Research Article

Physico Chemical Analysis of Bael (Aegle Marmelos) Fruit Pulp, Seed and Pericarp

Amarjeet Kaur[1*] and Manoranjan Kalia[2]

[1]Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, Ludhiana-141004, India
[2]Retired Professor, CSKHPKV, Palampur, Himachal Pradesh

Abstract

India is the botanical garden of the world as it is the largest producer of medicinal herbs. Bael (*Aegle marmelos*) has been known to be one ofthe most important medicinal plants of India since Charak (1500 B.C) Bael (Aegle marmelos) also known as Bengal quince or golden apple is medium sized, deciduous tree belonging to family Rutaceae. All the parts of this tree including stem, bark, root, leaves and fruit at all stages of maturity have medical properties and have been used in the traditional medicine for a long time. The ripe fruit is of considerable medical value when it just begins to ripen. The ripe fruit is aromatic, astringent, cooling and laxative. The unripe or half ripe fruit is stomachic, anti-scorbutic, and digestive. Ripe bael fruit is regarded as best of all laxatives.

Keywords: bael, traditional medicine, aromatic, digestive and laxative

***Correspondence**
Author: Amarjeet Kaur
Email: sekhonamarjeet@rediffmail.com

Introduction

India has a large variety of flora and fauna which is available from temperate to cold deserts to sub-tropical and tropical climates and regions. References of such wild varieties of herbs and shrubs with rich medicinal values us available in our epics. 'Rigveda' one of the oldest repositories of human knowledge mention use of 67 medicinal plants. 'Yajurveda' and 'Atharveda' also mentions use of many plants for therapeutic purpose. Ayurveda and Unani type of treatments with healing touch have therapeutic and nutritional value of medicinal plants but unfortunately, the knowledge and information had not been preserved for posterity.

Bael (Aegle marmelos) is one of the medicinal plants of India. It is also known as golden apple or Bengal quince. It is a medium sized deciduous tree belonging to family Rutaceae. Other names of bael include maredu, bill, bill patra, balwa, vilwam and kuvalam in India. Bael is native of northern India, but is found widely throughout the Indian peninsula and in Ceylon, Burma, Thailand and Indo-China. The bael tree is Indigenous to India and the history of this tree has been made in 'Yajurveda' In early Buddhist and Jain literature (8000-325 B.C), methods of ripening this fruit have been described. Bael fruit has also been portrayed in paintings of Ajanta caves. It grows wild throughout the low hills of Himachal Pradesh, ascending up to 1000 meters. It is found in plenty in wild forms in the states of Uttar Pradesh, Orissa, West Bengal, and Madhya Pradesh. However, the fruits of the wild trees are considerably smaller than those of the cultivated types grown in the plains.

The fruits are good to taste containing 40 per cent TSS. The bael tree is one of the most useful medicinal plants of India. Its medicinal properties have been described in the ancient medical treatise in Sanskrit, "Charaka Samhita". All the parts of this tree including stem, bark, root, leaves and fruit at all stages of maturity have medical virtues and have been used in the indigenous medicine for a long time. The ripe fruit is of considerable medical value when it just begins to ripen. The ripe fruit is aromatic, astringent, cooling and laxative. The unripe or half ripe fruit is stomachic, anti-scorbutic, and digestive. Ripe bael fruit is regarded as best of all laxatives [1].

It cleans and tones up the intestines. Its regular use for two or three months can throw out even the old accumulated faecal matter. The pulp of the ripe fruit can also be taken with a spoon without the addition of milk or sugar. About 60 g of fruit will suffice for an adult [2].

The unripe or half ripe fruit is perhaps, the most effective food remedy for chronic diarrhea and dysentery. Dried bael or its powder provides the better results. The bael fruit when it is still green, is sliced and dried in the sun. These slices can also be reduced into powder and preserved in air tight bottles. An infusion of bael leaves is regarded as an effective food remedy for peptic ulcer. The beal fruit taken in the form of beverage has also great healing properties because of its mucilage content. This substance forms a coating on the stomach mucosa and thus helps in healing of ulcers [1].

Materials and Methods

Procurement of Raw Material

The bael fruits were procured from local market of Ludhiana in Punjab. To ensure the proper maturity of the fruits, March harvest fruits were used in the study. Fruits were broken and pulp was taken out and dried in the air drier. Similarly, seeds and pericarp were dried for physical, chemical and pharmacological analysis.

Physical Properties of Bael Fruit

All linear measurements were taken by using vernier caliper. Other quality attributes like colour, appearance, shape, uniformity and defects were recorded visually. Weights of the samples were taken by using the physical balance.

Volume

For measuring the volume, the fruits were put in a measuring cylinder. The water was poured in this measuring cylinder up to the mark (A ml). After a few minutes, when there were no air bubbles inside, the water was drained in another measuring cylinder and noted the volume of water (B ml). Volume displaced by fruits = (A -B) ml

Specific gravity

The specific gravity of the fruits was calculated by applying the formula as given below:

$$\text{Specific gravity (g/cc)} = \frac{\text{weight of fruits}}{\text{Volume of water displaced}}$$

Chemical Properties of Bael Fruit

For analyzing chemical properties of the fruit, the pulp, seed and pericarp of fruit were separated, dried in the air drier and ground. Moisture, titrable acidity, sugars, crude fibre, crude fat, crude protein and ash content were estimated by employing the standard methods of analysis [3]. pH was measured by control dynamic digital pH meter

Minerals were analyzed by acid digestion [4]

Iron in the digested sample was determined by atomic absorption spectrophotometer according to method of Lindsey and Norwell [5]. Other minerals including calcium, magnesium, phosphorus, zinc and potassium etc. were determined by the flame photometer according to the method of Lindsey and Norwell [5].

Pharmacological Properties of Baal Fruit

For pharmacological analysis dried and ground samples were used.

Anti - nutritional factors

Tannins were estimated by determining their oxidisability by potassium permanganate solution by standard method of AOAC (2000) while oxalic acid was determined by method given by Italia 2002.

Ascorbic acid [3]

The principle for determination of ascorbic acid content is based on the reduction of 2.6 - dichlorophenol indophenols by ascorbic acid.

Results and Discussion

Physical Characteristics of Bael

Assessment of physical characteristics of a fruit is very important for quality evaluation of fruits. The external colour of the fruit was brownish yellow and the fruit shape was roundish-oblong. The polar and transverse diameter of bael was found to be 12.965 and 13.35 cm respectively. The pulp had a bright yellow colour. As per the earlier reports [6],

the colour of pulp was found to be yellow at maturity. The colour was observed to be brownish yellow, yellowish green and greenish yellow in different varieties of bael [7]. The polar and transverse diameter was reported within a range of 14.20 to 8.97 cm and 13.80 to 17.80 cm for different varieties of bael [8], which supported the present findings. The values for fruit length and diameter between 39.87 to 53.27 cm and 37.37 to 54.53 cm, respectively [6].

Fruit weight varies between green and ripe stage of maturity. The average weight of ten fruits was noted to be 1120 g. The value for same parameter was recorded to range between 1063 to 2950 g [8] and to be around 650 to 764 g [9]. The variations in fruit weight could be due to varietal or agro climatic conditions.

The specific gravity of the fruit was found to be 1.11 g/cc. Specific gravity varied between 0.81 to 1.06 g/cc [6] thus, supporting the results of present investigation. The increase in specific gravity was mainly due to increase in dry matter content of fruit [10]. However, the fall in specific gravity during after harvest was mainly due to loss in weight without corresponding decrease in volume. The volume of fruit was recorded to be 1.01 litre [6] also reported the volume of the fruit to be 0.81 to 2.19 litres.

The data in **Table 1** depicts the per cent peel value of bael fruit to be 24 while edible portion i.e., pulp to be 68 per cent. The pulp and peel per cent as reported by [6] were 38.19 - 56.17 and 16. 28 – 21. 13 per cent, respectively which were near to the investigated values [11] gave a pulp percentage of 71.70 per cent. Seeds were compressed, oblong, white having cotton like hair on their outer surface and comprises about 1.3 per cent of fruit weight. Fruits were fully ripe, free of bruises blemishes and uniform in size. The fruits used were free from any defects.

Table 1 Physical parameters of bael fruit

Parameter	Value
External Colour	Brownish yellow
Pulp Colour	Bright yellow
weight(g)	1120
Polar Diameter (cm)	12.96
Transverse Diameter (cm)	13.35
Specific Gravity (g/cc)	1.11
Volume (I)	1.01
Peel(%)	24
Pulp(%)	68
Seed(%)	1.3
Shape	Roundish-oblong

Chemical Characteristics of Bael

Moisture

Moisture content is an index of stability and quality and a measure of yield and quantity of food solids. A perusal of data given in **Table 2** illustrates that moisture content of bael fruit pulp, seed and pericarp is 61.06, 31.80 and 38.92 per cent, thus indicating the high perishability of fruit. The moisture content of the pulp gradually decreased with the increase in dry matter content. A very close value of 61.50 per cent was reported by [12, 13]. Similar results were reported by [14] i.e., 61.50 per cent.

Table 2 Chemical constituents of bael fruit

Parameter	Pulp	Seed	Pericarp
Moisture (%)	61.06	31.8	38.92
PH	4.95	5.49	5.28
Acidity (% Citric acid)	0.30	0.06	0.29
Crude Protein (%)	3.64	1.01	1.31
Ash (%)	2.85	4.02	3.18
Crude Fibre (%)	4.80	–	30.65
Crude Fat (%)	0.43	1.08	0.06
TSS Brix	36	–	–

pH

It is a measure of active acidity which inferences the flavour or palatability of a fruit or a product and effects the processing requirements The pH was measured with digital pH meter buffered with 4.0 and 7.0 and the values wore recorded to be 4.95, 5.49 and 5.28 for pulp, seed and perfume respectively (Table 2). [15] recorded a pH range of 5.00 to 5 30 in bael fruit pulp. The results reported by [16] also gave a pH range of 4.70 to 5.00 in pulp of the fruit.

Acidity

The acid content of foods directly affects their flavour. The acids present are largely responsible for the tart or sour flavour. Total acidity determination is useful as a measure of this tartness, The acidity measured by titration method as per cent citric acid was 0.3 per cent in bael fruit pulp, while in seed and pericarp it was found to be 00 06 and 0.29 per cent, respectively (Table 2). [9] recorded 0.50 per cent acidity in bael fruit while [6] reported an acidity range of 0.49 to 0.88 per cent The acidity decreases during fruit development and ripening and it could be due to rapid utilization of organic acids and conversion of organic acids into their salts and sugars.

Crude protein

Data with respect to protein content is depicted in Table 2. The protein content of bael fruit pulp, seed and pericarp was found as 3. 64. 1.01, and 1.31 per cent, respectively in the present study and is found in consonance with the range reported by various researchers. The protein content of bael fruit was reported as 1.80 per cent by [12] while [9] gave a value of 3.30 per cent. [13] reported the value for crude protein to be 1.80 which is same as given [12]. Crude protein content fall progressively during fruit development but there was a slight increase at ripening. Direct relationship of crude protein content with the respiration rate was thus reported.

Ash

The ash content was reported to be 2.85, 4.02 and 3.18 per cent in bael fruit pulp, seed and pericarp, respectively (Table 2). An ash content of 1.7 mg per 100 g was reported [12, 13]. However, a higher value for ash content was recorded by [17] i.e., 2.66 per cent.

Crude fibre

The value reported by [12] for crude fibre content of bael fruit was quite low (0.31 per cent) as compared to present study. However, the present values were in consonance with the values reported by [9] i.e., crude fibre content of bael fruit was reported to be 4.5 per cent. [13] reported the value to be 2.90 per cent.

Crude fat

The crude fat content for bael fruit pulp was found to be 0.43 per cent, which is close to the values reported [13].

Minerals

The values for various minerals found in bael fruit pulp as P, K,Ca, Mg, Fe, Cu and Zn were 51.6, 603, 78, 4.0. 0.55. 0.19, 0.28 mg per 100g respectively (**Table 3**). These values are well in agreement with the results reported [13]. For seed and pericarp, the values for P, K, Ca, Mg, Fe, Cu and Zn were recorded as 3.3 and 2.8,108 and 210, 0.0 and 6, 0.82 and 0.91, 0.08 and 0.02, 0.01 and 0.0, 0.03 and 0.02 respectively.

Table 3 Mineral constituents ofbael (mg per 100 g)

Mineral	Pulp	Seed	Pericarp
Phosphorus	51.60	3.30	2.80
Potassium	603	108	210
Calcium	78.00	–	6.00
Magnesium	4.00	0.82	0.91
Iron	0.55	0.08	0.02
Copper	0.19	0.01	–
Zinc	0.28	0.03	0.02

Sugars

According to the **Table 4**, the non-reducing and total sugars content of bael fruit pulp are 9.93 and 14.35 per cent respectively. [8] reported the results for non-reducing sugars in a range of 11.52 to 14.93 per cent which is close to the value obtained in the present investigation. A value of 2.04 per cent for non-reducing sugars was given by [17]. The total sugar content of 8.36 per cent was reported by [17], while the results reported by [15] gave a much higher value for total sugars i.e, in a range of 12.5 to 16.7 per cent which are well in accordance with the results of present

investigation The reducing, non-reducing and total sugar content for pericarp were found to be 0.92, 0.91 and 1.83 per cent, respectively (Table 4).

Table 4 Sugar content in bael (per cent)

Sugar	Pulp	Seed	Pericarp
Reducing Sugars	4.42	–	0.92
Non-reducing Sugar	9.93	–	0.91
Total Sugars	14.35		1.83

Reducing sugars

The reducing sugar content was found to be 4.42 per cent and 0.92 per cent in bael fruit pulp and pericarp, respectively (Table 4). Reducing sugars constitute about 60 to 70 per cent of total sugars present in bael [16], i.e., 12.31 to 17.97 per cent. [8] reported 3.43 to 4.59 per cent reducing sugars in bael which is in consonance with the present study. Reducing sugar content of 6.21 per cent was reported by [17], while [7] reported the value to range between 2.7 and 5.2 per cent which is again in accordance with the present findings.

Pharmacological Characteristics of Bael

Anti-nutritional factors

Many foods particularly those of plant origin contain a wide range of anti-nutritional factors which interfere with the assimilation of nutrients contained in them.

Tannins and oxalates

Tannins are condensed polyphenolic compounds which are widely distributed in plant kingdom. The tannic acid content in bael fruit is expressed as per cent gallotannic acid. As is evident from **Table 5**, the bael fruit pulp contained 0.42 per cent of tannic acid and 1.03 per cent in pericarp. The results reported by [9] gave a value of 6.6 mg/100 g for tannins. The tannin content of 0.21 per cent was given by [17] which is lower than the value reported in the present investigation Phenolics as tannic acid in bael fruit to be in a range of 1755 to 3000 mg per 100 g was also observed [10]. Total phenols and tannins were significantly lower at ripe stage as compared to green stage of maturity. The reduction in tannins began with the increase in sugar synthesis and the original acrid taste of fruit diminishes. Oxalic acid, a dicarboxylic acid or its salts are widely distributed in plant foods. Oxalic content in bael fruit pulp, seed and pericarp was found to be 0.96, 0.20 and 0.30 g per 100 g, respectively as shown in Table 5.

Table 5 Anti nutritional content in bael

Constituent	Pulp	Seed	Pericarp
Tannic Acid (gallotannic acid)	0.42		1.03
Oxalates (g/100g)	0.96	0.20	0.30

Ascorbic acid

The perusal of **Table 6** depicts that ascorbic acid content of bael fruit pulp, seed and pericarp was 22.5, 2.8 and 8.0 g per 100 g, respectively. Ascorbic and content in a range of 7.82 to 17.63 mg per 100 g was reported by [8]. A value near to it i.e., 18.3 mg per 100 g was recorded [9] in ripe stage of bael and a value of 11.7 mg per 100 g in green stage of beet fruit.

Table 6 Ascorbic acid content in bael

Ascorbic acid (mg/100g)	
Pulp	22.5
Seed	2.80
Pericarp	8.00

Conclusion

The present study was an attempt to analyse the different properties of bael fruit pulp, seed and periarp to find out the future perspectives of this fruit. The edible pulp, 100g of bael fruit contains 61.06g water, 3.64 g crude protein, 0.43 g fat, 2.85g ash, 603 mg potassium, 78 mg calcium, and 51.60 mg phosphorous with a total sugar content of 14.35 per cent. The TSS content of about 36 makes it suitable for development of various products. Ascorbic acid content of 22.5mg/100g fruit pulp makes it a good choice to be used as a source of vitamin c.

References

[1] K.P. Sampathkumar, M. Umadevi, Debjit Bhowmik, Durgesh Mohan Singh, A.S. Dutta, 2012: Recent Trends in Medicinal Uses and Health Benefits of Indian Traditional Herbs Aegle Marmelos. The Pharma Innovation.1 (4), 57-65.

[2] Krushna, G., Kareem, M.A. and Devi, K.L., 2009: Antidyslipidaemic effect of Aeglemarmelos Linn. fruit on isoproterenol induced myocardial injury in rats,International Journal of Pharmacology. 6, 2.

[3] Anonymous., 2000: Official methods of analysis of the association of official analytical chemists, 17th edition AOAC, Washington. DC.

[4] Piper, C.S., 1950: Soil and plant analysis, Inter science Publication, New York.212

[5] Lindsey, W.L. and Norwell, M.A., 1969: A new DPTA-TEA soil test for zinc and Iron. Agronomy abstract. 61-84.

[6] Singh Rajesh, Misra KK and Jaiswal HR., 2000: Studies on physico-chemical characters of fruits of bael genotypes. Indian J of Horticultural. 57(4), 314-317

[7] Jauhari OS, Singh RD,Awasthi RK. 1969, Survey of some important varieties of bael (AeglemormelosCorrea.), Punjab Hort J. 9, 48-53.

[8] Prasad, Yogesh and Singh, R.P., 2001: Evaluation of bael (Aegle marmelos) in Uttar Pradesh and Bihar areas, Haryana Journal of Horticultural Sciences. 30(1&2), 70-71.

[9] Kaushik, R.A., Yamdagni, R. and Dhawan, S.S., 2000: Physico-chemical characteristics of Bael fruit at green and ripe stage of maturity, Haryana J of Horticultural Sciences. 29(1&2), 44- 45.

[10] Roy, S.K. and Singh, R.N.,1980: Studies on changes during development and ripening of Baelfruit, Punjab Horticulture Journal. 20(3), 190-197.

[11] Kumar, D., Rajput, C.B.S. Singh, S.P. and. Kumar, D., 1996: Survey of some important bael (Aegle marmelos) genotypes in Varansi region. Recent Horticulture. 3(1), 49-51.

[12] Roy, Deepti,Mishr, K.K., and Mishr, N., 2001: Labhkari Bael. Phal Phool. 26-27.

[13] Gopalan,C., Ramasastri, B.V. and Balasubramanian, 2000: Nutritive value of Indian foods, National institute of Nutrition, ICMR, Hyderabad.

[14] Subbian, P.,Annadurai, K.,and Palaniappan, S.P., 2000: Nutrition, agricultutral facts and figures. Kalyani publishers. 1,223.

[15] Roy, S.K., Pande, R.M., and Singh, R.N.,1972: Preliminary studies on availability of ripe Bael fruit in off season. I ndian J of Horticulture. 29, 344-347.

[16] Teaotia, S.S., Mauraya, V.N. and Agnihotri, B.N., 1963: Some promising varieties of Bael (aegle marmelos correa) of eastern districts of Uttar Pradesh. Indian J of Horticulture. 20 (3&4), 210-214.

[17] Parmar, C. and Kaushal, M.K.1982: Wild fruits of the sub-Himalayan region. Kalyani. Publishers, New Delhi, India. 1, 1-5.

Publication History
Received 02nd May 2017
Revised 28th May 2017
Accepted 11th June 2017
Online 30th June 2017