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Medicinal and theraptic properties of minor fruits - A Review

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ABSTRACT

A large number of minor and wild fruit species have originated in Indian subcontinent. Many of these fruits or their plants parts have been used in folk, Ayurvedic and Unani medicines since time immemorial. Several fruits were introduced in India during colonial period. Most of them adapted to climatic conditions of India but remains minor crops .These fruits also have several medicinal properties and were used by the native people of their respective origin of centres. Some the fruits such as bael, aonla, jamun, tamarind, karonda, wood apple, kokum etc were known for their use in Indian pharmacopeia. The exotic fruits such as sour sop, rambutan, mangosteen, avocado, water apple, durian, passion fruit, carambola etc. have been reported for their different medicinal importance. These fruits contain several chemical ingredients such flavonoids, quinolizidine, alkaloids, tritepenes, stilbenes, tannins, steroids, coumarin, saponins, triterpenoids, glycosides, taraxerone, cryptoxanthin, taraxerol, etc. These exhibited varied biological effects like anti-inflammatory, analgesic, ant diabetic, antipyretic, antioxidant, hypoglycaemic, hepatoprotective, anticancerous. In recent years the global focus is shifting towards the plant based medicines and there is lot of research is being done on these fruits. Thus an attempt has been made in this article to compile the information available in the minor fruits.

***Keywords*:** Antioxidants, medicinal value, minor fruits, theraptic properties

There are more than three thousand of edible fruits species in the world. These were used by human being some times in therein diet. The commercialization of agriculture led emphasis on few edible fruit species. As results of this, more than 75 percent of the global area and production of fruits is comprised by few species such as Banana and plantain, apple, citrus fruits, grapes, etc. (Anomymous, 2019). There are quite a large number of underutilized and wild fruit species, which are being used by the local inhabitants, to meet their dietary requirements **(**Ashrafuzzaman *et al.,* 2021). In fact the underutilized fruits are not only source of food, vitamin and mineral requirements but also the source of livelihood because of their food and curative properties (Das, 2021). Many of these fruits or their plants parts have been used in local medicine. In India many of them are used in Ayurvedic and Unani medicines since time immemorial. Apart from their nutritive and medicinal values quite a few of these underutilized fruits have excellent flavour and very attractive colour. In spite of these quality attributes most have not undergone any conscious phase of domestication and human selection. Their cultivation is very restricted and they grow mainly wild. As far as the native fruits are concerned, several fruit plant species have originated in Indian subcontinent. India is centre of origin of jack fruit, bael, aonla, ber, khejri, jamun, tamarind, mahua, phalsa, Lasoda, karonda, wood apple, pilu, bilimbi, Garcinia, and several other wild fruits (Table 1). Several minor fruits such as Rambutan, mangosteen, longan, avocado, water apple, hog plum, macadamia nut, kiwifruit, longsat, durian, passion fruit, dragon fruit, pulasan, carmbola, etc. were introduced during last few centuries and several are naturalized in Indian conditions (Table 2). Apart from these there more than 100 wild edible fruits native to India which are yet to be domesticated but these are gathered from forest by the rural and tribal people and sold in the rural market (Tripathi *et al.,* 2018).

There is lot of sctter information avaible on the medicinal and therapeutic prpeoerties of minor fruits.Thus an attempt has been made in this artilce to compile these informations in a precise way.

Table 1: Indigenous minor fruits in India

Common Name	Scientific Name	Family	Common Name	Scientific Name	Family
Jack fruit	*Artocarpus heterophyllus*	Moraceae	Tamarind	*Tamarindus indica*	Leguminosae
Aonla	*Emblica officinalis*	Euphorbiaceae	Phalsa	*Grewia subinaequalis*	Malvaceae
Star Gooseberry	*Phyllanthus acidus*	Euphorbiaceae	Bael	*Aegle marmelos*	Rutaceae
Bilimbi	*Averrhoa bilimbi*	Oxalidaceae	Wood apple	*Ferronia limmonia*	Rutaceae
Jamun	*Syzygium cumini*	Myrtaceae	Kokum	*Garcinia indica*	Clusiaceae
Ber	*Ziziphus jujuba*	Rhamnaceae	Yellow mangosteen	*Garcinia xanthochymus*	Clusiaceae
Jherberi	*Ziziphus nummularia*	Myrtaceae	Malabar tamarind	*Garcinia gummigutta*	Clusiaceae
Rose Apple	*Syzygium jambos*	Myrtaceae	Governor's plum	*Flacourtia indica*	Flacourtiaceae
Pommelo	*Citrus grandis*	Rutaceae	Mahua	*Madhuca indica*	Sapotaeceae
Citron	*Citrus medica*	Rutaceae	Pilu	*Salvadora oleoides*	Salvadoraceae
Phog	*Calligonum polygonoides*	Polygonaceae	Ker	*Capparis decidua*	Capparaceae
Sea buckthorn	*Hippophae rhamnoides*	Elaeagnaceae	Indian almond	*Terminalia catappa*	Combretaceae

Table 2: Exotic minor fruits in India

Common Name	Scientific Name	Family	Common Name	Scientific Name	Family
West Indian Cherry	*Malpighia glabra*	Malpighiaceae	Malay Apple	*Syzygium malaccense*	Myrtaceae
Durian	*Durio zibethinus*	Malvaceae	Mangosteen	*Garcinia mangostana*	Clusiaceae
Soursop	*Annona muricata*	Annonaceae	Rambutan	*Nephelium lappaceum*	Sapindaceae
Passion Fruit	*Passiflora edulis*	Passifloraceae	Custard Apple	*Annona squamosa*	Annonaceae

1.0. Phytochemicals in minor fruits

Fruits are rich source of vitamins and minerals. Besides, nutritional importance, these fruits have medicinal and theraptic values. Fruits contain several chemical ingredients such as flavonoids, quinolizidine, alkaloids, tritepenes, stilbenes, tannins, steroids, coumarin, and saponins, quinolizidine, triterpenoids, glycosides, fatty acids, taraxerone, cryptoxanthin, taraxerol, β-carotene, (24R)-24-ethylcholest-5-en-3β-ol glucoside, and β-sitosterol, etc. These exhibited varied biological effects like anti-inflammatory, analgesic, antidiabetic, antipyretic, antioxidant, hypoglycemic, hepatoprotective, and anticancer, dysentery, cholera, wounds, and sores (Doka *et al*., 2014; Ebbo *et al*., 2014; Ibragic and Sofic, 2015; Goyal, 2012). Flavonoids are a large group of natural substances with variable structures present almost in all growing parts of the plants, being reported as the most abundant plant pigment along with chlorophyll and carotenoids, also providing fragrance and taste to fruits, flowers and seeds, which makes them attractants for other organisms. These compounds are also one of the largest groups of secondary metabolites. Besides their relevance in plants, flavonoids are important for human health because of their high pharmacological activities. Recent interest in these substances has been stimulated by the potential health benefits arising from the antioxidant activities of these polyphenolic compounds. Minor fruits are rich source of antioxidants. The antioxidants play an important role in health-promoting biochemical pathways. Oxidative stress, resulting from imbalance among the reactive oxygen species including free radicals and antioxidant defences in living organisms produces oxidative changes to proteins, fatty acids, and DNA molecules in the living cells, which encourage the initiation of ailments, e.g., inflammation, liver cirrhosis and vascular diseases (Aruoma, 1998). Phenolic compounds are the largest group of phytochemicals found in the plants. Phenols, as the major bioactive substances in fruits, play a vital role as antioxidant. Phenolic compounds are good antioxidants found in the flesh of fruits including phenolic acids and flavonoids, whereas flavonoids and lignans are found in the seeds or kernel. Among the phenolic acids, gallic acid is the major component of plant. Each fruit has, at least, a few major phenolic compounds. In addition to fruit, catechin is one of the main flavonoids found in leaves. Since phenolics are potent antioxidants, increased consumption of a mixture of fruits daily should be able to provide an adequate phenolic antioxidant. Among hundreds of types of flavonoids, quercetin is a bioactive flavonoid isolated from the fruit. Besides quercetin, geraniin, quercetin 3-*β*-D-glucopyranoside, kaempferol 3-*β*-D-glucopyranoside, isocorilagin, and kaempferol were detected. To date, only a very limited information on phenolic compounds is available for the scientific community, especially phenolic compounds in the minor fruits such as *Baccaurea*, *Cynometra*, *Garcinia,* durian etc. Monoterpenes, diterpenes, triterpenes, and sesquiterpenes are some of the terpenes. Terpenoid is a vast and diverse class of natural occurring organic chemicals related to terpene. Most of the terpenoids including saponins are possible antioxidants. Besides antioxidant activity, saponins have several health benefits. Among the terpenes and terpenoids, some are volatile compounds found in plants. Geraniol, limonene, linalool, and pinene are some of the volatile components detected in fruit samples. Terpenes, mainly sesquiterpenes, have been identified in the root, bark, flowers, and leaves of plants. Only a few terpenes have been discovered in fruits. Although many studies have been performed on volatile terpenes in essential oils of plants, most of the studies analyzed the other parts of the plant rather than the fruit. From our literature search, a minimum of 20 volatile components including terpenes were found in different parts of the plant. Little information on terpenes and terpenoids content in fruit is available for the scientific community, especially the underutilized and indigenous tropical fruits. The carotenoids are classified as terpenoids. The compounds are found abundantly in yellow to orange- and orange to red-colored fruits. Carotenoids are grouped into carotenes and xanthophylls. In nature, *β*-carotene is the most abundant type of carotene, while lycopene is the primary phytochemical in orange-red colored fruits. Among the xanthophylls, lutein is typically detected in green leafy vegetables. However, some fruits also contain lutein. Among the carotenes, all-

trans *â*-carotene is the most common type of carotenoid found in plant because it is part of the antioxidant defence system at cellular level of a plant. Some green-colored fruits may contain a high amount of carotenoid because the yellow-orange-coloured carotenoid pigments are masked by chlorophylls. The intake of carotenoids from various plant sources is thought to be able to maintain good health. There are several phytochemicals present in minor fruits. Some are unique for particular species and some are present in most of the fruits but their quantity may vary in different plants as well as in their plant parts. Some of the phytochemical presnt in some minor fruits are given in Table 3.

Table 3: Phytoconstituents in various parts of minor fruits

Fruit species	Plant Part	Phytoconstituents
Aonla *(Emblica officinalis)*	Leaf	Gallic acid, chebulic acid, ellagic acid, chebulinic acid, chebulagic acid, amlic acid, alkaloids phyllantine and phyllantidine (Khan, 2009).
	Fruit	Gallic acid 1.32%, tannin, gum 13.75%; albumin 13.08%; crude cellulose 17.08%; mineral matter 4.12% and moisture 3.83%. Amla fruit ash contains chromium, 2.5 ppm; zinc 4 ppm; and copper, 3 ppm (Kumar *et al*., 2012a).
	Stem Bark	Leukodelphinidin, tannin and proanthocy-anidin (Khan, 2009)
	Seed	linolenic acid (8.78%), linoleic (44%). oleic (28.40%), steric (2.15%), palmitic (2.99%) and miristic acid (0.95%) (Khan, 2009).
	Root	Ellagic acid and lupeol (Khan, 2009).
Bael *(Aegle marmelos)*	Leaf	Tannins, Limonene, Aegelin, p- Cymene Phellandrene, Cineole, Skimmianine (Maity *et al.*, 2009); O-(3, 3-dimethylallyl)- halfordinol (Manandhar *et al.*, 1978); Marmelosin (Nandkarni, 1976); Marmesinin, Rutin, β- Sitosterol-D- glucoside, Marmeline(Sharma *et al.*, 1980); Umbelliferone (Arul *et al.*, 2004);Y-Sitsterol, flavones, lupeol, eugenol, citral, Glycoside, O-isopentenyl, Citronellal, Cuminaldehyde phenylethyl cinnamamides (Farooq, 2005)
	Fruit	Alloimperatorin, Imperatorin Scoparone, Scopoletin (Sharma *et al.*, 1980); Auraptene (Kakiuchi *et al.*, 1991); Calcium compounds, Linoleic acid (Maity *et al.*, 2009); Glutamic acid, Glycine, Lysine, Magnesium compounds, Phenylalanine, Proline, Skimmin, Umbelliferone, Xanthotoxol (Barthakur and Arnold, 1989) ; Marmelosine (Badam *et al.*, 2002); Psoralen (Chakthong *et al*., 2012); Luvangetin, Marmelide, Tannin (Farooq, 2005)
	Stem Bark	Fagarine, Marmin (Chatterjee and Mitra, 1949) ;Skimmianine (Maity *et al*., 2009)
	Seed	Anthraquinones (Mishra *et al*., 2009); Linoleic acid, Linolenic acid, Palmitic acid, Stearic acid (Singh and Malik, 2000); Essential oil: D-limonene, A-D-phellandrene, Cineol, Citronellal, Citral, P-cyrnene, Cumin aldehyde (Farooq, 2005)
	Root	Á- Methyl scopoletin, Skimmin, Scopoletin, Timbamine (Shoeb *et al*., 1973); Psoralen, Umbelliferone, Xanthotoxin (Basu and Sen, 1974)
Wood apple *(Ferronia limmonia)*	Fruit	Flavonoids, glycosides, saponins and tannins , tyramine derivatives (Ilango and Chitra, 2010), Flavone glycoside - 5,4-dihydroxy-3-(3-methyl-but-2-enyl) 3,5,6-trimethoxyflavone7-O-b-D-glucopyranoside (Amin *et al*,2017), Citric acid, , alkaloids, coumarins, fatty acids, sterols, umbelliferone, dictamnine, xanthotoxol, scoparone, xanthotoxin, isopimpinellin, isoimperatorin and marmin (Pratima Vijavyargia *et al*, 2014)
	Leaf	Alkaloids - Psoralen, bergapten. Flavones - Orientin, vitexin Saponins Essential oils (Amin *et al*, 2017). Eudesma-4 (Thomas and Ponnammal, 2005), 11-dine (46.3%), carvacrol (29.6%) and 1,5-cyclodecandine (13.4%) , α-Thujene, αPinene, Linalool 0.1, 1,5-Cyclodecandine, Caryophyllene 1.3, cis-Anethole, Elemicin 0.9, Aromadendrene, Germacrene-D, 3,4-Dimethyl cinnamic alcohol, Veratraldehyde, Caryophyllene oxide (Senthil Kumar *et al*, 2010), Stigmasterol,

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Table 3 Contd.

Fruit species	Plant Part	Phytoconstituents
		orientin, vitedin, saponarin, tannins (Pratima Vijavyargia *et al*, 2014) , Carbohydrate, amino acid, protein, lipid, tannins, alkaloids, steroids (Patil *et al* , 2012)
	Seed	Fixed oil, carbohydrates, proteins and amino acids
	Shell	Psoralene, xanthotoxin, 2, 6-dimethoxybenzoquinone, osthenol (anti-fungal)
		(Ilango and Chitra, 2010), Amino acid, total amino acid (Thomas and Ponnammal,2005)
	Bark	Coumarins - Marmesin, bergapten, psoralen, luvangetin, xanthotoxin, scopoletin, isoimperatorin, osthol and 6,7-dimethoxycoumarin " feronolide and feronone (Pratima Vijavyargia *et al*, 2014), Alkaloids Steroids - Sitosterol and sitosterol-o-beta-d-glucoside. Terpenoids - Lupeol and limonin Flavones - 5, 7-dihydroxy-3', 4'-dimethoxy-6,8-di (3-methylbut-2-enyl) stigmasterol, sitosterol-3-O-β-D-glucopyranoside. The bark of the plant has yielded (-)(2S)-5,3'-dihydroxy-4'-methoxy-6",6"dimethyl chromeno-(7,8,2",3")-flavanone along with several known compounds, five coumarins, a flavanone, a lignan, (antimicrobial) (Ilango and Chitra, 2010),Carbohydrate, amino acid, protein, lipid tannins (Patil *et al* , 2012), Phenols (Thomas and Ponnammal,2005)
	Root	Lactones - Feronia lactone, geranylumbelliferone, frenolin. Coumarin - Aurapten, marmesin, bergapten, xanthotoxin, osthol, xanthyletin, 6-methoxy-7-geranyloxycoumarin, osthenol. Quinolone alkaloid - 1-methyl-4-methoxy-2-quinolone (Amin *et al*, 2017)
Bilimbi *(Averrhoa bilimbi)*	Fruit	Flavonoids, saponins, and triterpenoids (Hock Eng Khoo *et al*, 2016)
Rose apple *(Syzygium jambos)*	Fruit	Phenols, tannins, alkaloids, and flavonoids (Hock Eng Khoo *et al*, 2016)
Malayan apple *(Syzygium malaccense)*	Fruit	Phenolic compounds and terpenes (Hock Eng Khoo *et al*, 2016)
Jherberi *(Ziziphus mauritiana)*	Fruit	Phenolic compounds and saponin (Hock Eng Khoo *et al*, 2016)
Karonda *(Carissa carandus)*	Fruit	L Ascorbic acid, Chlorogenic acid, Ellagic acid, *Piceatannol, Resveratrol. Syringic acid, Vanillic acid, p Coumaric acid, Caffeic acid,* Epicatechin, Rutin, Carissol (Kaunda and Zhang, 2017, Patil *et al*., 2012; Pandya, 2012; Parvin,2018)
	Leaf	Carissic acid, Carissic acid methyl ester, Carissic acid monoacetate, Betulinic acid, Carandinol(Kaunda and Zhang 2017, Patil *et al*., 2012; Pandya, 2012; Parvin,2018)
	Flower	Nerolidol, Farnesol, Camphene, Menthol, p Cymene , α Terpineol, Neryl acetate, Neryl acetate, Geranyl acetate(Kaunda and Zhang 2017, Patil *et al*., 2012; Pandya, 2012; Parvin,2018)

2.0. Minor fruits in folk medicine

A number of species of minor fruits are being used by the people in as suitable food, food supplements and sources of spices and condiments, edible oils, medicine, etc. A number of studies have shown the use of locally available indigenous or traditional fruit speices and their plant parts in medicine by indigenous communities. Some of them are tabulated as Table 4.

3. Medicinal and pharmceatical properties

3.1 Therapeutic values

The therapeutic value of some minor fruits such as aonla (Indian goose berry), Jamun, kokum etc is known since time immortal. Aonla fruit is traditionally known for its medicinal value in India for the treatment of several health complications, suchas diarrhea, dysentery, anemia, jaundice, and

Table 4: Use of minor fruits in folk medicine

Fruits	Use in folk medicine
Bael *(Aegle marmelos)*	Abdominal pain, cholera, night fever, stomach disorder and snake bite. They use specially fruits and roots for treating gastric troubles. Roots of Bael for curing bite of mad dog. leaves use for treatment of heat in abdomen and jaundice, diabetes ,fruit is used as a laxative by different tribes of India (Gupta, 2016), root bark as fish Poison and use the leaf paste as an antivenom against venom of poisonous insects and animals. The powder of fruit and bark is used for the treatment of stomachache and dysentery in eastern Rajasthan (Joshi , 1986)
Bilimbi *(Averrhoa bilimbi)*	Ripe fruits combined with pepper for inducing sweating; pickled bilimbi is smeared all over the body to hasten recovery after a fever; fruit conserves for treatment of coughs, beriberi, and biliousness; fruit syrup for reducing fever and inflammation and to alleviate internal haemorrhoids (Lim, 2012)
Aonla *(Emblica* Officinlis)	Fruit for treating cough and asthma, and several other health complications in Malaysia (Mohamad e*t al*., 2011)
Rose apple *(Syzygium jambos)*	Ripe fruit is used as a tonic for brain and liver and as a diuretic; seeds for treatment of diarrhea, dysentery, and catarrh (Morton, 1987)
Malayan apple *(Syzygium malaccense)*	Fruit decoction as a febrifuge (Morton, 1987)
Jherberi *(Ziziphus mauritiana*)	Ripen fruit for treatment of sore throat and cough; seed for treatment of diarrhea and weakness of stomach [*(*Morton,1987), Marwat *et al*., 2009]
Karonda *(Carissa carandus)*	Roots are used as stomachic, anthelmintic and antiscorbutic; in curing stomach disorders including flatulence and acidity, intestinal worm infestation, diabetic ulcer, scabies, pruritus, pyrexia, urinary disorders, chronic ulcer and biliousness; and even acts as insect repellent (Kumar *et al*, 2013, Trivedi, 2004). Used in the treatment of remittent fever, diarrhoea, earache, mouth and throat soreness, and syphilitic pains, (Kumar *et al.,* 2013 Trivedi, 2004). Unripe fruit used as an appetiser, astringent, antiscorbutic, acidic, stomachic, anthelmintic, laxative and antipyretic, and in curing anorexia, diarrhoea and haematemesis (Kumar *et al*., 2013; Trivedi, 2004). Ripe fruits are used as an appetiser, antiscorbutic and expectorant; in curing anorexia, burning sensation, pruritus and skin disorder; in the treatment of anaemia; as antidote for poisons and carminative; for female libido improvement; in curing worm infestation; as antimicrobial and antifungal; in insanity treatment (Khare 2007; Bisset,1994, Sharma *et al*., 2007).
Jamun *(Syzygium cumini)*	Infusion of fruit or mixture of powdered bark and fruit is used to treat diabetes in North east India(Sharma *et al*., 2001).The juice of ripe fruits is stored for 3 days and then is given orally for gastric problems. The juice obtained from the bark is given orally for the treatment of women with a history of repeated abortion in Lakher and Pawi in North east India. Fruit and stem bark are used in the treatment of diabetes, dysentery, increases appetite and headache in Maharashtra (Jain *et al*., 2005). Decoction of stem bark is taken orally three times a day for 2–3 weeks to treat diabetes (Chhetri *et al*., 2005). Leaves are used in the treatment of diabetes and renal problems by native indians and Quilombolas in North eastern Brazil (de Albuquerque *et al*., 2007). Leaves juice with honey or cow's milk used to treat diabetes. Fresh fruits are taken for stomachache and to treat diabetes by Kani tribals in Southern India (Ayyanar, 2008; Udayan *et al*., 2006). Seeds are taken orally for diabetes in Madagascar (Ratsimamanga, 1998). Dried seeds powder is taken orally thrice a day in the treatment of diabetes in Andhra Pradesh (Nagaraju *et al*. 2006).The juice obtained from the leaves is mixed with milk and taken orally early in the morning, to treat diabetes

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Table 4 Contd.

	by Siddis in Karnataka (Bhandary *et al*., 1995).The juice of stem bark is mixed with butter milk to treat constipation. Leaves are taken orally for treatment of diabetes in Brazil (Braga *et al*., 2007). The tender leaves are taken orally to treat jaundice in Maharashtra (Natarajan and Paulsen, 2000).
Rambutan *(Nephelium lappaceum)*	Unripe fruit is astringent, stomachic; acts as a vermifuge, febrifuge, and is taken to relieve diarrhea and dysentery. The leaves are poulticed on the temples to alleviate headache. In Malaya, the dried fruit rind is sold in drugstores and employed in local medicine. The astringent bark decoction is a remedy for thrush. A decoction of the roots is taken as a febrifuge.
Kokum *(Garcinia indica)*	Traditionally, kokum is used in herbal medicines to treat diarrhoea, inflammatory ailments, dermatitis, bowel problems, rheumatic pains and to prevent hyper perspiration. Fruits are used as antihelmintic and cardiotonic. Kokum juice from the rind is used against piles, colic problems, dysentery and diarrhoea (Baliga *et al*., 2011). Decoction of fruit rinds are traditionally used against diabetes. Kokum butter is used traditionally to healwounds, fissures in hands and is supposed to restore elasticity of skin and used as a moisturiser (Jeyarani and Reddy, 1999; Padhye *et al*., 2009). Leaves of *G. indica* are used to treat skin ulcers, dyspepsia and hyperplasia.
Malabar Tamarind *(Garcinia gummigutta)*	Treatment of edema, delayed menstruation, ulcers, open sores, hemorrhoids, fever, rheumatism, and also against intestinal parasites (Majeed *et al*., 1994, Semwal *et al*., 2015). The astringent properties of the rind make it an indispensible ingredient in gargles for weak gums, bowel complaints, constipation, diarrhoea and dysentery. The plant is used in veterinary medicine, for mouth diseases in livestock.
Yellow mangosteen *(Garcinia xanthochymus)*	Plant is widely used as a traditional folk medicine for bilious condition, diarrhea, dysentery, anthelmintic, cardiotonic and as a tonic to improve appetite (Whitmore, 1973; Perry, 1980; Baishya *et al*., 2013; Joseph *et al*, 2016). In traditional Chinese Dai medicine, it is used for expelling worms and removing food toxins (Lin *et al*., 2003)
Mangosteen *(Garcinia mangostana)*	Peel and seed in the form of infusions and decoctions used to treat infections of skin, urinary tract, and gastrointestinal, and act as laxative, anti-scorbutic, and anti-fever agent (Ovalle-Magallanes *et al*., 2017). Treatment of diarrhea, abdominal pain, dysentery, suppuration, wound infection, and chronic ulcer (Cui *et al*., 2010; Gorinstein *et al*., 2011; Suksamram *et al*., 2006) and to treat inflammatory and immunological related-diseases, such as acne, food allergies, and arthritis (Wang *et al*., 2017).
Passion fruit *(Passiflora edulis)*	*Passiflora* (or Passion flower) is a folk remedy used for anxiety (Miyasaka *et al*., 2007; Reginatto *et al*., 2006). Several species of *Passiflora* have been employed widely as a folk medicine because of sedative and tranquillizer activities (Barbosa *et al*., 2008). *Passiflora*, an herbal medicine, could be an op-tion for treating anxiety if shown to be effective and safe (Miyasaka *et al*., 2007).
Jack fruit *(Artocarpus heterophyllus)*	The leaves are useful in fever, boils, wounds and skin diseases. The young fruits are acrid, astringent, and carminative. The ripe fruits are sweet, cooling, laxative, aphrodisiac and also used as a brain tonic. The seeds are, diuretic, and constipating.The wood is nervine, antidiabetic, sedative and is useful in convulsions (Hemborn, 1996). The latex is useful in dysopia, ophthalmic disorders and pharyngitis and also used as antibacterial agent (Sato *et al*., 1996). The ash of Jackfruit leaves is used in case of ulcers. The dried latex yields artostenone, convertible to artosterone, and a compound with marked androgenic action. Mixed with vinegar, the latex pomotes healing of abscesses, snakebite and glandular swellings (Vaidya Gogte, 2000). The root is a remedy for skin diseases and asthma. An extract of the root is taken in cases of fever and diarrhoea. The bark is made into poultices. Heated leaves are placed on wounds. The wood has a sedative property and its pith is said to be abortifacient. Latex is used as an anti-inflammatory agent (Gupta and Tandon, 2004).

cough (Chopra *et al.*, 1992). The fruit is also rich in antioxidant. A study on the healing activity of ethanolic extract of aonla fruit has shown some positive results,where the rats were induced with indomethacin (30mg/kg BW, oral intubation) (Bhattacharya *et al.,* 2007). The results showed that the extract (100mg/kg BW) of this fruit had significantly reduced the lipid peroxidation parameters (MDA, carbonyl, total DNA, SOD, and CAT), ulcer index (3.8), and DNA damage induced by indomethacin (85.73% of protection) in rats after seven days of postulcerative treatment compared with the controls. Other than that, the extract of emblic fruit also inhibited the growth of *Staphylococcus aureus, Bacillus subtilis, Salmonella paratyphi, Shigella dysenteriae,* and *Candida albicans* (Ahmad and Beg, 2001). The aqueous extract of aonla has shown the potential as an anticancer agent, where the extract inhibited the growth of human lung carcinoma and (A549) and human hepatocellular carcinoma (HepG2) celllines (Bhattacharya *et al.,* 2007). Moreover, the emblic fruit powder demonstrated a significant chondroprotective effect based on an *in vitro* model of cartilage degradation in explant cultures of articular knee cartilages obtained from osteoarthritis patients (Sumantran *et al.,* 2008). The fruit extract of jamun is reported on the medical properties.The methanolic extracts of jamun leaves were tested for antimicrobial activity, where the extracts inhibited the growth of some Gram-positive and Gram-negative bacteria (Mohanty and Cock, 2010). Besides that, antimicrobial activities of the extracts of bark, leaves, and seeds of rose apple have also been reported by Murugan *et al*. (2011). The leaves of *S. malaccense* (Malay apple) were reported to be useful for preventing inflammation (Cox,1993). Most of the plants from genus *Garcinia* have medicinal effects. In Southeast Asia, only a few studies were reported on the potential medicinal properties of underutilized Garcinia fruits. The fruit extract of *G. hombroniana* inhibited in vitro lipid peroxidation and had antiplateletactivities (Jantan *et al*., 2011). Kapadia and Rao (2011) report antimicrobial effects of Garcinia plants towards bacteria, fungus, and other parasites. The stems and leaves of three Garcinia plants indicate platelet-activating factor antagonist activity (Hemshekhar *et al*., 2011). The main bioactive compound in the leaves that possess antimicrobial effect is reported as garcihombronane (Kapadia and Rao, 2011). Most of the plants from genus *Garcinia* have antihypercholesterolemic effect (Hemshekhar *et al*., 2005). The fruit extract of *G. hombroniana* inhibited in vitro lipid peroxidation and had antiplateletactivities (Jantan *et al*., 2011). Indian jujube is known for its medicinal properties. It is traditionally used for treating abscesses, wounds, anodyne, and tonic, as well as styptic and purifying blood. The leaves of *Z. Mauritiana* were reported to significantly prevent leucopenia and noise induced enhancement of neutrophil function in Guineapigs compared with diazepam, in which the Guinea pigs were subjected to 100Db industrial noise (8–50 kHz) (Vakharia *et al.,* 2014). Antioxidant activities have also been determined for the fruits from two varieties of *Z. mauritiana*, and the I50values of the ethanolic extract of both varieties (Beri and Narikeli) were 72 and 250 ug/mL, respectively (Nimbalkar and Rajurkar, 2009). The ethanolic extracts of *Z. mauritiana* seed were found to induce cancer cells death and significantly reduced tumor volume and tumor cell countin albino mice after 13 days of treatment with the extract (100–800mg/kg BW) (Mishra *et al*., 2011). Besides that, the seed extract exhibited hypoglycemic activity, where administration of the extract (at a concentration of 800mg/kg BW) reduced weight loss and mortality of alloxan-induced diabetic mice (Bhatia and Mishra, 2010). The fruit of bilimbi (tree) has potential health benefits. According to Ambili *et al* (2009), the extracts of bilimbi exhibited the cholesterol-lowering potential in rats. The water extract of bilimbi fruit (0.8mg/kg body weight) improved lipid profile in Triton-induced hypercholesterolemia in rats. The active fraction of the water extract at a dose of 0.3mg/kg BW possessed an optimum antihypercholesterolemic activity. The fruit (125mg/kg BW) and its water extract (50mg/kg BW) also effectively improved the lipid profile of the rats fed with high-fat diet (Ambili *et al*., 2009). Besides that, this fruit is also reported as an active antimicrobial agent. Chloroform and methanolic extracts of bilimbi were reported to have good inhibitory activities on several types of bacteria, such as *Aeromonas hydrophila, Escherichia coli, Klebsiella*

pneumoniae, Saccharomyces cerevisiae, Staphylococcus aureus, Streptococcus agalactiae and *Bacillus subtilis* (Wahab *et al*., 2009). Flavonoids and anthocyanins in dabai fruit (*C. odontophyllum*) are the potent antioxidants. The defatted dabaiextract (5%) was shown to significantly reduce the levels of total cholesterol and low-density lipoprotein-cholesterolin rabbits supplemented with high-cholesterol diet for eight weeks as compared to the control group (Nurulhuda *et al*., 2013). Besides that, rabbits fed a high-cholesterol diet and defatted dabaipulphave a significant increment in high-density lipoproteinlevel (Nurulhuda *et al*., 2012). The severity of atherosclerotic plaques in the high-cholesterol diet rabbit group that supplemented with defatted *dabai* extracts was also reduced compared to the control group. Durian possesses some anti-inflammatory properties. The methanolic extracts of *D. zibethinus* fruit were reported to have anti-inflammatory effects (Leverett *et al*., 2005). The fruit *of Cynometra cauliflora* possesses antiproliferative activity by inhibition of cytotoxic effect to human promyelocytic leukemia HL-60 cells (Tajudin *et al* , 2012).The fruit of *Syzygium jambos* (rose apple) has been traditionally used as an astringent and for brain and liver, as well as digestive problems (Reynertson, 2007). The aqueous fruit extracts of rose apple reduced the *in vitro* glucosidase and amylase inhibitory activities (Das *et al*., 2012). The fruit extracts of *Syzygium samarangense* (samarang apple) were also as effective as antibiotics to inhibit microbial activities (Ratnam and Raju, 2008). Aqueous leaf extact of pasion fruit was more effective in suppressing the TNFα and IL-1β levels than dexamethasone. This may be a source of new therapeutic candidates with a spectrum of activity simi-lar to the current anti-inflammatory steroids such as dexamethasone (Montanher *et al*., 2007).

3.2 Antidiabetic activity

Diabetes has become a common disease around the world. When the body cannot produce sufficient amount of insulin the blood glucose level increases. Antidiabetic aims at reducing the blood glucose level by inducing the production of a higher amount of insulin. Several plant and their parts have anti diabetic properties. Antidiabetic effect of Jamun is well known in Ayurveda. The seed powder of Jamun is effective in controlling high blood sugar levels. The hypoglycaemic effect of different parts of Jamun to control diabetes in preclinical models has been reported. Majority of the preclinical reports have indicated that different parts of Jamun reduced blood sugar levels in rodent models of diabetes and clinical setting. The seed powder extracted in water has shown to reduce blood sugar level in diabetic rabbits (Brahmachari and Augusti, 1961).The use of aqueous seed extract of Jamun at a dose of 1 g/kg body weight in diabetic rats has been reported to produce hypoglycaemic effect in the blood (Kedar and Chakrabarti, 1983). Numerous studies on aqueous seed extract have been found to reduce blood sugar in the diabetic rats (Achrekar *et al*., 1991; Prince *et al.,* 1998). The lyophilized powder of aqueous seed extract has been reported to decrease the blood glucose level in diabetic mice and rats (Vikrant *et al*., 2001; Grover *et al.,* 2001).Similarly, aqueous jamun seed extract consisting of gummy fibres has been highly effective in controlling diabetes in alloxan induced diabetes in rats. The alloxan-induced diabetic rats and rabbits administered with ethanol extract of jamun seeds showed a decline in fasting blood glucose levels in an earlier study (Sharma *et al.,* 2003). The jamun seed kernel extracted in ethanol reduced the blood glucose level in the streptozotocin-induced diabetic rats and also restored the activities of catalase, glutathione peroxidase and superoxide dismutase enzymes accompanied by restoration of glutathione concentration in liver and kidney of diabetic rats (Ravi *et al.,* 2004). Administration of various doses of jamun seed powder into streptozotocin-induced diabetic rats has shown attrition in the fasting glucose level (Sridhar *et al.*, 2005). Likewise, treatment of streptozotocin-induced diabetic rats with 100mg/kg body weight seed kernel ethanol extract reduced the blood sugar level, urea and cholesterol and led to a rise in the glucose tolerance and decreased the glutamate oxaloacetate transaminase and glutamate pyruvate transaminase activities (Ravi *et al.* 2005). Bael (*Aegle marmelos*) has been used as a herbal medicine for the management of diabetes mellitus in Ayurvedic, Unani and Siddha systems of medicine in India (Choudhry *et al*., 2003). Bael extract, when

administered at a dose of 250 mg/kg of body weight, shows better result than glycenamide (antidiabetic drug). This antidiabetic effect may be due to the coumarins present in the fruit which induce the beta cells of islet of Langerhans to produce insulin. Aqueous extract of bael seeds reduces blood glucose level in case of severe diabetic patients (Maity *et al*., 2009; Kamalakkannan and Prince, 2003). Aqueous extract of bael leaves were useful in the long-term management of diabetes due to hypoglycemic and antioxidant effect (Upadhya *et al.,* 2004; Maity *et al.*, 2009). Similarly, anti hyperlipidaemic activity of aqueous extract of bael fruits was demonstrated by Marinzene *et al.* (2005), using the streptozotocin induced diabetic. Sunderam *et al.* (2009) worked on alcoholic extract of bael and jamun in diabetic rats and confirmed their protective activity against laboratory induced cell necrosis. Leaf extract of bael on Alloxane induced diabetes and reported that used extract was enough capable to reduce oxidative stress by scavenging lipid peroxidation and enhancing certain anti oxidant levels which causes lowering of elevated blood glucose level (Kuttan and Sabu, 2004). Rambutan reported to have hypoglyric properties. Geraniin, an ellagitannin, a major bioactive compound isolated from the ethanolic extract of rind act as an anti hyperglycemic agent In addition to its extremely high anti oxidant activity and low pro oxidant capability. Geraniin has the potential to be developed into an anti hyperglycemic agent (Uma *et al*., 2011). Geraniin, one of polyphenol compounds, was used as an index to investigate the optimum condition of extraction from rambutan peel (red and yellow) in Taiwan. The highest total phenolic content found in red rambutan variety was at 1:15 (g/ml) ratio, but no significant difference for yellow rambutan. FRAP ranged in Rambutan rind ranged from 3800.25±86.49 to 4116.5±88.41 (ìmol Fe2+/g dry weight), flavonoid from 6.41±0.48 to 8.57±0.35 (mg Quercetin/g dry weight) and total phenolic recovery from 297.78±4.06 to 358.42±4.63 (mg GAE/g dry weight). Anti diabetic properties of jack fruit is also reported**.** According to a study carried out by Fernando *et al*. (1991), the hot water extract of jackfruit leaves significantly improved glucose tolerance in the normal subjects and the diabetic patients when investigated at oral doses equivalent to 20 g/kg. It also exhibited hemagglutination activity against human and rabbit erythrocytes. Rambutan fruit peel have antidiabetic and antihypercholesterolemic activities. The highest percentage reduction in blood glucose and cholesterol levels are shown of rambutan fruit peels extract with dose 500 mg/kg and the value of percentage reduction were 61.76±4.26% and 60.75±8.26 (Muhtadi *et al*., 2016).The fruit of bilimbi has antidiabetic effect studied using streptozotocin-induced diabetic rats (Tan *et al*., 1996) . The flavonoids, carotenoids, and terpenes could be the potent bioactive compounds in bilimbi fruits that provide the antidiabetic effect. Aqueous leaf extract of graviola to streptozotocin-induced diabetic rats sas found to reduce glucose levels treated diabetic rats along with an elevation in blood insulin (Adewole and Ojewole, 2010). Aqueous fruit rind extract of the kokum exhibited antidiabetic activity in streptozotocin-induced hyperglycemic rats (Kirana and Srinivasan, 2010).

3.3 Antioxidant activity

Normal metabolic activities give rise to free radicals. These free radicals, mainly oxygen free radicals, referred as ROS (Reactive Oxygen Species) causes oxidative stress. ROS are harmful for the body as they damage macromolecules, DNA, proteins and lipids. Antioxidants are compounds that scavenge the free radicals and reduce oxidative stress. Bael fruit has proven to show antioxidant activity. On administration of bael fruit extract of 250 mg/kg of body weight, the activity of ROS scavengers such as glutathione peroxidase, glutathione reductase, superoxide dismutase (SOD) and catalase is shown to increase considerably. Use of above mentioned dose of bael fruit extract shows better results than glibenclamide (36 ìg/kg). The antioxidant activity may be due to presence of flavonoids, alkaloids, sterols, tannins, phlobatannins and flavonoid glycosides (Kamalakkannan and Prince 2003; Singh and Malik, 2000). The rambutan unpigmented fruit flesh, does not contain significant polyphenol content, but its colorful rind displays diverse phenolic acids, such as syringic, coumaric, gallic, caffeic and ellagic acids having antioxidant activity in vitro. Ethanol extract of rambutan fruit peels

contains ethyl gallate (Muhtadi, *et al.*, 2016) which has the strong antioxidant activity. Ethanol extract of rambutan fruit peels are known to have a greater ability as an antioxidant to capture DPPH free radicals than vitamin E (Tamimy, 2006). In rambutan variety**,** ethyl acetate extract of rambutan peels had the highest DPPH scavenging activity with IC50 3.5 ìg/mL, while ethyl acetate extract of binjai rambutan peels had the highest FRAP capacity with EC50 77.1 ìg/mL. N-hexane extract of binjai rambutan peels had the highest total flavonoid (3.46 g QE/100 g), ethyl acetate extract of lebakbulus rambutan peels had the highest phenolic content (40.9 g GAE/100 g) and n-hexane extract of rapiah rambutan peels had the highest carotenoid content (0.61 g BE/100 g). There was a positively high correlation between total phenolic content with their antioxidant activity using DPPH and FRAP assays. In rambutan peel, the extraction of antioxidant compounds, FRAP ranged from 3800.25±86.49 to 4116.5±88.41 (ìmol Fe2+/g D.W), flavonoid from 6.41±0.48 to 8.57±0.35 (mg Quercetin/g D.W), and total phenolic recovery from 297.78±4.06 to 358.42±4.63 (mg GAE/g D.W.) (Azaria and Pi –Jen, 2015). Antioxidant properties in aonla fruit exhibit due to the presence of phenolic compounds (Anila and Vijayalakshmi, 2002; Sabu and Khuttan, 2002; Kumar *et al*., 2006). Total polyphenolic content of different aonla varieties fresh fruits ranged from 70.6 to 159.4 mg GAE/g. Significant difference ($p < 0.05$) was observed in total polyphenol content of different varieties. Similarly, total polyphenol content in aonla powders varied from 90.5 to 385 mg/g, showed significant ($p < 0.05$) varietal difference. Jamun fruit has been reported for strong antioxidant and anti-genotoxic potential. Different parts of this plant are used in herbal formulations. The pulp of the fruit contains diglucoside of five anthocyanidins (Arun *et al.,* 2011; Li *et al.,* 2009). Anthocyanins exhibit anticarcinogenic properties such as induction of cell-cycle arrest and apoptosis, as well as the inhibition of tumor formation and growth in animals (Sabu and Khuttan, 2002). Kokum fruit has high antioxidant properties (Krishnamurthy and Sampathu, 1988; Mishra *et al*., 2006). Choloroform extracts of *G. indica* fruit rinds exhibited excellent antioxidant activities in â-carotene-linoleate and DPPH assays (Tamilselvi *et al.*, 2003). Aqueous extracts of *G.indica* fruits acts as very good antioxidants as evident from their DPPH and lipid peroxidation assays. Aqueous extracts of kokum inhibit ascorbate-Fe2+ induced lipid peroxidation in rat liver mitochondrial fractions (Mishra *et al.*, 2006). Organic acids like citric acid and malic acid from *G. indica* also acts as good antioxidants (Swami *et al*, 2014). *G. indica* bark exudates showed its total phenol and xanthone content as 53.43 g/100g and 32.42 g/100g respectively, revealing it as a potential source of antioxidants (Parthasarathy and Nandakishore, 2016). Palakawong *et al.* (2010) have evaluated the 50% ethanolic extracts of peel, leaves, and bark of mangosteen and found that the highest antiradical activities using DPPH radicals with IC50 of 5.94 ìg/ml, followed by bark 6.46 and leaves 9.44 ìg/ml. Ethanol and n-hexane extract of karonda fruits showed significant antioxidant activities in both extracts compared to ascorbic acid, ASA and tertbutyl- 1-hydroxytoluene (BHT) in 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging with IC of 1.44 and 1.98 ìg/ml of ethanolic extract and n-hexane extract, respectively. Total antioxidant activity and total phenolic content in karonda fruit were comparable to vincristine sulfate, having IC values of 3.43 and 2.66 of ethanolic extract and n-hexane extract, respectively.

3.4 Anticancer activity

Several mnoir fruits have anticarcenogenic properties. Extracts of different plants of sour sop (*Annona muricata)* are well known for their medicinal values. It has been found that the compound present have a variety of anticancer effects including cytotoxicity (Zeng *et al*., 1995; Kim *et al.,* 1998), induction of apoptosis (Eggadi *et al*., 2014), necrosis (Torres *et al*., 2012), and inhibition of proliferation on a variety of cancer cell lines, including breast, prostate, colorectal, lung, leukemia, renal, pancreatic, hepatic, oral, melanoma, cervical and ovarian cancers. The bark, fruit, leaves, root, and seeds, are used as natural medicines in the tropics (Adewole and Ojewole, 2010). The study on methonlic extracts of leaves of jack fruit showed inhibitory effect on various cariogenic bacteria (Sato *et al.,* 1996). The extracts of bael for cytotoxic action using brine shrimp lethality assay; sea urchin eggs assay, and MTT

assay using tumour cell lines. The extract of Aegle marmelos was found to exhibited toxicity on all used assays (Leticia and Costa, 2005). Anticancer effect of hydroalcoholic extract of bael leaves in the animal model of Ehrlich ascites carcinoma and proposed that induction of apoptosis may be due the presence of Skimmianine in extract (Jagetia *et al*., 2005). The anthocyanin i.e., cyanidin-3-glucoside present in kokum fruits decreased the number of non-malignant and malignant skin tumours in the two staged skin carcinogenesis and also caused a dose-dependent inhibitory effect on the migration and invasion of metastatic A549 human lung carcinoma cells (Ding *et al*., 2006). In extract of fruits of karonda was found effective for breast cancer. Free radical scavenging and anticancer activity analysed by DPPH and MTT assays; invasive ductal carcinoma breast cancer protein –aromatase was selected as target which is an oestrogen-synthesising enzyme. IC50 concentration of extract was 86.7308 (µg/ml) found effective against MCF-7 cell lines (Kiruthika *et al*., 2019). Decoction of fruits of passion fruit was found inhibiting activity of gelatinase matrix metalloproteinases (MMP-2 and MMP-9), two metallo-proteases involved in the tumour invasion, metastasis and angiogenesis (Puricelli *et al*., 2003).

3.5 Anti microbial properties

The ethnolic extract of dried fruit pulp of *bael* was found effective against various intestinal pathogens i.e. *Shigella boydii, S. sonnei & S. Flexneri.* This was due to presence of certain phytochemicals such as phenols, tannins and flavonoids (Maheshwari *et al.,* 2009). It was also confirmed by Kaur *et al.* (2009) by getting treat *E. Coli* with bael fruit extract. Citarasu *et al.* (2003) found positive bactericidal effects of bael on certain pathogenic bacteria like *Salmonella typhi, Pseudomonas aeruginosa, Aeromonas hydrophyla* and *Vibrio sp.* The rambutan peel extract exhibited antibacterial activity against five pathogenic bacteria. The most sensitive strain, *Staphylococcus epidermidis*, was inhibited by the methanolic extract (MIC 2.0 mg/mL) (Fidrianny 2015). The methanolic extracts of stem, roots, bark and leaves and seeds of jack fruit exhibit broad spectrum antibacterial properties against various gram positive and negative bacteria (Jagtap and Bapat, 2010; 2013). However the butanol fractions of root bark and fruit have much promising antibacterial activity (Khan *et al.,* 2003). Methanolic extracts of the stem and root, barks, heartwood, leaves, fruits, and seeds of jackfruit have exhibited abroad spectrum of antibacterial activity (Khan *et al.,* 2003). Aqueous and methanol extracts of *Garcinia indica* leaves and fruit rinds showed antibacterial activity against *Salmonella* species (Pasha *et al.*, 2009). Methanol and petroleum ether extracts of both roots and fruits of *Carisaa carandas* compared with standard drug ciprofloxacin (antibacterial activity) and fluconazole (antifungal activity) (Mishra *et al.,* 2009). *G. xanthochymus* showed prominent zones of inhibition against *Vibrio cholera*, *Salmonella typhimurium*, *Shigella flexnerii*, *Streptococcus pyrogens*, *Streptococcus mutans* and *Candida parapsilosis* (Murmu *et al.*, 2016).

3.6. Anti-inflammatory activity

The extract of leaves of bael have anti-inflammatory, antipyretic & analgesic and the extract caused a significant inhibition of the carrageenan-induced paw oedema and cotton-pellet granuloma in rats (Arul *et al.*, 2005). Ghangale (2008) evaluated aqueous extract of bael for anti inflammatory activity by using rat paw oedema model and found anti-inflammatory activity. Shankharananth (2007) found that methanolic extract of leaves of bael @ 200 and 300 mg/ kgBW show significant analgesic activity on acetic acid induced writhing and tail flick test in mice. Rambutan is reported to have many biological activities (Suganthi and Josephine, 2016; Nethaji *et al.*, 2015). The study of anti-inflammatory activities of the aqueous extract of the peel of rambutan *cv.* Malwana special revealed that total phenolic content and the total flavonoid content of AEPR were 463.5±5.2 mg (PGE)/g and 375.0±13.2 mg (QE)/g respectively. The 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of AEPR was 3.9-64.5% for concentrations of 10–500 ìg/ml. The hydroxyl radical scavenging activity of AEPR ranged from 10.3-35.0% for concentrations of 1000–1500 ppm. The protection reported for Human Red Blood Cell (HRBC) assay was 17.1-34.8% for concentrations from 35.5-250.0 ppm. Aspirin protection ranged from 32.3-54.5%.

These results show that the AEPR prepared from peelwaste has a potential to be used as an antioxidant and also it possesses anti-inflammatory activity (Uduwela *et al.,* 2019). The anti-inflammatory effects of methanol extract of dried fruits of karonda@400 mg/kg showed significant inhibition of paw volumein carrageenan-induced hind paw oedema in rats (Anupama *et al.,* 2014).

3.7. Antifungal activity

Kokum rind extract showed antifungal effects against *Candida albicans, Penicillium* sp. and *Aspergillus flavus* (Varalakshmi *et al.*, 2010; Tamilselvi *et al.*, 2003). An anti fungal protein was isloted from passion fruit seed. The iso-lated 67-kDa protein, designated as passiflin, exhibited an N-terminal amino acid sequence closely resembling that of bovine beta-lactoglobulin (Lam & Ng, 2009). Patil (2009) reported the antifungal activity of ethanolic extract of the bael leaves. Rana (1997) evaluated anti fungal activity of essential oils isolated from the leaves of bael using spore germination assay. The oil exhibited variable efficacy against different fungal isolates and 100% inhibition of spore germination of all the fungi tested. It was proposed that from bael leaf essential oil may interfere with the Ca-dipicolonic acid metabolism pathway and possibly inhibit the spore formation. Pitre and Srivastava (1987), demonstrate the antifungal activity of ethanolic root extract against *Aspergillus fumiganus and Trichphyton mentagrophytes*. Jackfruit is also known for its antifungal properties. The studies of jackfruit seeds shown to inhibit growth of *Fusarium moniliforme* and *Saccharomyces cerevisiae* (Trinade *et al.,* 2006). It was found that a chitin-binding lectin namedjackin present in the seeds has ability to inhibit the growth of *Fusarium moniliforme* and *Saccharomyces cerevisiae*.

3.8. Hyperlipidemic activity

Hydroxy citric acid is the main active ingredient of most of the species of genus *Garcinia*. It acts in inhibiting the recapture of serotonin, inhibiting acetylcholinesterase, increasing the oxidation of fatty acids, and reducing lipogenesis. The lipid levels were maintained at near normalcy when co-treated with *Garcinia cambogia* extract in dexamethasone administered rats (Mahendran and Devi, 2001). *Garcinia cambogia* showed an antiobesity effect and a significant reduction in the values of triacylglycerol (TAG) of the adipose tissue and liver of the tested groups; however, it significantly increased the TAG pool of the gastrointestinal system. The antiobesity effect and significant reduction of triacylglycerol was also exhibited by aqueous extract of the rind of kokum fruits. Aqueous extract of *Carissa carandas* has been investigated for lipid-lowering activity in egg yolk-induced hyperlipidemic rats. The researchers concluded that the extract exhibited a significant reduction in body weight, cholesterol, triglycerides, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) in model-induced rats. All the results were compared with the standard drug, atorvastatin. Even the histopathological changes in high-cholesterol diet have been reduced significantly with the extract (Sumbul and Ahmed, 2012).

3.9. Hepatoprotective activity

Singanan *et al*. (2007) worked on bael leaf extract on alcohol induced liver injury in albino rats and presented data of excellent hepatoprotective effects. Similarly, Ramnik Singh and Rao (2008) also demontrated that aqueous extarct of bael fruit pulp and seeds are effective in the treatment and prevention of CCl4 induced hepatic toxicity. Methanolic extract of karonda leaves showed hepatoprotective activity using carbon tetrachloride-induced hepatotoxicity in albino rats. The results was as effective as silymarin-treated animals (Bhati *et al*., 2014).

3.10. Antiulcer activity

Oral administration of pyranocoumarin isolated from the seeds of bael showed significant protection against pylorus-ligated and aspirin-induced gastric ulcers in rats and cold restraint stress-induced gastric ulcers in rats and guinea pigs (Goel,1997; Dhuley, 2004) reported that pretreatment of rats with unripe bael fruit extract produce a significant inhibition of absolute ethanol induced gastric mucosal damage. The anti-ulcer activity had examined with different extracts of karonda using petroleum ether, chloroform, alcohol applied on different models using acetic acid-induced chronic gastric ulcer, pylorus ligation and even ethanol-induced acute gastric ulcer, respectively. Oral administration of 500 mg/kg of all extracts would

have enhanced the healing of acetic acid-induced chronic gastric ulcers. Among all the extracts, alcoholic extract showed significant activity in pylorus ligation and stress-induced ulcer. It is concluded that the alcoholic extract of the plant would possess highly potent effect when compared to other extracts (Merai and Jadhav, 2014).

3.12. Anti thyroid activity

Panda and Kar (2006) isolated scopoletin (7-hydroxy-6-methoxy coumarin) from bael leaves and evaluate for its potential to regulate hyperthyroidism. It was observed that scopoletin (at 1.00 mg / kg, p.o. for 7 days) to levo-thyroxine treated animals, decreased serum thyroid hormones level. It was also proved that the scopoletin have superior therapeutic activity than the standard antithyroid drug, propylthiouracil.

3.13. Antinociceptive and anthelmintic activity

Methanol leaf extract of crude drug was investigated for antinociceptive, anthelmintic and cytotoxic activities.Antinociceptive effect of *Carissa carandas* was determinedusing acetic acid-induced writhing assay in Swiss albinomice, whereas in case of anthelmintic activity, the fresh juice of plant leaves was evaluated by recording the time duration of paralysis and the death of *Pheretima posthuma*, earthworms. The cytotoxic activity of methanolleaf extract was analysed using brine shrimp lethality bioassay. Results revealed the potency of the plant that it possesses significant antinociceptive and anthelminticactivity. Methanol leaf extract showed marked cytotoxicproperty as compared with vincristine sulfate used as standard drug (Prveen, 2018).

3.14 Antidiarrhoeal activity

The ethanolic fruit and root extracts of *Carissa carandas* @ 200 and 400 mg/kg BW considerably reduced the total number of wet faeces, compared with standard drug, loperamide (5 mg/kg). Even the ethanol fraction of both plant parts decreased the propulsion of charcoal meal through gastrointestinal tract when compared to atropine sulfate as standard drug. Results revealed the fact that the highest doses of both the plant part extract contained similar effects (Mishra and Sasmal, 2015). In case of chronic diarrhoea and dysentery without fever, half ripe or unripe fruit of bael acts as a remedy. Half ripe fruit is considered best for the purpose but fully ripe fruits or even fruit powder has shown effective results. When the fruit is still unripe, it is cut, dried and ground into powder. The unripe fruit can also be consumed by baking and then consumption with brown sugar or jaggery. After use of fruit, the amount of blood passed in the faecal matter reduces and the faecal matter gets a more solid form (Sharma *et al*., 2006; Patel *et al*., 2012).

Conclusion

It is quite evident from this review that a minor fruits contain a number of phytoconstituents which reveals its uses for various medicinal and therapeutic purposes. The fruits and other plant parts are being used in the folk and tradiotnal medicines by the local inhibitants since long. Some the researches on the phytochemicals present in these speices are being analised and documented. The validation of these pepoerties is also in the progress for the treatment of various disorders in human being such as, diabetes, liver toxicity, fungal infection, microbial infection, inflammation, pyrexia and to relieve pain. Although a part of these fruits have been studied for their medicinal properties, substantial scientific data is still lacking and theresearches are still at a very preliminary stage. Still, very few fruits ahve been studied and most of the much work is required to csriied out in most of these fruits. As the global trends on plant based medicines is radidly growing. The studies need to be performed for the fruits to investigate the mechanism of actions with other therapeutic activities.

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