

Design and Fabrication of Betel Nut Dryer Using Mesh System

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Abstract: The drying of betel nut is an essential post-harvesting process that directly influences its quality, shelf life, and market value. Traditional sun-drying methods are highly time-consuming, weather-dependent, and prone to contamination, while conventional solid-tray dryers restrict airflow and cause non-uniform drying. This project focuses on the design and fabrication of an improved betel nut dryer by replacing the existing tray system with a mesh-based drying arrangement to enhance airflow penetration and drying efficiency. The dryer consists of a mild steel frame, a thermally insulated chamber, stainless-steel mesh trays, fin-type electric heating coils, and an AC blower to facilitate forced convection. The mesh tray design allows hot air to pass uniformly from both top and bottom surfaces, significantly reducing drying time and improving consistency. A temperature control system ensures safe and optimized operation within the required drying range. Experimental observations confirm that the mesh system provides better moisture removal, reduced energy consumption, and improved product quality compared to traditional tray dryers.

Betel nut, commonly known as areca nut, is an important commercial crop cultivated in several tropical regions, particularly in India. It is widely used for chewing and in various traditional and commercial products. After harvesting, betel nuts contain a significant amount of moisture, which must be reduced to improve their storage life, maintain quality, and prevent the growth of mould and other microorganisms. Therefore, proper drying is an essential step in betel nut processing. Traditionally, betel nuts are dried by spreading them under direct sunlight. Although this method is economical, it has several disadvantages, including dependence on weather conditions, longer drying time, uneven moisture removal, contamination by dust and insects, and the requirement for a large drying area. These limitations highlight the need for an improved and efficient drying system.

Keywords: Betel Nut, Areca Nut Drying, Mesh System, Design and Fabrication, Moisture Content, Drying Efficiency, Heat Transfer, Agricultural Drying Technology

I. INTRODUCTION

Betel nut, or areca nut, is an important cash crop in Karnataka and other parts of India. Traditionally it is dried in the open sun, which is slow, weather-dependent, and prone to contamination by dust, insects, and moisture due to rain. These drawbacks affect the quality, shelf life, and market value of betel nut. To overcome these limitations, mechanical dryers are being adopted in the agro-processing industry. This project focuses on the Design and Fabrication of a Betel Nut Dryer Using Mesh System, where the nuts are spread on perforated mesh trays or a continuous mesh belt and dried by hot air passing upward through the mesh.

The mesh-system ensures uniform airflow, faster drying, and better hygiene compared to sun-drying. Betel nut, commonly known as areca nut, is an important commercial crop cultivated in several tropical regions, particularly in India. It is widely used for chewing and in various traditional and commercial products. After harvesting, betel nuts contain a significant amount of moisture, which must be reduced to improve their storage life, maintain quality, and prevent the growth of mould and other microorganisms. Therefore, proper drying is an essential step in betel nut



processing. Traditionally, betel nuts are dried by spreading them under direct sunlight. Although this method is economical, it has several disadvantages, including dependence on weather conditions, longer drying time, uneven moisture removal, contamination by dust and insects, and the requirement for a large drying area. These limitations highlight the need for an improved and efficient drying system.

II. LITERATURE SURVEY

Drying is one of the most important post-harvest processes used in agriculture to reduce the moisture content of agricultural products and improve their storage life. Betel nut, also known as areca nut, requires proper drying after harvesting to prevent spoilage, reduce the growth of mould, and maintain product quality. Several drying methods have been developed and used for agricultural products, including traditional sun drying, solar drying, hot-air drying, and mechanical tray drying. The selection of a suitable drying method depends on factors such as drying time, energy consumption, initial moisture content, final moisture content, cost, and the quality of the dried product. The literature on agricultural drying systems provides useful information for designing and fabricating an efficient betel nut dryer using a mesh system.

Hot-air tray dryers use a heating element and a blower to circulate warm air through the drying chamber. Multiple mesh trays allow air to pass around the betel nuts, helping to improve moisture removal and drying uniformity. Proper tray spacing and temperature control are important for achieving effective drying. The present project focuses on designing and fabricating a betel nut dryer using a mesh system. The proposed dryer aims to reduce drying time, minimize contamination, improve drying uniformity, and provide an economical drying solution for small-scale farmers.

III. PROJECT OBJECTIVES

The main objective of this project is to design and fabricate an efficient and economical betel nut dryer using a mesh system. The system aims to improve air circulation and ensure uniform drying of betel nuts while reducing drying time, contamination, and manual effort. It also focuses on reducing dependence on traditional open-sun drying and evaluating the performance of the dryer based on moisture reduction, drying efficiency, and overall drying quality.

The specific objectives are:

- To design and fabricate a low-cost betel nut drying machine using mesh trays.
- To reduce the drying time compared with traditional sun drying.
- To achieve uniform drying by providing proper hot-air circulation.
- To maintain suitable drying temperatures and improve product quality.
- To minimize contamination from dust, insects, and other environmental factors.
- To reduce manual effort and improve the efficiency of the drying process.
- To develop an energy-efficient and user-friendly system suitable for small-scale farmers.
- To evaluate the performance of the dryer based on drying time, moisture reduction, and energy consumption.

IV. SCOPE OF THE PROJECT

The scope of this project is to design and fabricate a betel nut dryer using a mesh system for efficient and uniform drying. The system aims to improve air circulation, reduce drying time, minimize contamination, and decrease dependence on traditional open-sun drying. The project also includes evaluating the drying performance based on moisture reduction, temperature, and drying efficiency. The developed dryer can be further improved for larger drying capacity, automatic temperature control, and energy-efficient operation to support farmers and small-scale agricultural industries.

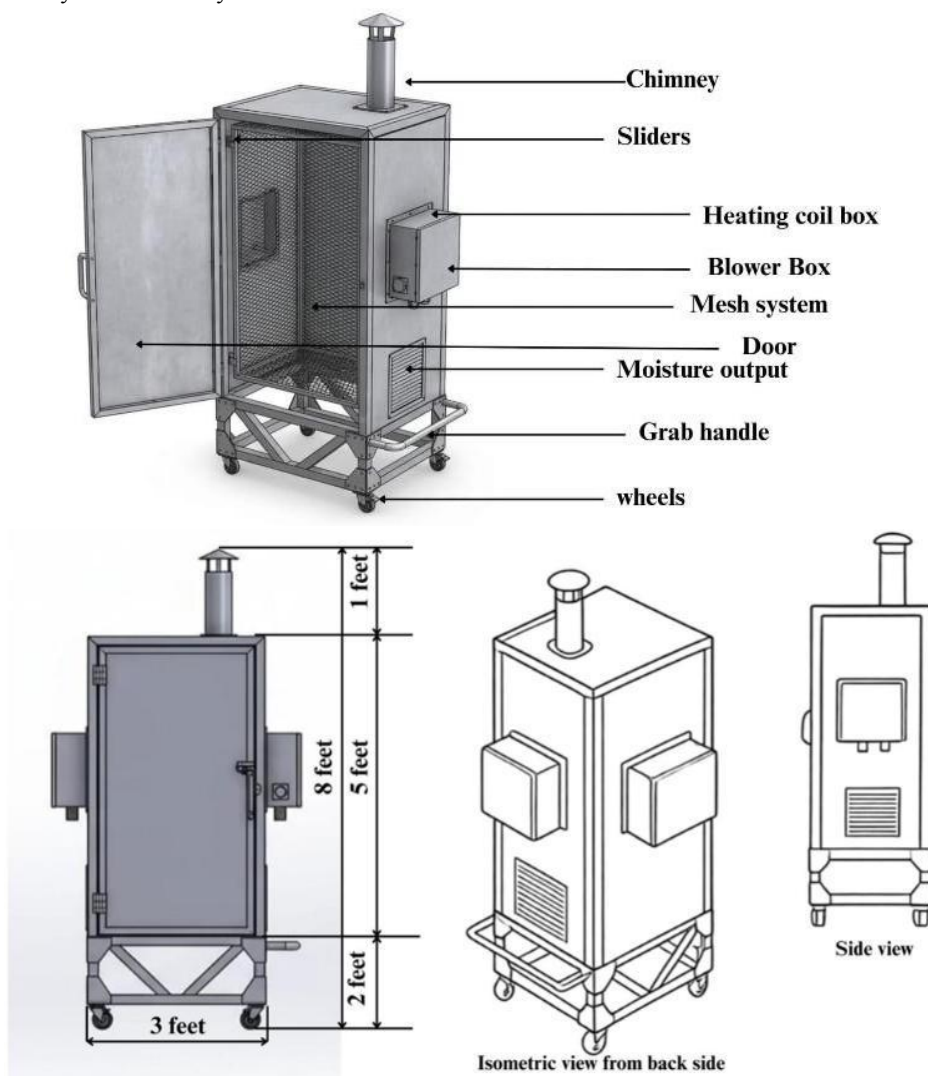
The project focuses on developing a low-cost, energy-efficient, and easy-to-operate dryer suitable for small-scale farmers and agricultural industries. The mesh trays allow hot air to circulate around the betel nuts, improving drying efficiency and reducing contamination from dust and insects. The system can also be modified to use solar energy or a combination of solar and electrical heating.



The performance of the dryer can be evaluated based on drying time, moisture reduction, energy consumption, and product quality. In the future, the system can be improved by increasing its capacity, automating temperature control, and incorporating renewable energy sources to reduce operating costs.

V. METHODOLOGY AND DESIGN

The project involves designing and fabricating a betel nut dryer using a mesh system. Suitable materials are selected to construct the frame, drying chamber, and mesh trays. A heating system and proper air circulation arrangement are provided for effective drying. Betel nuts are placed on the mesh trays, and the drying process is monitored by measuring temperature, drying time, and moisture reduction. Finally, the performance of the dryer is evaluated based on drying efficiency and uniformity.



VI. RESULTS AND DISCUSSIONS

Design Calculations for Betel Nut Dryer Using Mesh System

1. Given dimensions

- Length (L) = 8 ft
- Width (W) = 3 ft
- Height (H) = 8 ft

2. Conversion into metres

1 ft = 0.3048 m

- Length = $8 \times 0.3048 = 2.4384$ m
- Width = $3 \times 0.3048 = 0.9144$ m
- Height = $8 \times 0.3048 = 2.4384$ m

3. Area of the dryer

Formula:

$$\text{Area} = \text{Length} \times \text{Width}$$

$$= 8 \times 3$$

$$\text{Area} = 24 \text{ ft}^2 = 2.23 \text{ m}^2$$

4. Volume of the dryer

Formula:

$$\text{Volume} = \text{Length} \times \text{Width} \times \text{Height}$$

$$= 8 \times 3 \times 8$$

$$\text{Volume} = 192 \text{ ft}^3 = 5.44 \text{ m}^3$$

5. Mesh tray area

Assume 5 mesh trays, each measuring 8 ft $\times$ 3 ft. Area of one tray = $8 \times 3 = 24 \text{ ft}^2$

Total mesh area = 24×5

Total mesh area = $120 \text{ ft}^2 = 11.15 \text{ m}^2$

6. Drying capacity

Assume a loading rate of 5 kg/m². Capacity of one tray = $2.23 \times 5 = 11.15$ kg Total capacity = 11.15×5

Estimated capacity = 55.75 kg per batch

This is an illustrative estimate; actual capacity depends on the loading depth and airflow.

7. Heating power calculation

Assume 15 kg of water is removed in 8 hours. Energy required = Mass of water $\times$ Latent heat

$$= 15 \times 2400 = 36,000 \text{ kJ}$$

$$\text{Energy in kWh} = 36,000 \div 3600 = 10 \text{ kWh}$$

$$\text{Average ideal evaporation power} = 10 \div 8$$

$$\text{Ideal evaporation power} = 1.25 \text{ kW}$$

The actual heater must also account for air heating, exhaust losses, and cabinet heat losses.

8. Final design summary

Parameter	Value
Length	8 ft
Width	3 ft
Height	8 ft
Floor area	24 ft ²
Cabinet volume	192 ft ³
Number of trays (assumed)	5
Total mesh area	120 ft ²
Estimated capacity	55.75 kg/batch
Ideal evaporation power	1.25 kW



VII. CONCLUSION

The project “Design and Fabrication of Betel Nut Dryer Using Mesh System” aims to develop an efficient, economical, and user-friendly drying system for betel nuts. The proposed dryer uses multiple mesh trays, a heating arrangement, and an air circulation system to improve moisture removal and achieve uniform drying. Compared with traditional sun drying, the system can reduce exposure to dust, insects, and changing weather conditions while minimizing manual effort.

The mesh tray arrangement allows hot air to circulate around the betel nuts, improving drying efficiency and making better use of the available space. The system can be designed to operate using electrical heating, solar energy, or a combination of both, depending on the requirements. Proper temperature control and airflow distribution can help maintain product quality and reduce uneven drying.

The proposed design is suitable for small-scale farmers and agricultural processing units because it can be fabricated using readily available materials. Its performance can be evaluated based on drying time, moisture reduction, energy consumption, and the quality of the dried betel nuts. Overall, this project provides a practical approach to improving betel nut drying, reducing dependence on conventional sun drying, and supporting better post-harvest management.

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