

Review Article

NUTRACEUTICAL VALUE AND THERAPEUTIC APPLICATIONS OF BAEL, WOODAPPLE, AONLA, BER, AND KARONDA- A REVIEW

Abstract

This review delves into the nutraceutical value and therapeutic uses of bael, woodapple, aonla, ber, and karonda fruits, revered for their medicinal properties across traditional medicine systems. Enriched with essential nutrients and bioactive compounds like phenolics, flavonoids, and alkaloids, they offer diverse health benefits, including immune support and digestive health enhancement. Through a meticulous analysis of scientific literature, the review underscores their potential in preventive and holistic healthcare. By acknowledging and leveraging their nutraceutical and therapeutic potentials, individuals and communities can endeavor towards improved health and well-being.

Keywords: Underutilized fruits, medicinal uses, therapeutic properties

Introduction

Underutilized fruits provide vital food, vitamins, and minerals, alongside contributing to livelihoods due to their medicinal properties (Das, 2021). Despite being used in local medicine, many of these fruits lack domestication and human selection efforts, restricting their cultivation mainly to the wild. Underutilized crops, although less explored in terms of promotion and research, thrive in diverse and challenging conditions. Their importance varies across different crops and regions but can be significantly enhanced through increased awareness. With a rich history of usage, underutilized wild edible plants are increasingly recognized for their high nutritional value, as evidenced by ongoing global research efforts (Kour et al., 2018).

Bael, woodapple, aonla, ber, and karonda are fruits deeply ingrained in the cultural and medicinal heritage of the Indian subcontinent. With a rich history of traditional use, these fruits are esteemed for their outstanding nutritional properties and therapeutic potentials. Packed with essential nutrients, bioactive compounds, and potent antioxidants, they offer a diverse range of health benefits deeply intertwined with ancient healing traditions like Ayurveda and Unani medicine. Beyond their culinary appeal, these fruits serve as vital ingredients in herbal formulations and natural remedies. This review meticulously examines their nutritional compositions, phytochemical profiles, and multifaceted therapeutic applications, highlighting their profound importance in promoting human health and well-being.

Bael

The bael tree, deeply rooted in Indian history and mythology, has long been recognized for its therapeutic value in traditional medicine. Modern research confirms its effectiveness, attributing to its antioxidant, and antimicrobial properties. Bael addresses various health concerns including gastrointestinal, and cardiac issues, while also exhibiting hepatoprotective, radioprotective, anti-diabetic, and wound-healing properties.

The subtropical fruit *Aegle marmelos*, commonly referred to as Bael, is a member of the Rutaceae family. The sacred Tripatra tree's leaves are vital in offerings to Lord Shiva. Its root, bark, leaf, flower, and fruit find diverse uses. While wild fruits are smaller and less commercial, cultivars like Kagzi Gonda, Gonda no 1, Gonda no 2, Kagzi Etawah, Mirzapuri, and Baghel are cultivated. (Sharma et al. 2007). Research on bael fruit indicates its rich nutritional composition, encompassing a diverse array of phytochemicals such as phenolic acids, flavonoids, alkaloids, tannins, and coumarins. Additionally, bael contains amino acids, fatty acids, various organic acids, minerals, carbohydrates, vitamins, and fibers, rendering it a highly nutritious fruit with significant health advantages (Bhardwaj,2014). Table 1 indicates the medicinal properties of bael.

Table 1: Medicinal properties of bael (Chhetri., 2021)

Parts of Bael	Bioactive Compounds	Medicinal Properties and Therapeutic Properties	Reference
Fruits	Marmelosin	Anthelmintic and antibacterial activity	Badam <i>et al.</i> 2002, Rastogi and Mehrotra 1998; Ghosh and Playford 2003, Shoba and Thomas 2001
	Auraptin	Treatment of hypertension	Rastogi and Mehrotra 1998
	Psoralean	Antispasmodic	Hansel <i>et al.</i> 1994
	Tannin	Diarrhoea	Shoba and Thomas 2001

Roots and Bark	Fagarine	Abortifacient property	Takase <i>et al.</i> 1994, Duke <i>et al.</i> 1992
	Marmin	Antiulcer activity	Takase <i>et al.</i> 1994
Leaves	Cuminaldehyde	Antifungal, antibacterial and anticancer property	Gurjar <i>et al.</i> , 2015; Rahman and Pravin., 2014 Maity <i>et al.</i> , 2009

Wood apple (Thakur *et al.*, 2020)

The botanical name of Wood apple is *Feronia limonia* belongs to Rutaceae family. The native of wood apple is India. The other names of wood apple are elephant apple; monkey fruit; curd fruit and kathbel. The tree is small to medium size, deciduous with thorny branches, hardy in nature and can withstand salt and drought (Troup., 1921). The fruit type is Amphisarca which is a hard shelled berry and fruit has sweet aromatic edible pulp (Meena *et al.*, 2022). The processed products of wood apple are powder, jam, RTS, pickle, candy, preserve, squash, toffee and wine (Vidhya and Narain., 2011). The medicinal uses of wood apple fruit includes several treatments such as cardiac tonic, Sore throat, peptic ulcer, tumors, hepatitis, asthma, diarrhoea, liver problems and blood purification. Wood apple leaves are used to cure diarrhoea, dysentery, breast cancer, uterus cancer, respiratory disorders, Carminative and Hepatoprotective activity. The bark is used to cure venomous wounds, constipation, diarrhoea and Haemorrhage (Bagul *et al.*, 2019; Dhakar *et al.*, 2019; Parvez & Sarker, 2021). Table 2 and 3 indicates chemical composition and pharmacological activities of wood apple.

Table 2: Chemical composition of Wood Apple (Pal *et al.*, 2019; Thakur *et al.*, 2020)

Characters	Composition
Moisture (%)	72.00 ± 2.04
Protein (%)	7.14 ± 0.24
Fat (%)	1.45 ± 0.09
Carbohydrates (%)	7.24 ± 0.12
Ash (%)	4.98 ± 0.02
Calcium (%)	0.12 ± 0.07
Phosphorus (%)	0.07 ± 0.002

Iron (%)	1.0 ± 0.03
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Table 3: Pharmacological activities of Wood Apple

Part	Pharmacological activities	Reference
Fruit	Anti- tumor activity	Saima <i>et al.</i> (2000); (Haque <i>et al.</i> , 2000)
Fruit	Anti- diabetic activity	Gupta <i>et al.</i> (2009); Priya <i>et al.</i> , 2012
Fruit pulp	Wound healing property	Senthilkumar <i>et al.</i> , 2010; Wakchoure <i>et al.</i> , 2023
Leaves	Anti- microbial activity	Bellah <i>et al.</i> , 2015; Kumar <i>et al.</i> (2010)
Seeds	Anti- microbial activity	Sonawane <i>et al.</i> , 2013
Root and bark	Hepatoprotective activity	Jain <i>et al.</i> , 2012
Fruit	Antioxidant activity	Phapale and Thakur, 2010
	Neuroprotective activity	Rakhunde <i>et al.</i> (2014)

Aonla (Diwan *et al.*, 2018)

Aonla, also known as Indian gooseberry (*Emblica officinalis* Gaertn.), is a member of the Euphorbiaceae family, revered for its medicinal properties since ancient times in India. This indigenous fruit of the Indian subcontinent is widely utilized in the Indian System of Medicine. Aonla fruits are characterized by their round shape, ribbed texture, and pale green color. The fruit's surface is shiny, divided into six segments by pale liner grooves, and varies in size from small marble to large plum. Despite its nutritional value, the raw fruit's high acidity and astringent taste make it unpalatable to consumers (Singh *et al.*, 2019). Aonla, also known as Amla, Adiphala, Amlaki, and Nelli in various languages, is commonly grown in arid zones and saline soils. It is a major component of traditional medicines like Chyawanprash. The fruit is rich in vitamin C (600 mg/100g) and possesses various medicinal properties. Fresh fruit is used to treat dysentery, fevers, indigestion, and eye inflammation. Dried fruit acts as an astringent, stomachic, and blood purifier, beneficial for diarrhea, dysentery, and anemia. A decoction of dried fruits is effective for gonorrhea, and when combined with iron, it treats jaundice and dysentery. Aonla seeds are infused for fever, diabetes, and eye diseases, while the oil extracted from seeds treats dandruff and darkens hair. The smoke from burning seeds is inhaled to relieve asthma and bronchitis. Overall, aonla fruit and seeds offer diverse therapeutic benefits for various ailments (Kumar, 2011). Table 4 indicates the medicinal uses of aonla.

Table 4: Medicinal uses of aonla

Part	Medicinal uses	Reference
Fruit extract	Cancer treatment	Alam and Gomes, 2003
	Diabetics treatment	Suryanarayan <i>et al.</i> , 2007
	Immunomodulation	Sai, <i>et al.</i> , 2002
	Memory enhancer	Vasudevan and Parle, 2007
	Cholesterol and Dyslipidemia treatment	Kim <i>et al.</i> , 2005; Anila and Vijayalakshmi, 2002
	Snake venom neutralizer	Alam and Gomes, 2003
	Antimicrobial activity	Srikumar <i>et al.</i> , 2007
	Antigenotoxicity	Srikumar <i>et al.</i> , 2007
	Antimutagenicity	Singh <i>et al.</i> , 2008

Ber

The ber tree, a thorny small tree native to India, has been cultivated since ancient times for its highly nutritious fruits, rich in vitamin C, A, and B12, with almost all parts possessing medicinal properties. The roots are bitter, cooling, and tonic, beneficial for cough, fever, wounds, and ulcers, while stem bark treats dysentery, diarrhea, and boils. Leaves are used for various ailments including stomatitis, wounds, asthma, and obesity, and boiled leaves are applied to promote suppuration in boils and abscesses. Fruits are sour, sweet, and cooling, beneficial for digestive issues, constipation, and wounds. Seeds, acrid and soporific, are used for encephalopathy, cough, and insomnia, with kernels applied as a liniment for rheumatism (Kumar, 2011). Table 5 indicates the medicinal uses of ber.

Table 5: Medicinal uses of ber

Part	Medicinal and therapeutic properties	Reference
Fruit	Anticancer property	Lee <i>et al.</i> , 2003
	Antidiabetics property	Jarald <i>et al.</i> , 2009
	Hepatoprotective	Dahiru <i>et al.</i> , 2010
	Antimicrobial Activity	Tanvir <i>et al.</i> 2014
	Anti-inflammatory Effect	Huang <i>et al.</i> , 1990
	Antispastic Effect	Huang <i>et al.</i> , 1990
	Antiallergic	Su <i>et al.</i> , 2000

Karonda

Karonda (*Carrisa* spp.) is an underutilized fruit belongs to Apocyanaceae (Wiart, 2006) which is commonly known as Christ thorn and it is an evergreen spiny shrub. The native of karonda is Indo-Malaysia. It is suitable for tropical and subtropical climate. *Carissa carandas*; *Carissa grandiflora*; *Carissa ovata*; *Carissa grandiflora*; *Carissa edulis*; *Carissa macrophylla*; *Carissa spinarum*; *Carissa bispinosa*; *Carissa diffusa* are the cultivated species of Karonda (Pareek and Sharma, 1993; Singh and Arora, 1978). Flowers are white in colour and the fruit type is berry. Flowering takes place in March-April and fruiting occurs in October-November. Unripe fruits are white in colour and ripe fruits are purplish in colour (Muhammad., 2016). Karonda is rich source of Iron (39.1%) and used to cure anaemia (Kumar et al., 2007; Saha et al., 2010). It is also used to cure malaria, head ache, cold, cough, leprosy, nervous disorders and myopatic spasms (Hasmah., 2013). Karonda is sexually propagated by seeds and asexual propagation through cuttings, air layering and inarching. The value-added products prepared from karonda are curries, condiments, jam, syrup and squash. Fruits contain high amount of pectin and is suitable for jelly making (Kumar et al., 2007). The varieties of karonda include Pant Manohar, Pant Suvarna and Pant Sudarshan released by GBPUA&T, Pantnagar; Thar Komal released by CIAH, Ghodhra (Singh *et al.*, 2013); Maru Gaurav released by ICAR-CAZRI, Jodhpur (Singh & Nigam., 2022). Table 6 & 7 indicates the medicinal properties of karonda and extraction methods.

Table 6: Medicinal properties of karonda

Parts of Karonda	Bio active compounds	Medicinal properties and therapeutic properties	Reference
Root	Carrissone and caridone	Antibacterial property	Lindsay et al., 2000 <i>Panda et al.</i> , 2014
	Urosolic acid and methyl ester	Anticancer activity and cardioprotective compund	Liobikas et al., 2011; Pathak et al., 2007; Shishodia et al., 2003 <i>Panda et al.</i> , 2014
Leaf	Oleanolic acid	Anti-inflammatory and anti hyperlipidemic property	Liu, 1995, <i>Panda et al.</i> , 2014

Wood and bark	Carindone	Antibacterial activity	Lindsay et al., 2000
Fruit	Linalool	Antimicrobial effect	Park et al., 2012
	Coumarin	Anti-HIC, Anti-tumor, Anti-hypertension and Anti-inflammatory	Pino et al., 2004; Singh and Rastogi, 1972; Reisch et al., 1990, Liu, 2011, Pal et al., 1975;

Table 7: Extraction methods of bioactive compounds in karonda (Muhammad Arif *et al.*, 2016)

Part used	Bio active compounds extraction method	Medicinal property	Reference
Karonda leaves	Methanolic extraction	Anti- inflammatory and anti-pyretic	Hati et al., 2014; Anupama et al., 2014
Fruit	Chloroform, n- hexane and methanol	Anti- cancer property	Sulaiman., 2014
Fruit	Solvent petroleum ether extract	Anthelmintic activity	Mishra., 2012
Fruits	Ethanollic extract	Antiviral activity and antimicrobial activity	Taylor., 1996
Leaves	Aqueous extract	Anti- diabetic property	Jigna et al., 2005
Roots	Ethanollic extract	Hepatoprotective activity and cardiovascular activity	Hedge and Joshi., 2009
Leaf, stem, bark and fruits	Methanolic and aqueous extract	Anti- malarial activity	Bapna et al., 2013

Conclusion

In summary, the fruits bael, woodapple, aonla, ber, and karonda epitomize nature's wealth, offering a diverse range of nutraceutical value and therapeutic applications. Their extensive nutritional composition and bioactive constituents, such as phenolics, flavonoids, and alkaloids, underscore their profound significance in preventive and holistic healthcare. As ongoing scientific investigations continue to unveil their latent potentials, integrating these fruits into dietary and wellness practices holds promise for fostering robust health and vitality. Embracing and harnessing the nutraceutical and therapeutic attributes of these fruits can significantly contribute to the advancement of comprehensive health and well-being on both individual and societal scales.

References

1. Alam, M. I., & Gomes, A. (2003). Snake venom neutralization by Indian medicinal plants (*Vitex negundo* and *Emblica officinalis*) root extracts. *Journal of Ethnopharmacology*, 86(1), 75-80.
2. Anila, L., & Vijayalakshmi, N. (2002). Flavonoids from *Emblica officinalis* and *Mangifera indica*—effectiveness for dyslipidemia. *Journal of Ethnopharmacology*, 79(1), 81-87.
3. Anupama, N., Madhumitha, G., & Rajesh, K. S. (2014). Role of dried fruits of *Carissa carandas* as anti-inflammatory agents and the analysis of phytochemical constituents by GC-MS. *BioMed Research International*, 2014.
4. Arif, M., Kamal, M., Jawaid, T., Khalid, M., Saini, K. S., Kumar, A., & Ahmad, M. (2016). *Carissa carandas* Linn.(Karonda): An exotic minor plant fruit with immense value in nutraceutical and pharmaceutical industries. *Asian J. Biomed. Pharm. Sci*, 6(58), 14-19.
5. Badam, L., Bedekar, S., Sonavane, K. B., & Joshi, S. P. (2002). In vitro antiviral activity of bael (*Aegle marmelos* Corr) upon. *J. commun. Dis*, 34(2), 88.
6. Bagul, V., Dhabekar, S., Sansarode, D., & Dandekar, S. (2019). Wood Apple (*Limonia Acidissima* L.): A multipurpose herb in cosmetics. *Int. J. Sci. Dev. and Res*, 4(7), 172-181.
7. Bapna, S., Ramaiya, M., & Chowdhary, A. (2013). Antimalarial activity of *Carissa carandas* Linn. against *Plasmodium falciparum*. *Photon J. Microbiol*, 12, 246-250.

8. Bellah, S. F., Raju, M. I. H., Billah, S. S., Rahman, S. E., Murshid, G. M. M., & Rahman, M. M. (2015). Evaluation of antibacterial and antidiarrhoeal activity of ethanolic extract of *Feronia limonia* Leaves. *The Pharma Innovation*, 3(11, Part B), 50.
9. Bhardwaj, R. L. (2014). Role of bael fruit juice in nutritional security of Sirohi tribals. *Benchmark Survey Report of Sirohi Tribals, Krishi Vigyan Kendra, AU, Jodhpur*, 11-37.
10. Chhetri, S., Kundu, S., Tamang, A., Mahato, S., & Mahato, A. (2021). The Bael (*Aegle marmelos* L. Corr.): Health benefits and its varietal wealth. *Environment and Ecology*, 19(4A), 1355-1361.
11. Dahiru, D., Mamman, D. N., & Wakawa, H. Y. (2010). *Ziziphus mauritiana* fruit extract inhibits carbon tetrachloride-induced hepatotoxicity in male rats. *Pakistan Journal of Nutrition*, 9(10), 990-993.
12. Das, A. (2021). Ethno-medicines used by Santals & Paharias for treating skin diseases.
13. Dhakar, A., Chorotiya, P., Meena, M., Singh, C., Purvia, R. P., & Adlakha, M. K. (2019). Pharmacological properties and phytochemical of *Limonia acidissima*: a review. *World J Pharm Res*, 8(10), 637-45.
14. Diwan, G., Sinha, K., Lal, N., & Rangare, N. R. (2018). Tradition and medicinal value of Indian gooseberry: A review. *Journal of Pharmacognosy and Phytochemistry*, 7(1), 2326-2333.
15. Dubey, G., Shahu, P., & Shahu, R. (2001). Role of plants in different religious ceremonies common to Bundelkhand region, Madhya Pradesh. *Jour. Of Med. Arom. Plants Sci*, 23(11A), 542-545.
16. Duke, J. A. (1992). *Handbook of biologically active phytochemicals and their activities*. CRC Press, Inc..
17. Ghosh, S., & Playford, R. J. (2003). Bioactive natural compounds for the treatment of gastrointestinal disorders. *Clinical science*, 104(6), 547-556.
18. Gupta, R., Johri, S., & Saxena, A. M. (2009). Effect of ethanolic extract of *Feronia elephantum* Correa fruits on blood glucose levels in normal and streptozotocin-induced diabetic rats.
19. Gurjar, P. S., Lal, N., Gupta, A. K., & Marboh, E. S. (2015). A Review on medicinal values and commercial utility of Bael. *International Journal of Life-Sciences Scientific Research*, 1(1), 5-7.
20. Hansel R, Keller K, Rimpler H, Schneider G (1994) Hager's Hand buch der Pharmazeutischen Praxis, Springer-Verlag, Berlin, 1:196.

21. Haque, N., Chowdhury, S. A. R., Nutan, M. T. H., Rahman, G. M. S., Rahman, K. M., & Rashid, M. A. (2000). Evaluation of antitumor activity of some medicinal plants of Bangladesh by potato disk bioassay. *Fitoterapia*, 71(5), 547-552.
22. Hasmah, S. N., Bhatt, A., & Keng, C. L. (2013). Micropropagation of Asam Karanda (*Carissa carandas* Linn). *Pertanika Journal of Tropical Agricultural Science*, 36(1).
23. Hati, M., Jena, B. K., Kar, S., & Nayak, A. K. (2014). Evaluation of anti-inflammatory and anti-pyretic activity of *Carissa carandas* L. leaf extract in rats. *Int. J. Pharm. Chem. Bio. Sci*, 1, 18-25.
24. Hegde, K., & Joshi, A. B. (2009). Hepatoprotective effect of *Carissa carandas* Linn root extract against CCl₄ and paracetamol induced hepatic oxidative stress.
25. Huang, L., Ye, W., Cai, B., Li, D., Liu, J., & Liu, M. (1990). A preliminary study on the pharmacology of the compound prescription huangqin tang and its component drugs. *Zhongguo Zhong yao za zhi= Zhongguo Zhongyao Zazhi= China Journal of Chinese Materia Medica*, 15(2), 115-7.
26. Jain, M., Kapadia, R., Jadeja, R. N., Thounaojam, M. C., Devkar, R. V., & Mishra, S. H. (2012). Hepatoprotective activity of *Feronia limonia* root. *Journal of Pharmacy and Pharmacology*, 64(6), 888-896.
27. Jarald, E. E., Joshi, S. B., & Jain, D. C. (2009). Antidiabetic activity of extracts and fraction of *Zizyphus mauritiana*. *Pharmaceutical biology*, 47(4), 328-334.
28. Jigna, P., Rathish, N., & Sumitra, C. (2005). Preliminary screening of some folklore medicinal plants from western India for potential antimicrobial activity. *Indian journal of pharmacology*, 37(6), 408-409.
29. Kim, H. J., Yokozawa, T., Kim, H. Y., Tohda, C., Rao, T. P., & Juneja, L. R. (2005). Influence of amla (*Emblica officinalis* Gaertn.) on hypercholesterolemia and lipid peroxidation in cholesterol-fed rats. *Journal of nutritional science and vitaminology*, 51(6), 413-418.
30. Kour, S., Bakshi, P., Sharma, A., Wali, V. K., Jasrotia, A., & Kumari, S. (2018). Strategies on conservation, improvement and utilization of underutilized fruit crops. *Int J Curr Microbiol App Sci*, 7(03), 638-650.
31. Kumar, A. S., Venkatesalu, V., Kannathasan, K., & Chandrasekaran, M. (2010). Chemical constituents and antibacterial activity of the leaf essential oil of *Feronia limonia*. *Indian journal of microbiology*, 50, 70-73.

32. Kumar, D., Pandey, V., & Nath, V. (2007). Karonda (*Carissa congesta*) an underutilized fruit crop. *Underutilized and Underexploited Horticulture Crops*. [Google Scholar], 313-325.
33. Kumar, V. (2011). Exploration of medicinal properties of fruits for health and nutritional security. *Progressive Agriculture*, 11(conf), 225-233.
34. Lee, S. M., Min, B. S., Lee, C. G., Kim, K. S., & Kho, Y. H. (2003). Cytotoxic triterpenoids from the fruits of *Zizyphus jujuba*. *Planta medica*, 69(11), 1051-1054.
35. Lindsay, E. A., Berry, Y., Jamie, J. F., & Bremner, J. B. (2000). Antibacterial compounds from *Carissa lanceolata* R. Br. *Phytochemistry*, 55(5), 403-406.
36. Liobikas, J., Majiene, D., Trumbeckaite, S., Kursvietiene, L., Masteikova, R., Kopustinskiene, D. M., ... & Bernatoniene, J. (2011). Uncoupling and antioxidant effects of ursolic acid in isolated rat heart mitochondria. *Journal of natural products*, 74(7), 1640-1644.
37. Liu, J. (1995). Pharmacology of oleanolic acid and ursolic acid. *Journal of ethnopharmacology*, 49(2), 57-68.
38. Maity, P., Hansda, D., Bandyopadhyay, U., & Mishra, D. K. (2009). Biological activities of crude extracts and chemical constituents of Bael, *Aegle marmelos* (L.) Corr.
39. Meena, V. S., Gora, J. S., Singh, A., Ram, C., Meena, N. K., Roupael, Y., ... & Kumar, P. (2022). Underutilized fruit crops of Indian arid and semi-arid regions: Importance, conservation and utilization strategies. *Horticulturae*, 8(2), 171.
40. Mishra, C. K., Sasmal, D., & Shrivastava, B. (2012). An in vitro evaluation of the anthelmintic activity of unripe fruits extract of *Carissa carandas* Linn. *Int J Drug Dev Res*, 4(4), 393-7.
41. Muhammad, A., Muhammad, Q., & Rafiq, A. (2016). Effect of sea salt irrigation on plant growth, yield potential and some biochemical attributes of *Carissa carandas*. *Pakistan Journal of Botany*, 48(3), 853-859.
42. Pal, R., Kulshreshtha, D. K., & Rastogi, R. P. (1975). A new lignan from *Carissa carandas*. *Phytochemistry*, 14(10), 2302-2303.
43. Panda, D., Panda, S., Pramanik, K., & Mondal, S. (2014). Karonda (*Carissa* spp.): an underutilized minor fruit crop with therapeutic and medicinal use. *International Journal of Economic Plants*, 1(1), 36-41.
44. Pareek, O. P., & Suneel, S. (1993). Genetic resources of under-exploited fruits. *Advances in horticulture: fruit crops-Volume 1.*, 189-225.

45. Park, S. N., Lim, Y. K., Freire, M. O., Cho, E., Jin, D., & Kook, J. K. (2012). Antimicrobial effect of linalool and α -terpineol against periodontopathic and cariogenic bacteria. *Anaerobe*, 18(3), 369-372.
46. Parvez, G., & Sarker, R. K. (2021). Pharmacological potential of wood apple (*Limonia acidissima*): A Review. *IJMFM and AP*, 7(2), 40-47.
47. Pathak, A. K., Bhutani, M., Nair, A. S., Ahn, K. S., Chakraborty, A., Kadara, H., ... & Aggarwal, B. B. (2007). Ursolic acid inhibits STAT3 activation pathway leading to suppression of proliferation and chemosensitization of human multiple myeloma cells. *Molecular cancer research*, 5(9), 943-955.
48. Phapale, R., & Thakur, S. M. (2010). Antioxidant activity and antimutagenic effect of phenolic compounds in *Feronia limonia* (L) swingle fruit. *International Journal of Pharmacy and Pharmaceutical Sciences*, 2(4), 68-73.
49. Pino, J. A., Marbot, R., & Vázquez, C. (2004). Volatile flavor constituents of Karanda (*Carissa carandas* L.) fruit. *Journal of Essential Oil Research*, 16(5), 432-434.
50. Priya, E. M., Gothandam, K. M., & Karthikeyan, S. (2012). Antidiabetic activity of *Feronia limonia* and *Artocarpus heterophyllus* in streptozotocin induced diabetic rats. *Am. J. Food Technol*, 7, 43-49.
51. Rahman, S., & Parvin, R. (2014). Therapeutic potential of *Aegle marmelos* (L.)-An overview. *Asian Pacific journal of tropical disease*, 4(1), 71-77.
52. Rakhunde, P. B., Saher, S., & Ali, S. A. (2014). Neuroprotective effect of *Feronia limonia* on ischemia reperfusion induced brain injury in rats. *Indian Journal of Pharmacology*, 46(6), 617.
53. Ram, M. S., Neetu, D., Yogesh, B., Anju, B., Dipti, P., Pauline, T., ... & Selvamurthy, W. (2002). Cyto-protective and immunomodulating properties of Amla (*Emblica officinalis*) on lymphocytes: an in-vitro study. *Journal of ethnopharmacology*, 81(1), 5-10.
54. Rastogi RP. Mehrotra BN (1998) In Compendium of Indian medicinal plants, CDRI., Lucknow & Publications & Information Directorate, New Delhi, 5:18.
55. Reisch, J., Hussain, R. A., Krebs, B., & Dartmann, M. (1990). Natural product chemistry, part 100: The structure of carissone, C₁₅ H₂₄ O₂. *Monatshefte für Chemie/Chemical Monthly*, 121(11), 941-944.
56. Saha, R., Hossain, L., Bose, U., & Rahman, A. A. (2010). Neuropharmacological and diuretic activities of *Carissa carandas* linn. leaf. *Pharmacologyonline*, 2010(2), 320-327.

57. Saima, Y., Das, A. K., Sarkar, K. K., Sen Sr, A. K., & Sur, P. (2000). An antitumor pectic polysaccharide from *Feronia limonia*. *International Journal of Biological Macromolecules*, 27(5), 333-335.
58. Senthilkumar, K. L., Kumawat, B. K., & Rajkumar, M. (2010). Antidiarrhoeal activity of bark extracts of *Limonia acidissima* Linn. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 1(4), 550-553.
59. Sharma, P. C., Bhatia, V., Bansal, N., & Sharma, A. (2007). A review on Bael tree.
60. Shishodia, S., Majumdar, S., Banerjee, S., & Aggarwal, B. B. (2003). Ursolic acid inhibits nuclear factor- κ B activation induced by carcinogenic agents through suppression of I κ B α kinase and p65 phosphorylation: correlation with down-regulation of cyclooxygenase 2, matrix metalloproteinase 9, and cyclin D1. *Cancer research*, 63(15), 4375-4383.
61. Shoba, F. G., & Thomas, M. (2001). Study of antidiarrhoeal activity of four medicinal plants in castor-oil induced diarrhoea. *Journal of ethnopharmacology*, 76(1), 73-76.
62. Singh, A. K., Pal, R., Abrol, G., Punetha, S., Sharma, P., & Pandey, A. K. (2019). Nutritional and medicinal value of underutilized fruits. *Acta Scientific Agriculture*, 3(1), 16-22.
63. Singh, B., & Rastogi, R. P. (1972). The structure of carindone. *Phytochemistry*, 11(5), 1797-1801.
64. Singh, D. P., Govindarajan, R., & Rawat, A. K. S. (2008). High-performance liquid chromatography as a tool for the chemical standardisation of Triphala—an Ayurvedic formulation. *Phytochemical Analysis: An International Journal of Plant Chemical and Biochemical Techniques*, 19(2), 164-168.
65. Singh, H. B., & Arora, R. K. (1978). Wild edible plants of India. *Wild edible plants of India*.
66. Singh, J., & Nigam, R. (2022). Underutilized Arid Fruits in India: A Review.
67. Singh, S., Singh, A. K., Apparao, V. V., & Bhargava, R. (2013). Thar Kamal: A new karonda variety. *Indian Horticulture*, 58(4), 9-10.
68. Sonawane, S., & Arya, S. S. (2013). Antioxidant activity of jambhul, wood apple, ambadi and ambat chukka: an indigenous lesser known fruits and vegetables of India. *Adv J Food Sci Technol*, 5(3), 270-275.
69. Srikumar, R., Parthasarathy, N. J., Shankar, E. M., Manikandan, S., Vijayakumar, R., Thangaraj, R., ... & Rao, U. A. (2007). Evaluation of the growth inhibitory activities of Triphala against common bacterial isolates from HIV infected patients. *Phytotherapy*

Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives, 21(5), 476-480.

70. Su, X., Chen, Z., Jiao, B., Huang, Q., & Li, W. (2000). Studies on anti-allergic activity of common foodstuffs in China and their constituents. *Journal of Southwest Agricultural University*, 21(1), 77-80.
71. Sulaiman, S. F., Wong, S. T., Ooi, K. L., Yusof, S. R., Muhammad, T., & Sifzizul, T. (2008). Anticancer study of *Carissa carandas* extracts. *Project Report. USM*, 1-6.
72. Suryanarayana, P., Saraswat, M., Petrash, J. M., & Reddy, G. B. (2007). *Emblica officinalis* and its enriched tannoids delay streptozotocin-induced diabetic cataract in rats.
73. Takase, H., Yamamoto, K., Hirano, H., Saito, Y., & Yamashita, A. (1994). Pharmacological profile of gastric mucosal protection by marmin and nobiletin from a traditional herbal medicine, *Aurantii fructus immaturus*. *The Japanese Journal of Pharmacology*, 66(1), 139-147.
74. Tanvir, E. M., Afroz, R., Karim, N., Mottalib, M. A., Hossain, M. I., Islam, M. A., ... & Khalil, M. I. (2015). Antioxidant and Antibacterial Activities of Methanolic Extract of BAU K ul (*Ziziphus mauritiana*), an Improved Variety of Fruit from Bangladesh. *Journal of Food Biochemistry*, 39(2), 139-147.
75. Taylor, R. S. (1996). *Medicinal plants of Nepal: ethnomedicine, pharmacology, and phytochemistry* (Doctoral dissertation, University of British Columbia).
76. Thakur, N., Chugh, V., & Dwivedi, S. (2020). Wood apple: An underutilized miracle fruit of India. *The Pharma Innovation Journal*, 9, 198-202.
77. Troup, R. S. (1921). *The silviculture of Indian trees* (Vol. 1). Clarendon Press.
78. Vasudevan, M., & Parle, M. (2007). Effect of Anwala Churna (*Emblica officinalis* G AERTN.): An Ayurvedic preparation on memory deficit rats. *Yakugaku Zasshi*, 127(10), 1701-1707.
79. Vidhya, R., & Narain, A. (2011). Development of preserved products using under exploited fruit, wood apple (*Limonia acidissima*). *American Journal of Food Technology*, 6(4), 279-288.
80. Wakchoure, S. M., Raut, P. G., Jadhav, S. N., Kinikar, D., & Dhangar, H. MULTIPOTENTIAL TRADITIONAL PLANT WOOD APPLE (*LIMONIA ACIDISSIMA*): A.
81. Wiart, C. (2006). *Medicinal plants of the Asia-Pacific: drugs for the future?*. World Scientific.

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