JFST No. 172, Vol. 23, June 2026

Journal of Food Science and Technology (Iran)

Homepage:www.fsct.modares.ir

Scientific Research

Effect of osmotic pretreatments on physico-chemical properties of button mushroom and process optimization

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ARTICLE INFO

Article History:

Received: 2024/12/14

Review: 2025/08/05

Accepted: 2025/08/20

Keywords:

Rehydration,
Osmotic pretreatment,
Shrinkage,
Mushroom,
Optimization

DOI: **10.48311/fsct.2026.83726.0**

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ABSTRACT

This study aimed to examine the impact of osmotic pretreatment using sodium chloride at concentrations of 5%, 10%, and 15%, applied at temperatures of 30 and 50 degrees Celsius for durations of 60, 120, 180, and 240 minutes on the physicochemical properties of button mushrooms, including shrinkage, color parameter, firmness, and moisture content. Additionally, optimization was performed to identify the ideal conditions for the osmotic dehydration of button mushrooms utilizing the AHP-TOPSIS method with MATLAB 2019a software. Subsequently, the biotin content in the optimal sample was compared to the control sample. The results indicate that the moisture content, rehydration rate, color, and shrinkage of the sample were dependent on temperature. As the temperature increased, the moisture content of the sample increased, while the rehydration decreased. The results related to the color parameters revealed that as the temperature increased, the browning index decreased, while the extent of color changes increased. The shrinkage and firmness significantly decreased with the rise in temperature. It was also found that the concentration of the osmotic solution and the process time had a significant effect on the quality factors. By increasing the concentration of the osmotic solution, the moisture content of the sample decreased, as did rehydration, browning index, and shrinkage. The color changes increased as the concentration increased. The results also showed that with increasing time, color changes, shrinkage, and firmness increased, while the browning index decreased. The optimal conditions for osmotic dehydration were 50 degrees Celsius, 15% concentration, and 120 minutes. Overall, this method functions as a pretreatment technique for button mushrooms in the pharmaceutical, food, and cosmetic industries, due to its ability to shorten processing time, enhance energy efficiency, and alleviate adverse effects linked to the final process.

1- Introduction

The drying process significantly reduces the water content of food materials, thereby limiting the water activity, microbial and enzymatic activity of the product, minimizing physical and chemical changes during storage, and consequently extending shelf life. This results in the development of new products with novel qualitative and nutritional properties. Additionally, this process provides more variety and convenience for consumers, reduces packaging weight and volume, and decreases transportation and storage costs. Many studies have been conducted on drying fruits and vegetables [1,2]. Food drying, especially of fruits, can be done by various methods such as sun drying, hot air drying, microwave drying, combined methods, and so forth. Different pretreatments are used in drying processes to improve quality, quantity, and energy savings. One of these pretreatments is osmotic dehydration [3,4]. Osmotic dehydration involves removing part of the water from the food tissue by direct contact with a concentrated solution (such as sugar, salt, or mixtures of sugars and salts). Due to the concentration gradient between the food and the solution, two opposite flows occur: water moves out of the food tissue into the solution, and solids from the solution enter the food tissue. The primary goal of osmotic dehydration is to minimize damage to cell structure and extract water quickly without phase changes, compared to other drying methods. It also reduces thermal interactions that negatively affect color and flavor compounds. Improvements in texture, reduction of shrinkage, and increase in product bulk density are other goals of this pretreatment [5].

Since the major component of fruits and vegetables is water, osmotic dehydration can be used as a pretreatment for initial water removal before hot air drying. Button mushrooms are among vegetables sensitive to environmental conditions and high temperatures [6,7].

Button mushrooms (Agaricus bisporus) are nutritionally valuable, rich in protein (25-30% dry matter) [8], and have important nutritional and medicinal properties. They are produced extensively in most regions of Iran both domestically and industrially. According to FAO, Iran is the seventh-largest producer of button mushrooms worldwide, with an annual production of 180,000 tons [9]. The main producing provinces are Tehran, Isfahan, Karaj, Qazvin, Chaharmahal and Bakhtiari, Fars, Hamedan, and Kermanshah. According to the latest reports from the Ministry of Agriculture, mushroom exports amount to 1703 tons worth 2.1 million dollars [10]. Due to high perishability, increasing shelf life through various methods is important. Osmotic dehydration can reduce the water content and damage during different processes. Providing a preservation method can facilitate production of value-added mushroom products for export, making mushrooms a valuable export commodity [11].

Several studies have examined osmotic dehydration and the effects of different factors on final product quality, all highlighting the positive impact of this pretreatment on texture, color, and other quality attributes of dried materials. Ramalho and Mascarenhas (2010) found that pineapple slices pretreated by osmotic dehydration and then frozen had

significantly less drip loss and higher soluble solids content compared to controls [12]. Olatidoye et al. (2013) reported no significant changes in vitamin C between osmotic pretreated and control tomato slices after freezing [13]. Ando et al. (2012) showed osmotic pretreatment had no effect on cellular membranes during thawing of carrots [14]. Basiri (2020) found that increasing temperature, osmotic solution concentration, and immersion time increased water loss, solids gain, and weight loss in button mushrooms [15]. Aslnejadi et al. (2016) demonstrated that osmotic pretreatment reduced drying time, shrinkage, rehydration, and lightness index of edible mushrooms during hot air drying, and increased drying rate, but had no significant effect on overall color changes or a* and b* indices [7].

Based on these prior studies, this research investigates the effects of osmotic pretreatment under varying temperature, time, and solute concentration conditions on the physical and chemical properties of button mushrooms.

2-Materials and Methods

Sample Preparation

Mushrooms purchased from the local market in Shahrekord were initially graded based on size and appearance. Selected samples were washed and surface moisture was removed using absorbent paper. Uniform slices with a thickness of 4 mm were prepared. Osmotic solutions were prepared using food-grade sodium chloride in distilled water at three concentrations: 5%, 10%, and 15% w/w.

After weighing, the sliced samples were immersed in the osmotic solution at a sample-to-solution weight ratio of 1:20. A control sample was also considered. Osmotic dehydration was carried out at temperatures of 30°C and 50°C for durations of 60, 120, 180, and 240 minutes (Table 1) [15,16]. After the set time intervals, samples were removed from the solution and reweighed. Physicochemical tests were conducted in triplicate after this stage.

Table 1-Variable of Process

Treatment	Concentration of osmotic solution (%w/w)	Temperature (˚C)	Time (min)			
A	5	30	A_1=60	A_2=120	A_3=180	A_4=240
B	10	30	B_1=60	B_2=120	B_3=180	B_4=240
C	15	30	C_1=60	C_2=120	C_3=180	C_4=240
D	5	50	D_1=60	D_2=120	D_3=180	D_4=240
E	10	50	E_1=60	E_2=120	E_3=180	E_4=240
F	15	50	F_1=60	F_2=120	F_3=180	F_4=240

Chemical Composition Percentage

Moisture, protein, fat, fiber, and ash content of the samples were measured according to the Iranian National Standards No. 745, 10703, 1-415, 520, 11143, respectively. Carbohydrate content was calculated by subtracting the sum of the other components from 100 [17-23].

Texture Analyzing

Texture properties were measured using a penetration test with a Brookfield Texture Analyzer equipped with a TA41 metal probe, 2 mm diameter, and speed of 2 mm/s [22].

Color Test

The color of mushroom treatments was measured using the HunterLab colorimeter (Colorflex Ez), recording L*, a*, and b* values. L* indicates brightness intensity, a* represents redness or greenness, and b* represents yellowness or blueness. Higher a* values indicate more redness; higher b* values indicate more yellowness. Total color change (ΔE) and browning index (BI) were calculated using equations (1), (2), and (3) [23,24].

$$\Delta E = \sqrt{(\mathrm{L} - \mathrm{L}_0)^2 + (\mathrm{a} - \mathrm{a}_0)^2 + (\mathrm{b} - \mathrm{b}_0)^2} \quad (1)$$

$$BI = \frac{(100 \times (X - 0.31)}{0.17} \quad (2)$$

$$X = \frac{a + 1.75L}{5.6451L + a - 3.012b} \quad (3)$$

Rehydration Percentage

Rehydration was measured by immersing dried samples in 50°C water for 30 minutes, then calculating rehydration percentage using equation (4) [25].

$$Percentage\ of\ Rehydration = \frac{\text{weight of sample after rehydration}}{\text{weight of sample before rehydration}} * 100 \quad (4)$$

Shrinkage Percentage

Shrinkage percentage was calculated by volume displacement method using equations (5), (6), and (7) [1], where V_0 is the initial volume and Vt is the volume at the given time.

$$\rho s = \frac{Wsc - Wc}{\mathrm{Wwc} - Wc} \quad (5)$$

$$Vn = (Wwc - Wc) - \left(\frac{Wcns - Wnc}{\rho s}\right) \quad (6)$$

$$Percentage\ of\ Shrinkage = \left(1 - \frac{V_t}{V_0}\right) \times 100 \quad (7)$$

Where W means weight and the subscripts s,c,w,n are seed, container, water and sample respectively. The density of seed is shown by ρs and sample volume is indicated by Vn. Vt and V0 are volume of sample after and before dehydration respectively.

Optimization

Optimal treatment selection was performed using a multi-criteria decision-making method combining AHP and TOPSIS in two stages with MATLAB 2019a. Variables included temperature, time, and osmotic solution concentration. Responses were color, texture, shrinkage, and rehydration indices. The method involved 10 steps:

1- Creating pairwise comparison matrix based on importance of each performance index as per expert opinion.
2- Normalizing the pairwise comparison matrix by dividing each element by the column sum.
3- Calculating weights of each index by averaging the rows of the normalized matrix.
4- Forming the initial decision matrix.
5- Normalizing the decision matrix by dividing each element by the square root of the sum of squared elements in its column.
6- Calculating weighted normalized decision matrix by multiplying the normalized matrix by the weights from step 3.
7- Determining positive ideal solution (best performance) and negative ideal solution (worst performance).
8- Calculating the distance of each alternative from the positive and negative ideal solutions.
9- Calculating the relative closeness to the ideal solution by dividing the distance from negative ideal by the sum of distances from positive and negative ideals.
10- Ranking alternatives based on the values obtained in step 9; the highest value is the most effective [26,27].

Biotin Content in Control and Optimal Treatment

Vitamin B measurement was conducted using thin-layer chromatography (TLC). Biotin standards at various concentrations were injected to establish calibration curves. Mushroom samples containing vitamin B compounds were injected, and concentration was calculated using the area under the curve. Five grams of mushroom sample were mixed with 50 mL phosphate buffer, then 4 g pancreatin was added and mixed. Then, 6 mL of 10% sodium ascorbate was added, and the mixture was incubated in a 37°C bath for

2 hours, then in a 100°C bath for 30 minutes. After cooling to room temperature, the mixture was centrifuged at 3500 rpm for 15 minutes. The supernatant was filtered through a 0.45-micron filter and injected into the chromatography device. Measurement was done using high-performance liquid chromatography (HPLC) at BioPharma company with a 12 cm column length [7].

Statistical Design

A factorial experiment arranged in a completely randomized block design with three replicates was conducted. Duncan's multiple range test at 5% error probability was used to compare means. Data analysis was performed using SPSS version 20.

3-Results and Discussion

Chemical Analysis

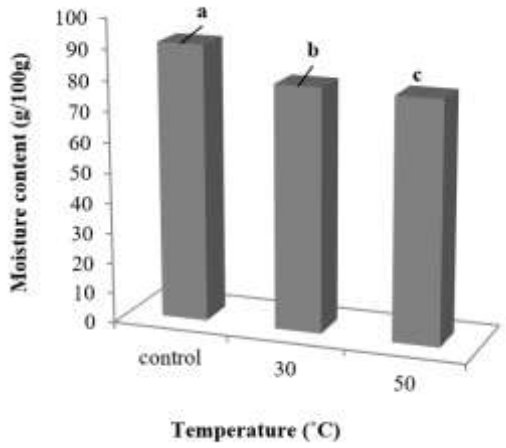
Table 2 shows the chemical composition of mushroom samples used in this study. Given the high moisture content in mushrooms, osmotic pretreatment is expected to have a significant effect ($p < 0.05$) on the physical and chemical properties of the samples.

Table 2-Chemical properties of sample at 25˚C

Ash (g/100 g)	Fat (g/100 g)	Protein (g/100 g)	Fiber (g/100 g)	Carbohydrate (g/100 g)	Moisture (g/100 g)
0.84±0.01	0.60±0.05	3.50±0.07	0.80±0.12	3.16±0.16	91.10±0.11

Moisture Content

Figure 1-a shows the average moisture content of osmotically dehydrated samples at different temperatures. Moisture content decreases as temperature increases. The control sample had the highest moisture content (10.91 g/100g), and samples treated at 50°C had the lowest (7.79 g/100g). Since osmotic diffusion is temperature-dependent [28], increasing temperature increases cell membrane permeability, leading to faster moisture diffusion and higher water removal from the tissue [29]. Similar results were reported by Bermor et al. (2016) [30].



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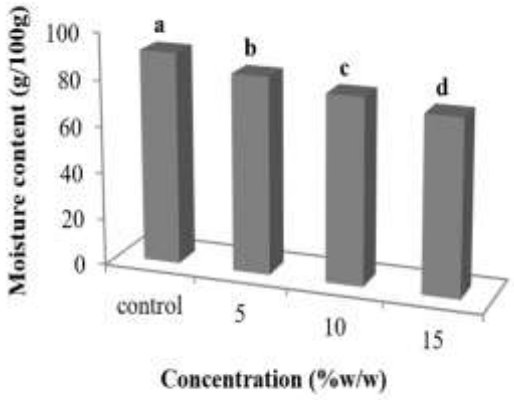

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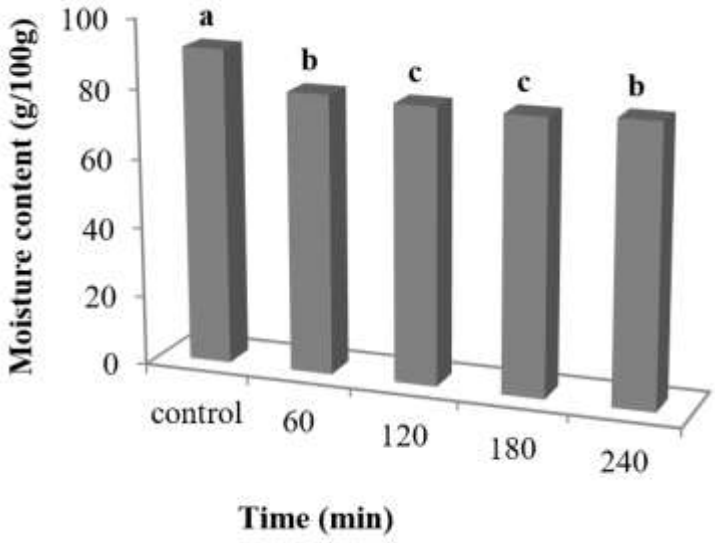

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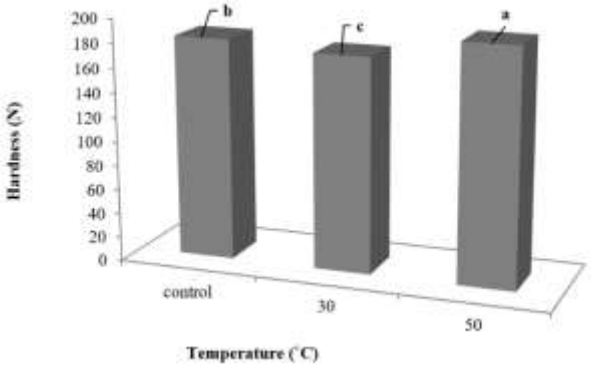
Figure 1- Effect of temperature (a), concentration (b), and time on moisture content of sample

Figure 1-b shows the effect of osmotic solution concentration on moisture content. The control sample had the highest moisture (10.91 g/100g), and the 15% w/w osmotic solution sample had the lowest (7.75 g/100g). The significant difference ($p < 0.05$) is attributed to the osmotic pressure difference between the solution and intracellular fluids, which drives water out of the food matrix [28]. Similar findings were reported by Ispir et al. (2009) for osmotic drying of peaches [31].

Figure 1-c shows the effect of time on moisture content. The control had the highest moisture (9.45 g/100g), and the lowest was at 180 minutes (7.13 g/100g).

Texture Hardness

Figure 2 shows the effects of temperature, time, and osmotic concentration on mushroom texture hardness. At 30°C, hardness decreases and the tissue softens due to disruption and loosening of the structure by osmotic pretreatment [19]. With an increase in temperature to 50 degrees Celsius, the tissue stiffness reaches its maximum value. This can be attributed to the activation of esterase enzymes present in the mushroom at this temperature, which leads to the production of free carboxyl groups. These groups form complexes with divalent ions and create cross-links between polyuronide chains. Therefore, by increasing the overall amount of cross-linking in the matrix, the tissue firmness increases [32].



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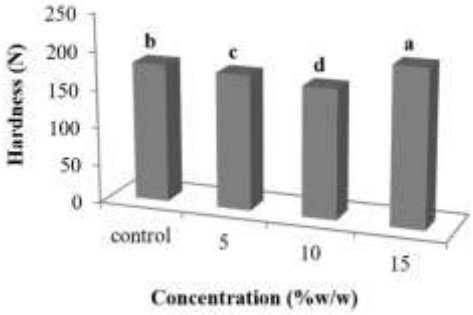

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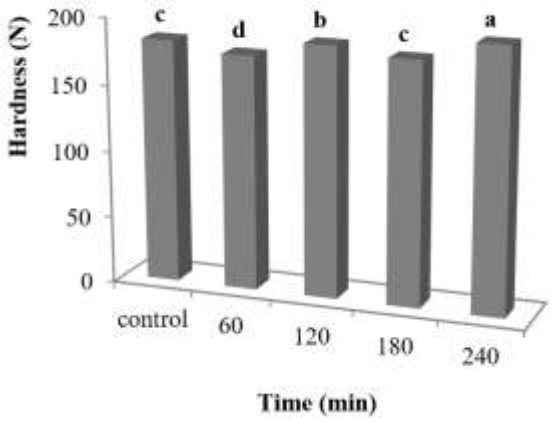


(c)

Figure 2- Effect of temperature (a), concentration (b), and time on hardness of sample

The results of tissue stiffness at different concentrations of osmotic solution (Figure 2-B) show that with increasing osmotic solution concentration, tissue stiffness decreases. This is related to the increased salt penetration into the food structure, causing more damage and permeability of the cell wall. However, at the highest concentration, the greatest tissue firmness is observed, which can be attributed to the substantial moisture loss (Figure 1-B)

from the sample structure at this osmotic solution concentration [32].

Figure 2-C also illustrates the tissue stiffness with increasing osmotic process duration. In this regard, the highest average firmness corresponds to 240 minutes with a value of 195.94 N, and the lowest corresponds to 60 minutes with a value of 175.3 N.

Rehydration

Figure 3 shows the effect of temperature, process duration, and osmotic solution concentration on the rehydration of button mushrooms. The results indicate that samples processed at higher temperatures exhibit greater rehydration (Figure 3-A). This can be attributed to the greater moisture loss of the samples during the osmotic dehydration process with increasing temperature (Figure 1-A), which facilitates higher moisture absorption.

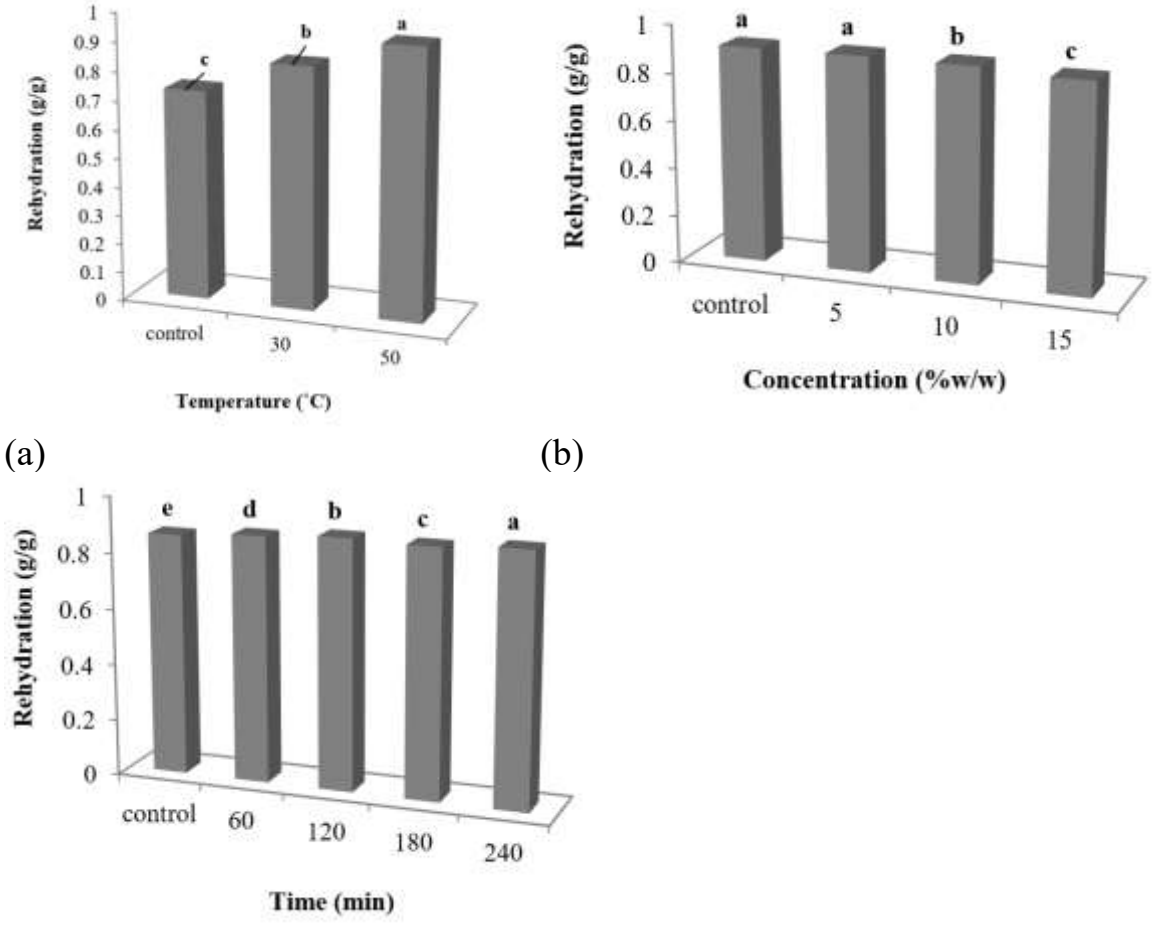


Figure 3- Effect of temperature (a), concentration (b), and time on rehydration of sample

Figure 3-B shows the rehydration level of pretreated button mushrooms after the process. The results indicate that increasing the concentration of the osmotic solution negatively affects rehydration. This is due to the saturation of the sub-surface layer of the food tissue with salt and the lower water absorption of the salt layer compared to the natural tissue, as well as the reduced cell permeability caused by osmotic pressure. Therefore, upon rehydration, these cells cannot absorb as much water as the control samples.

Additionally, with the increased loss of soluble substances along with water during osmotic pretreatment, structural changes occur, which hinder and reduce water reabsorption. These structural changes are clearly reflected in the wrinkle diagrams; as concentration increases, wrinkling increases, indicating cellular changes, cell compression, and the closure of capillary tubes, which consequently reduce water reabsorption [33]. Similar results were reported by Asl Nezhadi et al. (2016) on mushrooms dried with osmotic pretreatment [7].

The results also showed that the highest average rehydration (0.89 g/g) corresponded to 240 minutes, and the lowest (0.87 g/g) corresponded to 60 minutes (Figure 3-C).

Color

Table 2 shows the L*, a*, and b* values of the button mushroom samples. To better evaluate the effect of osmotic pretreatment on color, two indices are used: color change relative to the initial color and the browning index.

Table 2- The amount of L*, a*, and b* of samples

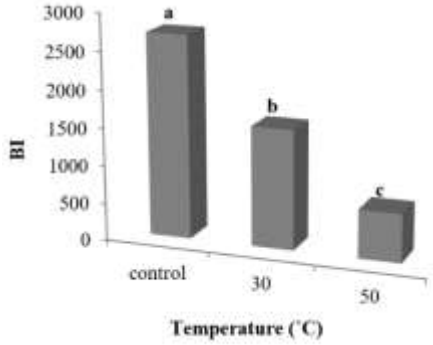
	Color index		
	L*	a*	b*
Temperature (˚C)			
Control	80.67	0.66	14.62
30	62.57	1.94	15.06
50˚C	40.96	2.79	9.3
Concentration (%w/w)			
Control	80.67	0.66	14.63
5	53.27	1.27	12.01
10	51.16	3.24	12.59
15	50.88	2.59	11.94
Time (min)			
Control	80.67	0.66	14.63
60	57.69	2.43	12.87
120	49.91	3.1	12.45
180	50.88	2.45	12.13
240	48.6	1.48	11.26

The results of the browning index of button mushrooms at different osmotic process temperatures (Figure 4-A) showed that increasing the sample temperature from room temperature (control sample) led to a decrease in the browning index.

This is due to the inactivation of the polyphenol oxidase enzyme at higher temperatures. Additionally, with increasing osmotic solution concentration, the browning index decreased, with the lowest value (1057.38) observed in the sample treated with a 15% osmotic solution concentration (Figure 4-B).

Button mushrooms are prone to rapid browning due to the presence of polyphenol oxidase. The presence of salt reduces the water activity and moisture content of the product, inhibiting and inactivating this enzyme, thereby decreasing the production of brown color as salt concentration increases [34]. Salt acts as a mixed-type inhibitor that can bind not only to the free enzyme but also to the enzyme-substrate complex at sites other than the active site [35]. Lou et al. (2006) demonstrated that in the presence of salt, both substrate affinity to the enzyme and reaction rate decrease. They also showed that salt inhibits polyphenol oxidase activity by directly affecting the enzyme rather than the substrate. Furthermore, salt can alter browning reaction products such as quinones formed during the reaction and produce colorless diphenols [36]. Additionally, salt stabilizes color in the product by inactivating the tyrosinase enzyme, and this effect becomes more pronounced with increasing salt concentration [37].

Naturally, with increasing exposure time of the sample to the osmotic solution, enzyme inhibition increases, leading to a decrease in the browning index, which is confirmed by the results of this study (Figure 4-C). In other words, increasing exposure time significantly reduces the browning index, with the lowest value observed at 240 minutes. Similar results were reported by Asl Nezhadi et al. (2016) on mushrooms [7]



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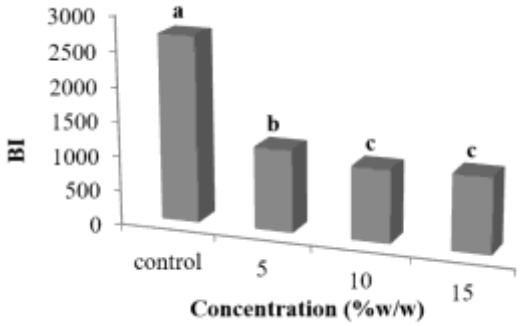

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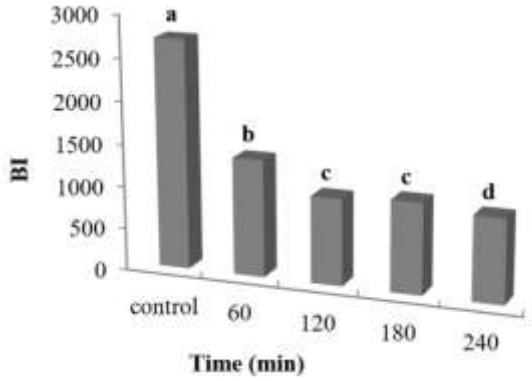

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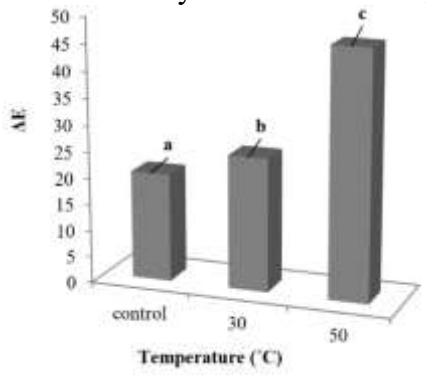
Figure 4- Effect of temperature (a), concentration (b), and time on browning index of sample

Figure 5 illustrates the effect of time, temperature, and osmotic solution concentration on color changes of the samples relative to their initial color. As shown in Figure 5-A, with increasing osmotic process temperature, the color change relative to the initial color showed a significant increase ($p < 0.05$).

Similarly, with an increase in the concentration of the osmotic solution, this index also showed a significant increase ($p < 0.05$) (Figure 5-B), reaching its highest value (36.95) at a concentration of 15%. This is due to a significant decrease in the L* value, caused by the presence of salt on the surface layers of the tissue, which results in surface opacity of the product [38]. With longer exposure times, this effect is intensified due to increased salt absorption. The results related to the exposure time to the osmotic solution (Figure 5-C) also confirm this finding. Similar results were reported by Asl Nezhadi et al. (2016) regarding the reduction in the L* value of hot-air dried mushrooms subjected to osmotic dehydration pretreatment with increasing exposure time and osmotic solution concentration [7].



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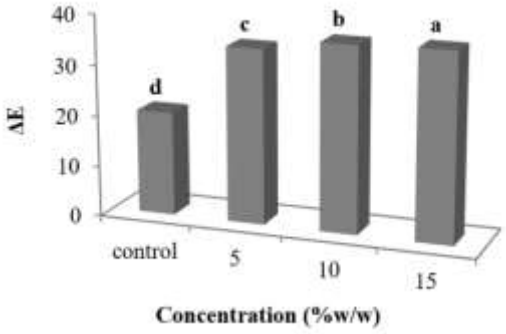

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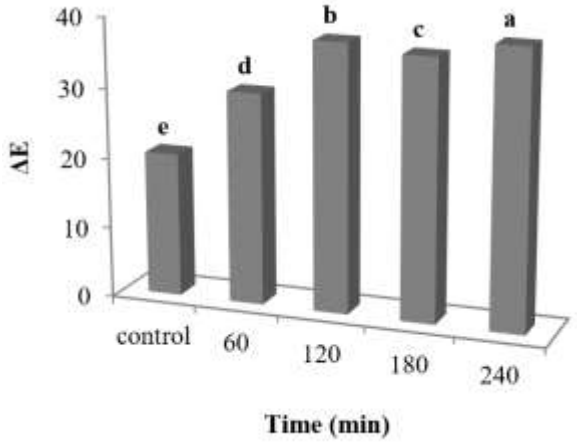

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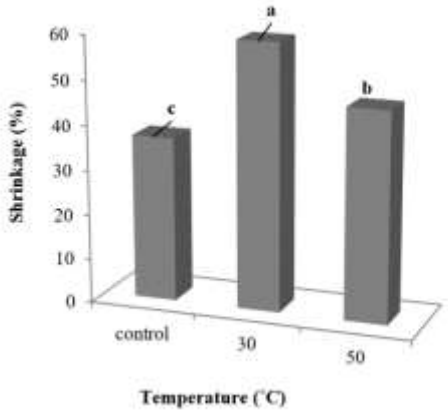
Figure 5- Effect of temperature (a), concentration (b), and time on ΔE of sample

osmotic solution on tissue shrinkage. In all the variables studied, the control treatment showed less shrinkage compared to the samples subjected to osmotic dehydration.

Shrinkage

Figure 6 shows the effect of temperature, concentration, and exposure time to the



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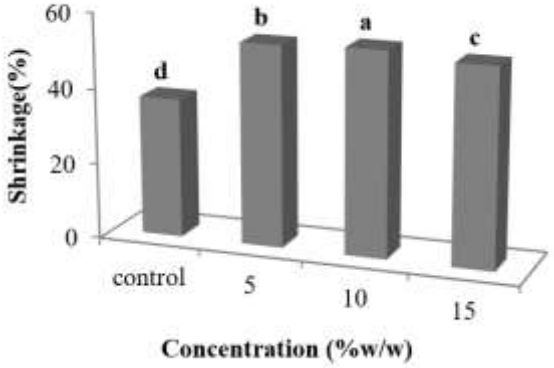

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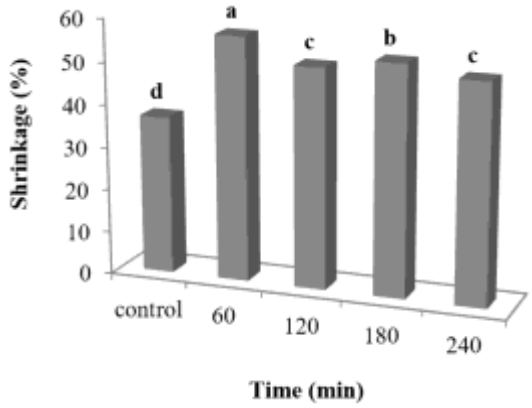

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Figure 6- Effect of temperature (a), concentration (b), and time on shrinkage of sample

In the treatments subjected to osmotic dehydration, an increase in temperature led to a significant decrease in shrinkage ($p < 0.05$). Higher temperatures alter cell wall permeability and increase the diffusion coefficient, leading to enhanced mass transfer in the sample. Additionally, as temperature rises, the viscosity of the osmotic solution increases, resulting in greater salt penetration into the tissue and, consequently, increased firmness. As a result, the likelihood of shrinkage decreases with rising temperature [7].

Furthermore, with increasing concentration of the osmotic solution, the samples initially showed increased shrinkage, but the least shrinkage among the osmotically treated samples was observed in those treated with 15% sodium chloride. This can be attributed to the higher salt concentration and its greater penetration into the tissue, which increases the structural firmness of the sample. This effect is more pronounced at the highest salt concentration compared to samples exposed to lower salt concentrations [21].

Moreover, when the mushroom tissue loses its water and internal pressure drops, the cells lose their turgidity and are no longer able to exert pressure on one another, resulting in a wrinkled appearance. Consequently, the rigid cell walls and ultimately the mushroom tissue become shriveled.

With increased water loss from the mushroom tissue, shrinkage also increased. The results related to the exposure time of the samples to the osmotic solution followed a similar pattern. As the exposure time increased to 60 minutes, shrinkage reached 57.02%, and then showed a significant decreasing trend ($p < 0.05$) until 240 minutes, where it reached 51.04%. This is because, with longer exposure time, more salt entered the tissue structure and more moisture was removed. During osmotic dehydration, structural damage and shrinkage are minimized after subsequent processing steps.

Similar results were reported for osmotic pretreatment of hot-air dried mushrooms by Asl Nezhadi et al. (2015) and Emamjomeh et al. (2009) [7, 21].

Selection of the Optimal Sample

The optimal process indicators include the lowest moisture content after dehydration, minimum solute uptake in the osmotic solution, minimum shrinkage, minimum color changes compared to the control sample, and the lowest browning index.

Among the tested samples and after applying the AHP-TOPSIS method, the sample with the closest proximity to the optimal indicators was selected. This was the sample dehydrated at 50°C for 120 minutes in a 15% sodium chloride solution.

Biotin

Vitamin H, or biotin, is a member of the B-vitamin group found in small amounts in all living cells and plays an important role in the biochemical reactions of living cells. The biotin content was measured in both the control and the optimal sample, and the vitamin concentration was calculated based on the area under the peak and using the standard calibration curve.

As shown in Table 3, the biotin content in the treated sample decreased compared to the control. This reduction may be due to the loss of vitamin along with water from the mushroom during osmotic pretreatment.

Table 3- Concentration of Biotin

Samples	Concentration of Biotin (ppm)
Control	98.4
Optimal sample	68.55

4-Conclusion

In this study, the physicochemical properties of button mushrooms pretreated by osmotic dehydration with saline solution at the laboratory scale were investigated. To determine the potential for production, preservation, and shelf life of the produced button mushroom products, various factors such as chemical composition measurement were used. Subsequently, tests including moisture measurement, texture analysis, rehydration rate, color indices, and shrinkage percentage were performed to evaluate the effects of different variables. The optimal sample was then selected through a multi-criteria decision-making method, and finally, the biotin content in the control and optimal samples was compared.

The results showed that increasing the osmotic solution concentration, temperature, and processing time led to a greater moisture loss due to increased osmotic pressure. The effects of temperature, concentration, and process duration on texture firmness were significant, with firmness increasing as these factors increased. Rehydration capacity increased with higher temperature and longer processing time but decreased with higher concentration. Browning index decreased and color changes increased with increasing temperature, concentration, and processing time. The optimal osmotic dehydration conditions were 50°C, 15% osmotic solution concentration, and 120 minutes processing time.

Mushrooms prepared under these conditions can subsequently undergo various processes and be used as raw materials in pharmaceutical industries for supplement production, in the food industry for producing functional foods, as spice and flavor substitutes, and in cosmetic and hygiene industries as antioxidants. Considering the reduction in water content during osmotic pretreatment, besides shortening the final process time and saving energy, it can prevent adverse effects on texture during the final processing.

It is recommended that comparative studies be conducted to evaluate the efficiency of this method against other methods for different products.

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مقاله علمی–پژوهشی

اثر پیش تیمار اسمزی بر ویژگی های فیزیکوشیمیایی قارچ دکمه ای و بهینه سازی فرایند

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اطلاعات مقاله

تاریخ های مقاله :

تاریخ دریافت: ۱۴۰۳/۰۹/۲۴

تاریخ داوری: ۱۴۰۴/۰۵/۱۴

تاریخ پذیرش: ۱۴۰۴/۰۵/۲۹

کلمات کلیدی:

آب‌گیری مجدد،

پیش تیمار اسمزی،

چروکیدگی،

قارچ دکمه‌ای،

بهینه‌سازی

DOI: 10.48311/fsct.2026.83726.0

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چکیده

ازآنجاکه شاخص اصلی در انتخاب فرایند، کیفیت ماده غذایی است و دمای فرایند اسمزی بسیار کم‌تر از فرایندهای آب‌گیری دیگر است، در این مطالعه اثر پیش تیمار اسمزی محلول کلرید سدیم با غلظت‌های ۵، ۱۰و ۱۵ درصد و در دماهای ۳۰ و۵۰ درجه سلسیوس به‌مدت ۶۰، ۱۲۰، ۱۸۰ و ۲۴۰ دقیقه، بر ویژگی‌های فیزیکوشیمیایی قارچ دکمه‌ای از جمله میزان چروکیدگی، رنگ، سفتی بافت، رطوبت و جذب آب مجدد مورد بررسی قرار گرفت. بهینه سازی به‌منظور انتخاب بهترین شرایط برای آب‌گیری اسمزی قارچ دکمه‌ای با روش AHP-TOPSIS با نرم افزار متلب ۲۰۱۹، انجام شد و در نهایت میزان بیوتین در نمونه‌بهینه با میزان آن در نمونه شاهد مقایسه شد. نتایج نشان داد که میزان رطوبت، آب‌گیری مجدد، رنگ و چروکیدگی نمونه، وابسته به دماست. با افزایش دما، میزان رطوبت نمونه افزایش و جذب مجدد آب کاهش می‌یابد. بررسی نتایج مربوط به شاخص رنگ نشان داد که با افزایش دما، شاخص قهوه‌ای شدن کاهش و میزان تغییرات رنگ افزایش داشت. چروکیدگی و سفتی بافت محصول نیز با افزایش دما، کاهش ($p<0.05$) نشان داد. همچنین مشخص شد که غلظت محلول اسمزی و مدت‌زمان مواجهه با نمونه نیز اثر معنی دار ($p<0.05$) بر شاخص‌های کیفی داشت. با افزایش غلظت محلول اسمزی، میزان رطوبت نمونه، جذب مجدد آب، شاخص قهوه‌ای شدن و چروکیدگی کاهش و تغییرات رنگ، افزایش نشان داد. نتایج هم‌چنین نشان داد که با افزایش مدت‌زمان مواجهه، تغییرات رنگ، چروکیدگی و سفتی بافت افزایش و شاخص قهوه‌ای شدن کاهش یافت. شرایط بهینه آب‌گیری اسمزی برای شاخص‌های کیفی مورد بررسی، ۵۰ درجه سلسیوس، غلظت ۱۵ درصد محلول اسمزی و زمان ۱۲۰ دقیقه بود. به‌طورکلی می‌توان نتیجه گرفت که این روش برای پیش تیمار قارچ دکمه‌ای به دلیل کوتاه‌شدن زمان فرایند نهایی و صرفه‌جویی در انرژی و جلوگیری از اثرات نامطلوب فرایند نهایی، در صنایع دارویی، غذایی و آرایشی می‌تواند به عنوان یک روش استفاده شود