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Research Article

SHELF LIFE ENHANCEMENT OF BUTTON MUSHROOM (*Agraricus bisporus*) BY MODIFIED ATMOSPHERE PACKAGING (MAP)

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Abstract- Production and consumption of edible mushroom have increased continuously in last two decades particularly due to their nutritional and health benefits. Mushroom is a macro fungus with a distinctive fruiting body, which can be either epigenous or hypogenous and large enough to be seen with naked eye and to be picked by hand. Mushrooms are highly perishable and cannot be stored too long. Mushrooms have very short shelf life of less than 3 days under ambient condition and from 8 to 10 days under refrigeration. Modified atmosphere packaging (MAP) of fresh mushroom depends on the modification of atmosphere inside the package which can be achieved by the combination of two processes first is the respiration rates of the mushroom and second is the permeability of the packaging films. MAP proves to be the best technology to meet the consumer's demand for best quality and fresh foods.
Keywords- *Macro fungus, fruiting body, Modified Atmosphere Packaging*

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Introduction

The world population is increasing at a faster rate and by the year 2050 the global population is expected to reach 9 billion and during 2100 it could reach around 20 billion. Now it is very difficult to meet the demands of the growing population effectively as there is concomitant reduction in arable land. By converting lignocellulosic agricultural residues into protein-rich mushrooms is one of the most economically viable processes to meet the world food demands [1]. The word mushroom is derived from the French word meaning fungi and moulds. In 1650, a melon grower of Paris discovered mushrooms growing in vicinity of his melon crop. In India mushroom cultivation was initiated for the first time at Solan in mid-sixties by Dr. E. F. K. Mental from Germany who started his work as the FAO consultant at Solan. He worked on small scale at the Department. of Agriculture, Solan, Himachal Pradesh and successfully grew button mushrooms for the first time in India. He was also associated with the project at Solan with the late Dr. P.K. Seth from the Dept. of Agriculture and cultivated button mushroom as a pilot project at Srinagar. The three most cultivated and well-known varieties of mushroom are *Agaricus bisporus* (button mushroom), *Lentinus edodes* (shiitake mushroom), *Pleurotus spp*. (oyster mushroom). *Agaricus bisporus* (button mushroom) is the most widely cultivated and consumed mushroom throughout the world. It constitutes 40% of total mushroom production [2]. Button mushroom are rich in nutrients and include bioactive polysaccharides (β-glucan such as lectinnan), antioxidants dietary fibres, ergosterol, vitamin B1, B2 and C, folates and minerals.

Nutritional Benefits

Mushroom is good source of protein carbohydrates and minerals. Raw brown mushrooms contain 92% water, 4% carbohydrates, 2% protein and less than 1% of fat. Mushroom (100g) provide 22 calories and are rich source of vitamin B and minerals like selenium (37%), copper (25%), and a moderate source of potassium, phosphorus, and zinc [3]. Some mushrooms are used as possible treatments for disease which includes polysaccharides, glycoproteins, and proteoglycan. Extracts of mushroom are widely used in Japan, Korea and China, as adjuncts to radiation treatments, chemotherapy and effective in cancer treatment.

Mushroom Spoilage

Production and consumption of mushroom have increased dramatically in last 15 years because of its rich nutrient source, mouthwatering flavor, and some medicinal uses. Mushroom is highly perishable crop, so they lose their quality very soon after the harvest because of high respiration rate and no barrier to protect their water loss. Mushroom shelf life is limited to only 1-3 days at ambient temperature. Browning and textural changes are the main processes responsible for the loss of sensory quality [4] reported that oxygen consumption rate of *Agaricus bisporus* under air at 10^0C is 17.8 $\mu gO_2\ kg^{-1}\ s^{-1}$ which decreased to 3.7 $\mu g\ O_2\ kg^{-1}s^{-1}$ at 0^0C.Respiration rate increased 2.9 times by increasing temperature by 10^0C. CO_2 production rate of *Pleurotus ostreatus* are 20.0 $\mu gCO_2kg^{-1}s^{-1}$, 39.6 $\mu gCO_2kg^{-1}s^{-1}$ and 49.2 $\mu gCO_2kg^{-1}s^{-1}$ under 0, 4 and 7^0C respectively [5]. Browning of mushroom is major cause of loss of quality during postharvest storage. Browning is defined in terms of Browning index which is is important quality factors that affect the sale of fresh button mushroom at the retail shop [6]. Mushroom browning is a major consideration for a costumer while buying mushroom from market. Browning is the result of mainly two distinct process of phenol oxidation, first is the activation of tyrosinase enzyme and second is spontaneous oxidation. Tyrosinase enzyme belongs to polyphenoloxidase family which oxidizes some monophenols to o-diphenols and then these are oxidized to quinines, which spontaneously polymerize to form brown, black or red pigments [7].

Senescence results in cell membrane disruption, loss of compartmentalization allowing enzymes and substrate to mix which accelerates browning [8]. Two most important quality factors that affect the sale of fresh button mushroom at the retail shop are the whiteness and stage of maturity i.e. the unopened button stage. Loss in texture of mushroom is also main cause of deterioration of mushroom. Softening of mushroom and loss in firmness is mainly due to changes membrane functioning [9]. The textural changes are related to the protein and polysaccharide degradation, shrinking of hyphae, disruption of central vacuole and expansion of intercellular spaces at the pilei surface [11]. Increase in cohesiveness has also been observed due to increase in chitin content and formation of covalent bond between chitin and R-glucan, which increases the rigidity of the hyphae wall. Disease and disorders are common in mushroom during post-harvest storage. Most common disorder noticed in mushroom is upward bending of caps and opening of the veil. These are mainly due to continuous growth after harvesting. Bacterial blotch or Pseudomonas spp. is severe treats during extended storage at high temperature. Quality deterioration starts just after harvesting [12].

Modified Atmosphere Packaging

Modified atmosphere packaging (MAP) of fresh mushroom depends on the modification of atmosphere inside the package which can be achieved by the combination of two processes first is the respiration rates of the mushroom and second is the permeability of the packaging films. MAP proves to be the best technology to meet the consumer's demand for best quality and fresh foods. Respiration and permeation are going on simultaneously, so it is necessary to select the matching films to meet the demand of MAP. Different plastic films are either laminated or coextruded can be used Polystyrene has also been used but polyvinylidene, polyester and nylon have such low gas permeabilities that they would be suitable only for commodities with very low respiration rates. Since mushrooms are highly perishable and have high respiration rates so increasing post-harvest storage period by preserving their quality will benefit the mushroom industry as well as consumers. Modified atmosphere packaging is one of the recent technologies that reported to be an effective tool for extending shelf life of mushrooms [13]. MAP can be defined as a modified atmosphere created by changing the normal air composition which provides the desired atmosphere surrounding the packaged product. MAP provide atmosphere which is rich in CO_2 and poor in O_2 which results in decrease in respiration rates and thus shelf life extension [14]. The effects of different concentrations of acidic washing (acetic, ascorbic, citric and malic acids) of mushroom and followed by coating with gum arabic (GA), carboxymethyl cellulose and emulsified gum arabic (EGA) were evaluated and reported that weight loss of the uncoated mushrooms was significantly ($p < 0.05$) greater than that of the coated mushroom, and the minimum weight loss was obtained with EGA coating. Loss in firmness of the EGA-coated mushrooms was by 21%, while loss value of the uncoated ones was by 39% [15]. Fresh button mushrooms (*Agaricus bisporus*) treatment with solution of 1.5% $CaCl_2$ + 0.5% citric acid and stored for 16 days at 12°C. The report states that post-harvest chemical treatment maintained better firmness, weight, color and inhibit cellulase, beta-1, 3 glucanase, chitinase and phenylalanine ammonialyase activities [16]. [17] found that $CaCl_2$ treated mushrooms packaged under MAP experienced lowest weight loss and L value (brightness), highest degree of overall color change (ΔE) and glucose contents. Overall, low storage temperature and $CaCl_2$ treatment significantly affected the quality of packaged mushrooms. [18] again reported that MAP of 5% CO_2: 10% O_2 with $CaCl_2$ dipping (0.3% for 5 min) and storage at 4°C can be used successfully for extending the shelf-life of the mushrooms for more than 11 days. Mushroom treated with 1 mmol L−1Na_2EDTA + 2.5% $CaCl_2$ + 0.5% citric acid + 2.5% sorbitol maintained good firmness and color and had less weight loss during the postharvest storage. Treated samples followed by MAP also have lower levels of H_2O_2, −OH, low malondialdehyde content (MDA) and significantly higher soluble protein contents and higher activities in the antioxidant enzymes, i.e., superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), peroxidase (POD) [19]. Mushroom cultivation has great scope in China, India and other developing countries because mushroom is a cheap source and raw materials for mushroom cultivation are easily available. Wastes crop material such as cereal straws are burnt by the farmers, which causes air pollution. However, these raw materials can be utilized for the cultivation of mushroom. Processing mushroom into value added products like ketch-up, murabba, candy, chips, pickles, canned mushroom, mushroom soup, powder, biscuit, nuggets etc. can be substituting to increase shelf life of mushroom. Modified atmosphere Packaging followed by some chemical treatments can provide good results for extending shelf life of mushroom.

Conclusion

Mushroom cultivation has great scope in China, India and other developing countries because mushroom is a cheap source and raw materials for mushroom cultivation are easily available. Wastes crop material such as cereal straws are burnt by the farmers, which causes air pollution. However, these raw materials can be utilized for the cultivation of mushroom. Processing mushroom into value added products like ketch-up, murabba, candy, chips, pickles, canned mushroom, mushroom soup, powder, biscuit, nuggets etc. can be substituting to increase shelf life of mushroom. Modified atmosphere Packaging followed by some chemical treatments can provide good results for extending shelf life of mushroom.

Application of research: Since mushroom is highly perishable crop but due to increasing demands in people it can greatly contribute to Indian economy. So, by extending its shelf life we can narrow the gap between demand and supply.

Research Category: Post harvest Technologies

Abbreviation: MAP: Modified Atmospheric Packaging

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