American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

American Journal of Food Technology 3 (1): 13-23, 2008
ISSN 1557-4571
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Status of Post harvest Technology of Aonla in India-A Review

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Abstract: Aonla is an important fruit crop indigenous to Indian sub-continent, which can be grown successfully in dry and neglected regions. The area under aonla has been expanding rapidly in the last couple of years. The growing popularity for alternate medicines, health foods and herbal products are enhancing the requirement for aonla fruit. The raw fruit, due to its high acidic nature and astringent taste, is unacceptable to consumers. The chemical composition of aonla fruits is influenced by environmental factors. Aonla fruit is highly nutritive with a great medicinal use and the richest source of vitamin C. The pulp of fresh fruit contains 200-900 mg of vitamin C. As aonla fruits are highly perishable in nature, its storage is very limited. The main objective of the review is to highlight its uses, existing processing methods and their limitations and further propose to develop pilot plant for aonla processing.

Key words: Aonla, Indian gooseberry, post harvest technology, pricking machine, shredding machine

INTRODUCTION

The Amla or Aonla (*Emblica officinalis* Gaertn) also known as Indian Gooseberry is a minor sub-tropical deciduous tree indigenous to Indian sub-continent. It can be grown successfully in dry and neglected regions owing to its hardy nature, suitability to various kinds of wasteland. A mature aonla tree can tolerate freezing as well as high temperature of 46°C. In India, aonla is grown in an area of about 50,000 ha with a production of around 2,00,000 metric tonne.

The main varieties of aonla are Banarasi, Chakaiya, Hathijhool, Bansi red, Pink-tinged, NA7, etc. The aonla gets ready for harvesting during November-December. However, the fruit may be allowed to remain on the tree till February without much fruit drops. The optimum stage of harvesting falls between the periods extending from the second week of December to the third week of January in Northern plains. However, at some places in Southern India, the fruit is available throughout the year. A fully mature aonla tree may yield 250-300 kg of fruit annually.

The area under aonla (Indian gooseberry) has been expanding rapidly in the last couple of years. From about 3,000 ha in the early 80s the area had stretched to over 25,000 ha in 2000. It has doubled to 50,000 ha in the last two years. Intensive cultivation is being done in the salt-affected districts of Uttar Pradesh including the ravenous area in Agra, Mathura, Etawah, Fatehpur and semi-arid tracks of Bundelkhand. It is rapidly spreading in the semi-arid regions of Maharashtra, Gujrat, Rajasthan Andhra Pradesh, Karnataka, Tamil Nadu and the Arawali ranges in Haryana, Kandi area in Punjab and in Himachal Pradesh.

The present review describes the status of post harvest technology for aonla fruit in India and highlights various processing technologies and emphasize the importance to pilot plant for aonla processing.

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Fig. 1: A view of aonla plant

AGRONOMIC PRACTICE

Aonla is successfully propagated through patch/modified ring budding in the North India from mid of May to September with 60 to 100% success. However, in South India, aonla propagation is being done almost 8-10 months in a year, with the aid of green and net house facilities (Pathak, 2003). Considering the efficiency and requirement of single bud, budding and soft grafting appears to be ideal methods of aonla propagation.

Grafted or budded aonla plants are planted at the distance of 6-10 m during July-August or February. Pits of 1-1.25 m size are dug two months prior to planting. In each pit 3-4 baskets of well rotten Farm Yard Manure (FYM) and 1 kg neem cake or 500 g bone meal is mixed with soil and filled. In the sodic soil, as per GR value, 5-8 kg gypsum along with 20 kg sand is also incorporated. Filled pits are irrigated thoroughly if there is no rain. In aonla orchards, ber, guava and lemon, etc. have been found to be ideal filler plants and these are planted in the center of each square of aonla plants. Hedge row planting is also being tried at some of the places where line to line distance of 8 m is kept while plant to plant distance is reduced to 4-5 m apart. In order to establish aonla orchards particularly under adverse soil conditions, it is advisable to grow the seedling directly in the pits or raise these in suitable container and transplant at permanent site and perform budding (*in situ*) subsequently. Aonla scion shoots can be safely stored/transported for 5-7 days with ample success.

Aonla plant should be encouraged to develop a medium headed tree. The main branches should be allowed to appear at a height of 0.75 to 1.0 m above the ground level (Fig. 1).

HARVESTING AND YIELD

The change in seed colour from creamy white to brown is indicative of fruit maturity. Fully developed fruits, which show sign of maturity, are harvested. This helps in size gain of remaining fruit. Delay in harvesting results in heavy dropping of fruits particularly in varieties like Banarasi and Francis. It also adversely affects the following years bearing. Individual fruits are plucked by climbing on tree with the help of pegged bamboo or ladder. Harvesting should be done in early or in the late hours.

A budded/grafted aonla tree starts bearing 3rd year onwards after planting, whereas a seedling tree may take 6-8 years for start of bearing. Vegetatively propagated plant attain full bearing within 10-12 years and may continue to bear 60-75 years of age under well managed conditions. Yield varies greatly in aonla varieties. Banarasi is a shy bearer, Francis and NA-6 are average bearer while Kanchan and NA-7 are prolific bearer. An aonla tree may bear from 100 to 300 kg per tree, thus giving 15 to 20 tonnes production per hectare of area.

Table 1: Chemical composition of fresh aonla fruit

Characters	Composition
pH	2.50
T.S.S, ^{0}Brix	14.00
Acidity, % citric acid	2.24
Ascorbic acid (mg/100 g)	571.60
Reducing sugar (%)	2.37
Non- reducing sugar (%)	0.74
Total sugar (%)	3.11
Pectin, as % Ca pectate	0.54
Tannin, as % gallotannic acid	0.55
Protein (%)	0.88
Moisture (%)	84.36

PHYSICAL CHARACTERISTICS

The aonla fruits are round, ribbed and pale green. It is divided into six segments through pale liner grooves. The surface of the fruit is shiny and the size varies from small marble to a large plum. It is quite hard with a thin and translucent skin. The raw fruit, due to its high acidic nature and astringent taste, is unacceptable to consumers. The average fruit weight and seed weight varies from 22.29-25.20 and 1.54-1.82 g, respectively among Krishna, NA7 and Chakaiya cultivars (Goyal *et al*., 2007). The seed pulp ratio is reported to vary from 1:15 to 1:22 (Kalra, 1988).

CHEMICAL COMPOSITION

The chemical composition of aonla fruits is influenced by environmental factors. The chemical composition of fresh fruit in respect to moisture, protein, fat, crude fibre, starch, sugars, minerals and vitamins has been reported by lot a of researchers (Tripathi *et al*., 1988) and shown in Table 1. The fruits are rich in ascorbic acid and tannins.

The total sugars content in aonla fruit varies from 7 to 9.6%, reducing sugars from 1.04 to 4.09% and non-reducing sugars from 3.05 to 7.23% among the various varieties. Aonla is particularly rich in vitamin C. The pulp of fresh fruit contains 200-900 mg of vitamin C as reported by several workers (Kalra, 1988).

NUTRITIVE VALUE/BENEFITS

Aonla fruit is highly nutritive with a great medicinal use and the richest source of vitamin C. It contains 500-1500 mg of ascorbic acid per 100 g of pulp (Chauhan *et al*., 2005). This is much more than the vitamin C content of guava, citrus and tomato fruits. The fruit juice contains nearly 20 times as much vitamin C as in orange juice. Its other constituents are phenols and tannins containing gallic acid, elegiac acid and glucose which prevent oxidation of vitamin C. A tablespoonful each of fresh aonla juice and honey mixed together forms a very valuable medicine for the treatment of several ailments like tuberculosis of lungs, asthma, bronchitis, scurvy, diabetes, anemia, weakness of memory, cancer, tension, influenza, cold, loss and grayness of hair etc. Because of its highly acidic and astringent nature, the consumers do not relish this fruit in fresh form and consequently it is used in the preparation of various ayurvedic tonics like Chayvanprash, Triphala, etc.

STORAGE

Aonla fruits are highly perishable in nature as it's storage in atmospheric conditions after harvesting is very limited. The objective of the storage of fresh fruit is to extend the period of their availability. Storage facilities such as cold storage and controlled/modified atmospheric storage are very

expensive and not in the direct reach of poor farmers (Kumar and Nath, 1993). Singh and Kumar (1997) stored fully mature aonla fruits at room temperature, modified storage condition, zero energy chamber and zero energy+modified storage condition. It was found that decay loss was minimum (26.56%) in modified storage condition on 24th day of storage whereas it was maximum (48.70%) in zero energy chamber. The fruits may be kept in cold storage for 7-8 days at 0-2°C and 85-90% relative humidity.

Due to its perishable nature, it is difficult to store or transport aonla fruits over long distances. In order to have good income from aonla, it must be sold immediately in the market. But, the problem arises when there is glut in the market. To get profit during that period, proper storage facilities should be available to help the farmers get maximum profit. The extension of shelf life during storage should be made possible by checking the rate of respiration, transpiration and microbial infection. Plant growth regulators, certain chemicals and fungicides have played a great part for short period storage.

Nath *et al*. (1992) studied the effect of post harvest treatments on shelf life of aonla fruits with calcium nitrate (1%), GA_3 50 ppm and Borax (4%) and found that the physiological loss in weight and pathological loss increased with the length of storage period. Calcium nitrate (1%) minimized the weight loss during the storage period and no pathological loss was observed with Borax upto 9 days of storage.

TRADITIONAL/CONVENTIONAL METHODS OF PROCESSING AND PRODUCTS

Aonla has been in use for pickle and preserve since ages in India and the methods employed were based on traditional knowledge of grandmothers. Besides, aonla has been an important ingredient for chavanprash, a ayurvedic health tonic. The methods used previously were unhygienic in nature and time consuming. The nutrient loss in these methods was higher. The manual methods are costly, laborious and cannot maintain quality of the products. Minor accidents have also been reported during manual pricking and shredding. The shelf life of the prepared products was also less and the quality not up to the mark.

MODERN METHODS OF PROCESSING

Aonla fruit is highly nutritive with great medicinal benefits. As aonla fruits are highly perishable in nature, its storage is very limited. Thus, researchers are paying due attention towards processing aspects of aonla fruits so that the demand of its products increases among the consumers. Due to its astringent nature, consumers are hesitant to eat it in raw form. Attempts are being made to produce products which are not only nutritionally delicious but also acceptable among the consumers.

The modern methods for preparation of different aonla products are hygienic, consume lesser time and provide maximum retention of nutrients. The processes for preparation are standardized with proper preservation. Various R and D institutions have been working on aonla processing at laboratory scale. There is an urgent need to design matching processing equipment such as grader, segment separator, pricking machine, shredder, etc to develop a complete pilot plant. The engineering input in terms of machines will improve its quality as per international standards so that products can compete in the international market.

AONLA PRODUCTS AND USES

Aonla Preserve

In India preserves or *Murrabbas* of various kinds are used for taste as well as for medicinal purpose. It is acclaimed to impart energy to heart, brain and liver. It is also reported to stop diarrhea and useful as remedy for giddiness. Process flow chart and aonla preserve as product are shown in Fig. 2 and 3.

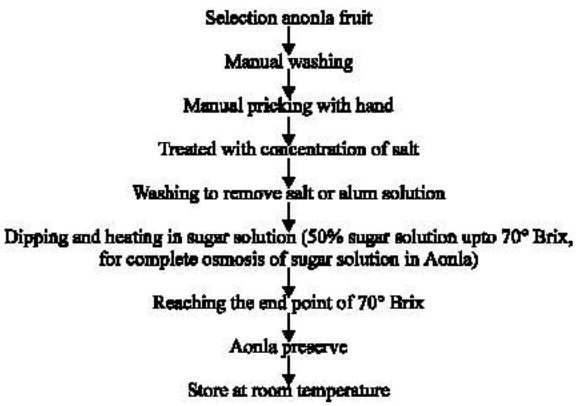

Fig. 2: Flow chart for preservation of Aonla preserve

Fig. 3: Aonla preserve

Tripathi *et al.* (1988) reported the chemical changes occurring in aonla preserve during processing and storage for 135 days. They observed that most constituents including total soluble solids content, vitamin C, total sugar, pectin, tannin, protein decreased in as compared to the fresh fruits. Further, increased acceptability was observed in aonla preserve up to 135 days of storage. It is rich in sugars and calcium but poor in ether extract, protein, phosphorous and iron.

The effect of sugar concentration at different temperature on the kinetics of total sugar gain, moisture loss, ascorbic acid loss, TSS gain in aonla preserve was studied by Geetha *et al.* (2005). They observed that the rate of constant kinetics for all the constituents increased with the increase in sugar concentration and temperature.

Candy and Jam

Tandon *et al.* (2003) studied the effect of blanching and lye peeling on candy preparation. They found that the candy prepared from lye peeled fruits of aonla showed decreased content of ascorbic acid than blanched fruits. The candy prepared from Lakshmi-52, Kanchan and Chakaiya was found to be the best. However, the effect of the blanching on some of nutritional parameters was less severe than that of lye peeling. General process flow chart for osmotic dehydration of aonla segment for candy is shown in Fig. 4.

Fig. 4: Flow chart for preparation of aonla segment

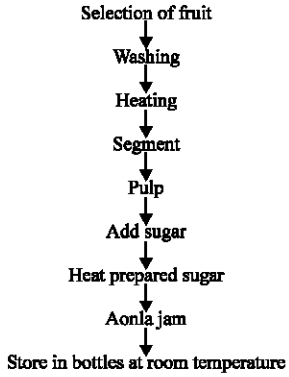

Fig. 5: Flow chart for preparation of aonla jam

Singh *et al*. (2003) conducted a study to find out the techno-economic feasibility of processing of aonla products, like the preparation of aonla pulp based products (Jam, squash, sauce) and non pulp based candy (segmented). They found that the per liter processing cost of squash and cost of 1 kg candy was much lower than that the cost of 1 L sauce and one kg jam. Agrawal and Chopra (2004) have carried out a study with regard to changes occurring in ascorbic acid and total phenols during storage in different aonla products. They observed that the shreds registered greater loss in ascorbic acid followed by jam, candy and squash. However, the candy showed greater loss in total phenols followed by shreds and squashes and jam recorded slight increase in total phenol content. On the whole, squash contained highest percentage of ascorbic acid and total phenols. Process flow chart for jam preparation is shown in Fig. 5.

Aonla Sauce, Juice and Pulp Preparation

Nath (1999) carried out a study on the extraction of aonla pulp and suggested a method for preparation of aonla pulp from fully matured fruits. In this process, the fruits are blanched in boiling water for about 10 min to separate the segments from stone. Equal quantity of water is added to the segments and in the pulper to make pulp. If the pulp has to be preserved, it should be heated to 75°C and cooled to room temperature. Potassium metabisulphite (2 g kg^{-1} of pulp) should be mixed thoroughly and the pulp should be filled in clean sterilized bottles and then sealed.

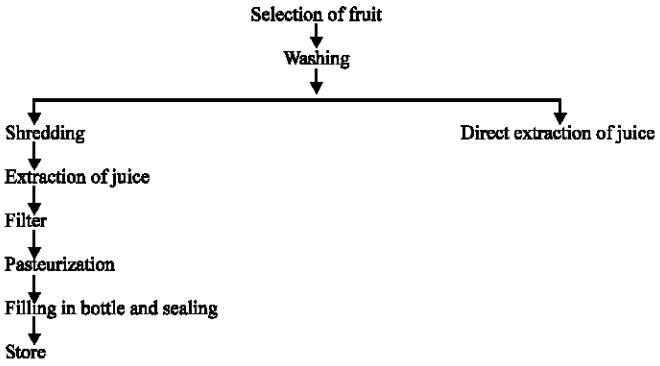

Fig. 6: Flow chart for preparation of aonla juice

Deka *et al.* (2001) conducted different experiments to study the feasibility of blending juices and pulp from lime, aonla, grapes, pineapple and mango in different proportion for the preparation of a ready-to-drink fruit juice beverages. The prepared beverages were subjected to sensory analysis using a 9 point hedonic scale. The highest sensory scores were obtained with a formulation comprising of 95% lime and 5% aonla juice/pulp. Process flow chart for juice is shown in Fig. 6.

Chauhan *et al.* (2005) have conducted studies on the development of aonla-blended sauce. The blended sauce was prepared using aonla pulp and tomato pulp. The pH, total soluble solids and ascorbic acid were found to decrease and titratable acidity to increase during storage. The sensory score for colour, appearance, flavour, texture and over all acceptability were found to be in acceptable limits during storage.

Aonla Shred Drying and Powder Preparation

A study carried out by Pragati *et al.* (2003) on aonla fruit drying by 4 different methods viz., osmo-air drying, direct sun drying, indirect solar drying and oven drying. They observed that the osmo-air drying method was best for the drying of aonla fruits, resulting in better retention of nutrition, such as ascorbic acid and sugars. They also found that the level of anti-nutrition, such as tannins were also lower in osmo-air dried aonla, because the leaching and the browning were minimal. The nutrition content in osmo-air dried aonla was satisfactory after 90 day of storage.

Alam and Singh (2005) have conducted a study to prepare aonla powder from its fruits. The pricked aonla fruits were blanched for 5 min in 5% boiling salt solution containing 0.15% $NaHCO_3$ and 0.10% MgO. The blanched aonla fruits were suliphited for 30 min in 0.5% KMS. The treated fruit were sliced manually with knife. For the dehydration of aonla slices, the mechanical dryer (50, 60, 70°C), solar and cabinet dryers were used. They found that the mechanically dried slices contained higher in vitamin C content and were organoleptically superior than slices dried under solar and cabinet dryer.

In a study, the raw and treated (KMS) samples of Banaras and Chakkiya varieties of aonla were dehydrated by sun and mechanically dried (60°C) for the preparation of aonla powder (Sharma *et al.*, 2002). The processed dehydrated powder was packed in 100 gauge packages of high-density polyethylene (HDPE) and low-density polyethylene (LDPE). The packages were stored under ambient (5-18°C and 60% RH) and refrigerated (4±1 and 90% RH). It was found that the aonla powder prepared from pretreated, Chakkiya variety and mechanically dried can be stored effectively in HDPE packages under refrigerated condition for 3 months without much loss in vitamin C, having better overall acceptability in terms of appearance, taste, flavor and texture.

Fig. 7: Flow chart for preparation of aonla shreds

Fig. 8: Dried aonla shreds

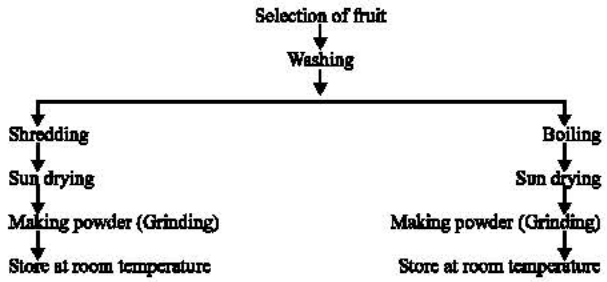

Fig. 9: Flow chart for preparation of aonla powder

Kavitha *et al.* (2003) studied the effect of osmotic dehydration on vitamin C content of aonla at different salt concentrations and different temperatures. The overall retention of vitamin C was found better in the un-blanched osmotically dehydrated and aired dried samples. Flow charts for shred drying and powder making processes are shown in Fig. 7-9.

Aonla Pickles

Small size aonla fruits, which are not suitable for preparation of preserves and other confectionary items, may be utilized for pickle making. To improve upon the texture of the fruit and also to remove astringency, brining is important in pickling. Add necessary oils, spices etc. and leave it for few days in sunshine. When pickle is ready after few days, store it at room temperature (Fig. 10).

Fig. 10: Flow chart for preparation of aonla pickle

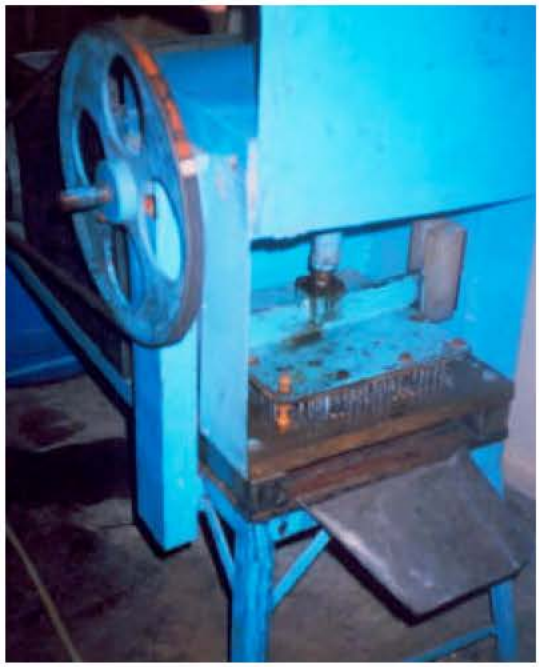

Fig. 11: A view of aonla pricking machine

Machines Used for Aonla Processing

At present, the machines used for aonla processing are neither well established nor popular among the processors. Most of the processing is still done manually. In recent times, the awareness of aonla is increasing due to the growing popularity of health foods and herbal products. Thus, thrust is being given towards the development of processing machines of aonla with higher efficiency. The main machines, which need immediate attention, are grading, pricking and shredding machines.

Currently, small capacity pricking and shredding machines are being used in the processing industry but these are less efficient, consume more power and susceptible to numerous breakdowns. This leads to the decrease in the total output of the processing unit. The photographs of machines currently in the industry are shown in Fig. 11 and 12.

Fig. 12: A view of aonla shredding machine

CONCLUSIONS

The Amla or Aonla (*Emblica Officinalis* Gaertn) also known as Indian Gooseberry is a minor sub-tropical deciduous tree indigenous to Indian sub-continent and it can be grown successfully in dry and neglected regions owing to its hardy nature, suitability to various kinds of wasteland. The growing popularity for alternate medicines, health foods and herbal products are enhancing the requirement for aonla fruit. The fruits are rich in vitamin C, protein, fat, crude fibre, starch, sugars and minerals. The fruits are rich in ascorbic acid and tannins. Because of its highly acidic and astringent nature, the consumers do not relish this fruit in fresh form. Hence, it is necessary to process this fruit and develop novel innovative products of high value. The modern technologies mentioned in the study for preparation of different aonla products are hygienic, consume lesser time and provide maximum retention of nutrients. The information generated by other researchers will be basis for development of pilot plant for aonla processing which is need of hour to mechanize processing operations to produce quality products of aonla for domestic as well as global market.

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