Journal of Pharmacy & Technology. 2014; 5(4):6094-6103.
74. Ganguly A, Al Mahmud Z, Nasir Uddin M, Abdur Rahman SM. Asian Pac J Trop Dis. 2013; 3(4):301-307.
75. Jain PK, Soni P, Upmanyu N, Shivhare Y, European Journal of Experimental Biology. 2011; 1(1):14-17.
76. Shaik J, Khasim SM, Naidu PB. Int J Advances Pharmaceut Sci. 2011; 2(2):264-275.
77. Otari SV, Patil RM, Ghosh SJ, Pawar SH, Materials Letters, 2014; 116:367-369.
78. Boleti AP, Freire MG, Coelho MB, Silva W, Baldasso PA, Gomes VM *et al.* J Agric Food Chem. 2007; 55:2653-2658.
79. Rajakumar G, Abdul Rahuman A, Research in Veterinary Science, 2012; 93:303-309.