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# Studies on Drying of Coriander Leaves

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**ABSTRACT:** Coriander leaves were dried in heat pump dryer at 40, 45, and 50°C temperatures. The maximum drying rate and minimum drying time was found at 50°C temperature. The maximum rehydration ratio and minimum water activity was observed at 50°C while minimum value of both rehydration ratio and water activity was found at 40°C. The highest dehydration value of 6.62 was obtained at 50°C. The best colour values comparative to fresh leaves was obtained in coriander leaves dried at 40°C. A significant ( $p < 0.05$ ) effect of drying air temperature on rehydration ratio, water activity and colour was also found. Coriander leaves dried at 40°C were found to be most acceptable on basis of its texture, flavour and aroma. Heat pump dryer can become a viable option for drying of coriander leaves in preserving colour, aroma and flavour.

**KEYWORDS:** Heat pump drying, Rehydration ratio, Water activity, Dehydration ratio.

## I. INTRODUCTION

Coriander commonly known as Dhania, is a herbal plant belongs to Apiaceae family and its botanical name is *Coriander Sativum*. It is a native plant of the eastern Mediterranean region from where it spread to India, China and rest of the world [1]. Coriander leaves are rich source of protein, vitamins and dietary fibres. Fresh coriander juice is highly beneficial in treatment of deficiencies of vitamin A and vitamin C [2]. The presence of bioactive compounds and vitamins, make it used as a flavouring agent in foods like sauce, seafood, etc. Other than culinary it also used in form of medicine since many years [3]. In present times, importance of coriander leaf increases considerably since its uses in various fast food industries and preference given to aroma and flavour of food irrespective of cost.

Coriander leaves contains approximately 85 per cent moisture [4]. It is very difficult to store it for more than 10 days without any postharvest facilities. Due to this reason it remains non available during lean periods and prices are very high, if hardly made available. Hence a proper drying technique should be required to dehydrate the coriander leaves so that it can be made available during lean period at low cost price without compromise in its quality parameters. Drying, a postharvest technique, preserve the quality of food product by lowering the moisture which is responsible for microbiological spoilage. Heat pump dryer is highly efficient drying mechanism developed to reduce moisture effectively without loss in the quality of the product. The quality parameters are mainly influence by techniques adopted for drying. Although, heat pump dryer is highly efficient in preserving the quality of the food product without much deterioration caused by any other drying method like tray dryer, solar dryer etc. Hence the purpose of this research work to investigate the drying characteristics of the coriander leaves dried at different conditions of temperature so that a proper drying technique could be developed.

The related work is presented in section II followed by materials and method employed in the research is presented in section III. Section IV of this research paper presents the results of the conducted experiments with graphs and figures.

## II. RELATED WORK

Natesh et al. [5] reported that green leafy vegetables are cheapest and richest sources of vitamins, proteins and minerals. They also reported that green leafy vegetables like coriander, fenugreek, spinach and cabbage are rich in soluble dietary fibre content which helpful in resolving problems related to obesity, constipation and diabetes. Carotenoids such as  $\alpha$ -carotene,  $\beta$ -carotene and  $\gamma$ -carotene are forms of vitamin A in green leafy vegetables. Kaya and Aydin [6] conducted an experimental study on drying kinetics of mint and nettle leaves. Mint and nettle leaves were dried at 35, 45, 55°C temperature and air flow rate at 0.2, 0.4 and 0.6m/s. They observed that increasing the drying temperature or the velocity of the drying air decreases the total drying time and drying rate of leaves. At constant temperature 35°C, increasing air velocity from 0.2 m/s to 0.6 m/s, a decrease of 6.9 per cent in the total drying time for nettle leaves and 6.67 per cent for mint leaves was observed. At constant air velocity 0.2m/s, an increase in drying temperature from 35 to 55°C, a 25 per cent decrease in the total drying time of nettle leaves and 26.67 per cent decrease

in the total drying time in mint leaves was found. Kadam et al. [7] conducted a study on basil leaves to understand the effect of drying conditions on its drying kinetics. Basil leaves were dried in tray dryer and tunnel dryer at 55, 60 and 65°C. It was found that drying of basil leaves predominantly occurs in falling rate period. The effective moisture diffusivity found to be increased with increase in drying temperature. The effective moisture diffusivity values were found to be higher when basil leaves dried in tray dryer than those dried in the tunnel dryer. Coskun et al. [8] investigate the drying characteristics of tomato slices using a heat pump dryer at three different temperatures (35, 40 and 45°C). They reported that drying rate and drying time significantly influenced by drying air temperature. The drying of tomato slices took place in a falling-rate period at each temperature; a constant-rate period of drying was not seen.

### III. METHODOLOGY

Coriander leaves of variety Green Ganga were brought from the university farm of Maharana Pratap University of Agriculture and Technology. Procured leaves were cleaned, washed and sorted to remove unwanted materials like dirt and dust.

#### Drying procedure

Sorted and washed coriander leaves were dehydrated in heat pump dryer at temperature 40, 45, and 50°C and reductions in the weight of the samples were measured after a particular time intervals by a digital weighing balance having least count of 0.001 g. Initial moisture content of the fresh coriander leaves was recorded using air oven drying method [9] and calculated with following equation 1.

$$\text{Initial moisture content (\%, db)} = \frac{\text{Initial weight of sample} - \text{Dry Matter}}{\text{Dry Matter}} \times 100 \quad \dots (1)$$

The reduction in moisture content of coriander leaves was recorded at varying interval of time using digital weighing balance. Thereafter, the rate of drying was calculated by method as suggested [7] with following equation 2.

$$\text{Drying Rate} = \frac{W_t - W_{t+\Delta t}}{\Delta t \times W_d} \quad \dots (2)$$

Where,

$W_t$  = Weight of sample at time t, g

$W_{t+\Delta t}$  = Weight of sample after t+Δt, g

$W_d$  = Bone dry weight of leaves, g

The rehydration ratio was calculated was in accordance with the method suggested by Ranganna [10]. An amount of 5g of each dehydrated sample obtained from different dryers was placed in a glass beaker carrying 400ml of boiled water at 80°C for about 10 min. Thereafter excess water was removed from the samples and weighed using digital weighing balance. The Rehydration ratio ( $R_R$ ) was calculated for each sample by following equation 3.

$$\text{Rehydration ratio} = \frac{\text{Weight of rehydrated sample}}{\text{Weight of dehydrated sample}} \quad \dots (3)$$

Colour of fresh and dried coriander leaves were measured using a Hunter Lab Colorimeter (Model CFLX/DIFF, CFLX-45) and water activity was measured by water activity analyser that was provided by department itself. The texture and taste were assessed by a panel of fifteen members using nine point Hedonic scales [11].

#### Statistical Analysis

The experimental data of dehydrated coriander leaves were analysed graphically using the software DESIGN EXPERT version 13 at 5 per cent significance level. For the analysis, five replicate of each sample was taken and mean value of above samples was presented in table 1.

### IV. EXPERIMENTAL RESULTS

#### Effect of drying air temperature on moisture content

The initial moisture content of 594.74 per cent (db) was found in fresh coriander leaves and found to be decrease as drying air temperature increases, as shown in fig. 1. The final moisture content was in the range of 5 to 7 per cent (db). This decrease in moisture content might be due to increase in heat and mass transfer between the samples and drying air. The time required to achieve same level of final moisture content was minimum at 50°C and maximum at 40°C, 220 and 360 min respectively. The moisture content decreases with time in exponential manner, as observed from fig. 1. Ahmed et al. [12] and Kannan et al. [13] observed the same behaviour exhibited by coriander leaves and mint leaves respectively.

**Effect of drying air temperature on drying rate**

The drying temperature significantly affects the rate of drying of coriander leaves, as observed from the fig. 2. It was discovered that the drying rate increases as the temperature rose from 40°C to 50°C. Higher drying temperatures increase product vapour pressure, facilitating faster moisture evaporation from the interior of drying leaves to the surface. At all drying air temperatures, the drying rate was higher during the early drying hours, and it thereafter starts declining as the moisture content of the leaves reduces. At a temperature of 50°C, the greatest drying rate of 0.122 g of water/g of dm-min was observed. The rate of drying was found to decrease continuously and was not constant at any time. Therefore it can be interpreted that drying of coriander leaves follows falling rate period of drying. The similar results on drying rate were reported by Kaya and Aydin [6] for herbal leaves and Singh et al. [14] for coriander leaves. A second order polynomial relation between drying rate and moisture content (per cent, db) was adequately describe the variation of moisture content and drying rate for all selected drying air temperatures. . It is also seen that the values of coefficient of correlation ( $R^2$ ) are more than 0.95 for all the drying temperatures which shows the good correlation among the predicted and observed values. Similar trend was also reported by various research workers for different food products such as, for cauliflower by Gupta et al. [15] and for onion by Revaskar et al. [16].

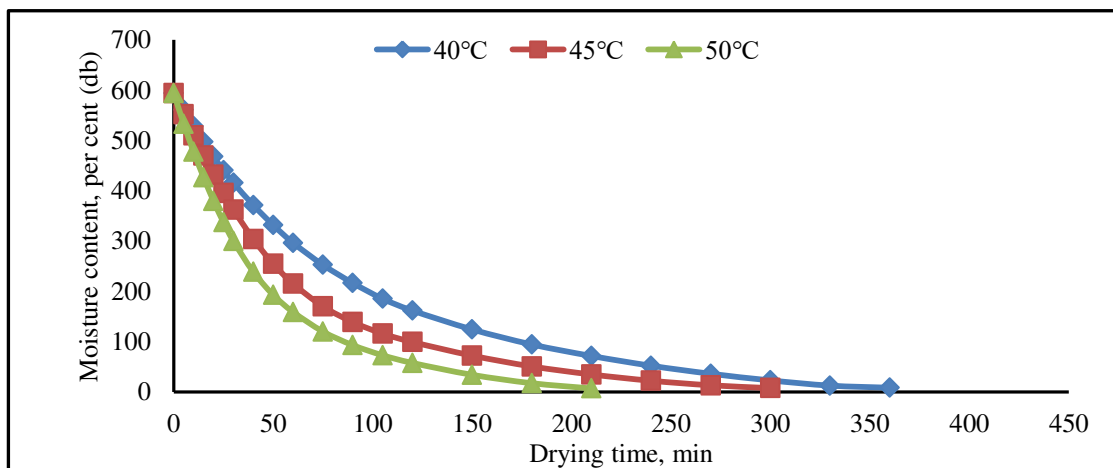


Fig.1. Variation of moisture content with time for coriander leaves dried at different temperatures

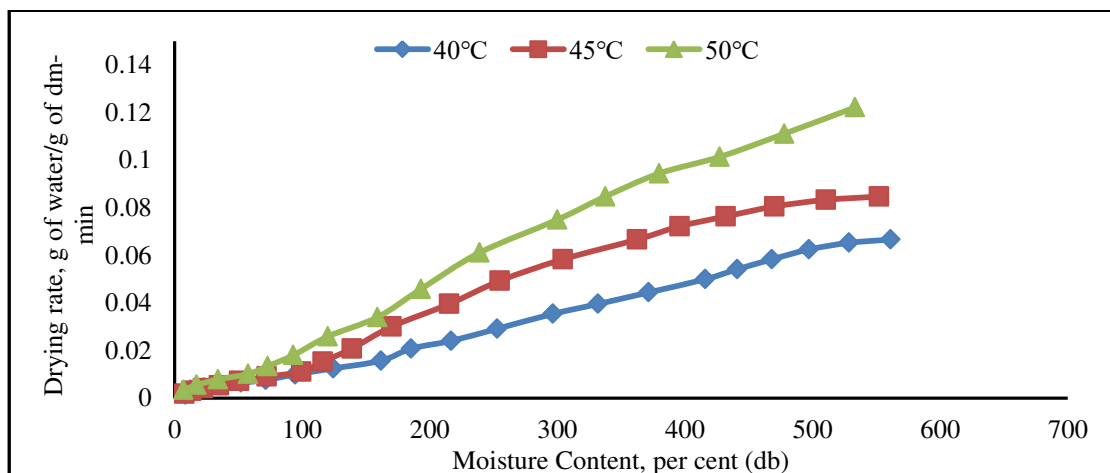


Fig.2. Variation of drying rate with moisture content at different drying air temperatures





Fig.3. Samples of (a) fresh coriander leaves (b) Dehydrated coriander leaves

#### Effect of drying air temperature on dehydration ratio

The dehydration ratio was calculated by ratio of weight of coriander leaves before drying and weight of dehydrated product. Dehydration ratio values are presented in Table 1. The value of dehydration ratio was found to vary from 6.50 to 6.62. A larger dehydration ratio was seen at 50°C because the loss of moisture from the leaves was higher at higher drying temperatures.

#### Effect of drying air temperature on rehydration ratio

Rehydration ratio found to increase with increasing temperature and maximum value of 2.78 was found at 50°C. This increase in rehydration ratio with temperature may be due to the less structural damage occurred at 50°C because of less drying time compare to other temperature levels. This effect was also explained by Singh et al. [17]. According to research, structural and cellular disturbance affects a sample's capacity to absorb water after drying [18].

#### Effect of drying air temperature on colour values

Fresh samples' colour was considerably impacted by the drying process. For fresh coriander leaves, the lightness  $L^*$  coordinate was 41.45, greenness  $a^*$  coordinate was -22.75 and yellowness  $b^*$  coordinate was 18.68. With an increase in drying air temperature, it was discovered that the value of the  $L^*$  coordinate decreases. This shows that the sample becomes darker after drying. According to Mrad et al.[19] and other sources, this is most likely caused by enzymatic and non-enzymatic browning, which reduces the lightness of leaves. The negative  $a^*$  coordinate demonstrates the retention of greenness in dried samples, however, it was discovered to be lower than in fresh leaves due to chlorophyll destruction. High drying temperatures cause more chlorophyll to degrade, which causes higher value of  $a^*$  in leaves dried at 40°C than 50°C. As a result of non-enzymatic interactions, it was observed that the  $b^*$  (yellowness) coordinate decreased with rising drying air temperature and was higher than fresh coriander leaves. Similar results were obtained by Kamal et al. [20] for green chilli.

The effect of temperature on colour values  $L^*$ ,  $a^*$  and  $b^*$  were also analysed using ANOVA. ANOVA shows a significant ( $p < 0.05$ ) effect of drying air temperature on rehydration ratio.

#### Effect of drying air temperature on water activity

There was significant difference in the water activity of fresh and dried leaves. The water activity of samples decreases with the increase in the drying air temperature from 40 to 50°C and ranges from 0.518 to 0.478. The observed value of water activity was presented in table 1.

| Table 1 Effect drying air temperature on various parameters |                   |                |                |                |             |              |             |
|-------------------------------------------------------------|-------------------|----------------|----------------|----------------|-------------|--------------|-------------|
| Temp (°C)                                                   | Drying Time (Min) | D <sub>R</sub> | R <sub>R</sub> | a <sub>w</sub> | L*          | a*           | b*          |
| 40                                                          | 360               | 6.50           | 2.35±0.055     | 0.518±0.0040   | 37.33±0.098 | -15.79±0.12  | 28.74±0.091 |
| 45                                                          | 300               | 6.56           | 2.51±0.053     | 0.507±0.0048   | 36.89±0.094 | -14.58±0.10  | 28.43±0.082 |
| 50                                                          | 220               | 6.62           | 2.78±0.058     | 0.475±0.0045   | 36.43±0.091 | -14.15±0.089 | 27.95±0.105 |

D<sub>R</sub>=Dehydration ratio, R<sub>R</sub>=Rehydration ratio, a<sub>w</sub>=Water activity, Temp=Temperature, Data are expressed as mean of five measurements±standard deviation. Significant differences (p<0.05) at a given temperature

## VI. CONCLUSION

The minimum drying time of 220 min and maximum drying rate was found for the sample dehydrated at 50°C. The maximum value of dehydration ratio and rehydration ratio was also obtained for samples dried at 50°C. The best colour values were found in coriander leaves dehydrated at 40°C comparative to 50°C temperature. The coriander leaves dried at 40°C temperature was found to be most acceptable in terms of flavour, aroma and texture. The significant (p<0.05) effect of drying air temperature was also found. Hence, it can be concluded that drying of coriander leaves at 40°C in heat pump dryer gives better results in comparison to 45 and 50°C temperature on the basis of quality parameters like rehydration ratio, colour, and overall acceptability.

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