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A review on *Grewia* genus as important source of medicinal substances

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Abstract
The plant *Grewia* genus belonging to the family Malvaceae. This genus includes multipurpose plant species which are the source of food, fodder, fiber, fuel wood, timber and a range of traditional medicines that cure various perilous diseases and have mild antibiotic properties. The plant preparations can be used for the treatment of bone fracture and for bone strengthening and tissue healing. The fruits are used for promoting fertility in females and are considered in special diets for pregnant women and anemic children. The plant is adapted to high temperatures and dry conditions and has deep roots which stabilize sand dunes. The shrubs play effectively for rehabilitation of wastelands. The plant parts are rich in amino acids and mineral elements and contain some pharmacologically active constituents. The plant is identified in trade for its fruits. Plants of this genus can be sold as wild species of medicinal and aromatic plant and is direct or indirect source of income for the tribal people. But the prolonged seed dormancy is a typical feature and vegetative propagation is not well characterized for the plant. Micropropagation by tissue culture techniques may play an effective role for plant conservation. The plant needs phytochemical and pharmacological investigations on a wider range which may have great scope in near future. Thus, efforts are needed to conserve, domesticate and cultivate the plant. This paper reviews the plant's medicinal aspects and chemical constituents, also provides brief information of plant bioprospecting and its manifest market values.

Keywords: *Grewia genus*, pharmacological activities, phytochemicals

Introduction
Grewia genus members are the most diverse and large flowering genus in the Malvaceae family, which are mostly shrub and small tree. The genus *Grewia* members are widely distributed all over the tropical and subtropical regions of the world, especially in Asia, Africa, Saudi Arabia, Yemen and Australia. *Grewia genus* are found in Asia, including India, Sri Lanka, and Pakistan. They are extensively cultivated for fruits and timber in the Asian countries. Every member can be used in various traditional herbal practices for the treatment of various disease conditions.
In our Gujarat, it is mostly found in abundance in semi -arid area of north Gujarat, including the forest of Balaram Ambaji.
The light green *Grewia genus* have beautiful, bright yellow, and sometimes fragrant flowers. It is a frost-resistant, hardy shrub or small tree that is adaptable to all soils, from clay to sand, and does not require much water. It makes a good screen for your bird garden.

Description
Grewia genus members are multi-stemmed shrubs or small trees, up to 5 m high. Its bark is dark grey-brown. The main stem is 4-angled and deeply grooved. The young branchlets have rough hairs and later become smooth. The leaves are alternate, oblanceolate, obovate or oblong-lanceolate, 40-120 x 20-85 mm, usually ± 70 x 30 mm, with apex pointed or with a drip tip. They are 3-veined from a rounded or lobed base, almost symmetric, light green, roughly hairy, particularly below, and the margin is irregularly serrate. The leaf stalk is up to 7 mm, with long hairs. The flowers are bright yellow, borne in axillary clusters of 3 on short stalks, and are sometimes fragrant. Their sepals are yellowish-green flushed with pink on the outside and yellow inside. The petals are yellow and about half the size of the sepals. The flowers have a central mass of yellow stamens. The fruits are single, shallowly 2-lobed, or occasionally 4-lobed; each lobe is 8-14 mm in diameter and shiny with rough white hairs. The flowering time is December-March

Fig 1

Origin & history
The genus *Grewia* was named after Nehemiah Grew (1641-1712), an English physician. Native of the plant is Africa. It is dominantly found in Asia and in India it is found in Delhi, Uttar Pradesh, Rajasthan, Bihar, and Gujarat. It is migrated from Africa.

Habitat
Grewia genus naturally occurs in open woodland and thicket. It is frequently associated with termite mounds, rocky koppies, riverine fringes and the margins of forests. It is widespread at medium to low altitudes, in temperate climates with moderate summer rainfall. Its distribution ranges from northern Kwa Zulu-Natal to tropical Africa, and India.

Ecology

The sandpaper raisin is often associated with termite mounds, rocky koppies and riverine fringes. Wild animals such as warthogs, antelopes and baboons, as well as birds, eat the fruits. The seeds that have passed through the stomach of these animals germinate rapidly, presumably due to the stomach acids that help to dissolve the tough seed coat.

Classification

Table 1

Kingdom	Plantae
Division	Phanerogams
Class	Dicotyledones
Sub-class	Polypetalae
Series	Thalamifloriae
Order	Malveles
Family	Malvaceae
Genus	*Grewia*

(According to Bentham and Hooker Classification System)

Common names

Sandpaper raisin, rough-leaved raisinbush, square-stemmed raisin (Eng.); skurweblaarrosyntjie (Afr.); mogwane (N. Sotho); loklolo (Swazi); nsihana, nciwana (Tsonga); mokgomphatha, motsotsojane, motuu (Tswana); mupharasheni (Venda); ilalanyathi (Zulu), Marathi: ***खटखटी*** Khatkhati Kannada: ***ಕರ್ಕಲ*** Karkala Hindi: ***चपरा*** Chapra, ***जर खैर*** Jar khair.

Phytochemicals

Alkaloids

n-Methyl microcosamine B, Microgrewiapine A, Microcosamine B, Homomicrogrewiapine, Harman, 6-Methoxyharman, 6-Hydroxyharman

[Meena *et al*. (2017) [40], Jaspers *et al*. (1986)

Flavonoids

Catechin, Epicatechin, 7-*O*-methylcatechin, Epigallocatechin, (-)- Epigallocatechin-7-*O*-glucuronide, Vitexin, Isovitexin, Apigenin-7-*O*-apiosylglucoside, Apigenin-7-*O*-rutinoside, Luteolin-4'-glucoside, 6-Hydroxyluteolin, 3-*O*-*β*-D-glucopyranosyl quercetin, Quercetin-3-*O*-xyloside, Quercetin-7-*O*-glucoside, Quercetin 3,7-di-*O*-glucoside, Quercetin-7-*O*-sophoroside, Quercetin-4'-*O*-glucoside, Quercetin-3-*O*-glucosyl-xyloside, Kaempferol-3-*O*-glucoside, Myricetin-3-*O*-arabinoside, Myricetin-3-*O*-rhamnoside, Myricetin-3-*O*-galactoside, Methylguanine, Rhamnetin, 7-Hydroxyflavanone, Liquiritigenin, Narirutin, Hesperetin-3'-*O*-glucuronide, Dihydroquercetin, Dihydroquercetin-3-*O*-hexoside, Petunidin, Cyanidin-3-*O*-arabinoside, Cyanidin-3-*O*-sambubioside, Cyanidin 3-galactoside, Delphinidin-3-*O*-arabinoside, Delphinidin-3-*O*-sambubioside, Delphinidin 3-*O*-glucoside, Peonidin 3-*O*- glucoside

[Talpur *et al*. (2017), Hidalgo *et al.* (2010), Xu *et al.* (2017), Koley *et al.* (2020), Montoro *et al.* (2006), Koley *et al.* (2020), Adisakwattana *et al.* (2009), Ullah *et al.*, (2012), Lee *et al.* (2013), Hwang *et al.* (2014), Rajan *et al.*, (2019), Sunil & Xu (2019), Chakraborty & Basu, (2017), Su *et al.* (2016); Qamar *et al.* (2020) [1], Mikell *et al.* (2012), Zahoor *et al.* (2020)]

Iso flavonoids

6-Aldehydoisoophiopogonone, Calycosin, Dihydrodaidzein-7-*O*-glucuronide, Genistein

[Qamar *et al.* (2020) [1], Koley *et al.* (2020), Li *et al.* (2020)]

Phenols and phenolic acids

Nitidanin, Bilagrewin, Cleomiscosin D, Grewialin, Grewin, Umbelliferone, 1,2,3 benzene triol, Syringaldehyde, Vidalenolone, 4-((1*E*)-3-Hydroxy-1-propenyl)-2-methoxyphenol, Coniferaldehyde, Sinapaldehyde (*E*)-4-hydroxy-3,5- dimethoxycinnam aldehyde), *p*-Coumaroyl glycolic acid, Gallic acid, Vanillic acid, Syringic acid, Caffeic acid, Rosmarinic acid, Salvianolic acid D, 3,5 Dihydroxy phenyl acrylic acid, Chlorogenic acid (5-Caffeoylquinic acid), Mangiferin, Ellagic acid, Pedunculagin, 2,6-dimethoxy-1-acetonylquinol

[Ma *et al.* (2006), Ullah *et al.* (2012), Uddin *et al.* (2013), Singh *et al.* (2010), Koley *et al.* (2020), Bari *et al.* (2019), Mulholland *et al.* (2002) [47], Akwu *et al.* (2019) [38], Qamar *et al.* (2020) [1] Kadam *et al.* (2018), Zahoor *et al.* (2020) [42], Li *et al*. (2017), Spagnol *et al.* (2019), Naveed *et al.* (2018), Du *et al.* (2018)

Volatile compounds

Betulin, Betulinic acid, Oleanolic acid, Ursolic acid, Oleanonic acid, Ursene-3,19,28-triol, α-Amyrin,,20-lupandiol, Lupeol, Friedelin, Epi-friedelan-3-ol 2*α*,3*β*-dihydroxyolean-12-en-28- oic acid, Daucosterol, *β*-Sitosterol, *γ*-Sitosterol, Sitosterol *β*-D-glucoside, Stigmasta-3,5-dien-7-one, Cholestanol, Friedelan-3-one, Lup-20(29)-en-3-ol, acetate, (3*β),* Hexatriacontane, Heneicosane, 9-Hexacosene,1-Hexadecyne, 1-Butanol,1-Pentanol, 1-Hexanol, 1-Octanol, 1-Nonanol, *n*-Heptadecanol-1, 1-Heneicosanol, *n*-Tetracosanol-1, Decanal, *E*-14-Hexadecenal, 6-Methyl-5-hepten-2-one, 5,9-Undecadien-2-one, 6,10- dimethyl-,(*E*), Cyclopentadecanone, 2-hydroxy, Hexanedioic acid, Pentadecanoic acid, Palmitic acid (*n*-Hexadecanoic acid), Hexadecanoic acid, ethyl ester, Ethyl 14-methyl-hexadecanoate, Hexadecanoic acid, propyl ester, Hexadecanoic acid, 2-hydroxy-1- (hydroxymethyl)ethyl ester, Quinic acid [Pavlova *et al.* (2003), Uddin *et al.* (2011), Hordyjewska *et al.* (2019), Ríos *et al.* (2018), Siddiqui *et al.* (2019), Funari *et al.*, (2016), Giner-Larza *et al.*, (2001), Mulholland *et al.* (2002) [47], Zia-Ul-Haq *et al.* (2013a) [16], Cardoso *et al.* (2018), Ma *et al.* (2006), Geetha & Varalakshmi, (2001), Jayasinghe et al. (2004), Tsai et al., (2016), Akwu et al. (2019) [38], Jiao *et al.* (2007), Liu *et al.* (2008), Antonisamy *et al.* (2015), Wei *et al.* (2018), Akwu *et al.* (2019) [38], Uddin *et al.* (2011), Rajavel *et al*. (2017), Bari *et al*. (2019) [42], Choi *et al.* (2012), Choi *et al.* (2012), Bruno *et al.* (2015), Aboagarib *et al*. (2015)]

Table 2

Plant Part	Name of the Solvent	Name of the Activity	Name of the Organism or Cell on which the activity was assessed	Name of Authors with Year in which the article was published.
Leaf	Alloxan monohydrate	Anti-diabetic	Blood glucose Metabolism & Reactive oxygen	MRM, JP, JK,KDM, *et al.,* 2013
Leaf	Ethanol	Anti-diabetic	Blood glucose Metabolism & Reactive oxygen	MRM, JP, JK, KDM, *et al.,* 2013
Aerial part	Ethanol	Anti-diabetic	Induced hypergliycemic rats	Chandiran, *et al.,2013*
Leaf	Methanol, DCM, Acetone, h-haxane	Antimicrobial	*S.aureas, E.faecaelis, E.Coli, P.aeruginosa*	Gololo, *et al.,2016*
Root	Methanol, Acetone, Ethyl acetate, hexane	Anticancer	Cancer cells	Mshelia, *et al.,2016*
Leaf	Acetone, Acetyl acetate, water	Antimicrobial	*S.aureus,S.typhimurium, B.cereus, E.coli*	Lamola, *et al.,*2017
Root	Acetone, Acetyl acetate, water	Antimicrobial	*S.aureus,S.typhimurium, B.cereus, E.coli*	Lamola, *et al.,*2017
Twigs	Acetone	Antifungal	*Aspergillus fumigates, A.niger, Candida glabrata, Trychophyton sp., Geotrichum sp., Microsporum gypsium, Penicillium sp.*	Afolayan, *et al.,*2002
Fruits	Methanol	Radioprotective	Prophylactic action against gradiatio-Induced metabolic Disorders in mice	Ahaskar, Sharma, *et al.,*2007
Fruits	80% methanol	Hepatoprotective	Hepatoprotective effects in rats	Sharma, Sisodia, *et al.,*2010a
Leaf	Ethanol	Hepatoprotective	Restored & normalized elevated Liver enzymes	Dwivedi & Manigauha, *et al.,*2017
Leaf	Methanol	Antiplatelet	Platelet aggregation Inhibition	Zia-Ul-Haq, *et al.,*2012a
Fruits	hexane, DCM, Methanol	Antipyretic		Qamar, *et al.,*2020 [1]
Leaf	Methanol	Antimalarial	*Plasmodium falciparum*	Zia-Ul-Haq, *et al.,*2012b, Ma, *et al.,*2006
Fruits	Hydro methanol	Anti inflammatory		Qamar, *et al.* 2020
Leaf	Methanol, Ethanol, 70% aqueous	Antiemetic	Significant effects in mice and rats	Yaqeen, Tijani, *et al.,*2008, Zia-Ul-Haq, *et al.,*2012b
Leaf & stock	Methanol	Anticancer	HL-60, K-562, MCF-7, and Hella cells	Kakoti, *et al.,*2011
Leaf bark & root	Acetone	Anticancer	Verocells	Lamola, *et al.,*2017
Fruits	50%hydro-methanol	Anticancer	MCF-7, Hep-2, NCI-H522	Qamar, *et al.,*2020 [1]
Leaf % fruits	Aqueous	Anticancer	Kidney cell, lung cell, cervical, laryngeal& breast cancer cell	Qamar, *et al.,*2020
Root bark	Methanol	Analgesic		Paviaya, *et al.,*2013
Fruits	Methanol, Aqueous	Analgesic		Akhtar, *et al.,*2016
Whole	Methanolic	Anticancer	Showed moderately cytotoxic against for Vero and HEp-2 cell lines	Ramshankar *et al.* (2008)
Leaf	Methanolic	Anticancer	Showed against MCF-7 breast cancer cell line	Meena *et al*. (2017)
Stems and roots	95% methanolic	Anticancer	95% Methanolic extract was found to be nontoxic for tested cell lines	Zahoor *et al.* (2020) [42]
Berries, leaves, bark and roots	methanolic, aqueous, acetyl acetate and acetone	Anticancer	Less toxic to Vero cells	Lamola *et al.* (2017)
Fruits and leaves	Aqueous	Anticancer	Cytotoxic activity on epidermal kidney, cell lung, cervical, laryngeal and breast cancer cell lines	Marya *et al.* (2011)
Root	70% aqueous methanolic	Antiemetic	Showed antiemetic activity	Tijani *et al.* (2008)
Bark	95% methanolic	Antidiabetic	Showed significant reduction of cholesterol and triglycerides	Dogar *et al.* (1988)
Twig and leaves	Acetone	Antimalarial	Showed least activity	Afolayan *et al.* (2002)
Berries, leaves, bark and roots	Methanolic, aqueous acetyl acetate and acetone	Antioxidant	Showed good free radical scavenging activity	Lamola *et al.* (2017)
Bark and wood	Aqueous and conifer aldehyde	Uterotonic	Showed significant uterotonic activity in guinea pig	Mulholland *et al.* (2002) [47]
Fruits	Ethanol	Antioxidant	Showed significant antioxidant activity	Gwatidzo *et al.* (2018)
Leaves	Methanolic	Antioxidant	Showed significant free radical scavenging activity	Malar *et al.* (2017)

Ethnic uses

The fruits are used for promoting fertility in females and are considered in special diets for pregnant women and anaemic children. The plant is adapted to high temperatures and dry conditions and has deep roots which stabilize sand dunes. The shrubs play effectively for rehabilitation of wastelands.

The plant parts are rich in amino acids and mineral elements and contain some pharmacologically active constituents. It is used to treat anaemia, cuff, diabetes, malaria, typhoid, ulcer etc. *Grewia* fruits is used to cure asthma, liver-disorders, diarrhea and treating throat. The plant is identified in trade for its fruits. Plant is also sold as wild species of medicinal and aromatic plant and is direct or indirect source of income for the tribal people.

Conclusion

On basis of this review we can conclude that all the members of *Grewia* genus are very important medicinal plants because they have so many pharmaceutical activities and ethnic uses. Not even single part of plant but every plant parts can be used as medicinal important part so this genus has to be conserved with different ways. Researchers has to be focused on further activities of this plants of *Grewia* genus.

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Useful web links

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