

Effect of pretreatment on the nutritional quality of white button mushroom (*Agaricus bisporus*)

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ABSTRACT

Mushroom is considered a super food because of their rich nutrient composition. Increased mushroom production has been witnessed due to its increased per capita consumption. One of the major constraints in the mushroom production and marketing is its short shelf life. Drying is one of the oldest methods to increase shelf life of the perishable food items such as mushrooms but the drying of the mushrooms causes discoloration and loss of some nutritional qualities. Effect of pretreatments before drying was studied on the color, percent recovery, and nutritional composition of white button mushroom (*Agaricus bisporus*). The study concluded that the per cent recovery after drying decreases in treated mushrooms compared to the non-treated ones. The color of the treated button mushroom was retained well even after drying than the non-treated counterpart. Pre-treating the mushroom before drying had a significant effect on the moisture, protein, and carbohydrate content.

Keywords: Button mushroom, *Agaricus bisporus*, pretreatment, percent recovery, nutritional composition

Numerous chronic degenerative diseases are caused by food and lifestyle. Therefore, maintaining good health requires a diet full of high-quality nutritious foods. Foods, that are high in macronutrients as well as micronutrients, are helpful in preventing the development of such disorders. Mushrooms are good example of such foods. More than 2000 different species of mushrooms are found in nature, but only 22 of them are commercially cultivated (Manzi *et al.*, 2001). According to Singh *et al.*, (2022), mushroom production in India surpassed 200 million kg (225 million kg) in annually in 2019 of which 72.9 % are produced as button mushrooms, 16.3 % as oyster mushrooms, 2.45 % as milky mushrooms, and the remaining 8.20 % as other mushrooms.

The common mushroom taste or umami taste of the mushroom is due to the presence of aspartic and glutamic acid, the monosodium glutamate-like (MSG-like) components (Tsai *et al.*, 2008). Because of its extensive nutrient profile, which is substantially higher than that of other plant foods, mushrooms are regarded as superfoods. It has a significant proportion of protein, non-starchy carbohydrates, dietary fiber, minerals, and vitamin B. It also has very little fat and cholesterol (Sadler, 2003). Both digestible and indigestible carbohydrates are present in the mushroom, with the latter accounting for the majority of the total carbohydrates. Mannitol, glucose, and glycogen are the three types of digestible carbohydrates found in mushrooms. On the other

hand, oligosaccharides and non-starch polysaccharides including chitin, β -glucans, and mannans are indigestible (Dez and Alvarez, 2001; Cheung, 2010). The protein found in mushrooms contains a large number of important or high-quality amino acids. Because of their high levels of lysine, leucine, valine, and tryptophan, mushrooms are a good addition to Indian diets based on cereal (Bano & Rajarathnam, 1982). The amino acid composition of mushrooms is close to or better than that of soy proteins (Yin & Zhou, 2008).

A significant proportion of the vitamins in mushrooms are B-vitamins like thiamine, riboflavin, niacin, biotin, pantothenic acid, and folic acid along with a small amount of ascorbic acid (Hossain *et al.*, 2007). The B vitamins like folic acid along with vitamin B₁₂ involve in the process of single carbon metabolism, further associated with the production of monoamine neurotransmitters, and help in maintaining good mental health (Gilbody *et al.*, 2007). When it comes to the mineral composition of the mushroom, the primary ingredients include K, P, Na, Ca, and Mg, while minor constituents include elements like Cu, Zn, Fe, Mo, and Cd (Bano & Rajarathnam, 1982). Mushroom also has a large number of bioactive chemicals in addition to the major macro- and micronutrients. Polysaccharides, lipopolysaccharides, peptides, glycoproteins, nucleosides, triterpenoids, lectins, lipids and their derivatives, and phenolic compounds are among the bioactive substances found in mushrooms (Tolera & Abera, 2017). These bioactive substances have a variety of pharmacological actions, including anti-tumor, antioxidant, antiviral, hypocholesterolemic, and hypoglycemic properties. Ergothioneine, a water-soluble thiol molecule, is the primary antioxidant present in mushrooms. 29 species of mushrooms have between 48 and 2851 mg of ergothioneine per kilogram of dry mass (Chen *et al.*, 2012). It is believed that wild edible mushrooms contain more ergothioneine. The primary phenolics include quercetin, catechin, p-coumaric acids, caffeic acid, and gallic

acid (Liu *et al.*, 2012). The phenolic compounds gallic acid, homogentisic acid, ferulic acid, and p-hydroxybenzoic acid are also present in edible mushrooms (Guo *et al.*, 2012). The two key functional substances are chitosan, a deacetylated derivative of chitin, and chitin (N-acetyl-D-glucosamine polymer), a nitrogen-containing polysaccharide of the fungal cell walls. According to Bobek and Galbav (1999), these functional compounds are associated with a decrease in the physiological cholesterol pool.

Agaricus bisporus, generally known as the white button mushroom, is the most grown mushroom in India during the winter, but now due to technological advances, it is grown all year round under controlled conditions. It makes up 73 percent of the total amount of mushrooms produced nationwide (Sharma *et al.*, 2017). In terms of production and consumption, button mushrooms account for 13% of global mushroom production in the year 2013 (Singh *et al.*, 2017). Mushroom cultivation is considered to have begun as early as 300 BC, and it was the China that first disseminated the crop to the rest of the world about 600 AD. Nonetheless, in hilly areas of India, such as Chail (Himachal Pradesh), Kashmir, and Ooty (Tamilnadu), at temperatures of 17–18°C, white button mushroom cultivation for commercial purposes commenced during late 70s and gradually extended to India's Northwestern Plains during winter season as a seasonal crop (Mehta *et al.*, 2011).

White button mushroom, *Agaricus bisporus*, is the most popular mushroom in India and its commercial value depends upon its colour. Due to the presence of tyrosinase enzyme and high moisture content (~90%), the shelf life of this mushroom is very short. The present study was conducted with the aim to evaluate the effect of pretreatment on the percent recovery, change in color and nutritional composition of the button mushroom to enhance its shelf life and availability.

MATERIALS AND METHODS

The button mushroom (*Agaricus bisporous*) was collected from the farm of GBPUA&T, Pantnagar Mushroom Research Center. They were scrubbed clean and cut into equal pieces. The button mushrooms were processed in three different ways after cleaning. Pretreatment was carried out to avoid enzymatic browning, stabilize color, enhance flavor retention, and preserve textural qualities. Out of the total 500gms mushrooms, 125gms were kept untreated (T₁), 125 grams were blanched for 3-4 minutes (T₂), 125 grams were osmosed where they dipped in 10% brine solution for 30 minutes after blanching for 3-4 minutes (T₃) and the other 125 grams were treated by dipping in 0.5% KMS solution for 30 minutes after blanching (T₄). In order to attain a constant weight, the pretreated and untreated materials were dried in a hot air oven at 50 °C. At hourly interval, the weight of dried samples was recorded. The button mushroom took 5.30 hours in the hot air oven for drying up to the moisture content of 4-5%. The dried mushrooms were ground into a fine powder after drying and used for nutritional analysis. Using the techniques outlined by AOAC (2012), the moisture content, proteins, crude fat, crude fiber, total ash, and carbohydrate content of the mushroom powder, were estimated on dry weight basis.

The percent recovery (%) of usable product recovered after it has been processed is calculated as,

$$(\%) \text{ recovery} = \frac{\text{Amount of product recovered (g)}}{\text{Amount of crude material used (g)}} \times 100$$

RESULTS AND DISCUSSION

Table 1 shows the effect of various treatments before drying on color and percent recovery of the dried product. The mushrooms' color altered after

drying. The untreated and osmosed mushrooms had a dark brown hue, whereas the blanched, blanched + KMS treated mushrooms had light brown and yellow hues, respectively. It may be concluded that the KMS-treated mushrooms had a more appealing hue than the other three, but after grinding, the color of the powder changed becoming light yellow for the blanched plus KMS-treated mushroom and light brown for the untreated, osmosed, and blanched + dried powdered mushroom.

Short shelf life (1-3 days) of button mushrooms results in some post-harvest alterations (Czapski & Szudyga 2000). According to Manzi *et al.* (2004), the high moisture content and the enzymatic activity of protease and polyphenol oxidase cause a browning response, which are the reason for the post-harvest alterations in mushrooms. On wet weight basis, the moisture content of mushrooms ranges from 67.2 to 91.5 grams per 100 grams (Manzi *et al.*, 2004). In this study, it was discovered that button mushrooms had a moisture content of 89 percent. The drying method is one of the most popular ways to ensure long-term food storage, according to Manzi *et al.* (2004).

Studies conducted by Rama *et al.* (2000) revealed that dried mushrooms packed in airtight containers can have a shelf life of more than a year, making it a relatively affordable technique as well. There are numerous variables that affect drying pace, including temperature, mushroom thickness, drying method, and moisture diffusivity (Yapar *et al.*, 1990).

The texture of the mushrooms changed while drying, including their toughness, cohesion, springiness, and chewiness. The springiness and cohesiveness of the mushroom were originally enhanced but later reduced, and its hardness and chewiness improved (Kotwaliwale *et al.*, 2007). In this study's drying process affected the texture of the mushrooms, making them tougher and changing their color. During drying, mushrooms' whiteness declines while their yellowness grows. This might be because mushrooms

EFFECT OF PRETREATMENT ON THE NUTRITIONAL QUALITY OF WHITE BUTTON MUSHROOM

Table 1. Effect of pre-treatment on percent recovery and color of mushroom

Criteria	Button mushroom-Pre treatment			
	Untreated (T ₁)	Blanched (T ₂)	Osmotic dehydrated (T ₃)	Blanched + KMS treated (T ₄)
Initial weight (gm)	125	125	125	125
Initial moisture content (%)	89			
Drying condition	Hot air oven drying for 6 hours at 50 °C			
Weight after drying (gm)	10.6	7.35	8.16	7.02
Percent recovery	8.48	5.88	6.58	5.61
Color of the powder	Brown	Brown	Brown	Yellow

are sensitive to high temperatures and develop pigmentation (Kotwaliwale *et al.*, 2007). In contrast to other pretreated and untreated mushrooms, the application of blanching together with KMS forbids the darkening of the button mushroom.

During the study, the highest percent recovery was found in untreated dried mushrooms (T₁) that did not receive any pretreatment, with 8.48 percent, while the lowest percent recovery was seen in mushrooms that were blanched i.e., 5.88 % and followed by dipping in KMS (T₄), with 5.81 percent. Table 2 shows the effect of various treatments on the nutritional composition of mushroom. The moisture content is highest in blanched mushroom powder i.e., 5.2 ±0.15% whereas lowest in blanched and KMS

treated mushroom powder i.e., 4.73±0.15%. Statistically, the moisture content of the various treated mushroom powders varied at a 5% accuracy level. According to the study, the mushroom has a dry weight-based protein content of 25–30%. It is similar to the protein content reported by Haddad *et al.* (1979). He asserted that the protein in mushrooms is of a higher caliber than that found in fruits and vegetables. It was also reported that the protein concentration rises when the mushroom is pretreated, such as blanched and dipped in KMS solution before drying. The protein content of untreated, blanched, osmosed and KMS treated dried mushroom powder was recorded as 27.13±0.7, 25.3±0.5, 26.71±0.4, and 28.52±0.73, respectively. Statistically, there was a significant difference between all these treated

Table 2. Proximate analysis of mushroom powder

Nutrient	Button mushroom-Pre treatment				CD (5%)
	Untreated (T ₁)	Blanched (T ₂)	Osmotic dehydrated (T ₃)	Blanched + KMS treated (T ₄)	
Moisture (%)	5.1±0.1 ^a	5.2 ±0.15 ^a	5.0±0.18 ^a	4.73±0.15 ^b	0.249
Protein (gm)	27.13±0.7 ^a	25.3±0.5 ^b	26.71±0.4 ^b	28.52±0.73 ^c	1.138
Crude fat (gm)	2.25±0.3	1.8±0.1	1.9±0.1	2.03±0.4	NS
Crude fiber (gm)	4.66±0.13	4.70±0.23	4.52±0.26	4.8±0.27	NS
Total ash (gm)	6.46±0.15	6.3±0.2	6.23±0.3	6.56±0.25	NS
Carbohydrate (gm)	54.4±0.68 ^a	56.7±0.7 ^{ab}	55.65±1.12 ^{bc}	53.36±1.06 ^c	1.722

*All values are measured in triplicates

*All results are mean± standard deviation of three replicates of dry weight basis

*Different alphabets in superscripts in each row show significant different between values

mushroom powders ($p < 0.05$). The protein content of mushrooms depends upon the species of mushroom, their harvesting time, the composition of the substratum, and the size of the pilus or cap (Chang *et al.*, 1982). The usual protein content of button mushrooms ranges from 25-28%, on average 26.9 ± 0.16 %.

According to Manzi *et al.* (2004), the average crude fat content of mushrooms is 0.6 to 1.5 g/100 g wet weight. Based on the results of this study, it was observed that button mushrooms have fat contents of 2 ± 0.08 % of dry matter. Mushroom is a good source of fiber. Apart from some mushrooms like *Craterellus aureus* and *Sarcodon aspratus*, mushrooms contain up to 40% of their total dry matter as fiber (Wang *et al.*, 2014). During the study, the fiber content of button mushrooms was found to be 4.64 ± 0.08 % on dry matter basis. Pretreatment did not show any significant effect on the crude fiber content of button mushroom.

The total ash content of mushrooms is reported in the ranges from 0.5 to 2.0 g/100 g of fresh weight (Manzi *et al.*, 2004), however, the present study reveals the total ash content as 6.34 ± 0.06 % of dry weight basis, which is almost similar. Though the total ash content of T_4 was found to be the highest i.e., 6.56 ± 0.25 %, and the lowest in T_3 i.e., 6.23 ± 0.3 % but statistically, they were not significantly varied. The study found that of the total dry matter, the carbohydrate content of button mushrooms, both with and without pretreatments, was 55.04 ± 0.2 %. The carbohydrate content of untreated, blanched, osmosed, and KMS-treated dried mushroom powder was recorded as 54.4 ± 0.68 , 56.7 ± 0.7 , 55.65 ± 1.12 and 53.36 ± 1.06 , respectively. There was a significant difference between the carbohydrate content of differently treated button mushrooms.

CONCLUSION

Button mushroom is the most produced and consumed mushroom in India and are the subject of

the study. Mushrooms are an excellent vegan food source since they include a variety of nutrients. A considerable amount of protein is included in mushrooms, which the body can use for a number of purposes. The mushroom also has a good amount of additional nutrients like total ash, crude fiber, and crude fat in addition to protein and carbohydrates. The mushrooms can be stored after drying, in powder form, and can be used in various food products for value addition.

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EFFECT OF PRETREATMENT ON THE NUTRITIONAL QUALITY OF WHITE BUTTON MUSHROOM

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