

ANTI-CANCER POTENTIAL PLANTS FROM BAHRAICH (UTTAR PRADESH) INDIA

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ABSTRACT

On November 21, 2017 in Deink Jagran Daily Newspaper Page 13, there was an information that the daily consumption of four fruits viz., Bel, Jamun, Karonda and Falsa has potential to cure cancer, this information has been the outcome of the research held in the Division of Biochemistry, Faculty of Basic Sciences and Cancer Pharmacology, Division of Indian Institute of Integrative Sciences, Sher- E- Kashmir Agricultural Sciences and Technology University, J&K. As per Dr. Vikash Sharma Assistant Professor, these fruits are not only for cure specially Lung Cancer it is also a prophylactic medicine. He also told

that Karalla and Awala has also such properties. Since all these plants are found in enormous number in not only Bahraich but these all are common in UP. The ethno botanical potential of these novel plants has to be work out and known to the mass by one way or the other.

KEYWORDS: Cancer, Bahraich, Phytochemicals, Ethnomedicinal, Ethnobotanical Potential.

INTRODUCTION

We cannot survive without plants. We depend on plants for food: directly in the form of grains, roots and tubers, fruits, vegetables, spices, oil and beverages. Much of our food also comes indirectly from plants. We get our meat and milk from animals that are dependent on plants for food. Plants provide fuel, either as firewood or in the form of fossil fuel, to cook our food, keep us warm, run our machinery and light up our homes and cities. We also depend on trees for construction materials to build our houses and to craft our furniture. From cotton and flax, we get fibres for our clothes. Plant dyes colour our clothes, at least before synthetic dyes were developed. In cities and towns, trees provide shade and shelter, and their

flowers brighten the surroundings, Plants in parks and gardens contribute to the serene and peaceful environment, making such places favourite retreats (Chin, 2005).

The knowledge of utilizing wild plants was pains takingly passed on from generation to generation database of valuable information of the plants around him. It is natural to assume that certain members of the tribe were gradually entrusted with such knowledge. These were variously known as shamans, bomohs, healers or witchdoctors. As communications between settlements was then poor, it is likely that such knowledge developed independently in various locations (Chin, 2005). The primitive man, through his trial and error, has selected many wild fruits which are edible and subsequently domesticated them which played a very vital part in supplementary diet knowingly or unknowingly. Although due to the ignorance of modern generation the importance of wild plants was recently have been decreasing yet many people especially in rural areas still use them extensively as a supplementary to their basic food requirement. A scientific study of wild fruits is important for the potential sources which are protective foods. The nutrients/pigments present in the fruits prevent different degradative/ageing process in our body and thus via restoring health offer longevity (Singh, 2011). These wild fruits would be utilized at the time of scarcity or cultivated as a source of food material for ever increasing population (Rashid et al., 2008).

Biological resources are being viewed as national capital, waiting to be tapped for their potential utility, but at the same time demanding to be conserved for posterity. India being a tropical subcontinent has always supported a wonderful diversity of plants. Indian culture made use of its plant resources to maintain the health of the society, people and pets alike. Several traditions, rituals, taboos, totems, similes and beliefs related with plants, also got associated with the life of the Indian people. Plants also became intricate part in various spheres of the human society. The knowledge of use of plants got transferred from one to another generation since time immemorial. A respectable number of plants are being used curing various ailments and for edible purposes. Many species used during emergency and famine are not known to urban people but frequently used by tribal's. Due to several natural and manmade factors a respectable number of such plants are passing through serious threat. India has been considered as one of the 17 mega-diversity centres of the world with a wide range of Phyto-geographical variations. It consists of about 64 million hectares forest covers out of which 86% is tropical forest comprising 54% dry deciduous, 37% moist deciduous and 9% wet evergreen & semi-evergreen (Kaul and Sharma, 1971). As a characteristic feature,

the tropical forest shows a huge variation in tree species diversity place to place (Pitman et al., 2002). Among the different Phyto diverse regions found in the country, the Terai region is one of them existing from Uttarakhand to West. Bengal. It is the transition zone between two eco-climatic zones, the Gangatic plain towards south and Bhabhar towards north, along with the sub- Himalayan tracts (Tripathi and Singh, 2009). The region has lost majority of its natural forest due to deforestation chiefly for agriculture and lack of sustainable forest management in last many centuries (Bajpai et al., 2012 a, b). Now the natural forests of the region have been restricted to the wildlife protected areas only. Katarniaghat Wildlife Sanctuary (KWS) is also one of them.

Medicinal plants were used by people of ancient cultures without knowledge of their active ingredients. There is an ever increasing need to limit toxic clinical drugs (Lowan,1993). Plants produce a diverse range of bioactive molecules making them a rich source of diverse types of medicines (Stuffiness, et al.,1982). About 50% of all modern clinical drugs are of natural product origin and natural products play a vital role in modern drug development in the pharmaceutical Industry.

Traditional medicines are used by about 60 percent of the world's population. These are not only used for primary health care just in rural areas, in developing countries, but also in developed countries, where modern medicines are predominantly used. While the traditional medicines are derived from medicinal plants, minerals, and organic matter, the herbal drugs are prepared from medicinal plants only. Use of plants as a source of medicines has been inherited and is a vital component of the health care system in India. There are about 45,000 plant species in India, with high concentration in the region of Eastern Himalayas, Western Ghats and Andaman Nicobar Island. The officially documented plants with medicinal potential are 3,000 but traditional practitioners use more than 6,000. India is the largest producer of medicinal herbs and is appropriately called the botanical garden of the world. In rural India, 70 percent of the population is dependent on the traditional system of medicine, the Ayurveda, which is the ancient Indian therapeutic measure renowned as one of the major systems of the alternative and complementary medicine (Bhatia, et al., 2013).

The available literature reveals that most of the tree plants are multipurpose, ethnobotanical, nutrimental, ethnomedicinal, ethnoveterinary and of environmental use in Agro-forestry which provide shade, habitat for organisms, soil improvement, etc, many useful products are also obtained such as fruits, timber, fire wood and variety of metabolic chemicals which may

be used in the form of home remedies and for traditional medicine. Considering the multipurpose importance of these trees, the present overview is an attempt to summarise the information's available on these four plants viz., *Aegle marmelos*, *Carissa carandas*, *Grewia asiatica* and *Schizigium cumini* which are yet not popular due to one reason or the other despite providing an array of benefits.

STUDY AREA

The study area Katerniaghat Wildlife Sanctuary (KWS) is situated in Bahraich district of Uttar Pradesh in India. It lies along Indo-Nepal international boarder and is situated between 270 41' – 270 56' N and 810 48' – 810 56' E covering an area of 440 km² with 116 to 165 m elevation. The sanctuary comes under the tropical moist deciduous forest of the Himalayan Terai-Bhabar region (Champion and Seth, 1968; Rodgers and Panwar, 1988). The forest of the sanctuary area has been classified into two major forest types (i) The Sal forest and (ii) The miscellaneous forest (Champion and Seth, 1968). Pedagogically the study area is made up of the alluvial soil of the Kaudiyala and Saryu rivers and its tributaries flowing adjoining to it. Geologically the sanctuary area has been divided into high and low land areas.

CLIMATE

A typical tropical monsoonal climate with three distinct seasons i.e. summer (April to June), winter (November to February) and warm-rainy (July to September) prevails in the study area. March and October are considered as transition months between the seasons. The mean maximum temperature ranges from 22°C in January to 40°C in May and the mean minimum temperature ranges from 8°C in January to 27°C in June. The annual rainfall ranges from 36 to 142 cm in winter, 34 to 662 cm in summer and 1294 to 1689 cm in warm-rainy seasons (Bajpai *et al.*, 2012).

Enumeration

1. *Aegle marmelos* (L.) Corr.; Bael, Bel, Sirphal (Rutaceae)

It is a medium-sized, deciduous, armed tree. Leaves trifoliate. Flowers yellowish. Fruits large, globose. Phenology- April-May & March-July. In Katerniaghat Wildlife Sanctuary *Aegle marmelos* is found only in teak plantation forest with IVI value 3.8.

Phytochemicals

Aegle marmelos has been reported to contain several Phyto chemicals mainly marmenol, marmin, marmelosin, marmelide, psoralen, alloimperatorin, rutaretin, scopoletin, aegelin,

marmelin, fagarine, anhydromarmelin, limonene, α -phellandrene, betulinic acid, marmesin, impertorin, marmelosin, luvangentin and auropetene (Rahman and Parvin).

Ethno-medicinal Potential

Bael is one of the most important tree species used in various indigenous system of medicine in India, China, Burma, and Sri Lanka. Bael is used in all tridosas- vata (air), Pitta (phlegm) and kapha (cough). Out of more than 66 ethnobotanical uses of bael, 48 are exclusively for medicinal purposes. Almost all parts of bael are used in preparing medicine (Kala, 2006).

Leaf: Abscess, backache, eye complaints, abdominal disorders, vomiting, cut & wounds, ulcer, destroy, beriberi, weakness of heart, cholera, diarrhoea, cardio tonic, blood sugar, injuries caused by animals, nervous disorders, hair tonic, acute bronchitis, child birth, veterinary medicine for wounds, killing worms, fodder for sheep, goat and cattle, stimulation of respiration and contraction of de-nervosed nictitating membrane in anaesthetized cats.

Fruit: Astringent, diarrhoea, gastric troubles, constipation, laxative, tonic, digestive, stomachic, dysentery, brain & heart tonic, ulcer, antiviral, intestinal parasites, gonorrhoea, epilepsy.

Root: Dog bite, gastric troubles, heart disorders, intermittent fevers, ant-amoebic, hypoglycaemic, rheumatism.

Bark: Stomach disorders, intermittent fevers, heart disorders.

Seed: Febrifuge.

Flower: Expectorant, and in epilepsy.

Whole Plant: Abdominal pain, abscess, astringent backache, dog bite, breast pain, cholera constipation, convulsions, cramp, diabetes, diarrhoea, dysentery, fevers, eye complaints, gastric trouble, abdominal disorders, jaundice, laxative, nausea night fever, heart disorders, snakebite, stomach disorder, vomiting tonic, cut & wounds.

Seed oil: Laxative.

Wood: Beads worn by low caste, special couches for rheumatic patients.

The medicine is prepared in the form of pills, powder and paste. Ayurvedic practitioners commonly use the roots of bael as an ingredient of dasmula (ten roots), which is useful in recovering the loss of appetite and the fruit is also used in the preparation of chawanprash.

Bael fruits regarded as an astringent are frequently used by various ethnic communities for the treatment of diarrhoea, dysentery, constipation, stomach-ache, intestinal ulcer, diabetes, dyspepsia, heart diseases and cholera due to its digestive and carminative properties.

Bael is highly valued in Ayurvedic medicine for the treatment of chronic diarrhoea and dysentery and also as brain tonic.

Bael possesses antiviral, anti-helminthic anti-inflammatory, anti-bilious, anti-parasitical, anti-pyretic, anti- scorbutic, aromatic, astringent, digestive, febrifuge, haemostatic, anti-diarrheal, laxative and nutritive properties.

Ripe bael fruit is sweet, aromatic and nutritive, whereas fresh fruit is stringent and has laxative properties.

Bael fruit powder exhibits anti-cancerous and anti-proliferative activities.

The combinations of five parts of bael such as, fruit, leaf, bark, root and flower are assumed to be effective for certain mental disorders.

Unripe fruits pulp mixed with boiled rice water is taken twice a day to cure vomiting in pregnancy.

Unripe fruits pulp mixed with sugar is taken with milk twice daily for curing urinogenital disorders.

Half roasted unripe fruit pulp mixed with equal quantity of sugar is taken twice a day to cure dysentery.

Unripe fruit pulp powder is taken twice daily to cure abscess.

Bael leaf extract is taken twice a day to remove the intestinal worms.

Leaf poultice is used as remedy in ophthalmic problems and ulcer.

Leaf juice is reported to have multiple medicinal uses, including controls of diabetes. Cooling delicious drink prepared from fruit pulp along with sugar and tamarind diluted with water is useful for health.

Bael root decoction is given twice daily to cure fever and cold. Extract of bael root, pyaz (*Allium cepa* Linn.), and haldi (*Curcuma domestica* Valetton) mixed in equal proportion is put in the ears to relive earache and secretion from ears. Root decoction is used in the treatment of intermittent fevers and heart palpitation.

Root and stem bark decoction is used in the treatment for fever and various types of heart disorders. Bael root is used in the treatment of abdominal pain, heart palpitation and urinary troubles.

Bael tea is good for health and is used for flatulence, gastrointestinal problems, cough and chronic intestinal diseases in children.

Due to the presence of various Phyto constituents the plant has antidiarrheal, antimicrobial, anticancer, antipyretic, antigenotoxic, antifertility, anti-inflammatory antidiabetic and diuretic activities.

The essential oil isolated from the leaves of *A. marmelos* tree has proved to have antifungal activity against animal and human fungi like *Trichophyton mentagrophytes*, *Trichophyton rubrum*, *Microsporum gypseum*, *Microsporum audouinii*, *Microsporum cookie*, *Pidermophyton floccosum*, *Aspergillus niger*, *Aspergillus flavus* and *Histoplasma capsulatum*.

The leaf extracts and fractions have fungicidal activity against various clinical isolates of dermatophyte fungi.

Various extracts of *A. marmelos* leaves, roots ad fruits have been reported to be active against many bacterial strains.

Various extracts of *A. marmelos* leaves, roots ad fruits have been reported to be active against many bacterial strains.

The fruit pulp is administered to cure diarrhoea.

The stem bark is used to cure eye diseases.

The leaves of *A. marmelos* is used as a part of formulation for treatment and Prophylaxis of malaria. The formula consists of *Aegle marmelos* + *Ailanthes excels* + *Andrographis paniculate* + *Aristolochia indica* + *Azadiracta indica* + *Trachyspermum ammi* + *Nyctanthes arbor-tristis* + *Ocmum tenuiflorum* + *Piper longum* + *Piper nigrum* + *Pongamia pinnata* + *Zingiber officinale* + *Ziziphus mauritiana*. Most of the plant parts used to treat malaria are not stored except the fruits of *Piper longum*, *Piper nigrum* and the dried rhizome of *Zingiber officinale*. All the plants are collected fresh, crushed and ground to make pea-sized tablets which are dried under shade. The tablets are stored in air-tight bottle. The amount of plants parts for concoction in order to make tablets are reported in terms of handful. However, the amount of fruits of *Piper longum*, *Piper nigrum* should be twenty-one in number. Two tablets are given twice a day for five days with warm water followed by one tablet per day for five days for complete cure (Marandi *et al.*, 2015).

Decoction prepared in two hundred ml water with about 25 g root is taken twice a day to cure vomiting (Begum and Nair, 2011).

Powdered dried leaves mixed with a cup of cow's milk is taken orally in Cardio vascular problems. The leaves juice is given in case of emetics (Prakasha *et al.*, 2010).

Root, stem and bark decoction is used for intermittent fever, diarrhoea and gastric troubles; leaf poultice is used to cure ophthalmia; roasted tender leaves are used in venereal diseases unripe dried fruits are taken for diarrhoea and dysentery (Sukumaran and Raj, 2010).

Young fruits and leaves are used to treat pneumonia loss of appetite, in digestion and diarrhoea (Rout and Panda, 2010).

Ethno-botanical Potential

For Hindus, the Bael is sacred tree, which they dedicate to the lord Shiva by offering of Bael leaves. Its three leaflets are assumed by the symbols of three gunas or attributes (e.g., satva, rajas and tamas, literally meaning morality, superiority and immorality, respectively); three Gods (Brahma, Vishnu and Mahesh); and three lives (past, present and future). Bael is extremely auspicious and cultivated around most of the Hindu temples.

Gum around seed is used to improves adhesive strength of water paints.

Unripe fruit rind, and bark produces yellow dye which is used in calico printing.

Stem is used to prepare pestles of oil and sugar mills.

Bael fruits are edible, contain high protein and are used in making tasty aromatic cold drinks and jam. Its fresh juice is better and pungent. Fruits are used as a substitute for soap, as source of essential oils and perfumes.

The mucilage of bael seed is a good cementing material.

Bael wood is used in building houses, making carts, agricultural implements, pestles, handles of tools and combs. An essential oil is also distilled from the rind.

Dried fruit after removing the pulp are used as pill boxes for keeping valuable medicines and sacred ashes.

Bael stem yields gum, which is used for improving the adhesive potency of water paints. Its wood is suitable for making charcoal.

The root bark is used as fish poison and the seed mucilage is used for plaster of walls.

Fruits are edible, medicinal, religious, and source of gum and resin (Bajpai *et al.*, 2015).

Fruits are antispasmodic and are used in indigestion and asthma.

The leaves juice is used in diabetes and oedema.

Leaves are used in wounds of cattle's.

Fruits are used as digestive (Murtem and Chaudhary, 2016).

The oil obtained from unripe fruits is useful in removing the peculiar burning sensation in the soles (Kaur, 2015).

Ethnoveterinary Potential

About 500 g leaves is made into paste by grinding and mixed with 100ml seed oil of *Ricinus communis*. This paste is applied over skin affected till the rest due to sun burn (Verma, 2014).

The animals are fed with an unripe or half ripe bael along kitchen wastes twice a day. Sometimes unripe bael is burned and then it is given to animals to check diarrhoea. This also helps solidifying the dung (Saha *et al.*, 2010).

Pipened fruits pulp is given twice daily till the cure of internal injury by fire (Satapathy, 2010).

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2. **Carissa carandas** Auct., Bengal, Currant, Karonda, Karamardaka, Kau Li hannu, Kali maina, Karauna vakkaya, Kerenda, Karaunda (Apocynaceae):

Synonyms: *Arduina carandas* (L.) Baill., *Arduina carandas* (L.) K. Schu., *Carissa congesta* Wight, *Capparis carandas* (L.) Burm.f, *Carissa salicina* Lam., *Echites spinosus* Burm.f., *Jasminonerium carandas* (L.) Kuntze, *Jasminonerium salicinum* (Lam.) Kuntze.

Carissa carandas grows naturally in the Himalayas at elevations of 30 to 1,800 m, in the Siwalik Hills, the Western Ghats and in Nepal and Afghanistan. It flourishes well in regions with elevated temperatures. In India it is grown on a limited scale in Rajasthan, Gujarat, Bihar, West Bengal and Uttar Pradesh. It is also growing in the Sri Lanka lowland rain forests. Its origin is India, but it is grown in Afghanistan, India, Nepal and Sri Lanka.

Carissa carandas is a species of flowering shrub in the dogbane family, Apocynaceae. This species is a rank-growing, straggly, woody, climbing shrub, usually growing to 3-5 m high, sometimes ascending to the tops of tall trees; and rich in white, gummy latex. The branches, numerous and spreading, forming dense masses, are set with sharp thorns, simple or forked, up to 5 cm long, in pairs in the axils of the leaves. The leaves are evergreen, opposite, oval or elliptic, 2.5-7.5 cm long; dark-green, leathery, glossy on the upper surface, lighter green and dull on the underside. The fragrant flowers are tubular with 5 hairy lobes which are twisted to the left in the bud instead of to the right as in other species. They are white, often tinged with pink, and borne in terminal clusters of 2 to 12. The fruit, in clusters of 3 to 10, is oblong, broad-ovoid or round, 1.25-2.5 cm long; has thin but tough, purplish-red skin turning dark-purple or nearly black when ripe; smooth, glossy; enclosing very acid to sweet, often bitter, juicy, red or pink, juicy pulp, exuding flecks of latex. There may be 2 to 8 small, flat, brown seeds. The karonda is native and common throughout much of India, Burma and Malacca and dry areas of Ceylon; is rather commonly cultivated in these areas as a hedge and for its fruit and the fruit is marketed in villages. The karonda was first fruited in the Philippines in 1915 and P.J. Wester described it in 1918 as "one of the best small fruits introduced into the Philippines within recent years." It produces berry-sized fruits that are commonly used as a condiment in Indian pickles and spices. It is a hardy, drought-tolerant plant that thrives well in a wide range of soils Phenology: March-July.

Phytochemicals

Isolation of many terpenoids has been reported (Zaki et al., 1983). Mixture of sesquiterpenes namely carissone (Pino et al., 2004) and carindone as a novel type of C31 terpenoid have

been reported. (Pal *et al.*, 1975) Other products include pentacyclic triterpenoid carissin. (Singh and Rastogi, 1972) Alkaloids, Flavonoids, Glycosides, Carbohydrates Sterols, Terpenoids, Tannins, Saponin are reported in different quantities in different plant parts (Mishra *et al.*, 2013). The roots of *C. congesta* have yielded many volatile principles including 2-acetyl phenol (Zaki *et al.*, 1983, Pino *et al.*, 2004). Pal *et al.* have reported a new ligna, carinol from root of *C. congesta* (Pal *et al.*, 1975). Whereas studies carried out by Rastogi *et al.* have led to isolation of a mixture of sesqui terpenes, namely carissone and carindone as a novel type of C31 terpenoid (Singh and Rastogi, 1972, Reisch *et al.*, 1990, Joshi and Boyce, 1957). The leaves were reported to have triterpenoid constitutes well as tannins, and a new isomer of urosolic acid namely carissic acid was also found (Siddiqui *et al.*, 2003, Naim *et al.*, 1988). Fruits of this plant were reported to contain a mixture of volatile constituents including 2-phenly ethanol, linalool, β -caryophyllene, isoamyl alcohol, benzyl acetate and a novel triterpenic alcohol, carissol. Enzymatic mild hydrolysis of polar glycoside from the plant yielded oderoside H, digitoxigenin and the sugars D-glucose and D-digitalose. Moreover, *C. congesta* contains crude protein 13%, polyphenols 7.8%, fixed oil 5.3 % hydrocarbons 58 % and free acid 31.4 %. Higher gross hest values of this species indicate that it can be used as fuel source. Essential oil from *C. congesta* was found to contain coumarin (Siddiqui *et al.*, 2003).

It has been reported that fresh leaves of *C. congesta* contain four pentacyclic triterpenoids including one new constituent carissin and two hitherto unreported compounds. The structure of the new triterpenoid has been elucidated as 3-p-hydroxy-27-E-feruloyloxyurs-12-en-28-oic acid. Complete assignment of the protons of the compounds has also been made based on 2D NMR studies (Siddiqui *et al.*, 2003).

Ethnobotanical Potential

C. congesta is the best known as member of the genus as it has been used as a traditional medicinal plant over thousands of years in the Ayurvedic system of medicine as it is practiced on the Indian sub-continent. The traditional uses of *C. congesta* are well established All the plant parts viz., leaves, fruits, root and dried stem bark are used in one way or the other.

The fruit is a rich source of iron, so it sometimes used in treatment of anaemia.

It contains a fair amount of Vitamin C and therefore, is an antiscorbutic.

Mature fruit is harvested for pickles.

It contains pectin and accordingly is a useful ingredient in jelly, jam, syrup and chutney. Ripe fruits exude a white latex when severed from the branch.

The roots of the plant are heavily branched, making it valuable for stabilizing eroding slopes. It is highly effective in anaemia.

It is effective in acid reflux, anorexia, anxiety.

Action of *Carissa carandas* is effective as analgesic, anthelmintic, and anti-diarrhoeal.

Carissa carandas combines with cardamom, honey, jiggery, lemon, sandalwood and sesame oil.

The root is credited with bitter, stomachic, antidiarrheal and ant anthelmintic properties.

The ripe fruits are utilized in curries, tarts, puddings and chutney.

When only slightly under ripe, they are made into jelly.

Green, sour fruits are made into pickles in India. With skin and seeds removed and seasoned with sugar and cloves, they have been popular as a substitute for apple in tarts.

The unripe fruit is used medicinally as an astringent. The ripe fruit is taken as an antiscorbutic and remedy for biliousness.

The fruits have been employed as agents in tanning and dyeing British residents in India undoubtedly favoured the karonda as being reminiscent of gooseberries.

Karonda leaves have furnished fodder for the tussar silkworm.

The leaf decoction is valued in cases of intermittent fever, diarrhoea, oral inflammation and earache.

A paste of the pounded roots serves as a fly repellent.

The root is employed as a bitter stomachic and vermifuge and it is an ingredient in a remedy for itches.

The roots contain salicylic acid and cardiac glycosides causing a slight decrease in blood pressure.

The white or yellow wood is hard, smooth and useful for fashioning spoons, combs, household utensils and miscellaneous products of turnery.

A higher gross heat value of this species indicates its higher potential to be used as good fuel source. It is sometimes burned as fuel (Addis *et al.*, 2001, Pakrashi *et al.*, 1968).

Fruits are edible and medicinal (Bajpai *et al.*, 2015).

Leaves are used in diarrhoea, earache, soreness of mouth and throat. Bark is used skin diseases and root in urinary disorders (Bajpai *et al.*, 2016).

Side effects

Massive intake for extended periods because it may affect sexual health and may reduce the semen production and leads to low libido.

Ethnomedicinal Potential

Various herbal drugs individually or in combination have been recommended for the treatment of different disease.

The *C. congesta* commonly known as karonda has been recognized in different system of traditional medicine to cure various diseases. It contains several phytochemical constituents belonging to terpenoids category.

The root is attributed with bitter, stomachic, antidiarrheal, vermifuge and an anthelmintic property.

The unripe fruit is used medicinally as an astringent.

The ripe fruit is taken as an antiscorbutic and remedy for biliousness.

The leaf decoction is valued in cases of intermittent fever, diarrhoea, oral inflammation and earache.

C. congesta has shown wide range of evidences for its cardiogenic, hepatoprotective, free radical scavenging and xanthine oxidase inhibitory, histamine releasing, antirheumatic, antibacterial, antiviral and anticonvulsant activity.

Pharmacological Activities

Anticonvulsant action

It has been reported that ethanolic extract of *C. congesta* has powerful anticonvulsant action on electrically and chemically induced seizures by unknown mode of action (Hegde et al., 2009).

Cardiotonic activity

The alcoholic extract of roots of *C. congesta* exhibited cardiotonic activity and prolonged blood pressure lowering effect. An amorphous water-soluble polyglycoside possessing significant cardiac activity has been isolated. The cardiac activity of water-soluble fraction has been attributed to the presence of the glucosides (Vohra and De, 1988).

Free radicals scavenging and xanthine oxidase inhibitory activity

The free radical scavenging activity of ethanolic and aqueous extracts of *C. congesta* been evaluated, in vitro, using 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging method and compared with ascorbic acid, quercetin and apigenin. The plant has demonstrated good DPPH radical scavenging activity.

Inhibitory effects towards the in-vitro reaction of hypoxanthine and xanthine oxidase (XO) was also carried out in the presence of plant extract, aglycones quercetin, and apigenin along with allopurinol XO inhibitory activity of Plant extracts, was comparable with aglycones but less than allopurinol.

Potential Hepatoprotective and Antioxidant activity

It has been proved that *C. congesta* has hepatoprotective and antioxidant action by Chatterjee et al. They have used Wistar albino rats to estimate serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), serum alkaline phosphatase (SALP), uric acid, total protein content and total bilirubin content. They have measured antioxidant action by estimating lipid peroxidation, reduced glutathione (GSH), super oxide dismutase (SOD) and catalase (CAT) activity in liver.

Histamine releasing activity

It has been proved that *C. congesta* have histamine releasing effect that was observed by estimating plasma histamine in cats, histamine content in rat hind-limb and histamine content of the lung tissue.

Antimicrobial action

It has been reported that ethanolic extract of *C. congesta* has potent antibacterial action against different test bacteria like *B. subtilis*, *S. aureus*, *S. faecalis*, *E. coli*, *P. aeruginosa* and *S. typhi murium*. Moreover, ethanol extract has also showed considerable anticandidal action.

Antiviral action

It has been reported that ethanolic extract of *C. congesta* possess potent antiviral activity against Sindbis virus (SINV) at 3 µg/ml, polio virus (POLIO), at 6 µg/ml HIV-1, and herpes simplex virus (HSV) at 12 µg/ml.

It was known that Root of *C. congesta* had antirheumatic property. Isolated carissone derivatives exhibited an anti-zymotic, antibacterial and atropine like spasmolytic activity. The lipase activity of fruit has also been studied. An aqueous extract of the root demonstrated anthelmintic, spasmolytic, cardiotoxic and hypertensive action in a preliminary pharmacological screening. It is reported that *C. congesta* has also good antipyretic activity.

CONCLUSION

Nowadays, herbal drugs are widely used as curative agent for different ailments. Concentrated extract of *C. congesta* can be found in various herbal preparations which are readily available in the market. *C. congesta* preparations have broad range of distribution in the market and employed by practitioner of natural health for the treatment of rheumatism. In the traditional system of medicine, *C. congesta* plant is used as cardiotoxic, hepatoprotective, free radical scavenger and xanthine oxidase inhibiting agent, histamine releasing agent, antirheumatic, stomachic; antidiarrheal, vermifuge, ant anthelmintic, astringent, antiscorbutic, antibacterial, antiviral and anticonvulsant. Moreover, it has good potential to be used as potent energy source.

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3. *Grewia asiatica* Linn., Phalsa, Shunkri, Phulsa, Phutiki, Unnu, Chadicha, Shukri, Falsay (Tiliaceae):

Synonyms: *Grewia hainesiana* Hole, *Grewia obtecta* Wall. *Grewia subinaequalis* DC.

Grewia asiatica (Phalsa or Falsa) is a species of *Grewia* native to southern Asia from Pakistan, India east to Cambodia, and widely cultivated in other tropical countries *Grewia celtidifolia* was initially considered a mere variety of Phalsa, but is now recognized as a distinct species.

It is a shrub or small tree growing to 8 m tall. The leaves are broadly rounded, 5–18 cm long and broad, with a petiole 1–1.5 cm long. The flowers are venkanna in cymes of several together, the individual flowers about 2 cm diameter, yellow, with five large (12 mm) sepals and five smaller (4–5 mm) petals. The fruit is an edible drupe 5–12 mm diameter, purple to black when ripe.

Phalsa originated in India and other parts of Southeast Asia, including Pakistan, Sri Lanka and Bangladesh. At of the early part of the 20th century, the fruit was introduced to Indonesia and the Philippines, where it has since naturalized. The Luzon province displays an abundance of the small, purple fruits in its lower elevations in dry zones. Today, it's an exotic plant in Thailand, Vietnam, Cambodia, and Laos.

Phalsa shrubs grow in the Himalayan regions of India, and thrive at elevations up to 3,000 feet. The major areas in India cultivating the fruit commercially are Punjab, Uttar Pradesh, Madhya Pradesh, Haryana, and Rajasthan. On a local level, the fruits also grow in Maharashtra, Gujarat, Bihar, Karnataka, Andhra Pradesh and West Bengal.

Few countries in the west cultivate phalsa, though some gardeners and research laboratories grow the fruit out of interest or for educational purposes. The easy growing conditions of Phalsa are one reason that they are an invasive plant in Australia and parts of the Philippines. When it comes to fruiting, however, phalsas are awfully fickle plants: unless the region experiences distinct seasonal changes between summers and winters, the shrub flowers sporadically and yields poor fruits. Most farmers grow the trees on the outskirts of the city wherever the land has loamy soils.

Phalsa is a summer fruit, ready for picking in the south from March through April, and in the north, from May to June. The harvesting season itself is short, lasting only three weeks. There

are other factors limiting phalsa's availability: The plant ripens unevenly, and each small fruit must be hand-picked—a laborious task. The yield per plant is also quite low, offering roughly 11kg per tree. Phenology: April-July.

Perishability is high, and buyers must consume fruit within a mere day or two of purchase. This short shelf life and risk of spoilage make it difficult for vendors to buy phalsas for sale to the public. As such, most fruits get sold by a handful of vendors with direct access to the trees.

Phalsa is green when unripe on the tree, slowly turning red when ripening and, at last, a deep purple when ready for harvest. Some phalsa fruits get plucked once they turn red with the expectation that they will become blackish purple within a week's time. At peak ripeness, the fruit's thin skin should be pliable and tender.

Many people—especially those growing up in Pakistan and northern India—have fond memories of the tiny fruit's vibrant taste. Phalsas have a sweetness beautifully counter balanced by astringent, acidic and sour notes. If needing comparison to other fruits, grapes, cranberry, and jamuns are the best bet. Phalsas resemble blueberries in appearance, but their sharp notes share no likeness with the shyer, milder fruits. The texture also mirrors a grape with its fleshy, whitish pulp.

Nutritional Value

According to a nutritional analysis conducted at Fort Valley, Georgia, phalsa fruits contain the following value per 100g: 90.5 Kcal, 0g Fat, 76.4g Moisture, 1.57g Protein, 21.1g Carb, 5.53g Fibre, 1.1g Ash, 136mg Calcium, 24.2mg Phosphorous, 1.08mg Iron, 372mg Potassium, 17.3mg Sodium, 16.11ug, Vitamin A .02mg Thiamin, .264mg Riboflavin, .825mg Niacin and 4.385mg Vitamin C

Phytochemicals

Plant parts are found to have all the essential mineral elements, carbohydrates, proteins, fatty acids and other active metabolites like flavonoids, tannins, phenols, alkaloids, steroids and triterpenoids, lignans, lactones, flavones, anthocyanins etc. (Patil et al., 2011, Ullah et al., 2011). *Grewia asiatica* contains anthocyanin type cyanidin 3- glucoside Nair, 2005 vitamin C, minerals and dietary fibres (Yadav et al., 1999). GCMS Analysis of *Grewia asiatica* shows the presence of Citric acid trimethyl ester (5.10%), alpha. -methyl-1 sorboside

(11.52%), stigmasterol (1.23%), campesterol (2.15%) and 9, 12- octadecadienoic acid, methyl ester (0.10%). (Gupta et al., 2012). A new δ -lactone i.e 3, 21, 24 trimethyl-5, 7-dihydroxy hentriacontanoic acid δ -lactone is isolated from the flowers of *Grewia asiatica* (Lakshmi et al., 1976). The flowers contain grewinol (keto alcohol) and tetratricontane-22-ol-13-one. The seeds contain 5% of a bright-yellow oil containing 8.3% palmitic acid, 11.0% stearic acid, 13.4% oleic acid, 64.5% linoleic acid; 2.8% unsaponifiable (Morton et al., 1987). In a study gas chromatography-mass spectrometry led to the identification of the principal component 2-(1-oxopropyl)-benzoic acid very similar to the active salt found in the standard drug Aspirin (2-acetyloxybenzoic acid) in Jwarhar Mahakashay ayurvedic preparation of which *Grewia asiatica* is a constituent. (Gupta et al., 2010). Pigments and total soluble solids have been obtained from pomace. Qualitative examination reveals the presence of Alkaloids, Sugars, Tannin & Phenolic compound, Steroids, Flavonoids.

Drug is soluble both in water and alcohol, due to the respective soluble metabolites. (Joshi et al., 2013).

Pharmacological activities

Radio protective effect

Many studies have been done to show protective effect of *Grewia asiatica* in radiation induced damages in different organs of rodents by a group of authors.

In a study pre-treatment with *Grewia asiatica* fruit pulp extract in Swiss albino mice protects hematopoietic system against radiation-induced damage. Radiation induced deficit in different blood constituents like glutathione, sugar and protein levels in serum is significantly increased, whereas increase in level of lipid peroxidation and cholesterol level due to radiation was markedly decreased in pre-treated animals compared to control group (Singh et al., 2007).

Fruit pulp extract administered for 15 days at 700mg/kg shows radioprotective effect in swiss albino mice exposed to gamma radiation by decreasing enhanced lipid peroxidation and by checking the depleted level of glutathione and protein in cerebrum (Ahaskar et al., 2007).

Effect of *Grewia asiatica* extract as radioprotective agent is examined in testis. Histopathological study showed that due to radiation exposure spermatogonia "A",

spermatogonia “B”, spermatocytes and spermatid count declines significantly compared to the control group.

Whereas these counts were higher in *Grewia asiatica* pre/post treated irradiated group compared to the respective radiation treated group. There is a significant depletion in testis weight after irradiation, whereas pre/post treated *Grewia asiatica* group showed significantly increase in values (Sharma and Sisodia, 2010 a).

Grewia asiatica shows hepatoprotective effect against oxidative stress induced by irradiation with gamma radiation by causing a significant elevation in liver DNA and RNA level in comparison to irradiated mice and increase in different hepatocytes counts thus protecting liver against damages caused by radiation (Sharma and Sisodia, 2010 b).

Oral administration of 700 mg/kg of *Grewia asiatica* for 15 consecutive days before exposure to 10 Gy of radiation was found to afford maximum protection as mice of experimental group exhibited significant modulation of radiation- induced decrease of reduced glutathione (GSH) and radiation- induced increase in lipid peroxidation (LPO) in the whole brain and liver at 24 hours after radiation exposure (Ahaskar et al., 2007).

Supplementation of *Grewia asiatica* at 700mg/kg for 15 days prior to and post irradiation 5gy whole body radiation in mice ameliorated changes in the amount of cerebellar lipid peroxidation, Glutathione, protein, nucleic acids and histopathological changes significantly ($p < 0.001$) showing its radioprotective as well as neuroprotective properties of extract against the radiation. (Sisodia and Singh, 2009).

Administration of *Grewia asiatica* fruit extract to mice before and after irradiation caused a significant depletion in Thiobarbituric acid reactive substances content followed by a significant elevation in Glutathione and protein concentration in the intestine and testis of mice in comparison to irradiated mice. And it causes significant protection of DNA and RNA in testis. Extract also shows strong radical scavenging activity in 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and O (2) (-) assays and showed in vitro radioprotective activity in protein carbonyl assay showing its radio protective activity (Sharma et al., 2009).

In a similar studies administration of fruit pulp extract of *Grewia asiatica* to 5 Gy gamma radiation irradiated mice causes significantly amelioration of augmented lipid peroxidation

and prevented significantly radiation induced depletion in the level of glutathione and protein in mice cerebrum (Sisodia *et al.*, 2008, Ahaskar *et al.*, 2007).

Anti-malarial and Antiemetic activity

Crude alcoholic extract of *Grewia asiatica* possess antiemetic effect in experimental model dogs at a dose of 120mg/kg and control emesis induced by apomorphine at a dose of 0.44 mg/kg. Effect is significant in comparison to standard drug maxolon (metocloamide) and chlorpromazine or largactil (Yaqeen *et al.*, 2008). In another study antimalarial and antiemetic activities of methanolic extract of leaves is assessed. The crude methanolic extract showed antimalarial activity, (69% inhibition), emetic action of methanolic extract was 39.14% and 59.69%, when administered to male chicks at 50 mg/kg and 100 mg/kg dose levels (Haq *et al.*, 2012).

Antihyperglycemic activity

Numerous studies have been done on leaves, fruits, stem bark of *Grewia asiatica* to shows its antidiabetic activity.

Alcoholic and chloroform extract of leaves of *Grewia asiatica* (200mg/kg) shows highest antidiabetic activity in alloxan induced diabetic wistar rats compared to control and glibenclamide (10mg/kg) when compared with bark of *Sesbania sesban* and fruits of *Luffa acutangular* (Patil *et al.*, 2010).

Different extracts of leaves of *Grewia asiatica* i.e petroleum ether, ethanol and chloroform were tested for antihyperglycemic activity in alloxan induced diabetic rats. Ethanolic extract shows profound antihyperglycemic activity compared to control and glybenclamide (Patil *et al.*, 2011).

Comparative anti-hyperglycemic activity of ethanolic extracts of fruit, stem bark and leaves of *Grewia asiatica* and their fractions were examined in alloxan induced hyperglycemic rabbits. Crude extracts and their fractions i.e aqueous, methanolic, butanolic, ethylacetate, chloroform, carbon tetrachloride at the dose of 200 mg/kg and 100 mg /kg respectively reduced serum glucose level suggesting significant antidiabetic activity (Abidah *et al.*, 2012). Aqueous, methanolic and butanolic extracts of *Grewia asiatica* fruits were found to produce a stimulatory effect on ROS production however; the chloroform, hexane and ethanol-acetate extract exerted significant inhibitory effect. Hence *Grewia asiatica* fruit causes low glycem

response and modulation of ROS production in healthy non-diabetic humans (Mesaik et al., 2013).

Administration of aqueous extracts of leaves orally (250 mg/kg and 500 mg/kg) to normal rats and streptozotocin (50 mg/kg) treated diabetic rats for 21 days significantly reduced blood glucose level in streptozotocin induced diabetic rats. Extracts significantly reduced the blood glucose level in a dose dependent manner as measured by oral glucose tolerance test (Latif et al., 2012).

In a study by Dogar et al. comparative evaluation of antihyperglycemic activity of three plants is done. Bark of *Grewia asiatica* reported highest significant reduction in glucose, cholesterol and triglycerides levels in blood in normal and alloxan diabetic rat, when compared with *Gossypium herbacium* and *Gymnema sylvestre* (Dogar et al., 1988).

Anti-platelet activity

Crude methanolic extracts of leaves of *Grewia asiatica* exhibits potent platelet aggregation inhibition activity in a dose-dependent manner at concentration range (1 to 10 mg/ml) in arachidonic acid induced aggregation in human volunteers (Zial Ul haq et al., 2012).

Analgesic and antipyretic activity

Aqueous extract of fruits of *Grewia asiatica* possess antipyretic and analgesic activity at a dose of 200mg/kg and 300mg/kg. It shows good analgesic activity due to its inhibitory effect on pain induced by acetic acid writhing and tail immersion test. Extract at a dose of 400mg/kg had significant effect than aspirin, 100mg/kg on reducing pyrexia induced by administering lipopolysaccharides extract from *E. coli* (Das et al., 2012).

Methanolic and aqueous extract of root bark of *Grewia asiatica* at a dose of 200 mg/kg and 400 mg/kg is subjected to analgesic effect using acetic acid-induced writhing in mice and hot plate analgesia in rats and to anti-inflammatory activity using carrageenan-induced paw oedema. There is a significant inhibition by extracts on writhing response, increase in hot plate reaction time and caused a decrease in paw oedema reflecting its analgesic and anti-inflammatory effect (Paviaya et al., 2013).

Antioxidant activity

Medicinal plants typically contain mixtures of different chemical compounds that may act individually or in synergy to improve the health of common man. Most of the antioxidant activity is due to the isoflavones, flavonoids, flavones, anthocyanins, lignans, coumarins, catechins and isocatechins which were shown to be present in *Grewia asiatica*. Antioxidant-based drug formulations are used for the prevention and treatment of complex diseases like Alzheimer's disease, stroke, cancer, diabetes and atherosclerosis etc which may arise due to oxidative damage by free radicals (Kumar and Kumar, 2009). Anti-oxidant activity of *Grewia asiatica* have been studied by different authors.

In a study by Siddiqi et al., four polyphenolic fraction i.e Flavanols, flavonols, phenolic acids and anthocyanins of fruits of *G. asiatica*, *E. jabolana* and *C. carandas* is analyzed for total content of phenolics and flavanoids as well as for antioxidant activity by β -carotene-linoleic acid assay, DPPH and total reducing power assay.

Maximum antioxidant activity is found in DPPH assay, 62-85% and β -carotene-linoleic acid assay it is found to be 58-89. DPPH scavenging activity of flavanol fraction in *G. asiatica* (85% at 20 ppm) was comparable to BHA (89%) (Siddiqi et al., 2013).

In another study comparison of Quercetin and total flavanoid content as well as antioxidant activity of in vitro and in vivo parts of *Grewia asiatica* is done. The flavonoid contents in the in vivo (leaf, stem) and in vitro (old callus) plant parts were found to be present in the alcoholic, chloroform and aqueous solvents. Amount of Quercetin in the leaf sample was found to be double that of the callus (4.28ng/ μ l). Antioxidant potential of fruit extract was observed maximum (98.2%) among all plant parts. For the stem extract it was found to be higher (89.8%) than leaf and callus by the DPPH assay. Thus, showing presence of flavonoids and enormous antioxidant activity (Sharma and Patni, 2013).

The successive extracts of *Grewia asiatica* exhibited antioxidant activity in the DPPH and the nitric oxide radical inhibition assay as evidenced by the low IC 50 values. The successive extracts such as petroleum ether, benzene, ethyl acetate, methyl alcohol, water and 50% crude methanolic extracts exhibited IC 50 values of 249.60 ± 7.37 , 16.19 ± 2.132 , 26.17 ± 1.49 , 27.38 ± 1.80 , 176.14 ± 5.53 and 56.40 ± 3.98 μ g/mL, respectively in DPPH and 22.12 ± 02.65 , 27.00 ± 01.62 , 47.38 ± 05.88 , 56.85 ± 06.16 , 152.75 ± 5.76 and 72.75 ± 13.76 μ g/mL,

respectively in nitric oxide radical inhibition assays. These values are more than those obtained for ascorbic acid and quercetin as standards (Gupta *et al.*, 2007).

Antifungal and Antiviral activity

In a study by Kumari *et al.*, it was found from the MIC studies of methanolic extract of leaves of *Grewia asiatica* that the sensitivity pattern of the organism was found to be decreased in the order: *Candida albicans* than *Aspergillus thiogenitalis* then *Penicillium notatum*, *Penicillium citrinum* and *Aspergillus niger*. So, it was found that it was active maximum against *Candida albicans*. However, *Aspergillus niger* was totally resistant against the extract. The examination of antiviral potency of the extract showed the maximum inhibitory property at a concentration of 1000g/ml against Urd bean leaf crinkle virus (Kumari *et al.*, 2009).

Anticancer activity

As there is vast range of antioxidants in *G. asiatica* like vitamin c, anthocyanins, carotenoids etc, anti-tumour activity has been studied by various authors which shows role of plant in anticancer activity.

Marya *et al.* determined in-vitro cytotoxic activity of aqueous extract of fruits and leaves of *Grewia asiatica* by MTT assay using cell lines HEK-293 (Epidermal Kidney Cancer cell line), NCI-H522 (Cell Lung cancer cell line), HELA (Cervical Cancer cell line), Hep – 2 (Laryngeal Cancer cell line), and MCF-7 (Breast cancer cell line). From the results it is concluded that the aqueous extracts of leaves and fruits showed significant activity against liver cancer and breast cancer (Marya *et al.*, 2011).

In another study in vitro, cytotoxic activity of methanolic extract of fruit of *Grewia asiatica* is determined by MTT assay using cell lines HEK-293 (Epidermal Kidney Cancer cell line), NCI-H522 (Cell Lung cancer cell line), HELA (Cervical Cancer cell line), Hep – 2 (Laryngeal Cancer cell line), and MCF-7 (Breast cancer cell line). Comparable cytotoxicity was found against lung cancer cell line and breast cancer cell line respectively, but no activity found against normal cell line, Cervical cancer cell line and Larynx cancer cell line (Dattani *et al.*, 2011).

Methanolic extract of *Grewia asiatica* when administered at 250 and 500 mg/kg showed anticancer activity against Ehrlich's ascites carcinoma (EAC) cell lines and increased the life

span of EAC ascetic tumour bearing mice by 41.22% and 61.06%, respectively. Extract was assessed for in-vitro cytotoxicity activity against four cancer cell lines and showed 50% cytotoxicity at 53.70, 54.90, 199.5 and 177.8 µg/ml, for HL – 60, K-562, MCF-7 and HeLa cells respectively (Kakoti *et al.*, 2011).

In a study crude ethanolic extract and fractions of fruit, stem bark and leaves of *Grewia asiatica* are subjected to cytotoxic assay using brine shrimps and investigated for hemagglutination activity. Hemagglutination activity is used to determine effect of drug on blood and determines safety margins in case of blood disorders like haemorrhages and clot formation. It was concluded that *Grewia asiatica* have insignificant brine shrimp lethality and hemagglutination activity was found to be absent (Abidah *et al.*, 2013).

Immunomodulatory effect

Many indigenous medicinal plants have been reported to possess immune modulatory effect by improving defence mechanism of the body also known as rasayanas. In a study Ethanolic extract of fruit of *Grewia asiatica* at 200 and 400 mg/kg showed significant immune stimulant property. It counteracts effect of cyclophosphamide-induced reduction in total WBC, % neutrophil and haemoglobin levels and showed increase in the phagocytic index in assay of carbon clearance (Singh and Yadav, 2014).

Ethnobotanical Potential

G. asiatica have enormous uses for economically weaker sections.

Ripe phalsa fruits are eaten fresh and made into soft drinks or squash during summer months in India.

Fresh leaves of plant are used as animal fodder.

The bark is used as substitute of soap in Burma.

Mucilaginous extract obtained from bark is used in clarifying sugar.

Fibre obtained from the bark is used to make rope.

Wood from plant is used for making archers' bows, shingles and poles for carrying of loads on the shoulders (Pal, 2015).

Fruits are edible and medicinal (Bajpai *et al.*, 2015).

Fruit is used in blood disorders, fever, and diarrhoea. Leaves are used in malaria and diabetes.

Bark is used in rheumatism (Bajpai *et al.*, 2016).

The tuber of the plant is used to cure cuts. (Podal *et al.*, 2010).

Health Benefits of Phalsa

Falsa fruit has several traditional health benefits. According to the “Encyclopaedia of World Medicinal Plants,” phalsa is an astringent, coolant, and stomachic.

In Vedic times, the bark was used as a demulcent and serves as a treatment for rheumatism. Ground leaves treat pustular infections, and possess strong antimicrobial and antibacterial properties capable of remedying *E. coli*.

Unsurprisingly, given the fruit’s arrival during the scorching summer months, the fruit treats dehydration and acts as a coolant.

Phalsa has several health benefits substantiated by the scientific community as well:

According to an article published by the Pakistan Journal of Pharmaceutical Sciences, phalsa is a low glycaemic index fruit, thereby having positive effects on blood glucose metabolism. Simply put, the fruit is an excellent choice for those with blood sugar problems such as diabetes.

Like other purple-skinned fruits, phalsa has strong irradiation protection qualities due to its amazing free radical scavenging activities. Such findings were explored in a 2009 study published by the Journal of Radiological Protection, and affirmed again in another 2008 study published in the Journal of Complementary and Integrative Medicine.

Amazingly, a 2011 study published in Der Pharma Chemical found that falsa fruit and leaves exhibited significant anticancer activities against breast cancer cells and liver cancer cells. This affirms traditional Native American applications of the fruit to treat cancer-like illnesses.

According to a study published in the International Journal of Food Science & Technology, phalsa significantly inhibited fungal growth, thereby supporting its traditional use as an antifungal and antimicrobial.

How to Open/Cut

When eating out of hand, larger fruits have two large seeds, whereas the smaller phalsas have only one. Unlike most fruits, phalsa's seeds have a pleasant crunch and require no removal.

If desiring the juice, it is exceptionally difficult to de-seed each fruit. However, if in possession of a powerful blender, it's possible to blend the fruits. Before doing so, soak the fruits overnight. Boil with sugar the next day if desiring sweetness; otherwise, skip this step. Next, blend until the mix is pulpy and then strain the concoction using cheesecloth.

Another method of getting to the juice is soaking the fruit overnight in a shallow amount of water, and then manually squishing the fruits by the fistful. Then, sieve the concoction.

Storage

If storing at room temperature, consume falsa fruit within a day or two. Otherwise, store the fruits in shallow clamshell containers (like the ones used for raspberries and strawberries) and place in the refrigerator—this will extend phalsa's shelf life up to a week.

Phalsa Recipe Ideas and Uses

Some of the most common recipes for falsa fruit include juice and sherbet with rosewater. Note: fresh phalsa juice ferments quickly.

With the juice, it's easy to reduce it by boiling with sugar to create syrups for use on ice creams, pies, teas, and sweet breads. Indeed, phalsa syrup is a delicacy in northern India.

Use in any recipe calling for black currants.

Related Fruits

India grows several other lesser-known fruits in the *Grewia* genus. Most of these drupes are consumed by birds than humans, and are not nearly as delectable as phalsa:

Donkey berry (*Grewia flavescens*), Crossberry (*Grewia abutilifolia*, *Grewia laevigata*, *Grewia tenax*, *Grewia umbellifera*), Kukurbicha (*Grewia hirsuta*) and Dhaman (*Grewia tiliifolia*).

Amazing Health Benefits of Phalsa fruit

1. Source of Antioxidants

As a fruit which has a major source of antioxidants, falsa fruit is having a role in maintaining the body health. Moreover, if you want to eat other fruits which are rich in antioxidants, try to have orange, strawberries, lettuce as options.

2. Source of Sodium

As you can see on the table above, falsa fruit has a major source of sodium. Then, what is the function of sodium in our body? Well, it acts as an electrolyte and essential ion to promote the enzymes operation and muscle as well. Moreover, it also increases the performances of a nervous system and is needed for blood regulation. Hence, it is very best option to have falsa fruit as your number one sodium's food source.

3. Source of Vitamin A

With the high concentration of vitamins contained in falsa fruit, it will boost your health for sure. Like other nutrients do, Vitamin A is a great natural nutrient that helps to promote good vision and prevents macular degeneration.

4. Source of Vitamin B1

Vitamin B1 which presents in falsa fruit helps to maintain the heart and nerve function. In contrast, the deficiency of vitamin B1 consumption may lead to certain health problems including anorexia, muscle weakness, and nerve damage.

5. Source of Vitamin B2

Vitamin B2 as known as Riboflavin is having a role in promoting blood cells and the body metabolism. To fulfill the needs of vitamin B2, you can consume almonds, egg, and spinach as well.

6. Source of Vitamin B3

Vitamin B3 is referred to as niacin which helps in maintaining the cardiovascular and metabolism system in the body. Indeed, it also helps to balance the cholesterol levels.

7. Source of Vitamin C

You may have to consume fruits and vegetables that are rich in vitamin C. Hence, it is recommended to have falsa fruit in case fulfilling the needs of this nutrient. Then, with the great consumption of vitamin C, you will get a healthier body for sure.

8. Treats Rheumatism

It is known that the barks part of falsa tree is good as a treatment of rheumatism.

9. Treats Arthritis

The symptoms of having arthritis are including the pain and the limited function of joints. It is also linked to the presence of inflammation. Then, to prevent this disease, you may have to consume falsa fruit as an option.

10. Treats Respiratory Problems

Drinking falsa fruit juice is great to treats the respiratory problems including asthma, bronchitis, colds, and others. For the tips, simply mix falsa fruit with ginger or lemon juice to add the flavour. Therefore, you will have a glass of enjoying and healthy drink at the same time.

11. Builds Muscle

Build a good muscle by consuming falsa fruit regularly. Due to the presence of potassium and protein, it will promote the muscle function as well as strengthen the muscle.

12. Provides Energy

As described, falsa fruit contains a reliable source of protein. As a result, with protein, it helps the body to gain more energy. Then, it is time to say no to the presence of weakness.

13. Builds Healthy Bone

Due to the presence of calcium contained in falsa fruit, indeed it is beneficial to increases the performance of healthy bone. At this point, it strengthens the bone and promotes the bone density.

14. Relieves Stomach-ache

Fibre, which presents in falsa fruit is taking part in relieving stomach-ache. You can have a falsa juice to relieve the pain of stomach-ache, nausea, and other digestion system problems. Then, drink the falsa juice daily to prevent the risks of having the stomachache.

15. Treats Diarrhoea

As explained before, falsa fruit is having a role in treating the stomach-ache naturally. Hence, it is known that falsa fruit is also great to treat diarrhoea as well.

16. Promotes Heart Health

The regular consumption of falsa fruit helps to control the blood pressure and soothing the liver as well as promoting the heart health.

17. Prevents Stroke

This statement is linked to the previous statement. Therefore, with the function to control the blood pressure, then the falsa fruit also works to prevent the stroke.

18. Prevents Diabetes

According to research, it has shown that falsa fruit is a low glycaemic index fruit, then it has a role in controlling the blood glucose metabolism. As a result, this fruit is really preventing diabetes greatly.

19. Lowers Cancer Risk

Also, the recent research has shown that chemical in falsa fruit helps to prevent the cancer cell growth including breast cancer cells and liver cancer cells.

20. Cures Anaemia

The presence of iron contained in falsa fruit helps to treats anemia. Besides, the lack of this kind of nutrients may lead to certain health problems including the chronic fatigue.

21. Heals Wounds

It is also known that falsa fruit leaves help to heal the wounds and eczema. Grind the leaves and apply it on the skin, leave it for a few minutes to let them work.

22. Prevents Free Radicals

To prevent free radicals, you may have to consume fruits and vegetables which are rich in nutrients contained. Consequently, eating the falsa fruit may become one of best options to choose as it contains great nutrients in it.

23. Acts as Anti-Inflammation

Our body needs anti-inflammation nutrients to prevent certain inflammations including coughs and sore throat. Then, with the great consumption of falsa fruit, it helps you to have a natural anti-inflammation as well.

24. Acts as Anti-Microbial

The study shows that falsa fruit is beneficial to prevent the fungal growth. As a result, falsa fruit is great to act as antifungal and antimicrobial to promote the body health.

25. Heals Urinary Problems

Last, falsa fruit is taking part in healing urinary problems as well as it promotes the healthy digestion system.

Tips for Consuming Phalsa fruit

While eating falsa fruit, you do not need to remove the seeds as it has a pleasant crunch texture.

Store this fruit at room temperature and consume it as soon as possible. Moreover, keep it in the refrigerator can make it last for one week.

For recipe tips, make the falsa fruit as your favourite syrup, juice, pies, and even for an ice cream. Indeed, you will be very happy to eat such a wonderful and tasty meal.

Consuming falsa fruit is very recommended due to the health benefits of falsa fruit it has provided. Then, the option is now in your hand. Whether you want to be a healthier person by eating best food or not. Then, eat this kind of fruit regularly to get the best benefit. Hence, your life will be perfectly complete by eating this great fruit as well.

CONCLUSION

The global scenario is changing their face towards herbal medicinal uses due to less side effect and emphasis given to develop a modern drug to cure many acute diseases. *Grewia asiatica* is the plant which may not be freely available in future due to overexploitation, habitat destruction or lack of domestication and cultivation. Therefore, this review served as an important reference for reviewing and timely recognition of enormous medicinal application of this plant.

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4. *Syzygium cumini* (L.) Skeels, Jambolan, Black plum, Jamun, Java plum, Indian blackberry, Portuguese plum, Malabar plum, Purple plum, Jamaica and Damson plum. (Myrtaceae):

Synonyms: *Eugenia jambolana* Lam., *Myrtus cumini* Linn., *Syzygium jambolana* DC., *Syzygium jambolanum* (Lam.) DC., *Eugenia djouant* Perr., *Calyptrocalyx jambolana* Willd., *Eugenia cumini* (Linn.) Druce. and *Eugenia caryophyllifolia* Lam.

The genus *Syzygium* is one of the genera of the myrtle family Myrtaceae which is native to the tropics, particularly to tropical America and Australia. It has a worldwide, although highly uneven, distribution in tropical and subtropical regions. The genus comprises about 1,100 species, and has a native range that extends from Africa and Madagascar through southern Asia east through the Pacific. Its highest levels of diversity occur from Malaysia to north-eastern Australia, where many species are very poorly known and many more have not

been described taxonomically. Plants of this family are known to be rich in volatile oils which are reported for their uses in medicine (Mahmoud et al., 2001) and many fruits of the family have a rich history of uses both as edibles and as traditional medicines in divergent ethnobotanical practices throughout the tropical and subtropical world (Reynertson et al., 2009). Some of the edible species of *Syzygium* are planted throughout the tropics worldwide.

The tree is known to have grown in the Indian sub-continent, and many others adjoin regions of South Asia such as India, Bangladesh, Burma, Nepal, Pakistan, Sri Lanka and Indonesia. It was long ago introduced into and became naturalized in Malaysia. In southern Asia, the tree is venerated by Buddhists, and it is commonly planted near Hindu temples because it is considered sacred to Lord Krishna (Mortan, 1987). The plant has also been introduced to many various places where it has been utilized as a fruit producer, as an ornamental and for its timber. In India, the plant is available throughout the plains from the Himalayas to southern India.

Jambolan is a large evergreen and densely foliaceous tree with greyish-brown thick bark, exfoliating in woody scales. The wood is whitish, close grained and durable; affords brown dyes and a kind of a gum Kino. The leaves are leathery, oblong-ovate to elliptic or obovate-elliptic with 6 to 12 centimetres long (extremely variable in shape, smooth and shining with numerous nerves uniting within the margin), the tip being broad and less acuminate. The panicles are borne mostly from the branchlets below the leaves, often being axillary or terminal, and are 4 to 6 centimetres long. Flowers are scented, greenish-white, in clusters of just a few or 10 to 40 and are round or oblong in shape and found in dichotomous paniculate cymes. The calyx is funnel-shaped, about 4 millimetres long, and toothed. The petals cohere and fall all together as a small disk. The stamens are numerous. Several types, which differ in colour and size of fruits, including some improved races bearing purple to violet or white coloured flesh and seedless fruits have been developed. The fruits are berries and are often obviously oblong, 1.5 to 3.5 centimetres long, dark-purple or nearly black, luscious, fleshy, and edible; it contains a single large seed (Gamble, 1935, Hooker, 1879). The plant produces small purple plums, which have a very sweet flavour, turning slightly astringent on the edges of the pulp as the fruit becomes mature. The dark violet coloured ripe fruits give the impression the fruit of the olive tree both in weight and shape and have an astringent taste (Craveiro et al., 1983). The fruit has a combination of sweet, mildly sour and astringent flavour and tends to colour the tongue purple. Phenology: March-August.

Ethnobotanical potential

It is an avenue tree, fruits are edible. It is also used as fodder, fire, timber wood, and medicinal (Bajpai *et al.*, 2015).

Bark and seed is used in diabetes, cholera and dysentery (Bajpai *et al.*, 2016).

Phytochemicals

Fruits

Analyses of the fruit in the Philippines were reported in 1924 as follows: Waste, 25%; edible portion: water, 80.80%; ash, 0.70; protein, 0.81; sugar, 12.70 (fructose and glucose; no sucrose); acidity (as sulphuric), 0.63%; (as malic) 0.88% (Mortan, 1987).

The following composition per 100 grams of edible portion was reported for fruits freshly picked at the Lancetilla Experimental Garden, Honduras, in 1948: Moisture, 85.8 gm; ether extract, 0.15 gm; crude fiber, 0.3 gm; nitrogen, 0.129 gm; ash, 0.32 gm; calcium, 8.3 mg; phosphorus, 16.2 mg; iron, 1.62 mg; carotene, 0.004 mg; thiamine, 0.008 mg; riboflavin, 0.009 mg; niacin, 0.290 mg; total ascorbic acid, 5.7 mg (Gamble, 1935).

Virmani gives the following analysis: specific gravity, 1.0184; total acidity (as acetic acid), 5.33 per 100 cc; volatile acidity (as acetic acid), 5.072 per 100 cc; fixed acidity, 0.275% as citric; total solids, 4.12 per 100 cc; ash, 0.42; alkalinity of ash, 32.5 (N/10 alkali); nitrogen, 0.66131; total sugars, 0.995; reducing sugars, 0.995; non-volatile reducing sugars, 0.995; alcohol, 0.159% by weight; oxidation value (KMnO₄, 186.4); iodine value, 183.7; ester value, 40.42. Other reported constituents of the seeds are: protein (6.3 to 8.5%), fat (1.18%), crude fibre (16.9%), ash (21.72%), calcium (0.41%), phosphorus (0.17%), fatty acids (palmitic, stearic, oleic and linoleic), starch (41%), dextrin (6.1%), a trace of phytosterol, and 6 to 19% tannin (Hooker, 1879).

The fruits are avidly eaten by birds and four-footed animals (jackals and civets in India). In Australia, they are a favourite food of the large bat called “flying fox”.

Analyses of the leaves show: crude protein (9.1%), fat (4.3%), crude fibre (17.0%), ash (6.0%), calcium (1.3%), phosphorus (0.19%). It consists mainly of mono- or sesqui-terpene hydrocarbons which are “very common in essential oils.” Constituents of *Syzygium cumini* seeds are fatty oils (30 g/kg), including lauric (2.8%), myristic (31.7%), palmitic (4.7%), stearic (6.5%), oleic (32.2%), linoleic (16.1%), malvalic (1.2%), sterculic (1.8%) and vernolic

acid (3%) and phytosterols such as β -sitosterol. Further constituents are tannins (6%), predominantly corilagin, ellagitannins, ellagic acid, galloyl-galactoside and gallic acid (Lock et al., 2009). The leaf oil consists of 16.91% octadecane, 9.98% nonacosane, 9.38% triacontane, 7.38% octacosane, 4.86% Heptacosane, 4.25% hexadecanoic acid and 4.02% eicosane. The seed oil consists of 33.2% 1-chlorooctadecane, 9.24% tetratetracontane, 8.02% decahydro-8a-ethyl-1,1, 4a,6-tetramethylnaphthalene, 5.29% 4-(2-(2-dimethyl-6-6-methylenecyclohexyl) butanol, 5.15% Octadecane, 3.97% octacosane, 1.72% heptacosane and 1.71% eicosane. (Ravi et al., 2004a). Java Plum consist of Energy 251 kJ (60 kcal), Carbohydrates 15.56 g, fat 0.23 g, Protein 0.72 g, water 83.13 g, Vitamin A 3IU, Thiamine (vit B1) 0.006 mg (1%), Riboflavin (vit. B2) 0.012 mg (1%), 0.260 mg (2%) Niacin (vit. B3), 0.160 mg (3%) Pantothenic acid (B5), 0.038 mg (3%) Vitamin B6 0.038 mg (3%), 14.3 mg (17%) Vitamin C, 19 mg (2%) Calcium, 0.19 mg (1%) Iron, 15 mg (4%) Magnesium, 17 mg (2%) Phosphorus, 79 mg (2%) Potassium, 14 mg (1%) Sodium (Bajpai et al., 2005). The Fruit Contain 83.70 -85.80 g moisture, 0.70 - 0.13 g protein, 0.15 - 0.30 g fat, 0.30 - 0.90 g crude fibre, 14.00 g carbohydrate, 0.32 - 0.40 h ash, 8.30 - 5.00 mg calcium, 35.00 mg magnesium, 15.00 - 16.20 mg phosphorus, 1.20 - 1.62 mg iron, 26.20 mg sodium, 55.00 mg potassium, 0.23 mg copper, 13.00 mg sulfur, 8.00 mg chlorine, 8. IU vitamin A, 0.01 - 0.03 mg thiamine, 0.009 - 0.01 mg riboflavin, 0.20 - 0.29 mg niacin, 5.70 - 18.00 mg ascorbic acid, 7.00 mg chlorine and 3.00 mcg folic acid per 100 g of edible portion (The wealth of India, 1948).

Jambolan is rich in compounds containing anthocyanins, glucoside, ellagic acid, isoquercetin, kaemferol and myrecetin. The seeds contain alkaloid, jambosine, and glycoside jambolin or antimellin, which halts the diastatic conversion of starch into sugar and seed extract has lowered blood pressure by 34.6% and this action is attributed to the ellagic acid content (Mortan, 1987).

The seeds have been reported to be rich in flavonoids, a well-known antioxidant, which accounts for the scavenging of free radicals and protective effect on antioxidant enzymes (Ravi et al., 2004, Ravi et al., 2004a) and found to have high total phenolics with significant antioxidant activity (Bajpei et al., 2005) and are rich in protein and calcium. Java plums are rich in sugar, mineral salts, vitamins C, PP which fortifies the beneficial effects of vitamin C, anthocyanins and flavonoids (The wealth of India, 1948).

Leaves

The leaves are rich in acylated flavonol glycosides (Mahmoud *et al.*, 2001), quercetin, myricetin, myricitin, myricetin 3-O-4-acetyl-L-rhamnopyranoside (Timbola *et al.*, 2002), triterpenoids (Gupta and Sharma, 2013, 2014), esterase, galloyl carboxylase (Bhatia *et al.*, 1974), and tannin (Mortan, 1987).

Stem bark

The stem bark is rich in betulinic acid, friedelin, epi-friedelanol, β -sitosterol, eugenin and fatty acid ester of epi-friedelanol (Sengupta and Das, 1965), β -sitosterol, quercetin kaempferol, myricetin, gallic acid and ellagic acid (Bhargava *et al.*, 1974), bergenins (Kopanski and Schnelle, 1988), flavonoids and tannins (Bhatia and Bajaj, 1975). The presence of gallo- and ellagi-tannins may be responsible for the astringent property of stem bark.

Flowers

The flowers are rich in kaempferol, quercetin, myricetin, isoquercetin (quercetin-3-glucoside), myricetin-3-L-arabinoside, quercetin-3-D-galactoside, dihydromyricetin, oleanolic acid acetyl oleanolic acid, eugenol-triterpenoid A and eugenol-triterpenoid B (Nair and Subramanian, 1962).

Roots

The roots are rich in flavonoid glycosides (Vaishna *et al.*, 1992) and isorhamnetin 3-O-rutinoside (Vaishnava and Gupta, 1990).

Fruits

The fruits are rich in raffinose, glucose, fructose (Srivastava, 1953), citric acid, mallic acid (Lewis *et al.*, 1956), gallic acid, anthocyanins (Jain and Seshadri, 1975); delphinidin-3-gentiobioside, malvidin-3-laminaribioside, petunidin-3-gentiobioside (Venkateswarlu, 1952), cyanidin diglycoside, petunidin and malvidin (Sharma and Seshadri, 1955). The sourness of fruits may be due to presence of gallic acid. The color of the fruits might be due to the presence of anthocyanins (Venkateswarlu, 1952). The fruit contains 83.70–85.80 g moisture, 0.70–0.13 g protein, 0.15–0.30 g fat, 0.30–0.90 g crude fibre, 14.00 g carbohydrate, 0.32–0.40 g ash, 8.30–15.00 mg calcium, 35.00 mg magnesium, 15.00–16.20 mg phosphorus, 1.20–1.62 mg iron, 26.20 mg sodium, 55.00 mg potassium, 0.23 mg copper, 13.00 mg sulphur, 8.00 mg chlorine, 80 I.U. vitamin A, 0.01–0.03 mg thiamine, 0.009–0.01 mg

riboflavin, 0.20–0.29 mg niacin, 5.70–18.00 mg ascorbic acid, 7.00 mg choline and 3.00 mcg folic acid per 100 g of edible portion (Noomrio and Dahot, 1996). One of the variety of jambolan found in the Brazil possesses malvidin-3-glucoside and petunidin-3-glucoside (Lago et al., 2004). The peel powder of jambolan also can be employed as a colorant for foods and pharmaceuticals and anthocyanin pigments from fruit peels were studied for their antioxidant efficacy stability as extract and in formulations (Veigas et al., 2007).

Essential oils

The essential oils isolated from the freshly collected leaf (accounting for 82% of the oil) (Kumar et al., 2004), stem, seed, fruits contain α -Pinene, camphene, β -Pinene, myrcene, limonene, cis-Ocimene, trans-Ocimene, γ -Terpinene, terpinolene, bornyl acetate, α -Copaene, β -Caryophyllene, α -Humulene, γ -Cadinene and δ -Cadinene (Craverio et al., 1983), trans-ocimene, cis-ocimene, β -myrcene, α -terpineol, dihydrocarvyl acetate, geranyl butyrate, terpinyl valerate (Vijayanand et al., 2001), α -terpineol, β -caryophyllene, α -humulene, β -selinene, calacorene, α -muurolol, α -santalol, cis-farnesol: lauric, myristic, palmitic, stearic, oleic, linoleic, malvalic, sterculic and vernolic acids (Daulatabad et al., 1988). Unsaponifiable matter of the seed fat was also chemically investigated (Gupta and Agrawal, 1970).

Ethnomedicinal Potential

The bark is acrid, sweet, digestive, astringent to the bowels, anthelmintic and used for the treatment of sore throat, bronchitis, asthma, thirst, biliousness, dysentery and ulcers.

It is also a good blood purifier. The fruit is acrid, sweet, cooling and astringent to the bowels and removes unpleasant smell from mouth, biliousness, stomachic, astringent, diuretic and antidiabetic (Nadkarni, 1976).

The fruit has a very long history of use for various medicinal purposes and currently has a large market for the treatment of chronic diarrhoea and other enteric disorders (Veigas et al., 2007).

The seed is sweet, astringent to the bowels and good for diabetes.

The ash of the leaves is used for strengthening the teeth and gums.

Vinegar prepared from the juice of the ripe fruit is an agreeable stomachic and carminative and used as diuretic (Kiritikar and Basu, 1987).

It is also useful in spleen enlargement and an efficient astringent in chronic diarrhoea.

Juice of tender leaves of this plant, leaves of mango and myrobalan are mixed and administered along with goat's milk and honey to treat dysentery with bloody discharge.

The juice of tender leaves alone or in combination with carminatives such as cardamom or cinnamon is given in goat's milk to treat diarrhoea in children (Nadkarni, 1976).

Traditional medical healers in Madagascar have been using the seeds of jambolan for generations as the centerpiece of an effective therapy for counteracting the slow debilitating impacts of diabetes (Ratsimamanga, 1998).

The seed extract is used to treat cold, cough, fever and skin problems such as rashes and the mouth, throat, intestines and genitourinary tract ulcers (infected by *Candida albicans*) by the villagers of Tamil Nadu (Chandrasekaran and Venkatesalu, 2004).

Jambolan fruit can be eaten raw and can be made into tarts, sauces and jams. Excellent quality jambolan juice is excellent for sherbet, syrup and “squash”, an Indian drink.

Uses in traditional medicine

All parts of the jambolan can be used medicinally and it has a long tradition in alternative medicine. From all over the world, the fruits have been used for a wide variety of ailments, including cough, diabetes, dysentery, inflammation and ringworm (Reynertson et al., 2009). It is also an ancient medicinal plant with an illustrious medical history and has been the subject of classical reviews for over 100 years. It is widely distributed throughout India and ayurvedic medicine (Indian folk medicine) mentions its use for the treatment of diabetes mellitus.

Various traditional practitioners in India use the various parts of the plant in the treatment of diabetes, blisters in mouth, **cancer**, colic, diarrhoea, digestive complaints, dysentery, piles, pimples and stomach-ache (Jain, 1991). During last four decades, numerous folk medicinal reports on the antidiabetic effects of this plant have been cited in the literature.

In Unani medicine various parts of jambolan act as liver tonic, enrich blood, strengthen teeth and gums and form good lotion for removing ringworm infection of the head (Sagrawat et al., 2006).

Folk medicinal uses

The plant has been viewed as an antidiabetic plant since it became commercially available several decades ago. In the early 1960s to 1970s, some preliminary reports on the antidiabetic activity of various parts of jambolan in diabetic animals were reported. Most of these studies have been conducted using crude preparation of the plant without pointing out their chemical profile and antidiabetic action in animals is not fully understood. Many herbal formulations were also prepared in combination with this plant available in market which showed potential antidiabetic activity and are used regularly by diabetic patients on the advice of the physicians.

Various parts of the jambolan were also reported for its antioxidant, anti-inflammatory, neuropsychopharmacological, anti-microbial, anti-bacterial, anti-HIV, antileishmanial and antifungal, nitric oxide scavenging, free radical scavenging, anti-diarrheal, antifertility, anorexigenic, gastroprotective and anti-ulcerogenic and radioprotective activities (Sagrawat *et al.*, 2006).

Pharmacological actions

Various parts of the jambolan especially fruits, seeds and stem bark possess promising activity against diabetes mellitus and it has been confirmed by several experimental and clinical studies.

In the early 1960s to 1970s, (Chirvan-Nia and Ratsimamanga, 1972), (Sigogneau-Jagodzinski *et al.*, 1967), (Lal and Choudhuri, 1968), (Shrotri *et al.*, 1963), (Bose and Sepha, 1956) and (Vaish, 1954) reported the antidiabetic activity of various parts of jambolan in diabetic animals.

Tea prepared from leaves of jambolan was reported to have antihyperglycemic effect (Teixeira *et al.*, 1989).

The stem bark of the plant could induce the appearance of positive insulin staining cells in the epithelia of the pancreatic duct of treated animals (Schossler *et al.*, 2004) and a significant decrease in blood glucose levels was also observed in mice treated with the stem bark by oral glucose tolerance test (Villasenor and Lamadrid, 2006). Many clinical and experimental studies suggest that, various parts of the jambolan especially fruits and seeds possess

promising activity against diabetes mellitus (Ravi et al., 2004), (Grover et al., 2000, Vikrant et al., 2001, Prince et al., 2003, Sharma et al., 2003, Sharma et al., 2006, Ravi et al., 2005).

Despite tremendous advancements have been made in the field of diabetic treatments, several earlier investigations have been reported from the different parts of jambolan with antioxidant (Banerjee and Dasgupta, 2005, Sultana et al., 2007), anti-inflammatory (Chaudhari et al., 1990, Muruganandan et al., 2002, Muruganandan et al., 2001), neuropsychopharmacological (Chakraborty et al., 1985), anti-microbial (Chandrasekaran and Venkatesalu, 2004), antibacterial (Bhuiyan et al., 1996, Shafi et al., 2002, Nascimento et al., 2000), anti-HIV (Kusumoto et al., 1995), antileishmanial and antifungal (Barga et al., 2007), nitric oxide scavenging (Jagetia and Baliga, 2004), free radical scavenging (Silva et al., 2006), anti-diarrheal (Mukherjee et al., 1998), antifertility (Rajasekara et al., 1988), anorexigenic (Krikorian-Manoukian and Ratsimamanga, 1967), gastroprotective and anti-ulcerogenic (Ramirez and Rao, 2003), behavioural effects (De lima et al., 1998) and radioprotective (Jagetia and Baliga, 2003) activities. Besides the above, the effect of various concentrations of the leaf extracts of the plant on the radiation-induced micronuclei formation was studied by (Jagetia and Baliga, 2002).

CONCLUSIONS

Jambolan is widely used by the traditional healers for the treatment of various diseases especially diabetes and related complications. The plant has many important compounds which confer most of the characteristics of the plant. Most pharmacological works on diabetes were carried out with seeds but the pharmacological potential of the other parts of the plant is required to explore in detail. Similarly, not many works are there with pharmacological actions of phytochemical constituents of jambolan. Based on these facts, the authors hope that this review highlights the role of jambolan in various treatments and recommend that further phytochemical and clinical research should be done on this traditional medicinal plant for the discovery of safer drugs.

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