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SHELF-LIFE EVALUATION AND QUALITATIVE CHARACTER ANALYSIS OF OYSTER MUSHROOMS (*Pleurotus ostreatus*) USING DIFFERENT PACKAGING MATERIALS UNDER DIFFERENT STORAGE CONDITIONS

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ABSTRACT

Ananna MA, Sultana S, Niloy M, Ahmed F, KHANDAKAR J (2022) Shelf-life evaluation and qualitative character analysis of oyster mushrooms (*Pleurotus ostreatus*) using different packaging materials under different storage conditions. *Int. J. Sustain. Crop Prod.* 17(2), 01-05.

In Bangladesh, mushrooms especially oyster mushroom (*Pleurotus ostreatous*) not only serve as a scrumptious and nutritious part of the diet but also proved to be a cash crop for the population. As we know, the mushroom is a highly perishable food item. So, the extension of the shelf life of oyster mushrooms is one of the major concerns in mushroom marketing. At ambient temperature and without proper packaging, we have observed that the shelf life of the oyster mushroom is few hours to a day depending on the season. There are several genetic and environmental factors are involved in the extension of the shelf life of oyster mushrooms like types of cultivars, age of mushroom, time of harvesting etc. Furthermore, proper packaging conditions and packaging materials also play a significant role in prolonging the shelf life of a product. Polyethene and polypropylene are commonly used packaging materials in the food industry. Hence, the purpose of the study was to assess the shelf life of oyster mushrooms by using polyethene and polypropylene packaging at different storage conditions like ambient (25°C-29°C) and refrigerated (4°C) conditions. In the experiment, we considered six major quality parameters of storage life such as moisture content, texture, odour, browning index, and weight loss for assessing shelf life. The data were collected for 5 days at intervals of 48 hours. For collecting data, precise instruments like Perten TVT 300 XP texture analyzer, AnD MX-50 moisture analyzer and colour analyzer were used to assess the changes in the texture, moisture, and browning index of the mushrooms respectively. The results indicate that the mushrooms remain fresh in polypropylene packages in contrast to the polyethene packages and the results of other storage quality parameters revealed that refrigerated condition performed better than the ambient condition. Therefore, farmers are encouraged to use polypropylene packaging and store it in refrigerated condition to increase the shelf life of their harvested mushrooms. During study time there was no bacterial growth observed on the samples. This indicates that proper handling can minimize post-harvest microbial loss.

Key words: *mushroom, shelf life, pleurotus spp. texture analysis, packaging*

INTRODUCTION

Oyster mushrooms represent the most consumed as well as first-ranked commercially cultivated mushrooms in Bangladesh (Ferdousi *et al*. 2020). In the climatic conditions of Bangladesh, the shelf life of oyster mushrooms is only a few hours in summer and 24 hours in winter at ambient temperature which suggested that it is an extremely perishable food item. The physiology and biochemical mechanism underlying rapid spoilage are the lack of surface cuticles that protect mushrooms from physical and microbial damage and prevent loss of water (Burton and Noble, 1993). Additionally, fresh mushrooms contain a greater amount of moisture usually 85-90% along with a high respiration rate making them highly susceptible to microbial attack and enzymatic browning (Castellanos-Reyes *et al.* 2021; Brennan *et al*. 1999). Usually, the post-harvest quality of mushrooms has been assessed by both the producers and consumers using certain traits that determine their value in the market. Factors such as genotype, maturity stage, and harvesting time, together with storage conditions like temperature, humidity, packaging etc., have a notable contribution to the post-harvest quality losses in mushrooms (Burton and Noble, 1993).

The visually appealing typical oyster mushroom is white, firm, and smooth. This impressive morphology makes them preferable for consumption. After harvesting, mushrooms rapidly lose water resulting in wilting and shriveling which consider a major factor for rendering them unfit to consume (Das *et al*. 2010). Such postharvest change is a natural process so we cannot be stopped it, but we can reduce the speed of spoilage within a certain limit. Hence, the producers and handlers must understand the biological underlying, environmental and technological aspects affecting the quality and deterioration of the mushroom.

Mushrooms are usually traded as a fresh product or a processed product such as canning, drying, pickling etc. In Bangladesh, fresh mushroom demand is higher than other processed items. So, the extension of shelf life, and maintaining quality are mandatory to meet the consumer’s demand and reduce losses along the food chain.

In the viewpoint of commercial feasibility, proper packaging and storage at appropriate temperatures are two crucial points for the extension of mushroom shelf life. The commonly used packaging materials in the food industry are polypropylene (PP) and polyethene (PE) (Rao *et al.* 2021) as both are low-cost, easily available, durable, and easy to recycle. Based on the above views, the objectives of our study are to figure out the best packing practices along with storage conditions of fresh oyster mushrooms and find out the effects of these treatments on physicochemical features such as weight loss, firmness, colour etc. It is expected that our findings will improve the understanding of mushroom post-harvest biology and will serve as a useful source of information on packaging for mushroom growers and sellers.

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MATERIALS AND METHODS

In our experiment, freshly harvested oyster mushrooms (*Pleurotus ostreatus*) were collected from National Mushroom Development Institute at Savar, Dhaka. Based on the size and appearance mushrooms were sorted. Usually damaged, extra large and small mushrooms were discarded. Two packaging materials such as PP and PE were used, and each package contained 100±5 g mushrooms. The packets were sealed and then stored at ambient and refrigerator temperatures. The experimental conditions are shown in Table 1.

Table 1. The features of packaging materials used and environmental conditions of the experiment

Packaging Materials	Size (cm)		Thickness (mm)	Weight of sample size (g)	Storage condition			
	Length	Width			Temperature (^{0}C)		Humidity (%)	
					Ambient	Refrigerator	Ambient	Refrigerator
PP	26.7	17.7	2.0	100±5	29	4-5	70-80	65
PE	22.6	17.5	0.25	100±5	29	4-5	70-80	65

Quality attributes

Data were collected based on the following parameters.

Texture

The mushrooms' texture was analyzed on a Perten TVT 300 XP texture analyzer and the changes in resilience and hardnessof the fruiting bodies throughout the study were recorded. The readings were taken from a height of 40mm, at a test speed of 1.5 mm/s, trigger force of 25 g and compression of 5.0 mm.

Moisture content (%)

The moisture contents of the samples were analyzed with an AnD MX-50 Moisture Analyzer equipped with both heating and weighing units. In the analyzer, the mushrooms were heated at a constant temperature of 110°C while the total moisture contents were recorded in percentage. The quantification is carried out by using the following expression(Alam *et al.* 2008) :

$$\text{Moisture content (\%)} = \frac{\text{Weight of fresh sample} - \text{Weight of dried sample}}{\text{Weight of fresh sample}} \times 100$$

Browning Index

It was assessed with a colour analyzer. Before taking the readings, the analyzer was calibrated using the black and white calibrators that came with the equipment. Three mushrooms were obtained from each treatment and readings were taken in triplicates from each of the samples. The colour parameter values, L^* represents lightness and darkness, a* indicates redness or greenness and b^* stands for yellowness or blueness, were used to work out the browning index using the following formula.

$\text{BI} = 100 \times \frac{X-0.31}{0.71}$ Where, $X = \frac{a+1.75L*}{5.645L*+a*-3.012b*}$------------(Bozkurt and Bayram, 2006).

Weight loss

It must be noted that to evaluate the weight loss (W_L) of the samples, the initial weights (W_0) and the final weights (W_f) of the packaged mushrooms were weighed using an electronic balance (Xpart Weighing Scale). The readings were taken in grams and the following equation was used for the investigation.

$(W_L = ((W_o – W_f)/W_o) \times 100$. ---(Jafri *et al.* 2013).

Results were expressed as an average of three replicates.

Odour

Oyster mushroom has a unique fragrance. It is well known that a change of smell is correlated with the degree of mushroom spoilage. Hence to evaluate the odour of mushroom samples depending on storage time, a panel of evaluators were made up which consist of 10 volunteers. All the panellists were well-educated (above secondary education) and well-conversant with agricultural products. Most of them were mushroom scientists and technicians from National Mushroom Development Institute. The smells of the mushrooms were recorded from the first day to 5th day of storage. The degree of smell was categorized accordingly.

Score	Odor
4	It has strong fragrance
3	Normal, No peculiar smell
2	Slightly unpleasant smell
1	Serious unpleasant smell

RESULTS AND DISCUSSION

Texture Analysis

From a viewpoint of consumer acceptance, texture is an important quality attribute. Usually, the mushroom is prone to softening during storage (Qu *et al.* 2022). In our study, we analyzed firmness by measuring the hardness, and resilience of the mushrooms under each condition. As shown in Table 2 the firmness declined gradually throughout the storage. The result showed that the hardness was most on 1st day in both treatments while the resilience was most on the 5th day. From Table 2, it can also be deduced that unlike samples of refrigeration (PP) ambient (PE) went through major changes which indicates the role of low temperature in retarding metabolic activity (Sveine *et al.* 1967).

Table 2. Analysis of the texture of oyster mushrooms during storage

Treatment	1st day		3rd day		5th day	
	Hardness	Resilience	Hardness	Resilience	Hardness	Resilience
Ambient(PP)	152±3.5	0.24±0.05	116±5.65	0.32±0.02	96±5.65	0.35±0.04
Ambient(PE)	156±1.42	0.27±0.11	130±7.07	0.36±0.06	115.5±6.36	0.38±0.19
Refrigeration(PP)	150±3.5	0.22±0.07	142±3.53	0.25±0.02	127.5±3.5	0.30±0.02
Refrigeration(PE)	153±7.07	0.22±0.04	125±7.07	0.27±0.01	114±1.4	0.35±0.07

The mean and standard deviation values were obtained by three replicates

Moisture Content

The moisture content of fresh oyster mushrooms ranges from 85 to 90%. According to the bar chart provided (Fig. 1), it noted that moisture percentage decreases at every 2-day interval. At 5 days we observed that samples of ambient (PE) showed the highest moisture content whilst samples of refrigeration (PE) showed the lowest moisture content. Moreover, sample in refrigeration the moisture percentage showed drastic changes compared to the ambient.

Our observation revealed that at ambient conditions, the high moisture content is prone to spoilage, whereas loss of moisture in refrigerated conditions showed a shrinkage tendency. Ambient (PE) showed the highest moisture content. On the other hand, refrigerated (PE) showed the lowest moisture content. Usually, the permeability of the polyethene (PE) packaging is higher than polypropene PP (Siracusa 2012). Refrigerated (PP) showed high shelf life with freshness because the rate of moisture exchange and other metabolic activities is lower under refrigeration conditions.

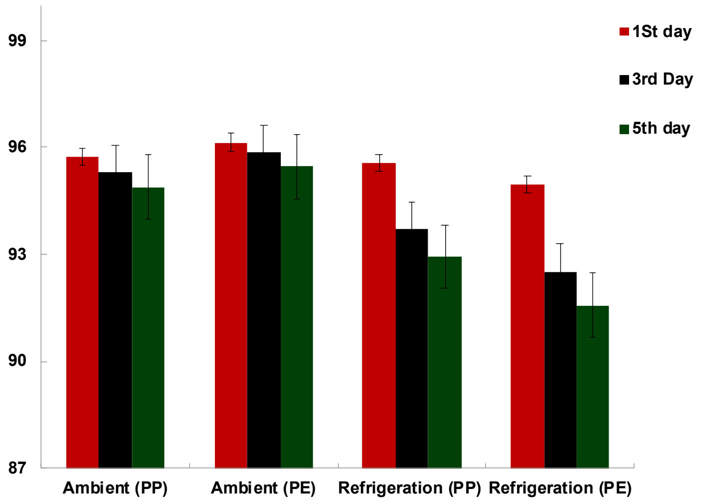

Fig. 1. Moisture content (%) of mushroom during storage

Browning Index

In the case of white mushrooms like oysters, buttons and milky white mushrooms, the white colour is first perceived by the consumer. Unlike button mushrooms, oyster mushroom show less browning tendency. Among the biochemical associates of mushroom browning phenol oxidase is one of the key players. It was reported that phenol oxidase activity in button mushrooms is about 3 fold higher than that of oyster mushrooms (Rajarathnam *et al.* 2003). As shown in Table 3 browning index increased gradually in all groups during storage. Among the four treatments, mushroom samples of ambient (PE) underwent the most browning while refrigeration (PE) samples had the least browning but there is no significant difference among the treatment. On 5th day of the experiment, it was observed that the mushrooms at ambient (PE) treatment, start to get darker in colour and fully slimy.

Table 3. Browning Index of oyster mushroom during storage

Condition	Browning Index		
	1st day	3rd day	5th day
Ambient (PP)	1.28	2.03	2.8
Ambient (PE)	1.07	2.5	5.17
Refrigeration (PP)	0.96	1.31	2.01
Refrigeration (PE)	0.95	1.51	2.54

Odor: Mushroom has a characteristic aroma which is the combined result of several groups of compounds such as alcohols, aldehydes, ketones, acids, hydrocarbons, esters, and heterocyclic, aromatic and sulfur compounds etc. (Sun *et al.* 2020; Aisala *et al*. 2019). These are not only associated with the post-harvest quality of mushroom-like aroma (Sun *et al*. 2020 Aisala *et al.* 2018), but also have several key functions related to growth physiology and mycelium interactions (Ditengou 2015; Hynes *et al*. 2007. Our panel observed that the mushroom at ambient PE has already spoiled (score 1 seriously unpleasant smell) likewise ambient PP the smell has onset to change (score 2 slightly unpleasant smell) in 3 days. On the other hand, at refrigeration, both PP and PE remained unchanged (score 3 normal no peculiar smell) in day 3. In day 5, we examined only the refrigeration sample. The odour of PE has changed, similarly, PP commenced to change.

Weight Loss and Microbial Study: Evidently, it is proved that weight loss is a common parameter in post-harvest loss of mushrooms (Xiao *et al*. 2011) But in our experiment, we did not find any significant losses in the weight of mushrooms. A possible cause is the low number of mushrooms only 100gm / packet was taken for the experiment. Similarly, we did not find any microbial contamination over time.

CONCLUSION

Fresh fruit bodies have a high rate of metabolic activity which quickly declines and leads to deterioration. From our study, we can conclude that the mushrooms have remained fresh and taken a longer time to deteriorate inside polypropylene (PP) packages in contrast to the polyethene (PE) packages. Furthermore, refrigerated (4°C) conditions showed better storage life with preserving better qualities than ambient (25°C-29°C). So, we will suggest to the farmers to use polypropylene (PP) packaging and store in the refrigerator for prolonging the shelf life of freshly harvested mushrooms.

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