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Development and sensory evaluation of unripe and ripe *Bael* fruit powder (*Aegle marmelos*)

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Abstract
The *bael* fruit is known for its medicinal properties and is one of the most nutritious fruits. In the present study unripe and ripe *bael* fruit pulp (*Aegle marmelos*) was used to develop powder in the laboratory. Purpose of this was to study the sensory evaluation of developed powder. There are four different techniques were used separately for drying unripe and ripe *bael* fruit pulp these were mechanical tray drier, solar try drier, open sun light and shade drying and developed powder after drying them properly. Results of the present study indicate that unripe and ripe *bael* fruit powder samples "liked very much" on six point hedonic scale. The highest score was achieved by shade dried powder as compared to other powders. Hence, it was selected for future research work.

Keywords: *Bael*, drying, unripe, ripe, fruit pulp, *Aegle marmelos*

Introduction
India has a rich source of plant as a natural or herbal medicine and it is being used from thousands of years ago. This is very true belief that natural plants are very healthier, energetic and mostly safer than synthetic drugs. (Modi and Patel, 2013) [3]. Among the natural herbs and plants, *bael* (*Aegle marmelos*) fruit is beneficial for the chronic dysentery, diarrhoea, anticancer, cholesterol, peptic ulcer, inflammation and constipation. The most valuable part of the tree is fruit because it contains many vitamins like vitamin C, vitamin A, thiamine, riboflavin, niacin and minerals like calcium and phosphorus. The *bael* fruit pulp contains many functional and bioactive compounds such as *carotenoids, phenolics, alkaloids, coumarins, flavonoids* and *terpenoids* due to this reason *bael* has multiple therapeutic properties such as anti in flammatory, antipyretic and anti diabetic (Sharma *et al*., 2006) [7]. Nigam and Nimbiar (2014) [4] revealed that *bael* is a fruit crop of sub tropical origin also can perform well in arid and semi arid regions. Fairly rich and well drained sandy loam soil is best. It tolerate harsh climate and also can withstand in 47 - 49 °C to -5 to -7 °C. In Rajasthan *CISHB-1, CISHB-2* and pant *aparna* variety of fruit is grown which matures during April-May. Average weight of fruit is 1.0 kg. Fruit takes around 8-10 months to mature. At this stage colour of plant starts change from dark green to yellowish green. Yield of the plant of 300-400 fruits per tree per year. Storage life of fully matured fruit is 1 week and it can be kept for 3 months at 10 °C. Rani *et al*. (2009) [6] prepared *bael* fruit powder by drying the pulp to a thin sheet to below 4 per cent moisture level and then grinding to powder. Packed ground *bael* powder in polyethylene bags and stored in dry places after proper sealing for consumption in future. The colour of *bael* pulp powder was found golden poppy in direct sun drying, light brownish in hot water, orange in hot sand and orange/burnt orange and rust in oven. Before this, fruits were cracked and treated with hot water at 70 °C for 1 hour, hot sand for 2 hours at 70 °C, oven for 2 hours at 70 °C after that, rind of *bael* fruit was broken and removed the *bael* pulp and dried in direct sun light. The *bael* (*Aegle marmelos*) is an important indigenous fruit and has various nutritional and therapeutic properties. Five air-drying temperatures (60, 65, 70, 75 and 80 °C) and five thickness of pulp on the tray (2, 4, 6, 8 and 10 mm) were chosen to obtain the drying characteristics of *bael* fruit pulp. Moisture loss was recorded at every 5 min intervals during drying. The samples were also evaluated for variation in vitamin C and colour. The powder prepared from the pulp dried at 65 °C with a drying thickness of 2 mm was found optimum with respect to drying time, colour and ascorbic acid content. Two term model gave the best results for describing the drying kinetics of *bael* fruit pulp. Temperature at 65°C can be considered as the limiting temperature for drying of *bael* pulp to observe minimum reasonable change in colour and ascorbic acid content. Loss of vitamins was also more with increase in temperature and thickness of layer. (Singh *et al*. 2015) [8].

Materials and Methods

1. Procurement of unripe and ripe *bael* fruit

1.1 Selection of unripe and ripe *bael* fruit

Unripe and ripe *bael* were purchased from orchard of Swami Keshwanand Rajasthan Agricultural University, Bikaner for present investigation.

1.2 Cleaning and sorting of unripe and ripe *bael* fruit

2. Cleaning and sorting of *bael*

Damaged and non-edible portion were discarded. *Bael* fruit was first washed with tap water for few minutes and then rinsed with distilled water to remove the dust, dirt and other adhering impurities.

2.1 Pulping: Pulp was removed from the fruit after applying the force to crack fruit.

2.2 Destoning: Removed seeds & other non-edible part manually from pulp.

2.3 Drying: Drying the fruit pulp under different methods of drying.

3. Dehydration of fruit pulp

Standardization of drying method for unripe and ripe *bael* fruit pulp was carried out using standard methods of drying (CFTRI, 1996) [1].

3.1 Method used for drying

Unripe and ripe *bael* fruit pulp were dried using different methods i.e. sun drying, shade drying, solar tray drying and oven drying. Method of drying conditions was standardized before conducting the experiment.

Drying was carried out in following manner

(a) Sun drying

Fruit pulp were spread singly on a clean and dry muslin cloth placed on clean cemented floor under open sun shine. Drying process was continued up to three days till the completion of constant weight. The minimum and maximum temperature ranged from 22- 30 °C during the month of January.

(b) Shade drying

Fruit pulp were dried under the shade on a clean and dry muslin cloth placed on the cemented floor till the weight of the samples remained constant. Drying was continued up to five days at room temperature 16-18 °C.

(c) Solar tray drying

Fruit pulp were loaded uniformly in a tray and kept for dehydration in the drier. The tray had to be changed in relation from lower shelf to the upper one in order to ensure uniform drying of the entire mass and to avoid burningof the lower one due to excessive heat. The temperature of the solar drying of 5-7 °C is higher than normal day temperature. Fruit were completely dried in two days.

(d) Oven drying

Fruit pulp were spread on the trays and kept for dehydration in the oven. The trays had to be changed in relation for lower shelf to upper one in order to ensure uniform drying of the entire mass and to avoid burning of the lower one due to excessive heat. The temperature of the drying ranged from 60-65 °C. The fruit were completely dried in two- three days.

3.2 Organoleptic evaluation of developed powders

Standardization of the developed powders (Sun, Shade, Solar and Oven) was carried out thorough organoleptic evaluation. The developed powders evaluated for their sensory characteristics like colour, aroma, texture and overall acceptability by selected panel of ten semi trained panel members.

Selection of panel members for evaluation of developed powders

Threshold test was used for selection of the panel member as given by Potter, 1987. Convenience, experience, knowledge, willingness, interest and sincerity were the criteria for consideration of panel members. Ten members were enlisted in the panel comprise of staff members of the college of Home Science, SKRAU, Bikaner, Rajasthan.

Preparation of score card

Six- point hedonic rating scale suggested by Ranganna (1986) [5] was provided to the judges for scoring acceptability of powders on the basis of certain qualities such as appearance, colour, aroma, texture and overall acceptability.

The aim of standardization of powders

To obtain consistently good quality outcome which means that every repetition of procedure will result in a standard quality powder. Standardization is must for introducing any product for circulation in market as a standard quality and to ensure that product is acceptable to the consumer. The shade dried powder from unripe and ripe *bael* fruit were selected by the panelist for conducting the present study.

Organoleptic evaluation of developed powders

Standardization of the developed powders were carried out thorough organoleptic evaluation. At the interval of 15 days for a period of two months of storage the developed powders were evaluated for their sensory characteristics like colour, aroma, texture and overall acceptability by selected panel of ten semi trained panel members.

Shelf life study

The shelf life study of any powder determined its wholesomeness during the definite period of time. Therefore, the quality of developed powders during storage for 60 days was evaluated for its organoleptic characteristics.

Statistical analysis

The data of the organoleptic acceptability, nutritional assessment and shelf life study were statistically analyzed to find out significance of the results (Chandel, 1997) [2]. The results are expressed as mean ± SD. The obtained data statistically analyzed by using SPSS statistics (Ver. 20)

Results and Discussion

1. Organoleptic evaluation of developed *bael* fruit powder

Selected *beal* fruit pulp was dried using sun drying, shade drying, solar drying and oven drying. The developed powders were evaluated for sensory characteristics by a panel of 10 semi-trained judges using six- point hedonic rating scale. Score awarded to the individual sensory attributes by panelists are presented in Table 1

1.1 Colour

Colour is the first parameter by which a consumer judges a product before purchase. Mean scores for colour of shade

dried powder both ripe and unripe *bael* fruit was found superior (6.9 each) when compared to sun dried (5.6 and 5.4), oven dried (6.1and 6.0) and solar dried (5.5 and 5.4) powders respectively (Table 1). The colour of powder obtained by shade and oven drying method were found in the category of "liked very much" whereas sun and solar dried powder "liked moderately".

1.2 Aroma

Mean score of aroma of powders obtained through different treatments and found that maximum scores secured by unripe shade dried powder (6.7) followed by sun dried (5.7), oven dried (5.4) and solar dried (5.6) powders. Somewhat similar scores recorded for powder developed from ripe *bael* fruit i.e., 6.6, 5.8, 5.8 and 5.8 respectively for all treated powders (Table 1).

1.3 Texture

Unripe and ripe shade dried powder obtained 6.7 and 6.6 mean score for texture whereas sun, oven and solar dried powder obtained similar scores for powders developed from unripe and ripe *bael* fruit i.e. 5.6 & 5.7, 6.1 & 5.6 and 5.8 & 5.9 respectively. It was observed that shade dried powder secured higher mean score of texture followed by sun, solar and oven drying portrayed in Table 1.

1.4 Overall acceptability

Unripe *bael* fruit shade dried sample scored highest (6.7) as compare to oven drying (5.8), sun drying (5.6) and solar drying (5.3) respectively for overall acceptability. Similarly powder developed from ripe *bael* fruit observed somewhat similar pattern i.e. 6.5,5.8, 5.2 and 5.6 for shade drying, oven drying, sun drying and solar drying (Table 1). Mean overall acceptability score found in the category of "liked very much" by the panel members. Hence, among all dried powders the shade dried powder was selected for further study.

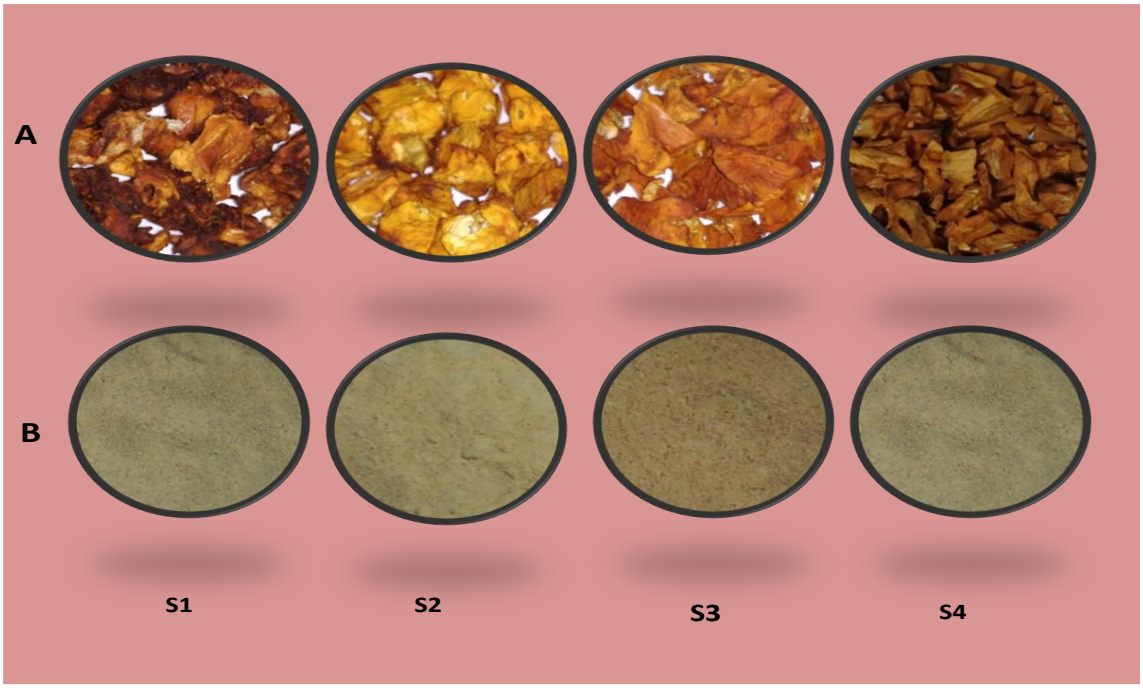
Table 1: Organoleptic acceptability of unripe and ripe *bael* fruit powder

Sr. No.	Powder	Fruit	Mean Scores Of Sensory Characteristics On Six Point Hedonic Scale			
			Colour	Aroma	Texture	Overall Acceptability
1.	Sun Dried	U	5.6±0.51	5.7±0.82	5.6±0.96	5.6±0.51
		R	5.4±0.69	5.8±0.42	5.7±0.48	5.2±0.42
2.	Shade Dried	U	6.9±0.31	6.7±0.48	6.7±0.48	6.7±0.48
		R	6.9±0.31	6.6±0.51	6.6±0.51	6.5±0.52
3.	Oven Dried	U	6.1±0.73	5.4±0.57	6.1±0.73	5.8±0.78
		R	6.0±0.47	5.8±0.63	5.6±0.51	5.8±0.42
4.	Solar Dried	U	5.2±0.42	5.6±0.96	5.8±0.78	5.3±0.67
		R	5.4±0.51	5.8±0.42	5.9±0.31	5.6±0.51

Values are mean ±SD of ten penalist
U= Unripe, R= Ripe

S1 = Sun dried S2 = Shade dried
S3 = Oven dried S4 = Solar dried

Plate 1: Unripe *bael*: (A) Fruit pulp (B) Powder



S1 = Sun dried S2 = Shade dried
S3 = Oven dried S4 = Solar dried

Plate 2: Ripe *bael:* (A) Fruit pulp (B) Powder

Conclusion

Samples of unripe and ripe *bael* fruit were dried in oven drier, solar tray drier, sun and shade separately. Methods of drying for sample were standardized before conducting the experiment. Mean overall acceptability scores of unripe *bael* fruit shade dried sample scored highest i.e. 6.7 as compared to oven drying, sun drying and solar drying. i.e. 5.8, 5.6 and 5.3 respectively for overall acceptability. Similarly powder developed from ripe *bael* fruit observed similar pattern i.e.6.5, 5.8, 5.2 and 5.6 for shade drying, oven drying, sun drying and solar drying. Inclusion of these powders in the diet will definitely improving the nutritional value of the meals. In future the commercialization of unripe and ripe *bael* powder and its value added products.

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Disclosure Statement

No potential conflict of interest was reported by the author.

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