

# Influence of fluidised bed drying on the quality and storage of *Murraya koenigii* leaves

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## Abstract

In the present investigation, the effect of drying temperature and air velocity on the quality of *Murraya koenigii* leaves was studied. Freshly harvested, washed and stripped *M. koenigii* leaf (curry leaf) was dried at different air temperature of 40, 45 and 50 °C temperature and at 2, 3 and 4 m/s air velocity in a fluidised bed dryer from an initial moisture content of 184.5 % (dry basis) to a final moisture of around 5% (dry basis). The drying rate decreased with the decrease in the moisture content at all drying temperatures. Drying studies revealed that fluidised bed drying at 45 °C and 4 m/s air velocity was found to maintain the quality of dried curry leaf in terms of rehydration ratio and volatile oil content. The dried leaves packed in 38 micron thickness and stored under ambient condition (30±2 °C) for a period of one month resulted in better product as seen from the volatile oil content and overall acceptability for 4m/s fluidised bed dried sample at 45 °C.

**Key words:** Curry leaf, drying, temperature, air velocity, rehydration ratio, volatile oil

## Introduction

Curry leaf, *Murraya koenigii* (L.) Spreng of the family Rutaceae, is a spicy leafy vegetable used in Asian Indian cuisine. It is commonly found in forests, often as a gregarious growth along the foot of the Himalayas up to Sikkim and Assam. It is also found in West Bengal, Madhya Pradesh and in the South and South Western states, namely, Maharashtra, Tamil Nadu, Kerala and Andhra Pradesh (Bhattacharjee, 2004). Throughout India, it is much cultivated for its aromatic leaves and for ornamental value. It is also found in cultivation in Sri Lanka, Burma, Indo-China, South China and Hawaii and cultivated on a commercial scale in large areas in Tamil Nadu, Andhra Pradesh and Karnataka. Fresh curry leaves on steam distillation yield 2.5% volatile oil, which is used as a fixative in soap industry (Lathan Kumar *et al.*, 2003). The leaves are preserved dried for long term storage (Usha *et al.*, 2002). The dried leaves are being exported and also used as an ingredient in masala industries.

Drying is commonly employed in preparing spices for market, as some spices contain up to 75-80% water, and water levels need to be lowered to less than 15% (Conseulo *et al.*, 2002). Drying regimes for aromatic crops must allow the retention of flavor, color and aroma. The removal of water greatly restricts the ability of microorganisms to flourish; hence the keeping quality is improved (Deans and Svoboda, 1992). A suitable method of drying with retention of flavor is required for export of leafy spices (Omanakutty *et al.*, 1984). The preservation of fruits and vegetables through drying dates back many centuries and is based on sun and solar drying techniques. The poor quality and product contamination lead to the development of alternate drying technologies. The present system of drying *Murraya koenigii* leaves (curry leaf) is under sun or shade where the quality of the end product is inferior. The present study was taken up to dry curry leaves in a mechanical dryer under optimized condition for better quality retention of the leaves.

## Materials and methods

**Raw material:** Freshly harvested curry leaf of local cultivar, “Senkaambu” was procured from the experimental farm of Tamil Nadu Agricultural University, Coimbatore to conduct drying studies. The leaves were first washed in water. The leaflets were then separated from the petiole. About 50 g of the sample was taken for each trial during drying.

**Drying experiment:** Fresh curry leaf samples were dried in a laboratory model fluidised bed dryer consisting of a fluidising chamber, a built in type blower run by an electric motor. The outlet of the blower is provided with heater to heat the air entering into the dryer. The hot air enters into the fluidizing chamber from the bottom. A wire mesh is fixed at the bottom of the chamber to hold the material for drying. A removable wire mesh is fixed at the top to prevent the material escaping along with the air during drying. There are two temperature sensors in the inlet and outlet and a timer to put the unit to off at desired set time.

The washed and stripped fresh curry leaves were subjected to drying at different air temperature of 40, 45 and 50 °C and air velocities of 2, 3 and 4 m/s, respectively. The weight of the sample during drying was recorded periodically at hourly interval using a top pan balance having a least count of 0.001 mg. The samples were dried to moisture content of about 5 % (dry basis) approximately. The experiment was replicated three times.

**Quality analysis and storage:** Moisture content of fresh curry leaf was estimated by drying the leaves in hot air oven at 60 °C till constant weight was achieved. The volatile oil content of the dried samples was estimated by Clevenger distillation method. Dried curry leaf samples were packaged in polyethylene bag of 38 micron thickness and stored under ambient condition (30±2 °C) for a period of one month. The changes in the color and volatile oil content of the samples were recorded at the end of storage.

**Rehydration ratio:** Initial trials were carried out to standardize

the rehydration time of dried curry leaf. There was no weight gain of the samples after 15 minutes time. About 5 g of dried curry leaf samples were dipped in boiling water (98 °C) for 15 minutes. The excess moisture was removed through Watman No. 4 filter paper. The samples were then weighed. The Rehydration Ratio (RR) was computed using the following equation (Ranganna, 1986)

$RR = WR / WD$ . Where, RR= Rehydration Ratio; WR= Weight of rehydrated curry leaf (g); WD= Weight of dehydrated curry leaf (g)

**Statistical Analysis:** Data was statistically analysed as per the procedure of two way ANOVA using computer software AGRES to compare among different treatments at 5% probability. The treatments were replicated three times.

## Results and discussion

**Fluidised bed drying characteristics:** The moisture content of the curry leaf decreased with drying time irrespective of the drying temperature and air velocity. The drying time from initial moisture content of 184.5% (dry basis) to the final moisture content 2.4 to 5.2 % (dry basis) varied from 40 to 100 min, generally decreasing with increase in drying air temperature and air velocity (Fig.1). The moisture-time relationship was found to be non-linear, the decrease in moisture being larger initially as compared to the later part of drying. The drying rate decreased with the decrease in the moisture content at all drying temperatures. Drying at 40 °C took longer time to reach the required final moisture content. Similar result was observed for garlic drying (Ambrose and Sreenarayanan, 1998). Among the dried samples, curry leaf dried at low temperature of 40 °C at different air velocities was most unstable with respect to its keeping quality, since they were infested with fungus after a week and therefore considered to be undesirable. This may be due the fact that if the temperature is low in the beginning, microorganisms may survive and even grow before the food is adequately dried (Kendall *et al.*, 2004). With the increase in drying air temperature, higher amount of moisture was removed resulting in lesser time for drying. This may be due to the fact that the moisture diffusivity increases with increase in drying air temperature (Islam *et al.*, 2012). Drying was faster at 50 °C temperature at different air velocity. However, considering the quality of the end product, drying at 45 °C at 4m/s air velocity was found to be the optimum.

**Volatile oil and rehydration ratio of dried curry leaf:** The effect of drying at different temperature and air velocity on the volatile oil and rehydration ratio of the samples is presented in Table 1. The volatile oil content influences the flavor characteristics of curry leaf. At 50 °C temperature, the loss of volatile oil was greater at all the different drying air velocities. Similarly drying at lower air velocity at lower temperature resulted in less volatile oil content. Drying at 45 °C temperature and 4 m/s air velocity resulted in maximum retention of volatile oil content. Similar findings have been reported for drying of bay leaves (Consuelo *et al.*, 2002). Statistical analysis showed that the treatments *i.e.* drying air temperature and velocity differed significantly as regard to the volatile oil content of the samples at 5% level of significance.

Rehydration ratio is also considered as a quality index, because it could indicate the physical and chemical changes of the product

during drying. The leaves regained their original shape once rehydrated. The rehydration ratio varied from 1.96 to 2.59 (Table 1). With the increase in drying air temperature, the rehydration

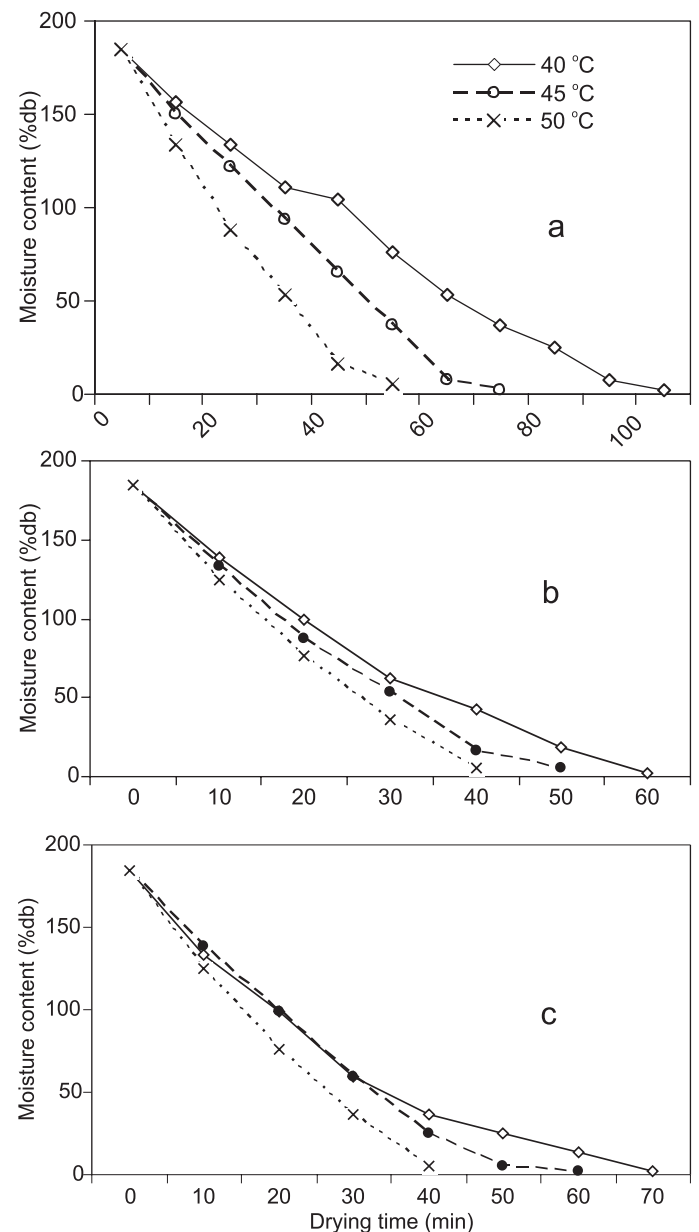


Fig. 1. Drying characteristics of curry leaf at a) 2m/s; b) 3m/s and c) 4 m/s air velocity at different temperatures (n=3)

Table 1. Effect of drying on volatile oil content and rehydration ratio of dried curry leaf

Drying condition	Volatile oil (% v/w)	Rehydration ratio
40 °C, 2 m/s	1.33±0.07	1.96±0.24
40 °C, 3 m/s	1.46±0.10	2.08±0.15
40 °C, 4 m/s	1.46±0.09	2.11±0.17
45 °C, 2 m/s	1.6±0.08	2.05±0.12
45 °C, 3 m/s	1.6±0.03	2.07±0.16
45 °C, 4 m/s	1.76±0.06	2.59±0.36
50 °C, 2 m/s	1.2±0.07	2.21±0.21
50 °C, 3 m/s	1.3±0.04	2.35±0.22
50 °C, 4 m/s	1.3±0.05	2.49±0.15
SEd	0.06	0.173
CD (0.05)	0.12	0.36
CV %	5.31	9.90

Each observation is a mean ± SD (n=3)

ratio also increased. This may be due to the fact that the moisture removal rate being faster at higher temperature which results in less shrinkage of the dried samples (Stela *et al.*, 2009). The color of the rehydrated leaves was dark green compared to the lush green when fresh. The effect of drying on the rehydration ratio showed that the samples dried at 45 °C drying air temperature and 4 m/s air velocity had a good rehydration capability compared to other samples. The values of rehydration ratio at different air velocities at 50 °C were almost the same. However from the statistical analysis of the rehydrated samples at 5 % level of significance it was observed that there was no significant difference among the treatments *i.e.*, drying air temperature and air velocity.

**Storage studies on dried curry leaf:** The dried and packed samples were analyzed for their quality after a period of one month during storage. Based on visual observation on the overall acceptability of the samples and the volatile oil content, the quality of the samples was assessed during storage. The observation was in triplicates. It was found that that the samples dried at 40 °C were spoiled due to fungal infections at all the three levels of air velocity. Similarly, the sample dried at 45 °C and 2 m/s air velocity also spoiled after a month. The samples dried at 45 °C and 50 °C temperature and at 3 and 4m/s air velocity were of good acceptability during storage. The samples at 3 & 4 m/s air velocity were in good condition without change in their volatile oil content. Though the color of the sample was found to be better at 50 °C temperature at different air velocities, there was changes in the volatile oil content of the samples.

Studies on the dehydration of curry leaves revealed that increase in drying air temperature and air velocity resulted in lesser drying time. The drying time varied from 40-100 min. depending upon the air temperature and velocity. Volatile oil content and rehydration ratio of dried samples revealed that fluidised bed drying at 45° C and at 4m/s to be the optimum condition for drying.

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