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Effect of Drying Methods and Temperature on Physical Properties of Spine Gourd (*Momordica dioica* Roxb.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation entitled "Effect of Drying Method and Temperature on Physical Properties of Spine Gourd (*Momordica dioica* Roxb.)" was conducted at the Post Harvest Technology Laboratory, Department of Horticulture, Rajasthan College of Agriculture and Department of Processing and Food Engineering, College of Technology and Engineering, MPUAT, Udaipur, Rajasthan during August to December, 2023. The study consisted of 4 different drying methods

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(sun drying, tray drying, heat pump drying and fluidized bed drying), pretreatment (water blanching) and different temperatures (50°C, 60°C and 70°C). The experimental design used for this study was completely randomized design with three replications. The various physical observations were also recorded after drying. Among different types of drying methods and temperatures, water blanched and dried at 60°C tray dryer was found best with maximum dehydration ratio (0.174) and recovery % (17.43).

Keywords: Tray drying; heat pump drying; fluidized bed drying; pre-treatment; water blanching.

1. INTRODUCTION

Momordica dioica Roxb**.** is a perennial, dioecious climbing creeper, be owned by cucurbitaceous family. Spine gourd plant is sometimes cultivated in India for its edible vegetable fruit. Based on current study of Indian Momordica, there are different six well grant species of which four are dioecious and two are monoecious [1]. They posses some medicinal and remedial properties *e.g*., the decoction of leaves reduces fever, tuberous roots help in relieving headache, sweating, stone formation and migraine while fruit is quite useful in controlling diabetes and blood pressure. It is often cultivated for its fruits which are used as a vegetable [2]. As spine gourd contains spacious amount of antioxidants, vitamins, secondary metabolites and other important elements which helps to fight against several diseases including diabetes, cancer, and neurodegenerative diseases. Ethyl acetate and ethanol extract of kakrol containing steroids, triterpenoids *etc*. have potential role in alloxan-induced diabetic rats. Methanol withdraw from fruits reduces serum glucose and increases serum insulin and urea levels there by it reduces the risk of diabetes [3].

Pretreatment can speed up drying rate, improves the quality of dried product, prevents browning, and helps retain volatile compounds [4]. Drying is one of the traditional methods of preservation, which converts the vegetables into light weight, easily transportable and storable product. Advantage of this method is that the vegetable can be easily converted into fresh like form by rehydrating it and can be used throughout the year. In addition to increasing variety in the menu, reducing losses, labour and storage space, dehydrated vegetables are simple to use and have longer shelf-life than fresh vegetables along with concentration of nutrients [5]. Dehydration process is a unit operation which means drying of a commodity by artificial thermal means in a controlled condition. It depends on two fundamental processes *i.e*., i) heat transfer into the product and, ii) mass/ moisture transferred out from the product. The rate of drying depends on the i) dehydration conditions *viz*. dry bulb temperature, relative humidity, air velocity and rate of heat transfer and, ii) the character of the food viz., moisture content, surface to volume ratio, surface temperature, area of cut surface and rate of moisture loss. It is one of the most widely used methods for preservation of fruits and vegetables. The main objective of dehydration is reducing the water activity by removal of water to a level at which growth of microorganisms and deterioration reactions are decrease [6]. As the fresh fruit availability is hardy for 2 months, therefore presenting it dried from for year around availability is needed and keeping this in view the present study was carried out to standard drying method,

2. MATERIALS AND METHODS

The experiment was carried out in the Post-Harvest Technology Laboratory of Department of Horticulture, Rajasthan College of Agriculture and Department of Processing and Food Engineering, College of Technology and Agricultural Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan. Fresh spine gourd were used for this investigation. These were procured from local market. For the improvement in colour and shelf life, the spine gourd were water blanched. After soaking, the samples were immediately removed and blotted gently through tissue paper. Then the fruit slice were weighed again. The experiment included 10 treatments with 3 replications through Completely Randomized Design (CRD).

2.1 Moisture Content

To determine the moisture content of fresh spine gourd slice, a known amount of spine gourd was taken in moisture dishes (aluminum pan) and kept it in hot air oven and left it for 24 hrs at 103±2°C oven temperature. After 24 hrs of drying, moisture dishes were taken out from oven

and allowed to cool at room temperature in a desiccator. After attaining the room temperature, the weight of the moisture dishes along with sample was recorded. Then, the moisture content of the sample was calculated through the following relation.

$$\text{Moisture content (\% db)} = \frac{W\theta \text{ x DM}}{\text{DM}} X\ 100$$

Where,

Wθ= Weight of sample at time θ, DM = Dry matter of the sample, g

2.2 Drying Rate

The moisture content data recorded during experiments were analyzed to determine the moisture lost from the sample of spine gourd in particular time 30 minutes interval. The drying rate of samples were calculated by following equation Kadam et al. [7].

$$\text{Drying rate} = \frac{\text{Amount of water removed (g / g)}}{\text{Time taken in min.XAmount of dry matter (g)}}$$

2.3 Dehydration Ratio (g)

The dehydration ratio of spine gourd was calculated by measuring initial and final mass of spine gourd as:

$$\text{Dehydration ratio} = \frac{\text{Weight of dehydrated sample}}{\text{Initial weight of Fresh sample}}$$

2.4 Product Recovery Percent

The weight of fresh spine gourd at the end of drying obtained from each treatment was noted down and the percentage recovery of dried spine gourd was calculated by through the following formula :

$$\text{Recovery (\%)} = \frac{\text{Weight of dehydrated spine gourd}}{\text{Weight of fresh fruit}} \text{ x } 100$$

3. RESULTS AND DISCUSSION

Effect of drying methods and temperatures on moisture content (%): The impact of different types of drying methods (Table 1 and Figs 1-3), without water blanched and sun dried (495.24), water blanched and 50, 60, 70 °C tray dried, (524.15, 521.43 and 526.67), water blanched and 50, 60, 70 °C heat pump dried (527.85, 527.01 and 530.71), water blanched and 50, 60, 70 °C fluidized bed dried (526.19, 529.33 and 525.27), (%db) were the average initial moisture contents for the spine gourd samples. Drying was kept up until the sample's constant weight was reached. After drying to constant weight the final moisture contents were reduced for without water blanched and sun dried (0.12), water blanched and 50, 60, 70 °C tray dried (3.80, 8.35 and 7.26), water blanched and 50, 60, 70 °C heat pump dried (4.88, 8.92, 5.84) and water blanched and 50, 60 and 70 °C fluidized bed dried (3.81, 5.40 and 4.42), (%db), respectively.

The time needed to achieve a constant weight for the spine gourd samples through various drying techniques with constant air flow a rate of 2 m/s, the drying times for without water blanched and sun dried (880 minutes), water blanched and 50, 60 and 70 °C tray dried (540, 500 and 460 minutes), water blanched and 50, 60, 70 °C heat pump dried (620, 540 and 460 minutes) and water blanched and 50, 60, 70 °C fluidized bed dried (460, 420 and 360 minutes), respectively.

This might be due to the fact treat temperature of drying increased removal of moisture from the plant material and drying was at a faster rate at higher temperature, thus reducing time taken for drying. Since, drying takes place at faster rate at higher temperature probably the loss of volatile compounds and dry matter along with moisture will be reduced resulting in slightly better yield compared to low temperature drying which takes longer time Soysal et al. [8].These results are obvious and confirmation with the results obtained by various researchers by tray drier for carrot and fluid bed drier for garlic by Baysal et al. [9], Gupta et al. [10] for drying of red chilli and Momenzadeh et al. [11] for drying of green pea.

Effect of drying methods and temperatures on dehydration ratio of spine gourd: Table 2 and Fig. 4 shows the impact of various drying techniques and temperatures on the dehydration ratio of dried spine gourd. Regardless of drying techniques, it was discovered that the impact of various dryers and temperatures on the dehydration ratio of dried spine gourd was significant. The maximum dehydration ratio (0.174) was recorded in T_3 (water blanched and dried at 60°C tray dryer) while T_7 and T_8 both had same minimum dehydration ratio (0.165). Similar result was found by the Hiremath et al. [12] for dehydrated of palak (*Beta vulgaris* cv. Bengalensis) leaves, Sagar and singh [13] for drying of spine gourd, Kukanoor et al. [14] for dehydrated of carrot slices and Kohli et al. [15] for asparagus roots (*Asparagus racemosus* l.).

Table 1. Effect of drying methods and temperature on moisture content (%db) of spine gourd

Treatment	Moisture Content (%db)	
	Before Drying	**After Drying**
T_1 = Sun drying (control) + Without water blanching	495.24	0.12
T_2 = Tray drying + 50°C drying temperature	524.15	3.80
T_3 = Tray drying + 60°C drying temperature	521.43	8.35
T_4 = Tray drying + 70°C drying temperature	526.67	7.26
T_5 = Heat pump drying + 50°C drying temperature	527.85	4.88
T_6 = Heat pump drying + 60°C drying temperature	527.01	8.92
T_7 = Heat pump drying + 70°C drying temperature	530.71	5.84
T_8 = Fluidized bed drying + 50°C drying temperature	526.19	3.81
T_9 = Fluidized bed drying + 60°C drying temperature	529.33	5.40
T_{10} = Fluidized bed drying + 70°C drying temperature	525.27	4.42

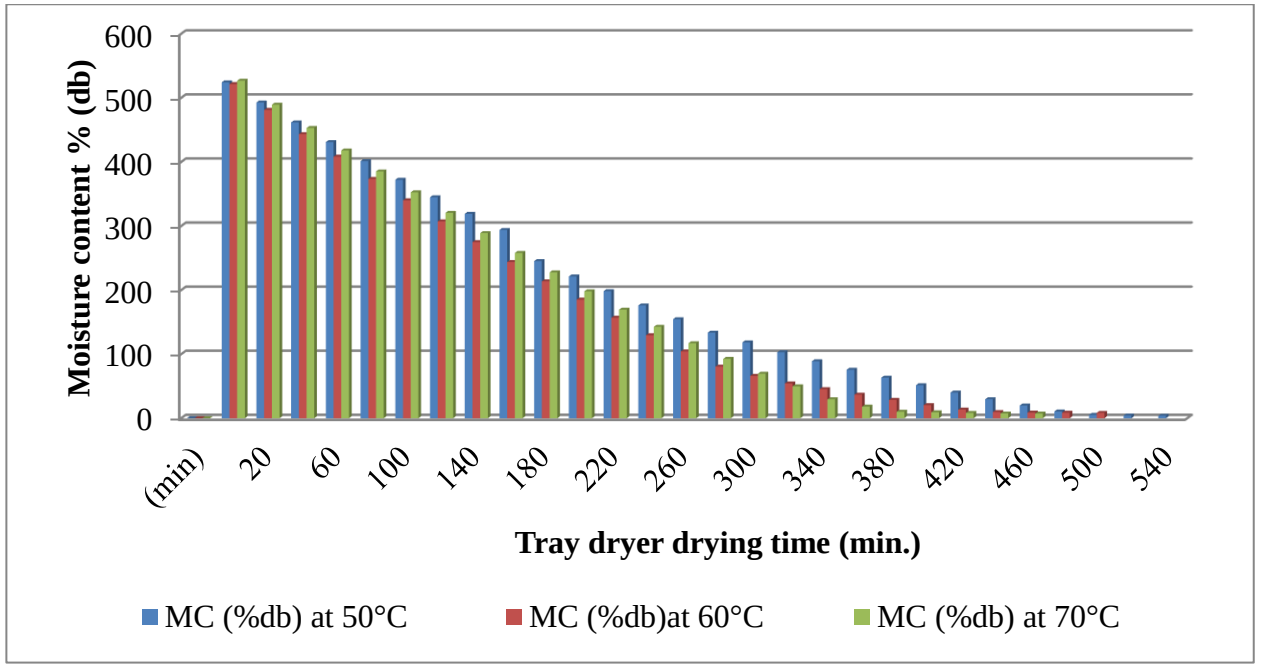

Fig. 1. Variation in moisture content (%db) with time (min.) for tray drying of dried spine gourd at various air temperature

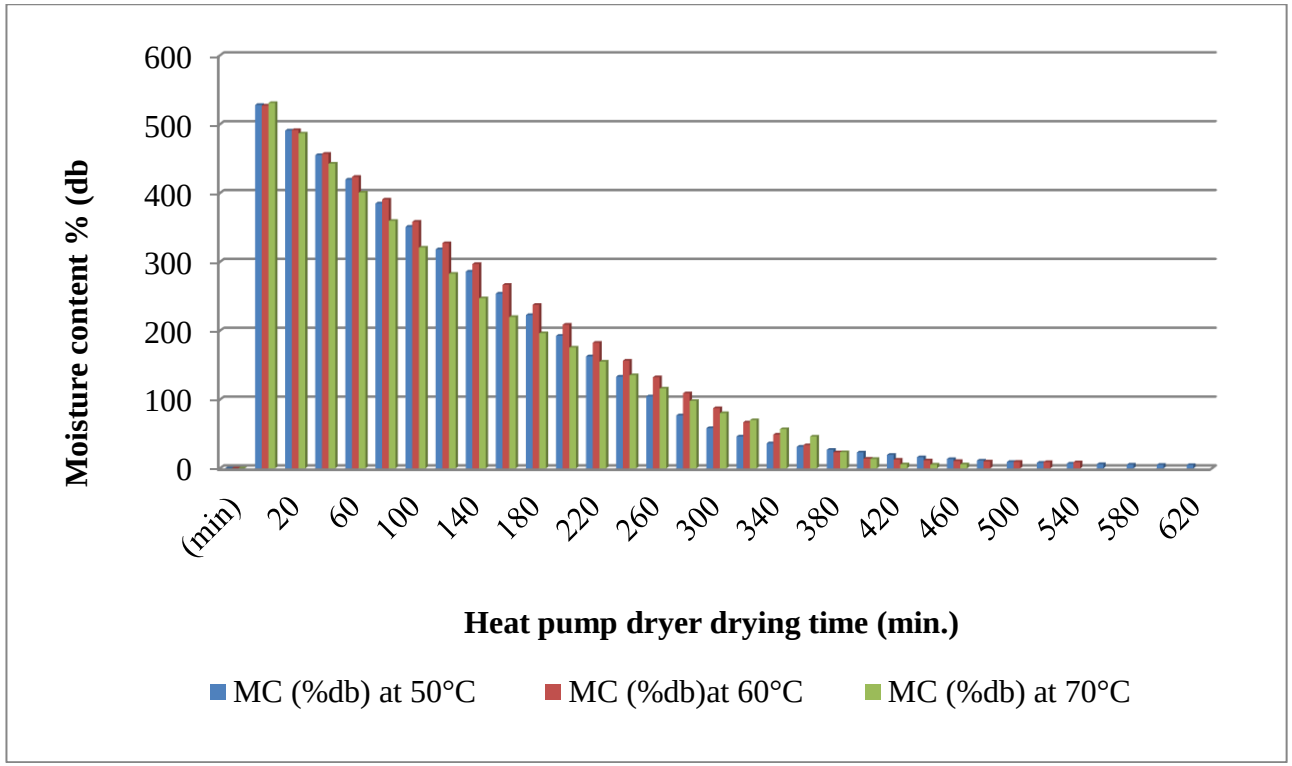

Fig. 2. Variation in moisture content (%db) with time (min.) for heat pump drying of dried spine gourd at various air temperature

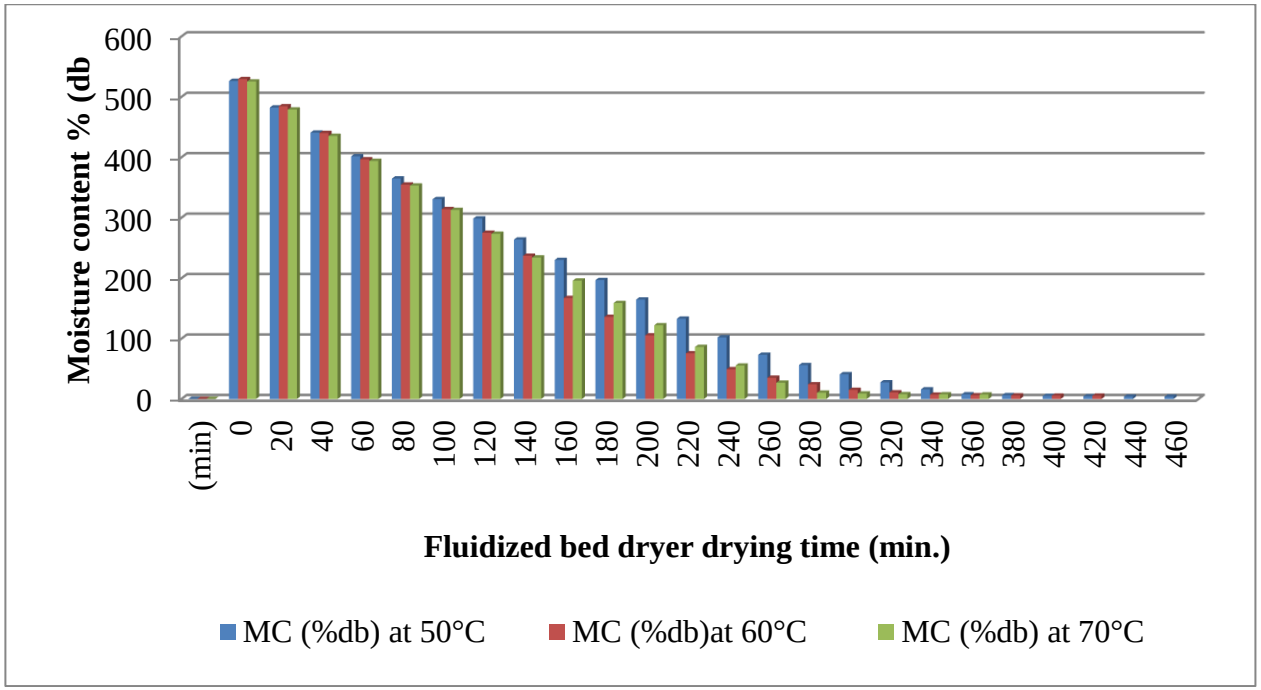

Fig. 3. Variation in moisture content (%db) with time (min.) for fluidized bed drying of dried spine gourd at various air temperature

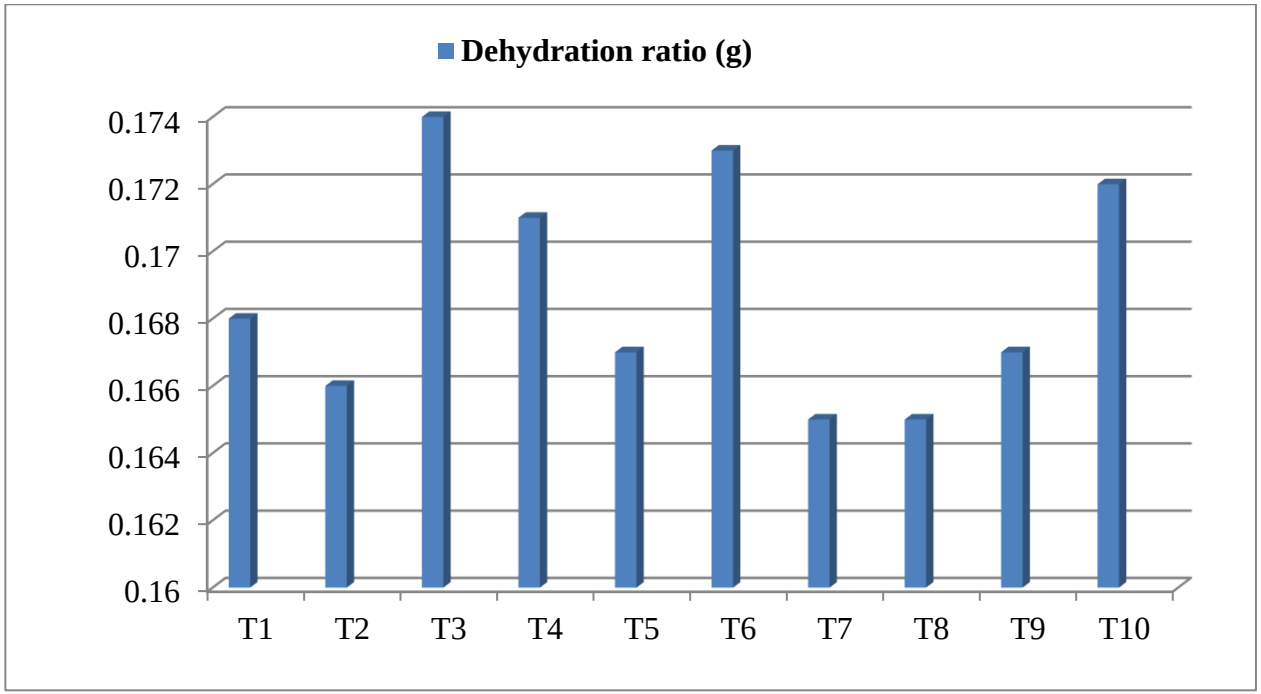

Fig. 4. Variation in dehydration ratio

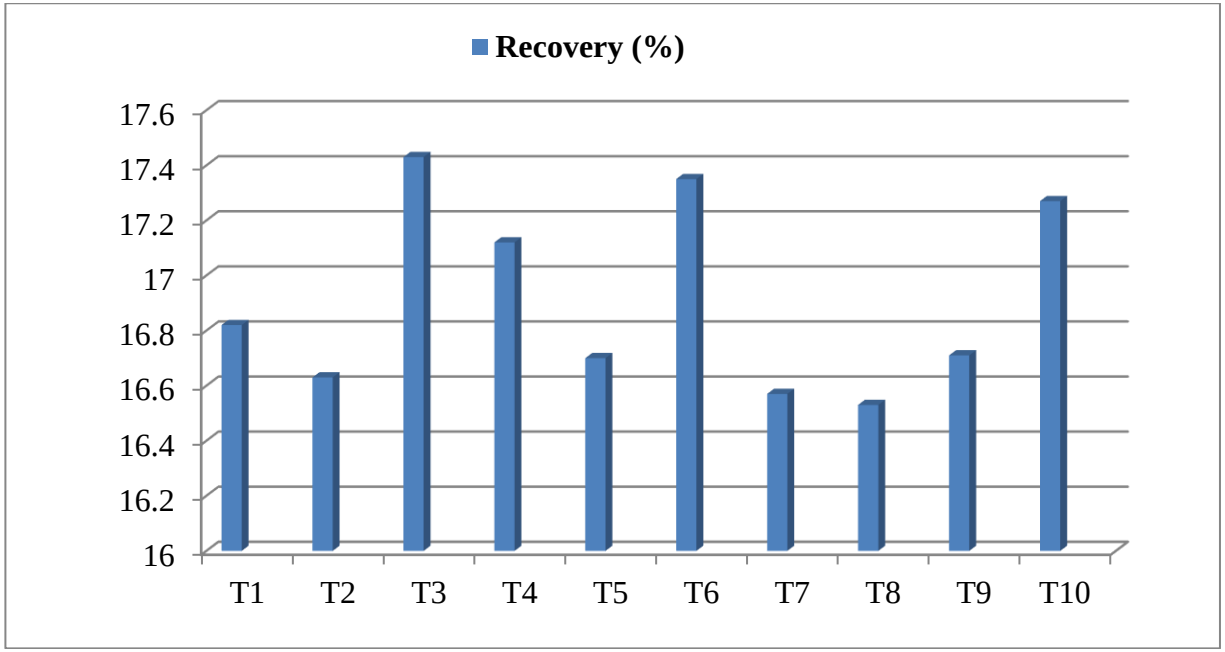

Fig. 5. Variation in recovery (%)

Table 2. Effect of drying methods and temperature on dehydration ratio (g) and recovery (%) of spine gourd

Treatment	Dehydration Ratio (g)	Recovery (%)
T_1 = Sun drying (Control) + Without water blanching		2
T_2 = Tray drying + 50°C drying temperature		3
T_3 = Tray drying + 60°C drying temperature		3
T_4 = Tray drying + 70°C drying temperature		2
T_5 = Heat pump drying + 50°C drying temperature		0
T_6 = Heat pump drying + 60°C drying temperature		5
T_7 = Heat pump drying + 70°C drying temperature		7
T_8 = Fluidized bed drying + 50°C drying temperature		3
T_9 = Fluidized bed drying + 60°C drying temperature		1
T_{10} = Fluidized bed drying + 70°C drying temperature		7
SEm±		**4**
CD (P=0.05)		**9**
CV		**3.195**

Effect of drying methods and temperatures on recovery (%) of spine gourd: The influence of various drying techniques and temperatures on dried spine gourd recovery (%) is shown in Table 2. Whatever the drying techniques, the effect of different dryers and temperatures on recovery (%) of dried spine gourd was found significant. The water blanched and dried at 60°C tray dryer produced the maximum recovery per cent (17.43 %) of the spine gourd samples, whereas the water blanched and dried at 60°C heat pump dryer produced the minimum recovery per cent (16.53). Similar result was found by the Khurana et al. [16] for dehydrated of capsaicin and Kukanoor et al. [14] for dehydrated of carrot slice.

4. CONCLUSION

On the basis of the results of the present investigation it may be concluded that among different types of drying methods and temperatures tray dryer method with water blanching and dried at 60°C was found best as it resulted into maximum dehydration ratio (0.174) and recovery % (17.43).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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