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Value Addition to Arid Fruits for Nutrition and Livelihood

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Abstract: *Developing countries are being encouraged to diversify their food exports by developing new products and adding more value to existing products. Adding value to and diversifying food exports depends not only on changing production but also processing system. The traditional Indian fruits are very rich in nutritional parameters and a variety of byproducts can also be prepared from them. This paper describes the importance of some of Indian fruits like bael, phalsa, wood apple and custard apple. These fruit trees thrive well in stony, infertile and neglected lands and bear heavily without any input. Their bulk use in food industry will improve the nutrition and provide variety. With little efforts they can be semi processed locally for supply to food industry. This can- provide employment opportunity to the unskilled but energetic youths. The medicinal values of these fruits have additional attraction and there is a tremendous scope for its further exploration.*

INTRODUCTION

The Indian sub-continent recognized as wealth of biodiversity harbours 49,000 species of higher plants which are having medicinal as well as nutritional values. These natural resources are means to attain a sustainable agricultural production, improve the nutritional value of food for large sections of the population and reduce India's dependence on imports of agricultural products. In order to be successful, new introductions had to be attractive to farmers and easily fit in existing farming systems. Income assurances, availability of appropriate markets, postharvesting technology and facilities and sufficient research back-up are all considered important issues to facilitate introduction.

Some of these fruits viz. wild pomegranate, wild apricot, bael, phalsa, galgal (Hill lemon) and aonla are of great importance due to their medicinal properties. Only a small quantity of these fruits is used in some pharmaceutical industries. Due to our ignorance the processing industries' have interest only in conventional fruits and vegetables. These fruits are used by local people in one form or the other to cure some diseases and body disorders as they are without side effects. These fruit trees thrive well in stony, infertile and neglected lands and bear heavily without any input. Their bulk use in food industry will improve the nutrition and provide variety. With little efforts they can be semi processed locally for supply to food industry. This can- provide employment opportunity to the unskilled but energetic youths. The medicinal values of these fruits have additional attraction and there is a tremendous scope for its further exploration. Values of some items like "Chayavanprash", "Triffla", and "Dadimastak"; well known tonics and appetizers are greatly appreciated and have further scope of their popularity. These wild fruits are their main ingredients. These valuable items can be further exported to advanced countries particularly to earn hard currency. The technique for the preparation of refreshing/health drinks or fruit sauce from these fruits in combination with conventional fruits can be also be standardized.

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BAEL (*Aegle marmelos*)

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It is an important indigenous fruit of India found naturally in U.P., Tamil Nadu, Bihar and West Bengal etc. It is quite popular for its having important curative properties as laxative and therapeutic value. It is a very hardy tree and can thrive even under adverse agroclimatic conditions. All the parts of the tree, including stem, bark, root, leaves, and fruit at any stage of maturity and ripening, have some use or other. Various chemicals constituents, namely, alkaloids, coumarins, and steroids, have been isolated and identified from different parts of the bael tree. Bael pulp contains a balsam-like substance, and 2 furocoumarins-psoralen and marmelosin (C13H12O3). There is as much as 9% tannin in the pulp of wild fruits whereas the rind contains up to 20%. Tannin is also present in the leaves, as skimmianine. The essential oil of the leaves contains d-limonene, 56% a-d-phellandrene, cineol, citronellal, citral; 17% p-cyrnene, 5% cumin aldehyde.

Table 1
Food Value Per 100 g of Edible Portion

Nutrient	*Food Value/100 g*
Water	54.96-61.5 g
Protein	1.8-2.62 g
Fat	0.2-0.39 g
Carbohydrates	28.11-31.8 g
Ash	1.04-1.7 g
Carotene	55 mg
Thiamine	0.13 mg
Riboflavin	1.19 mg
Niacin	1.1 mg
Ascorbic Acid	8-60 mg
Tartaric Acid	2.11 mg

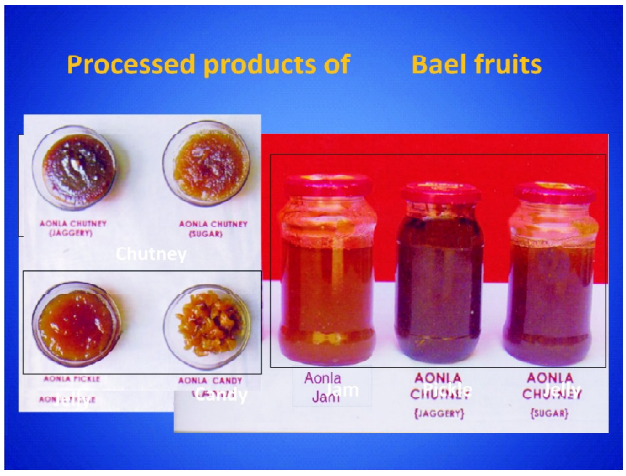
According to Gopalan *et al.* (1978), 100 grams of edible partition of bael contains several important ingredients including (Table 1) protein, fat, minerals, carbohydrates and vitamins. No other fruit has such a high content of riboflavin. Mukherjee and Ahmed (1954) also commented on the high riboflavin content of ripe bael fruit. Tannic acid is the only polyphenolic substance detected in bael fruit. Chemical analysis of bael fruit seeds revealed that the seed contained 62% protein (2% water soluble and 60% water insoluble), 32% oil, 3% carbohydrates, and 3% ash (Banerjee and Maity ,1980).A total of 39 aroma components were identified in bael fruit. Among these components, terpene alcohols and J3-ionone were considered to contribute to the aroma of bael fruit (Tokitomo, *et al.*, 1982). Marmelosin is most probably the therapeutically active principle of the bael fruit. It was isolated as a colorless crystalline compound. It is present in the fruit and in no other part of the plant. The content varies from 0.03 to 0.37% according to the locality of cultivation.

Food Uses

Bael fruit has been used widely from time immemorial for processing in the mature green form to prepare preserves. In order to prepare preserves, the hard rind of the fruit is removed by a special strong knife. The fruit is sliced into 1/2-in.-thick pieces, washed in water, pricked with a stainless steel fork, and soaked overnight in cold water. The pieces are then blanched and put in light sugar syrup. The strength of the syrup is gradually raised to 70° Brix.

Very scant information is available in the literature regarding the processing of ripe bael fruit. Extraction of the pulp from ripe bael fruit is the main hindrance to processing. Verma and Ahmed (1958) reported that bael fruit powder could also be manufactured successfully. Roy and Singh (1979) first discussed a process for successful extraction of pulp from bael fruit which could be successfully extracted by adding water equal to the pulp (with seeds and fiber), adjusting the pH to 4.3 with citric acid (titratable acidity 0.5%), heating at 30°C for 1 minute, and then passing through a pulping machine. Addition of water helped in recovering

the pulp. The application of heat coupled with addition of citric acid inactivated the enzymes and also helped in dissolving the mucilage uniformly to provide a homogenous pulp. Bael fruit pulp obtained by the standard method had almost the same consistency and colour as that of mango pulp. Various products can be prepared from bael fruit pulp. Bael fruit nectar is prepared by blending pulp with sugar, acid, and water. A composition of 35% pulp, 25% Brix, and 0.3% acidity gives a highly acceptable product. Similarly, the best composition for bael fruit squash was found to be 50% pulp, 50° Brix, and 1% acidity. Bael fruit slab is prepared by adding 10% sugar with 1500 ppm $S0_2$ and drying to a moisture level of 14.5 %. Bael fruit toffee is prepared by mixing 40 parts of sugar, 4.5 parts of glucose, 10 parts of skimmed milk powder, and 6 parts of hydrogenated fat to every 100 parts of bael fruit pulp. The proper moisture content of bael fruit toffee was found to be 8.5%. Bael fruit powder can be mixed with an equal quantity of milk powder and reconstituted with water as required to make an acceptable beverage (Jauhari and Singh, 1971). Pure and clear bael fruit juice is prepared by enzyme treatment. The storage performance of all these bael fruit products was found to be satisfactory even after 6 months storage under ambient conditions. Addition of S02 not only improves the initial quality of the bael fruit products but also prevents non-enzymatic browning reaction during storage (Roy and Singh, 1979).



Bael fruits may be cut in two half, or the soft type's broke open, and the pulp, dressed with palm sugar, eaten for breakfast, as is a common practice in Indonesia. A popular drink (called "sherbet" in India) is made by beating the seeded pulp together with milk and sugar. A beverage is also made by combining bael fruit pulp with that of tamarind. These drinks are consumed perhaps less as food or refreshment than for their medicinal effects. Mature but still unripe fruits are made into jam, with the addition of citric acid. The pulp is also converted into marmalade or syrup, likewise for both food and therapeutic use, the marmalade being eaten at breakfast by those convalescing from diarrhea and dysentery. A firm jelly is made from the pulp alone or combined with guava to modify the astringent flavor. The pulp is also pickled.

Bael pulp is steeped in water, strained, preserved with 350 ppm S02, blended with 30% sugar, then dehydrated for 15 hrs at 48.89° C and pulverized. The powder is enriched with 66 mg per 100 g ascorbic acid and can be stored for 3 months for use in making cold drinks ("squashes"). The young leaves and shoots are eaten as a vegetable in Thailand and used to season food in Indonesia. They are said to reduce the appetite. An infusion of the flowers is a cooling drink.

Other Uses

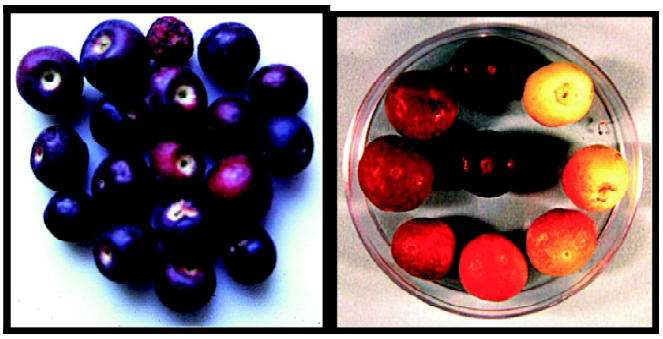
Fruit: The fruit pulp has detergent action and has been used for washing clothes. Bael fruit is employed to eliminate scum in vinegar-making. The gum enveloping the seeds is most abundant in wild fruits and especially when they are unripe. The gum is commonly used as household glue and is employed as an adhesive by jewelers. Sometimes it is resorted to as a soap-substitute. It is mixed with lime plaster for waterproofing wells and is added to cement when building walls. Artists add it to their watercolors, and it may be applied as a protective coating on paintings.

The limonene-rich oil has been distilled from the rind for scenting hair oil. The shell of hard fruits has been fashioned into pill- and snuff boxes, sometimes decorated with gold and silver. The rind of the unripe fruit is employed in tanning and also yields a yellow dye for calico and silk fabrics. In Hindu culture, the leaves are indispensable offerings to the 'Lord Shiva'. The leaves and twigs are lopped for fodder. A cologne is obtained by

distillation from the flowers. The wood is strongly aromatic when freshly cut. It is gray-white, hard, but not durable; has been used for carts and construction, though it is inclined to warp and crack during curing. It is best utilized for carving, small-scale turnery, tool and knife handles, pestles and combs, taking a fine polish.

Medicinal Uses: The fresh ripe pulp of the higher quality cultivars, and the "sherbet" made from it, are taken for their mild laxative, tonic and digestive effects. A decoction of the unripe fruit, with fennel and ginger, is prescribed in cases of hemorrhoids. It has been surmised that the psoralen in the pulp increases tolerance of sunlight and aids in the maintaining of normal skin color. It is employed in the treatment of leucoderma. Marmelosin derived from the pulp is given as a laxative and diuretic. In large doses, it lowers the rate of respiration, depresses heart action and causes sleepiness. For medicinal use, the young fruits, while still tender, are commonly sliced horizontally and sun-dried and sold in local markets. They are much exported to Malaya and Europe. Because of the astringency, especially of the wild fruits, the unripe bael is most prized as a means of halting diarrhea and dysentery, which are prevalent in India in the summer months. A bitter, light-yellow oil extracted from the seeds is given in 1.5 g doses as a purgative. It contains 15.6% palmitic acid, 8.3% stearic acid, 28.7% linoleic and 7.6% linolenic acid. The seed residue contains 70% protein. The bitter, pungent leaf juice, mixed with honey, is given to allay catarrh and fever. With black pepper added, it is taken to relieve jaundice and constipation accompanied by edema. The leaf decoction is said to alleviate asthma. A hot poultice of the leaves is considered an effective treatment for ophthahnia and various inflammations, also febrile delirium and acute bronchitis. A decoction of the flowers is used as eye lotion and given as an antiemetic. The bark contains tannin and the cournarin, aegelinol; also the furocourmarin, marmesin; umbelliferone, a hydroxy coumarin; and the alkaloids, fagarine and skimmianine. The bark decoction is administered in cases of malaria. Decoctions of the root are taken to relieve palpitations of the heart, indigestion, and bowel inflammations; also to overcome vomiting. The fruit, roots and leaves have antibiotic activity. The root, leaves and bark are used in treating snakebite.

PHALSA *(Grewia subinaequa1is* L.)



Phalsa *(Grewia subinaequa1is* L.) plant from family 'Tiliaceae' is indigenous to India and recognized for its refreshing and medicinal properties (Samson, 1986). In wild form it is found all along the foot-hills of the Himalayas in Uttar Pradesh, Punjab, Haryana, Rajasthan, Madhya Pradesh, Maharashtra, West Bengal, Bihar and in 'South India over the Western ghats and along the Malabar coasts. In India, this plant grows under natural conditions up to an elevation of 1,000 m. The phalsa is a warm climate, drought resistant fruit plant and normally loses its leaves slowly in those areas with mild winter season. The phalsa plant grows vigorously and produces satisfactorily under variable soil types including fine sand, clay or even limestone, when soil fertility is not very poor. Phalsa is often grown in marginal lands close to city markets to facilitate prompt marketing of fruit. In cultivated form it is commonly grown around cities and towns in the states like Punjab, Haryana, Uttar Pradesh, Rajasthan and Andhra Pradesh. From these locations it could find ready market for disposal. Though the 'phalsa' fruit is extremely delicate in nature, yet the plant is one of the hardiest fruit trees grown in arid and semi arid region.

The small fruits, almost round drupes like blueberry and purple, crimson or cherry red in colour when ripe are produced in great numbers in open, branched clusters. Individual fruits measure from 1.0 to 1.9 cm in diameter, 0.8 to 1.6 cm in vertical height, and 0.5 to 2.2 g in weight. Fruits ripen gradually on bushes during the summer months. While ripening, the fruit skin turns from light green to cherry red or purplish red finally

becoming dark purple or nearly black. The ripe fruit is covered with a very thin, whitish blush, and becomes soft and tender. The delicate, fibrous flesh is light greenish-white becoming colored purplish-red from seed reaching near the skin. Overripe fruit flesh attains purple color followed by shriveling of fruit skin due to moisture loss. Large fruits have two hemispherical, hard, buff-colored seeds up to 5 mm in diameter while small fruits are generally single-seeded. The mature but not completely ripe fruits when harvested can be stored upto 48 hours while fully ripe can hardly be stored upto 24 hours at room temperature(Yadav,1998) .The fruits are small in size and ripen gradually on the plant with the result that only a few fruits are ready to be picked in each cluster at a time. Its fruits ripen in summer (May to June) and have an extremely low keeping quality. The ripe phalsa fruits are consumed fresh, in desserts, or processed into refreshing fruit and soft drinks enjoyed during hot summer months in India (Salunkhe and Desai, 1984).

Analysis made long ago in the Philippines (Table 2) established the following values as reported by Morton (1987): 725 calories/kg edible fruit; moisture, 81.13%; protein, 1.58%; fat, 1.82%; crude fiber, 1.77%; and sugar, 10.27%.

Table 2
Nutrient content of phalsa fruits (Yadav, 1998)

Nutrients	*Nutrient values/100 g fruit*
Calories (Kcal)	90.5
Calories from fat (Kcal)	0.0
Moisture (%)	76.3
Fat (g)	<0.1
Protein (g)	1.57
Carbohydrates (g)	21.1
Dietary Fiber (g)	5.53
Ash) (g)	1.1
Calcium (mg)	136
Phosphorus (mg)	24.2
Iron (mg)	1.08
Potassium (mg)	372
Sodium (mg)	17.3
Vitamin A (µg)	16.11
Vitamin B_1, Thiamin (mg)	0.02
Vitamin B_2, Riboflavin (mg)	0.264
Vitamin B_3, Niacin (mg)	0.825
Vitamin C, Ascorbic acid (mg)	4.385

Processing

Phalsa juice has a deep, crimson-red colour and a pleasing flavor, which makes the juice very popular. In addition, the juice is extremely refreshing in summer .The popularity of 'Phalsa' fruit is due to its attractive colour and pleasing taste. The phalsa flavor is pleasantly astringent but delicious due to very appropriate sugar-acid blend. It is rated very high in the indigenous system of medicine. Besides this, the juice is considered to have a cooling effect especially in hot months. Hence, it is used extensively in summer both as a fresh fruit and also in the form of a home made syrup. Commercial processes like bottling of 'phalsa' juice or syrup, if developed can ensure their ready sale prompting a considerably larger production of this fruit. The pomace (30.92%) left after the extraction of the juice from phalsa fruit has been used to extract pigments and the total soluble solids. It was found that addition of 75% water to pomace gave the most pigments and total soluble solids (Waskar and Khurdiya 1988). A ready-to-serve (RTS) beverage from phalsa fruit juice was formulated and standardized. It contained 25% juice and a Brix - acid ratio of 45: 1 (Khurdiya and Anand, 1981). The syrup was prepared from phalsa fruit juice in which the clear juice was mixed with an equal amount of sugar and preserved with sodium benzoate (Amba, 1973). A carbonated beverage can also be prepared from phalsa juice. The colour in 'phalsa" fruit is due to water soluble pigments viz., anthocyanins which lend an attractive colour to the juice. Based on paper chramatography and spectral characteristics two anthocyanin pigments viz., delphinidin-3-glucoside and cyanidin-3-glucoside were identified, in the 'phalsa' fruits (Khurdiya, 1990).

Medicinal and Other Uses

The fruit is astringent and stomachic. Morton (1987) reported that when unripe, phalsa fruit alleviates inflammation and is administered in respiratory, cardiac, and blood disorders, as well as in fever reduction. Furthermore, an infusion of the bark is given as a demulcent, febrifuge, and treatment for diarrhea. The root bark is employed in treating rheumatism. The leaves are applied on skin eruptions and they are known to have antibiotic

action. The fresh leaves are valued as animal fodder. The bark is used as a soap substitute in Burma. A mucilaginous extract of the bark is useful in clarifying sugar. Fiber extracted from the bark is made into rope. The wood is yellowish-white, fine-grained, strong, and flexible. It is used for archers' bows, spear handles, shingles, and poles for carrying loads on the shoulders. Stems that are pruned serve as garden poles and for basket-making. The flowers contain grewinol, a long chain keto-alcohol, tetratricontane 22-ol-13-one (Lakshmi and Chauhan, 1976). The phalsa seeds produce approximately 5% yield of a bright yellow oil that contains 8% palmitic acid, 11% stearic acid, 13.5% oleic acid, and 64.5% linoleic acid with 3% unsaponifiable (Morton 1987).

Sita Phal (A*nnona squamosa*)

Custard apple *(Annona squamosa* L.) is one of the most delicious fruit plants of tropical and sub-tropical area belonging to family Annonaceae. It is a drought hardy, tolerant to drought, salinity and saline irrigation water to certain extent and grows well even on shallow soil without much care. Plants shed their leaves during stress period to avoid moisture loss from plant. Its flowering coincides with maximum moisture availability period thus making its survival possible in even extreme conditions. It also sheds off leaves during stress periods. Plant escape from the animal damage due to its hardy nature. Custard apple is mainly found in wild form in the states of Andhra Pradesh, Tamil Nadu, Orissa, Assam and Rajasthan. In India, the fruits are eaten mainly by the lower and medium class people. The fruit is appreciated by all in Central America, Mexico and the West Indies. When fully ripe, it is soft to touch and the stem and attached core can be easily pulled out (Khurdiya, 2001). The flesh may be scooped from the skin and eaten as such as served with light cream and a sprinkling of sugar. Often it is pressed through a sieve and added to milk shakes, custards or ice cream. a delicious sauce for cake and puddings can be made by blending the seeded flesh with mashed banana and a little cream.

Composition: The fruit of custard apple is very sweet and delicious hence this fruit is used for table purpose; however, in recent years it is being used in ice cream and puddings. The pleasant flavour and mild aroma is the typical taste of custard apple fruit. The food value of custard apple fruit pulp is presented in Table-3. The ripe fruits are rich in sugars. Its pulp contains about 73 per cent moisture, 0.8 to 1.5 per cent proteins and 14.5 per cent sugars, 0.3 per cent fat, 1.0% iron and 0.7 per cent mineral matter(Table :5). It is quite rich in calcium (0.02%), phosphorus (0.04%) and iron (1.0%). The calorific value is 105/100 g of pulp. Glucose is predominant sugar.

Table 3
Food value per 100 g of edible portion of custard apple pulp

Constituent	*Content*	*Constituent*	*Content*
Calories	80-101	Phosphorus	14.7-32.1 mg
Moisture	68.3-80.1 g	Iron	0.42-1.14mg
Protein	1.17-2.47 g	Carotene	0.007-0.018 mg
Fat	0.5-0.6 g	Thiamine	0.075-0.119 mg
Carbohydrates	20-25.2 g	Riboflavin	0.086-0.175 mg
Crude Fibre	0.9-6.6 g	Niacin	0.528-1.190 m
Ash	0.5-1.11 g	Ascorbic Acid	15.0-44.4 mg
Calcium	17.6-27 mg	Nicotinic Acid	0.5 mg

Medicinal uses: The seeds are so hard that they may be swallowed whole with no ill effects but the kernels are very toxic. The seeds, leaves and young fruits are having insecticidal properties. The leaf juice kills lice. The bark contains 0.12% anonaine. Injection of an extract from the bark caused paralysis in a rear limb of an experimental toad. Sap from cut branches is acrid and irritant and can severely injure the eyes. The root bark has yielded 3 alkaloids: anonaine, liriodenine and reticuline (muridnine). The leaf decoction is given as a vermifuge. Crushed leaves or a paste of the flesh may be poulticed on boils, abscesses and ulcers. !he unripe fruit is rich in tannin; is dried, pulverized and employed against diarrhoea and dysentery. The bark is very astringent and the decoction is taken as a tonic and also as a remedy for diarrhoea and dysentery. In severe cases, the leaves bark and green fruits are all boiled together for 5 minutes in a liter of water to make an exceedingly potent decoction. Fragments of the root bark are packed around the gums to relieve toothache. The root decoction is taken as a fabrifuge.

Processing

Pulp: Extraction of the pulp is a major constraint in processing of the custard apple. A centrifugal process has been developed to separate the gritty portion from the pulp, which was otherwise objectionable in processed products (Anonymous, 1971). Pulp is scooped out from ripe fruit and preserved with potassium metabisulphite. A recovery of 50% of pulp can be obtained from the ripe edible fruit. The custard apple pulp can be preserved with a minimum dose of 250 ppm of S02 in refrigerator but it required 500 ppm of S02 if it is to be stored at ambient temperature. In this way, it has a storage life of about 180 days. The custard apple pulp can be employed for making fruit drinks (Khurdiya, 2001.).

Squash: Sugar syrup is prepared by adding cane sugar to the boiling water. The syrup is filtered through a muslin cloth to remove impurities. Fruit pulp and the freshly prepared hot syrup are added together in the proportion of proposed recipe on weight basis. The mixture is boiled by adding required amount of citric acid. Finally, the product is treated with potassium metabisulphite (300 ppm) to prevent spoilage. The organoleptic evaluation of the RTS (Ready to serve) beverage showed that the beverage prepared by using 20% juice was the most acceptable (Kotecha *et al*., 1995). The organoleptic properties of the custard apple wine were comparable with those of the grape wine properties.

Nectar: Sugar syrup is prepared by adding cane sugar to boiling water. The prepared syrup is filtered through a muslin cloth to remove impurities. The hot syrup is mixed with fruit pulp on the weight basis. The mixture is boiled and citric acid added to get a consistent product. The prepared nectar is poured into the pre-sterilized 220 ml glass bottles and sealed airtight by using crown caps. The bottles are sterilized in boiling water for 25 minutes, cooled to room temperature and stored for further use.

Jam: Custard apple jam (pulp 45-50%, TSS (Total soluble solids) 60-68 per cent) with a fixed level of acidity (0.5 per cent) is prepared. The required quantity of pulp, sugar as per the recipe is taken in a steel vessel and heated, stirring continuously. Separately, citric acid is dissolved in a little water and mixed with the pulp. Heating is continued until the required TSS is reached. Chemical preservative, potassium metabisulphite (0.1 g/kg) is mixed into the product after dissolving in little water. The product is poured into clean and sterilized jam bottles (500 g) and sealed hermetically.

Other uses: The leaves have been employed in tanning and they yield a blue or black dye. A fiber derived from the young twigs is superior to the bark fiber from *Annona squamosa.* Custard apple wood is yellow, rather soft, fibrous but durable, moderately close-grained, with a specific gravity of 0.650. It has been used to make yokes for oxen.

The seeds of fruit contain 30% oil which can be used for making soap and paint. The oil has insecticidal properties. When mixed with neem oil, it has demonstrated efficacy against Nephotetttx Virus and its transmission of rice tungro Virus. The oil cake containing 4% nitrogen is used as manure and beneficial to the crop

Kainth (*Feronia limonia*)

Wood Apple (*Feronia limonia*)

Wood apple (*Feronia limonia* (L.) Swingle) is a globose woody fruit produced on a medium sized tree and belongs to family Rutaceae (Bose and Mitra, 1989). The wood-apple is native and common in the wild state in dry plains of India and Ceylon where it is planted along roads and edges of fields and occasionally in orchards. It is also frequently grown throughout Southeast Asia, in northern Malaya and in Penang Island (Morton, 1987). In India, the fruit was traditionally a "poor man's food" until

processing techniques were developed in the mid -1950's.

It can be planted under almost all conditions of soil and climate, thrives in adverse climatic conditions, and tolerates salinity and low temperatures. Wood apple is propagated by seeds or by cuttings and layering. Buds from mature trees budded on seedlings are said to produce dwarf trees which fruit early. Planting is done in the rainy season at a distance of 10 x 10 m. Wood apple starts bearing at an age of 5-6 years. The fruits ripen from November to March. Ripe fruits drop from the trees, and as they have a hard shell outside, the inner pulp keeps well for some days (Bose and Mitra, 1989).Wood apple is also called as elephant apple and monkey fruit because elephants are fond of this fruit. For an animal that wholly survives on plant parts, including the bark of several trees, it is not a surprise that elephants are especially attracted to this fruit. There is more to it than mere fondness of elephants for this fruit. The rural folk believe that the digestive tract of the animal has a peculiar capacity for digesting the inner contents of the fruit without, in any manner, affecting the fruit's woody rind. So, as the animal defecates, the fruit comes out looking as if it is whole. How far this is true remains verifiable but this belief is not wholly confined to tribal but has percolated even into the urban milieu is borne out by the fact that in the literature of local languages (at least Telugu) lends some credence to the belief.

An average tree yields 250-500 fruits per year; bigger and more vigorous trees may yield more. Each fruit weighs about 150-500 g. Its pulp is used for preparation of sherbet, chutney and pickles. The gum obtained from the trunk and branches are used as a substitute of gum arabic. The pulp represents 36% of the whole fruit. The seeds contain non-bitter oil high in unsaturated fatty acids.

The fruit has 55-58% edible part, which contains74 % moisture, 8 % proteins1.5 % fat, 1.9% minerals, 5.2% fiber, 7.5% carbohydrates, 170 mg/ 100g riboflavin, 2 mg/100 g vitamin C 0.13% calcium, and 0.11% phosphorus (Table 4) (Bose and Mitra, 1989).The acid content of the pulp varies from 7.6% in unripe fruits to 2.3% in fully ripe ones. The pectin content of the pulp is 3 to 5% (16% on the basis of dry-weight).and forms an excellent material for making jelly. Woodapple jelly resembles black currant or apple jelly. It is clear and bright purple in color, with firm consistency and agreeable flavor (Bose and Mitra, 1989).

Table 4
Composition of wood apple (per 100 g edible pulp)

Constituents	*Pulp (ripe)*	*Seeds*
Moisture	74.0%	4.0%
Protein	8.00%	26.18%
Fat	1.45%	27%
Carbohydrates	7.45%	35.49%
Ash	5.0%	5.03%
Calcium	0.17%	1.58%
Phosphorus	0.08%	1.43%
Iron	0.07%	0.03%
Tannins	1.03%	0.08%

Medicinal properties: The wood apple has several medicinal properties. The leaves and bark have medicinal values. It is antiscorbutic. It is an antidote for poisons and also helps in curing sore throat. After the rains, the trunk and branches give off a gum called' *Feronia gum',* which counteracts diarrhoea, dysentery and diabetes. However, this statement should not be understood that the gum totally cures these diseases. It serves to mitigate the problem. The fruit is much used in India as a liver and cardiac tonic, and, when unripe, as an astringent means of halting diarrhoea and dysentery and effective treatment for hiccup, sore throat and diseases of the gums. The fruit is considered' to be tonic, refreshing, antiscorbutic, and alexiformic. It is used as a substitute for bael in the treatment of diarrhea and dysentery (The Wealth of India, 1980).

The pulp is poulticed onto bites and stings of venomous insects, as is the powdered rind. Juice of young leaves is mixed with milk and sugar candy and given as a remedy for biliousness and intestinal troubles of children. The pulp is used to treat infections of the gum and throat. The powdered gum, mixed with honey, is given to overcome dysentery and diarrhoea in children derived from the crushed leaves is applied on itch and the leaf decoction is given to children as an aid to digestion. Leaves, bark, roots and fruit pulp are used against

snakebite. The spines are crushed with those of other trees and an infusion taken as a remedy for menorrhagia. The bark is crushed with that of *Barringtonia* and applied on venoum wounds. The unripe fruits contain 0.015% stigmasterol. Leaves contain stigmasterol (0.012%) and bergapten (0.01%). The bark contains 0.016% marmesin. Root bark contains aurapten, bergapten, isopimpinellin and other coumarins. The fruits are highly acidic and contain 7.6 per cent acidity when unripe and 2.3 per cent when ripe. They also contain 3-5 per cent pectin making it suitable for preparation quality jelly. Its fruits are also used in various *ayurvedic* preparations for curing diarrhoea, dysentery, gum and throat problems.

Processing: The fruit is very rich in acid and pectin (The Wealth of India, 1980). The acidity of the pulp varies from 7.6% in raw fruits to 6.3% in semi ripe and 2.3% in fully ripe ones. Ripe fruits contain 7.25% total sugars. The fruit thus forms an excellent raw material for jelly making. The jelly is purple and much similar to that made from black currants. The fruit has a thick, hard shell, inside which is a darkish brown and acid-sweet pulp, in which a large number of small seeds are embedded. The rind must be cracked with a hammer. The scooped-out pulp, though sticky, is eaten raw with or without sugar, or is blended with coconut milk and palm-sugar syrup and taken as a beverage, or frozen as ice cream. It is also used in chutneys and for making jam. Bottled nectar is made by diluting the pulp with water, passing through a pulper to remove seeds and fibre, further diluting, straining, and pasteurizing. A clear juice for blending with other fruit juices has been obtained by clarifying the nectar with pectinol. Pulp sweetened with syrup of cane or palm sugar, has been canned and sterilized. The pulp can be freeze-dried for future use but it has not been satisfactorily dried by other methods.

Wood apple squash

The reddish pectin of wood apple has potential for multiple uses in India after purification. The shell is broken and the pulp is boiled with water, in a proportion of 1:3 (pulp: water) for about 30 min. Upon cooling, it is strained, and to the liquid is added about its own volume of clean crystalline sugar. The liquid is then boiled to about 105°C and poured hot into sterilized containers for setting. In addition to jelly, woodapple syrup can also be prepared and used as a drink.

Other uses: The fruit shell is fashioned into snuffboxes and other small containers. The trunk and branches exude a white, transparent gum especially after the rainy season which can be utilized as a substitute for adulterant of gum arabic and also for making watercolors, ink, dyes and varnish. It consists of 35.5% arabinose and xylose, 42.7% d-galactose, and traces of rhamnose and glucuronic acid (Singh, 2001).

The wood is yellow-gray or whitish, hard, heavy, durable, and valued for construction, pattern-making, agricultural implements, rollers for mills, carving, rulers, and other products. It also serves as fuel. The wood is also used in making agricultural implements and handles of different tools. The heartwood contains urasolic acid and a flavanone glycoside, 7-methylporiol-D-xylopyranosy l-D-glucopyranoside.

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