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# Effects of Graded Concentrations of Brine Solution on Refrigerated Oyster Mushroom (*Pleurotus ostreatus*) Quality

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**Abstract:** The preservative effect of brine solution on refrigerated mushroom quality parameters of colour, texture and smell were examined. Various concentrations of brine solution, viz; 5, 10, 15, 20, 25, 30 and 35% were used. The experiment was laid out in a Complete Randomized Design (CRD) and each treatment replicated 4 times including control. Evaluation of quality parameters was carried out through sensory evaluation by panelists using a hedonic scale ranking and statistical differences were analyzed using Analysis of Variance (ANOVA). Results indicate a minimal loss in colour within a 14 days period when a concentration of 15-35% brine solution is applied. Also, quality parameters of texture and smell remained acceptable when compared against the freshly harvested mushroom.

**Key words:** Post harvest preservation, mushrooms, brine solution, quality parameters, evaluation

## INTRODUCTION

There is an increasing need for mushroom production in Nigeria, based on the market demand parameters. However, a problem encountered is the inability of cultivated mushroom to reach the consumers in a state that is wholesome and acceptable. Post-harvest losses pose a major problem in mushroom cultivation. Therefore, the need to extend the shelf life of mushroom will enhance food security and availability, prevent wastage arising from spoilage. The market for mushroom continues to grow due to interest in their culinary, nutrition and health benefits.

In regions where mushrooms are widely accepted people appreciate them for their palatability and nutritional value. The water content is rather high 90% and is considered a health food because of their high and quantitatively good protein contents (on a dry weight basis) and they are low in fat content, also contains vitamins ($B_1$, $B_2$, C) and minerals. The objective of this research is to evolve a method that will extend the shelf life of the product at a minimal cost to the mushroom farmer. This will prevent wastage arising from spoilage and keep the mushroom in a condition that is wholesome and acceptable to the consumer.

The use of brine solution as a preservative has been in existence for a long period. Brine solution suppress the growth and activity of micro-organism that cause spoilage in food systems, however, it yields a salty product. Salt acts as a preservative by reducing the water activity of the food.

The antimicrobial activity of salt relates largely to its effect on adding ions to the media surrounding microbial cells. Mushroom cells must maintain homeostasis by active accumulation of ions, uptake or synthesis of compartible solutes. The energy expended in these activities reduce growth rate and eventually growth is prevented. Fresh mushrooms have limited shelf life. The processes responsible for mushroom sensory quality deterioration or loss are browning reactions and textural changes. The quick deterioration of mushroom is caused mainly by high metabolic respiration rate and dehydration (Ares *et al*., 2006).

Fresh fruits, vegetables and mushrooms are metabolically active for long periods after harvest. Respiration is a metabolic process that provides the energy for biochemical processes. Aerobic respiration consists of oxidative breakdown of organic reserves (mainly carbohydrates, lipids and organic acids) to simpler molecules including carbon dioxide and water, with the release of energy. These organic reserves support the respiration of harvested mushroom (Fonseca *et al*., 2002). Blanching of harvested produce is aimed at inactivating

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biochemical enzymes causing detrimental changes in color, odor, flavor and nutritional value (Gutschmidt, 1968).

Mushroom browning is an important cause of deterioration in quality parameters of color during post harvest storage of mushrooms. Browning occurs as a result of two distinct mechanisms of phenol oxidation; activation of tyrosinase, an enzyme belonging to the polyphenol oxidase family and spontaneous oxidation. Tyrosinase oxidizes some monophenols to 0-diphenols which are then oxidized to quinines. The quinines undergo spontaneous polymerization to form brown, black and red pigments (Nerya *et al*., 2006; Jolivet *et al*., 1998).

Texture is an important quality parameter of fresh mushroom. One of the major changes associated with mushroom deterioration are changes in textural characteristics. Changes in cell membrane of mushrooms have been described to be responsible for loss of firmness or textural degradation of mushrooms during post harvest storage. Also, hyphae shrinkage, protein and polysaccharide degradation, central vacuole disruption and expansion of intercellular space at the pilei surface have contributed to mushroom softening after harvest (Villaescusa and Gil, 2003; Zivanovic *et al*., 2000).

However, Spiess (1984) reported that the loss of water soluble vitamins and minerals during blanching can be minimized or reduced drastically by keeping blanching time and temperature at an optimum condition.

Holdsworth (1983) stated that the effectiveness of blanching is dependent upon the temperature and time of blanching. Blanching is more effective at a temperature range of 75-95°C for 1-10 min depending on the particle size of the product.

Also, Archuleta (2003) reported that for water blanching, vegetable is put in a basket and placed in a kettle of boiling water covered with a lid and timing begins immediately.

## MATERIALS AND METHODS

- *Pleurotus ostreates* (fresh mushroom)
- Table salt (NaCl)
- $H_2O$
- Weighing balance
- Transparent plastic containers
- Refrigerator
- Conical flask
- Measuring jar
- Scissor
- Masking tape
- Sieve
- Electric heater

Table 1: Effect of brine solution on refrigerated mushroom quality parameters

| Treatment (%) | Colour | Smell | Texture | Duration (days) |
|---|---|---|---|---|
| Control | 2.22 | 1.77 | 1.77 | 8 |
| 5 | 1.39 | 1.47 | 1.47 | 9 |
| 10 | 1.09 | 1.07 | 1.07 | 13 |
| 15 | 1.00 | 1.00 | 1.00 | 14 |
| 20 | 1.00 | 1.00 | 1.00 | 14 |
| 25 | 1.00 | 1.00 | 1.00 | 14 |
| 30 | 1.00 | 1.00 | 1.00 | 14 |
| 35 | 1.00 | 1.00 | 1.00 | 14 |

*DMRT at 5% level of probability (Appendix)

**Treatment (NaCl concentration):**

- Control
- 5%
- 10%
- 15%
- 20%
- 25%
- 30%
- 35%

Plastic transparent containers were washed with soapy water, rinsed and rinsed again. Various percentage concentration of sodium chloride was prepared and added to the containers including a control. Each treatment is replicated 4 times. Fresh mushroom was washed with clean water and blanched in hot water for 1 min to inactivate biochemical enzymes. The blanched mushroom was immersed in the various concentration of brine solution and packaged in a plastic transparent container.

The plastic transparent containers were then transferred to a refrigerator where the temperature is regulated to between 10-15°C and smell by a selected panel. A Hedonic scale ranking was used to record changes in either color, texture or smell. Differences analyzed by using of variance (ANOVA). Consumer assessment of quality is mainly sensory hence evaluation of quality parameters of color, texture and smell was done by a sensory panel (Table 1 and Appendix).

## RESULTS

Results obtained indicate that the control which did not contain brine solution showed a higher rate of deterioration in terms of quality parameters of colour, texture and smell. However, quality characteristics of color, texture and smell showed remarkable improvement as the concentration of brine solution is increased to 15%. Also, the keeping quality of the mushroom increased from 8 days for the control to 9 days with the addition of 5% brine solution. This improved further to 13 days at 10% concentration level. The results also showed that quality parameters of color, smell and texture remained the same as freshly harvested mushroom when brine solution of 15% and above is used as a preservative.

## DISCUSSION

Brine solution has preservative effect in extending the shelf life and improving the quality characteristics of harvested mushroom. Results obtained indicate that there was a deterioration in the color of mushroom samples which were not stored in brine solution. However, as the concentration solution is increased to a range of 5-10% the change in colour of mushroom is reduced. In refrigerated storage, brine solution has a significant preservative effect on color at 15-35% concentration of brine than at lower concentrations.

Also, textural characteristics of brined mushroom remained the same as the freshly harvested mushroom when refrigerated medium containing 15-35% brine solution (Fig. 1).

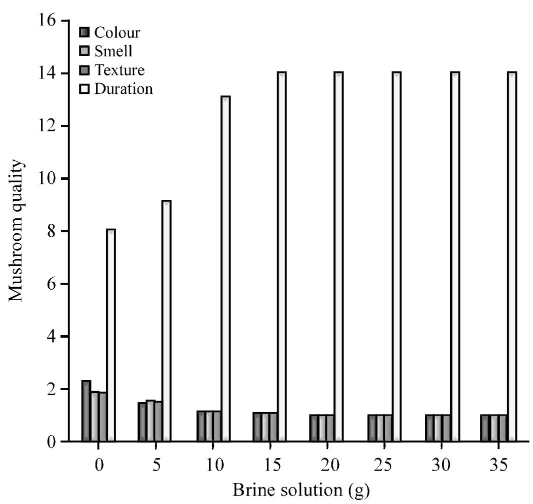


Fig. 1: Quality characteristics of colour, texture and smell of brine solution on mushroom

Therefore, at a concentration of 15-35% brine solution, all the quality parameters of color, texture and smell that were examined remained the same as the freshly harvested mushroom when refrigerated at a temperature of 10-15°C.

Also, the mushroom remained fresh for a period of 14 days when compared with non-brined mushroom which had a shelf stability of 8 days under the same temperature of storage. This shows a 75% improvement in the shelf life of mushroom between the brined and the non brined samples.

## CONCLUSION

As a result of the data obtained brine solution has a preservative effect on quality parameter of colour, texture and smell of mushroom under refrigerated storage. Brine concentration of 15-35% when kept at a temperature range of 10-15°C kept mushroom quality fresh. Treating mushroom with brine concentration of 15-35% prior to storage extended the shelf life of mushroom by about 75%.

## APPENDIX

**Ranking of colour, smell and texture:**

- Colour: 1-9
  - 1: Fresh
  - 5: Bad
  - 9: Very bad
- Smell: 1-5
  - 1: Fresh
  - 5: Bad
- Texture: 1-5
  - 1: Strong
  - 5: Soft

One way ANOVA for the effect of brine solution on mushroom quality

| Descriptive | N | Mean | SD | SE | 95% confidence interval for mean<br>Lower bound | <br>Upper bound | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|
| **Colour** | | | | | | | | |
| 0 | 12 | 2.60119 | 1.142637 | 0.329851 | 1.87519 | 3.32719 | 1.500 | 4.429 |
| 5 | 12 | 2.09524 | 1.343345 | 0.387790 | 1.24172 | 2.94876 | 1.000 | 4.143 |
| 10 | 12 | 1.99405 | 1.406142 | 0.405918 | 1.10063 | 2.88747 | 1.000 | 4.143 |
| 15 | 12 | 1.92857 | 1.374968 | 0.396919 | 1.05496 | 2.80218 | 1.000 | 4.000 |
| 20 | 12 | 1.35714 | 0.556626 | 0.160684 | 1.00348 | 1.71081 | 1.000 | 2.571 |
| 25 | 12 | 1.08333 | 0.166357 | 0.048023 | 0.97764 | 1.18903 | 1.000 | 1.571 |
| 30 | 12 | 1.00000 | 0.000000 | 0.000000 | 1.00000 | 1.00000 | 1.000 | 1.000 |
| 35 | 12 | 1.00000 | 0.000000 | 0.000000 | 1.00000 | 1.00000 | 1.000 | 1.000 |
| Total | 96 | 1.63244 | 1.081183 | 0.110348 | 1.41337 | 1.85151 | 1.000 | 4.429 |
| **Smell** | | | | | | | | |
| 0 | 12 | 1.75595 | 0.643548 | 0.185776 | 1.34706 | 2.16484 | 1.000 | 2.751 |
| 5 | 12 | 1.63095 | 0.626290 | 0.180794 | 1.23303 | 2.02888 | 1.000 | 2.571 |

Continue

| Descriptive | N | Mean | SD | SE | 95% confidence interval for mean Lower bound | Upper bound | Minimum | Maximum |
|---|---|---|---|---|---|---|---|---|
| 10 | 12 | 1.45238 | 0.625178 | 0.180473 | 1.05516 | 1.84960 | 1.000 | 2.429 |
| 15 | 12 | 1.39286 | 0.590980 | 0.170601 | 1.01737 | 1.76835 | 1.000 | 2.429 |
| 20 | 12 | 1.16667 | 0.291075 | 0.084026 | 0.98173 | 1.35161 | 1.000 | 1.857 |
| 25 | 12 | 1.02381 | 0.055607 | 0.016052 | 0.98848 | 1.05914 | 1.000 | 1.143 |
| 30 | 12 | 1.00000 | 0.000000 | 0.000000 | 1.00000 | 1.00000 | 1.000 | 1.000 |
| 35 | 12 | 1.00000 | 0.000000 | 0.000000 | 1.00000 | 1.00000 | 1.000 | 1.000 |
| Total | 96 | 1.30283 | 0.517652 | 0.052833 | 1.19794 | 1.40771 | 1.000 | 2.571 |
| **Texture** | | | | | | | | |
| 0 | 12 | 1.70833 | 0.584635 | 0.168770 | 1.33687 | 2.07979 | 1.000 | 2.429 |
| 5 | 12 | 1.58333 | 0.567219 | 0.163742 | 1.22294 | 1.94373 | 1.000 | 2.429 |
| 10 | 12 | 1.41667 | 0.584139 | 0.168626 | 1.04552 | 1.78781 | 1.000 | 2.429 |
| 15 | 12 | 1.35714 | 0.546536 | 0.157771 | 1.00989 | 1.70440 | 1.000 | 2.429 |
| 20 | 12 | 1.20238 | 0.313330 | 0.090451 | 1.00330 | 1.40146 | 1.000 | 1.857 |
| 25 | 12 | 1.03571 | 0.064610 | 0.018651 | 0.99466 | 1.07677 | 1.000 | 1.143 |
| 30 | 12 | 1.00000 | 0.000000 | 0.000000 | 1.00000 | 1.00000 | 1.000 | 1.000 |
| 35 | 12 | 1.00000 | 0.000000 | 0.000000 | 1.00000 | 1.00000 | 1.000 | 1.000 |
| Total | 96 | 1.28795 | 0.478255 | 0.048812 | 1.19104 | 1.38485 | 1.000 | 2.429 |

Post Hoc test, homogeneous subsets

Duncan[a]

| Brine | N | Subset for $\alpha = 0.05$ 1 | 2 | 3 | Brine | N | Subset for $\alpha = 0.05$ 1 | 2 | 3 | Brine | N | Subset for $\alpha = 0.05$ 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Color** | | | | | **Smell** | | | | | **Texture** | | | | |
| 30 | 12 | 1.00000 | - | - | 30 | 12 | 1.00000 | - | - | 30 | 12 | 1.00000 | - | - |
| 35 | 12 | 1.00000 | - | - | 35 | 12 | 1.00000 | - | - | 35 | 12 | 1.00000 | - | - |
| 25 | 12 | 1.08333 | - | - | 25 | 12 | 1.02381 | - | - | 25 | 12 | 1.03571 | - | - |
| 20 | 12 | 1.35714 | 1.35714 | - | 20 | 12 | 1.16667 | 1.16667 | - | 20 | 12 | 1.20238 | 1.20238 | - |
| 15 | 12 | - | 1.92857 | 1.92857 | 15 | 12 | 1.39286 | 1.39286 | 1.39286 | 15 | 12 | 1.35714 | 1.35714 | 1.35714 |
| 10 | 12 | - | 1.99405 | 1.99405 | 10 | 12 | - | 1.45238 | 1.45238 | 10 | 12 | - | 1.41667 | 1.41667 |
| 5 | 12 | - | 2.09524 | 2.09524 | 5 | 12 | - | - | 1.63095 | 5 | 12 | - | - | 1.58333 |
| 0 | 12 | - | - | 2.60119 | 0 | 12 | - | - | 1.75595 | 0 | 12 | - | - | 1.70833 |
| Sig. | | 0.41200 | 0.08700 | 0.12000 | Sig. | | 0.59000 | 0.148000 | 0.75000 | Sig. | | 0.06500 | 0.02420 | 0.06300 |

Means for groups in homogeneous subsets are displayed. [a]Uses harmonic mean sample size = 12.000

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