

# Nutritional and Phytochemical Evaluation of Fruit Pulp Powder of *Aegle marmelos* (Bael)

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## ABSTRACT

**Background:** *Aegle marmelos* also known as Bael has been familiarly known as a constituent of traditional medication for treating several human ailments. Even though every part of the plant is beneficial leading to their significant use in vital medicines, the leaves and fruits are commonly useful as essential drugs from the ancient times of medicinal system to treat most of the general illnesses of humans. Its fruit consists of vast medicine related benefits which are useful in diarrhea, dysentery and gastrointestinal disorders. The medicinal properties of Bael work as chief components for discovering and designing of drugs.

**Purpose:** The present study was evaluated for the nutritional and phytochemical compositions of *Aegle marmelos* dry leaves.

**Basic Procedure:** AOAC standard method was used. For experiments, mineral compositions were determined by atomic absorption spectrophotometry for Ca, Na, Mg, Zn, Cu and Fe. Flame photometer was used to determine K. The qualitative phytochemical examination was done to determine tannins, flavonoids, alkaloids, saponins, phenols and steroids.

**Results:** *Aegle marmelos* fruit pulp powder depicted the existence of tannins, flavonoids and alkaloids as main bioactive components and presence of Vitamin C in higher concentration. Micronutrients like potassium, magnesium and sodium were present in adequate amount.

**Conclusion:** It was examined that Bael fruit pulp powder consists of protein, minerals, crude fiber and energy in good amount. It is richer source of carbohydrates and dietary fiber. It provides various nutrients and phytochemicals which are not provided by allopathic medicine having no side effects.

**KEY WORDS:** *Aegle marmelos*, phytochemical, proximate, fruit pulp.

## 1. INTRODUCTION

*Aegle marmelos* (L) Correa belongs with its common name as Bael belongs to the family Rutaceae. Its usage has been in folklore medicines from ancient times to treat different human diseases. This plant is native to India with its abundance in Himalayan tract, Bengal, Central and South India. Most of the parts of the tree like root, stem, bark, leaf, flowers and fruit at every have medicine related advantages at every maturing stage (Maity, 2009). It is the tree of medium size that grows all over the forests of India at an altitude of 1200 meters. It is present in India all around sub-Himalayan forest, Bengal, central and south India. The peel of the fruit is made up of harder shell; color varies from green to brown depending upon the ripening. The yellow or orange eatable pulp appears like a boiled pumpkin which gives a slight sweet taste, is very fragrant and has pleasant flavor. There is surrounding of oily transparent mucilage around the seeds (Suvimol and Pranee, 2008). Various parts of this plant constitute variety of coumarins, alkaloids, sterols and essential oils. Different parts of this plant like leaves, fruit and seeds have hypoglycaemic, hypolipidemic and blood pressure lowering properties (Lmbole, 2010).

Among the other parts of this tree, its fruit is found to have ayurvedic medicinal value for chronic diarrhea, tonic for heart and brain as per the reports. It possesses anti-viral, hypoglycemic, antibacterial, anti-proliferative activities (Sunita, 2011). The ripened fruit is aromatic, cool, alternative, laxative and nutritive. It is beneficial in usual constipation, chronic dysentery and dyspepsia when consumed in fresh form. It also treats flatulent colic in patients suffering from chronic gastrointestinal discharge. Ripened fruit marmalade is beneficial in preventing cholera epidemics. The fruit pulp converted into powder form after drying is used as febrifuge, antiscorbutic, stimulant and antipyretic (Patkar, 2012). Unripen fruit in powdered form is crucial in countering intestinal parasite *Entamoeba histolytica* and *Ascaris lumbricoides*. Brijesh (2009), examined the decoction of unripe fruit to be an astringent which has beneficial effect in diarrhea and chronic dysentery.

This plant has its medicinal properties in certain chemically active elements laying some physiological action on human body (Aiyelaaghe and Osamudiamen, 2009). The major ingredients in Bael comprise of alkaloids, terpenoids, steriods, phenols glycosides and tannins (Venkatesan, 2009). Limonene (82.4%) is the chief component of Bael (Kaur, 2006). Bael extract is found to significantly lower blood urea, reduction in lipid peroxidation, cholesterol whereas on the other hand increase the levels of super dioxide dismutase, catalase, glutathione peroxidase and glutathione level in serum along with liver in experimental animals having diabetes (Sharma, 2007). Bael patra is useful in managing hyperglycemia as per the study in which blood glucose level as well as urine decreased significantly by the end of 8th week (Shankhla, 2009). In addition to being regarded as a remedial plant, it has good nutritional value and is rich in carbohydrates, fiber, minerals and vitamins (Baliga, 2011).

The most valuable and consumable part of the tree is fruit and it has different therapeutic values at different stages of ripening. The unripened and half ripened fruits are used to cure scurvy which is due to deficiency of vitamin C (Yadav, 2011). Bael fruit is used in different forms of food in various countries. In Thailand these fruits are dried and packaged in tea bags and also well-preserved in syrup for the further use as deserts and ingredient for cake (Charoensiddhi and Anprung, 2008). Bael seed is an affluent source of good quality protein and would also be used as protein supplement in meals and food products (Rao, 2011). The present study was conducted with the objective to reveal the nutritional and phytochemical contents of fruit pulp of Bael. This data would be helpful to make the most of this marvelous medicinal plant even as source of good quality food.

## 2. MATERIALS AND METHODS

**Collection of Plant Material:** The fresh fruits of *Aegle marmelos* were collected from the orchard of Banasthali University, Rajasthan, India. Fresh Bael fruit were thoroughly washed in clean water to remove unwanted material and dirt. The washed mature Bael fruits were broken; the pulp along with the seeds and fibre were scooped out. Then they were mixed properly and pulp was separated from the fibre. Bael fruit powder was prepared by drying the pulp after adding 2g of sodium carbonate in the form of thin layer. This layer was cut down into pieces and further dried to below 4% moisture in a cabinet drier at  $60 \pm 5^\circ\text{C}$ . The dried fruit pulp was homogenized to powder and stored in airtight bottles for further analysis.

**Proximate Analysis:** The crucible was sterilized, dried up and weighed. The crucible was measured again after taking sample into it. It was further weighed once again after oven drying at  $110^\circ\text{C}$ . It was weighed repeatedly until determining the constant weight. Each time before the weight was taken; the crucible was cooled down in desiccators to get accurate results. Nutrient analysis included moisture, fat, ash and vitamin C estimations for fruit pulp powder. Crude fat was estimated by the use of petroleum ether as extract solvent in Soxhlet apparatus. Total ash was calculated after weighing the furnace incinerated residue at  $550^\circ\text{C}$  for 12hrs. The crude protein was estimated through micro Kjeldahl's distillation method (Imamul and Alam, 2005). Percentage carbohydrate was calculated by difference method.

**Mineral Analysis:** Chemical estimations were estimated for determining sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), zinc (Zn), copper (Cu), iron (Fe). The aqueous digest was examined using Atomic Absorption Spectroscopic standard method for Ca, Na, Mg, Zn, Cu, and Fe. K was calculated using flame photometer.

### Preparation of Extract:

**Decoction:** 1g of dried fruit pulp powder was boiled in 16ml of double distilled water until the volume was decreased to 4 ml. The decoction was strained and utilized for further estimations.

**Soxhlet Extract:** Crude plant extract was produced using soxhlet extraction method. About 50g of fruit powder was homogeneously packaged into a thimble and extracted with 250ml of different solvents distinctly. Ethanol, methanol and acetone were used as solvents. The extraction process continued until the solvent in siphon tube of an extractor turned neutral. Followed by it, the extract was poured in a beaker and kept above the hot plate and heated at  $30-40^\circ\text{C}$  until whole solvent was evaporated. Dried extract was preserved in a refrigerator at  $4^\circ\text{C}$  for the further usage in phytochemical estimations.

**Phytochemical Screening:** The extract and decoction were examined to test whether the bioactive compounds (tannins, phenols, flavonoids, saponins, alkaloids, steroids, terpenoids) were present through the usage of standard methods (Trease and Evans, 1989; Harbrone, 1973).

## 3. RESULTS AND DISCUSSION

Table.1, demonstrates the presence of moisture, ash, vitamin C, protein, fat and carbohydrate in powdered Bael fruit pulp. Amount of moisture content in the powdered Bael fruit pulp was 6.04%; ash content was higher 4.10%. The proportion of the fat was 1.54% that was higher as the study reveals. The percentage of vitamin C was 49.09%. The protein content in Bael fruit pulp powder was 4.35% and carbohydrate was 74.31%.

**Table.1. Proximate Analysis of Fruit pulp powder of *Aegle marmelos* (%)**

S.No.	Nutrients	Result (%)
1.	Moisture	6.04
2.	Ash	4.10
3.	Vitamin C	49.09
4.	Protein	4.35
5.	Fat	1.54
6.	Carbohydrate	74.31

In Table.2, the AAS analysis depicted that the Bael powder contained Sodium (Na) 184ppm. Sodium (Na) is very important physiological component and a primary extracellular cation in human beings. Sodium (Na) along with Chlorine (Cl) and Potassium (K) are electrolytes that regulate normal fluid balance in and out the cells and along with maintaining optimum acid-base balance in humans. Deficient potassium may result in muscle cramp and

hypertension (Adotey, 2009). Potassium (K) is the most abundant mineral 1596 ppm content present in Bael pulp powder. Human body requires a higher amount of potassium. Potassium is the prime electrolyte positioned in the body's cell and stored in muscle fibers with glycogen. It is an important part in helping in carrying out the transportation of glucose into the muscle cells. Deficient potassium levels results in nerve irritability, cardiac and mental disorder, muscular weakness and paralysis (Adotey, 2009). The Calcium (Ca) content was 94.9 ppm. It has numerous essential functions such as bone and dental tissues development, hormonal release, muscles contraction and glycogen metabolism (Kaneko, 1977). The amount of Magnesium (Mg) was 243 ppm. Magnesium (Mg) helps in bones growth, maintaining a constant metabolic process, keeping the flexibility of blood vessels, preventing cardiovascular diseases, and repairing injured cerebral cells (Sasaki et al., 1999). The amount of Zinc (Zn) was 1.39 ppm. WHO task force has given the recommendation for usage of Zinc (Zn) required for treating diarrhea (WHO, 2002). A huge content of Zn has been discovered in the cerebrum hippocampus area that intensely influences memory formation that signifies the fact that Zn status could thus affect the human memory (Takeda, 2000).

The Copper (Cu) content was 1.34 ppm. Copper (Cu) is a crucial micro-nutrient necessary for the hematologic and neurologic systems (Tan, 2006). A Copper (Cu) containing enzyme has a significant importance in producing energy in body cells. It is commonly concentrated in the brain and liver. It has its usefulness in synthesizing the cell membrane phospholipids maintaining myelin. It also supports in regulating neurotransmitter levels. Deficient copper amounts can lead to the impairment of the functioning of the nervous system (Watts, 1997). The AAS analysis revealed that Iron (Fe) content was 18.24 ppm. Iron (Fe) is a vital trace constituent required in formation of haemoglobin, for regular working of the central nervous system and in carbohydrates, proteins and fats oxidation (Adeyeye and Otokiti, 1999). Either in a direct or in an indirect way, the iron status can shows an effect on the capacity of a cell to produce adenosine triphosphate (ATP) and on the glucose and other carbohydrates oxidation process (Griffith, 1995). Bryan (2004), have determined that deficient iron levels result in deterioration of cognitive functioning, mainly among school going children (Sungthong, 2002). Verbal performance may directly get affected by deficient iron status.

**Table.2. Concentrations of Mineral Analysis of Fruit pulp powder of *Aegle marmelos* (ppm)**

S.No.	Minerals	Result (ppm)
1.	Sodium (Na)	184
2.	Potassium (K)	1596
3.	Calcium (Ca)	94.9
4.	Magnesium (Mg)	243
5.	Zinc (Zn)	1.39
6.	Copper (Cu)	1.34
7.	Iron (Fe)	18.24

Medicinal plants that were used traditionally yield diversified known therapeutic potentials that can be accredited to its secondary metabolites. Plants act as the natural sources of obtaining these components in a greatest effective manner with specific selectivity. Phytochemical screening of several solvent extracts and decoction of *Aegle marmelos* fruit pulp powder revealed the existence of most significant phytoconstituents. The medicinal properties of the fruit can be attained due to the existence of several bioactive chemical compounds as shown in Table.3.

**Table.3. Phytochemical screening of fruit pulp powder of *Aegle marmelos* in different solvents**

S.No.	Phytochemical Compounds	Ethanol	Methanol	Acetone
1.	Tannin	+	+	-
2.	Phenol	+	-	+
3.	Flavonoids	+	+	-
4.	Saponins	-	-	-
5.	Alkaloids	+	+	+
6.	Steroids	+	-	-
7.	Terpenoids	+	-	-

+ is present, - is absent

Ethanol extract of powder of fruit pulp revealed the existence of tannins, phenols, flavonoids, alkaloids, steroids, terpenoids. Ethanol extract of fruit pulp powder depicted the absence of saponins. Moreover, the existence of the phytochemicals in the ethanolic extract resulted in extreme antibacterial activities as per several studies (Joshi, 2009).

Methanol extract of fruit pulp powder exhibited that only Tannins, flavonoids and alkaloids were present. On the other hand, acetone extract of fruit pulp powder depicted that only phenols and alkaloids were present. The phytochemical screening of crude produces the maximum favorable secondary metabolites such as alkaloids, flavonoids, phenols and tannin that are accountable for medicinal as well as physiological activities (Edoga, 2005).

It has been observed that tannin reacts with proline-rich protein to produce irreversible complexes that result in the inhibition of the synthesis of cell protein. Fruits having tannins as their main constituents are astringent in nature. These are beneficial in curing abdominal ailments like diarrhea and dysentery (Chrinius, 2011; Nisha, 2011). The saponins present in this fruit lend confidence for its usage in management of inflammation. Flavonoids have also revealed a wide range of biological activities including antimicrobial, antioxidant, anti-inflammatory, anti-allergic and cytostatic properties (Tsuchiya, 1996). Tannins and flavonoids are found to exhibit anti-diarrheal activity through inhibition of intestinal motility and anti-secretory effects in general as per the reports (Brijesh, 2009). Reports stated that steroids and triterpenoids consist of antibacterial properties; triterpenoids weaken the membranous tissues resulting in dissolving of cell wall of microorganisms. Alkaloids have found to be analgesic, antispasmodic and antibacterial (Okwu & Okwu, 2004).

#### 4. CONCLUSION

A present result indicates that the fruit pulp powder of Bael (*Aegle marmelos*) offers a good pool of nutrients. Fruit pulp was wealthy source of carbohydrates and vitamin C. In the light of these explored nutritional facts, it can be concluded that the studied part of Bael would exercise as a new source of superior quality food. The results of the present study depicted that the ethanol extract and decoction of powder of fruit pulp confirmed the existence of several polar and non-polar compounds followed by the methanol extract. Lowest components were extracted in acetone. Thus, decoction and ethanol powder of fruit pulp extract can be deliberated as appropriate solvent for carrying out other pharmacological examination. Also the existence of bioactive compounds like tannin, phenols, flavonoids, alkaloids and steroids in powder of fruit pulp of *Aegle marmelos* helps in the traditional usage of the fruit by the rural people of India. Thus the fruit is helpful in maintaining nutritional status as well as protect us from various diseases and metabolic disorders. Apart from this, it also provides novel or leading components that could develop the initial material for the production of an innovative inexpensive drug.

**Conflict of Interest:** The authors declare that there is no conflict of interest regarding the publication of this paper.

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#### REFERENCES

- Adeyeye EI, Otokiti MKO, Proximate composition and some nutritionally valuable minerals of two varieties of *Capsicum annum* (Bell and Cherry peppers), *Discovery and Innovation*, 11, 1999, 75-81.
- Adotey DK, Serfor-Armah Y, Fianko JR, Yeboah PO, Essential elements content in core vegetables grown and consumed in Ghana by instrumental neutron activation analysis, *African Journal of Food Science*, 3 (9), 2009, 243-249.
- Aiyelaaghe OO, Osamudiamen PM, Phytochemical screening of active compounds of *Mangifera indica* leaves from Ibadan, *Oyo State Plant Science Research*, 2 (1), 2009, 11-13.
- Baliga MS, Bhat HP, Joseph N, Fazal F, Phytochemistry and medicinal uses of the Bael fruit (*Aegle marmelos* Correa): A concise review, *Food Research International*, 44, 2011, 1768-1775.
- Brijesh S, Daswani P, Tetali P, Anita N, Birdi T, Studies on the anti-diarrheal activity of *Aegle marmelos* unripe fruit: Validating its traditional usage, *BMC Complementary Alternative Medicine*, 9, 2009, 1-12.
- Bryan J, Osendarp S, Hughes D, Calvaresi E, Baghurst K, Klinken JW, Nutrients for cognitive development in school-aged children, *Nutrition Revision*, 62 (8), 2004, 295-306.
- Charoensiddhi S, Anprung P, Bioactive compound and volatile compounds of Thai Bael fruit (*Aegle marmelos* (L.) Correa) as a valuable source from functional food ingredient, *International Food Research Journal*, 15, 2008, 287-295.
- Chrinius H, Gary GY, Gideon AS, Asabe MM, Abel SA, Phytochemical and antimicrobial screening of methanol and aqueous extracts of *Agave sisalana*, *Acta Poloniae Pharmaceutica, Drug Research*, 68 (4), 2011, 535-539.
- Devlin TM, *Textbook of Biochemistry with Clinical Correlations*, Wiles-Liss Inc USA, 1997, 1129-1136.
- Edoga HO, Okwu DE, Mbaebic BO, Phytochemical constituents of some Nigerian medicinal plants, *African Journal of Biotechnology*, 49 (7), 2005, 685-688.
- Griffith HW, *Complete guide to vitamins, minerals and supplements*, 1<sup>st</sup> ed, New York, Fisher Books Company press, 92 (11), 1995, 4733-4737.

Harbrone JB, Phytochemicals Methods, Chapman and Hall Ltd, London, 1973, 49-188.

Helrich K, AOAC, Official methods of Analysis, 15<sup>th</sup> Edition, Association of Official Analytical Chemists, Washington DC, 1, 1990, 93-101.

Imamul Huq SM, Alam MD, A Hand Book on Analyses of Soil, Plant and Water, BACER-DU, University of Dhaka, Bangladesh, 2005, 55-59.

Joshi PV, Patil RH, Maheshwari VI, *In vitro* anti-diarrheal activity and toxicity profile of *Aegle marmelos* Correa ex Roxb. dried fruit pulp, Natural Product Radiance, 8 (15), 2009, 498-502.

Kaneko JJ, Harvey JW, Bruss ML, Clinical Biochemistry of Domestic Animals, 5<sup>th</sup> ed, Academy Press London, 1977, 619- 702.

Kaur HP, Garg SN, Sashidhara KV, Yadav A, Chemical Composition of the Essential Oil of the Twigs and Leaves of *Aegle marmelos* (L.) Correa, Journal of Essential Oil Research, 18 (3), 2006, 288-289.

Imbole VB, Murti K, Kumar U, Bhatt SP, Gajera V, Phyto pharmacological Properties of *Aegle marmelos* as a Potential Medicinal Tree: An Overview, International Journal of Pharmaceutical Science Review and Research, 5 (2), 2010, 55-59.

Maity P, Hansda P, Mishra D, Biological activities of crude extracts and chemical constituent of Bael, *Aegle marmelos* (L) Corr, Indian Journal of Experimental Biology, 47, 2009, 849-861.

Nisha Y, Gunjan T, Deepak KJ, Ranjana M, Rapid determination of polyphenol, vitamins, organic acids and sugars in *Aegle marmelos* using reverse phase-high performance liquid chromatography, Journal of Pharmacy Research, 4 (3), 2011, 717-719.

Okwu DE, Okwu M E, Chemical composition of *Spondias mombin* linn. Plant part, Journal Sustain Agricultural Environment, 6 (2), 2004, 140-147.

Patkar AN, Desai NV, Ranage AA, Kalekar KS, A review on *Aegle marmelos*: A Potential Medicinal tree, International Research Journal of Pharmacy, 3 (8), 2012, 86-91.

Radojevic M, Vladimir P, Practical Environmental Analysis, Royal Society of Chemistry Cambridge, UK, 366, 1999, 180-430.

Rao GN, Balaswamy K, Rao PP, Rao DG, Satyanarayana A, Nutritional quality, fatty acid, amino acid and functional characteristics of Bael (*Aegle marmelos* L.) seed protein concentrate, Journal of Food Drug Analysis, 19, 2011, 528-535.

Reaves SK, Fanzo JC, Arima K, Wu JY, Wang YR, Lei KY, Expression of p53 tumor suppressor gene is up-regulated by depletion of intra cellular zinc in HepG2 cells, Journal of Nutrition, 130, 2000, 1688-1694.

Sasaki S, Oshima T, Teragawa H, Matsuura H, Kajiyama G, Kambe M, Magnesium status in patients with cardiovascular diseases, Rinsho Buori, 47, 1999, 396-401.

Shankhla A, Sharma S, Sharma N, Hypoglycemic effect of Bael patra (*Aegle marmelos*) in NIDDM patients, Journal of Dairying Food and Home science, 28, 2009, 3-4.

Sharma PC, Bhatia V, Bansal N, Sharma A, A review on Bael Tree, Natural Product Radiance, 6 (2), 2007, 171-178.

Sungthong R, Mo-Suwan L, Chongsuvivatwong V, Effects of haemoglobin and serum ferritin on cognitive function in school children, Asia Pacific Journal of Clinical Nutrition, 11, 2002, 117-122.

Sunita S, Savikumar M, Harshada H, Method validation of marmelosin from fruit pulp of *Aegle marmelos* (L) Correa using HPTLC technique, Journal of Pharma Research, 4 (5), 2011, 1353-1355.

Suvimol C, Pranee A, Bioactive compounds and volatile compounds of Thai Bael fruit (*Aegle marmelos* L.) Correa as a valuable source for functional food ingredients, International Food Research Journal, 15 (3), 2008, 1-9.

Takeda A, Movement of zinc and its functional significance in the brain, Brain Research Review, 34 (3), 2000, 137-148.

Tan JC, Burns DL, Jones HR, Severe ataxia, myelopathy, and peripheral neuropathy due to acquired copper deficiency in a patient with history of gastrectomy, Journal of Parenteral Enteral Nutrition, 30 (5), 2006, 446-450.

Trease GE, Evans MD, A text book of Pharmacognosy, 13<sup>th</sup> Edn, Baillier, Tindal and Caussel, London, 1989, 144 -148.

Tsuchiya H, Sat M, Miyazaki T, Fujiwara S, Tanigaki S, Ohyama M, Comparative study on the antibacterial activity of phytochemical flavonones against methicillin resistant *Staphylococcus aureus*, Journal of Ethnopharmacology, 50, 1996, 27-34.

Venkatesan D, Karrunakarn CM, Selva SK, Palani PTS, Identification of Phytochemical Constituents of *Aegle marmelos* Responsible for Antimicrobial Activity against Selected Pathogenic Organisms, Ethno botanical Leaflets, 13, 2009, 1362-1372.

Watts D, Trace Elements and Other Essential Nutrients, Clinical Application of Tissue Mineral Analysis, Writer's Block Edn, United States of America, 1997.

WHO, Trace elements in human health and nutrition, WHO, Geneva, 2002.

Yadav N, Singh P, Mehrotra R, Determination of some ethno medicinally important constituents of *Aegle marmelos* fruit during different stages of ripening, China Journal of Natural Medicine, 9 (2), 2011, 204-209.