Drying Methods for Enhancing Copra Quality in Coconuts

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Introduction

Agriculture is the largest economic sector in India. Coconut palm is one of the most flexible trees known in view of its utilization, source of food, drink and asylum. Copra is the dried meat or kernel of coconut which is the fruit of coconut palm. The production of copra by removing the shell, breaking it up and drying is usually done where the coconut palms grow. The dried coconut-copra is the main source of coconut oil. Naturally it contains 70 per cent of moisture and it is dried to about 7 per cent for production of coconut oil. The automated grading system not only speeds up the time of processing, but also minimizes the error. The task of copra grading is vital in the agricultural industry because there is great demand for high quality copra in the market. Copra can be made by smoke drying, sun drying or kiln drying. Hybrid solar drying systems can also be used for a continuous drying process (Pooja et al., 2020).

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Ball copra

For the production of ball copra, whole coconut is dried in shell for 8 to 12 months by smoke from husk and leaves, till all the coconut water dries out, and the kernel detached from shells, which can be audibly detected by shaking the dried nut. The dried nut is split carefully and the dried copra is obtained as a whole kernel in the shape of a hollow ball, which helps in getting very delicious ball copra.

For copra oil milling, two methods are usually used. Sun-drying for 4 or 5 days and covering against dew or rains at night and during rainy season, kilns are used for drying. The kiln is usually a smoke dryer.

Smallholder's Copra Dryer

- Split cups are loaded into the drying chamber at alternate orientation of layers.
- Coconut shells are used as fuel, ignited in a wire mesh tray, and maintained at a drying temperature of 70°C.

- Shells are removed after 8–10 hours, with further drying conducted after tempering to ensure uniform moisture migration.
- Final drying continues until shells are fully removed, with drying completed within 15 hours.

Shell-Fired Copra Dryer

Split cups are loaded into two chambers (1,000 cups each).

Coconut shells are arranged in one layer as fuel, ignited, and maintained over a 12-hour drying cycle.

Further drying continues in stages, reducing fuel usage after the third cycle, achieving a moisture content of 6% for safe storage.

Advanced Drying Methods

Solar Drying Unit Using GSM

The use of solar drying systems in agriculture is steadily increasing due to their practicality, cost-effectiveness, and environmentally responsible design. Solar heating systems improve product quality by reducing wastage. Drying primarily involves the removal of moisture through evaporation rather than pressure or other mechanical methods.

One major challenge faced by farmers is converting raw coconuts into copra, a process that typically takes 3 to 5 days. Additionally, fungal growth and unexpected climatic changes can compromise the quality of the copra. In response, solar drying systems designed with UV-resistant materials have proven to be efficient and time-saving. Using these systems, coconuts can be dried at a constant temperature of 60°C, reducing the drying time to just one day. However, a drawback of existing solar dryer units is the need to manually monitor temperature and humidity. If the humidity increases, a vent located at the top center of the dryer cabin must be manually opened.

Solar Coconut Dryer Unit

This system comprises of a control section and a signal-processing module. The detection section includes temperature and humidity sensors placed strategically inside the solar dryer unit. These sensors measure the temperature and humidity levels, generating analog signals that are converted into digital signals using an analog-to-digital converter. The processed data is stored in an Arduino board. The system compares the real-time temperature and humidity values with preset thresholds.

If humidity exceeds the set limit, the system sends an SMS alert to the relevant plant authority via a GSM network. Additionally, if the temperature or humidity rises beyond acceptable levels, the system triggers a relay to activate a motor that opens the exhaust vent of the solar dryer unit.

Estimation of drying efficiency

The drying efficiency of the semi-direct dryer was estimated using equation

$$\text{Thermal efficiency} = \frac{\phi\ \lambda\ (Mo- Mf)}{WC(100-Mo)} \times 100$$

Where, Mo = Initial moisture content of coconut (% wet basis), Mf = Final moisture content (% wet basis), ø – quantity of the final dried product at Mf moisture content (kg), λ = latent heat of vaporization of water in kcal/kg, W = quantity of fuel used (kg) and C = calorific value of fuel used (kcal/kg) (Source: Singh et al., 2004)

Forced Convention Solar Dryer

Mohanraj and Chandrasekar (2008) designed a forced convention solar dryer comprising a 2 m² flat plate solar air heater connected to a drying chamber. The solar air heater featured a 2 mm thick copper absorber plate coated with black paint to enhance absorption of solar radiation. The absorber plate was positioned behind a transparent glass cover, with a layer of air between them. Air to be heated passed through this space. The drying chamber was insulated with 10 mm thick glass wool, and the system was oriented southward to maximize solar radiation on the collector.

Sun Drying of Coconut

Coconut cups, with the inner surface facing the sun, are spread on black polythene sheets. Each cup has an average diameter of 10 cm. During the night or on cloudy and rainy days, the cups are covered with polyethylene sheets. Temperature sensors are installed on the drying cups' surfaces to measure their temperature. Moisture content is recorded at the beginning, morning, and evening of each day. After three days of sun drying, the shells are removed, and the kernels are spread out for further drying. By the sixth day, visual observations and moisture content measurements confirm sufficient drying. The copra is then graded according to accepted standards.

Solar Greenhouse Dryer

A solar greenhouse dryer for copra drying, designed by Ayyappan et al. (2016), evaluated the effects of concrete, rock beds, and sand on drying characteristics (moisture content and drying time) and thermal performance (efficiency, SMER, and SEC).

Energy storage using sensible heat storage

Sensible heat storage is commonly used for temperatures up to 100°C. This system is simple, cost-effective, and designed to ensure direct contact between the solid storage medium and the heat transfer fluid, minimizing operational costs. Advantages of using sensible materials for thermal storage include:

- Non-toxic and inflammable properties
- Economic feasibility
- Dual functionality as a heat transfer surface and storage medium

The heat transfer between air and the storage material is efficient due to a large heat transfer area, low effective heat conductance, and minimal contact area between materials. These factors reduce heat loss from the system. Optimal storage size depends on parameters like storage temperature, material type, heat losses, auxiliary energy costs, and ambient operating conditions (e.g., solar intensity and wind speed).

Conclusion

Aflatoxins are highly toxic and potent natural carcinogens. Compared to conventional drying methods, solar tunnel dryers offer numerous advantages despite their higher initial cost. These include shorter drying times, better-quality copra, higher market value, ease of use, reduced need for skilled labor, minimal risks during monsoons, mold-free production, and improved storage quality. ■

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