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**RESEARCH PAPER**

# Osmotic Dehydration of Button Mushroom

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**Abstract**

Osmotic dehydration of button mushrooms (*Agaricus bisporus*) slices carried out done by dipping them in brine of different concentrations of salt (10%, 20% and 30%), mass ratios (1/10 and 1/25 w/w) solution at a temperature of 60°C, and duration of 30 minutes. With respect to water loss (WL) and salt gain (SG), with the increase in concentration of salt, the water loss increased and the solid gain decreased. The quality of dehydrated slices were evaluated on the basis of moisture per cent, non-enzymatic browning, rehydration ratio and colour values. The lowest moisture content (6.3%) and non-enzymatic browning (0.37) and highest rehydration ratio of 2.68 respectively was observed in treatment $T_6$ (containing salt 30g and mushroom to solution ratio of 1:25) nad thus, was the best.

**Keywords:** Button mushroom, osmotic dehydration, water loss, salt gain, rehydration ratio, non-enzymatic browning

Production and consumption of mushrooms is increasing due to their medicinal and nutritional value (Rai and Arumuganathan, 2003). The world's largest button mushroom growing unit is located in Punjab, India (Mehta *et al.,* 2011). Punjab alone produces about 32% of the total production in India. In India, white button mushroom (*Agaricus bisporus)*, oyster mushroom (*Pleurotus sajor-caju)* and the paddy straw mushroom (*Volveriella volvaceae)* are commercially grown of which white button mushrooms contributes 90%, to the total production. The white button mushrooms are low in calorie, as the carbohydrates are stored as glycogen: chitin, hemicellulose instead of starch (Matilla *et al.* 2001). But due to high moisture content, they start deteriorating immediately within a day after harvest due to microbial, enzymatic and chemical reactions. Thus, it is very important to evolve a suitable method of preservation for increasing the shelf-life besides maintaining this quality. It can be achieved by some type of processing e.g. heating, dehydration. To save the crop from post-harvest losses, it has to be preserved in one or the other form and drying is one of the methods of preservation. Drying is the easiest means to increase the longivity of high moisture products (Shukla and Singh, 2007). On the other hand, mushrooms are very sensitive to temperature, therefore choosing a proper method of drying is a very important decision (Rezagah *et al.* 2010).

Osmotic dehydration is used for partial removal of water from materials such as fruits and vegetables by immersing in aqueous solutions of high osmotic pressure such as sugar and salts (Pandharipande *et al.* 2012). It is used as a pre-treatment before hot – air drying of mushrooms because it has the advantage of improving nutritional, sensorial and functional aspects of foods without changing its colour, texture and aroma. Besides, the osmotic dehydration minimizes the thermal damage to colour and flavor prevents enzymatic browning (Mehta *et al.* 2013).

Due to their unique and subtle flavor, mushrooms have been used as food and food flavoring material in soups for centuries (Tulek, 2011).

The dehydrated productd offer, apart from increased shelf-life, the advantage of decreased mass and volume which have the potential for savings in the cost of packaging, handling, storage and transport of the product. The methods of drying as well as physiological changes that occur in foods during drying affect the quality of the dehydrated products. Conventional air drying is one of the most frequently used methods for mushroom dehydration, which involves thermal and/or chemical pretreatment and drying at temperature maintained between 50 and 70$^{o}$C. Due to long drying time and overheating of surface during hot air drying, the problems of darkening in colour, loss in flavour and decrease in rehydration ability occur (Giri and Prasad, 2012). It may be mentioned that pretreatments of mushrooms before drying in one form or other viz, washing in water, potassium metabisulphite (KMS), sugar, salt either alone or in combination help in checking enzymatic browning, stabilizing colour, enhancing flavour retention and maintaining textural properties (Walde *et al.* 2006). Thus, dehydration combined with some pre-treatments appear to be a cost effective method of preservation for Indian conditions as dehydrated mushrooms are easy to transport as compared to the canned, pickled and frozen products. The purpose of the present work was to study the effect of osmotic process parameters viz. brine temperature, salt concentration and duration of osmosis on water loss and solid gain, and to optimize these parameters for developing higher quality finished product. The results obtained are presented paper.

## Materials and Methods

Fresh button mushrooms were obtained from Dept. of Pathology, University of SKUAST-J, washed to remove dirt and sliced uniformly (5mm thickness) with a sharp knife. Mushroom slices were then, dipped in different salt solution concentrations maintained at a temperature of 60$^{o}$ C and kept for 30 minutes on a water bath. After dipping, the slices were subjected to dehydration for 5 hours in hot air oven. The treatment details are mentioned in Table 1, whereas the processing steps are shown in Fig. 1. Commercial salt was used as an osmotic agent. The brine solution of desired concentration was prepared by dissolving the required quantity of salt (w/v) in water.

**Table 1. Detail of osmotic treatment of button mushrooms**

| Treatments | Salt concentration | Mass Ratio |
|---|---|---|
| $T_1$ | 10 | 1:10 |
| $T_2$ | 10 | 1:25 |
| $T_3$ | 20 | 1:10 |
| $T_4$ | 20 | 1:25 |
| $T_5$ | 30 | 1:10 |
| $T_6$ | 30 | 1:25 |
| $T_7$ | Plain water | 1:10 |
| $T_8$ | Plain water | 1:25 |

Fresh mushrooms
↓
Sorting and cleaning
↓
Slicing
↓
Immersion in brine solution (60$^{o}$C for 30 min.)
↓
Draining
↓
Drying
↓
Dehydrated mushrooms

**Fig. 1: Processing steps for osmotic dehydration of button mushrooms**

## Physico-chemical Analysis

The dehydrated product was kept in a desiccator soon after removal from the dryer and was used for further analyses. Rehydration ratio was determined according to the method described by Ranganna (1986). Colour of the fresh and dehydrated product was measured by Hunter Colour meter and expressed as L*(whiteness/darkness), a*(red/green) and b*(yellow/blue). Sample slices were kept on the specimen port so as to cover the full exposed area of the port to the light. All measurements were replicated thrice and the mean readings were taken.

**Results and Discussion**

The mass transfer process with respect to water loss and solid gain occurred at the same time. During the extended osmotic treatment, in an increase of solute concentrations resulted in the increase in water loss and solid gain rates as separated earlier (Phisut, 2012). The highest water loss of 61.90% was observed in treatment $T_6$(mass to solution ratio, 1:25 with 30%salt concentration) and the highest solid gain of 2.75 per cent was found in treatment $T_2$ (Table 2). Nsonzi and Ramaswamy (1998) had stated that even though the moisture loss and solids gain occurred at the same time, the rate of moisture loss was much higher than the rate of solids gain. The increased osmotic solution concentrations led to increased weight reductions which is attributed to the water activity of the osmotic solution that is decreases with the increase in solute concentration in the osmotic solution (Marcotte, 1991; Tortoe, 2010). The moisture content was reduced during osmotic dehydration. The lowest moisture content of 6.3 %was recorded in the treatment $T_6$ and the highest moisture content of 11.7% was recorded in $T_8$as more loss of water occured in solutions with higher concentrations (Rezagah *et al.* 2010) (Table 3). The lowest rehydration ratio of 1.40 took place in $T_7$ and the highest rehydration ratio of 2.68 was obtained in $T_6$. Rehydration ratio increased with the increase in salt concentration. It may be noted that higher rehydration ratio indicates better quality product (Kulshreshtha, *et al.* 2009).

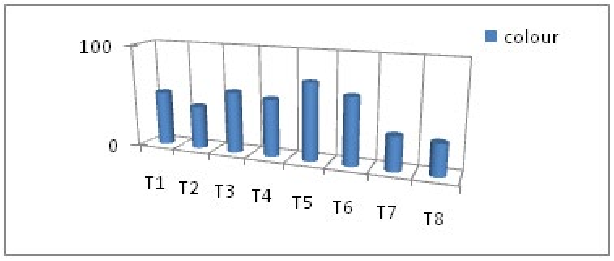


**Fig. 2: Effect of different concentration on the color (whiteness) of mushrooms ($T_7$ and $T_8$ are control treatments with different mass to solution ratio)**

The lowest non-enzymatic browning of 0.37 was recorded in $T_6$ and the highest value of 0.72 was observed in $T_7$ (Table 3). Osmotic and air dried green pumpkins had lower browning degree than blanching and air dried green pumpkins at both the processing temperatures (60 and 80$^o$C). Browning however, is known to decrease with the increase in salt concentration (Chang, 2003) and the colour of the rehydrated mushrooms also improved with increased concentration. So the shelf-life of mushroom stored in brine solution at room temperature of 26-30$^o$C can be doubled. There was, thus a 100% improvement in shelf-life of mushroom when treated with 30% brine solution when compared with control that had a shelf-life of 3 days (Victor and Obele, 2013). The lowest L* value of 30.32 was observed in $T_8$ (Fig. 2) and highest L* value of 73.77 was observed in $T_5$ where lower salt concentration was used whereas the highest a* (8.47) and b* (22.06) value

(L

was observed in $T_2$ and the lowest a* (0.61) and b* (3.07) value was documented in $T_5$ (Table 4). The present results are supported by Ghavidel and Davoodi, 2009 and Nour *et al.* (2011) who have reported that, pre-drying treatments had a significant effect on the whiteness and colour change of dried mushroom slices. Drying at 50°C – 70°C produced dried mushroom slices of superior quality exhibiting the highest lightness, lowest colour change and maximum rehydration ratio.

**Table 2. Water loss and solid gain (%) at different concentration**

| Treatments | Concentration (w/w %) | Mass Ratio | Water loss (%) | Solid Gain (%) |
|---|---|---|---|---|
| $T_1$ | 10 | 1:10 | 38.38 | 1.50 |
| $T_2$ | 10 | 1:25 | 49.40 | 2.75 |
| $T_3$ | 20 | 1:10 | 42.90 | 0.90 |
| $T_4$ | 20 | 1:25 | 55.60 | 1.70 |
| $T_5$ | 30 | 1:10 | 47.40 | 0.59 |
| $T_6$ | 30 | 1:25 | 61.90 | 1.33 |

**Table 3. Effect of osmotic (brine) solution concentration on different quality parameters of mushroom**

| Treat-ments | Concen-tration (w/w %) | Mass Ratio | Moisture content (%) | Non-enzymatic browning (440nm) | Rehy-dration ratio |
|---|---|---|---|---|---|
| $T_1$ | 10 | 1:10 | 10.1 | 0.66 | 1.98 |
| $T_2$ | 10 | 1:25 | 9.75 | 0.55 | 2.25 |
| $T_3$ | 20 | 1:10 | 8.9 | 0.50 | 2.39 |
| $T_4$ | 20 | 1:25 | 9.2 | 0.41 | 2.59 |
| $T_5$ | 30 | 1:10 | 8.1 | 0.38 | 2.62 |
| $T_6$ | 30 | 1:25 | 6.3 | 0.37 | 2.68 |
| $T_7$ | D.W | 1:10 | 11.5 | 0.72 | 1.40 |
| $T_8$ | D.W | 1:25 | 11.7 | 0.70 | 1.45 |
| C.D (0.05) | | | 1.76 | 0.170 | N.S |

**Table 4. Colour of rehydrated mushrooms**

| Treat-ments | Concen-tration (w/w %) | Mass ratio | L* | a* | b* |
|---|---|---|---|---|---|
| $T_1$ | 10 | 1:10 | 52.49 | 3.34 | 6.99 |
| $T_2$ | 10 | 1:25 | 41.21 | 8.47 | 22.06 |
| $T_3$ | 20 | 1:10 | 58.49 | 2.04 | 4.74 |
| $T_4$ | 20 | 1:25 | 54.89 | 2.81 | 5.69 |
| $T_5$ | 30 | 1:10 | 73.77 | 0.61 | 3.07 |
| $T_6$ | 30 | 1:25 | 64.22 | 1.30 | 3.89 |
| $T_7$ | D.W | 1:10 | 32.52 | 5.53 | 14.43 |
| $T_8$ | D.W | 1:25 | 30.32 | 4.46 | 13.32 |
| **Mean** | | | 50.98 | 3.57 | 9.27 |

**Drying behaviour:** Curves of moisture content *versus* drying time for pretreated and control samples for different concentration and mass ratio are presented in Fig. 3 and Fig. 4. It is apparent that the moisture content and drying rate decrease continuously with the drying time. As shown in these figures, the falling-rate period was mostly observed in all mushroom samples at different drying temperature. Similar results have been shown by Doymaz, (2014) where it was showed that the physical mechanism governing moisture movement in the samples is dominated by the diffusion of water vapor or bound water through the dry tissue to the drying air at a rate slower than the evaporation rate from the surface. It means that the drying temperature and pretreatment have significant effects on the moisture removal from mushroom.

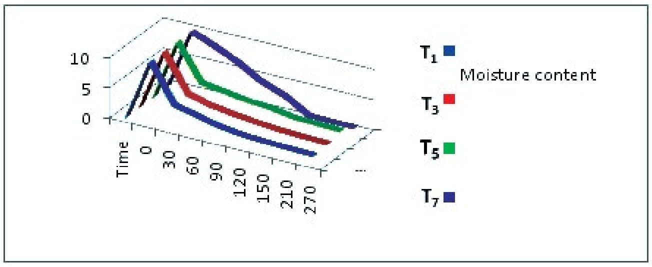


**Fig. 3: Drying Curves of mushroom with 1:10 mass ratio**

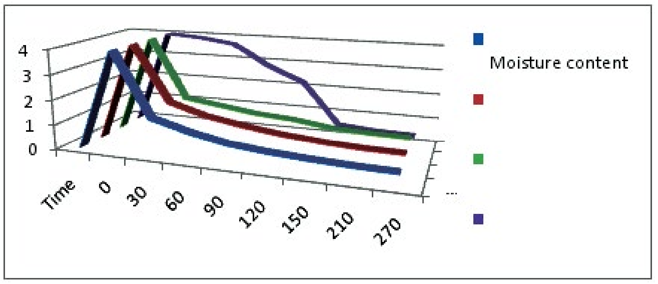


**Fig. 4. Drying curves for mushroom with 1:25 mass ratio**

## Conclusion

It was found that moisture content reduces during osmotic dehydration and more loss of water occurs in solutions with higher concentrations. Treatment of mushroom slices with a salt concentration of 30 (w/w%) at 60°C at a ratio of 1:25 resulted in a better rehydrated product and was thus found to be suitable as a pre-treatment for dehydration of button mushroom. Osmotic dehydration provides minimum thermal degradation of nutrients due to low temperature water removal process. It presents some benefits such as reducing the damage of heat to the flavor, color, inhibiting the browning of enzymes and decreases the energy costs (Akbarian *et al*. 2014).

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