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TROPICAL FRUIT PEELS AS SOURCES OF BIOACTIVE COMPOUNDS: A REVIEW

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Abstract

Tropical ecosystems are rich in plant species of special interest to the pharmacological industry. Tropical fruit peels contain several bioactive compounds and show biological activities, unfortunately they don't get enough attention. This is an updated review of the bioactive compounds present in tropical fruits peels: *Actinidia deliciosa* (Kiwifruit), *Mangifera indica* L. (Mango), *Annona squamosa* L. (Sugar-apple), *Annona reticulata* L. (Custard apple), *Ananas comosus* (Pineapple), *Canarium odontophyllum* Miq. (Dabai), *Carica papaya* L. (Papaya), *Cucumis sativus* L. (Cucumber), *Persea americana* Mill. (Avocado), *Punica granatum* L. (Pomegranate), *Musa acuminata*, *Musa sapientum*, *Musa paradisiaca* (Banana), *Psidium guajava* L. (Guava), *Genipa americana* L. (Jagua), *Citrus maxima - Citrus grandis* L. (Pomelo), *Citrus paradisi* Macfad (Grapefruit), *Citrus sinensis* (Orange), *Citrus macroptera* (Wild Orange), *Citrus reticulata* (Mandarine), *Citrus limon* (Lemon), *Citrus medica* L. (Citron), *Melicoccus bijugatus* Jacq. (Spanish Lime), *Euphoria longana* Lam. (Longan), *Nephelium lappaceum* L. (Rambutan) and *Chrysophyllum cainito* L. (Star Apple) belonging to 15 different families. The peels of tropical fruits are a potential source of various bioactive compounds, such as polyphenols, flavonoids, carotenoids, terpenoids, alcaloids, among others. They also possess properties and antioxidant, antiviral, anticancer and antidiabetic activities that could be used to create new therapeutic agents. This review shows the pharmacological potential of tropical fruit peels and also pretends to be a basis to encourage cultivation and conservation of these rare (non-commercial) fruit species and promote their integral and sustainable use.

Key words: Fruit peels, Neotropical fruit shells, Biological activities, Pharmacological potential.

Introduction

Natural products for the development of new pharmacological agents have had a long-standing history in the annals of medicine (for a thorough review on the matter see Newman & Cragg, 2020). Fortuitous observation and chance have undoubtedly played a vital role in this process, though. Other important and more controlled approaches include ethnobotanical bioprospecting and chemotaxonomics. Both strategies have relied heavily on the analysis of leaves, bark and the inflorescences of plants for their success. However, new studies have recently shed light on the use of fruits and their peels for the same purposes (Vílchez *et al*., 2011; Chaouch & Benvenuti, 2020). Considering the above, the present review has the aim to provide a general overview of the pharmacological potential of the peels from eighteen tropical fruits: *Actinidia deliciosa* (Kiwifruit/ Actinidiaceae), *Mangifera indica* L. (Mango/ Anacardiaceae), *Annona squamosa* L. (Sugar-apple/ Annonaceae), *Annona reticulata* L. (Custard apple/ Annonaceae), *Ananas comosus* (Pineapple/ Bromiliaceae), *Canarium odontophyllum* Miq. (Dabai/ Burceraceae), *Carica papaya* L. (Papaya/Caricaceae), *Cucumis sativus* L. (Cucumber/ Cucurbitaceae), *Persea americana* Mill. (Avocado/Lauraceae), *Punica granatum* L. (Pomegranate/ Lythraceae), *Musa acuminata*, *Musa sapientum*, *Musa paradisiaca* (Banana/Musaceae), *Psidium guajava* L. (Guava/Myrtaceae), *Genipa americana* L. (Jagua/ Rubiaceae), *Citrus maxima - Citrus grandis* L., *Citrus paradisi* Macfad, *Citrus sinensis*, *Citrus macroptera*, *Citrus reticulata*, *Citrus limon*, *Citrus medica* L. (Pomelo, Grapefruit, Orange, Wild Orange, Mandarine, Lemon and Citron/Rutaceae), *Melicoccus bijugatus* Jacq. (Spanish Lime/ Sapindaceae), *Euphoria longana* Lam. (Longan/ Sapindaceae), *Nephelium lappaceum* L. (Rambutan/ Sapindaceae) and *Chrysophyllum cainito* L. (Star Apple/ Sapotaceae). Hopefully with the information presented here, future studies can delve deeper into the pharmacological potential of tropical fruits and their peels. We also wish to promote the sustainable use of the listed species.

Materials and Methods

Between October 2017 and August 2021, an exploration of scientific literature was conducted through the search engines: Pubmed, Science Direct, Springer Link, Science.Science.gov, SciELO, Dialnet and Google Scholar to collect publicly available information on the bioactive compounds and biological activities of tropical fruit shells.

Search terms included scientific and common names of each fruit species, along with terms such as tissues, peel, shell, skin, rind, husk, epicarp, exocarp, peels review, traditional medicine, chemical composition, phytochemical study, pharmacological study, *In vivo* study, *In vitro* study, bioactivities and pharmacological properties, as well as the types of chemical compounds and kinds of bioactivities of each one. The reference lists of scientific articles were cross-checked and only relevant works were included. The search for data was limited to reports of fruits from tropical places and included articles and books published between 1987 and 2021. The summaries presented in the tables were taken from the data of different authors. Chemical composition and bioactivities tables were also included.

Results

Fruits of the neotropics: The fruit species present in the tropical regions of the Americas (i.e. the Neotropics) has been estimated at more than 2,000. From these, 259 are commercially grown, with 10% of such lands being exclusively destined for the cultivation of just 64 species. These same species are also responsible for generating 14% of the total revenue derived from local agriculture (Segura-Ledesma *et al*., 2009; Blancke, 2016). Introduced species are commercially important as well, and most of them have their origins either in the old world or in the Far East. Today, such plants exist in a naturalized state; however, phenotype selection and persistent cultivation have given rise to new varieties vastly different from those present in their ancestral habitats. The Neotropics, therefore, represent an exceptional opportunity for the innovative use of novel biological resources in diverse sectors of the economy, including those that pertain to the pharmacological industry alone. In this sense, tropical ecosystems are particularly rich in plant species of special interest to such sectors (Valli *et al*., 2012; Blancke, 2016). This comes in addition to their prior role as reservoirs of staple food crops. Already, many tropical food products (including certain fruits) are known to possess a relatively high nutritional content (Kehlenbeck *et al*., 2013; Kumoro *et al*., 2020), a fact that has helped to increase their demand in many international markets.

Botanical description: The eighteen species presented here are tropical fruits with different botanical characteristics and are described in Table 1.

Use in Traditional medicine of tropical fruit peels Diverses tissues like leaves, flowers and bark of Kiwifruit, Mango, Sugar-apple , Custard apple, Pineapple, Papaya, Cucumber, Avocado, Pomegranate, Banana, Guava, Jagua, Pomelo, Grapefruit, Orange, Wild Orange, Mandarine, Lemon, Citron, Spanish Lime, Longan, Rambutan and Star Apple are used in traditional medicine to treat various diseases such as asthma, cancer, diabetes, rheumatoid arthritis, syphilis, gonorrhea, dengue, fever, hypertension, among others, (Morton, 1987; Rangkadilok *et al*., 2005; Ojewole & Amabeoku, 2006; Khare, 2007; Yasir *et al*., 2010; Da Conceicao *et al*., 2011; Gajalakshmi *et al*., 2011; Sanda *et al*., 2011; Bystrom, 2012; Rajendra *et al*., 2012; Anjum *et al*., 2013; Mukherjee *et al*., 2013; Chavan *et al*., 2014; Jiménez *et al*., 2014; Shailajan & Gurjar, 2014; Yogiraj *et al*., 2014. Haque *et al*., 2015; Sangeetha & Jayaprakash, 2015; Singh-Pal *et al*., 2015; Chaudhari *et al*., 2016; Chawla *et al*., 2016; Mishra *et al*., 2017; Sukmandari *et al*., 2017; Faustino *et al*., 2019). On the other hand, only pomegranates, banannas and oranges have reports on the use of their peels as a remedies to protect against skin infections (Manodeep *et al*., 2012), dysentery, diarrhea and ulcers (Lavanya *et al*., 2016) and anthelmintic (Mabberley, 2004), respectively. Concerning the buah dabai (*Canarium odontophyllum* Miq.), to the best of our knowledge, there are currently no reports that mention its use in traditional medicine.

Chemical constituents and pharmacological activity of tropical fruit peels: For many years, botanical bioprospecting relied almost exclusively on the use of leaves, bark and the inflorescences of plants as sources for clinically relevant bioactive compounds, with other organs or structures being analyzed relatively recently (Vílchez *et al*., 2011; Majeed *et al*., 2019; Fierascu *et al*., 2020). An important example of the latter is the study completed by Deng *et al*., (2012) concerning the antioxidant potency and phenolic content present in the residues (i.e. peels and seeds) of 50 different types of fruits. Included in this analysis were 19 taxonomic families, chief among them the Annonacea, Sapindaceae, Myrtacea, Rutaceae, and Cactaceae. The authors concluded that the wastes of certain fruit species do contain relatively high levels of antioxidants and phenolics, the most abundant being the compounds catechin, cyanidin 3-glucoside, epicatechin, galangin, gallic acid, homogentisic acid, kaempferol and chlorogenic acid. The wastes of A. squamosa in particular (commonly known as sweetsop) were especially high in antioxidant activity, and it was determined that such residues–like those of other species–could be used as sources of inexpensive and readily available bioactive compounds of potential interest to the pharmaceutical industry.

Similar studies (namely phytochemical and pharmacological analyses) have also been conducted on the peels of other tropical fruits. What follows is the result of a bibliographical analysis of several fruit species with proven pharmacological properties. They appear organized according to their botanical family, with salient features summarized in Tables 2 and 3.

Family actinidiaceae: Phenols, tannins, and alkaloids have been detected in the peels of kiwifruit. Pharmacological studies also report the presence of cytotoxic, cytotoxicity-modulating, antibacterial, antioxidant, and anti-HIV activities (Motohashi *et al*., 2001; Lucas *et al*., 2003; Duda-Chodak & Tarko, 2007; Indhumathi *et al*., 2011; Singh-Pal *et al*., 2015; Alim *et al*., 2019).

Table 1. Geographical origin and description of selected fruits.

	Fruit data/ Number, scientific name, common name and family	Geographical origin	Size	Weight	Shape	Peel
1.	*Actinidia deliciosa* Kiwifruit Actinidaceae[a]	China	5 to 6.3 cm	0.03 -0.15 kg	Ovoid or oblong	Bright-green flesh and a dull-brown skin, covered by short epidermal hairs known as trichomes
2.	*Mangifera indica* L. Mangoes Anacardiaceae[b]	India	6.2 to 25 cm	0.18 to 2.3 kg	Round, oval, ovoid-oblong, or kidney-shaped	Thick and leathery, generally smooth, waxy, and aromatic with light green, dark green, light yellow, yellow, yellow-orange, reddish-pink, bright red, dark red, or even purple skin when mature
3.	*Annona squamosa* L. Sugar-apple Sweetsop Annonaceae[c]	Probably from either the tropical regions of Central America or the Antilles	5 to 12 cm (diameter)	0.200 to 0.80 kg	Globose to oviform and almost heart-like in shape	The exterior is marked by polygonal tubercles which correspond to the fused carpels from which the fruit is formed. The ripe fruit is light yellowish-green or purple and the exterior readily separates along the lines between the tubercles
4.	*Annona reticulata* L. Custard apple Annonaceae[d]	Central America and the Caribbean	8 to 15 cm in diameter	Up to 1 kg	Heart-shaped or spherical	The skin, thin but tough, may be yellow or brownish when ripe, with a pink, reddish or brownish-red blush, and faintly, moderately, or distinctly reticulated
5.	*Ananas comosus* Pineapple Bromiliaceae[e]	South America	30 cm or more	0.5 to 4.5 kg or more	Oval to cylindrical-shaped	The hard and waxy shell is formed by interlocking hexagonal units and can be a dark green, yellow, orange-yellow, or reddish color when the fruit is ripe
6.	*Canarium odontophyllum* Miq. Dabai Burceraceae[f]	Malaysia	3 to 4 cm	0.010 to 0.013 kg	Oval to ellipsoid	Drupe with thin skin, mostly white when immature, and bluish-black when ripe
7.	*Carica papaya* L. Papaya Caricaceae[g]	Perhaps in Southern Mexico	5 to 50 cm or more	0.2 to 9 kg	Large oval-shaped berry	Very thin skin which is green when immature, and yellow, orange, or red-orange when ripe.
8.	*Cucumis sativus* L. Cucumber Cucurbitaceae[h]	Native to Southern Asia	10 to up to 50 cm	0.050 to 4 kg	Elongated, ellipsoidal, convex, and laterally striated	Smooth, dark-green skin
9.	*Persea americana* Mill. Avocado Lauraceae[i]	Central America	7-20 cm long and 7-10 cm in diameter	0.100 and 1 kg	Usually spherical or piriform,	The exocarp (i.e. rind or skin) is variable in both thickness and texture, and can be of a green, black, purple, or even reddish color at maturity
10.	*Punica granatum* L. Pomegranate Lythraceae[j]	Northern Africa and the Caucasian	5 to 12.7 cm	0.250 to 0.300 kg	Nearly round and crowned by the pointed calyx	The tough, leathery skin or rind is typically yellow overlaid with light or deep pink or rich red
11.	*Musa acuminata*, *Musa sapientum*, *Musa paradisiaca* Banana Musaceae[k]	Southeast Asia	3–40 cm long, and 2–8 cm in diameter.	Average0.125 kg	Elongated, curved, and more or less round in cross section triangular ovary.	The skin is thin and tender to thick and leathery, and silver, yellow, green, or red in color
12.	*Psidium guajava* L. Guava Myrtaceae[l]	Probably from southern Mexico to South America	5 to 10 cm long	Up to 0.500 kg	Round, pyriform or ovoid berry	Smooth or rough epicarp and the skin turns a characteristic yellow (or reddish-yellow) color at ripe stage
13.	*Genipa americana* L. Jagua Rubiaceae[m]	Native to the tropical forests of North and South America	8-10 cm long and 6-7 cm in diameter	0.200 to 0.400 kg	Elliptic or rounded-oval berry, tapering briefly at the stem end	Thin leathery skin of greenish-brown or reddish color
14.	*Citrus maxima – Citrus grandis* L., *Citrus paradisi* Macfad, *Citrus sinensis*, *Citrus macroptera*, *Citrus reticulata*, *Citrus limon*, *Citrus medica* L. Genus *Citrus* (Pomelo, Grapefruit, Orange, Wild Orange, Mandarine, Lemon and citrón) Rutaceae[n]	Probably Southeast Asia.	Fruit of the genus *Citrus* vary greatly in size and range from about 3 cm (kumquats) to more than 30 cm in diameter (pummelos)	0.01 to 2 kg	Round to oblong	Tough outer skin or epicarp, commonly known as flavedo that can be green, yellow, orange, or even reddish in color
15.	*Melicoccus bijugatus* Jacq. Spanish Lime Sapindaceae[o]	Northern regions of South America	2.5 to 4 cm in diameter	0.009 to 0.022 kg	Round or ovoid-shaped drupes	Thin, leathery, brittle skin that is green to yellowish when mature
16.	*Euphoria longana* Lam. Longan Sapindaceae[p]	Southern China	1.2-2.5 cm in diameter	0.006 to 0.019 kg	Conical, heart-shaped or spherical	The peel is tan, thin, and leathery with tiny hairs
17.	*Nephelium lappaceum* L. Rambutan Sapindaceae[q]	Indonesia and Malaysia	Up to 7 x 5 cm	0.020 to 0.095 kg	drupe. Oval to spherical in shape	Thick and leathery skin covered entirely by (flexible) spines. When ripe, the skin turns red in color
18.	*Chrysophyllum cainito* L. Star Apple Sapotaceae[r]	Greater Antilles and the West Indies	5 to 10 cm in diameter	Average 0.129 kg	Subglobose berry	Smooth skin of a purple-red, dark purple, or even pale green color

[a]Lucas *et al*., 2003; Motohashi *et al*., 2001; Chawla *et al*., 2016. [b]Jahurul *et al*., 2015; Morton, 1987. [c]Morton, 1987; Chel-Guerrero *et al*., 2018a. [d]Chavan *et al*., 2014. [e]Rashad *et al*., 2015; Morton, 1987. [f]Basri *et al*., 2014a, 2014b; [g]Yogiraj *et al*., 2014. [h]Mukherjee *et al*., 2013.[i]Yasir *et al*., 2010. [j]Manodeep *et al*., 2012; Haque *et al*., 2015. [k]Ross, 2001; Dahham *et al*., 2015. [l]Morton, 1987; Mishra *et al*., 2017. [m]Bazílio-Omena *et al*., 2012. [n]Mabberley, 2004. [o]Morton, 1987; Crane & Balerdi, 2016. [p]Rangkadilok *et al*., 2005. [q]Sukmandari *et al*., 2017. [r]Morton, 1987; Chel-Guerrero *et al*., 2018a

Table 2. Chemical components in the peels of several tropical fruits.

Compound	Fruit																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Polyphenols	x	x	x	x		x	x	x	x	x	x	x		x	X	x	x	x
Flavonoids		x	x	x	x	x	x	x	x	x	x	x	x	x	X	x		x
Anthocianins		x				x				x	x							
Anthocyanidins						x						x						
Carotenoids		x				x	x		x		x			x				
Coumarins				x						x			x	x				
Terpenoids				x	x		x	x	x	x	x		x	x			x	
Saponins				x	x		x	x		x	x	x		x			x	
Tannins	x		x		x		x		x	x	x	x		x		x	x	
Alcaloids	x			x	x		x	x		x				x		x	x	
Esteroids				x	x		x	x	x	x	x			x				
Esterols				x	x		x			x	x		x					
Anthraquinones											x		x					
Anthrones													x					
Glycosides										x	x							
Carbohydrates											x			x				

The number in the columns corresponds to the fruit with the same number in Table 1. Source: Documented chemical studies; specific references are listed in the main text, in the sections corresponding to each family

Table 3. Pharmacological activities reported in the peels of several tropical fruits.

Activity	Fruit																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Antioxidant	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Antiviral	x				x												x	
Anti-immunomodulatory										x							x	
Anticancer							x			x	x	x		x			x	
Cytotoxic or antiproliferative	x	x	x					x	x	x								
Antitumor			x															
Modulated of the cytotoxicity	x																	
Antidiabetic					x	x				x		x		x			x	
Hypoglicemic										x						x		
Anti-inflammatory		x			x				x	x								
Analgesic										x								
Anti-arthritic									x								x	
Antiulceric											x							
Antibacterial	x				x		x	x	x	x				x			x	
Antimicrobial			x	x			x		x	x	x	x		x			x	
Anti-allergic														x				
Antifertility			x							x								
Antiparasitic					x													
Antifungal					x									x				
Diuretic											x							
α-amilase and α-glucosidase inhibiting																	x	
Anti-diarrheal												x						
Hipolipidemic												x		x				
Antihyperlipidemic																	x	
Antihypercolesterolemic														x			x	
Anti-alzheimer														x				
Anticholinesterase						x								x				
Anti-aging																	x	
Anti-thyphoid														x				
Antihelminthic														x				
Estrogenic														x				
Antidepressant														x		x		
Antinociceptive																x		
Hepatoprotective										x								
Gastroprotective						x				x								
Cardioprotective						x												
Radioprotective										x								
Anti osteoporotic										x								
Protective effect against prostatitis										x								

The number in the columns corresponds to the fruit with the same number in Table 1. Source: Documented chemical studies; specific references are listed in the main text, in the sections corresponding to each family

Family Anacardiaceae: Phenols, flavonoids, anthocyanins and carotenoids have often been detected in the peels of M. indica. Numerous pharmacological studies also report the presence of antioxidant, anti-inflammatory and antiproliferative activities (Knödler *et al*., 2008; Masibo & He, 2009; Kim *et al*., 2010; Ali *et al*., 2012; Solidum, 2012; Ahmad *et al*., 2015; Jahurul *et al*., 2015; Masud-Parvez, 2016; Fierascu *et al*., 2020).

The family annonaceae: Several bioactive compounds including polyphenolics and flavonoids have been detected in the peels of A. squamosa. Pharmacological studies also report the presence of antioxidant, antimicrobial, cytotoxic, and antiviral activities, as well as modulation of acetylcholinesterase activity (Sharma *et al*., 2013., Kaladhar *et al*., 2015; Chel-Guerrero *et al*., 2018a, 2018b; Alcántar-Ramírez *et al*., 2018; Shehata *et al*., 2021). Phenols, flavonoids, alkaloids, cholesterol, coumarins, tannins, saponins, steroids, and terpenoids have likewise been detected in the peels of *A. reticulata*, as have antioxidant, cytotoxic, antiviral, anti-inflammatory and antimicrobial activities (Kaladhar *et al*., 2015; Chel-Guerrero *et al*., 2018a, 2018b).

The family bromeliaceae: Alkaloids, flavonoids, saponins, tannins, steroids, triterpenes and phytosterols have often been detected in the peels of *A. comosus*. Pharmacological studies also report the presence of antioxidant, antiviral, anti-inflammatory, antibacterial, antiparasitic and antifungal activities (Azizan *et al*., 2020; Rashad *et al*., 2015; Lawal, 2013).

The family burceraceae: Phenols, flavonoids, anthocyanins, anthocyanidins and carotenoids have all been detected in the peels of *C. odontophyllum*. Pharmacological studies also report the presence of antioxidant, cardioprotetive, gastroprotective, antidiabetic and anticholinesterase activity (Xuan & Azlana, 2016, Salahuddin-Mirfat *et al*., 2018).

The family caricaceae: Phenols, flavonoids, terpenoids, tannins, alkaloids, saponins, carotenoids, steroids and sterols have been detected in the peels of *C. papaya* (Mendes dos Santos *et al*., 2014; Sihombing *et al*., 2015; Dada *et al*., 2016; Siddique *et al*., 2017). Pharmacological studies also report antioxidant, anticancer, antimicrobial and antibacterial activities (Dada *et al*., 2016; Siddique *et al*., 2017; Undugodage-Dulanjali & Kanchana-Perera, 2018; Villacís-Chiriboga, 2020).

The family cucurbitaceae: Phenols, flavonoids, alkaloids, saponins, terpenoids and steroids have all been detected in the peels of *C. sativus* (Mukherjee *et al*., 2013; Foong *et al*., 2015; Sonia *et al*., 2016; John *et al*., 2018). Pharmacological studies also report antioxidant, cytotoxic, antidiabetic, antimicrobial and antibacterial activities (Dixit & Kar, 2010; Mukherjee *et al*., 2013; Foong *et al*., 2015; John *et al*., 2018).

The family lauraceae: Phenols, flavonoids, carotenoids, terpenoids, tannins and steroids have all been detected in the peels of *P. americana* (Vinha *et al*., 2013; Putta and Kilari, 2015; Rodríguez-López *et al*., 2015; Smitha-Grace *et al*., 2015; Roser *et al*., 2019; Salazar-López., *et al*., 2020). Pharmacological studies also report antioxidant, cytotoxic, anti-inflammatory, antimicrobial, antiarthritic and antibacterial activities (Rodríguez-Carpena *et al*., 2011, Vinha *et al*., 2013, Enwa, 2016, Smitha *et al*., 2017; Tremocoldi *et al*., 2018; Roser *et al*., 2019; Figueroa *et al*., 2021).

The family lythraceae: In the peels of *P. granatum*, tannins, saponins, quinones, terpenoids, steroids, flavonoids, phenols, alkaloids, glycosides, cardiac glycosides, coumarins and anthocyanins have been determined (García *et al*., 2021; Chen *et al*., 2020; Foujdar *et al*., 2020; Magangana *et al*., 2020; Machado-Brêtas *et al*., 2020; Sangeetha & Jayaprakash, 2015). Pharmacological studies also report antioxidant activity, anticancer, antidiabetic, cytotoxic, analgesic, immunomodulatory, antifertility, anti-inflammatory, gastrointestinal protection activities, with uterine stimulant effect, protective effect against prostatitis, hypoglycemic activity, radioprotective, gastroprotective, antibacterial, antityrosinase, antimicrobial, antihyperlipidemic, hepatoprotective, antiproliferative and antiosteoporotic (Fawole *et al*., 2012; Ismail *et al*., 2012; Manodeep *et al*., 2012; Howel, 2013; Sreekumar *et al*., 2014; Haque *et al*., 2015; Mphahlele *et al*., 2016; John *et al*., 2017; Benguiar *et al*., 2020; Chen *et al*., 2020; Foujdar *et al*., 2020; Karim *et al*., 2020; Magangana *et al*., 2020; Peršurić *et al*., 2020; More & Aria, 2021).

The family musaceae: Different bioactive compounds including phenols, flavonoids, anthocyanins, carotenoids, carbohydrates, tannins, saponins, anthraquinones, steroids, glycosides, sterols and terpenoids have been detected in the peels of *Musa* spp. Pharmacological studies also report antioxidant, diuretic, anticancer, antiulceric, antiviral, antibacterial and antimicrobial activities as well as mutagenic effect and inhibition of the cholesterol crystallization (Swanson *et al*., 2010; Imam *et al*., 2011; Ehiowemwenguan *et al*., 2014; Dahham *et al*., 2015; Kibria *et al*., 2019; Oyeyinka & Jide-Afolayan, 2020a, 2020b).

The family myrtaceae: Phenols, tannins, flavonoids, anthocyanidins and saponins have all been detected in the peels of *P. guajava*. Several pharmacological studies also report the presence of antioxidant, antimicrobial, anticancer, hypoglycemic, antidiabetic, antidiarrheal and hypolipidemic activities (Thaiponga *et al*., 2006, Rai *et al*., 2009; Rai *et al*., 2010; Barbalho *et al*., 2012; Wang *et al*., 2014; Abdelmalek *et al*., 2016; Issa *et al*., 2016; Gupta *et al*., 2018; Liu *et al*., 2018; Angulo-López *et al*., 2021; Ganoza-Yupanqui *et al*., 2021).

The family rubiaceae: Flavonoids, anthraquinones, anthrones, coumarins, terpenoids and sterols have all been detected in the peels of *G. americana*. Antioxidant activity has also been reported (Bazílio-Omena *et al*., 2012; Náthia-Neves *et al*., 2017).

The family rutaceae (Syn. aurantiaceae): Phenols, flavonoids, tannins, carotenoids, terpenoids, steroids, carbohydrates, coumarins, saponins and alkaloids have often been detected in the peels of pomelos, oranges, grapefruits, mandarins, lemons and acid limes. Pharmacological studies also report the presence of antioxidant, anti-cancer, anti-Alzheimer, antimicrobial, antibacterial, antifungal, antithyroid, antidiabetic, hypoglycemic, hypolipidemic, antihypercholesterolemic, anti-allergic, lipolytic, anthelmintic, estrogenic, antidepressant and anticholinesterase activities (Panara *et al*., 2012; Lagha-Benamrouche and Madani, 2013; Oikeh *et al*., 2013, Kumar *et al*., 2014; Madhuri *et al*., 2014; Natesan *et al*., 2014; Vijayalakshmi and Radha, 2014; Muhtadi *et al*., 2015; Aktar and Foyzum, 2017; Vijayalakshmi and Radha, 2016; Amutha *et al*., 2017; Nongalleima *et al*., 2017; Safdar *et al*., 2017; Rafiq *et al*., 2018; Montero-Calderon *et al*., 2019; Klimek-Szczykutowicz *et al*., 2020; Santoshkumar-Jayagoudar *et al*., 2020; Singh *et al*., 2020; Czech *et al*., 2021; Nieto *et al*., 2021; Taktak *et al*., 2021).

The family sapindaceae: Both phenols and flavonoids have been detected in the peels of *M. bijugatus* and pharmacological studies report antioxidant activity and modulation of acetylcholinesterase activity (Chel-Guerrero *et al*., 2018a). In *E. longana*, phenols, flavonoids, tannins and alkaloids are present in its peel (Rangkadilok *et al*., 2005, Ripaa *et al*., 2015), and hypoglycemic activities have been described (Li *et al*., 2015, Ripaa *et al*., 2015). The peels of *N. lappaceum* also contain several bioactive compounds, including phenols, tannins, terpenoids, saponins, and alcoloids (Thitilertdecha *et al*., 2010; Fila *et al*., 2012; Rakariyatham *et al*., 2020). In this case, pharmacological studies reveal antioxidant, anti-aging, anticancer, antidiabetic, antihypercholesterolemic, anti-inflammatory, antihyperlipidemic, anti-immunomodulatory, antidepressant, antinociceptive, antimicrobial, antibacterial and antiviral activities. Protective effects against arthritis, as well as an inhibitory effect against α-amylase and α-glucosidase are likewise mentioned (Sukmandari *et al*., 2017; Phuong *et al*., 2020; Rakariyatham *et al*., 2020).

The family sapotaceae: Phenolic compounds and flavonoids have been detected in the peels of *C. cainito*. Recent studies also report antioxidant, cytotoxicity and antiviral activities (Moo-Huchin *et al*., 2015; Chel-Guerrero *et al*., 2018a, 2018b; Alcántar-Ramírez *et al*., 2018; Doan & Le, 2020).

Thus, it is clear that fruit peels will often harbor several pharmacologically-relevant bioactive compounds and should not simply be regarded as polluting waste. Doing so can result in several unnecessary expenditures as the cost of eliminating such wastes may be rather high, especially for producers. If, on the other hand, fruit peels are separated from polluting wastes and commercialized independently for use in other products or applications (e.g. pharmaceutical ones), the cultivars from which they originate could benefit from the increased demand. An interesting case in point (though one that does not involve peels) concerns the pharmaceutical product known commercially in Mexico as QG5. As incredibly as it may seem, guava leaves are now priced at a similar value to that of actual fruits – at least in certain regions of Mexico (Rivera-Arce *et al*., 2003).

Moreover, the confirmation of both medically-relevant and economically-important species would guide the conservation and sustainable use of the plants involved, as well as those of the ecosystems from which they originate.

Conclusion and future prospects: The work done by many researchers and reviewed here shows the tremendous potential of tropical fruit peels as sources of beneficial bioactive compounds, which can be used to develop new therapeutic agents. This in turn, confirm the importance of further research into the pharmacological potential of these tissues. Nowadays, few studies correlate chemical composition with pharmacological activity, which makes bioprospecting and chemical screening more relevant. Generally speaking, the issues that still need to be resolved in the near future are: 1) Obtaining and analyzing the metabolomic profile of tropical fruit peels; 2) Identifying the specific types of compounds present in the peels (i.e. not just the total content of their respective molecular classes); 3) Empirically correlating pharmacological activity with chemical composition; 4) Identifying the active compounds responsible for such activities; 5) Establishing environmentally-friendly methods of extraction and purification; 6) Standardizing the composition of extracts; and 7) Reaching Phase I of drug development. Such challenges must be adequately addressed by future studies aiming to characterize the chemical and pharmacological potential of tropical fruit peels. Ideally, this should also include molecular labeling data to permit the creation of biological parameters that are specific for the species being studied.

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References

Abdelmalek, S., E. Mohsen, A. Awwad and R. Issa. 2016. Peels of *Psidium guajava* fruit possess antimicrobial properties. *Int. Arab. J. Antimicrob. Agents*, 6(3): 1-9. DOI: 10.3823/791.

Ahmad, S., M.A. Sukari, N. Ismail, I.S. Ismail, A.B. Abdul, M.F.A. Bakar, N. Kifli and G.C. Ee. 2015. Gwendoline CLE: Phytochemicals from *Mangifera pajang* Kosterm and their biological activities. *BMC Complem. Altern. Med.,* 15(83): 1-8. DOI: 10.1186/s12906-015-0594-7.

Aktar, K. and T. Foyzun. 2017. Phytochemistry and pharmacological studies of *Citrus macroptera*: A medicinal plant review. *J. Evid. Based Complem. Altern. Med.,* 2017: 1-7. DOI: 10.1155/2017/9789802.

Alcántar-Ramírez, O.Y., E. Sauri-Duch, J.A. Mendoza-Espinoza, L.J. Pérez-Flores and M.C. Fragoso-Serrano. 2018. Análisis de la actividad citotóxica de *Annona squamosa* L. y *Chrysophyllum cainito* L. sobre líneas celulares cancerosas. In*:* La Homeopatía Hoy. Universidad Autónoma de Chapingo, CDMX, pp. 29-33.

Ali, R., M.J. Yong, R. Gyawali, A. Mosaddik, Y.Ch. Ryu and S.K. Cho. 2012. Mango (*Mangifera indica* L.) peel extracts inhibit proliferation of hela human cervical carcinoma cell via induction of apoptosis. *J. Kor. Soc. Appl. Biol. Chem.*, 55: 397-405. DOI: 10.1007/s13765-012-1024-x.

Alim, A., T. Li, T. Nisar, D. Ren, X. Zhai, Y. Pang and X. Yang. 2019. Antioxidant, antimicrobial, and antiproliferative activity-based comparative study of peel and flesh polyphenols from Actinidia chinensis. *Food. Nutr. Res.*, 63(1577): 1-10.

Amutha, R., T. Kavusik and A. Sudha. 2017. Analysis of bioactive compounds in *Citrus* fruit peels. *Int. J. Sci. Res*., 6(12): 19-27.

Angulo-López, J.E., A.C. Flores-Gallegos, C. Torres-León, K.N. Ramírez-Guzmán, G.A. Martínez and C.N. Aguilar. 2021. Guava (*Psidium guajava* L.) fruit and valorization of industrialization by-products. *Processes,* 9(1075): 1-17. DOI: 10.3390/pr9061075.

Anjum, V., S.H. Ansari, K.J. Naquvi, P. Arora and A. Ahmad. 2013. Development of quality standards of *Carica Papaya* Linn. leaves. *Pharm Lett.,* 5(2): 370-376.

Azizan, A., L.A. Xin, N.A. Abdul-Hamid, M. Maulidiani, A. Mediani, S.Z. Abdul-Ghafar, N.K. Zulaikha-Zolkeflee and F. Abas. 2020. Potentially bioactive metabolites from pineapple waste extracts and their antioxidant and α-glucosidase inhibitory activities by 1H NMR. *Foods,* 9(173): 1-20. DOI: 10.3390/foods9020173.

Barbalho, M., F.M.V. Farinazzi-Machado, R.A. Goulart, A.C. Saad-Brunnati, A.M.M. Bueno-Ottoboni and C.C. Teixeira-Nicolau. 2012. *Psidium guajava* (Guava): A plant of multipurpose medicinal applications. *Med. Aromat. Plants,* 1(4): 1-6. DOI: 10.4172/2167-0412.1000104.

Basri, D.F., M.A.A.R. Mohd, C.K. Meng, E.S. Latif and F.Z. Huyop. 2014a. Cytotoxic activity of stem bark extracts from *Canarium odontophyllum* Miq (Dabai) against human colorectal carcinoma HCT116 cell line. *Amer. J. Plant Sci.,* 5: 3925-3933. DOI: 10.4236/ajps.2014.526411.

Basri, D.F., S. FairuzIshak and N.M. Zin. 2014b. Shell extract of seed from *Canarium odontophyllum* Miq. (Dabai) fruit as potential source of antibacterial agent. *Int. J. Pharm. Sci. Rev. Res.*, 28*(*2): 257-262.

Bazílio-Omena, C.M., V. Lara-Barros, S.G. Glaucevane da, L.A. Rabelo, C.M. Mano, E.J. Henriques-Bechara, A.C.H.F. Sawaya, M.T. Salles-Trevisan, J. Gomes da Costa, R.C. Silva-Ferreira, A.E. Goulart-Sant'Ana and M.O. Fonseca-Goulart. 2012. Antioxidant, anti-acetylcholinesterase and cytotoxic activities of ethanol extracts of peel, pulp and seeds of exotic Brazilian fruits: Antioxidant, anti-acetylcholinesterase and cytotoxic activities in fruits. *Food. Res. Int.*, 49: 334-344. DOI: 10.1016/j.foodres. 2012.07.010.

Benguiar, R., I. Yahla, R. Benaraba, S. Bouamar and A. Riazi1. 2020. Phytochemical analysis, antibacterial and antioxidant activities of pomegranate (*Punica granatum* L.) peel extracts. *Int. J. Biosci.*, 16(6): 35-44. DOI: 10.12692/ijb/ 16.6.35-44.

Blancke, R. 2016. *Tropical fruits and other edible plants of the world*. Cornell University Press: London.

Bystrom, L.M. 2012. The potential health effects of *Melicoccus bijugatus* Jacq. Fruits: Phytochemical, chemotaxonomic and ethnobotanial investigations. *Fitoterapia.*, 83(2): 266-271. DOI: 10.1016/j.fitote.2011.11.018.

Chaouch, M.A. and S. Benvenuti. 2020. The role of fruit by-products as bioactive compounds for intestinal health. *Foods (Basel, Switzerland)*, 9(11): 1716. DOI: 10.3390/ foods9111716.

Chaudhari, S.Y., G. Ruknuddin and P. Prajapati. 2016. Ethno medicinal values of *Citrus genus*: A review. *Med. J. DY, Patil, Univ.,* 9: 560-565. DOI: 10.4103/0975-2870.192146.

Chavan, S.S., P.B. Shamkuwar, M.G. Damale and D.P. Pawar. 2014. A comprehensive review on *Annona reticulata*. *I.J.P.S.R.*, 5(1): 45-50. DOI: 10.13040/IJPSR.0975-8232.5(1).45-50.

Chawla, H., M. Parle and M. Yadav. 2016. Medicinal potential and phytopharmacology of *Actnidia deleciosa*. *I.J.E.P*., 6(1): 20-25.

Chel-Guerrero, L.D., R. Gómez-Cansino, S.L. Guzmán-Gutiérrez, M.G. Campos-Lara, E. Saury-Duch, F. Días de León Sánchez, R. Reyes-Chilpa and J.A. Mendoza-Espinoza. 2018b. *In vitro* antiviral activity and phytochemical screen in the extracts of peels from four species of tropical fruits collected in Merida Yucatan, Mexico. *Phyton-Int. J. Exp. Bot.,* 87: 4-11.

Chel-Guerrero, LD., E. Sauri-Duch, C.M. Fragoso-Serrano, L.J. Pérez-Flores, J.L. Gómez-Olivares, N. Salinas-Arreortua, E. Sierra-Palacios and J.A. Mendoza-Espinoza. 2018a. Phytochemical profile, toxicity and pharmacological properties of tropical fruit peels using *In vivo* e *In vitro* models. *J. Med. Food*., 21(7): 734-743. DOI: 10.1089/ jmf.2017.0124.

Chen, J., C. Liao, X. Ouyang, I. Kahramanog˘lu, Y. Gan and M. Li. 2020. Antimicrobial activity of pomegranate peel and its applications on food preservation. *J. Food. Qual*., 8850339: 1-8, DOI: 10.1155/2020/8850339.

Crane, J.H. and C.F. Balerdi. 2016. Mamoncillo (*Genip*) growing in the Florida home Landscape. Available at https://edis.ifas.ufl.edu/pdffiles/HS/HS31000.pdf (accessed 17 January 2016).

Czech, A., A. Malik, B. Sosnowska and P. Domaradzki. 2021. Bioactive substances, heavy metals, and antioxidant activity in whole fruit, peel, and pulp of *Citru*s fruits. *Int. J. Food Sci*., 2021(6662259): 1-14. DOI: 10.1155/2021/6662259.

Da Conceicao, A.O., M.H. Rossi, F. Faustino de Oliveira, L. Takser and J. Lafond. 2011. *Genipa americana* (*Rubiaceae*) fruit extract affects mitogen-activated protein kinase cell pathways in human trophoblast–derived bewo cells: implications for placental development. *J. Med. Food.*, 14(5): 483-494.

Dada, F.A., F.O. Nzewuji, A.M. Esan, S.I. Oyeleye and V.B. Adegbola. 2016. Phytochemical and antioxidant analysis of aqueous extracts of unripe pawpaw (*Carica papaya* Linn.) fruit's peel and seed. *I.J.R.R.A.S.,* 27(3): 68-71.

Dahham, S.S., M.T. Agha, I.M. Tabana and A.M.S. Abdul-Majid. 2015. Antioxidant activities and anticancer screening of extracts from banana fruit (*Musa sapientum*). *A.J.C.R.*, 8(2): 28-34. DOI: 10.5829/idosi.ajcr.2015.8.2.95162.

Deng, G.F., Ch. Shen, X.R. Xu, R.D. Kuang, Y.J. Guo, L.S. Zeng, L.L. Gao, X. Lin, J.F. Xie, E.Q. Xia, Sh. Li, Sh. Wu, F. Chen, W.H. Ling and H.B. Li. 2012. Potential of fruit wastes as natural resources of bioactive compounds. *Int. J. Mol. Sci.*, 13: 8308-8323. DOI: 10.3390/ ijms13078308.

Dixit, Y. and A. Kar. 2010. Protective role of three vegetable peels in alloxan induced diabetes mellitus in male mice. *Plant. Foods. Hum. Nutr.*, 65: 284 -289. DOI: 10.1007/s11130-010-0175-3.

Doan, H.V. and T.P. Le. 2020. *Chrysophyllum cainito*: A Tropical Fruit with Multiple Health Benefits. *J Evid Based. Complementary. Altern. Med.,* 2020(7259267): 1-9. DOI: 10.1155/2020/7259267.

Duda-Chodak, A. and T. Tarko. 2007. Antioxidant properties of different fruit seeds and peels. *Acta Sci. Pol. Technol. Aliment.*, 6(3): 29-36.

Ehiowemwenguan, G. and A.O. Emoghene. 2014. Inetianbor JE: Antibacterial and phytochemical analysis of banana fruit peel. *I.O.S.R.P.H.R.*, 4(8): 18-25.

Enwa, F.O., M. Oghenejobo, O.A. Clement and R.A. Ayeh. 2016. Antibacterial screening of the ethanol and aqueous extract of the fruit peel of *Persea americana* Mill against selected enteric bacteria. *A.J.M.R.,* 4(3): 40-46. DOI: 10.15413/ajmr.2015.0109.

Faustino, M., M. Veiga, P. Sousa, E.M. Costa, S. Silva and M. Pintado. 2019. Agro-food byproducts as a new source of natural food additives. *Molecules. (Basel, Switzerland)*, 24(6): 1-23. DOI: 10.3390/molecules24061056.

Fawole, O.A, N.P. Makunga and U.L. Opara. 2012. Antibacterial, antioxidant and tyrosinase-inhibition activities of pomegranate fruit peel methanolic extract. *BMC. Complement. Altern. Med.*, 12(200): 1-11. DOI: 10.1186/1472-6882-12-200.

Fierascu, R.C., E. Sieniawska, A. Ortan, I. Fierascu and J. Xiao. 2020. Fruits by-products - A source of valuable active principles. A short review. *Front. Bioeng. Biotechnol*., 8(319): 1-8. DOI: 10.3389/fbioe.2020.00319.

Figueroa, J.G., I. Borrás-Linares, R. del Pino-García, J.A. Curiel, J. Lozano-Sánchez and A. Segura-Carretero. 2021. Functional ingredient from avocado peel: Microwave-assisted extraction, characterization and potential applications for the food industry. *Food. Chem*., 352(129300): 1-13.

Fila, W.O., J.T. Johnson, P.N. Edem, M.O. Odey, V.S. Ekam, U.P. Ujong and O.E. Eteng. 2012. Comparative anti-nutrients assessment of pulp, seed and rind of rambutan (*Nephelium lappaceum*). *Ann. Biol. Res.*, 3(11): 5151-5156.

Foong, F.H.N., A. Mohammad and S.J. Arief-Ichwan. 2015. Biological properties of cucumber (*Cucumis sativus* L.) extracts (Sifat-Sifat Biologi Ekstrak Timun (*Cucumis sativus* L.). *M.J.A.S.*, 19(6): 1218-1222.

Foujdar, R., M. Bandhu-Bera and H.K. Chopra. 2020. Optimization of process variables of probe ultrasonic-assisted extraction of phenolic compounds from the peel of *Punica granatum* Var. Bhagwa and it's chemical and bioactivity characterization. *J. Food Process. Preserv*., 44(1): e14317. DOI: 10.1111/jfpp.14317.

Gajalakshmi, S., R. Divya, V. Divya-Deepika, S. Mythili and A. Sathiavelu. 2011. Pharmacological activities of *Annona squamosa*: A review. *Int. J. Pharm. Sci. Rev. Res.,* 10(2): 24-29.

Ganoza-Yupanqui, M.L., A. Muñoz-Acevedo, R.O. Ybañez-Julca, E. Mantilla-Rodríguez, E. Zavala, S. Gajardo, M. Ríos, J. Benites and J.L. Martínez. 2021. Potential antioxidant effect of fruit peels for human use by 5 different methods. *Bol. Latinoam. Caribe. Plant. Med. Aromat*., 20(6): 611- 637 (2021). DOI: 10.37360/blacpma.21.20.6.44.

García, P., C. Fredes, I. Cea, J. Lozano-Sánchez, F.J. Leyva-Jiménez, P. Robert, C. Vergara and P. Jimenez. 2021. Recovery of bioactive compounds from pomegranate (*Punica granatum* L.) peel using pressurized liquid extraction. *Foods*, 10(203): 1-17. DOI: 10.3390/foods10020203.

Gupta, M., A. Wali, Anjali, S. Gupta and S.K. Annepu. 2018. Nutraceutical potential of guava. In: (Eds.): Mérillon, J.M. and K. Ramawat. *Bioactive Molecules in Food. Reference Series in Phytochemistry*, Springer, Cham, pp. 1-27. DOI: 10.1007/978-3-319-54528-8_85-1.

Haque, N., G. Sofi, W. Ali, M. Rashidand and M. Itrat. 2015. A comprehensive review of phytochemical and pharmacological profile of Anar (*Punica granatum* Linn): A heaven's fruit. *J. Ayu. Herb. Med.,* 1(1): 22-26.

Howell, A.B. and D.H. D'Souza. 2013. The pomegranate: effects on bacteria and viruses that influence human health. *J. Evid. Based. Complementary. Altern. Med., 2013:* 1-11. DOI: 10.1155/2013/606212.

Imam, M.Z. and S. Akter. 2011. *Musa paradisiaca* L. and *Musa sapientum* L.: A Phytochemical and Pharmacological Review. *J. Appl. Pharm. Sci.,* 1(5): 14-20. ISSN: 2231-3354.

Indhumathi, T., G. Sruthi and S. Mohandass. 2011. Comparative phytochemical analysis and free radical scavenging activiy in different extracts of peel and pulp of *Actinidia chinensis*. *Asian. J. Pharm. Clin. Res.,* 4(2): 96-99.

Ismail, T., P. Sestili and S. Akhtar. 2012. Pomegranate peel and fruit extracts: A review of potential anti-inflammatory and anti-infective effects. *J. Ethnopharmacol.,* 143: 397-405. DOI: 10.1016/j.jep.2012.07.004.

Issa, R.A., W.H. Talib and M. Habash. 2016. Phytochemical investigation and antimicrobial activities of jordanian *Psidium guajava* raw fruit peel extract using Soxhlet and microwave extraction methods. *Res. J. Med. Plants*., 10(8): 443-449. DOI: 10.3923/rjmp.2016.443.449.

Jahurul, M.H.A., I.S.M. Zaidul, K. Ghafoor, F.Y. Al-Juhaimi, K.L. Nyam, N.A.N. Norulaini, F. Sahena and A.K. Mohd-Omar. 2015. Mango (*Mangifera indica* L.) by-products and their valuable components: A review. *Food. Chem.,* 183: 173-180. DOI: 10.1016/ j.foodchem.2015.03.046.

Jiménez, V.M., E. Mora-Newcomer and M.V. Gutiérrez-Soto. 2014. Biology of the papaya plant. In: (Eds.): Ming, R. and P.H. Moore. *Genetics and Genomics of Papaya*. Springer, New York, pp. 17-33.

John, K.M.M., A.A. Bhagwat and D.L. Luthria. 2017. Swarm motility inhibitory and antioxidant activities of pomegranate peel processed under three drying conditions. *Food. Chem.*, 235: 145-153. DOI: 10.1016/j.foodchem.2017.04.143.

John, S., S. Priyadarshini, J.M. Sarah, C. Sivaraj and P. Arumugam. 2018. *In vitro* antioxidant and antimicrobial properties of *Cucumis sativus* L. peel extracts. *Int. Res. J. Pharm*., 9(1): 56-60. DOI: 10.7897/2230-8407.0918.

Kaladhar, D., G.R. Duddukuri and N.S. Yarla. 2015. Phytochemical analysis, antioxidant and antimicrobial activities from raw fruit peel crude extracts of *Annona squamosa* Linn. *World. J. Pharm. Pharm. Sci*., 4(1): 1-9.

Karim, S., H.M. Alkreathy, A. Ahmad and M.I. Khan. 2020. Effects of methanolic extract based-gel from Saudi pomegranate peels with enhanced healing potential on excision wounds in diabetic rats. *Front. Pharmacol*., 12: 1-12. DOI: 10.3389/fphar.2021.704503.

Kehlenbeck, K., E. Asaah and R. Jamnadass. 2013. Diversity of indigenous fruit trees and their contribution to nutrition and livelihoods in sub-Saharan Africa: Examples from Kenya and Cameroon. In: (Eds.): Fanzo, J., D. Hunter, T. Borelli and F. Mattei. *Diversifying Food and Diets: Using Agricultural Biodiversity to Improve Nutrition and Health*. Routledge, New York pp. 257-269. ISBN: 9781849714563.

Khare, C.P. 2007. Indian Medicinal Plants. An Illustrated Dictionary. Springer-Verlag, Berlin. pp. 396-397. ISBN: 978-0-387-70637-5.

Kibria, A.A., Kamrunnessa, M.M. Rahman and A. Kar. 2019. Extraction and evaluation of phytochemicals from banana peels (*Musa sapientum*) and banana plants (*Musa paradisiaca*). *M.J.H.R.*, 2(1): 22-26. DOI: 10.2478/mjhr-2019-0005.

Kim, H., J.I Moon, H. Kim, D.S. Lee, M. Cho, H.K. Choi, Y.S. Kim, A. Mosaddik and S.K. Cho. 2010. Antioxidant and antiproliferative activities of mango (*Mangifera indica* L.) flesh and peel. *Food. Chem.,* 121: 429-436. DOI: 10.1016/j.foodchem.2009.12.060.

Klimek-Szczykutowicz, M., A. Szopa and H. Ekiert. 2020. *Citrus limon* (Lemon) phenomenon-A review of the chemistry, pharmacological properties, applications in the modern pharmaceutical, food, and cosmetics industries, and biotechnological studies. *Plants (Basel, Switzerland)*, 9(1): 1-24. DOI: 10.3390/plants9010119.

Knödler, M., J. Conrad, E.M. Wenzig, R. Bauer, M. Lacorn, U. Beifuss, R. Carle and A. Schieber. 2008. Anti-inflammatory 5-(11'Z-heptadecenyl)- and 5-(8'Z,11'Z-heptadecadienyl) originate resorcinols from mango (*Mangifera indica* L.) peels. *Phytochemistry,* 69: 988-993. DOI: 10.1016/j.phytochem.2007.10.013.

Kumar, M., N.K. Randhava and S. Devi. 2014. Acetylcholinesterase inhibition and phyto-constituents. Mini-Review. *R.I.P.,* 4(4): 8-15.

Kumoro, A.C., M. Alhanif and D.H. Wardhani. 2020. A critical review on tropical fruits seeds as prospective sources of nutritional and bioactive compounds for functional foods development: A case of indonesian exotic fruits. *Int. J. Food. Sci*., 2020: 1-15. DOI: 10.1155/2020/4051475.

Lagha-Benamrouche, S. and K. Madani. 2013. Phenolic contents and antioxidant activity of orange varieties (*Citrus sinensis* L. and *Citrus aurantium* L.) cultivated in Algeria: Peels and leaves. *Ind. Crops. Prod.,* 50: 723-730. DOI: 10.1016/ j.indcrop.2013.07.048.

Lavanya, K., G.A. Beaulah and G. Vani. 2016. *Musa paradisiaca* – A review on phytochemistry and pharmacology. *W.J.P.M.R.,* 2(6): 163-173. ISSN 2455-3301.

Lawal, D. 2013. Medicinal, pharmacological and phytochemical potentials of *Annona comosus* Linn. peel: A review. *Bajopas.,* 6(1): 101-104. DOI: 10.4314/bajopas.v6i1.21.

Li, L., J. Xu, Y. Mu, L. Han, R. Liu, Y. Cai and X. Huang. 2015. Chemical characterization and antihyperglycaemic effects of polyphenol enriched longan (*Dimocarpus longan* Lour.) pericarp extracts. *J. Funct. Foods,* 13: 314-322. DOI: 10.1016/j.jff.2015.01.006.

Liu, X., X. Yan, J. Bi, J. Liu, M. Zhou, X. Wu and Q. Chen. 2018. Determination of phenolic compounds and antioxidant activities from peel, flesh, seed of guava (*Psidium guajava* L.). *Electrophoresis.,* 39(13): 1654-1662. DOI: 10.1002/elps.201700479.

Lucas, J.S.A., S.A. Lewis and J.O.B. Hourihane. 2003. Kiwifruit allergy: A review. *Pediatr. Allergy Immunol.,* 14: 420-428.

Mabberley, D.J. 2004. *Citrus* (Rutaceae): A review of recent advances in etymology, systematics and medical applications. *Blumea.,* 49: 481-498. DOI: 10.3767/ 000651904X484432.

Machado-Brêtas, J., D. Beltrão-Pereira, I. Costa-César and G.A. Pianetti. 2020. "Miniaturized spectrophotometric method for quantification of tannins in pomegranate (*Punica granatum* L.) fruit peel dried extracts", *Curr. Anal. Chem*., 16(3): 321-331. DOI: 10.2174/1573411015666181204115035.

Madhuri, S., A.U. Hegde, N.S. Srilakshmi and T.R. Prashith-Kekuda. 2014. Antimicrobial activity of *Citrus sinensis* and *Citrus aurantium* peel extracts. *J.P.S.I.,* 3(4): 366-368 DOI: 10.7897/2277-4572.034174.

Majeed, H., H. N. Bhatti and I. A. Bhatti. 2019. Replacement of sodium alginate polymer, urea and sodium bicarbonate in the conventional reactive printing of cellulosic cotton. *J. Polym Eng*., 39(7): 661-670. DOI: 10.1515/polyeng-2019-0076.

Magangana, T.P. N. Pearl-Makunga, O. Amos-Fawole and U. Linus-Opara. 2020. Processing factors affecting the phytochemical and nutritional properties of pomegranate (*Punica granatum* L.) peel waste: A review. *Molecules.,* 25(4690): 1-34. DOI: 10.3390/molecules25204690.

Manodeep, C., G. Dipak, P. Axay and K. Jagdish. 2012. Phytochemical and pharmacological profile of *Punica granatum*: An overview. *I.R.J.P.,* 3(2): 65-68.

Masibo, M. and Q. He. 2009. Mango bioactive compounds and related nutraceutical properties-A review. *Food. Rev. Int.,* 25(4): 346-370. DOI: 10.1080/87559120903153524.

Masud-Parvez, G.M. 2016. Pharmacological activities of mango (*Mangifera Indica*): A review. *J. Pharmacog. Phytochem.,* 5(3): 1-7.

Mendes dos Santos, C., C.M. Patto de Abreu, J. Mesquita-Freire, E.de Rezende-Queiroz and M. Mendes-Mendonça. 2014. Chemical characterization of the flour of peel and seed from two papaya cultivars. *Food. Sci. Technol. Campinas.,* 34(2): 353-357. DOI: 10.1590/fst.2014.0048.

Mishra, R., P. Tiwari, M. Srivastava, C.S. Singh and S. Ghoshal. 2017. A comprehensive review on *Psidium guajava* Linn (Amaratafalam). *J. Ethnobiol. Ethnomed.,* 4(1): 1-6.

Montero-Calderon, A., C. Cortes, A. Zulueta, A. Frigola and M.J. Esteve. 2019. Green solvents and ultrasound-assisted extraction of bioactive orange (*Citrus sinensis*) peel compounds. *Sci. Rep*., 9(16120): 1-8. DOI: 10.1038/s41598-019-52717-1.

Moo-Huchin, V.M., M.I. Moo-Huchin, R.J. Estrada-León, L. Cuevas-Glory, I. Estrada, E. Ortíz-Vázquez, D. Betancur and E. Sauri. 2015. Antioxidant compounds, antioxidant activity and phenolic content in peel from three tropical fruits from Yucatan, Mexico. *Food. Chem*. 166: 17-22. DOI: 10.1016/j.foodchem.2014.05.127.

More, P.R. and S.S. Arya. 2021. Intensification of bio-actives extraction from pomegranate peel using pulsed ultrasound: Effect of factors, correlation, optimization and antioxidant bioactivities. *Ultrason. Sonochem*., 72(105423): 1-15. DOI: 10.1016/j.ultsonch.2020.105423.

Morton, J. 1987. Sugar apple, custard apple, star apple, mamoncillo. In*:* (Ed.): Dowling, C.F. *Fruits of Warm Climates*, Creative Resource Systems Inc, Florida, pp. 267-269, 408-410.

Motohashi, N., Y. Shirataki, M. Kawase, S. Tani, S., H. Sakagami, K. Satoh, T. Kurihara, H. Nakashima, K. Wolfard, C. Miskolci and J. Molnár. 2001. Biological activity of kiwifruit peel extracts. *Phytother. Res.,* 15: 337-343. DOI: 10.1002/ptr.876.

Mphahlele, R.R., O.A. Fawole, N.P. Makunga and U.L. Opara. 2016. Effect of drying on the bioactive compounds, antioxidant, antibacterial and antityrosinase activities of pomegranate peel. *BMC Complemt. Altern. Med.,* 16(143): 1-12. DOI: 10.1186/s12906-016-1132-y.

Muhtadi, H., H. Haryoto, T. Azizah, A. Suhendi and K.H. Yen. 2015. Antidiabetic and antihypercholesterolemic activities of *Citrus sinensis* peel: *In vivo* study. *Natl. J. Physiol. Pharm. Pharmacol.,* 5(5): 382-385. DOI: 10.5455/njppp. 2015.5.280720 1561.

Mukherjee, P.K., N.K. Nema, N. Maity and B.K. Sarkar. 2013. Phytochemical and therapeutic potential of cucumber. *Fitoterapia.,* 84: 227-236. DOI: 10.1016/j.fitote.2012.10.003.

Natesan, G., J.S. Justin and A. Milton. 2014. Phytochemical evaluation of peel of *Cittrus reticulata* blanco using various solvent extracts. *I.J.P.S.B.M.,* 2(9): 26-35.

Náthia-Neves, G., A.G. Tarone, M.M. Tosi, M.R. Maróstica-Júnior and M.A.A. Meireles. 2017. Extraction of bioactive compounds from genipap (*Genipa americana* L.) by pressurized ethanol: Iridoids, phenolic content and antioxidant activity. *Food. Res. Int.,* 102: 595-604. DOI: 10.1016/j.foodres.2017.09.041.

Newman, D.J. and G.M. Cragg. 2020. Natural products as sources of new drugs over the nearly four decades from 01/1981 to 09/2019. *J. Nat. Prod.,* 83: 770-803. DOI: 10.1021/acs.jnatprod.9b01285.

Nieto, G., J. Fernández-López, J.A. Pérez-Álvarez, R. Peñalver, G. Ros and M. Viuda-Martos. 2021. Valorization of *Citrus* co-products: recovery of bioactive compounds and application in meat and meat products. *Plants*, 10(1069): 1-22. DOI: 10.3390/plants10061069.

Nongalleima, K., T. Ajungla and Ch.B. Singh. 2017. Determination of antioxidant activity and simultaneous RP-HPLC analysis of quercetin, rutin and kaempferol in *Citrus macroptera* Montruz. *J. Pharmacog. Phytochem.,* 6(3): 474-478.

Oikeh, E.I., K. Oriakhi and E.S. Omoregie. 2013. Proximate analysis and phytochemical screening of *Citrus sinensis* fruit wastes. *The Biosci.,* 1(2): 164-170.

Ojewole, J.A.O. and G.J. Amabeoku. 2006. Anticonvulsant effect of *Persea americana* Mill (Lauraceae) (avocado) leaf aqueous extract in mice. *Phytother. Res.,* 20: 696-700. DOI: 10.1002/ptr.1940.

Oyeyinka, B.O. and B.A. Jide-Afolayan. 2020a. Potentials of *Musa* species fruits against oxidative stress-induced and diet-linked chronic diseases: *In vitro* and *In vivo* implications of micronutritional factors and dietary secondar metabolite compounds. *Molecules.,* 25(5036): 1-30. DOI: 10.3390/molecules25215036.

Oyeyinka, B.O. and B.A. Jide-Afolayan. 2020b. Comparative and correlational evaluation of the phytochemical constituents and antioxidant activity of *Musa sinensis* L. and *Musa paradisiaca* L. fruit compartments (Musaceae). *Sci. World J*., 2020(4503824): 1-12. DOI: 10.1155/2020/4503824.

Panara, K., K. Joshi and K. Nishteswar. 2012. A review on phytochemical and pharmacological properties of *Citrus medica* Linn. *I.J.P.B.A.,* 3(6): 1292-1297.

Peršurić, Z., L.S. Martinović, M. Malenica, I. Gobin, S. Pedisić, V. Dragović-Uzelac and S. Kraljević-Pavelić. 2020. Assessment of the biological activity and phenolic composition of ethanol extracts of pomegranate (*Punica granatum* L.) peels. *Molecules*, 25(24): 1-13. DOI: 10.3390/molecules25245916.

Phuong, N.N.M., T.T. Le, J. Van-Camp and K. Raes. 2020. Evaluation of antimicrobial activity of rambutan (*Nephelium lappaceum* L.) peel extracts. *Int J Food Microbiol*., 16(321): 108539. DOI: 10.1016/j.ijfoodmicro.2020.108539. Epub 2020 Jan 27. PMID: 32062528.

Putta, S. and Kilari, E.K. 2015. A review on fruit pericarp a rich source of phytochemicals and pharmacological activities. *I.J.P.P.R.,* 7(5), 960-966.

Rafiq, S., R. Kaul, S.A. Sofi, N. Bashir, F. Nazir and G.A. Nayik. 2018. *Citrus* peel as a source of functional ingredient: A review. *J. Saudi Soc. Agric. Sci*., 17(4): 351-358. DOI: 10.1016/j.jssas.2016.07.006.

Rai, P.K., D. Jaiswal, S. Meht and G. Watal. 2009. Anti-hyperglycaemic potential of *Psidium guajava* raw fruit peel. *Ind. J. Med Res.,* 129(5): 561-565.

Rai, P.K., S. Mehta and G. Watal. 2010. Hypolipidaemic & hepatoprotective effects of *Psidium guajava* raw fruit peel in experimental diabetes. *Ind. J. Med. Res.,* 131: 820-824.

Rajendra, P., J. Sapna, J., Shraddha and A. Kumar. 2012. Properties and therapeutic application of bromelain: A review. *Biotechnol. Res. Int., 2012:*1-6. DOI: 10.1155/2012/976203.

Rakariyatham, K., D. Zhou, N. Rakariyatham and F. Shahidi. 2020. Sapindaceae (*Dimocarpus longan* and *Nephelium lappaceum*) seed and peel by-products: Potential sources for phenolic compounds and use as functional ingredients in food and health applications. *J. Funct. Foods*, 67: 103846. DOI: 10.1016/j.jff.2020.103846.

Rangkadilok, N., L. Worasuttayangkurn, R.N. Bennett and J. Satayavivad. 2005. Identification and quantification of polyphenolic compounds in Longan (*Euphoria longana* Lam.) fruit. *J. Agric. Food Chem.,* 53(5): 1387-1392. DOI: 10.1021/jf0403484.

Rashad, M.M., A.E. Mahmoud, M.M. Ali, M.U. Nooman and A.S. Al-Kashef. 2015. Antioxidant and anticancer agents produced from pineapple waste by solid state fermentation. *I.J.T.P.R.,* 7(6): 287-296.

Ripaa, F.A., P.R. Dasha, M.L. Nesaband and Z. Sheikh. 2015. Phytochemical and hypoglycemic screening of seeds and peel of *Nephelium Longan Fruits. Photon.,* 197: 483-489.

Rivera-Arce, E., M.A. Chávez-Soto, M. Gattuso and X. Lozoya-Legorreta. 2003. La hoja de guayabo en el tratamiento de afecciones gastrointestinales. *Rev. de Fitoter.,* 3(2): 101-111.

Rodríguez-Carpena, J.G., D. Morcuende, M.J. Andrade, P. Kylli and M. Estévez. 2011. Avocado (*Persea americana* Mill.) phenolics, *In vitro* antioxidant and antimicrobial activities, and inhibition of lipid and protein oxidation in porcine patties. *J. Agric. Food Chem.,* 59: 5625-5635. DOI: 10.1021/jf1048832.

Rodríguez-López, C.E., C. Hernández-Brenes and R.I. Diaz-de la Garza. 2015. A targeted metabolomics approach to characterize acetogenin profiles in avocado fruit (*Persea americana* Mill.). *R.S.C. Adv.,* 5(128): 106019-106029. DOI: 10.1039/C5RA22854A.

Roser, J.C., S. Cruz, C. Osorio and N. Hurtado. 2019. Analysis of phenolic composition of byproducts (seeds and peels) of avocado (*Persea americana* Mill.) cultivated in Colombia. *Molecules.*, 24(3209): 1-17. DOI: 10.3390/ molecules 24173209.

Ross, I.A. 2001. *Musa sapientum* L. In*: Medicinal Plants of the World. Chemical Constituents, Traditional and Modern Uses*. Vol. 2. Humana Press Inc., New Jersey, pp.319-332. ISBN 978-1-4684-9706-9.

Safdar, M.N., T. Kausar, S. Jabbar, A. Mumtaz, K. Ahad and A.A. Saddozai. 2017. Extraction and quantification of polyphenols from kinnow (*Citrus reticulate* L.) peel using ultrasound and maceration techniques. *J. Food. Drug. Anal.,* 25: 488-500. DOI: 10.1016/j.jfda.2016.07.010.

Salahuddin-Mirfat, A.H., I. Amin, K.N. Kartinee, H. Muhajir and M.A. Mohd-Shukri. 2018. Underutilised fruits: a review of phytochemistry and biological properties. *J. Food Bioact.,* 1: 2-30.

Salazar-López, N.J., J.A. Domínguez-Avila, E.M. Yahia, B.H. Belmonte-Herrera, A. Wall-Medrano, E. Montalvo-González and G.A. González-Aguilar. 2020. Avocado fruit and by-products as potential sources of bioactive compounds. *Food. Res. Int*., 138(A): 109774. DOI: 10.1016/j.foodres.2020.109774.

Sanda, K.A., H.A. Grema, Y.A. Geidam and Y.M. Bukar-Kolo. 2011. Pharmacological aspects of *Psidium guajava*: An update. *Int. J. Pharm.,* 7(3): 316-324. DOI: 10.3923/ijp.2011.316.324.

Sangeetha, R. and A. Jayaprakash. 2015. Phytochemical screening of *Punica granatum* Linn. peel extracts. *J.A.I.R.,* 4(5): 160-162.

Santoshkumar-Jayagoudar, S.G. Ghane, P. Bhat, A. Konage, A. Hiremath, M. Rathod, M. Manakikar, R. Hiremath, R. Athani, S. Maragannavar, V. Chavan and H.V. Hegde. 2020. Isolation and characterization of volatile oil constituents from fruit peels of selected Rutaceae genotypes from India. *J. Essent. Oil-Bear. Plants*. 23(5): 998-1011. DOI: 10.1080/0972060X.2020.1829996.

Segura-Ledesma, S., D. Zavala-Robles, C. Equihua-Cervantes, J.A. Agustín and E. Yepez-Torres. 2009. Los recursos genéticos de frutales en Michoacán. *Rev. Chapingo Ser. Hortic.*, 15(3): 297-305.

Shailajan, S. and D. Gurjar. 2014. Pharmacognostic and phytochemical evaluation of *Chrysophyllum cainito* Linn. leaves. *Int. J. Pharm. Sci. Rev. Res.,* 26(1): 106-111.

Sharma, A., A.K. Sharma, T. Chanda and M. Khardiya. 2013. Preliminary phytochemical screening of fruit peel extracts of *Annona squamosa* Linn. *Int. J. Curr. Pharm. Res.,* 4(1): 1038-1043.

Shehata, M.G., M.M. Abu-Serie, N.M.A. El-Aziz and S.A. El-Sohaimy. 2021. Nutritional, phytochemical, and *In vitro* anticancer potential of sugar apple (*Annona squamosa*) fruits. *Sci. Rep*., 11(6224): 1-13. DOI: 10.1038/s41598-021-85772-8.

Siddique, S., S. Nawaz, F. Muhammad, B. Akhtar and B. Aslam. 2017. Phytochemical screening and *in-vitro* evaluation of pharmacological activities of peels of *Musa sapientum* and *Carica papaya* fruit. *Nat. Prod. Res.,* 1-5. DOI: 10.1080/14786419.2017.1342089.

Sihombing, J.R., A. Dharma, Z. Chaidir, Almahdy, E. Fachrial and E. Munaf. 2015. Phytochemical screening and antioxidant activities of 31 fruit peel extract from Sumatera, Indonesia. *J. Chem. Pharm. Res.,* 7(11): 190-196.

Singh, B., J. Pal Singh, A. Kaur and N. Singh. 2020. Phenolic composition, antioxidant potential and health benefits of *Citrus* peel. *Food Res. Int*., 132(109114): 1-22. DOI: 10.1016/j.foodres.2020.109114.

Singh-Pal, R., V.A. Kumar, S. Arora, A.K. Sharma, V. Kumar and S. Agrawal. 2015. Physicochemical and antioxidant properties of kiwifruit as a function of cultivar and fruit harvested month. *Braz. Arch. Biol. Technol.,* 58(2): 262-271. DOI: 10.1590/S1516-8913201500371.

Smitha, G.S.R., B.Ch. Jyoti and K.K. Hemanth. 2017. *In vitro* anti-inflammatory and anti-arthritic activity in methanolic peel extracts of *Persea americana*. *W.J.P.L.S.,* 3(4): 195-199.

Smitha-Grace, S.R., J.B. Chauhan and C.R. Jain. 2015. Preliminary phytochemical investigation and TLC analysis of peel and seed extracts of *Persea americana*. *A.J.P.S.T.,* 5(3):167-171.

Solidum, J.N. 2012. Essential chemicals in selected fruit peels from Manila, Philippines. *I.P.C.B.E.E.*, 37: 30-34.

Sonia, N.S., C. Mini and P.R. Geethalekshmi. 2016. Vegetable peels as natural antioxidants for processed foods – A review. *Agric. Rev*., 37(1): 35-41. DOI: 10.18805/ar.v37i1.9262.

Sreekumar, S., H. Sithul, P. Muraleedharan, J.M. Azeez and S. Sreeharshan. 2014. Pomegranate fruit as a rich source of biologically active compounds. *Biomed. Res. Int.,* 2014: 1-12. DOI: 10.1155/2014/686921.

Sukmandari, N.S., G.K. Dash, W.H.W. Jusof and M. Hanafi. 2017. A Review on *Nephelium lappaceum* L. Research. *J. Pharm. and Tech.,* 10(8): 2819-2827. DOI: 10.5958/0974-360X.2017.00498.X.

Swanson, M.D., H.C. Winter, I.J. Goldstein and D.M. Markovitz. 2010. A lectin isolated from bananas is a potent inhibitor of HIV replication. *J. Biol. Chem.,* 285(12): 8646-8655. DOI: 10.1074/jbc.M109.034926.

Taktak, O., S.B. Youssef, M.A. Vian, F. Chemat and N. Allouche. 2021. Physical and chemical influences of different extraction techniques for essential oil recovery from *Citrus sinensis* peels. *J. Essent. Oil-Bear. Plants*., 24(2): 290-303, DOI: 10.1080/0972060X.2021.1925596.

Thaiponga, K., U. Boonprakoba, K. Crosby, L. Cisneros-Zevallos and D. Hawkins-Byrne. 2006. Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. *J. Food Compos. Anal.,* 19: 669-675. DOI: 10.1016/j.jfca.2006.01.003.

Thitilertdecha, N., A. Teerawutgulrag, J.D. Kilburn and N. Rakariyatham. 2010. Identification of major phenolic compounds from *Nephelium lappaceum* L. and their antioxidant activities. *Molecules,* 15: 1453-1465.

Tremocoldi, M.A., P.L. Rosalen, M. Franchin, A.P. Massarioli, C. Denny, E. Daiuto, J. Augusto, R. Pascho, P.M. Melo and S.M. de Alencar. 2018. Exploration of avocado by-products as natural sources of bioactive compounds. *PLoS. ONE*, 13(2): e0192577. https://doi.org/10.1371/journal.pone.0192577.

Undugodage-Dulanjali, R. and B.G. Kanchana-Perera. 2018. Important biological activities of papaya peel extracts and their importance in formulation of a low cost fish feed to enhance the skin colour and the healthiness of guppies. *I.J.S.R.P*., 8(12): 702-708.

Valli, M., M. Pivatto, A. Danuello, I. Castro-Gamboa, D.H. Siqueira-Silva, A.J. Cavalheiro, A.R. Araújo, M. Furlan, M.N. Lopes and V. da Silva-Bolzani. 2012. Tropical biodiversity: Has it been a potential source of secondary metabolites useful for medicinal chemistry? *Quim. Nova.,* 35(11): 2278-2287. DOI: 10.1590/S0100-40422012001100036.

Vijayalakshmi, P. and R. Radha. 2014. Anti-alzheimer activity of *Citrus maxima* (J. Burm.) Merr fruit peel extract in mice with scopolamine induced alzheimer's disease. *R.J.I.F.,* 1(4): 77-82.

Vijayalakshmi, P. and R. Radha. 2016. *In vitro* anti-alzheimer and anti oxidant activity of the peels of *Citrus maxima* fruits. *R.J.P.P.D.,* 8(1): 17-22. DOI: 10.5958/2321-5836.2016.00005.7.

Vílchez, J.B., R. Díaz-García, J. López-Vivar, S. Gajardo-Solari, F. Kush-Fuschlocher and M. Rojas-Arredondo. 2011. Actividad antioxidante y antibacteriana de seis cáscaras de frutos del oasis de Pica. *Biofarb.,* 19(1): 1-7.

Villacís-Chiriboga, J., K. Elst, J. Van-Camp, E. Vera and J. Ruales. 2020. Valorization of byproducts from tropical fruits: Extraction methodologies, applications, environmental, and economic assessment: A review (Part 1: General overview of the byproducts, traditional biorefinery practices, and possible applications). *Comp. Rev. Food Sci. Food Saf*., 19: 405-447. DOI: 10.1111/1541-4337.12542.

Vinha, A.F., J. Moreira and S.V.P. Barreira. 2013. Physicochemical parameters, phytochemical composition and antioxidant activity of the algarvian avocado (*Persea americana* Mill.). *J. Agric. Sci.,* 5(12): 100-109. DOI: 10.5539/jas.v5n12p100.

Wang, F., Y.H. Chen, Y.J. Zhang, G.F. Deng, Z.F. Zou, A.N. Li, D.P. Xu and H.B. Li. 2014. Chemical components and bioactivities of *Psidium guajava*. *I.J.F.N.S.,* 5(2): 98-114.

Xuan, Ch. and T.A. Azlana. 2016. Nutritional, phytochemical and pharmacological properties of *Canarium odontophyllum* Miq. (Dabai) fruit. *P.J.S.R.R*., 2(1): 80-94.

Yasir, M., S. Das and M.D. Kharya. 2010. The phytochemical and pharmacological profile of *Persea americana* Mill. *Pharmacogn. Rev.,* 4(7): 77-84. DOI: 10.4103/0973-7847.65332.

Yogiraj, V., P.K. Goyal and C.S. Chauhan, A. Goyal and B. Vyas. 2014. *Carica papaya* Linn: An overview. *J. Herb. Med.,* 2(5): 01-08.

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