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REVIEW ARTICLE

The Nutritional and Pharmacological value of *Bilva Phala* (Aegle marmelos Corr.) - A Review

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ABSTRACT

Ayurveda is an ancient medicinal system in which herbal plants are widely used as medicine and food. Many of medicinal plants described in ayurveda among them *Bilva* (Aegle marmelos Corr.) is used as food and also for several ethnomedicinal applications in traditional and folk medicine. It is one of the ingredient of *Bruhatpanchamool*. Traditionally it has been used for treatment of diseases as like *Shoth*, *Atisar*, *Pravahika*, *Arsha*, *Jwara*, *Vibandha*, *Grahani*, *kamala*. Recent research studies states that it has Anti diabetic, Anti cancerous, Anti fertility, Anti microbial, Anti diarrhoea properties. Every part of *Bilva* plant such as fruit, seed, bark, leaf and root are important for their therapeutic uses but in which the fruit is the most valuable part and it has great commercial importance and Aegle marmelos fruit popularized in International market because now a days it utilized in day-to-day life in various forms due to its nutritional value and especially in Industrial food processing purposes. In ancient literature of Ayurveda mentioned the many *Pathyakalpana* of *bilva* fruit. The pharmacological studies have acknowledged the value of fruit contains some nutritional constituents and phytochemicals like Xanthotoxol, Sitosterol, Aegeline, Marmeline, Tannin, Carotenoids, Volatile oil and it is helpful to cure mainly the diseases related to digestive system. In ancient literature the medicinal properties are varies of *Apakwa* (Unripe) and *Pakwa* (Ripe) *Bilva phala*. Unripe *bilva* fruit used for medicinal purposes and ripe fruit is for edible. The present review deals with summarizing and discussing the essential details of nutritional and pharmacological value of *Bilva phala*.

Key Words *Bilva, Aegle marmelos Corr., Phytochemicals, Apakwa (Unripe) Bilva phala, Pakwa (Ripe) Bilva phala, Nutritional and Pharmacological action*

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INTRODUCTION

Bilva (Aegle marmelos Corr.) is a medium size tree belonging to family 'Rutaceae' and mainly found in tropical and subtropical regions and it is indigenous to Indian subcontinent. The common name of *Bilva* is Stone apple, Wood apple, Bengal quinoe, Japanese bitter orange. The harvesting period of fruits is mid-April to May[1].The leaves of it used for worship of Lord Shiva. It is also called '*Shivadurme'*. The mentioned of plant have also been found in ancient Indian scriptures [2].It acts as a 'sink' for chemical pollutants as it absorbs poisonous gases from atmosphere and make them neutral. The

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plant considered under the category of 'fragrant' species whose flowers and volatile vapours neutralize bad odour [3].The wood of tree used for house building, cart construction, agricultural implements, carving, combs and tool handles. Aegle marmelos fruit has been used traditionally in making paints in Burma [4, 5]. A yellow dye from the unripe fruit used with myrobalans in calico printing. The pulp is often used as soap for washing clothes .The shell used in preparation of hair oil [5]. A sweet scented water prepared from distillation of flowers and leaf juice is applied on to the body before taking bath [6].The fruit of Aegle marmelos has great demand in food industries due to it has nutritional and medicinal value. In India fruit pulp used for preparation of Murabba, Syrup, Jam, Toffee. The sweet fruit pulp used in preparation of '*Sharabat'* for refreshment. Full grown but unripe fruits are made into jam [7]. In literature of ayurveda there are many formulations of were described. Specially *Pathyakalpana* of *Bilva* are very useful in different diseases and also for nutrition of body. A detailed information regarding plant cultivation, commercial use, physical and chemical constants also mentioned in the book "The wealth of India''. The shape of *Bilva* fruit varies according to *Vanya* (wild) and *Gramya* (cultivated) varietyin different regions. *Bilva* has been classified into various varieties as like Mitzapuri, Rampuri, Basti number 1, Azamati, Khamaria, Kaghzi gonad, Gonda number 1, Gonda number 2, Gonda number 3, Kaghzi Etawah, Sewan large, Deoria large, Chakaiya, Baghael, Lamba, Darogali and Ojha. Mitzapuri is best variety and it possess a very thin breakable rind and fine textured pulp, few seeds, excellent taste and flavour [8].

Morphology-

Leaf- Trifoliate, alternate, gland-dotted, Palmately compound, acute, laterals sessile [9].

Flowers- Sweet scented, 5 petals white in colour, pedicellate, bisexual, complete [9].

Inflorescence- Cymose, axillary panicle [9].

Root- Tap root, branched [9].

Stem- Erect, branched, woody, cylindrical, with axillary straight single or paired spines [9].

Fruit- It may be round, oval, pyriform or oblong in shape and 5-20 cm in diameter. Sweet pulp, berry with wooden rind. The hard woody shell of unripe fruit is grey green in colour and turned in to yellowish when ripen. The seeds having flat-oblong shape and 1 cm long. Seeds can be 10-50 in number. Each seed is enclosed in a sac of adhesive, transparent mucilage that solidifies on drying. Fruits of wild trees are smaller than cultivated types. The aromatic tiny oil glands appears as dot on the fruit shell. Although having high moisture content of nearly 60% [8, 9,10,11].

Phytoconstituents-

Bilva fruit contains Polyphenols, Coumarins Xanthotoxol, Imperatonin, Alloimperatonin, Volatile contents such as monoterpenes and sequiterpens, Akaloids areaegelenine, aegeline, halfordinol and marmeline, Phenolic acids aregallic acids, chlorogenic acid, organic acid, Tannin. In fully ripe fruits contain highest Tannin. Ascorbic acid content decreases

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significantly with fruit ripening. Volatile contain monoterpenes and Sequiterpens also present [12, 13, 14, 15].

Unripe fruit- Marmeline, Aegeline, Tannin[10].

Ripe fruit- Xanthotoxol, B-sitosterol, Tannin, Riboflavin, Vitamin's [10].

Nutritional value of *Bilva* fruit- (In percentage or per 100gm)-

Water (moisture) 64.2, Protein-1.8, Fat-0.2, Mineral- 1.5, Fibre- 2.2, Carbohydrate-30.6, Calcium-0.09, Phosphorus- 0.05, Pottassium-0.6, Iron-0.3, Vitamin A(IU)-186, Vitamin B1-0.01, Nicotinic acid-0.9, Riboflavin-1.2, Vitamin C-0.01, Calorific value-129 [16,17,18].

***Karma* (Actions) of *Bilva Phala*-**

1. *Apakwa phala* (Unripe fruit)-*Dipana* (increases digestive fire), *Pachan* (digestive), *Hrudya* (Cardio tonic), *Grahi* (inhibit loose motion). Unripe fruit used in to the diarrhoea, dysentery [19, 20, 21, 22].

***2. Pakwa phala* (Ripe fruit)**-*Vidahi* (sensing of burning in abdomen), *vishtambhi* (difficulty in digestion), *agnisadak* (decreases digestive fire). Ripe fruit having laxative property and it used into the constipation[19, 20,21,22].

Table no.1. Classification of *Bilva phala* in *Samhita* and *Nighantu*- [20, 21, 22, 23.]

Tables 1 Classification of *Bilva phala* in *Samhita* and *Nighantu*[20, 21, 22, 23]

Sr. No	Name of texts	*Gana /varga*	Part used
1.	*Sushruta samhita*	*Ambashthadi*	*Apakwa phalamajja*
2.	*Ashtang sangraha*	*Ambashthadi*	*Apakwa phalamajja*
3.	*Ashtang Hruday*	*PriyanguAmbashthadi*	*Apakwa phalamajja*
4.	*Sushruta Nighantu*	*Ambashthadi*	*Apakwa phalamajja*
5.	*Madanadi Nighantu*	*Ambashthadi*	*Apakwa phala*
6.	*Hrudyadeepika Nighantu*	*Dwishpanda varga*	*Apakwa and Pakwaphala*
7.	*Bhavaprakash Nighantu*	*Guduchyadi varga* *Amradiphala varga*	*Apakwa phala* *Apakwa and Pakwa phala*
8.	*Haritakyadi Nighantu*	*Guduchyadi varga* *Amradiphala varga*	*Apakwa phala* *Apakwa and Pakwa phala*
9.	*Amarakosh*	*Vanaushadi varga*	*Apakwa and Pakwa phala*
10	*Paryayratnamala*	-	*Apakwa and Pakwa phala*
11.	*Dhanvantari Nighantu*		*Apakwa and Pakwa phala*
12.	*Dravyagunasamgraha*	*Phalavarga*	*Apakwa and Pakwa phala*
13.	*Shabdachandrika*	*Vrukshadi varga*	*Apakwa and Pakwa phala*
14.	*Shodha lNighantu*	*Guduchyadi varga*	*Apakwa and Pakwa phala*
15.	*Nighantushesha*	*Vrukshadiskanda*	*Apakwa and Pakwa phala*
16.	*Abhidhana Ratnavali*	*Shashthaskandha*	*Apakwa and Pakwa phala*
17.	*Madhav's Dravyaguna*	*Vividhaaushadgi varga*	*Apakwa and Pakwa phala*
18.	*Madanphala Nighantu*	*Abhayadi,* *Paniyadi*	*Apakwaand Pakwa phala,* *Phala*
19.	*Kaiyadeva Nighantu*	*Aushadhi*	*Apakwa and Pakwa phala*
20.	*Sarswati Nighantu*	*Mahavrukshaka varga*	*Apakwa and Pakwaphala*
21.	*Raj Nighantu*	*Amradi*	*Apakwa and Pakwaphala*
22.	*Shivakosha*	-	*Apakwa and Pakwa phala*
23.	*Rajavallabha*	*Phalavarga (3)*	*Apakwa and Pakwa phala*
24.	*NighantuRatnakara*	*Gunadoshaprakarana*	*Apakwa and Pakwa phala*
25.	*Aushadhi Nighantu*	*Gunadipika*	*Apakwa and Pakwa phala, Tarunaphala*
26.	*Shaligrama Nighantu*	*Guduchyadivarga*	*Apakwa and Pakwa phala*
27.	*Shankar Nighantu*	*Dwitiyapada*	*Apakwa and Pakwa phala*
28.	*Abhidhanmanjari*	*Ambashthadi*	*Apakwa and Pakwa phala*

28.	*Priya Nighantu*	*Haritakyadi varga*	*Apakwa and Pakwa phala*
29.	*Nighantuadarsha*	*Bijapoorakadi varga*	*Apakwa and Pakwa phala*
30.	*Sidhhamantraprakasha*	*Doshala varga*	*Pakwa phala*

Table no .2. Synonyms and *Nirukti* of *Bilva* fruit -[9, 19, 20].

Rasapanchak of Bilva phala-

1.***Apakwa* (Unripe) *Bilva phala***–It has *katu* (Pungent), *tikta* (bitter), *kashaya* (astringent) taste, *Katu vipak* (after digestion effect) and *ushna veerya* (hot potency). It is *laghu* (easy to digest), *ruksha* (dry) in properties [19].

Table 2 Synonyms and *Nirukti* of *Bilva* fruit[9, 19, 20]

Sr. No.	Synonyms	*Nirukti*
1.	*Gandhagarbha*	Fruit pulp having pleasant.
2.	*Hrudyagandha*	The Fruits those are pleasant in fragrance.
3.	*Mahakapittha*	The Fruits resembles large *Kapittha* fruit.
4.	*Kapeetana*	The Fruits resemble the wood apple.
5.	*Karkata*	Fruits having hard ring.
6.	*Mahaphala*	Fruits are larger in size.
7.	*Peetaphala*	Fruits become yellow after ripening.
8.	*Sadaphala*	The bearing fruits almost throughout the year.
9.	*Sangrahi*	The Fruits are having *grahi* action.
10	*Shalatu*	Unripe fruits are of therapeutic use.
11.	*Shreephala*	Beautiful fruits.

According to *Sushruta samhita*, *Charak samhita* and some *nighantu* it has *snigdha* (oily), *tikshna* (fast digested), Carminative property. It pacifies *Vata* and *Kapha dosha* and aggravates *Pitta* [21, 22].

2. ***Pakwa* (Ripe) *Bilva phala*-**It is *katu* (pungent), *madhur* (sweet) in taste, *madhur Vipak* (after digestion effect), *ushna veerya* (hot potency) and *guru* (heavy to digest), unpleasant smell. So that it aggravates the *dosha*, eliminates *Apana vayu* and burning sensation in the body.Ripen fruit has cooling, alterative, laxative effect [9, 19, 20,21, 22.]

Table no. 3. Formulations of *Bilva* fruit -[9, 21]

Ethno- medical uses of *Bilva* fruit –[9, 19]

Unripe fruit used as powder form mostly and half ripe fruit used for making *Murabba*, *Jam*. Ripe fruit used for preparation of *Panak* or Sharabat (Drink), Pickles, Toffee.

Unripe *Bilva* fruit-

1. Unripe fruit of *Bilva*, *Ela* (Elattaria cardamom), Sugar and *Laja* (parched paddy) are mixed together and advised in children to improve appetite.

2. Combination of unripe *bilva* fruit, jaggery, honey and oil administered in *Raktaj atisara* (diarrhoea with blood). Also used *bilvaphalamajja* (pulp of *bilva* fruit) and *takra* (buttermilk).

3. Fruit grind with *gomutra* (cow urine) then mix *ajakshir* (Goat milk) for cooking with oil. This medicinal oil used in *karnabadhirya* (deafness of ear).

Ripe *Bilva* fruit-

Ripe fruit used for preparation of *Panak* or *Sharabat* (Drink), Pickels, Tofee.

1. Sharabat prepared from *Pakwa phalamajja* administered in *jirna vibandha* (chronic constipation), *Arsha* (piles).

2. Ripe fruit useful for *Balya* (strengthen the body).

Pharmacological activity of *Bilva* fruit-

1. Antioxidant activity-

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The methanolic and ethanolic extract of Aegle marmelos fruit were found to be good natural antioxidant. In vitro free radical scavenging effect of Aegle marmelos fruit rind by DDPH method, Reducing power assay, Nitric oxide scavenging assay, Superoxide radical scavenging assay method, ABTS radical scavenging assay method,H_2O_2 method [24].

The antioxidant activity of Aegle marmelos fruit juice was evaluated using three model reaction systems (FRAP assay, β- carotene lineolate assay and Super-oxide anion scavenging activity.*Bilva* fruit shows good source of dietary antioxidants[25].

Chloroform extract and aqueous extract of dry and ripe fruit of *Bilva* show significant free radical quenching activity (reducing ferric chloride) [26].

2) Antidiabetic activity-

An aqueous extract of Aegle marmelos fruit at doses of 125 and 250 $mgkg^{-1}$ twice daily for 1 month exibits an antihyperlipidaemic effect in Streptozotocin- induced diabetic rats. Effect exerted by fruit extract at dose 250 $mgkg^{-1}$ or of glibenclamide (300 μgkg^{-1}) [27].

The extract of fruit of Aegle marmelos showed protective effects on pancreatic tissues in diabetic rats [28].

3) Ulcer healing activity-

The ethanolic extract of dried fruit pulp of Aegle marmelos at dose 100, 200, 400 mg/kg daily for 14 days in acetic acid (AA)-induced colitis in rats showed 200mg/kg of Aegle marmelos as an optimal effective dose against AA- induced colonic damage score and weight. Aegle marmelos decreased colonic mucosal damage and inflammation/ mucus/ bloody diarrhoea, faecal frequency and increased body weight affected in AA- induced colitis [29.]

The Pyranocoumarin was extracted from the seeds of Aegle marmelos Corr. provided protection against pylorus- ligated and aspirin-induced ulcers, induced stomach ulcers in rats and guinea pigs, as well as cold restraint stress induced ulcers in rats and guinea pigs [30, 31.]

4) Analgesic activity-

Analgesicactivity of ethanolic extracts of unripe fruits of Aegle marmelosin comparison with the standard drugs pentazocine and diclofenac in albino rats extract 200mg/ kg have shown significant increase in mean latency time in Eddy's hot plate and decrease in the average number of writhing movements [32].

5) Antidiarrhoel activity-

The ethanolic extract of dried fruit pulp of Aegle marmelosshowed excellent activity against Shigella boydii, S. sonnei, S. flexneri and moderate activity against S.dysenteriae[33].

Hot aqueous extract (decoction)of dried unripe fruit pulp of Aegle marmeloswas assessed for its antibacterial, antigiardial, antirotaviral activities. The decoction showed Cidal activity against Giardia and rotavirus. It significantly reduced bacterial adherence to and invasion of Hep-2 Cells [34.]

Antidiarrhoel activity of Aegle marmelos unripe fruit was studied on castor oil induced diarrhoea in mice at 400mg/kg and 800mg/kg BW. This study reported that ethanolic fruit extract of *Bilva*

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fruit significantly reduce considerable number of wet faeces [35].

In another study methalonic extract of Aegle marmelos fruit showed a 100% inhibition rate, except in the 1st hour, against diarrhoea in castor oil induced diarrhoea SD rat model [36].

Antidiarrheal activity of Ripe fruit of *Bilva* is due to calcium channel blocking compounds and not tannic acid in castor oil induced diarrhoea mice animal model [37].

6) Anthelmintic activity-

Anthelmintic activity of Aegle marmelos assess by egg hatch assay, larval development assay, the percent inhibition of hatching of stongyle type eggs and development of H. contorus larvae respectively. The aqueous and methanolic extracts of unripe fruit in dose 50, 25, 12.5, 6.25 mg/ml showed dose dependent enhancement in ovicidal activities [38].

Bilva fruits useful in cases of paralysis and death [39].

7) Anti-inflammatory activity-

The greater anti-inflammatory activity of the extract of the Aegle marmelos fruit without the peel was found than that of the extract of the fruit with the peel [40].

8) Antiviral activity-

The hydroalcoholic extract of the *bilva* fruit showed significant antiviral activity when tested against Ranikhet disease virus [41].

9) Anticancer activity-

Bilva (Aegle marmelos)fruitshowed anticancer effect in animal model with carcinoma. Ethanolic extract of fruit pulp was administered orally (200mg/kg b.w/day) for the next 5 weeks after developing breast tumors. The extract resulted in a reduction in breast tumour volume, involving a significant drop in serum biomarkers [42].

Bilva(Aegle marmelos)fruit could be used as a chemo-preventive drug. Swiss albino mice model revealed that a methanolic extract has strong preventive properties against DMBA-induced cutaneous papilloma genesis [43].

10) Antiarthritic activity-

Unripe fruit of Aegle marmeloscombined with heated mustard oil, its pulp can be administered to inflamed joints to relieve pain [44].

11) Anti constipating effect-

Ripe fruit of Aegle marmelosused to cleanse and tone the gut. After 2-3 months of consumption of ripe fruit, the intestines are cleared of old stored faecal matter. Ripe *bilva* fruit consumed in *Sharabat* form for this purpose [17.]

12) Cardioprotective activity-

Some studies confirm that the *bilva* having better Cardioprotective activity than digoxin. Fresh fruit juice with different dilution used for it [45.]

13) Anti-hyperlipidemia activity-

The oral administration of aqueous extracts of the seeds and fruits of Aegle marmelos was significantly showed the anti-hyperlipidaemia activity in the albino rat model at the dosage of 125 and 250 mg/kg. Aqueous extracts decreases the tissue lipid profile and serum [46.]

14) Radio-protective activity-

The alcoholic extract of the *bilva* fruit was administered through intra-peritoneal route of 5 days at the dosage of 5, 10, 15, 20, 40 mg/kg

before exposure to 10 Gy 60 Co gamma-radiations. The maximum protection was reported after the 30 days of post- radiation and it was also observed that 15 mg/kg dosage of the extract produces the highest survival rate [47].

15) Hepatoprotective activity-

Aqueous and ethanolic extract of Aegle marmelos fruit showed moderate to significant hepatoprotective activity in CCL4- induced liver damaged mice [48].

Conclusion

Bilva (Aegle marmelos Corr.)has been used since ancient times for edible and medicinal purposes. *Bilva* fruit is most valuable part of plant and it having important bioactive compounds so that it used in mainly in gastrointestinal disorders like *Atisar*, *Arsha*, *Grahani*, *Viband*. Many of research study proved that *bilva* fruit possess pharmacological activity such as antidiarrheal, ulcer healing property, radioprotective, cardioprotective, anti-inflammatory, anthelmintic, antioxidant and hepatoprotectiveactivity. *Bilva* fruit consumed worldwide due to its nutritional and ethanomedical value as food and medicine. It has also great demand commercially for food processing purposes. So there is serious need to conservation and cultivation of such immense fruit plant and explore the potential of it.

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