COMPARATIVE STUDIES ON QUALITY ANALYSIS OF FREEZE DRIED AND CROSS FLOW DRIED AMLA POWDER

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Abstract

Amla is known as wonder fruit for health. Due to its therapeutic properties, there is a great demand for the amla. It is as well as one of the richest sources of Vitamin C. Several value added products have been reported from Amla. Drying can be used as a means of increasing product stability and increasing ease of distribution and storage of this product and products derived from it. Freeze-drying is a technique that results in high-quality dehydrated products due to the absence of liquid water and the low temperatures required in the process. Use of a cabinet dryer is an alternative drying method that both decreases the drying time and improves the quality of the final product. The present work was undertaken to get good quality of amla powder by comparing the drying techniques of freeze dryer and cross flow dryer. Work were carried to produce amla powder by using amla juice but in this study instead of drying amla juice, directly amla chunks/ segments were used to produce powder. For easier consumer consumption and longer shelf life, amla can be dried and powdered. The powdered amla can be packed and can be used for longer days, mostly during the periods when the availability of amla fruits are less.

Keywords: *Amla, Freeze Drying, cross flow dryer and shelf life.*

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1. INTRODUCTION

Amla is one of the oldest Indian fruits and considered as "Wonder fruit for health**"** because of its unique qualities**.** It is a rich source of vitamin C and hence, its content of ascorbic acid. The indigenous fruit has extensive adaptability to grow in diverse climatic and soil conditions. The tree belonging to the family of *Euphorbiaceae* is botanically known as *Emblica phyllanthus or Emblica officinalis.* It is called by different names like Anola, Amalaki, Nelli, Indian gooseberry etc. Due to its therapeutic properties, there is a great demand for the amla fruit. They are useful in curing many diseases like, diabetes, cough, asthma, bronchitis, headache, ophthalmic disorders etc. It is used in making pickles and preserves (Kalra, 1988). The fruit is used as a major constituent in several Ayurvedic preparations such as Chyavanprash and Rasayana which promotes health and longevity (Rajkumar et al., 2001). In addition to this, potent antioxidant, several active tannoid principles (Emblicannin A, Emblicannin B, Punigluconin and Pedunculagin) have been identified which appear to account for its health benefits (Rastogi 1993; Rao et al., 1985).

Several value added products have been reported. Amla was used to prepare ready-to-serve beverage (Deka et al., 2001), candy, powder (Tripathi et al., 1988), sauce (Chauhan et al., 2005) etc. Indian gooseberry is a seasonal fruit and thus, various preservation techniques have been developed such as freezing, and pickling with salt, oil and spices, and drying (natural sun drying is widely practiced in most tropical countries).

Food drying is one of the oldest methods for preservation of food for later use. Drying of food sample is safe and easy to conduct. Drying removes the moisture from the food so bacteria, Yeast, and Mold cannot grow and spoil the food. It removes moisture, the food become lighter in weight, when the food is ready for use; the water is added back and food retain its original shape. There are three techniques for foods drying are commonly used such as sun drying, oven drying and freeze drying. First, the drying process is done to force out the moisture from food. Secondly, dry air to absorb the released moisture and finally the air movement to carry out the moisture away from the food. The freeze dried product should be passing through all the three stages which are freezing process, primary and secondary drying process. Freeze-drying is a technique that results in high-quality dehydrated products due to the absence of liquid water and the low temperatures required in the process. The solid state of water during freeze-drying protects the primary structure and minimizes changes in the shape of the product, with minimal reduction of volume (Ratti, 2001). The drying process may alter these properties, resulting in products with modified texture, optical, thermal and nutritional properties (Krokida, 2001).

Use of a cabinet dryer is an alternative drying method that both decreases the drying time and improves the quality of the final product. It is known that the drying conditions and also the sample geometry affect the quality of the dried product (Krokida, 2001).

Amla powder is prepared by using freeze drying to avoid nutrition loss compare to other normal drying method. The present work was undertaken to get good quality of amla powder by comparing the drying techniques of freeze dryer and cross flow dryer, to study the nutritional/quality parameters of powder, to find out best drying method regarding retention of quality. Work was carried to produce amla powder by using amla chunks/ segments. The powdered amla can be packed and can be used for longer days, mostly during the periods when the availability of amla fruits are less.

2. MATERIALS AND METHODS

Fresh amla were purchased from the local market. The fruits were selected manually according to their appearance.

2.1 Preparation of Amla for Drying

Sorting of fruits were done. Spoiled amla were discarded as they would give off-flavor to the whole batch. Beside they can lead to loss of nutrients too. Amla fruits were washed thoroughly three to four times to remove all the adhering dust particles. The fruits were then blanched at 80^0C for 2 mins for inactivation of enzyme and to retain color of the final product. They were then taken in to muslin cloth and kept for 2 mins in boiling water and this process is known as Hot water Blanching. They were then deseeded and cut into small segments of thickness 0.5cm to 1cm.

Two types of dryer were used namely Cabinet Dryer and Freeze Dryer. Cabinet dryer is also known as Cross flow dryer. The amla pieces were loaded on the trays and spread as thin layers in each tray and were placed on the tray holder inside the drying chamber and then appropriate experimental conditions (Air, Velocity and Temperature) were optimized and imposed. The air was heated to the required temperature in this region then distributed, side to side or bottom to top in a circular motion, according to specific drying requirement. After each 30 mins the sample was taken out and then weighed and experiments were repeated till constant weight was obtained for three temperatures (55°C, 60°C and 70C°)

Freeze-drying also known as lyophilisation, lyophilization, or cryodesiccation**,** is a dehydration process typically used to preserve a perishable material or make the material more convenient for transport. The amla pieces were loaded on the trays and spread as thin layer in each tray and were placed on the tray holders inside the drying chamber and then appropriate experimental conditions (Vacuum and Temperature) were maintained and experiments were conducted at temperatures (-40°C). During the primary drying phase, the pressure was lowered (to the range of a few mill bars), and enough heat was supplied to the material for the water to sublime. In this initial drying phase, about 95% of the water in the material was sublimated. This phase may be slow (can be several days in the industry), because, if too much heat is added, the material's structure could be altered. In this phase, pressure was controlled through the application of partial vacuum. The vacuum speeds up the sublimation, making it useful as a deliberate drying process. Furthermore, a cold condenser chamber and/or condenser plates provide a surface(s) for the water vapour to re-solidify on. Condenser temperatures were typically below −50 °C (−60 °F). It is important to note that, in this range of pressure, the heat is brought mainly by conduction or radiation; the convection effect is negligible, due to the low air density. The secondary drying phase aimed to remove unfrozen water molecules, since the ice was removed in the primary drying phase. This part of the freeze-drying process was governed by the material's adsorption isotherms. In this phase, the temperature was raised higher than in the primary drying phase, and was even above 40 °C, to break any physicochemical interactions that had formed between the water molecules and the frozen material. The pressure was also lowered in this stage to encourage desorption (typically in the range of microbars, or fractions of a Pascal). After the completion of freeze-drying process, the vacuum was usually broken with an inert gas, such as nitrogen, before the material was sealed.

2.2 Design of Experiment

The study on amla powder was designed by adopting the following independent and dependent variable.

2.2.1 Independent variable

The following independent variable and their levels were selected for the study:

2.2.1.1 Temperature

This is very important factor responsible for drying of any food sample. The different temperature used for drying of amla were 55°C , 60°C, 70°C and for freeze drying -40°C.

2.2.1.2 Air Velocity

The air velocity selected for cross flow dryer were 0.08 m/sec.

2.2.1.3 Thickness

The thickness selected for preparation of amla chunks were 0.5cm, 0.75cm and 1cm at 55°C, 60°C and 70°C respectively.

2.2.2 Dependent Variable

The effect of the various independent variable like drying temperature, air velocity and thickness were studied for the following dependent variable:

2.2.2.1 Quality Parameter

The following quality parameters were analyzed for the fresh and dried amla powder to understand the effect of drying on the quality of amla powder.

2.2.2.2 Average Solubility

The average solubility times were determined by adding 2g of the powder to 50 ml of distilled water at room temperature. The sample was stirred vigorously and the time required for the powder to dissolve completely was recorded.

2.3 Ascorbic Acid content

5 ml of standard ascorbic acid solution was taken and 5 ml of HPO_3 was added. Then the micro burette was filled with with dye. Titration was done with dye solution to a pink color which would persist for 15 sec. leading to a determination of the dye factor that is mg of ascorbic acid per ml of the dye. An aliquot of 10 ml of HPO_3 extract of the sample was taken and titrated with the standard dye to get a pink end point which would persist for at least 15 sec. Then it was titrated rapidly and a preliminary determination of titer was made. In the next determination, most of the dye required was added and then titrated accurately. The aliquot of sample taken was such that the titre would not exceed 3-5 ml.

$$\text{Ascorbic Acid} = \frac{\text{Titrate value} \times \text{dye factor} \times \text{Volume made up}}{\text{Aliquot extract taken} \times \text{weight of sample taken}} \times 100$$

2.4 Total Sugar and Reducing Sugar

5 g of sample was taken in to a beaker and 100 ml of warm water was added. The solution was stirred until all the soluble matters were dissolved and filtered through wattman filter paper into a 250 ml volumetric flask. Pipetted 100 ml of the solution prepared in to a conical flask, added 10 ml of the diluted HCl solution and boiled for 5 mins. On cooling, neutralized the solution to phenolphthalein with 10% NaOH and made up to volume in a 250 volumetric flask. This solution was used for titration against Fehling's solution and reading was calculated.

2.5 Total Phenolic Contents

The total phenolic content of the sample were determined by the Folin-Ciocalteau method with some modifications (Amin et.al.2006). 5g per 50 ml of sample was filtered with whatmann filter paper no.1. 0.5 ml of the sample was added to 2.5 ml of 0.2 N Folin-Ciocalteau reagents and placed for 5 mins. 2 ml of 75 g/L of Na2CO3 were then added and the total volume made up to 25 ml using distilled water. The above solution was then kept for incubation at room temperature for 2 hrs. Absorbance was measured at 765 nm against a blank methanol sample using 1 cm curette in Spectrophotometer.

2.6 Wettability

The wettability of the powders was determined by measuring the time for completely wetting 10g of sample placed around a beaker of 250ml containing 100ml of distilled water (at 25 °C).

2.7 Bulk Density

For the determination of bulk density, 20g of powder was gently loaded into a 100ml graduated cylinder. The measured volume was used to calculate the bulk density (ρ bulk) according to the relationship: mass/volume the bulk density was determined.

3. RESULTS AND DISCUSSIONS

Physical properties of local variety of Amla fruits is given in **Table 1**. The significant difference ($p < 0.05$) was observed. Juice yield was found to be significantly ($p< 0.05$) higher in local variety (46.83%). The total phenolic contents were found to be 26.5g/100g of gallic acid equivalent (dwb) **(Table 1)**. The total phenolic contents found in the juice and residue (left after extraction of juice) was also moderately high. The juices had total phenolic concentrations in the range of 143.8 mg/100g of juice (fwb). The phenolic contents in juices are low compared to fruits due to loss of phenolics during squeezing process. Another reason may be that polyphenols are involved in specific physicochemical interactions with the solid part of the fruits, especially the cell wall material (Ranaurd et al., 2001). This was reconfirmed by the polyphenolic estimation of residue of juice. Kaur and Kapoor (2002) reported more than 70% antioxidant activities as percentage inhibition of oxidation in Amla fruits which was correlated positively with total phenols. The total soluble solids in juice prepared from cultivated variety (9.3 °Brix) of amla were also lower than that of wild variety (13.1 °Brix).

3.1 Effect of Drying Methods on the Quality of Powder

Chemical Properties of amla powder were discussed in given **(Table 2)**. Local variety was used to prepare the powder. Powder yield varied with type of drying method as sun drying (12.36%), cabinet drying (9.69%) and freeze drying (2.26%). Significant differences ($p< 0.05$) were observed in L*, a*, b* values of the samples **(Table 3)**. Freeze dried sample was found lighter in color as compared to other powder samples, whereas the sun dried sample was found to be darkest in color which was observed by higher L* value in freeze dried (63.58) and lower L* value in sun dried (43.65) samples. On the basis of L*, a*, b* color values, the freeze dried sample was considered better in terms of color values followed by cabinet dried.

Table -1: Chemical Properties of Amla (n=3).

Particular	**Wild Variety**
Ascorbic acid (g/100 g)	536.0 ± 7.81
TSS (0 Brix)	9.31 ± 0.26
Total phenols in residue (g/100g, dwb)	10.58 ± 0.42
Total phenols in juice (mg/100 gm, fwb)	143.8 ± 4.65
Total phenols in fresh Amla (g/100g, dwb)	26.5 ±0.28

Values in same row with different superscripts differ significantly ($p < 0.05$) and they are represented as mean±SD.

Table -2: Chemical Properties of Amla powder

Drying Method	Total Sugar Content (%)	Total Reducing Sugar (%)	Total Phenolic Content	Ascorbic Acid Content	Solubility (Seconds)	Wettability (Seconds)	Bulk Density (g/ml)
Freeze dried (-40°C)	5.02 ±0.023	4.83± 0.075	10.9 ±0.23	560 ±6.83	73	195	0.113
Sun dried	4.98 ±0.053	4.78± 0.062	3.52 ±0.35	428 ±9.43	92	194	0.83
Cabinet dried at 55^0C	5.01 ±0.025	4.82± 0.057	4.0± 0.25	463 ±5.89	98	193	0.65
Cabinet dried at 60^0C	4.98 ±0.046	4.82± 0.036	3.85 ±0.27	425 ±5.64	93	230	0.48
Cabinet dried at 70^0C	5.0± 0.034	4.81± 0.053	3.56 ±0.23	390 ±6.32	85	270	0.33

Values in same row with different superscripts differ significantly ($p < 0.05$) and they are represented as mean±SD.

Table -3: Color profile of Amla powder

Drying Method	L*	a*	b*
Freeze dried	63.58	-0.48	15.29
Sun dried	43.65	1.68	13.68
Cabinet dried at 55^0C	58.63	1.67	16.39
Cabinet dried at 60^0C	58.42	1.35	14.28
Cabinet dried at 70^0C	56.35	1.39	13.62

4. CONCLUSION

The comparative studies on amla powder by using freeze drying process and cabinet drying process was taken up and its effect on nutritive value was studied under varying temperatures of 55°C, 60°C, 70°C and -40°C. It was found that moisture content decreased continuously throughout the drying period. Quality parameters of prepared amla powder under different temperatures were evaluated by studying the quality parameter. It is observed that freeze dried sample at -40°C retained maximum ascorbic acid, Total Sugar content, Total reducing Sugar content, Total Phenolic Content than Cross flow drier at 55°C,60°C,70°C. From the results, it may be concluded that the amla powder prepared from freeze drying has better chemical compositions than amla powder prepared from cabinet dryer, dried at 55°C,60°C,70°C. The powder developed from this variety showed better retention of nutrients and colour in the case of freeze dried samples followed by Cabinet dried.

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