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Exploring the Impact of Chemical Treatments on Textural Properties and Post-Harvest Longevity of Button Mushrooms: A Comprehensive Investigation

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ABSTRACT: As global population rises, mushroom production and consumption have increased correspondingly. Mushrooms have emerged as pivotal sources of both nutrients and medicinal compounds. The growing demand for diverse mushroom varieties stems from their delightful organoleptic qualities, enticing aroma, and high protein and nutrient concentrations. Enriched with an array of vitamins and minerals, mushrooms mitigate the risk of numerous human diseases. The texture of button mushrooms is firm yet tender, with a slight springiness which degrade with due course of time. They have very short shelf life due to its perishable nature. Chemical treatments help to maintain good texture of button mushroom which increase the shelf life button mushrooms. Sorbitol, Citric acid and Calcium Chloride can be used for maintaining the shelf life. 2.5% $CaCl_2$, 3% citric acid, 0.1% sorbitol can effectively maintain the texture of button mushroom up to 12 days and also helps to prevent enzymatic browning and microbial spoilage. The texture of button mushroom is very important factor in determining their market value as it directly impacts consumer satisfaction, perceived quality, shelf life, and competitive positioning.

Keywords: Button mushroom, Texture profile analysis, Calcium Chloride, sorbitol, citric acid.

INTRODUCTION

The exploration of mushrooms' chemical composition, nutritive properties, and medicinal values has witnessed dynamic progress in recent decades. The pivotal role of optimal nourishment extends beyond mere sustenance, influencing everyday life and serving as a cornerstone in the treatment of various diseases and infections. Button mushrooms, renowned for their dual significance as both food and medicine, offer a rich tapestry of essential nutrients and therapeutic compounds (Sinha *et al.,* 2021).

White button mushrooms stand out as an efficient source of vital nutrients, including the B-complex vitamins, vitamin D, and essential minerals such as potassium, selenium, and copper. Moreover, they harbor an extensive array of therapeutic compounds, comprising natural antibiotics, glycoproteins, triterpenoids, enzymes, and enzyme inhibitors, each conferring significant medicinal value (Phull *et al.,* 2022). Button mushrooms naturally contain a high amount of water, and they continuously lose water content with the storage time. This loss of water results in a softer, wilted texture, which may not be desirable for consumers who looks for firm and fresh mushrooms. Calcium chloride is commonly used as a firming agent for maintain the firm texture of button mushroom as it helps to strengthen cell wall and prevent softening of button mushroom (Muszynska *et al.,* 2017).

MATERIAL AND METHODS

Demands and consumption of button mushrooms has globally increased in this decade due to its delicious taste and excellent nutritional content. Within just 2-3 days of harvesting button mushrooms experience significant degradation in commercial value due to its loss in both sensory and textural parameters. Therefore, enhancing the shelf life of button mushrooms becomes can help to mitigate these challenges. The present investigation entitled **"Exploring the Impact of Chemical Treatments on Textural Properties and Post-Harvest Longevity of Button Mushrooms: A Comprehensive Investigation"** was performed at Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi with aim to maintain the good textural properties of button mushroom for longer period of time.

Button mushrooms were obtained from the Department of Plant Pathology and Mycology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, during the morning hours. Mature button mushrooms which were devoid of any physical injuries, were carefully sorted and chosen for the experiment.

They were given three chemical treatments:

C1: 2.5% $CaCl_2$ + 3% citric acid + 0.1% sorbitol C2: 2.5% $CaCl_2$, C3: Hot water treatment (blanched at 50^oC)

Then they were packed in Polyamide 20µm-Polyethylene 70µm with EVA Polythene sheets. Sample size was taken as 40g and they were stored at 8^oC for 12 days.

A. Texture profile analysis

Texture profile analysis was conducted using a texture analyzer (TA.XT Plus, Stable Micro Systems Ltd., UK). This instrument can help to assesses the hardness, cohesiveness, gumminess, springiness, and adhesiveness of button mushroom. A 50 kg load cell and a 75 mm diameter compression plate probe were utilized to measure the texture of button mushrooms. Button mushroom fruiting bodies measuring 1.5 cm × 1.5 cm were sliced with a blade and positioned between the probes, then compressed to a depth of 4 mm. The probe speed was standardized at 2.0 mm/s during compression, and the analysis was conducted at a room temperature of 25°C.

The textural properties like hardness, springiness, cohesiveness, and chewiness were measured and formula for the different textural properties are given below:

Hardness. Hardness, is the physical characteristics of a material related to its firmness, deformation resistance or structural integrity. In the context of button mushrooms, hardness describes the resistance of the mushroom flesh to pressure or deformation when subjected to external forces, such as biting or cutting. It's a crucial aspect of quality assessment in food products, indicating freshness, maturity, and overall condition**.** Its unit is (kg.f) = F1.

Springiness. Springiness is the ability of a material to return to its original shape after deformation. In case of button mushrooms, springiness refers to how quickly the flesh of the mushroom bounces back to its original form after being compressed. It reflects the elasticity and resilience of the mushroom's texture, providing insights into its freshness and structural integrity. Is isunitless.

Springiness = (t2/t1).

Cohesiveness. Button mushrooms (*Agaricus bisporus*), have high level of cohesiveness, as they can hold their shape well and may stick together when harvested or cooked. It is unitless

Cohesiveness = A2/A1

Chewiness. The chewiness of button mushrooms is the tactile sensation experienced during consumption of these mushrooms. It describes the resistance of the mushroom when it is bitten and chewed. Button mushrooms possess varying degrees of chewiness depending on factors such as their freshness, cooking method, and duration of cooking. Its unit is (kg.f).

Chewiness: = (F1) × (t2/t1) × (A2/A1) or Hardness × Springiness × Cohesiveness

where F1 is the maximum force, which is the force in the first peak, A1 and A2 are the areas of the first and second peaks, respectively, and t1 and t2 are the time intervals for the first and second peaks, respectively (Díaz-Mula *et al*., 2011).

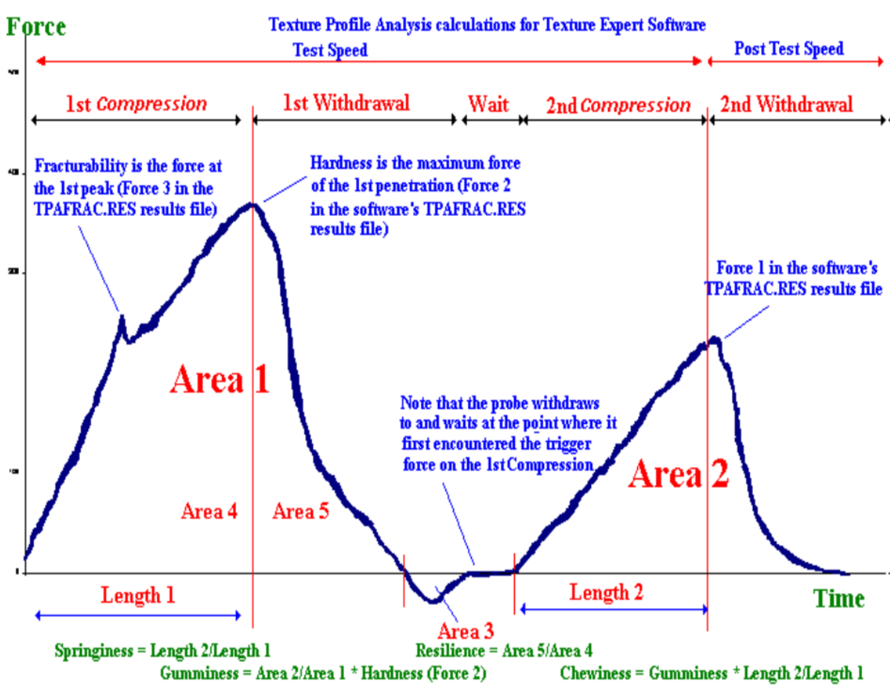

Fig. 1. Standard graph for measuring textural properties of Button mushroom.

RESULT AND DISCUSSION

The major factor which contributes to the deterioration of button mushrooms is the development of textural abnormalities (Usman *et al*., 2021). According to Jafri *et al*. (2013), all textural parameters exhibited a decline as the storage period progressed. In the current investigation, it was observed that the hardness of button mushrooms decreased over time in storage (Brennan *et al.,* 2000).

Button mushroom softening primarily results from protein denaturation, degradation of polysaccharides, and vacuole disruption. The rate of hardness reduction was notably higher in chemically untreated button mushrooms. Springiness, representing product elasticity, exhibited a declining trend over the storage period. Cohesiveness continuously shows increasing pattern with storage time, particularly at a higher rate in chemically untreated Chewiness, reflecting the effort required for chewing, also showed a significant decreasing trend over storage time (Kortei *et al.,* 2015). The primary deterioration in button mushrooms comes from the loss of firmness and tissue softening. Chemical treatments are very effective method for maintaining firmness of edible products especially button mushroom. Texture profile analysis curve shows that peak of the curve continuously degrades with the time. Highest peak was recorded for fresh button mushroom at 12000g Force (Fig. 1) which continuously degrades with the time. After 12 days the highest peak was obtained at 7000g Force for C1 (2.5% $CaCl_2$, 3% citric acid, 0.1% sorbitol) and lowest peak was obtained for the blanched samples 4700g Force after 12 days (Fig. 5). After 12 days chemically treated button mushroom C1 showed better hardness (7.94 Kg.f), springiness (0.70), cohesiveness (0.57), chewiness (2.84 Kg.) as compared to blanched samples as depicted in Table 1 (Oliveiraa *et al.,* 2012).

Different chemical treatments have been explored to enhance the shelf life of button mushrooms and maintain its market value for longer period of time. Citric acid, maintains freshness of button mushroom by reducing the pH, and it also act as a chelating agent Sorbitol is a great waterholding compound which helps to maintains firmness of mushrooms, (Anantheswaran and Sunkara 1996). Chemicals such as potassium metabisulfite (KMS), citric acid, calcium chloride, and sodium EDTA play crucial roles as ash guards, contributing to the long-term preservation of food products (Jafri *et al.,* 2013). These chemical treatments have been shown to increase antioxidant enzymes and decrease reactive oxygen species, thereby retaining the color, aroma, taste, and texture of the treated mushrooms. These chemical treatments are easy to handle, cost-effective, and environmentally friendly (Ghahremani-Majd and Dashti 2015).

Table 1: Effect of different chemical treatments on textural properties (Hardness, Springiness, Cohesiveness and chewiness of button mushroom) at 8°C after 4 days, 8 days and 12 days.

Texture Analysis parameter	Hardness (kg.f)			Springiness (dimensionless)			Cohesiveness (dimensionless)			Chewiness (kg.f)			Mean
Chemical Treatments	After 4 days	After 8 days	After 12 days	After 4 days	After 8 days	After 12 days	After 4 days	After 8 days	After 12 days	After 4 days	After 8 days	After 12 days	
C_1 C_1: 2.5% $CaCl_2$ + 3% citric acid + 0.1% sorbitol	9.52	8.72	7.00	0.88	0.76	0.70	0.48	0.54	0.57	4.23	3.43	2.84	3.38
C_2C_2: 2.5% $CaCl_2$	9.38	8.34	7.81	0.80	0.70	0.60	0.40	0.53	0.52	3.97	3.32	2.58	3.24
C_3Hot water treatment (blanched at 50°C)	8.55	6.42	4.06	0.81	0.62	0.56	0.39	0.55	0.60	3.96	2.34	2.15	2.75
Mean	9.15	7.82	7.27	0.83	0.69	0.62	0.42	0.54	0.56	4.05	3.03	2.52	3.12

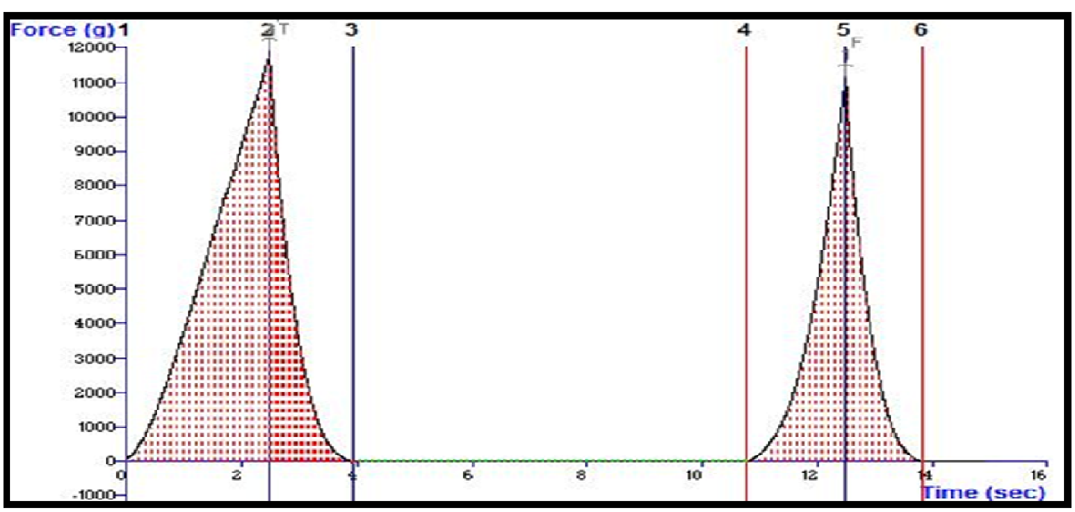

Fig. 2. Textural analysis of fresh button mushroom

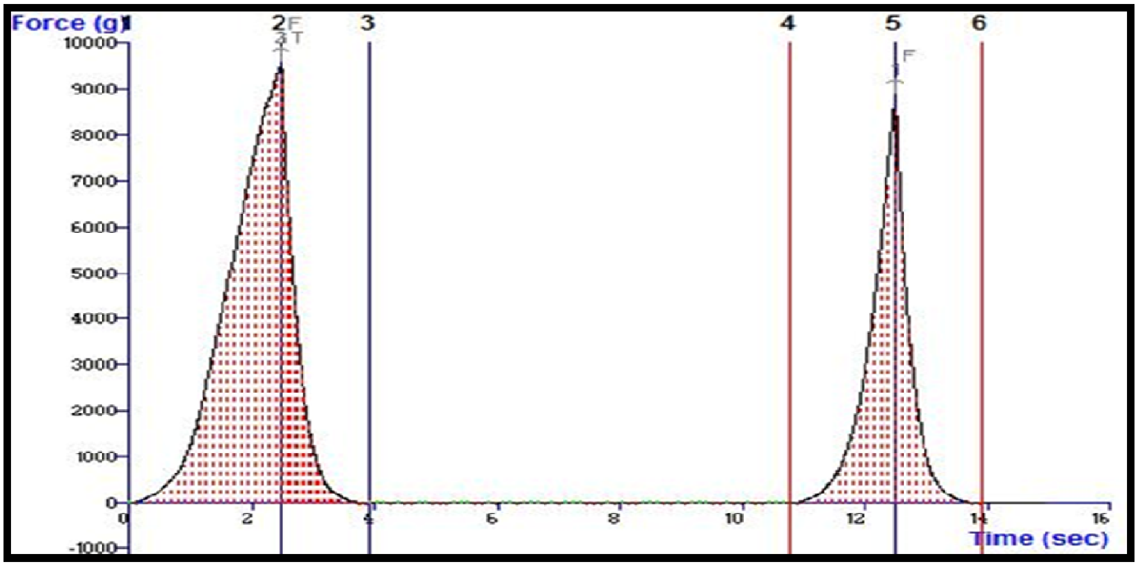

Fig. 3. Texture profile analysis curve of chemically treated (2.5% $CaCl_2$, 3% citric acid, 0.1% sorbitol) button mushroom at 8^{o}C after 4 days.

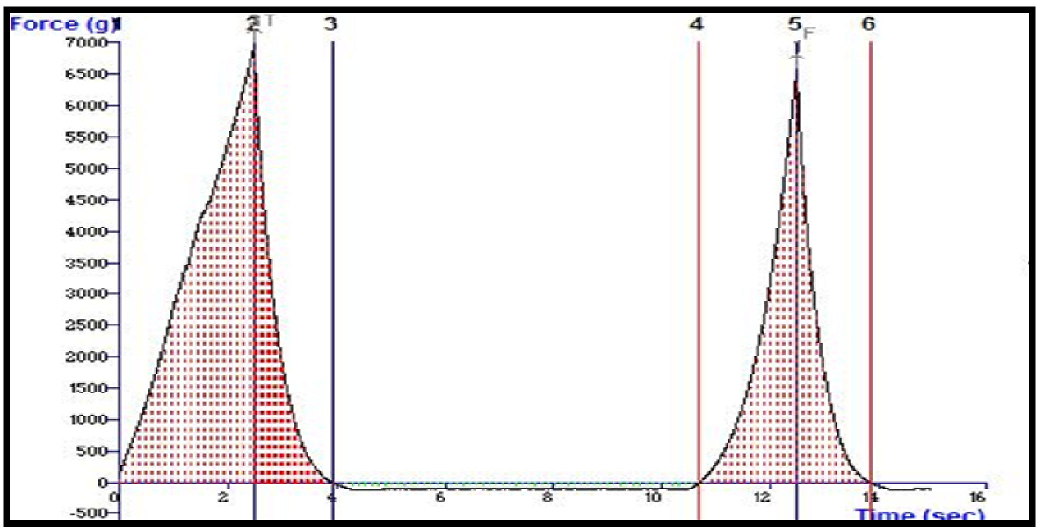

Fig. 4. Texture profile analysis curve of chemically treated (2.5% $CaCl_2$, 3% citric acid, 0.1% sorbitol) button mushroom 8^{o}C after 12 days.

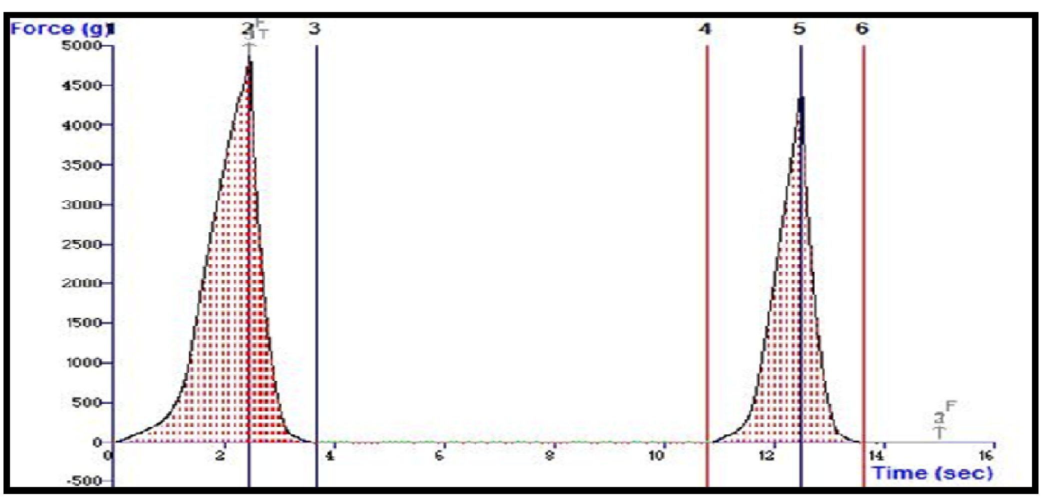

Fig. 5. Texture profile analysis curve of controlled/blanched button mushroom 8^{o}C after 12 days.

CONCLUSIONS

All the textural properties showed declining behaviour with respect to storage period. Texture, organoleptic taste, aroma, flavour and colour degraded with time. Major degradation in button mushroom was due to loss of firmness and tissue softening. Chemical treatments are very effective method for maintaining firmness of edible products especially button mutton mushroom (Shbeeb *et al.*, 2021). These results suggest that chemical treatments of button mushroom has potential in maintaining mushroom quality and extending its shelf life up to 12 days when stored at 8^{o}C. Further Chemical treatments can also be explored with other biochemical and physical treatments of button mushrooms.

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