International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 1601-1605

Received: 22-01-2018
Accepted: 25-02-2018

Sharma Anshu
Division of Food Science and Technology, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu Main Campus, Chatha, Jammu, Jammu and Kashmir, India

Bhat Anju
Division of Food Science and Technology, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu Main Campus, Chatha, Jammu, Jammu and Kashmir, India

Correspondence
Sharma Anshu
Division of Food Science and Technology, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu Main Campus, Chatha, Jammu, Jammu and Kashmir, India

Effect of osmotic dehydration on quality of oyster mushrooms

Sharma Anshu and Bhat Anju

Abstract
Osmotic dehydration was done in order to improve the quality of Oyster mushrooms. They were subjected to osmotic dehydration by dipping in brine solutions of concentrations of 5, 10 and 15% for 1 hour and dried by two methods i.e. sun drying and cabinet drying. Mushrooms treated with 15% NaCl and dried in cabinet tray dryer at 50^0C were best as there was lowest moisture content (7.75%), drying time (240 minutes), browning index (0.23) whereas dehydration ratio (12.5), rehydration ratio (2.41), total ash (7.89%) and total carbohydrates (59.54%) were higher.

Keywords: oyster mushrooms, osmotic dehydration, sun drying, cabinet drying, physico-chemical analysis

Introduction
Mushrooms are good source of protein, vitamin and minerals and have broad range of uses as food and medicine (Khan *et al.*, 2008) [11]. Mushrooms have become attractive as a functional food and as a source for the development of drugs and nutraceuticals (Ferreira *et al.*, 2009) [8] due to their antioxidant (Barros *et al.*, 2007) [4], antitumor (Wasser and Weis, 1999) [29] and antimicrobial properties (Correira *et al.*, 2008) [6]. *Pleurotus* as health promoter and environmental restorer is gaining more importance as compared to other medicinal mushrooms resulting in an upsurge in their research and development activities during the past two decades. The bioactive compounds present in this mushroom include polysaccharides, lipopolysaccharides, proteins, peptides, glycoproteins, nucleosides, triterpenoids, lectins, lipids and their derivatives. Because of their high medicinal value, consumption of oyster mushrooms can aid in ameliorating and preventing many ailments i.e. liver ailments, high blood cholesterol level, kidney problems, diabetes, hypertension, heart disease, gastric cancers, impaired immune response, hepatitis B, chronic fatigue syndrome, and microbial infection (Ooi *et al.*, 2000) [19]. Oyster mushrooms are very effective in reducing the total plasma cholesterol and triglyceride level (Alam *et al.*, 2007) [1] and thus reduce the chance of atherosclerosis and other cardiovascular and artery related disorders. Osmotic dehydration is one of the energy efficient means of dewatering process and works by soaking food in a higher osmotic pressure solution/hypertonic/concentrated solution such as salts, alcohols, starch solutions and concentrated sugars. It is used as a pre-treatment before hot-air drying of mushrooms (Shukla and Singh, 2007 and Dehkordi, 2010) [26, 7] 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 on colour, flavour and prevents enzymatic browning. Dehydration combined with some pretreatments appear to be a cost effective method of preservation (Rama and Jacob, 2000) [21] for Indian conditions as dehydrated mushrooms are easy to transport as compared to canned, pickled and frozen products (Murumkar *et al.*, 2007) [17]. Hence, development of appropriate storage and post-harvest technology in order to extend their marketability and availability to consumers in fresh as well as processed form is of immense importance.

Materials and Methods
Mushrooms were purchased from M/S Romesh Chander and Sons, Fresh Vegetable and Mushroom Shop, Parade, Jammu. They were washed with tap water and then kept on blotting paper to remove surface moisture. The research was conducted in the department of Food Science and Technology, SKUAST-J.

Mushrooms were cut into slices of 1 cm wide by 1 cm long for the stipe, while 1.5 cm by 3 cm long for the cap and subjected to osmosis by dipping in brine solutions of 5, 10 and 15% for 1 hour and dried by two methods i.e. sun drying and cabinet drying.

Treatment	Detail	
T_1	Control	Sun drying
T_2	5% NaCl	
T_3	10% NaCl	
T_4	15% NaCl	
T_5	5% NaCl	Drying method (Cabinet drying at 50^0C)
T_6	10% NaCl	
T_7	15% NaCl	

Moisture Content

Ten grams of mushroom were dried in hot air oven at 70°C in pre-weighed dishes till constant weight. The dish with dried sample was transferred to desiccators and cooled to room temperature. The dish was then weighed and moisture content in percent was calculated from loss in weight (AOAC, 2002).

$$\text{Percent (\%) moisture} = \frac{\text{Loss in weight (g)}}{\text{Weight of sample (g)}} \times 100$$

Dehydration ratio

Dehydration ratio was calculated by taking the weights of sample before drying and the weight of sample after drying.

$$\text{Dehydration ratio} = \frac{\text{Weight of sample before drying}}{\text{Weight of sample after drying}}$$

Rehydration Ratio

The rehydration ratio of dried mushroom flakes was determined by soaking samples with a defined weight (approx. 5 g) in boiling distilled water at 95°C for 20 minutes. The samples were removed, filtered, dried and weighed. In order to minimize the leaching losses, water bath was used for maintaining the defined temperature (Ranganna, 1986). Rehydration ratio (RR) of the samples was computed as follows:

$$\text{Rehydration ratio} = \frac{M_r}{M_d}$$

Where, M_r = Mass of rehydrated sample, g;
M_d = Mass of dehydrated sample, g

Drying Time

The total time taken for drying of mushrooms was calculated in minutes.

Browning Index

The degree of non-enzymatic browning of the dried mushrooms was determined following the method of Mudahar and Bains (1982) [16]. The color was extracted from dried mushroom using 60% ethanol, and the absorbance of the filtrate was measured using a spectrophotometer at 440 nm.

Crude Protein

Crude protein was estimated by micro-Kjeldhal method, using the factor 6.25 for converting nitrogen content into crude protein (Sadasivam and Manickam, 2008) [24]. Weighed sample of 2 g was digested with concentrated sulphuric acid (2 ml) and 2 g of catalyst mixture (K_2SO_4, $CuSO_4$ and SeO_2) in long neck kjeldhal flask for 2 hours till free from carbon. The contents were cooled and transferred to 100 ml volumetric flask and volume was made to 100 ml with distilled water. Measured aliquot was distilled with 40 per cent sodium hydroxide and liberated ammonia was collected through a condenser in a flask containing 10 ml 4 per cent boric acid solution and a few drops of mixed methyl red and bromocresol green indicator and was titrated against standardized 0.1 N sulphuric acid and protein content was calculated using the equation given below. A blank sample was also run along with the sample.

$$\text{Per cent Nitrogen} = \frac{\text{Titre value x 0.00014 x volume made}}{\text{Aliquot taken (g) x weight of sample (g)}} \times 100$$

Per cent Protein = per cent Nitrogen x 6.25

Crude fat

Five gram of dried sample was extracted with petroleum ether at 120^0C in Soxhlet extraction apparatus for six hours. Ether extract was filtered in pre-weighed beakers. The petroleum ether was completely evaporated from the beakers and the increase in weight of the beaker represented the fat content (AOAC, 2002) and was calculated as below:

$$\text{Per cent fat} = \frac{\text{Weight of fat (g)}}{\text{Weight of sample (g)}} \times 100$$

Total Ash

Five grams of each sample was weighed and taken in dry, clean silica dishes. It was first heated over bunsen flame. Then the samples were transferred into the muffle furnace and burnt at 525°C temperature for 4-6 hours and ignited until light grey ash resulted (or to constant weight). The samples were then cooled in desiccators and weighed (Ranganna, 1986). The ash content was expressed as:

$$\text{\% Ash} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

Total Carbohydrates

Carbohydrate content of the samples was determined as total carbohydrate by difference that is by subtracting the measured protein, fat, ash and moisture from 100 (Pearson, 1970) [20].

Statistical Analysis

The results obtained were statistically analyzed using completely randomized design (CRD) for interpretation of results through analysis of variance.

Results and Discussion

Moisture Content

The moisture content of osmotically dehydrated mushrooms ranged from 7.75 to 9.08 per cent (Table-1). The highest moisture content was recorded as 9.08 per cent in T_1 (Control) and lowest (7.75 per cent) was recorded in T_7 (15% NaCl Cabinet drying). Moisture content was observed to decrease with the increase in NaCl concentration in both drying +methods i.e. sun drying and cabinet drying. The moisture content was more in untreated sun dried oyster mushrooms while it was less in osmotically pretreated cabinet dried oyster

mushrooms. These results are in agreement with the findings of Tolera and Abera (2017) [28] who reported the highest moisture content in sun-dried mushroom samples and lowest in oven dried samples. This might be due to moisture absorption of the dried samples from the environment. In sun drying methods, case hardening might occur and causing the moisture content to be higher than samples dried by other drying methods under similar treatment conditions.

Dehydration and rehydration ratio

The dehydration ratio ranged from 10.5 to 12.5 (Table-1). The dehydration ratio was highest in T_7 (15% NaCl Cabinet drying) with mean value of 12.5 and lowest was recorded as 10.5 in T_1 (Control). There was significant difference in dehydration ratio among various treatments. The dehydration ratio was more in osmotically dehydrated cabinet dried oyster mushrooms as compared to osmotically dehydrated sun dried mushrooms. Suresh Kumar and Sagar (2014) [27] reported that the superior drying ratio was obtained in the fruits dried in cabinet drier. The good results of cabinet drier was due to high temperature, low RH and constant air flow (Jayaraman *et al.*, 1999 and Sharma and Prasad, 2002) [9, 25].

The highest rehydration ratio was recorded in T_7 (15% NaCl cabinet drying) with mean value of 2.41 and lowest in T_1 (Control) with mean value of 2.01 (Table-1). There was significant difference in rehydration ratio among various treatments. 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) [13]. Bhuvaneswari *et al.* (1999) [5] reported that rehydration ratio of osmotically treated peas was higher than those of untreated samples.

Table 1: Effect of osmotic dehydration on moisture content (%), dehydration ratio and rehydration ratio of dried oyster mushrooms

Treatments		Moisture content (%)	Dehydration ratio	Rehydration ratio
T_1 (Control)	Sun drying	9.08	10.5	2.01
T_2 (5% NaCl)	Sun drying	8.32	10.9	2.15
T_3 (10% NaCl)	Sun drying	8.25	11.1	2.21
T_4 (15% NaCl)	Sun drying	8.17	11.5	2.30
T_5 (5% NaCl)	Cabinet drying	7.97	11.8	2.23
T_6 (10% NaCl)	Cabinet drying	7.88	12.2	2.34
T_7 (15% NaCl)	Cabinet drying	7.75	12.5	2.41
Mean		8.20	11.5	2.23
$CD_{(0.05)}$		0.08	0.97	0.09
±S.E.(m)		0.03	0.32	0.03

Drying time and browning index

The drying time ranged from 240 to 400 minutes (Table-2). The drying time was highest in T_1 (Control) with a mean drying time of 400 minutes and lowest (240 minutes) in T_7 (15% NaCl). There was significant difference in drying time among various treatments. The total time taken to dry the osmotically pretreated mushrooms was less as compared to untreated mushrooms (Control) as shown in Fig. 1. This may be due to initial moisture reduction during the osmosis. This is in agreement with the results obtained by Kaleemullah *et al.* (2002) [10] in osmotically dehydrated papaya cubes and Amuthan *et al.* (1999) [2] in osmosed milky mushrooms *Calocybe indica*.

Browning index for different treatments has been presented in Table-2. Browning index of mushrooms decreased with the increasing concentration of sodium chloride in dipping solutions. It was maximum (0.62) in T_1 (Control) and minimum (0.23) in T_7 (15% NaCl). There was significant difference in browning index among various treatments. Lee *et al.* (2011) [14] observed that control samples were found darker in color when compared to the pretreated samples regarding the study of osmotic dehydration pretreatment for drying of pumpkin slices.

Table 2: Effect of osmotic dehydration on drying time (minutes) and browning index of dried oyster mushrooms

Treatments		Drying time (minutes)	Browning index
T_1 (Control)	Sun drying	400	0.62
T_2 (5% NaCl)	Sun drying	350	0.40
T_3 (10% NaCl)	Sun drying	330	0.36
T_4 (15% NaCl)	Sun drying	330	0.33
T_5 (5% NaCl)	Cabinet drying	260	0.31
T_6 (10% NaCl)	Cabinet drying	250	0.27
T_7 (15% NaCl)	Cabinet drying	240	0.23
Mean		308	0.36
$CD_{(0.05)}$		18.7	0.08
±S.E.(m)		6.10	0.03

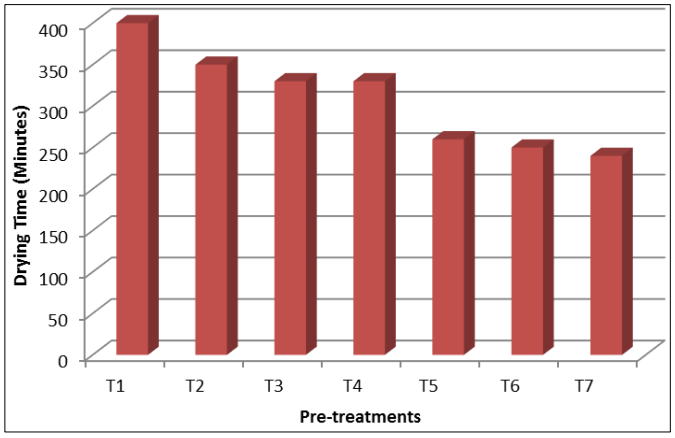

Fig 1: Effect of osmotic dehydration on drying time (minutes) of dried oyster mushrooms

Crude protein and crude fat

Data representing the crude protein has been presented in Table-3. The highest crude protein was recorded in T_2 (5 % NaCl) with mean value of 26.94 per cent and lowest (23.11 per cent) in (T_7) treated with 15% NaCl. Crude fat content was maximum (2.32 per cent) in T_1 (Control) while it was minimum (1.71 per cent) in T_7 (15% NaCl). Crude protein and crude fat contents of dried mushrooms were observed to decrease with the increase in NaCl concentration. It may be due to greater protein solubilization during osmotic treatment (brining) for a longer brining time (Muyanja *et al.*, 2014) [18]. Our results are in agreement with the findings of Tolera and Abera (2017) [28] regarding the study of nutritional quality of oyster mushroom (*Pleurotus ostreatus*) as affected by osmotic pretreatments and drying methods. Regula and Siwulski (2007) [23] observed similar findings regarding the crude fat content in dried shiitake (*Lentinulla edodes*) and oyster (*Pleurotus ostreatus*) mushrooms.

Total ash and total carbohydrates

The total ash content ranged from 4.68 to 7.89 per cent (Table-3). The highest total ash content was recorded in T_7 (15% NaCl) with mean value of 7.89 per cent and lowest (4.68 per cent) in T_1 (Control). Total carbohydrates content of osmotically dehydrated mushrooms as affected by pretreatments and drying methods has been presented in Table- 3. It ranged from 57.07 per cent in T_1 (Control) to 59.54 per cent in T_7 (15% NaCl). The increase in ash content in osmotically dried mushrooms is perhaps due to sodium in the solution that might have migrated into the mushroom slices when the water drained out. This is due to the simultaneous process of water and solute diffusion in osmotic dehydration (Krokida *et al.*, 2003 and Lerici *et al.*, 1985) [12, 15]. The carbohydrate content of dried mushroom slices increased with the strength of osmotic concentration regardless of drying methods. This might be due to the increase in total ash content with the strength of salt concentration (Tolera and Abera, 2017) [28].

Table 3: Effect of osmotic dehydration on crude protein (%), crude fat (%), total ash (%) and total carbohydrates (%) of dried oyster mushrooms

Treatments		Crude protein (%)	Crude fat (%)	Total ash (%)	Total carbohydrates (%)
T_1 (Control)	Sun drying	26.85	2.32	4.68	57.07
T_2 (5% NaCl)	Sun drying	26.94	2.21	5.24	57.29
T_3 (10% NaCl)	Sun drying	25.97	1.98	6.02	57.78
T_4 (15% NaCl)	Sun drying	25.18	1.81	6.99	57.85
T_5 (5% NaCl)	Cabinet drying	24.68	2.07	6.12	59.16
T_6 (10% NaCl)	Cabinet drying	23.76	1.89	7.08	59.39
T_7 (15% NaCl)	Cabinet drying	23.11	1.71	7.89	59.54
Mean		25.21	1.99	6.29	58.30
$CD_{(0.05)}$		0.13	0.11	0.11	0.13
±S.E.(m)		0.04	0.03	0.04	0.04

Acknowledgement

This study was funded by Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Chatha, Jammu.

References

1. Alam N, Hossain S, Khair A, Amin R, Asaduzzaman K. Comparative effects of oyster mushrooms on plasma lipid profile of hypercholesterolaemic rats. Bangladesh Journal of Mushroom. 2007; 1:15-22.
2. Amuthan G, Visvanathan R, Kailappan R, Sreenarayanan VV. Studying of osmo-air drying of milky mushroom *Calocybe indica*. Mushroom Research. 1999; 8:49-52.
3. AOAC. Official methods of analysis. Association of Analytical Chemists, Washington, DC, 2002.
4. Barros L, Ferreira MJ, Queiros B, Ferreira I, Baptista P. Total phenols, ascorbic acid, beta-carotene and lycopene in Portuguese wild edible mushrooms and their antioxidant activities. Food Chemistry. 2007; 103(2):413-419.
5. Bhuvaneswari S, Sreenarayanan VV, Kailappan R, Parvathy K. Osmotic dehydration of peas. Indian Food Packer. 1999; 53:10-12.
6. Correira DM, Barros L, Ferreira ICFR, Baptista P, Bulega CS. Optimization of the determination of tocopherols in *Agaricus* species edible mushrooms by a normal phase liquid chromatographic method. Food Chemistry. 2008; 110:1046-1050.
7. Dehkordi BM. Optimization of the process of osmo-convective drying of edible button mushrooms using response surface methodology. International Journal of Chemical and Molecular Engineering. 2010; 4(1):106-110.
8. Ferreira ICFR, Barros L, Abreu RMV. Antioxidants in wild mushrooms. Current Medicinal Chemistry. 2009; 16:1543-1560.
9. Jayaraman KS, Vibhakara HS, Mohan MS, Ramanuja MN. Browning and carotenoid oxidation in some high moisture fruit slices prepared by hurdle technique as compared with intermediate moisture fruits during storage. Journal of Food Science and Technology. 1999; 36(6):555-557.
10. Kaleemullah S, Kailappan R, Varadharaju N. Studies on osmotic-air drying characteristics of papaya cubes. Journal of Food science and Technology. 2002; 39(1):82-84.

11. Khan MA, Amin RSM, Uddin MN, Tania M, Alam N. Comparative study of The Nutritional composition of oyster mushroom cultivated in Bangladesh. Bangladesh Journal of Mushroom. 2008; 2:9-14.
12. Krokida MK, Karathanos VT, Maroulis ZB, Marinos-Kouris D. Drying Kinetics of some vegetables. Journal of Food Engineering. 2003; 59:391-403.
13. Kulshreshtha M, Singh A, Vipul D. Effect of drying conditions on mushroom quality. Journal of Engineering Science and Technology. 2009; 4(1):90-98.
14. Lee JS, Lim LS. Osmo-dehydration pretreatment for drying of pumpkin slice. International Food Research Journal. 2011; 18(4):1223-1230.
15. Lerici CR, Pinaavaia G, Dalla Rosa M, Bartolucci L. Osmotic dehydration of fruit: Influence of osmotic agents on drying behaviour and product quality. Journal of Food Science. 1985; 50(5):1217-1219.
16. Mudahar GS, Bains S. Pretreatment effect on quality of dehydrated Agaricus Bisporus mushroom. Indian Food Packer. 1982; 36(3):19-27.
17. Murumkar RP, Jain SK, Pisalkar PS, Verma RC. Effect of osmotic dehydration and drying air temperatures on the quality of dried white button mushroom. Journal of Agricultural Engineering. 2007; 44(3):80-83.
18. Muyanja C, Kyambadde D, Namugumya B. Effect of pretreatments and drying methods on chemical composition and sensory evaluation of oyster mushroom (*Pluerotus ostreatus*) powder and soup. Journal of Food Processing and Preservation. 2014; 38:457-465.
19. Ooi VEC, Liu F. Immunomodulation and anti-cancer activity of polysaccharide-protein complexes. Current Medicinal Chemistry. 2000; 7:715-719.
20. Pearson D. The Chemical Analysis of Foods. J. & A. Churchill Publisher, London, 1970.
21. Rama V, John PJ. Effects of methods of drying and pretreatments on quality of dehydrated mushroom. Indian Food Packer. 2000; 54(5):59-64.
22. Ranganna S. Manual of Analysis of Fruits and Vegetable Products. Tata McGraw Hill Publishing Company Ltd. New Delhi, 1986.
23. Reguła J, Siwulski M. Dried shiitake (*Lentinulla edodes*) and oyster (*Pleurotus ostreatus*) mushrooms as a good source of nutrient. Acta Scientiarum Polonorum Technologia Alimentaria. 2007; 6:135-142.
24. Sadasivam S, Manickam A. Biochemical Methods. New Age International Publisher, New Delhi, 2008.
25. Sharma GP, Prasad S. Comparison of convective and microwave drying of garlic: kinetics and energy consumption. Journal of Food Science and Technology. 2002; 39(6):603-608.
26. Shukla BD, Singh SP. Osmo-convective drying of cauliflower, mushroom and greenpea. Journal of Food Engineering. 2007; 80:741-747.
27. Suresh Kumar P, Sagar VR. Drying kinetics and physico-chemical characteristics of osmo-dehydrated mango, guava and aonla under different drying conditions. Journal of Food Science and Technology. 2014; 51(8):1540-1546.
28. Tolera KD, Abera S. Nutritional quality of oyster mushroom (*Pleurotus ostreatus*) as affected by osmotic pretreatments and drying methods. Food Science and Nutrition. 2017; 00:1-8.
29. Wasser SP, Weis AL. Medicinal properties of substances occurring in higher basidiomycetes mushrooms: current perspectives. International Journal of Medicinal Mushrooms. 1999; 1:31-62.