Comparative morphological, biochemical and bioactive potentials of different varieties of Bael [Aegle marmelos (L.) Corrêa] of India

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Bael [Aegle marmelos (L.) Corrêa] is a traditional medicinal plant indigenous to India. From olden days, it has been used as an alternative medicine for various purposes. Existence of different varieties of Bael raised a pertinent question, whether all of them show equivalent health benefits?. In the current study, Bael fruits from different varieties were analysed for nutritional composition and their bioactive potentials. Results revealed the broad range of physicochemical alterations among the screened five varieties. The best sweetish Bhopal variety composed with high polyphenols (27.3±1.56 mg GAE/g), vitamin A (54.6±2.48 mg/g), and enriched levels of phenolic acids (tannic, cinnamic, ferulic, and chlorogenic acids) compared to other varieties. The Bhopal variety showed good antioxidant activity (6.8±0.95 µg/mL) and cyto/DNA protective properties. It also showed potent antiulcer and anticancer activities by inhibiting H+ K+- ATPase (6.4±0.75 µg/mL) and tyrosinase (40.2±3.9 µg/mL) respectively as opposed to respective standard inhibitors – lanzoprazole (19.2±0.75 µg/mL) and kojic acid (25.6±0.89 µg/mL). Evaluation of comparative nutritional content and nutraceutical potency explains that all varieties are not edible and they differ also in possessing health beneficial compounds. Bael variety from Bhopal yielded sensorially acceptable Nectar and offered enriched bioactivities. This is the first study indicating the varietal effect on nutritional and nutraceutical composition of Bael.

Keywords: H+, K+- ATPase, Medicinal plant, Phenolic acids, Tyrosinase, Vitamins

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Medicinal plants are known for their remedial action against many chronic diseases. Continuous discovery has lead to identification of potent disease preventive and curative components\(^1\) that includes vincristine, vinblastine, resveratral, carotenoid – lycopene, etc\(^2\). Many a times they also become the basis for synthetic drugs. Therefore, identifying and validating the plant-derived nutritional and nutraceutical compounds for the treatment of various chronic diseases are of great value. In the present study Bael (Aegle marmelos), a traditionally valued underutilized medicinal plant\(^3-6\) was evaluated for its nutritional and nutraceutical components. Although Bael is a native fruit of India and one of the richest sources of micro and macro-nutrients\(^7\); it was underutilized across the country. This raised a pertinent question–whether the varieties differ in their composition? Current study thus focussed on collection of Bael fruit varieties from different parts of India and evaluated their morphological as well as nutraceutical properties. It is pertinent to study potential sources from various geographical locations since the environment influences physiological regulation, which in turn produce compounds that enable them to survive in that particular situation. Indeed previous studies from our laboratory have shown the physiological and biochemical modifications in different varieties of tomato\(^8\) and mushroom\(^9\) and effects of these on composition of various bioactive components which in turn exhibits differences in the disease-modulating properties such as antiulcer\(^10\), antidiabetic\(^11\) and anticancer properties\(^8,12-13\).

Materials and methods

Chemicals used

Folin – Ciocalteu reagent (FC), 1,1-Diphenyl-2-picrylhydrazyl (DPPH), Adenosine Triphosphate (ATP), Bovine Serum Albumin (BSA), Retinol,
Retinyl acetate, Cholecalciferol, Ergocalciferol, L-Ascorbic acid, D,L-α-Tocopherol acetate, Ascorbic acid, Phenolic acid, standards like Gallic acid, Ferulic acid, Cinnamic acid, Syringic acid, Vanillic acid, Gentisic acid and Protocatechuic acid were purchased from Sigma Chemical Co (St. Louis, MO), and all other routinely used lab chemicals/reagents, Agarose, Ethidium bromide employed in the experiments were of the highest quality from Merck and Sisco Research Laboratories, Mumbai, India. HPLC column (Shimpak C$_18$) was procured from Shimadzu Corp. Tokyo. only HPLC grade solvents were used for HPLC analysis.

Samples collection

Five different varieties of Bael fruits were collected from different geographical locations of Karnataka and Bhopal (Madhya Pradesh), India (Fig. 1). They were labeled as BAMV (Bael Mysore variety, Mysore, Karnataka); BATV (Bael Thirthahalli variety, Shimoga, Karnataka); BANV (Bael Nanjangud variety, Nanjangud, Karnataka); BACPV (Bael Channarayapatna variety, Hassan, Karnataka) and BABMPV (Bael Bhopal Madhya Pradesh variety, Bhopal, Madhya Pradesh). Since there are no standardized names for Bael cultivars, studied varieties were named after their locations. Morphological differences in fruit size, shape, color, aroma, texture, nature of seeds arrangement, mucilage, and rind texture were noted (Table 1). Largest edible fruits such as apple and pomegranate also collected from Mysore Deveraja market to compare the phenolic acid composition with Bael fruit. Fruit pulp was separated from seeds and mucilage and dried at 45 ± 5 °C. The pulp was made into a fine powder (20 mesh particle size) and stored in air tight bags at room temperature for further experiments.

Preparation of extracts

Hundred mg of dried pulp powder of all the varieties was subjected to extraction in 3.0 mL (w/v) of hot boiled water, vortexed for 10 min and centrifuged at 3000 g for 10 min. The supernatant was stored at 4 °C till the completion of the experiment$^{10}$. 

Determination of total polyphenols

Total polyphenol content was determined using Folin Ciocalteu (FC) phenol method$^{14}$. Gallic acid with a concentration range (5-25 µg) was used as a reference standard. Total polyphenol concentration was calculated using the standard graph and expressed in Gallic acid equivalents (GAE) as mg GAE per gram of sample.

Determination of potential antioxidant, antiulcer and anticancer properties

Oxidative, cellular and DNA damage were commonly encountered during ulcer and cancer pathogenicity$^{15}$. Similarly antioxidant potential along with cyto/DNA protective properties together with tyrosinase inhibitor provides anticancer potential$^{13}$.

Table 1 — Physical characteristics of Bael varieties from different locations of India

<table>
<thead>
<tr>
<th>Variety</th>
<th>Location</th>
<th>Fruit size/shape</th>
<th>Taste</th>
<th>Mucilage and seeds</th>
<th>Fruit pulp physiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAMV</td>
<td>Mysore; Karnataka</td>
<td>Medium Round</td>
<td>Bitter</td>
<td>Distinct pouches for seeds and mucilage, enriched amounts of seeds and mucilage</td>
<td>Hard flesh</td>
</tr>
<tr>
<td>BATV</td>
<td>Thirthahalli; Karnataka</td>
<td>Medium Round to oval</td>
<td>Bitter</td>
<td>No distinct separation; less amount of seeds and mucilage</td>
<td>Hard flesh</td>
</tr>
<tr>
<td>BANV</td>
<td>Nanjangud; Karnataka</td>
<td>Medium Round</td>
<td>Bitter</td>
<td>Seeds are prominent, and mucilage is medium</td>
<td>Slight soft flesh</td>
</tr>
<tr>
<td>BACPV</td>
<td>Channarayapatna; Karnataka</td>
<td>Medium Round to oval</td>
<td>Slightly sweet</td>
<td>Mucilage is less and no prominent seeds</td>
<td>Moderate soft flesh</td>
</tr>
<tr>
<td>BABMPV</td>
<td>Bhopal; Madhya Pradesh</td>
<td>Big, ovoid-oblong</td>
<td>Sweet</td>
<td>Enriched fiber, mucilage is less, and in sacs, seeds are in pouches</td>
<td>Soft flesh</td>
</tr>
</tbody>
</table>
H⁺, K⁺-ATPase and Tyrosinase enzyme assays were performed as described in our papers 10,13. DPPH method was employed to estimate antioxidant potencies of different Bael varieties 16.

Cytoprotective/DNA protective ability
The cyto/DNA protective ability of Bael extracts were examined biochemically/microscopically using RBCs as well as human buccal cells 8.

Vitamin analysis by HPLC
The presence of fat soluble natural antioxidant vitamins like vitamin A, D, and E and also water soluble vitamin C levels were analyzed using standardized HPLC methods 17-18.

Determination of phenolic acid composition by HPLC
Phenolic acid composition in Bael extracts and also in Apple aqueous extract (APAE – 100 mg in 3.0 mL w/v) and Pomegranate aqueous extract (PGAE – 100 mg in 3.0 mL w/v) were analyzed by HPLC (Shimadzu model) using a reverse phase shimpak C18 column (4.6 mm x 250 mm, Shimadzu) with diode array UV detector at 280 nm 8.

Statistical analysis
All experiments were conducted in triplicates (n = 3), and results were expressed in mean ± standard deviation (SEM). Data were analyzed using Tukey's test to calculate the statistical difference (p value < 0.05) between the Bael varieties.

Results

Morphological characteristics
Stage of the fruit in development process influences the physical/morphological characteristics. Alterations in the physical/morphological characteristics amongst selected Bael varieties were noted (Fig. 1, Table 1). Change in fruit size, shape, taste, aroma, internal fruit structure, mucilage/seeds quantity and organization, and rind texture were observed. BAMV, BATV, BANV and BACPV varieties were in raw form with bitter tasting fruit pulp, lot of seeds, thick mucilage, and hard outer rind at the time of fruit harvest; whereas BABMPV fruits were mature, sweet tasting fruit pulp, very less mucilage, and seeds. Fruits size and shape also varied from variety to variety (Table 1). BABMPV were ovoid to oblong shaped and bigger in size ~ 2kg/fruit (Fig. 1). Observations clearly revealed the wide alterations in rind: pulp:seeds:mucilage proportions in different geoclimatic Bael varieties. Channarayapatna (BACPV) and Bhopal (BABMPV) varieties showed ~ 60 – 75 % of pulp as opposed to the rind, (~ 25 – 40 %) respectively. Contrary to this, Mysore (BAMV), T. halli (BATV), and Nanjungud (BANV) varieties showed the major amount of rind (~ 57 – 68 %) and lesser (~ 22 - 26 %) pulp content. In Mysore variety, however, since mucilage was localized in a characteristic pouch along with seeds, they could be separated well and showed ~ 8 % each of seed and the mucilage. Slight amount (~ 1 %) of mucilage was found in BABMPV, and ~ 4-5 % was found in BACPV, BATV, and BANV.

Total polyphenol content
Phenolic compounds are a group of secondary metabolites and play an important role in various steps of chronic diseases. Data indicated significant changes in polyphenol content amongst the varieties from 15.0±1.22 mg/g (BAMV) to 33.3±1.83 mg/g (BACPV). Unripened, bitter taste hard pulp of Mysore (BAMV - 15.0±1.22 mg/g), T. halli (BATV - 23.7±1.49 mg/g), and Nanjangud (BANV - 22.2±1.41 mg/g) varieties showed lower polyphenol content. Lesser polyphenols could be due to hard raw fruit pulp with poor solubility. Moderately matured (BACPV) to completely matured Bael varieties (BABMPV) possessed higher levels of phenolics (33.3±1.83 & 27.3±1.56 mg/g) compared to remaining varieties. Enriched levels of polyphenols in both Channarayapatna (BACPV) and Bhopal (BABMPV) varieties might be due to the high quantity of fruit pulp, good solubility of soft fleshy fruit pulp and proper fruit development (Table 2). Thus, the nature of fruit development (unripened, maturation, and ripening) influences the polyphenol content.

Inhibition of H⁺, K⁺-ATPase activity
Elevation of H⁺, K⁺-ATPase, a key enzyme of the stomach wall, being a determinant factor for hyperacidity has been implicated in gastric ulcers and cancers. In vitro gastroprotective property of Bael varieties was studied with H⁺, K⁺-ATPase from sheep stomach parietal cells. Data (Table 2) showed that BABMPV inhibited significantly the activity with IC₅₀ of 6.42±0.75 µg/mL, which was ~ 3 folds better than commercial H⁺, K⁺-ATPase inhibitor - Lansoprazole (IC₅₀ 19.0±0.15 µg/mL). Whereas, BAMV (15.2±1.32 µg/mL); BATV (12.7±1.27 µg/mL); BANV (17.6±1.46 µg/mL) and BACPV (9.0±0.95 µg/mL) showed lesser activity than BABMPV.

Tyrosinase inhibitory property
Astounding activation of a key enzyme – tyrosinase in melanogenesis pathway leads to skin
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cancer/melanoma (one of the prevailing cancer in the world). In view of this, tyrosinase inhibitors gained more importance in pharma industries as photoprotective and anticancer agents. Results (Table 2) indicated that among all varieties, BABMPV (IC$_{50}$ 40.2±1.9 µg/mL) exhibited significant tyrosinase inhibition.

Free radical scavenging activity (FRS)

Free radical scavenging activity of all varieties of Bael fruits extracts was evaluated using DPPH method. FRS activity is a well-known phenomenon in quenching the free radicals during oxidative stress and many chronic diseases. Antioxidant ability of all the Bael varieties was compared with Gallic acid and expressed as IC$_{50}$ (µg/mL). Data (Table 2) indicated that all the tested Bael varieties showed potent FRS activity with IC$_{50}$ in the range of 4.1±0.65 µg/mL to 9.0±1.06 µg/mL suggesting the potential radical scavenging efficiency of Bael varieties. BAMV showed good antioxidant activity.

DNA protection property

DNA oxidation is an inexorable consequence with highly expressed ROS. Fig. 2 provided that in the presence of oxidants, DNA was completely oxidized and fragmented (Lane 2) compared to native control DNA (Lane 1). Bael extracts (5µg) protected DNA from oxidation and exhibited good DNA protection property. Among all the test varieties, BABMPV (Lane 8), BAMV (Lane 4), and BACPV (Lane 7) offered potent DNA protection by protecting the DNA from fragmentation.

Cytoprotective property

RBC protection

Over produced reactive oxygen species (ROS) under oxidative stress; attack cellular organelles and damage tissues. Free radical attack of RBCs causes oxidative burst and release hemoglobin. Therefore,

this is a good model to understand the cytoprotective ability of bioactive compounds. Data (Table 2) indicated that all the Bael varieties possessed potent RBC protection activity against oxidants. ~ 3.8-1.5 folds better activity was exhibited by Bael extracts compared to ascorbic acid which showed IC$_{50}$ of 10.7±1.45 µg/mL. BABMPV showed potent RBC protection which was ~ 3.8 folds higher than standard ascorbic acid. Phase contrast microscopic images also revealed the cytoprotective ability of Bael varieties (Fig. 3) (supplementary). Oxidative damage of RBCs in the presence of oxidants were protected by all the Bael varieties; suggesting that Bael has the innate property of cytoprotection.

Buccal cell protection (BC)

Epithelial cellular damage is an immediate adverse effect usually observed under oxidative stress and also in many chronic diseases, like ulcer, cancer, and CVD. Adverse cellular and nuclear damage with oxidants were well protected by Bael varieties. The cytoprotection of Bael varietes has a greater impact in combating diseases since diseases are preceded by cellular and DNA damages. The presence of rich quantities of phenolic acids in Bael might be involved in performing potent buccal cell protection activity.

Table 2 — Total polyphenols, H$^+$, K$^+$- ATPase, Tyrosinase inhibition, Antioxidant, and RBC protection of Bael varieties

<table>
<thead>
<tr>
<th>Bael Varieties</th>
<th>Polyphenols (mgGAE/g)</th>
<th>H$^+$, K$^+$-ATPase Inhibition IC$_{50}$ (µg/mL)</th>
<th>Tyrosinase inhibition IC$_{50}$ (µg/mL)</th>
<th>FRS IC$_{50}$ (µg/mL)</th>
<th>RBC protection IC$_{50}$ (µg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAMV</td>
<td>15.0±1.22$^a$</td>
<td>15.2±1.32$^d$</td>
<td>49.5±2.45$^b$</td>
<td>4.1±0.65$^a$</td>
<td>3.4±0.23$^a$</td>
</tr>
<tr>
<td>BATV</td>
<td>23.7±1.49$^{bc}$</td>
<td>12.7±1.27$^b$</td>
<td>70.2±2.91$^c$</td>
<td>8.0±1.12$^b$</td>
<td>3.6±0.54$^a$</td>
</tr>
<tr>
<td>BANV</td>
<td>27.6±1.41$^{bc}$</td>
<td>17.6±1.49$^c$</td>
<td>73.2±3.26$^e$</td>
<td>9.0±1.06$^b$</td>
<td>3.0±0.34$^a$</td>
</tr>
<tr>
<td>BACPV</td>
<td>33.3±1.83$^a$</td>
<td>9.0±0.95$^{de}$</td>
<td>90.0±4.1$^d$</td>
<td>7.0±0.98$^b$</td>
<td>6.7±0.81$^b$</td>
</tr>
<tr>
<td>BABMPV</td>
<td>27.3±1.56$^b$</td>
<td>6.4±0.75$^e$</td>
<td>40.2±3.9$^a$</td>
<td>6.8±0.95$^b$</td>
<td>2.8±0.42$^a$</td>
</tr>
</tbody>
</table>

Standard deviation (±) is mean of triplicates. Mean values followed by superscripts (a-d) in the same column differ significantly (p ≤ 0.05). Superscript ‘a’ represents the potent content/activity, while ‘d’ represents the least content/activity.

Fig. 2 — DNA protection of Bael varieties

Fig. 3 — Buccal cell protection of Bael varieties
Quantification of fat soluble vitamins (Vitamin A, D, and E) and water soluble vitamin (Vitamin C)

Vitamins are essential nutrients that function as natural antioxidants and are protective against various adverse biological effects. Vitamin content (A, D, E, and C) in Bael extracts were quantified by HPLC (Table 3). Among all the varieties, BABMPV contained high levels of vitamin A (54.6±2.48 mg/100 g), and significant levels of vitamin E (8.3±0.58 mg/100 g), and D (5.9±0.74 mg/100 g), while, BAMV contained significant amount of vitamin D. Levels of these vitamins were compared with that of known edible fruits - Apple and Pomegranate, which are known to have potent health benefits and are proficiently used in day-to-day life.

It is noteworthy that the best variety of Bael as per all biological potencies, BABMPV possessed ~1000 folds of vitamin A and 13-46 folds of vitamin E than that of Apple and Pomegranate. Vitamin C however although was higher in Apple and pomegranate, they were not significantly (~2-3 folds only) different from that of BABMPV (Table 3).

Phenolic acids composition

The presence of individual phenolic acids in BAMV and BABMPV varieties were quantified by HPLC. Varieties were selected based on their exhibited potential antioxidant, cyto/DNA protection, antiulcer (H+K+-ATPase inhibition) and anticancer (tyrosinase inhibitory) properties. Selected varieties (BAMV and BABMPV) were compared with apple and pomegranate (Edible fruits with potent health beneficial properties). Data (Table 4) indicated that Bael varieties had significant levels of different phenolic acids compared with apple and pomegranate. BABMPV had majorly tannic, gallic, gentisic, caffeic, vanillic, coumaric, ferulic and cinnamic acids which are potent antiulcer and anticancer phenolic acids. In BAMV, tannic and cinnamic acids seem to be major phenolic acids; but lacks in ferulic acid. While apple lack in like caffeic, chlorogenic, coumaric acids and pomegranate lacks in ferulic, chlorogenic acids.

Discussion

Bael is a multipurpose herbal medicinal plant known from traditional days especially as coolant, antibacterial and antidiarrheal agent. Fruit ripening is the important process that transforms the fruits from raw to matured/ripened form with many physiological and biochemical modifications. Medicinal values appear to enrich during ripening process with potent bioactive compound release including micronutrients such as vitamins and minerals and other bioactives.

Alterations in the bioactive composition intern exhibits different degree of nutraceutical potency. It is increasingly also evident that Bael is underutilized. In this context, the current study identified the best variety of Bael by assessing their potencies against oxidative stress, cyto/DNA damages, antiulcer and anticancer activities. Data revealed that Bael varieties...
Significant protection could be due to enriched levels of phenolic acids such as caffeic, cinnamic, vanillic, gentisic, and gallic acids which are potent antulcer compounds\textsuperscript{10,27}. Results were correlated with the nutraceutical composition of fruit varieties; in other words, the phenolic acid composition appear to dictate the antioxidant, H\textsuperscript{+}-K\textsuperscript{+}-ATPase inhibitory, tyrosinase inhibitory, antulcer and anticancer properties. Natural tyrosinase inhibitors are of great concern due to role in melanoma\textsuperscript{28}. Inhibition of this enzyme is crucial towards melanoma treatment. All the varieties showed good protection against tyrosinase activity. Among all, BABMPV and BAMV varieties exhibited potential tyrosinase inhibition. This could be due to the presence of rich amounts of vitamin A and C along with polyphenols\textsuperscript{29}. Inhibition of this vitamin could have the ability to bind to the active site of tyrosinase and inhibit enzyme activity\textsuperscript{30}. It is alluring to observe that Bael, particularly BABMPV variety repudiate the well known fruits - Apple and pomegranate that are confessed for their health benefits particularly in terms of vitamin A and Vitamin E. Study thus accentuates the potential greater health benefits of Bael which is cheaper and the native fruit of the country as opposed to Apple and Pomegranate which are not economically viable for our Indian population.

from different geographical locations of Karnataka were in unripened form without proper fruit maturation even at the stage of fruit harvest. Whereas, Bael variety from Bhopal (BABMPV) were big, round to oblong shape, excellent flavor, soft, and sweet pulp with distinct flavor of matured fruits. These visual morphological changes among the varieties could be attributed to differences in soil nature, climatic conditions, temperature, rainfall, and seasonal variations\textsuperscript{22}. Agro-climatic zones could impact pulp palatability, quality, and quantity of various bioactives as well as nutritive components.

Many reports documented that environmental parameters not only affect the fruit development physiologically but also alter the phytochemical constituents\textsuperscript{22,26}. In our studies semi-matured (BACPV) and matured (BABMPV) varieties were found to have high amounts of polyphenols compared to unripened BAMV, BATV, and BANV varieties. Less polyphenols content in unripened fruits could be due to less pulp content and also hard fruit pulp which resulted in poor solubility. Various biochemical modifications of phytoconstituents from unripened stage to matured stage may also be responsible for the release of cell wall components into the pulp during fruit maturation or ripening process.

Further antulcer ability of Bael varieties was determined by inhibition of H\textsuperscript{+}, K\textsuperscript{-} ATPase, a key regulatory enzyme responsible for hyperacidity and gastric ulcers\textsuperscript{12}. Dietary inhibitors of H\textsuperscript{+}, K\textsuperscript{-} ATPase enzyme, are therefore gastroprotective in nature. BABMPV exhibited significantly potent inhibition which is ~ 3 folds better than commercially known H\textsuperscript{+}, K\textsuperscript{-} ATPase inhibitor - Lansoprazole. Significant protection could be due to enriched levels
Over production of free radicals and unavoidable oxidative stress causes tissue damage and many a times, it is responsible for chronic diseases. Diminishing ROS provides several health benefits and protection against diseases. Hence, dietary sources rich in antioxidant compounds are in great demand. Antioxidant ability, cyto/DNA protective properties of \textit{Bael} varieties were identified using RBCs, BCs, and calf thymus DNA. BABMPV showed potent antioxidant activity which was correlated to the polyphenol and vitamin content.

Vitamins are the natural antioxidants which play significant role in the treatment of ulcer and cancer. Quantification of various fat-soluble vitamins A, D, E and vitamin C in \textit{Bael} extracts revealed the differences in vitamin content among the varieties. BAMBMPV had a high content of vitamin A followed by vitamin E. The presence of individual phenolic acids was also quantified in \textit{Bael} varieties and compared with nutritious fruits – apple and pomegranate. Though, apple was rich in ferulic acid, gentisic and cinnamic acids but lacked most potent antiulcer phenolic acids like protocatechuic, caffeic, chlorogenic, and coumaric acids. Whereas, pomegranate contained good amounts of tannic, gallic, and protocatechuic acids but lacked potent antiulcer/cancer ferulic, chlorogenic, and vanillic acids. In comparison to apple and pomegranate, BABMPV had more quantities of tannic, gallic and moderate amounts of cinnamic, gentisic, caffeic, ferulic, chloroeneic, vanillic, and coumaric acids which are potent antioxidant, antiulcer and anticancer phenolic acids. Though, BAMV had good contents of tannic, gallic and cinnamic acids but, chlorogenic and ferulic acids were absent. Thus, the study clearly suggested that fruit maturation influenced the presence of rich quantities of nutrients and antioxidant polyphenols in BABMPV. BAMV is comparatively better in Karnataka varieties; but it is not useful for consumption due to a unripened hard pulp with inseparable thick mucilage, and bitter tasting pulp. Therefore, best variety BABMPV could be explored for their health benefits in the form of products and results of the study may be helpful for economical development of tribes, who mainly depends on local available food sources.

**Conclusion**

Current study clearly reveals that unlike other fruits, \textit{Bael} showed large geographical variations in terms of morphology and also their biopotentials. The present study paves a way in picking up selected \textit{Bael} variety to avail the maximum health benefits. However, BABMPV is good among all the varieties and can be promoted for best medicinal and ethnopharmacological properties. Our study may be helpful for efficient utilization of \textit{Bael} as a functional food and also to use best \textit{Bael} variety for commercial production.

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**Conflict of interest** Authors declare no conflict of interest.

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