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**Adhi Srilatha**
Ph.D Scholar, Department of Family Resource Management, College of Community Science, University of Agricultural Sciences, Dharwad, Karnataka, India

**Veena S Jadhav**
Professor, Department of Family Resource Management, College of Community Science, University of Agricultural Sciences, Dharwad, Karnataka, India

**Hemalatha S**
Professor and Head, Department of Food Processing and Technology, College of Community Science, University of Agricultural Sciences, Dharwad, Karnataka, India

**Renuka S Salunke**
Professor, Department of Family Resource Management, College of Community Science, University of Agricultural Sciences, Dharwad, Karnataka, India

**Biradar MS**
Senior Scientist and Head, ICAR-KVK, University of Agricultural Sciences, Dharwad, Karnataka, India

**Corresponding Author:**
**Adhi Srilatha**
Ph.D Scholar, Department of Family Resource Management, College of Community Science, University of Agricultural Sciences, Dharwad, Karnataka, India

# Effect of different dehydration techniques on drying behavior of chrysanthemum (*Chrysanthemum morifolium*) waste flowers

**Adhi Srilatha, Veena S Jadhav, Hemalatha S, Renuka S Salunke and Biradar MS**

**Abstract**
A study was undertaken to assess various dehydration techniques for the drying of chrysanthemum (*Chrysanthemum morifolium*) waste flowers. The aim of this research was to establish standardized drying processes for chrysanthemum waste flowers. The process of drying chrysanthemum waste flowers was carried out using four distinct dryings: sun drying, cabinet drying, solar drying and microwave oven drying. The effect of the different drying techniques on change in weight of chrysanthemum waste flower petals, moisture loss and time taken for drying was analyzed. The quality parameters, including appearance, color, texture, fragrance and overall acceptability, were evaluated by sensory evaluation conducted by a panel of judges using a nine-point scale. The findings suggest that microwave oven drying and solar drying exhibited the highest level of moisture loss (88.26% and 87.16% respectively) during drying period, surpassing other drying methods significantly. Among the many procedures that were examined, it was found that the solar drying technique achieved a higher score of 8.16 for colour retention, 7.63 for appearance and 7.86 for overall acceptability compared to various drying techniques. The acceptability index was found to be high for solar dried chrysanthemum waste flower petals powder (94.62%). Hence, the solar drying was determined to be superior in comparison to alternative drying techniques.

**Keywords:** Chrysanthemum, drying technique, cabinet drying, solar drying, microwave oven drying, quality parameters

## Introduction
India is a country with a variety of religions where worshipping or praying is a way of life and where people make numerous offerings to the deities, including an immense number of floral offerings. Consequently, temple refuse contains a disproportionate amount of flower waste. After serving their purpose, flowers end up in the trash or are thrown into rivers, the sea, or the ocean, which causes a lot of problems for the earth. Flowers like marigold, rose, jasmine, chrysanthemum, hyacinth, hibiscus, etc. are given as offerings in temples. Chrysanthemum flowers (Shevanti flowers) have profound religious significance they are often used as garlands and offerings in pujas and temples. Without chrysanthemum flowers, no religious ceremony or ritual is complete, and they play a prominent role in all celebrations. Religious idols and frames are always adorned with yellow flowers and garlands which features this flower prominently.

Chrysanthemum (*Chrysanthemum morifolium*) is extensively cultivated in various Asian nations, where its flower heads have been employed as a traditional Chinese herbal remedy (Wang *et al.*, 2018) [9]. Chrysanthemums hold significant importance in contemporary flower markets, serving both as decorative elements and possessing economic worth. The medicinal properties of chrysanthemum include heat dissipation, eye soothing, headache reduction, alleviation of vertigo and detoxification of the blood and digestive system (Lu *et al.*, 2018) [6]. In contemporary world, chrysanthemums have also been employed as a useful meal. Fresh Chrysanthemum flower typically has a high-water content, which should be reduced to the standard level (less than 15%) for preservation (Yuan *et al.*, 2015) [11].

The process of drying flowers is of utmost importance as it serves to prevent the growth of microorganisms, withering effect and minimize the enzymatic breakdown of the medicinal chemicals present (Muller and Heindl 2006) [7]. The drying process has the potential to modify the physical characteristics, chemical composition and aromatic properties of flowers (Hossain *et al.*, 2010) [3].

Due to the lack of moisture, these desiccated flowers can be stored in an atmosphere devoid of moisture for extended periods of time without losing their appearance or aesthetic value. Thus, the flowers are liberated from the constraints of the seasons (Bhutani, 1995) [1]. Air drying, sun drying, hot air oven drying, microwave oven drying, solar drying, freeze drying and embedded drying can be used to create decorative floral craft items, such as cards, floral designs, wall hangings, landscapes and calendars, for a variety of purposes (Kant, 2018) [4].

Drying is considered as an important processing technique for value addition to waste flowers. Therefore, keeping in this view the tremendous potential of dried chrysanthemum flowers, the present study aims to standardize drying techniques for dehydration of chrysanthemum (*Chrysanthemum morifolium*) waste flowers.

## Materials and Methods

The present research was conducted in the year 2020-23 in the Department of Family Resource Management, College of Community Science, University of Agricultural Sciences, Dharwad, Karnataka. An experimental research design was chosen for this study to assess the effect of different drying techniques on the qualitative characteristics of chrysanthemum waste flowers and standardizing the drying technique which is suitable for chrysanthemum waste flowers. The chrysanthemum *morifolium.* flowers were sourced from different temples during festivals and from various events like krishi melas, conferences, convocation day and from flower mandi. Chrysanthemums exhibiting consistent color and type of variety were chosen as the samples for drying. Prior to conducting the research, the samples underwent a cleaning process to eliminate any dust particles present on their surfaces and weights were noted using heavy duty electronic weighing balance. The petals were extracted from the collected chrysanthemums waste flowers, while the other refuse was disposed of. The initial weight of chrysanthemums waste flowers was measured using electronic weighing balance and afterwards recorded for experimental study. Subsequently, the accumulated waste flower petals underwent drying procedures using different techniques. Sun drying was carried out by spreading the chrysanthemum waste flower petals on the plastic sheets under the hot sun. Cabinet drying technique was employed to the chrysanthemum waste flower petals that are loaded onto the trays that are inserted directly into the drying chamber maintained at a temperature of 45±5 °C. Chrysanthemum waste flower petals are spread on trays and kept inside the solar dryer which converts solar energy into heat energy. This heat is used to heat the drying air which helps in dehydration of the substances kept inside the solar dryer. Microwave oven works on the principle of liberating moisture by agitating water molecule in organic substances with the help of microwave. Chrysanthemum waste flower petals are spread on plates and kept inside the microwave oven for drying. The entire drying process will be subject to daily monitoring, wherein the weight of the waste flower petals will be observed and recorded on a regular basis until they acquire three consequent standard weights upon drying completely. The physico-analytical properties of the dried chrysanthemum waste flower petals were analyzed and recorded. The recorded data on various characteristics were subjected to statistical analysis using spss software version 16. 30 panellists conducted the sensory analysis of the dried chrysanthemum waste flower powder. The appearance, colour, aroma, texture and overall acceptability of dried chrysanthemum waste flower powder were evaluated on a nine-point scale (9: Like extremely, 7: Like moderately, 5: Neither like nor dislike 3: Dislike moderately, 1: Dislike extremely).

## Results and Discussion

Table 1 explains the effect of different drying techniques on the weight of chrysanthemum waste flower petals. On the first, second, third, fourth and fifth days of sun drying in chrysanthemum, the weight of waste flower petals was reduced by 321.33 g, 274.00 g, 198.33 g, 115.33 g and 94.67 g respectively. The weight of discarded chrysanthemum flower petals

**Table 1:** Effect of different drying technique on weight (in g) of chrysanthemum waste flower petals

| Flower | Initial weight | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 |
|---|---|---|---|---|---|---|
| Sun drying | 500.00 | 321.33±3.05 | 274.00±4.58 | 198.33±2.51 | 115.33±4.04 | 94.67±3.51 |
| Cabinet drying | 500.00 | 251.33±4.50 | 178.67±5.03 | 137.33±4.72 | 87.33±3.05 | - |
| Solar drying | 500.00 | 249.33±5.57 | 89.10±3.55 | 63.90±4.10 | - | - |
| Microwave drying | 500.00 | 58.66±3.05 | - | - | - | - |

**Note:** Values depicted in table are mean ± standard deviation of three replications

Decreased by 251.33 g on the first day of cabinet drying, then by 178.67 g, 137.33 g and 87.33 g on the second, third and fourth days of drying, respectively. Chrysanthemum waste flower petals lost 249.33 g on the first day of solar drying, then 89.10 g and 63.90 g on the second and third days of drying respectively. It was found that the weight of discarded chrysanthemums flower petals fell by 58.66 g after a single day of drying in a microwave. Dahiya *et al.* (2002) [2] stated that chrysanthemum fresh and dried flower weights ranged from 1.25 to 1.44 g and 0.13 to 2.6 g respectively. The weight of dried flowers was shown to dramatically decrease as drying temperatures and duration increased.

Table 2 explains the effect of different drying techniques on the moisture loss of chrysanthemum waste flower petals The moisture loss of chrysanthemum waste flowers was found to be approximately 81.06 per cent when subjected to sun drying technique, 82.46 per cent when dried using the cabinet drying method, 87.16 per cent when dried using solar drying technique and 88.26 per cent when dried using microwave oven drying technique. It was found that microwave oven drying and solar drying exhibited the highest level of moisture loss significantly ($p$<0.01) during drying period surpassing other drying methods. Similarly, Wilson *et al.*, (2013) [10] indicated that among different methods of drying solar drying registered the maximum moisture loss (79.31%).

**Table 2:** Effect of different drying techniques on moisture loss of chrysanthemum waste flowers

| Drying techniques | Chrysanthemum |
|---|---|
| Sun drying | 81.06±0.07[b] |
| Cabinet drying | 82.46±0.64[b] |
| Solar drying | 87.16±0.85[a] |
| Microwave oven drying | 88.26±0.6[a] |
| Total | 84.74±3.23 |
| F value | 73.85** |
| C.D | 1.939 |
| S. Em (±) | 0.408 |

**Note:** Values depicted in table are mean ± standard deviation of three replications. a, b, c the means within a line followed by different superscripts are significantly different at 0.01 level of statistical significance by Duncan's test.

Table 3 presents the sensory scores of chrysanthemum waste flower powder that were acquired through different drying procedures. The chrysanthemum waste flower powder exhibited a range of appearances, with scores ranging from 5.40±1.03 to 7.63±0.66. The highest appearance score was awarded to the solar dried powder, followed by the cabinet drying technique and microwave oven drying technique, with appearance scores of 7.63±0.66, 6.23±1.25 and 5.60±2.06 respectively. In contrast, the sun-dried chrysanthemum waste flower powder received the lowest appearance score of 5.40±1.03, which differed significantly from the other drying methods ($p$<0.01). The obtained chrysanthemum waste flower powder, exhibited 6.16±1.93 mean value of sensory score for colour. A statistically significant increase ($p$<0.01) was observed in the colour of solar dried chrysanthemum waste flower powder, with

**Table 3:** Effect of different drying techniques on sensory evaluation of crushed chrysanthemum waste flower petals powder

| Drying techniques | Appearance | Color | Aroma / Fragrance | Texture | Overall acceptability |
|---|---|---|---|---|---|
| Sun drying | 5.40±1.03[b] | 5.43±1.25[b] | 5.72±1.62[a] | 5.53±1.27[a] | 5.40±1.32[b] |
| Cabinet drying | 6.23±1.25[b] | 5.63±1.73[b] | 5.90±1.64[a] | 6.20±1.84[a] | 6.23±1.75[b] |
| Solar drying | 7.63±0.66[a] | 8.16±0.79[a] | 6.70±1.48[a] | 6.36±2.17[a] | 7.86±0.57[a] |
| Microwave drying | 5.60±2.06[b] | 5.43±2.16[b] | 6.10±1.62[a] | 5.90±1.39[a] | 6.06±1.57[b] |
| Total | 6.21±1.59 | 6.16±1.93 | 6.15±1.61 | 60.2±1.71 | 6.39±1.64 |
| F value | 16.813** | 21.750** | 1.683[NS] | 1.373[NS] | 17.197** |
| C.D | 0.911 | 1.061 | 1.080 | 1.157 | 0.935 |
| S.Em (±) | 0.246 | 0.286 | 0.291 | 0.312 | 0.252 |

**Note:** Values depicted in table are mean ± standard deviation of three replications. a, b, c the means within a line followed by different superscripts are significantly different at 0.01 level of statistical significance by Duncan's test.

A mean value of 8.16±0.79. The cabinet drying technique (5.63±1.73), microwave oven drying technique (5.43±2.16) and sun-dried chrysanthemum waste flower powder (5.43±1.25) did not exhibit significant variations in colour ($p$<0.01). Wilson *et al.*, (2013) [10] found that low-cost solar drying obtained better score (4.60) for colour retention than other drying methods.

The aroma of chrysanthemum waste flower powder, acquired by different drying methods, exhibited an average sensory score of 6.15±1.61. There was no statistically significant difference observed in the aroma profiles of dried chrysanthemum waste flower powder ($p$<0.01).

The range of the texture of chrysanthemum waste flower powder, obtained through different drying procedures, varied from 5.53±1.27 to 6.36±2.17, with a mean value of 60.2±1.71. There was no statistically significant variation observed in the texture of chrysanthemum waste flower powder when subjected to different drying methods ($p$<0.01).

The overall acceptability of chrysanthemum waste flower powders, as determined by different drying procedures, exhibited a range of scores from 5.40±1.32 to 7.86±0.57, with a mean score of 6.39±1.64. The solar drying process received the highest level of acceptability (7.86±0.57), followed by the cabinet drying technique (6.23±1.75), microwave oven drying technique (6.06±1.57) and sun drying (5.40±1.32). The results of the study indicate a statistically significant increase ($p$<0.01) in the general acceptability of chrysanthemum waste flower powders when using the solar drying technique. However, no statistically significant difference was seen among the chrysanthemum waste flower powders dried using sun, cabinet and microwave oven drying methods. According to Ravichandra and Pedapati (2014) [8], the structure, moisture content, harvesting stage, harvest timing, and drying techniques all have a significant impact on the quality of dried flowers.

Figure 1 illustrates the acceptance index of crushed chrysanthemum waste flower petals powder. The findings of the study indicated that the solar drying technique had the highest acceptability index (81.58), followed by the cabinet drying technique (67.09), microwave drying technique (64.64) and sun drying technique (61.07).

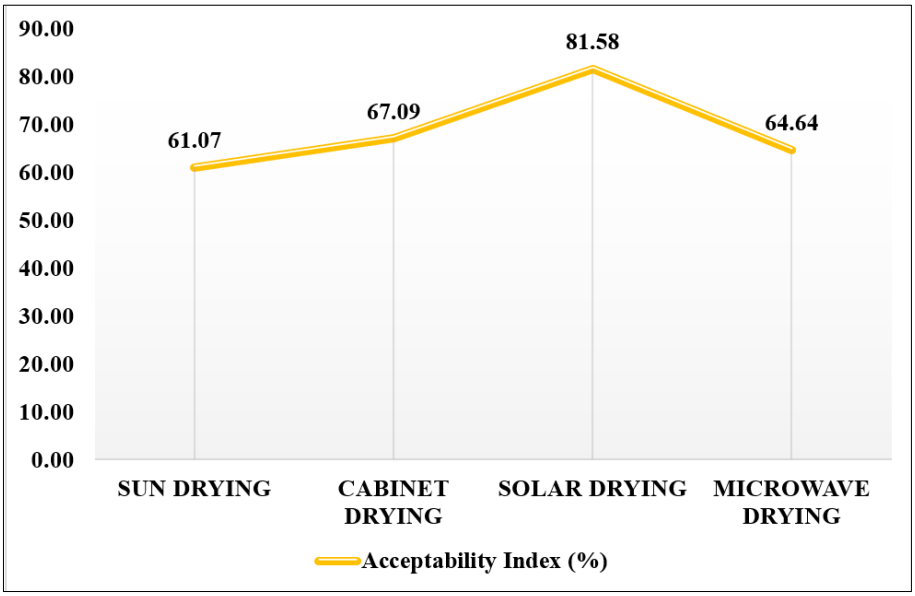


**Fig 1:** Acceptability Index of crushed chrysanthemum waste flower petals powder

## Conclusion

Based on the aforementioned data, it can be inferred that maximum moisture loss was found in solar and microwave oven drying. Using solar drying technique for chrysanthemum waste flowers yields the highest quality of dried flowers in terms of appearance, color and overall acceptability. Consumer acceptability index was found to be high for solar dried chrysanthemum waste flowers. Hence solar drying technique was found to be the most suitable for drying of chrysanthemum waste flowers.

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