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DEVELOPMENT OF DEHYDRATED KARCHIKAI (*MOMARDICA CYMBALARIA*)

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ABSTRACT

Given its medicinal importance and the lack of commercially available preservation techniques or products, the present study aimed to standardize a drying method for *M. cymbalaria* (karchikai). The research was conducted at the Department of Postharvest Management, College of Horticulture, Bagalkot, Karnataka, during 2023-24. The study examined the drying kinetics, as well as the physico-chemical and biochemical properties of *M. cymbalaria* powder under various drying methods. The freeze-dried (D_1) samples exhibited highest drying time (64 hours), lowest moisture content (6.43%), lowest water activity (0.24), highest rehydration ratio (2.96), highest wettability time (46.40 seconds) and the highest ascorbic acid content (265.43 mg/100g).
***Keywords* :** Karchikai (*M. cymbalaria*), Drying kinetics, Physico-chemical properties

Introduction

Momordica cymbalaria, is also referred to as *Momordica tuberosa* Roxb. or *Luffa tuberosa* Roxb. (Prashanth *et al*., 2013). It is commonly known as Karchikai in Kannada, Athalakkai in Tamil and Kasarakayee in Telugu. This plant is native to the tropical regions of India and Southeast Asia (Jeyadevi *et al*., 2012).

M. cymbalaria grows as a weed in the South Indian states of Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra and Tamil Nadu. It is allowed to grow along field boundaries, fences and within fields for its fruit, although it is not regularly cultivated. The plant has a tuberous root that supports its perennial nature; the above-ground parts die at the end of the season, while the tubers remain in the soil and sprout again in the next season.

This plant exhibits several pharmacological properties, including anti-cancer, anticonvulsant, anti-inflammatory, anti-ovulatory, abortifacient, antimicrobial and antioxidant activities. It also has anti-diabetic, hypolipidemic, anti-diarrheal, anti-ulcer and protective effects (Gopalasatheeskumar, 2018). The bioactive compounds responsible for these therapeutic properties in *M. cymbalaria* include phenolic acids, flavonoids, carotenoids, cucurbitane triterpenoids, saponins and phytosterols (Jha *et al.*, 2018).

M. cymbalaria is not commercially cultivated owing to its inherent problems which restricts it's availability to three to four months. Hence, preservation of karchikai and development of its dehydrated products has got immense scope owing to it's medicinal and nutritional importance. Hence, the present study was carried out with the following objective to standardise of drying method for karchikai (*M. cymbalaria*)

Materials and Methods

Procurement of raw material

Matured green karchikai (*M. cymbalaria*) fruits were purchased from the market in octomber 2023 at Bagalkot, Karnatakaand washed with clean water to remove any unwanted substances on their surfaces. The whole fruits blanched in water (80°C) for 3 minutes, followed by draining and air-drying. Subsequently, the fruits were subjected drying using freeze dryer, fruit and vegetable dryer (CAZRI, Jodhpur), cabinet dryer and solar tunnel dryer.

The completely dried samples were pulverized in to fine powder using electronic grinder and care was taken to keep the jar temperature cool by keeping it repeatedly in freezer. The powdered samples were sieved using (10 mm mesh size) to get uniform size particles. The powder thus obtained was packed in polythene cover, sealed and kept in cold storage (4-5°C) and analyzed for biochemical properties.

Drying kinetics

A first order kinetic model describing the moisture transfer during drying is considered:

$$dx/dt = k(X - X_e)$$

Where, X is the material moisture content (dry basis) during drying (kg water/kg dry solids), X_e, is the equilibrium moisture content of dehydrated material (kg water/kg dry solids), k is the drying rate (min^{-1}) and t is the time of drying (min). The drying rate was determined as the slope of the falling rate-drying curve (Krokida *et al.*, 2003).

Physico-chemical parameters

Moisture content (%)

The moisture content of dehydrated karchikai (*M. cymbalaria*) was assessed using a Radwag moisture analyzer (Model: MAC 50, Made in Poland). Two grams of the dried sample were placed in the sample dish. The analyzer signalled the endpoint of measurement with a beep sound and the resulting constant value for moisture was then recorded.

Water activity (a_w)

The water activity of the dried karchikai (*M. cymbalaria*) powder was assessed using a Labswift-aw water activity meter (Novasina). A small amount of the powder was placed in the sample holder up to the designated mark, and then inserted into the meter, ensuring the sample did not contact the sensor on the lid. The process concluded with three beeps, and the water activity value was shown digitally and recorded (Abbey and Ibeh, 1998).

Rehydration ratio

Five grams of dehydrated karchikai (*M. cymbalaria*) powder were placed in a beaker, and 50 ml of distilled water was added to the beaker at room temperature (Sacilik *et al.,* 2006). The weight of the rehydrating sample was measured at intervals of 0.5, 1, 2, 3, 4 and 5 hours until the sample reached a constant weight. Subsequently, the rehydrated material was drained, blotted with filter paper, and weighed. Rehydration ratio of the samples was calculated using the following formula.

$$\text{Rehydration ratio} = \frac{\text{Weight of the rehydrated sample}}{\text{Weight of the dehydrated sample}}$$

Wettability (s)

Wettability was assessed following the procedure outlined by Vissotto *et al.,* 2010. The time taken for 1g of powder placed on the liquid surface to become fully submerged in 400 mL of distilled water at 25°C was measured and recorded in seconds.

Phyto-chemical

Ascorbic acid (mg/100 g)

The ascorbic acid content of the dried karchikai (*M. cymbalaria*) samples was determined through titration using 2,6-dichlorophenol indophenol dye, following the AOAC method (Sadasivam and Manickam, 1992).

$$\text{Ascorbic acid (mg/100g)} = \frac{0.5 \times \text{Titre value of the sample} \times 100}{\text{Titre value of the standard solution} \times 5 \times \text{Weight of sample (g)}}$$

Results and Discussion

Drying kinetics

The drying kinetics of *M. cymbalaria* fruit was used to analyze the drying behaviour of *M. cymbalaria* fruit is presented in Fig 1. It can be noticed that there was a continuous decline in moisture ratio over the time, without 'constant rate' phase. As a result, the entire drying process occurred during the falling rate period and the steady reduction in moisture ratio indicated that mass transfer was controlled by diffusion.

Significantly highest drying time (64 hrs) was recorded in samples using freeze dryer (D_1) followed by samples dried using solar tunnel dryer (D_4) with (48 hrs). Significantly lowest drying time was recorded in samples dried using cabinet dryer (D_3) with (40 hrs).

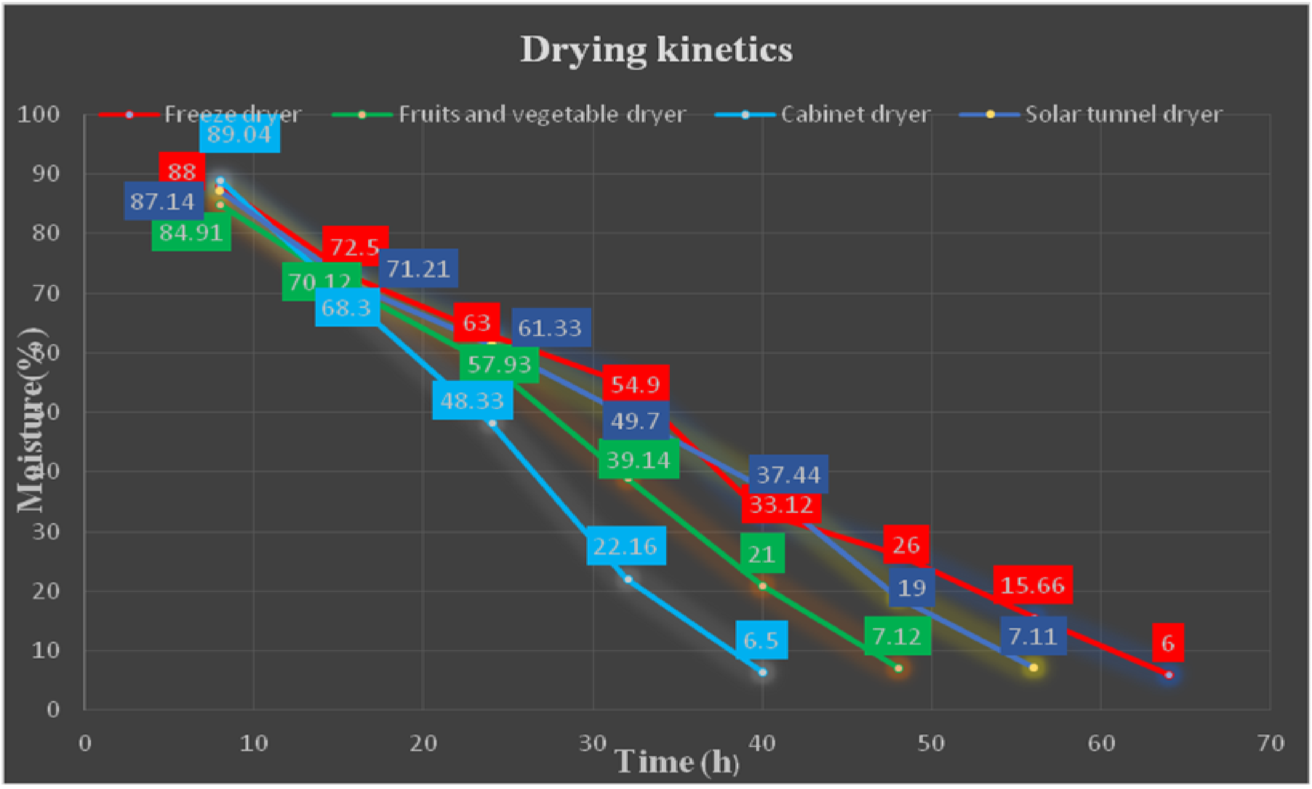

Fig. 1: Drying kinetics of *M. cymbalaria* fruit for different drying methods

The fruits of *M. cymbalaria* dried using a cabinet dryer and a fruit and vegetable dryer (CAZRI) exhibited a steeper falling rate compared to freeze-drying (Figure 1). This suggests that higher drying temperatures accelerated the falling rate period. Drying with its elevated temperatures, lead to faster moisture evaporation, whereas freeze-drying, which relies on sublimation at lower temperatures, resulted in a slower decrease in moisture. A similar observation was made by Osae *et al.* (2020) for drying of ginger slices using freeze, infrared, microwave and convective dryer with relative humidity control.

Moisture content (%)

Moisture affects physical properties of dehydrated powders and cause clumping or solidify. Significantly lowest moisture content of 6.43 per cent was recorded in freeze dried samples (D_1) followed by samples dried using cabinet dryer (D_3) with 7.33 per cent, whereas highest moisture content of 9.25 per cent was recorded in samples dried using fruit and vegetable dryer developed by (CAZRI- D_2). As freeze-drying operates on the principle of sublimation of water, the products were dried to lower moisture levels because of sub atmospheric drying conditions prevailed in the drying system. Further the moisture in the air decides the extent to which a produce can be dried.

Water activity (a_w)

The measured water activity (a_w) values in the samples studied in the present study revealed that the drying methods significantly influenced the a_w of dehydrated *M. cymbalaria* fruit powder. The freeze-dried samples recorded lowest water activity among all the samples. This might be due to low pressure and drying temperatures, which might have helped to prevent thermal and enzymatic degradation of the final product. A similar trend was noted in dehydration of Moringa seeds by Alicia *et al.* (2019) and Silva *et al.* (2019). Highest water activity of 0.34, was observed in the solar tunnel-dried samples, which is in consistent with studies conducted by Quek *et al.* (2007) and Tonon *et al.* (2010) in watermelon and acai powders.

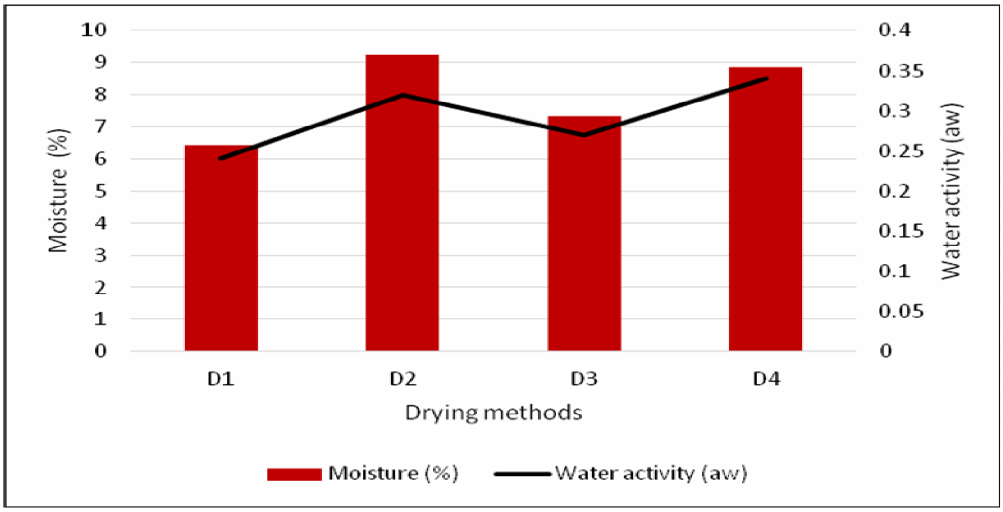

Fig. 2: Effect of different drying methods on moisture content and water activity of dehydrated Karchikai (*M. cymbalaria)* fruit powder

Rehydration ratio

The rehydration ratio serves as an essential quality parameter for dried foods, indicating their capacity to rehydrate quickly and thoroughly (Velic *et al*., 2004). Depending on the methods, the rehydration ratio of dehydrated *M. cymbalaria* powder ranged from 1.99 to 2.96, with freeze drying showing the highest rehydration ratio of 2.96, demonstrating its superior rehydration capacity. The wide variation in the rehydration ratio observed in the current study might be attributed to the established facts about freeze drying which can cause reduced cell damage, shrinkage, solute migration, loss of osmotic balance and changes in cell wall permeability as the products loose moisture showing less resistance (Aparna *et al*., 2021). This confirms that freeze dried samples are capable of preserving higher rehydration ratio compared to other methods of drying.

Wettability (s)

Wettability refers to a powders ability to absorb water on its surface, influencing whether particles of varying sizes and shapes will float or sink in food powders. Significant differences in the wettability of dehydrated *M. cymbalaria* powder were noticed among the samples dried using different drying methods. The freeze-dried samples required the shortest wetting time (46.40 s), while the solar tunnel dried samples required the longest time to wet (77.76 s). This variation could be attributed to differences in factors such as molecular polarity, heterogeneity, contact surface area and porosity.

Table 2: Effect of different drying methods on rehydration ratio, wettability and ascorbic acid of dehydrated karchikai (*M. cymbalaria)* fruit powder

Treatment	Rehydration ratio	Wettability (s)	Ascorbic acid (mg/100g)
D_1: Freeze dryer	2.96 ^{a}	46.40^d	265.43^a
D_2: Fruit and vegetable dryer (CAZRI, Jodhpur)	1.99^d	56.48^b	234.38^c
D_3: Cabinet dryer	2.75^b	51.34^c	250.00^b
D_4: Solar tunnel dryer	2.46^c	72.76^a	217.19^d
Mean	**2.54**	**56.74**	**279.24**
S.Em ±	0.003	0.329	10.880
CD at 1%	0.011	1.360	44.941

Ascorbic acid (mg/100g)

Ascorbic acid content of dehydrated *M. cymbalaria* powder was significantly influenced by the drying methods used. Ascorbic acid is a key nutritive component of processed foods and is particularly unstable during heat treatment. The extent of ascorbic acid loss during drying depends on the product's physical properties and the drying process employed (Goula and Adamopoulos, 2010). The ascorbic acid content in *M. cymbalaria* powder varied significantly across different drying methods. Samples dried using freeze dryer retained 1.82 times higher compared to cabinet drying. Retention of higher ascorbic acid might be due to the freeze-drying conditions where product loose moisture at very low temperature and without much resistance for escape of moisture (Negi and Roy, 2000). The lowest ascorbic acid content was recorded in the solar tunnel-dried samples with 217.19 mg/100g. Reduction in ascorbic acid might be attributed to thermal and photo-oxidative reactions, as ascorbic acid is sensitive to temperature (Roshanak *et al.,* 2016).

Conclusion

From the present study, it would be concluded that dehydrated *M. cymbalaria* fruit powder obtained from freeze dryer (D_1) recorded was found to be superior with respect to physicochemical and biochemical properties.

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