Chapter 1

Introduction

The amla/aonla (Emblica officinalis syn. Phyllanthus emblica), is an important minor fruit and a crop of commercial significance. It is quite hardy, prolific bearer and is highly remunerative even without much care. It belongs to the family Euphorbiaceae and is known as amla, amlaki, amali, ambala, amalakamu and nelli in different parts of India. Phyllanthus emblica is referred to as an evergreen tree although its leaves are deciduous. The main trunk look like that of guava. The bark is smooth and comes off in thin flakes or strips. The varieties Chakaiya and banarasi are reputed for large size fruits and are recommended for commercial cultivation. The aonla fruits are attractive, round, deeply ribbed and pale green. The fruits may be stored in cold storage for 7-8 days at 32-35 °F. Amla is rare example of of an edible material, which is rich in tannins as well as ascorbic acid. Aonla fruits are hard and unyielding to touch and as such well suited to long distant transportation. The fruit is nearly stalkless and smooth divided into six lobes through pale linear grooves. The surface is shiny, quite hard with a thin and translucent skin. The hexagonal stone containing six small seeds is embedded tightly in the flesh. The fruit taste bitter and extremely acidic. It is a good source of ascorbic acid (500 to 750mg/100gm of pulp) and is used in several medicines and also utilized either in fresh form or processed products. The aonla sugars are composed of fructose, glucose, sucrose and myo-inositol. The fruit contain many polyphenolic substances, which have antioxidant properties and good free radical scavenging activity. The fruit also contain alkaloids (phyllantidine and phyllantine), auxines and minerals. Aonla stone contains six small seeds. The
seed oil of aonla comprise 64.8% of linolenic acid and closely resemble to linseed oil. Aonla is used for various ailments in the Indian systems of medicine. It possesses pronounced expectorant, antiviral, cardiotonic, hypoglycemic and antioxidant activity. In Unani and Ayurvedic systems of medicine, aonla is widely used as a food due to its special dietetic and medicinal value. Emblica fruits are a good liver tonic; raw fruits are antiscorbutic and laxative.

Due to its high vitamin C, tannin, mineral contents and medicinal properties of aonla offer tremendous scope for processing. Aonla are being utilized and processed in many value-added products such as juice-based beverages such as syrups, squashes, nectar and ready to serve (RTS) drinks.

Aonla are important fruit grown extensively in India, its sale price often become unremunerative to the farmers and seasonal surplus results in spoilage of valuable product. Hence there is need to process aonla for value addition and off-season utilization in the interest of both growers and consumers. It is available in winter season only and can be stored for limited period at the refrigerated temperature. Hence an attempt was made to standardize the juice processing to yield good quality aonla juice concentrate, which can be preserved for long time. Several workers have reported the chemical composition of different varieties of Aonla and examined the aonla fruits and its products for their composition, but few data are available for satisfactory aonla juice processing product. The present investigation was undertaken to study aonla juice processing by adopting six different combination of treatments for juice extraction viz, without water from blanched and unblanched fruits, with water from blanched fruits, unblanched fruits, steamed fruits, and by maceration of fruit segments. The aonla juice processing products were prepared from Banarasi aonla cultivars and local small sized aonla fruits.
Aonla juice processing products obtained were analyzed for physico-chemical as well as antimicrobial properties in laboratory. Physico-chemical and antimicrobial properties were analyzed to test the significance of variation in both for physico-chemical parameters and its effect on quality of resultant juice. Based on studies a good quality aonla juice-processing product from Banarasi aonla cultivar was selected for further processing.

Problems associated with fruits and vegetable processing includes high losses and wastage of useful products. There is problem in concentration of diluted products in conventional heat evaporation due to loss of heat sensitive elements and nutrients. There is need to study various parameters to optimize the product recovery from food processing operation and to purify and concentrate juice. A combined unit comprising of microfiltration (MF) and Reverse Osmosis (RO) has been exploited for concentration of orange juice, apple juice, tomato juice, mango juice, guava juice, whey and other useful food products. In this study aonla juice was processed to yield satisfactory aonla juice concentrate using combined unit of MF/RO. The aonla juice products were analyzed for physico-chemical and antimicrobial properties.

1.1 Membrane Technology in the processing of foods:

The current Indian market for membranes used in food processing only US $0.91 Million. This is a meager amount as compared to the world Food and Beverage market of US$286 million. This suggest that currently there is reluctance within the country to the use of membranes in the Food Industry. This may possibly be due to the relatively high cost of membranes. Another reason is that we process about 1% of about total fruit and vegetable produce, where the use of membranes
is most prominent. There is an increasing interest in the use of membranes in the
dairy processing and in the clarification of fruit juices and ready-to-serve (RTS)
beverages. In our country the emphasis is on fresh produce rather than processed
fruits/vegetables, one has to try and identify only niche applications for the use of
membranes. Another major obstacle for their use is that membranes are not
manufactured within the country. Permionics, Baroda, now offers membranes in a
limited range of Ultrafiltration, nanofiltration and Reverse Osmosis, otherwise
most of the membrane modules are imported. Interest in the food-based
applications of membranes stems from several features that are associated with
membranes notably, low energy costs, high selectivity and uniform reproducibility.
In the food industry where flavor, aroma and taste profile are at the premium,
membranes can play a defined role in improving product quality.

1.1.1 Use for membranes in Food processing:

Dairy Industry:
The most traditional use for membranes in the food industry is for the
concentration of cheese whey (by ultrafiltration) for recovery of whey protein.
Whey protein can be used in soft cheeses and as food additives (soups, sauces etc.)
The inclusion of whey protein in soft cheeses give 5% extra yields in cheese
weight. The lactose in the permeate can be recovered in concentrated form which
can be crystallized as a powder. This lactose powder is currently used as filler in
the pharmaceutical industry. A concentrated solution of lactose finds application as
sweetener/flavourant in the confectionary industry.

Beverages
Beverages can be broadly classified into fermented and non-fermented products.
During the manufacture of fruit based beverages there are two major technical
issues, retention of flavor/aroma of the fruit and adequate shelf life. The traditional route for manufacture of these products involves a thermal treatment. Most thermal processes alter the flavor and aroma characteristic of these products. Synthetic membranes offer a very attractive non-thermal route in the preparation of clear fruit juices, where by an improved flavor/aroma profile and shelf life of the product is assured. Work on Neera derived from palm is in progress at NCL and CFTRI.

Waste treatment

In the food industry MF or UF membranes are used in conjunction with a microbial population, whereby the microbes degrade the compounds in effluents and allow permeation of the degradation products through the permeate. Waste from the potato processing, plants, pomace from apple, pear, and effluents from vegetable oil processing plants are some examples of treatment of the wastes using a membrane reactor. The MBR is capable of retaining high microbial sludge levels within the reactor and that suspended solids, oil, grease, NH₃ and organics are degraded.

Fruit juice concentration

Concentration of fruit juices is one of the important operations in food processing industries. Conventionally Evaporation was employed for this purpose, but it was observed that the sensory and nutritive qualities of the product are not preserved. By membrane separation techniques not only sensory and nutritive qualities are retained but also the concentration is effected without phase change, eventually resulting in less energy consumption.
1.2 Origin and distribution of aonla:

Aonla is used to be indigenous to tropical south-eastern Asia, particularly in central and Southern India (Firminger, 1947). It is also reported to be the native of India, Sri Lanka, Malaysia and China. It thrives well throughout tropical India and is met with wild or cultivated in the region extending from the base of the Himalaya to Sri Lanka and from Malacca to South China. The tree is also common in the mixed deciduous forests of India ascending to 1350 meters on the hills (Anen, 1952). It is more popular in India and is commercially cultivated in Uttar Pradesh (Bajpai, 1963; Ram, 1983).

1.2.1 Morphology

A deciduous tree, small to medium in size, the average height being 5.5 meters; its bark is usually light brown to black, coming off in thin strips or flakes, exposing the fresh surface of a different colour underneath the older bark; the average girth of the main stem is 70 cm; in most cases, the main trunk is divided into 2 to 7 scaffolds very near the base. Leaves, 10 to 13 mm long, 3 mm wide, closely set in pinnate fashion, making the branches feathery in general appearance. The leaves develop after the fruit-set. Flowers, unisexual, pale green, 4 to 5 mm in length, borne in leaf-axils in clusters of 6 to 10; staminate flowers, tubular at the base, having a very small stalk, gamosepalous, having 6 lobes at the top; stamens 1 to 3, polyandrous, filaments 2 mm long; pistillate flowers, fewer, having a gamopetalous corolla and a two-branch style; both staminate and pistillate flowers are borne on the same branch, but the staminate flowers occur towards the apices of small branches. Fruits, fleshy, almost depressed to globose, 2.14 cm in diameter, 5.68 g in weight, 4.92 ml in volume, primrose yellow 601/2. The stone of the fruit, six-ribbed, splitting into three segments, each containing usually two
seeds; seeds 4-5 mm long, 2 to 3 mm wide, each weighing 572 mg. 590 μl in volume, citron green 793/3.

1.2.2 The flowering and fruiting season: *Aonla* is a deciduous tree and the emergence of new shoots starts in the beginning of April. The shoots are light red and turn green after 2 or 3 days. After about 15 days, the small lateral twigs, which are 3-3.5 cm long, give out two rows of leaves on each side. They have the appearance of compound leaves, with about one hundred leaflets on each. Small circular green flowers also appear in the axils of these small leaves at the same time. The flowering season was observed to occur from the middle of April to the first week of May. The flowering reached its peak in the end of April. The fruiting season of *aonla* is exceptionally long. The fruit in this area become fit for harvesting in December. They can be retained on the tree up to March without any significant loss in quality or yield. The villagers generally do the picking of fruits in February and March.

1.2.3 Climate: It is subtropical fruit and is successfully grown in tropical as well as dry conditions. It is not much affected either by deciccatron through hot wind or frost (Gangwar, et al.1975). The mature trees can tolerate freezing temperature as well as temperature as high as 46°C (Shankar, 1996). The warm season appears conducive for the initiation of floral buds (Bajpai, 1963). It can be grown in semi arid, subtropical region (Pathak, 1991) with annual rainfall of 350-500 mm (Vashishtha, 1991). Under the North Indian conditions the tree start shading all its leaves from February onward and by the third week of March it is almost devoid of foliage. New branchlets emerge at nodes from the side of the scare left after the
abscission of previous seasons branchlets in the third week of February and continue till the first week of April. The process of shedding the branchlets overlaps the appearance of new branchlets on the naked branches. Aonla is characterized by very small leaves attached to branchlets in such a way that each branchlet looks like a compound leaf.

1.2.4 Soil: Aonla can be grown in light as well as heavy soils except very sandy one. However well drained fertile loamy soil is the best. The trees are adapted to dry conditions and can grow in moderately alkaline soils. Cultivar variation in salt tolerance has been reported. Aonla seedling and Chakaiya exhibited salt tolerance up to ESP 43.5 and 35.0 and Eec 9.7 and 9.0 mmhos/cm respectively (Dikshit, 1987), while Kanchan and Francis could tolerate up to ESP 35.0 and Eec 10.0 mmho/cm (Shukla, 1990). Salinity caused excessive accumulation of Cl in leaves, while sodicity resulted in accumulation of Na in toxic amounts in all the cultivars (Shukla, 1993).

1.2.5 Propagation: Soaking of seed in gibberellic acid solution (500 ppm) for 24 hours increased germination as well as the root system. Propagation from endosperm by the micro propagation technique also gave good result. Aonla plants when raised from seed bear fruits of inferior quality. Shield budding has been successfully tried at Saharanpur (UP) and also in Madhya Pradesh and it is reported to be cheaper and better than inarching. One-year-old aonla seedlings having girth of about 1cm are shield budded in early June. For top working the inferior trees are headed back to a height of 1-1/2 meters in March and the shoots produced from that are shield budded in May with scions of improved cultivars.
1.2.6 Bearing behavior

The budded plants commence bearing from the fifth year. Vegetative growth of the tree continues from April to July and flowering also commences. The flowers are of two types male and female. Both male and female flowers are located on the branchlets, the male in the axil of the leaf in the clusters throughout the branchlets while the female flowers are located on the apex of only a few branchlets. The ratio between the male flowers and the female flowers has been recorded as 307 : 1, and 197 : 1 in two years of observation.

The trees remain dormant from April to July and resume growth from last week of July to first week of August. The seedlings tree flowers first. The flowering period continue for about a month Aonla fruit is reported to flower twice in south India during February –March and June-July. Under north Indian conditions removal of shoots from the tree between July to October induces flowering but an economical crop is not obtained.

1.2.7 Pollination

Wind, honeybees and gravity plays important role in the pollination process of aonla flowers. Common visiting hours of visiting honeybees is late evening and morning. The initial percentage of fruit-set may vary 12-18 % in Banarasi. Mechanical pollination and incorporation of honeybees in aonla orchard may improve percentage of fruit-set. The poor fruit-set in Banarasi and Francis may be due to low sex ratio or lack of pollination.

Three waves of flowers and fruit drop are observed in aonla. More than 70% of flower drop within three weeks of flowering which normally due to lack of pollination. Second drop is that of young fruitlet at the time of dormancy break. The third drop of fruits is due to embryological and physiological factors is spread
over the entire period of the developing fruit starting from latter half of the August to harvest (Bajpai, 1968).

1.3 Cultivation of Aonla:

1.3.1 Planting

Prior to planting, the field should be deeply ploughed, harrowed and labeled. The pits 1m should be dug during May-June at appropriate distance and filled with surface soil mixed with 10-15 kg decomposed farmyard manure. Singh (1991) reported the filling of pits with normal soil + 25 kg FYM + insecticide (chlorpyriphos) for preventing termite attack resulted into maximum percentage of plant survivals, average height and trunk girth. A distance of 10 meters all around is recommended for good cultivation of aonla grafts, which are planted in pits. Fortuitously irrigation is required in Summer. Aonla plants may be given 10kgs compost, 100 grams N, 50g P, 75 g Potash in the first year. (Singh, 1991). This quantity is doubled in the second year, trebled in the third year, and so on till in the 10 years the quantity become 100 kg compost, 1kg N, 500 g P, 750 g Potash. This quantity is given each year there after. Entire quantity of compost and phosphorus along with 2/5 N and potash should be given in June-July and remaining after the few months,3-4 kg super phosphate is necessary preferably at the pre flowering time to boost up the bearing capacity of the plant. Plants bear fruits generally after 8-years. However a newly evolved cultivar NA 7 start bearing in three years.

Healthy grafts or budded plants are planted during rainy season in July at a distance of 9 m (Singh V. et al., 1967) or 11 m (Singh, 1974) each way in square system. Use of gypsum 75 % in alkaline soil (pH 9.1 and ESP 30.6) was reported to be beneficial for obtaining maximum growth of budded plants (Singh and Gaur, 2000).
1.3.2 Training and Pruning

As the branches of aonla tree often break carrying heavy crop load due to brittle nature of wood, the plants should be trained to develop a low headed one and the main branches constituting the foundation framework should be made to arise on the trunk within 0.75 m from the ground. Encouraging the growth of four to six well-spaced branches with fairly wide angle should develop the framework. The pruning of the bearing plants can be done after the termination of the crop each year. While pruning, dead, diseased, broken, weak, crossing branches and suckers appearing from rootstock should be removed.

1.3.3 Irrigation

Aonla plants hardly require any irrigation during the rainy season except long spell of dry period. The young plants require watering during summer months at fortnightly interval, particularly till they have fully established. Watering of mature, bearing plants is also necessary from April to June at bi-weekly interval to obtain higher fruit set and reduce fruit drop. Irrigation during October to December at 20 days interval helps in better development of fruit.

1.4 Species and Cultivars

The genus Phyllanthus (Greek for leaf flower) comprises about 350 (Hooker, 1973) or even 500 species (Bailey, 1917) mostly shrubs, herbs and trees. With the revision of the genus Phyllanthus emblica has been placed under emblica or emblica officinalis (Anon, 1969). There are other species which are also used for pickling etc. as Phyllanthus acidus, popularly known as star gooseberry or country gooseberry; emblica fischeri and Phyllanthus longiflorus.
Perry (1943) reported somatic number of chromosomes in aonla to be $2n=28$ while a variation from $2n=98$ to 104 has been observed by Janakiamal and Raghavan (1957).

**Cultivars**

There has been no standardization of cultivars of aonla and they are mostly known as basis of size (Janakiamal and Raghavan, 1957), color (Singh et al., 1967) or after the names of places. The cultivars mainly classified according to their color are green tinged, red tinged, pink tinged, white streaked and Bansi red. Singh (1974) reported that important cultivars grown in the district of Pratapgarh (U.P.) are banarasi, chakaiya and pink tinged which are grown successfully under north Indian conditions.

**Banarasi**

Tree has upright growing habit with three branchlets per node. Fruits large in size, flattened oblong, skin smooth, yellowish, segments raised in three parts, flesh moderately fibrous, soft, semi transparent. It has less number of female flowers and self-incompatibility and it is a shy bearing.

**Chakaiya**

The tree has spreading habit. It bears profusely and has 4.03 female flowers per branchlets. Fruits are small to medium, flattened, skin smooth, greenish in color, flesh fibrous and hard.

**Francis**

The branches have drooping habit. Moderate in bearing. Fruits large, flattened oval, skin smooth, greenish yellow, flesh soft, nearly fibreless and has moderate keeping quality and susceptible to fruit necrosis.
NA 4 (Krishna)
This is probably a chance seedling of Banarasi cultivar. The cultivar bears moderately. Fruit medium to large in size, flattened, conical, angular, basin appellate in shape; skin smooth, yellowish in color with red bluish on the exposed surfaces; flesh fibreless, hard and semi transparent.

NA 5 (Kanchan)
It is believed to be a chance seedling of Chakaiya. The tree has spreading habit. It bears profusely. Fruits small to medium, flattened, oblong; skin smooth, yellowish in color, ideally suitable for preparation of pickles.

NA 6
A seedling selection from Francis, prolific and regular bearer, no incidences of necrosis, ideally for processing processed products.

NA 9
Earlier maturing chance seedling from Banarasi, fruits large, suitable for reservation

1.5 Fruits weight and chemical composition of some aonla cultivars:
Naik and Chunawat (1993) evaluated some newly evolved aonla cultivars for their physico-chemical attributes. It was observed that Anand- II followed by Anand- I excelled over Deshi in respect of their fruit weight, stone weight, pulp:stone ratio, pulp thickness, fruit size and number of fruits per kg weight. However the cv. Deshi was found superior to newly evolved cultivars in respect of chemical composition (TSS, Ascorbic acid, Tannin and Moisture).
Table 1.1: The chemical compositions of aonla cultivars

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Fruit weight (g)</th>
<th>Total soluble solids (°Brix)</th>
<th>Total sugar (%)</th>
<th>Acidity (%)</th>
<th>Vitamin C (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banarasi</td>
<td>32.25</td>
<td>2.9</td>
<td>8.56</td>
<td>2.4</td>
<td>636.8</td>
</tr>
<tr>
<td>Chakaiya</td>
<td>26.6</td>
<td>10.7</td>
<td>9.78</td>
<td>1.94</td>
<td>474.5</td>
</tr>
<tr>
<td>Deshi</td>
<td>12.9</td>
<td>14.8</td>
<td>6.96</td>
<td>2.35</td>
<td>485.9</td>
</tr>
<tr>
<td>Harpharor (stargooseberry)</td>
<td>12.10</td>
<td>13.5</td>
<td>7.52</td>
<td>2.49</td>
<td>598.0</td>
</tr>
<tr>
<td>Francis</td>
<td>41.5</td>
<td>12.0</td>
<td>4.50</td>
<td>1.70</td>
<td>385.0</td>
</tr>
<tr>
<td>NA 4 (Krishna)</td>
<td>49.0</td>
<td>11.5</td>
<td>4.90</td>
<td>1.40</td>
<td>475.0</td>
</tr>
<tr>
<td>NA (Kanchan)</td>
<td>52.0</td>
<td>10.0</td>
<td>4.0</td>
<td>1.45</td>
<td>500.0</td>
</tr>
</tbody>
</table>

Aonla fruit is highly nutritive and it is the richest source of vitamin C except Barbedos cherry (Asenjo, 1953). The ascorbic acid and other constituents are well retained in dried aonla fruits (Sarivastava, 1964). An easy way to prepare aonla murabba with high vitamin C content has been reported by Gupta and Bopaiah (1986). Various workers have reported the variation in ascorbic acid content. The stability of ascorbic acid and presence of astringency in aonla fruit may be assigned to the presence of polyphenols or leucoanthocyanins (Sasry et al., 1956). Hanif et al. (1966) noted marked antioxidant effect of gallocatechin present in aonla fruit. A comparative evaluation of different products revealed that dried aonla
(flakes) had a maximum nutritive value followed *Cytophanprash*, aonla preserve (murabba), pickle and brined aonla fruits (Naik and Chundawat, 1993).

1.6 Growth substances in aonla fruit

Ram and Rao (1976) reported 6 cytokinin-like substances in aonla fruits showing growth after dormancy. In the rapidly growing fruits 6 gibberellins-like factors were identified, five of which behaved like gibberellin A1, A3, A4, A7 and A9. The young developing seeds appeared to be the major centers of synthesis of auxins, gibberellins and cytokinins in the fruit after its dormancy break (Ram and Rao, 1978, 1981).

1.7 Pest and diseases and fruit problem

1.7.1 Pests

Caterpillar make tunnel in the main trunk or branches. The larva constructs a typical loose irregular webbing of silks threads. Feeding of larva results into deterioration of the vitality of tree and reduction of yield (Larka, 1999). Among the pest *Betousa stylophora* and *inderbela* sp. The shoot gall maker and bark eating caterpillar respectively are of importance. Parathon (2% spray and removal of diseased portions have been recommended to control the pests. The trunk eating caterpillar gets into the main trunk and makes tunnel. The pest can be controlled by spraying 0.03% endrin or injecting kerosene oil or petrol in the holes and plugging them with cotton and waxing.

1.7.2 Disease: Blue mold (*Penicillium islandicum*)

Brown patches with water soaked area are formed on the fruits which are finally covered with bluish green pustules. Spray of borax or sodium chloride solution of low concentration have been found to control (Setty, 1959).
Chahal and Singh (1969) also isolated *Penicillium oxalicum* and *Aspergillus niger* from rotting aonla fruits.

**Aonla rust (Ravenilla indica)**

Causes brown pustules on fruits and leaves, which turn dark brown after some time. Control of the rust is possible by spray of dithane Z-78 at 0.2% concentration (Tyagi and Pathak, 1987). Banarasi and Chakaiya cultivars are supposed to be relatively free from the diseases (Nivan, et al., 1969). Boron deficiency symptoms have been reported causing internal necrosis. Three spray of 0.6% borax at 15-days intervals from early September removes the deficiency.

**1.7.3 Fruit problem or physiological disorder**

In a survey conducted to study the problems of aonla growing in U.P, it is observed that francis suffered the most fruit necrosis (70-80%) where as the fruits of chakaiya were not affected (Ram, 1976). Fruit necrosis symptoms start with the browning of the mesocarpin of the fruits extending towards the upper surface and resulting finally in brownish black areas on the fruit surface in the second and third week of October, depending upon the severity of the disease fruit turn black and latter into corky and gummy pockets.

**Control**

Borax spray 90.6 per cent twice or thrice in the month of September to October with about 10-15 days interval.

**1.8 Harvesting and storage**

Aonla plants start bearing quite late, usually after 8 to 10 years when raised from seed. The budded plants start fruiting after 4th years. The fruits are light green at first but when mature the color become dull, greenish-yellow or rarely brick red
(Naik, 1949). Bajpai (1969) observed that the best time of harvesting aonla fruit is February when fruits have maximum vitamin C content.

The aonla blossoms late in the spring and fruits ripen during winter. In southern India the trees bear the fruits throughout the year. Two quintal per plant may be annual production of well looked after trees of good cultivar (Singh et al., 1967). Singh (1974) reported an average fruit yield of 200 kg per grafted tree. The average yield of wild aonla rees growing in the forests is 23.5 kg.

1.8.1 Post harvest handling and storage

Sanjeev Kumar and Nath (1993) reported that physiological weight loss and decay and decrease in vitamin C were reduced in E. officinalis cv. Chakaiya fruits stored in the zero energy cool chamber compared with fruits stored in ventilated polyethylene bags at room temperature. In zero energy cool chamber fruits could be stored up to 12 days with acceptable minimum quality loss compared with 4 days at room temperature. Aonla fruits can be stored at 0 to 1.7°C and 85 to 90% RH for 8 weeks (Fantastico, 1975). Singh and Kumar (1997 a) observed that the decay loss of aonla cv. Chakaiya was minimum (26.56%) in modified storage condition (boxes containing fruits were packed in polythene bags) on 24th day of storage whereas it was maximum (48.7%) in zero energy chamber.

1.9 Uses:

The fruits are made into preserves (murabba), sauce, candy, dried chips, tablets, jellies, pickles, trohphies, powder, juice beverages such as syrup squashes, nectar and ready-to-serve (RTS) drinks (Singh and Kumar, 1995; Nath, 1999). Aonla fruit has played important therapeutic role from time immemorial and is frequently recommended for its synergistic effects in both the Ayurvedic and Unani systems of medicines (Jain et al., 1983). It is valued as antiscorbutic, diuretic, laxative
alternative (Nadkarni, 1976) and antibiotics (Ray and Mujumdar, 1958) bronchitis, diabetes, fever (Drury, 1873), diarrhea (Dalzell and Gibson, 1861), Jaundice, dyspepsia, cough (Burkill, 1935) and in tanning and dyeing industries. The literatures regarding its diverse medicinal, industrial and other application have been reviewed (Anon., 1952; Morton, 1960). The properties and nature of inhibitors of potato virus in the plant extract (Verma et al., 1969) pharmacological activities Phyllomenin isolated from fruit pulp (Rao and Siddiqui, 1964), protective effects of fruit extract in myocardial necrosis (Tariq et al., 1977 and anti-viral activity (Singh et al., 1983) have been reported. Aonla in fresh or dehydrated state is widely used in the preparation of some Ayurvedic drugs. Arogyawardhini, Chayvanprash, Triphala and Ashokaarishta are some popular drugs in which aonla fruits is one of the constituents. Attempts have been made to prepare ascorbic acid (Shivarama, 1949) and ascorbic acid concentrates (Deb and Chandrasekara, 1960).

1.9.1 Ayurvedic application and formulation:

Amlaki is one of the herbs, mentioned in all the ancient scriptures of Ayurveda. It is used in various archaic Sanskrit like Rgveda, Skanda, Purana, Ramayana, Garuda, Prabhu Sam hitra as well as in the famous play “Vikramorvasiyad” one of the great dramatist Kalidasa. The famous story of Cvavana an ancient seer quotes that Aswini Kumara’s rejuvenated him by a preparation, chiefly contained Amlaki fruits. Since then the preparation is known as Cvavanaprada. This speaks of the ancient heritage of amlaki in India. Amlaki is called Dharti or nurse, as it resembles a nurse or mother in its healing and soothing properties. It is also called
as _Santā_-pacifying, _Vayastha_-retaining youth, _Amrita_-an ambrosia, _Vṛṣya_-an aphrodisiac, _Siva_-beneficial to entire nature etc. Mharsi Caraka refers to it as one of the foremost amongst the _rasayanas_. The _rasayana_ or rejuvenator, bestows a long time, intelligence, memory, health, youth, glow, voice, complexion, strength and sex desire (Caraka _Sāṃhitā_, _Cīkītā_ A4). Amlaki is an all-round tonic and rejuvenator. It can be given to a person with any type or constitution, male or female, to youngsters as well as to elders. It is a “Universal Rasayana”. The herb is also categorized as _prajā-sīhāpāna_ promote reproduction, _vṛṣya_-augments seminal fluids, _vayahsīhāpāna_- delays aging, _vīreca-nopāga_-helps laxation (Caraka _sāṃhitāsūtra_, A4). Amlaki recommended as drug of choice in the treatments of diabetes (Astanga _Uṛḍhayā_, _Uttara Stanzas_, A-40, 4658) and maintain the youth.

**Ayurvedic Properties**

The amlaki have five tastes ( _Rasa_ ) viz. sour, sweet, astringent, bitter, pungent, it is predominantly sour and has a sweet post digestive effect ( _Vipaka_ ) and a cold potency ( _Vīrya_ ). It alleviates all the three dosas, _vata, kapha_ and _pitta_ chiefly it is used to alleviate _pitta_ diseases. It possesses _laghū_ (light), _ruska_ (dry) and _sita_ (cold) attributes when used externally, it relieves the burning sensation on the skin and is beneficial to the skin and hair.

**1.9.2 Medicinal use**

The roots, leaves, seeds and chiefly the fruits are used for medicinal purpose. Amlaki is used both internally as well externally. Externally the fruit juice is used for hair wash to prevent for premature graying and hair fall. It imparts beautiful luster and smoothen the hair. The medicated of Amlaki is used for the same. The decoction of the fruit juice cleanses and heals the wounds. The paste of the fruit
pulp is applied on the skin in the burning sensation. The juice instilled in the eyes, is beneficial in ocular problems. The skin of bark chewed alleviates the dental aches. Internally Amlaki is used in innumerable diseases. It enhances appetite, improves digestion, relieve constipation and combats hyperacidity. Amlaki is recommended in the treatment of skin diseases, raktaapittha, hepatitis, anaemia, diabetes, urinary disorders and hemorrhagia. In giddiness due to aggravated pitta, fruit juice mixed with equal amount of rock candy is very useful. The same can be used in urinary complaints like burning sensation and frequency. Hyperacidity can be well controlled with a mixture of amlaki juice, rock candy and pinch ful of cumin seed powder. "Rasayana Curna" is used with great benefit to alleviate the excessive body heat and is an anabolic to nourish all the elements- dhatu. It can be prepared by taking in equal parts the powder of dried fruits of malaki, gokswara and guduci stem. Daily in the morning 3 gms of rasayana curna mixed with 5 gms of honey and ghee is licked. It works well as a rejuvenator. Amlaki is said to be the herb of choice for diabetes (Astanga Hrdaya, Uttara Sthana, A-40/48). On this property of amlaki more scientific studies are required. Amlaki and Haritaki have many similar properties. It is also the best nervine tonic. It is beneficial to augment memory and intellect by alleviation of vitiated sadhaka pitta. Amlaki is used in raktaapittha with unfailing results. As a rejuvenator, it is a very rich medicine. It has attracted attention of entire world due to its properties of enhancing the longevity and preserving the youth.

1.9.3 Ayurvedic preparation

Triphalacurna, Cyavanaprasha, Dhautileha, Brahmyarasayana, Amla-kyadi curna, Amlaki rasaya etc.
Parts used: Dried fruits, the nut or seed, Leaves, roots, bark and flowers. Ripe fruits used generally fresh, dry also used.

**Action**

Fresh fruit is refrigerant, diuretic and laxative. Green fruit is exceedingly acidic. Fruit is also carminative and stomachic. Dried fruit is sour and astringent. Flowers are cooling and aperient. Bark is astringent.

**Action and uses in Ayurveda and Siddha**

*Ras*, all except *lavana, Kashayam* dominates, seethe *veeryam, mathura vipakam, tridosha, haran, rasayanam* and increases *sukram*.

**Action and uses in Unani**

Cold 2°, dry 3°, refrigerant, heart tonic, tonic to brain, prevents vicious humors in stomach and intestines, used in chronic diarrhea, in the convalescent stage of typhoid and other fevers.

**Indications**

*Rakta-pittam, prameham, vata-raktam*, giddiness, vertigo.

**External Use**

In mental disorders as paste and tailam to head.

1.9.4 **Preparation of decoction and infusion**

Decoction and infusion of the leaves and seeds; a fixed and essential oil; confection; powder; paste; and pickles. An astringent extract equal to catechu is prepared from the root by decoction and evaporation.

**Uses**

Fresh fruit is used in Turkey in inflammation of the lungs and the eyes. In Persia it is used as *vermifuge*; juice of the fruit is used; it is generally given with honey; the dose is from 1-3 drahms. The green fruits are made into pickles and preserves to
stimulate appetite. A paste of the fruit alone or with *Nelumbium speciosum*, saffron and rose water is a useful application over the public region in irritability of the bladder, in retention of the urine and to the forehead in cephalalgia. An infusion of the seed is given as a febrifuge and in diabetes. It is also used as a *collyrium* and applied with benefit to recent inflammation of the conjunctive and other eye complaints. Juice and extract of the fruits with honey and *pipli* added is given to stop hiccup and in painful respiration. Dried fruits immersed in new earthen vessel a whole night yield a decoction, which is used as a *collyrium* in opthalmia. It may be applied cold or warm. Dried fruit is useful in haemorrhage, diarrhoea and dysentery; with iron it is a valuable remedy in anaemia, jaundice and dyspepsia. A fermented liquor prepared from the root is used in jaundice dyspepsia, cough etc. Juice of fresh fruit and ghee mixed together is a good restorative tonic. A sherbet prepared from the fresh fruits with or without raisins and honey is a favorite cooling drink, which has a diuretic effect. A decoction made by boiling 4 drachms each of the powder of *emblie* and *chebulic myrobalan* and one drachms of *rhubarb* powder in a pint of water is a laxative as well as diuretic, given in 2-ounces doses to sick people. A decoction prepared from the fruit combined with *T. chebula* and *T. belerica* is useful in chronic dysentery and biliousness in doses of 1 oz. once or twice daily. Juice of the bark combined with honey and turmeric is a remedy for gonorrhea. Root bark rubbed with honey is used in aphthous stomatitis. A decoction of the leaves is also used as a mouthwash in aphthae. A mixture of the fruit juice and sugar relieves burning in vagina. Leaves are used as infusion with fenugreek seeds in chronic dysentery and as a bitter tonic. For loss of taste after fever a decoction of *emblie* seeds, dried grapes and sugar is used for gargling. A decoction of the *emblie* seed, *chiturak* root, *Chebulic myrobalan*, *Pipli* and
Saindhava is used similarly. A powder of emblic seed and red sandal is given with honey to stop nausea and vomiting. Dried seed in ghee and ground in Conjee is applied as lep to the forehead to stop bleeding from the nose. Seeds burned powdered and mixed in oil is useful application in scabbies or itch. One tola of seed soaked in a tinned vessel during the night and ground next morning, with cows milk and taken in 7 tolas or ¼ seer of milk is a good remedy for biliousness. A powder made of the equal quantity of emblic seed and root of Withania somnifera given with ghee and honey is a restorative, invigorates especially in winter days. Half a drachms each of emblic seed and gokhru powder and mixed with 15 grains of essence of Gulancha and given early morning in ghee and sugar is an equally nutrient tonic. For children, a compound powder of emblic seed, Chitrak root, Chebulic myobalan, Pipli and Palelone is given in suitable doses according to age in warm water daily, morning and at bed time. Milky juice of leaves is a good application to offensive sores. A fixed oil obtained from the berries strengthens and promote the growth of hairs. Essential oil distilled from the leaves is largely employed in perfumery. Tender shoots given in bitter milk cure indigestion and diarrhea; green shoots given in buttermilk cure indigestion and diarrhea, green fresh leaves combined with curds have also similar effect. Flowers combined with other articles are given in the form of electuary. Fruit is often dried and use as a medicine in bilious complaints and is used cooked, preserved and used in pickle or made into confection.

1.9.5 Preparation of confection

Berries are first soaked in water for 12 hours, strained and through away the water, boil the berries in fresh water for couple of hours so that they may become soft; then grind them into paste and add three times their quantity of sugar and make
into confection; it is given in the doses of 1-2 drachms. It is a pleasant purgative, useful in habitual constipation; it is employed by hakims with many benefits in palpitation of the heart and in various complaints connected with digestive organs; such as biliousness, anorexia or dyspepsia etc.

1.9.6 Other preparation recommended in Ayurveda

Dhatrileha

Take a powdered emblic myrobalan 64 tolas, prepared iron 32 tolas, liquorice powder 16 tolas, mixed them together and soak in the juice of Gulancha for seven times successively. This is given in the doses of 20-40 grains in anaemia, jaundice and dyspepsia.

Dhatri Arishta (fermented liquor of emblic myrobalan)

Take fresh juice of 2000 emblic myrobalan, honey in quantity equal to 1/8 th of the juice, powdered long pepper 16 tolas, sugar 6 seers and a quarter; mixed them together for a while and leave the mixture to ferment in an earthen jar. This liquor is used in jaundice, dyspepsia, indigestion cough etc.

Akrsirul-ul-imraz (for leucorrhoea)

Take of tukhi amla 5 parts and sugar candy 2 parts. Mix and take for 14 days. An ointment made of the dried emblic myrobalan 4-parts, camphor, Nux vomica seed 4 parts, sulphur 4, copper sulphate 1 part, red oxide of mercury 2 parts and ghee is useful application in obstinate itch, prurigo etc.

Recipe for curing fever and cough:

Take of Lovasavam 3ss, Chyavanaprasa 1 ounce, Asoka ghritam 1 oz, honey 6 oz and make it to leham. Give 1/4 tola morning and evening before food.
Chyavanaprasha preparation

Bark of Aegle marmelos, Premna serratifior Bignonia indica, Gmelina arborea Bignonia suaveolens roots of Sida cordifolia, phaseolustrilobus, Piper longum, Hedysarumgangeticum, Uraria lagopoides, Glycine debilis, Tribulus liguinosus, Solanum xanthocarpum, Rhus succedanea, Phyllanthus niruri, grapes, Caelogynne ovalis, Aplotaxis auriculata, Aquilaria agallocha, Chebulic myrobalans, Tinospora cordifolia, Riddhi, livek, Bishabhaka, Curcuma zemumbet, tubers of Cyperus rotundus, Boerhavia diffusa, meda, Withania somnifera, Eletteria cardemonum, Nympheae stellata, Red sandal wood, Convolulus paniculatus, roots of Justicia adhatoda, the root called Kakoli and Leeca hirta. Take one tola each of these. Take also 500 fruits of phyllanthus emblica and tie them poorly in a piece of cloth. Boil all these together in 54 seers of water down to 16 seers and strain the decoction. Throughout the seed of myrobalans and taking the remnants of the fruits, fry them in 6-palas of ghee and 6-palas of sesamum oil mixed together. Fried product is then to be reduced to a paste on curry stone. After this boil the decoction and this paste, with 50-palas of sugar candy. When the boiled matter assume some degree of consistency, through into bamboo manna 4-palas, powder of Piper longum 2-palas, that of the bark of Cinnamomum zeylanicum 2-tolas, that of the leaves Cinnamomum tamalocs 2-tolas, that of cardamoms 2-tolas, that of flowers of mesua ferrea 2-tolas and stir the contents. When cooled added 6-palas of ghee and keep the compound in a jar long in use for storing the ghee.

Doses:

1/2 – 2 tolas, vehicle being goats milk. This is a nutritive tonic useful in phthisis and improves all conditions of debility. The drug is also used in scorpion sting