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# Process Development of Drying of Mushroom

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**ABSTRACT:** Button mushroom is the most widely cultivated and consumed mushroom in the world, accounting for approximately 90 per cent of total country production versus a global share of approximately 40 per cent. Mushroom is a high-quality protein source that contains the majority of the essential amino acids, vitamins, and minerals. It is also popular for its delicacy and exotic flavour. However, mushroom is a highly perishable product that requires processing to extend its storage life. The most common and traditional method of food preservation is drying. The drying methods, drying air temperatures, and drying time all had a significant impact on the dried product's quality. Mushroom slices were dried using three different methods: tray drying, heat pump drying at three different temperatures (50, 60, and 70°C), and freeze drying. The drying rate increased with drying air temperatures for tray and heat pump drying methods. The time required for drying was minimum in case of heat pump dryer. The dehydration ratio ranged between 11.85 to 12.94 in tray drying, 11.86 to 12.97 in heat pump drying and 11.86 in freeze drying. Ascorbic acid was found maximum i.e., 25.95 mg/100 g in freeze drying.

**KEYWORDS:** Button mushroom, Dehydration ratio, Ascorbic acid, Tray dryer, Heat pump dryer, Freeze dryer.

## I. INTRODUCTION

Mushroom is a macroscopic fungus with a distinct fruiting body that lacks chlorophyll, requiring a substrate for nutrient absorption. When matured, the real fungus, which is a microscopic fine thread-like structure, is used to grow on the substratum or below the surface of soil. Mushrooms have been discovered to be a time-honored food of many cultures around the world (Chang and Buswell, 1996)[4]. They have been used not only for consumption but also for medicinal purposes (Yang et al., 2001)[14]. Mushrooms have been valued as an important food since ancient times due to their taste, flavour, and high medicinal and nutritional properties. Mushrooms represent one of the world's greatest sources of nutrition and an acceptable food for the future. Mushroom have been used as a nutrient supplement in the form of tablets to boost immunity. Because of its high protein content, developing countries were also advised by FAO to bridge the protein gap in order to combat poverty, malnutrition, and waste management (Nehru et al., 1995)[10]. Mushrooms are very useful for diabetic and heart patients due to its low cholesterol and fat contents (Bahl, 1983)[3]. Fresh button mushroom contain 2.18 g of protein, 0.34 g of total fat, 1 g of dietary fibre, 3.26 g of carbohydrates, 3.607 mg niacin, and 2.1 mg vitamin C. Per 100 g, there are 3 mg of calcium, 0.318 mg of copper, 0.50 mg iron, 9 mg magnesium, 86 mg phosphorus, 9.3 g selenium, and 0.52 mg zinc. (According to USDA National Nutrient Database). Button mushrooms are highly perishable due to their high moisture content. Opening of veils and browning are the first signs of deterioration and major contributors to quality losses. As a result, using the best post-harvest technique to extend the shelf life and maintain the quality of the mushroom can be critical in its commercialization. Among the various methods of preservation, drying is an energy-intensive operation in which the water activity of the food is reduced by removing the water. The primary goal of any drying process is to produce a dried product of desired quality at the lowest possible cost while minimising enzymatic and microbiological reactions. Traditionally, mushrooms are dried in the open sun, resulting in unsanitary and low-quality products (Chua et al., 2001)[5]. Conventional drying of mushroom has been reported by many researchers but colour deterioration and structural deformation are noticeable in hot-air dried mushrooms. Freeze drying has been used to address these issues. It has been discovered that freeze-dried mushrooms have excellent colour, flavour, and rehydration capacity. When compared to thermal treatment methods, freeze-drying or lyophilization has been identified as an effective method for drying bio-products while preserving available food nutrients (Xu et al., 2015)[7].

## II. RELATED WORK

The rehydration characteristics of the button mushroom dried by different drying methods studied by Arumuganathan *et al.* (2003)[2]. Button mushroom slices were dried by various methods of dehydration namely, sun-drying, fluidized bed drying, cabinet air-drying, osmo-air drying, freeze-drying and the dried product was assessed for rehydration characteristics including its suitability for preparation of mushroom curry. Organoleptic evaluation of rehydrated product showed that the texture, colour and flavour of the rehydrated samples of freeze-dried mushrooms were very good. Rehydrated mushrooms were used for preparation of mushroom curry which was found acceptable in the organoleptic evaluation.

The rehydration of freeze-dried and convective dried *Boletus edulis* mushrooms studied by Hernando *et al.* (2008)[9]. To assess the effect of rehydration temperature on some quality parameters, experiments at 20 and 70 °C were performed with convective dried and freeze-dried mushrooms. Rehydration characteristics (through Peleg's parameter,  $k_1$  and equilibrium moisture,  $W_e$ ), texture and microstructure were evaluated. Freeze-dried samples absorbed water more quickly and attained higher equilibrium moisture values than the convective dried ones. Freeze-dried samples showed a porous structure that allowed rehydration to take place mainly at the extracellular level. This explained the fact that, 10 regardless of temperature, freeze-dried mushrooms absorbed water more quickly and reached higher equilibrium moisture values than convective dried ones.

Wankhade *et al.* (2013)[13] compared traditional drying and other drying methods for the reduction of the drying time and to a significant improvement of the product quality in terms of color texture and taste. Drying characteristics of okra slices were investigated in a hot air dryer for a temperature range of 60 to 90°C at constant air velocity 1.0 m/s. Results indicated that drying took place in the falling rate period. The sample dried at 40°C was found better in color, texture and taste as compared to the samples obtained at 60 and 90 °C.

The drying of date fruit conducted by Gokcen (2016)[8]. Date slices were dried with the three drying methods namely convective (60, 70 and 80 °C), microwave (120 W) and freeze drying to compare the dried fruit quality. All colour parameters changed depending on the drying method and colours closest to the fresh sample were obtained with freeze drying.

## III. METHODOLOGY

Button mushrooms were collected from the Plant Pathology Department of the Rajasthan College of Agriculture, Udaipur and kept in a refrigerator at 4-5 °C for further use. The sample were washed thoroughly under running water to remove adhering impurities and graded by size to eliminate variations in exposed surface area. Button mushroom samples were vertically cut into uniform shape and size from the middle portions using a stainless-steel knife (approximately 5 mm thickness). Drying experiments were carried out using slices that had a distinct shape. The samples were dried at 50, 60 and 70°C in a convective tray, heat pump and freeze dryers. The initial moisture content of the mushroom sample was determined as per AOAC (2000)[1].

The mass of samples was measured after a regular interval of time and moisture contents of the samples were determined by mass balance equations.

## IV. RESULTS AND DISCUSSION

The drying time required to obtain the desired moisture content for mushroom samples in a tray and heat pump dryer at 50, 60 and 70°C was 720-960, 840-660 and 1080 minutes for freeze dried samples. The drying rate curves and moisture were determined by drying characteristics data analysis. There was a significant difference in drying time to attain the final moisture content (FMC) in the range of 7.028 to 10.151 per cent (dry basis) from the initial moisture content of 85 to 93 per cent (wet basis). The minimum time required for drying was 660 min for 70°C temperature in a heat pump dryer and the maximum time required was for drying samples in a freeze dryer which was 1080 min (Table 1). It was also found that the drying time required in a heat pump dryer was less when compared with the tray dryer for all the temperatures to achieve the same final moisture content, the observations are in line with the findings reported by Costa *et al.* (2015) [6]. Many researchers have also observed that the heat pump dryer can reduce the drying time (Phoungchandang *et al.* 2009; Phoungchandang and Saentaweek, 2011)[11, 12]. Heat pump drying of button mushroom at 70°C air temperature needed short drying time to make stable product with good quality dried product as



compared to tray dried mushroom samples. Moisture loss per minute was higher in the beginning and then began to decrease with drying time. It was discovered that drying took place entirely during the falling rate period, with no constant rate period observed. The time needed to freeze dried mushroom was reduced to 960 minutes whereas the tray and heat pump dried mushroom samples at 70°C needed 660 and 600 minutes respectively. Colour value L (lightness) was highest (73.15) in freeze dried mushroom slices and lowest (68.28) in tray dried product. Water activity was highest (3.14) in case of tray dried mushroom slices and lowest (0.193) in freeze dried product. Ascorbic acid was lowest (16.18 mg/100g) in tray and highest (25.95 mg/100g) in freeze dried mushroom slices. Rehydration ratio was highest (4.98) in freeze dried mushroom slices and lowest (2.97) in tray dried mushroom slices respectively.

Table 1: Comparison of drying parameters of mushroom in tray, heat pump and freeze dryer

Drying Methods	Temp(°C)	Time(min)	IMC (% db)	FMC (% db)	R <sup>2</sup>	D <sub>r</sub>	a <sub>w</sub>	R <sub>r</sub>
Traydrying	50	960	1150	10.151	0.9907	11.85	0.341	3.24
	60	900	1150	8.504	0.9960	12.03	0.286	3.02
	70	720	1150	7.334	0.9965	12.94	0.213	2.97
Heatpump drying	50	840	1150	9.988	0.9949	11.86	0.311	3.87
	60	720	1150	8.223	0.9930	12.38	0.272	3.66
	70	660	1150	7.028	0.9911	12.97	0.198	3.54
Freeze drying	- 40	1080	1150	10.151	0.9988	11.86	0.193	4.98

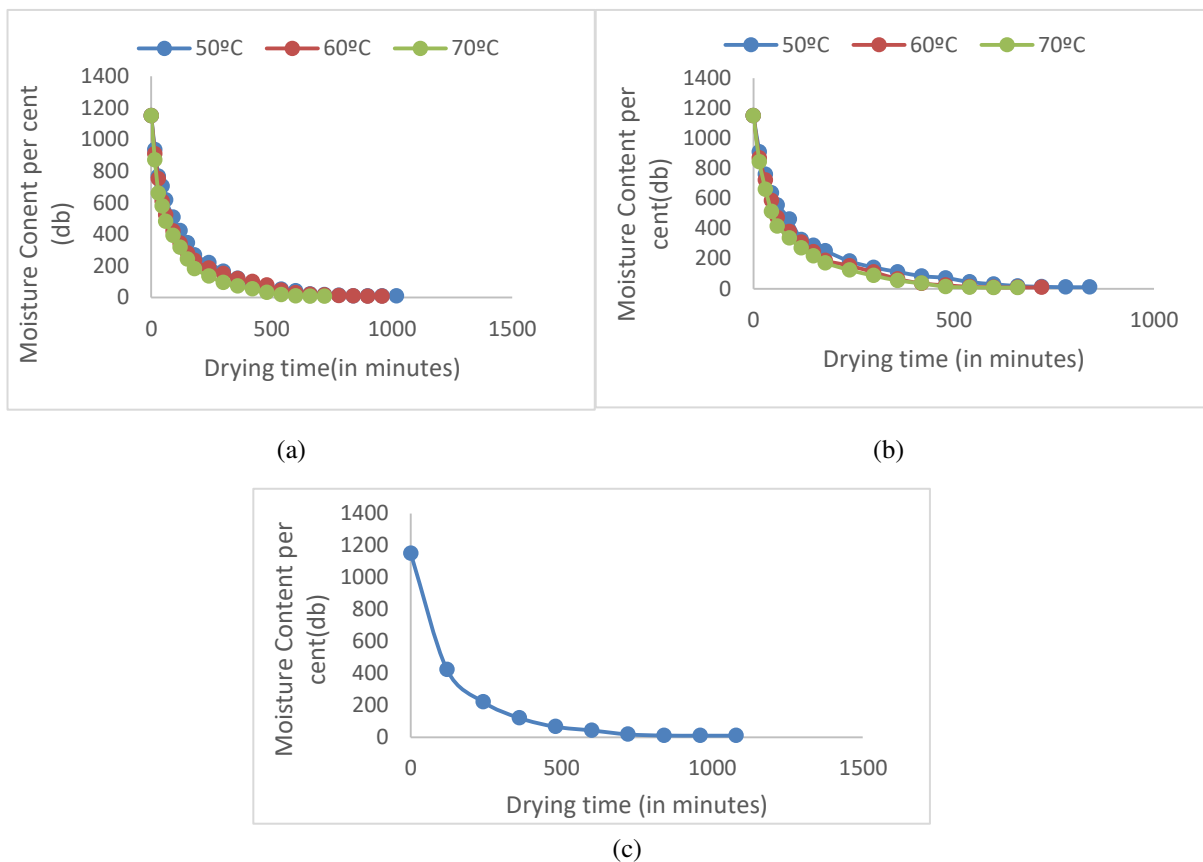


Fig 1: Variation in moisture content with drying time for (a) tray drying of sample (b) heat pump drying of sample and (c) freeze drying of sample

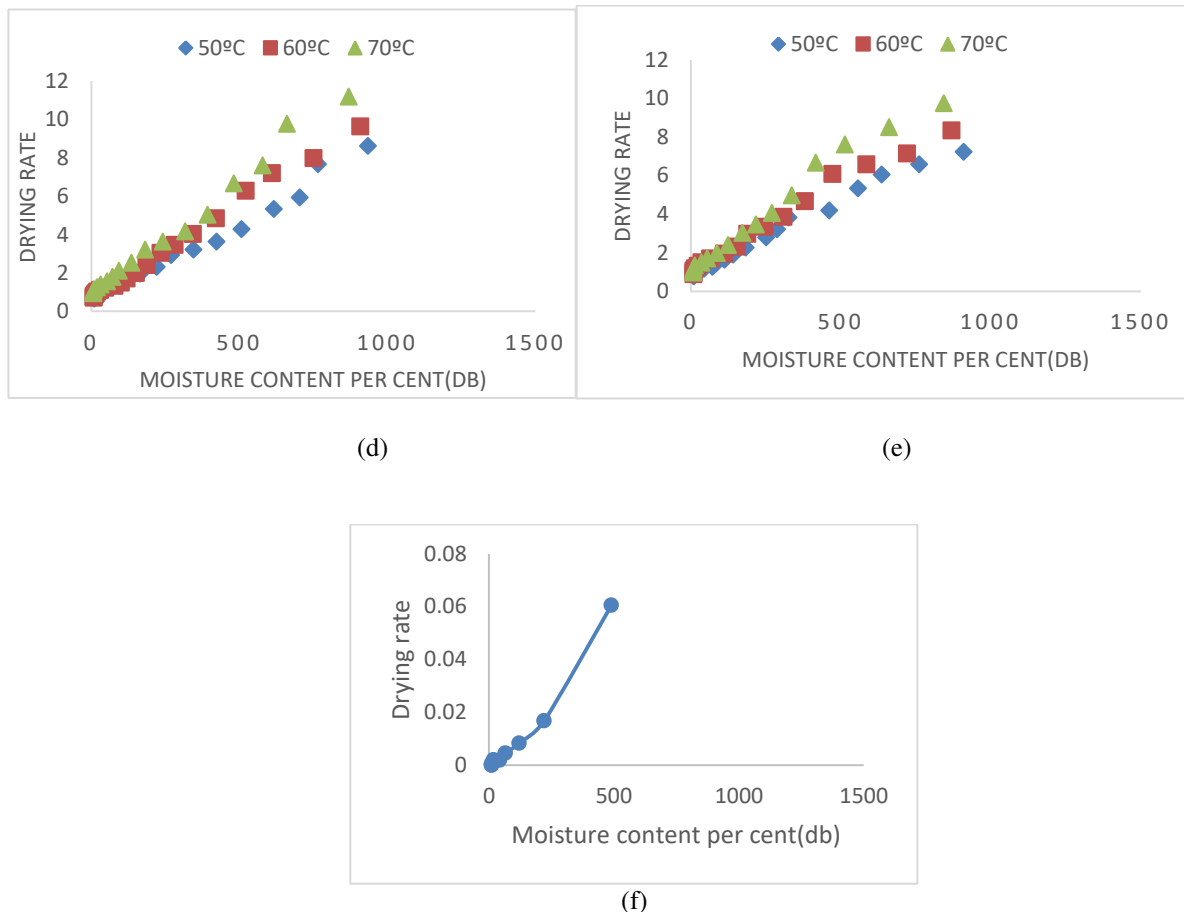


Fig 2: Variation in drying rate with moisture content for (a) tray drying of sample (b) heat pump drying of sample and (c) freeze drying of sample

We concluded from the Figures (d, e, and f) that the entire drying was carried out in a falling rate period for the entire duration, which was due to internal mass transfer caused by diffusion in all of the samples. The drying time decreases as the drying air temperature rises. According to kinetic theory, the energy of water molecules increases as temperature rises, allowing water molecules to escape more easily and quickly.

#### IV. CONCLUSION

The effect of drying methods on the drying characteristics of mushroom was studied. The increase in temperature reduced drying time. Heat pump drying of button mushroom at 70°C air temperature needed short drying time to make stable product with good quality dried product as compared to tray dried mushroom samples. The time needed to freeze dried mushroom was reduced to 960 minutes whereas the tray and heat pump dried mushroom samples at 70°C needed 660 and 600 minutes respectively. Water activity was highest (3.14) in case of tray dried mushroom slices and lowest (0.193) in freeze dried product. Colour value L (lightness) was highest (73.15) in freeze dried mushroom slices and lowest (68.28) in tray dried product. Ascorbic acid was lowest (16.18 mg/100g) in tray and highest (25.95 mg/100g) in freeze dried mushroom slices. Rehydration ratio was highest (4.98) in freeze dried mushroom slices and lowest (2.97) in tray dried mushroom slices respectively.

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