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Nutritional composition and value addition of bael fruit: A review

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Abstract
Bael (*Aegle marmelos*) is one of the important traditional underutilized fruits which contains important nutrients like vitamins, minerals, carbohydrates, fat, protein, iron, copper, zinc, potassium, phosphorus, calcium and magnesium. The current review highlights the nutritional profile and value addition of bael fruits. Due to these beneficial properties, this fruit can be explored for development of various nutritional and beneficial products in food industry. Various value addition products are developed from bael pulp, seed and outer shell like slab, squash, preserve, candy, toffee, jam. Juice and RTS. Beside its commercial products like jam, candy, toffee, RTS various parts are used in number of herbal formulations.

Keywords: Nutritional composition, value addition, bael fruit

Introduction
Bael fruit is a tropical fruit found in Southeast Asia that belongs to the Rutaceae family (Islam *et al*., 2011) [1]. Bael was discovered in India's Himalayan areas after originally appearing in Southeast Asia (Vinita Bisht & Johar, 2017) [5]. In the months of May and June bael fruit is accessible and several Indian states including Assam, Andhra Pradesh, Himachal Pradesh, Orissa and Maharashtra, have bael. Because bael is a traditional fruit it goes by various names including bilva (Sanskrit), belo (Oriya), bel (Marathi), and bilva marum (Tamil), (Sarkar *et al*., 2021) [13]. In India bael has many wild varieties like Kagzi Gonda, Mirzapuri, Kagzi Banarsi, Kagzi Gonda- 1, Kagzi Gonda- 2, Narendra Bael- 2, Narendra Bael- 5, and Narendra Bael- 9. Due to the extreme hardiness of bael it can grow in any type of soil but the tree is not very tall so it grows slowly. The tree contained bark, flowers, fruit, leaves and seeds and the fruit have tough or woody shell (Sawale *et al*., 2018) [22]. The Hindu religion entails offering its leaves to Lord Shiva (Sarkar *et al*. 2020) [15]. The fruit of bael is green in unripe stage and in ripen stage it is yellow in colour (Vinita Bisht & Johar, 2017) [5]. Bael fruit has 8–20 segments inside it (Pathirana *et al*., 2020) [12]. A good amount of nutrients is present in this fruit, including vitamins (A, B, and C), minerals (calcium and phosphorus), carbohydrates, thiamine, niacin, and riboflavin. Bael fruit's edible component included potassium, copper, calcium, phosphorus, iron, carotene, thiamine, riboflavin, and vitamin C. (Moazzem *et al*., 2019) [7]. Bael is the healthiest and least expensive fruit (Kumari *et al*., 2018) [10].
The hard shell prevents it from being served as dessert. Bael is a seasonal fruit so we can only find it in May and June. However various value-added goods included as jam, juice, candy, toffee, and pickles are manufactured from this fruit so that we can have it at any time (Sarkar *et al*., 2020) [15]. Bael can be used to create fermented liquids that taste like wine and from both ripened and unripen fruit the beverages are made (Chauhan *et al*., 2016) [14].

Nutritional Composition of Bael
Bael fruit was examined and was reported as highly nutritious fruit. Micronutrients and water-soluble vitamins were reported in the ripened form of the fruit. The fruit pulp is regarded as nutrient dense. Fibre, water, iron, sugar, fat, protein, vitamin (A, B, C, and riboflavin), phosphorus, potassium, calcium, and other minerals are present in fruit pulp. Bael pulp is also known to contain steroid hormones, flavonoids, phenolic compounds, carbohydrates, alkaloids, cardiac glycosides, terpenoids, inulin, protein, oil, lignin, and alkaloids (Bhatt and Verma 2016) [9]. Studies concluded that bael contains the highest concentration of riboflavin among all fruits (Shashank & Poonia, 2018) [8]. It has been studied that unripe fruit has a very high vitamin C concentration and antioxidant effects of vitamin B2 are advantageous to the skin.

High protein content has been reported in the bael fruit seeds whereas the moisture content is found to be more in leaves (71.26) than the fruit (63.04) or seeds (53.75). The fat content in leaves and fruit pulp is low as compared to pulp (14.94), but high level of total soluble solid has been observed in fruit pulp. Moreover, fibre, glucose, and sugar quantity are reported to be high in it. The edible part of its fruit contains calcium, phosphorus, potassium and iron. According to some researchers, immature fruit is preferred to ripe fruit for medical purposes (Sarkar *et al*., 2020) [15] and nutritionally rich compared to apples, guavas, and mangoes (Bhatt & Verma, 2016) [9]. Marmelosin, a therapeutically active compound in bael fruit (Kr & Db, 2018) [16]. Other compounds such as alkaloids are present in the fruit and leaves of the bael plant, coumarins are found throughout the entire plant, and terpenoids are found in the leaf, bark, and fruit (Pathirana *et al*., 2020) [12].

Table 1: Nutritional characteristics of bael parts per 100g

Components	Zehra *et al*., (2015) [17] (%)	Ullikashi *et al*., (2017) [18]	Saranraj *et al*., (2017) [19]	Thukral, (2017) [20]	Sharma & Chauhan, (2017) [21]	Sawale *et al*., (2018) [22] (%)	Anadani *et al*., (2018) [23]
Moisture	63.04	64.2 g	61.06%	66.00%	6.04	62.04	56.91%
Acid content	-	-	0.30%	-	-	0.43	-
Reducing sugar	-	-	4.42%	7.90 mg	-	5.19	7.52%
Non reducing sugar	-	-	9.93%	27.80 mg	-	-	-
Total sugar	-	-	-	35.70 mg	-	15.76	13.25%
Carbohydrates	34.35	31.8 g	-	22.3%	74.31	-	29.21%
Protein	1.87	1.8 g	3.64%	4.70%	4.35	1.57	2.79%
Fat	0.28	0.3 g	0.43%	0.10%	1.54	0.39	0.47%
Fibre content	2.78	2.2 g	4.80%	0.02%	-	3.07	5.79%
Vitamins							
A	-	-	-	-	-	-	---
B_1 (thiamine)	0.16	0.13 mg	-	-	-	-	0.16
B_2 (riboflavin)	0.18	1.19 mg	-	-	-	-	0.18
B_3 (niacin)	0.87	1.1 mg	-	-	-	-	0.87
C (ascorbic acid)	73.2	60 mg	-	-	49.09	-	73.2
Potassium	-	600 mg	603 mg	-	1596	-	-
Phosphorus	-	50 mg	51.60 mg	78.80 mg	-	-	-
Calcium	-	85 mg	78.00 mg	117.60 mg	94.9	-	-
Iron	-	-	0.55 mg	52.20 mg	18.24	-	-
Copper	-	-	0.19 mg	-	1.34	-	-
Zinc	-	-	0.28 mg	-	1.39	-	-
Magnesium	-	-	4.00 mg	-	243	-	-

Value Addition of Bael

The bael fruit (Aegle Marmelos) has a lot to offer in terms of nutrition and health benefits (Ullikash et al., 2017) [18]. In their 2018 [8] analysis, Abhinay Shashank and Amrita Poonia highlighted the importance and added value of bael fruit, which is rich in various nutrients and bioactive substances like marmelosin and aeglin. Beyond its nutritional and therapeutic benefits, bael fruit can be utilized in various non-edible applications such as corrosion-resistant film, biodiesel, bio-adsorbents for pollutants, and more. Despite being an underutilized fruit for processing, numerous value-added products such as slab, squash, preserve, wine, drinks, and others have been developed, making the commercialization of bael products possible. Fruit toffee is a healthy product with a chewy texture that is high in dietary fibre and natural sugar (Batt and Verma, 2016) [9]. To avoid extra production during the season, bael can be converted into value added products such as jam and fruit bars. It is necessary to employ methods to extend storage life, for better distribution, and to preserve them for use in the offseason on a large and small scale. Jam is a concentrated fruit preparing with a thick consistency and substance. It is also flavourful, as it is made from ripe fruits that have developed full flavour. Fruit bar is a nutritious snack that has a chewy texture like dried raisins and is high in dietary fibre and natural sugar. When combined with other fruits, bael juice can make a delicious beverage. Recognizing the significance of wood apple fruit as an essential component to human well-being, as a less expensive and more effective source of protective foods. Its perishable nature and variation in seasons in production necessitate its preservation to be available for human consumption throughout the year (Ravani & Joshi 2014) [24]. Fruit pulp contains detergent properties and can be used to wash garments. Bael fruit is utilized to remove scum from vinegar production. The glue that envelops the seeds is most common in wild fruits, particularly when fruit are immature. The gum is often used as a household glue and by jewellers as a bonding agent. It is occasionally used as a soap replacement. It is combined with lime plaster for sealing wells and is incorporated into cement when constructing walls. It is used by artists in watercolours and as a protective coating on artworks. The limonene-rich oil extracted from the peel has been used for perfume hair oil.

Conclusion

Bael is an underutilized plant, but it is rich in nutritional value and medicinal properties. The fruit of bael is available in summer months. The bael is rich in nutritional value but still this plant is underutilized, and it is not used in commercial utilization for value added product. Most people like the taste of the fruit. The bael fruit is rich in carotenoids, carbohydrates and vitamin C. So being nutritionally rich it can be used to fortify many food products hence it can help in promoting healthier diet

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