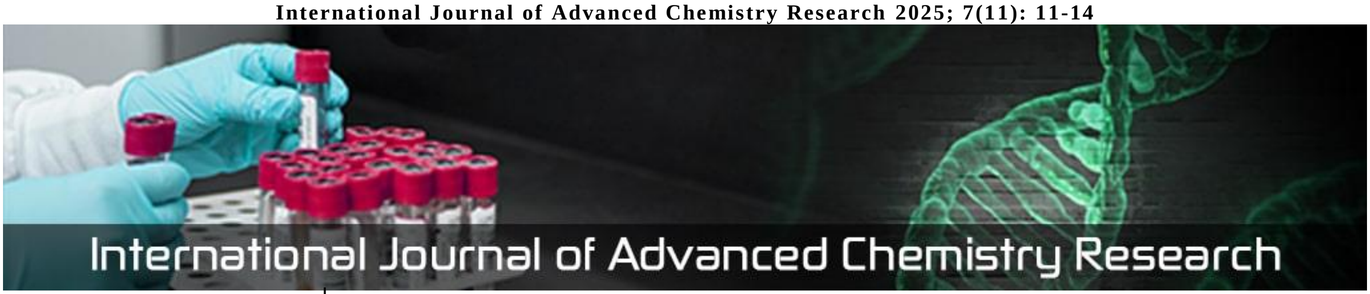

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Vedantam Sai Krishna
Assistant Professor,
Department of Agricultural Engineering, Aditya University, Surampalem, Andhra Pradesh, India

Corresponding Author:
Vedantam Sai Krishna
Assistant Professor,
Department of Agricultural Engineering, Aditya University, Surampalem, Andhra Pradesh, India

Effect of pre-treatments on drying and rehydration characteristics of Amla (*Phyllanthus emblica* L.) under direct solar radiation

Vedantam Sai Krishna

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Abstract
This study investigates the effect of various pre-treatments on the drying and rehydration characteristics of Amla (*Phyllanthus emblica* L.) under open sun drying. Five treatments were studied: untreated (control), flaking, pricking, pricking with blanching, and pricking with blanching and flaking. Moisture reduction during drying and rehydration behavior were assessed. Results showed that untreated Amla required approximately 8 days to dry, while pricking reduced drying time to 42 h. Combining pricking with blanching further reduced the drying time to 29 h, while flaking alone limited drying to 12 h. The highest rehydration ratio (3.14) and coefficient of restoration (0.558) were observed for flaked samples. These findings suggest that appropriate pre-treatments can significantly improve drying efficiency and rehydration quality of Amla, thereby enhancing its potential as a value-added dried product.

Keywords: Amla, sun drying, pre-treatment, rehydration, dehydration

1. Introduction
Amla (*Phyllanthus emblica* L.), also known as Indian gooseberry or *aonla*, is valued not only as a food fruit but also for its high nutritional and medicinal value, particularly its richness in vitamin C, polyphenols, and antioxidants (Verma & Gupta, 2004; Prabhu Reshmi *et al*., 2018) [37, 34]. However, its fresh form is highly perishable, because of high moisture content, enzymatic activity, and sensitivity to microbial spoilage. To reduce post-harvest losses and extend shelf life, dehydration is often employed. Among dehydration methods, open sun drying remains widely used in many rural and low-cost settings because of its simplicity and minimal energy input. Yet it has well-known drawbacks: slow drying times, uneven drying, exposure to environmental contaminants (dust, insects), risk of quality loss (colour, flavour, nutrients), and variable final moisture content.

One route to mitigate these drawbacks is the use of pre-treatment(s) applied to the fruit before drying. Pre-treatments such as blanching (hot water or steam), pricking or piercing of the skin, slicing or flaking, use of osmotic agents or salt/citric acid, dipping in antioxidant solutions, or combinations thereof, serve multiple potential functions: (i) disruption of skin to facilitate moisture removal; (ii) inactivation of enzymes (e.g. polyphenol oxidase) that lead to browning or nutrient loss; (iii) alteration of the microstructure to reduce internal resistance to moisture movement; (iv) removal or reduction of surface waxes or cuticle barriers; (v) possibly reducing microbial load.

Several studies have demonstrated that pre-treatments significantly influence drying kinetics and rehydration properties of fruits and vegetables. Verma and Gupta reported that pre-treated Amla exhibited better rehydration ratios compared to untreated samples. Arumuganathan *et al*., 2003 [2], found that blanching improved the rehydration characteristics of mushrooms, while Walde *et al*., 2006 [3], showed that different drying methods influenced final product quality. Studies on solar drying techniques further confirm that treatments like pricking and blanching can reduce drying time and improve overall quality. Building upon these findings, the present work evaluates the impact of different pre-treatments on Amla drying efficiency and rehydration capacity.

2. Materials and Methods
2.1 Raw Material Procurement and Selection
Fresh Amla (*Phyllanthus emblica* L.) fruits were procured from the local market in Surampalem, Andhra Pradesh, India, during the peak harvest season. Only healthy, fully matured, and uniform-sized fruits without blemishes or signs of microbial spoilage were selected for experimentation. The fruits were manually sorted to remove diseased or damaged ones, ensuring uniformity in size and colour for consistent drying behaviour.

Fig 1: Fresh Amla

2.2 Cleaning and Washing
Selected fruits were thoroughly cleaned to remove adhering dust and debris. Washing was carried out with potable water to remove soil particles. To minimize enzymatic browning and microbial contamination, the fruits were dipped briefly in a reducing solution containing food-grade antimicrobial agents, following the recommendations of Beelman *et al.* (1989) [35] and Sapers *et al.* (1994) [36]. Care was taken to minimize mechanical injury to the surface to avoid excessive water uptake that could predispose the fruits to spoilage.

2.3 Pre-treatments
Five treatments were applied to evaluate the effect of different pre-processing methods on drying and rehydration characteristics.

Table 1: Pre-treatments and their actions for evaluation of different Pre-processing methods

Sl. No.	Treatments	Action
1	Control (T_1)	Whole, unprocessed Amla fruits.
2	Flaking (T_2)	Fruits were flaked into thin slices (≈ 3-5 mm thickness) using a stainless-steel knife to increase surface area for moisture evaporation.
3	Pricking (T_3)	Fruits were pricked with a sterilized stainless-steel needle to create multiple small perforations, facilitating moisture diffusion through the cuticle.
4	Blanching (T_4)	Pricked fruits were blanched in a boiling 0.1% (w/v) sodium chloride solution for 5-6 min at 95-100 °C, following the method reported by Saxena and Rai (1990).
5	Combined (T_5)	Fruits were subjected to pricking, blanched as above, and subsequently flaked into thin slices.

After pre-treatment, excess surface moisture was removed using clean muslin cloth before subjecting the fruits to sun drying.

Fig 2: Processing of Amla

2.4 Sun Drying Procedure
Open sun drying was carried out under ambient conditions typical of the tropical climate of Surampalem. The average temperature during the experimental period ranged between 30-35 °C with relatively low humidity and clear skies. The treated and untreated samples were uniformly spread on clean, food-grade trays lined with muslin cloth and placed in a well-ventilated, insect-protected drying area exposed to direct sunlight. Samples were periodically turned to ensure uniform drying and weighed at 3-hour intervals until constant weight was achieved. The total drying time for each treatment was recorded.

Fig 3: Flacking of Amla

2.5 Moisture Content Determination
Initial moisture content of fresh amla and final moisture content of dried samples were determined using the hot air oven method at 105 °C until constant weight (AOAC, 2019). Moisture reduction curves were plotted to study drying kinetics under different treatments.

3. Rehydration Studies
3.1 Rehydration Ratio (RR)
Dried samples (2 g) from each treatment were soaked in distilled water at 35 °C. At 30-minute intervals, the samples were removed, surface water blotted with absorbent paper, and weighed. The procedure was repeated until no further

weight change was observed, indicating equilibrium rehydration. The rehydration ratio was calculated using:

$$Rehydration\ ratio = \frac{Weight\ of\ rehydrated\ samples}{Weight\ of\ dehydrated\ samples}$$

Fig 4: Drying of Amla

3.2 Coefficient of Rehydration (CR)

The coefficient of rehydration, which reflects the extent of restoration of the dried sample toward its original state, was calculated using the following expression:

$$Coefficient\ of\ Rehydration = \frac{W_r}{\frac{W_d - W_u \times 100}{100 - A}}$$

Where;

- Wr = weight of rehydrated sample (g),
- Wd = weight of dried sample (g),
- Wu = moisture content of dried sample (g),
- A = weight of raw material (g).

4. Results and Discussion

The untreated control samples required nearly 8 days to reduce moisture content from 495% to 6% (db). Pricking significantly accelerated drying, reducing the drying time to 42 h, while pricking combined with blanching further reduced it to 29 h. Flaking alone reduced drying time to 12 h, and the combination of pricking, blanching, and flaking limited it to 14 h. These reductions in drying time are attributed to increased surface area and disruption of the waxy layer. Rehydration studies showed that flaked samples had the highest RR (3.14) and COR (0.558), followed by pricked + blanched + flaked samples, while untreated samples had the lowest values (RR 1.76, COR 0.315). Overall, pre-treatments significantly improved drying efficiency, colour, texture, and rehydration characteristics as shown in the fig. 5.

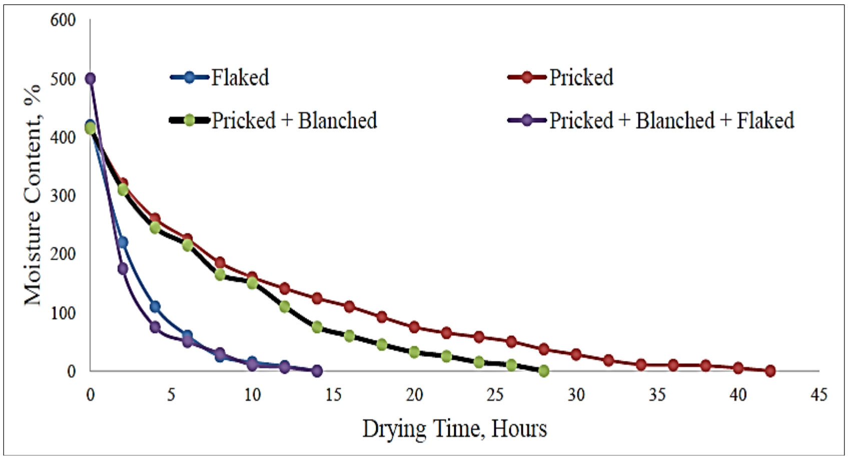

Fig 5: Variation in Moisture content with time

5. Conclusions

The study demonstrates that pre-treatments play a crucial role in improving the drying and rehydration behavior of Amla. Flaking was found to be the most effective treatment, yielding the shortest drying time and best rehydration properties. These results indicate that the adoption of pre-treatment techniques can enhance the efficiency and quality of sun drying Amla, thereby supporting its utilization in value-added food products.

References

1. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists, Washington, D.C.; 1990.
2. Arumuganathan T, *et al*. Rehydration characteristics of dehydrated mushrooms. Journal of Food Science. 2003;68(2):547-550.
3. Asenji CF. The story of West Indian cherry (*Malpighia punicifolia* L.). Boletin del Colegio de Químicos de Puerto Rico. 1953;10:8-11.
4. Barthakur N, Arnold NP. Chemical analysis of the Emblic (*Phyllanthus emblica* L.) and its potential as a food source. Sci Hort. 1991;47:99-105.
5. Chen G, Zhang M, Mujumdar AS. Dehydration of vegetables by different methods. Drying Technology. 2007;25(3):487-495.
6. Clydesdale FM, Lin YD, Francis FJ. Formation of 2-pyrrolidone-5-carboxylic acid from glutamine during processing and storage of spinach puree. J Food Sci. 1972;37:45-49.
7. Da Cunha RL, de la Cruz AG, Menegalli FC. Effects of operating conditions on the quality of mango pulp dried in a spout fluidized bed. Drying Technol. 2006;24:423-432.
8. Dubois M, Gilles K, Hamittom JK, Robers PA, Smith FA. Colorimetric method for determination of sugar. Nature. 1951;16:167-170.
9. Ghorai K, Sethi V. Varietal suitability of amla (Desi and Banarasi) fruits for storage and preservation. Ind Food Packer. 1996;50:11-18.

10. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. John Wiley and Sons, New York, USA; 1984.
11. Halpin BE, Lee CY. Effect of blanching on enzyme activity and quality changes in green peas. J Food Sci. 1987;52:1002-1006.
12. Hanif M, Rahman J, Ahmed I, Bhatty MK, Karimullah. The antioxidant factor of aonla fruit. J Res. 1966;18:61-63.
13. Kalra CL. The chemistry and technology of aonla: A resume. Ind Food Packer. 1988;42:67-82.
14. Khurdiya DS, Roy SK. Solar drying of fruits and vegetables. Ind Food Packer. 1986;40:28-39.
15. Mehta S. Evaluation of different cultivars of aonla (*Emblica officinalis* Gaertn.) for processing [MSc thesis]. Hisar: CCS HAU; 1995.
16. Mohamed S, Hussein A. Effect of pretreatments on drying characteristics of fruits. Journal of Food Engineering. 1994;21(1):123-130.
17. Murthy ZVP, Joshi D. Fluidized bed drying of aonla (*Emblica officinalis*). Drying Technol. 2009;25:883-889.
18. Pareek S, Kitinoja L. Aonla. In: Yahia EM, editor. Post Harvest Biology and Technology of Tropical and Subtropical Fruits, Vol. II. UK: Woodhead Publishing Ltd; 2011. p. 65-97.
19. Pareek S. Processing technologies of aonla. In: Peter KV, editor. Underutilized and Underexploited Horticultural Crops, Vol. II. New Delhi: New India Publishing Agency; 2009. p. 283-308.
20. Patter HE. Evaluation of Quality of Fruits and Vegetables. Westport (CT): AVI Publishing Co Inc; 1985.
21. Fennema OR. Food Chemistry. New York and Basel: Marcel Dekker Inc.; 1985.
22. Pragati, Dahiya S, Dhawan S. Effect of drying methods on nutritional composition of dehydrated aonla fruit (*Emblica officinalis* Gaertn.) during storage. Plant Foods Hum Nutr. 2003;58:1-9.
23. Ranganna S. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. New Delhi: Tata McGraw Hill Publishing Co. Ltd; 1986.
24. Vedantam SK, Sagili JL, Dikkala PK, Sridhar K. Functional, thermal, pasting, and rheological properties of gluten-free maize composite flour: Effect of moth bean flour and hydrocolloid addition. Journal of Food Processing and Preservation. 2021;45:e16104.
25. Singh PL, Ganesan S, Singh S. Drying study of amla (*Emblica officinalis* Gaertn.) in a solar tunnel dryer. Ind Food Packer. 2006;60:47-51.
26. Somogyi M. Biochemical Methods for Agricultural Sciences. New Delhi: Wiley Eastern Ltd; 1952. p. 5-6.
27. Stanislawski J. Drying of diced carrot in a combined microwave fluidized bed dryer. Drying Technol. 2005;23:1711-1721.
28. Tang J, Yang T. Food drying technology and applications. Trends in Food Science & Technology. 2004;15(1):3-9.
29. Tripathi VK, Singh MB, Singh S. Studies on comparative compositional changes in different preserved products of amla (*Emblica officinalis* Gaertn.) var. Banarasi. Ind Food Packer. 1988;42:60-65.
30. Krishna VS, Jain SK, Panwar NL, Wadhawan N. Emergence of IoT in the field of food and agricultural sector. Journal of Food Process Engineering. 2024;47(8):e14698.
31. Krishna VS, Jain SK, Panwar NL, Rama Sree. An overview on phase change material incorporated in convective solar dryers. Journal of Energy Storage. 2025;131:e14698.
32. Verma RC, Gupta AK. Effect of pre-treatments on quality of open-sun dried amla. Agricultural Engineering Journal. 1996;5:63-69.
33. Walde SG, *et al*. Drying characteristics of mushrooms by different methods. Journal of Food Engineering. 2006;74(3):354-362.
34. Prabhu Reshmi, Natarajan K, Venkatesan A. Phytochemical analysis and antioxidant potential of *Phyllanthus emblica* (L.) fruit extracts. Journal of Pharmacognosy and Phytochemistry. 2018;7(1):322-327.
35. Beelman RB, Witowski ME, Doores S, Kilara A, Kuhn GD. Acidification process technology to control thermophilic spoilage in canned mushrooms. Journal of food protection. 1989 Mar 1;52(3):178-83.
36. Sapers GM, Miller RL, Miller FC, Cooke PH, CHOI SW. Enzymatic browning control in minimally processed mushrooms. Journal of Food Science. 1994 Sep;59(5):1042-1047.
37. Verma RC, Gupta AK. Effect of pre-treatments on quality of open-sun dried amla (*Phyllanthus emblica* L.). Agricultural Engineering Journal. 1996;5:63-69.