ACTA SCIENTIARUM POLONORUM Acta Sci. Pol., Technol. Aliment. 8(1) 2009, 17-22

CHANGES OF QUALITY OF *PLEUROTUS* SSP. CARPOPHORES IN MODIFIED ATMOSPHERE PACKAGING

Maria Sapata, Ana Ramos, Armando Ferreira, Luis Andrada, Manuel Candeias

Instituto Nacional dos Recursos Biológicos L-INIA in Oeiras, Portugal

Abstract. There is a general trend towards a continuous increase in fresh market sales of mushrooms and many methods have been researched to improve quality and shelf life during storage and marketing. As it is known, mushrooms are a very perishable commodity, with very high respiration rate and rapid quality deterioration, when kept at ambient temperature. In order to study the effect of modified atmosphere packaging (MAP) on the quality of three species of oyster mushrooms, *P. ostreatus*, *P. sajor-caju* and *P. eryngii*, whole mushrooms were packaged with two polymeric low density polyethylene films – Vileda Freshmate (A) and PE 52 LV Amcor (B), with passive modified atmosphere and stored at 4ºC. The quality and stability of MA packaged mushrooms were assessed, during storage, by package atmosphere composition (O_2, CO_2), soluble solid contents, weight loss, texture, surface colour and exudates measurements. It was verified that on the seventh day the *P. ostreatus* and *P. sajor-caju* carpophores presented identical quality, when packaged with the two films types, thereafter some decay was observed. Carpophores of *P. eryngii* had the same quality in the two film types at the end of the established storage.

Key words: mushrooms, packaging conditions, polymeric films, storage, shelf life

INTRODUCTION

The oyster mushrooms (*Pleurotus* spp.) cultivation technology has been recently developed, with an increasing production, due to the peculiar taste and texture which makes it very successful with consumers. These mushrooms have gained popularity, for the manipulation easiness, capacity and fructification development, in different agricultural substrates, and also for the adaptability to several ecological conditions.

Although *Pleurotus* gen. includes more than fifty species, almost all foodstuffs and very similar among them are domesticated and industrially manipulated, namely

Corresponding author – Adres do korespondencji: Maria Sapata, I.P. Instituto Nacional dos Recursos Biológicos L-INIA, Quinta do Marquês, 2784-505 Oeiras, Portugal, e-mail: margarida.lobo@gmail.com

P. ostreatus, for its rusticity, *P. sajor-caju* for the peculiar flavour and *P. eryngii* for the excellent quality and texture.

Given their intrinsic characteristics, namely chemical composition and metabolic activity, post harvest handling procedures and storage of mushroom carpophores is connected with some complexity to extend the shelf life. The main spoilage symptoms are represented by physiological disorders, dehydration, with textural, flavour and colour changes [Amodio et al. 2003, Moda et al. 2005].

The abundance of imported mushrooms in retail shops and supermarkets reflects the need for a continuous supply of good quality, locally grown mushrooms. As these mushrooms are marketed usually, *en nature*, some post-harvested treatments have been tried and utilized for preserving the freshness of *Pleurotus* mushrooms [Barron et al. 2002].

These methods include proper use of refrigeration and modified atmosphere packaging (MAP), in which fresh cut carpophores preparations represent an opportunity to increase demand for high convenience products [Amodio et al. 2003, Choi and Kim 2003].

With this technology it is possible to preserve the carpophores and extend the shelf life, choosing proper temperature and plastic films packages. So, an optimal in-package atmosphere is assured and kept that is determined by the respiration rate of the product and the permeability of the packaging film to oxygen, carbon dioxide and water vapour [Barron et al. 2002, Choi and Kim 2003]. This study aimed to evaluate the impact of MAP on the quality of carpophores of three referred to *Pleurotus* species, during eleven days storage, at 4°C, when packaged with two polymeric films types with passive modified atmosphere.

MATERIAL AND METHODS

The mushrooms *P. ostreatus* (*P.o.*), *P. sajor-caju* (*P.s.c.*) and *P. eryngii* (*P.e.*) were produced under controlled conditions on our unit of L-INIA. Harvested carpophores from the first flush of fructifications were sorted by appearance and size. Fresh carpophores after sorting, were washed and drained with paper toweling and were placed (about 120 g) in polyethylene trays B-12 H47 Ovarpack (PS-EVOH-PE of 230 × 144 × 47 mm, thickness 550 µm) that contained in its interior moisture absorber MP – Ovarpack (12 × 18 cm). These were heat-sealed with a sealing machine MGM SAV. vuoto gas, with two types of polymeric films of low density polyethylene, with different permeability: A – Freshmate Vileda and B – PE – 52 LV Amcor (Table 1), with passive modified atmosphere, at 4°C, for 11 days.

The quality control was determined at the times 0, 3, 7, and 11 days by the following parameters: Composition of the packs atmosphere – gas PBI Dansensor, Checkmate 9900; soluble solids content (SSC) – digital refractometer ATAGO PR-1; pH values – potenciometer Crisonmicro pH 2002; weight loss – monitored the weight of the package content before and after storage period; moisture absorbed amount – weight difference between the dry absorber and moistened, relatively to the fresh carpophores mass; texture – texturometer Stable Microsystems TA-Hdi, with a load cell of 50 N, using a puncture, with a probe inox P6 (Ø 6 mm), at 20°C; colour – colorimeter Minolta Chroma 200b; exudates – amount of liquid freed for approximately 4 g of carpophores

Table 1. Characteristics of the packaging films

Code	Plastic polyethylene	Thickness µm	O_2 permeability mL/m^2·24 h·atm	CO_2 permeability mL/m^2·24 h·atm	Commercial denomination
A	Low density	10	≈9 550	≈28 000	Freshmate Vileda*
B	Low density	90	2 250	8 000	PE – 52 LV Amcor**

*Data calculated in specifications of the film PE (*in*: data of the catalogue of Amcor-Flexibles).
**Microperfurated film for packing of this product type – 1 microperfuration/14 cm^2 (the manufacturer's responsibilit.

when pressed with weight of 10 kg (Salles Torres), for 10 seconds. The results were treated with the Statistical V.6 program, for Principal Components Analysis (PCA) and Factorial Discriminate Analysis (FDA).

RESULTS AND DISCUSSION

On the third storage day, O_2 concentration had a sharply decrease in all the A film packages: about 36% at *P.s.c.* and *P.e.* and 9% in the *P.o.* packages. The CO_2 corresponding values presented an increase of about 3%, and then remained at a constant level [data not shown]. For the three species in the B film packages, O_2 concentration stayed constant, until it declined by 10%; in the final storage, CO_2 concentration in these packages, showed highest values, when compared with the similar changes, in the A packages. These results showed that the physiological balance was reached on the third storage day, independently of the packing film, for all *Pleurotus* species used in the study.

Carpophores of *P.o.* stored in A film, exhibited a higher weight loss of 13.28%, whereas of *P.e.* showed the lowest loss of 6.57%, after 11days of storage. This is due to the high moisture that *P.o.* carpophores presented, being more predisposed to the dehydration. Independently of the package film, *P.e* kept their initial firmness, while a decreased texture was verified, about 43.2% for the *P.o*. and 48.8% for *P.s.c*., accompanied of turgidity loss. Exsudates and pH variations were not verified. Characteristics changes in visual colour were observed. Oyster mushrooms became yellowish and little tone defined by the increase of b* value, independently of the packing films. This happens, in most of the mushrooms of clear colour, being due mainly to the tyrosinase enzyme action [Gormley 1975].

With a principal component analysis performed on all data, 82.33% of the total variance could be explain by the first three components (Fig. 1). The variables texture, pH, exsudate and lightness (L*) are mostly linked to the first component PC1 (36.21% of explain variance) showing the partially carpophores decay, during storage. The second component PC2 (28.10% of explain variance) is justified by CO_2, chroma (C*) and O_2 with lower contribution. The third component PC3 (18.02% of explain variance) is explained by hue (°H), and shows the influence of the CO_2 concentration on mushrooms colour definition.

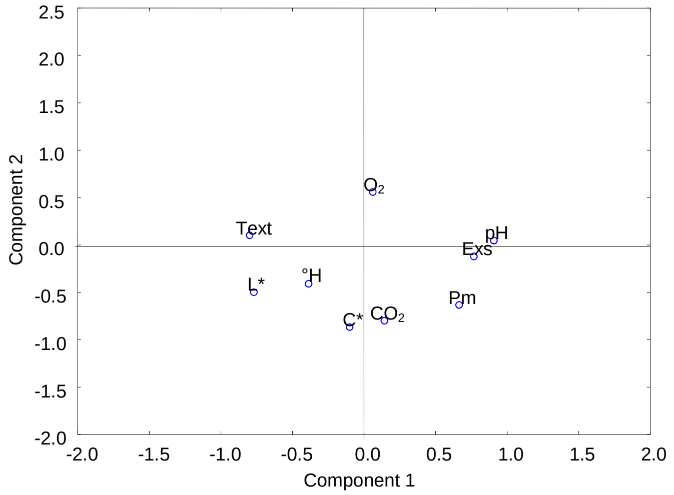

Fig. 1. Principal Component Analysis (PCA): O_2 – oxygen, CO_2 – carbon dioxide, Pm – weight loss, Text – texture, pH, Exs – exsudate, L* – lightness, C* – chroma, °H – hue

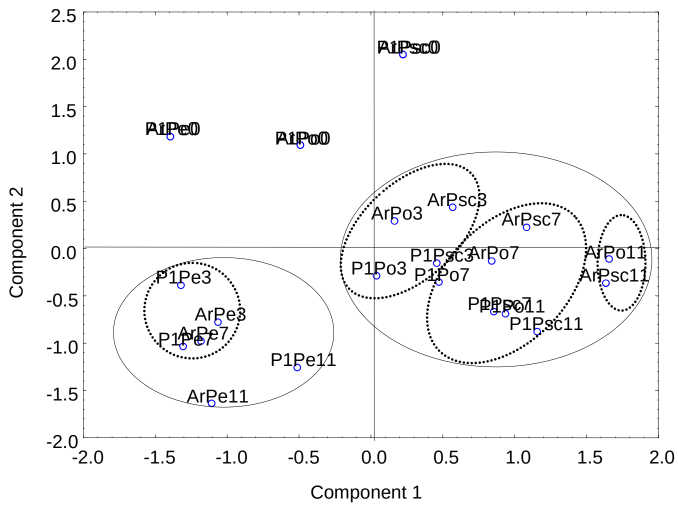

Fig. 2. Factorial Discriminate Analysis (FDA): Ar – A Film, P1 – B Film, *P.o.* – *P. ostreatus*, *P.s.c.* – *P. sajor-caju*, *P.e.* – *P. eryngii*

By factorial discriminate analysis (Fig. 2), the distribution of the experimental points allows to distinguish a definable difference between the three oyster mushroom species, during storage, to group them in the following way: two different groups, one composed of *P.o.* and *P.s.c.* and other for *P.e.* Relatively to the first group, on the third day, independently of the packing film type, an identical quality was verified.

However, the B film packing (P1) allowed to maintain a better product characteristics just to final storage, with smaller weight loss and some yellowiest, justified by *P.o.* and *P.s.c.* samples proximity, of 11 days with the one of 7 days of storage respectively, showed in FDA score plot. The carpophores samples packaged with A film (Air) with a pH and exudates increased, manifesting high decay, justified for the removal of the same ones, relatively to the B film (P1). In the second group, constituted by *P.e.* carpophores, independently of the packing film applied, an identical quality was verified, just with a quick colour change in the final of storage.

CONCLUSION

The results of this study model could be used to predict a good MAP atmosphere storage, which is always the function of the temperature and of the relative humidity. It was verified that on the seventh day the *P. ostreatus* and *P. sajor-caju* species presented identical quality, when packaged with the two films types, but thereafter some decay it was observed. It was observed that *P. eryngii* in the two film types presented the same quality, after eleven days, at the end of the established storage period. Results present a valuable starting point in order to design a commercial application of modified atmosphere packaging technology with these products, since packaging is essential for reducing respiration rate and maintaining the quality.

Acknowledgement

We thank the National Institute Agricultural Research (INIA; applicative Research Project PIDDAC 122/05: "Improving shelf-life of fresh *Pleurotus* mushrooms by modified atmosphere packaging") that enabled us to write this article.

REFERENCES

Amodio M.L., Colelli G., De Cillis F.M., Lovino R., Massignan L., 2003. Controlled-atmosphere storage of fresh-cut 'Cardoncello' mushrooms (*Pleurotus eryngii*). Acta Hort. 599, 731-735.

Barron C., Varoquaux P., Guilbert S., Gontard N., Gouble B., 2002. Modified atmosphere packaging of cultivated mushroom (*Agaricus bisporus* L.) with hydrophilic films. J. Food Sci. 67, 1, 251-255.

Choi M.H., Kim G.H., 2003. Quality changes in *Pleurotus ostreatus* during modified atmosphere storage as affected by temperatures and packaging material. Acta Hort. 628, 357-362.

Gormley R., 1975. Chill storage of mushrooms. J. Sci. Food Agric. 26, 401-411.

Moda E.M., Spoto M.H.F., Horii J., Zocchi S.S., 2005. Uso de peróxido de hidrógenio e ácido cítrico na conservação de cogumelos *Pleurotus sajor-caju* in natura. Ciênc. Technol. Aliment. Campinas. 25, 2, 291-296.

ZMIANY JAKOŚCI OWOCNIKÓW BOCZNIAKA W OPAKOWANIACH Z MODYFIKOWANĄ ATMOSFERĄ

Streszczenie. Istnieje ogólna tendencja do ciągłego wzrostu sprzedaży na rynku grzybów świeżych. Przebadano wiele metod w celu poprawy jakości i trwałości owocników podczas przechowywania i obrotu. Jak wiadomo, grzyby są łatwo psującym się towarem, charakteryzującym się dużym współczynnikiem oddychania i gwałtownym pogarszaniem jakości podczas przechowywania w temperaturze otoczenia. W celu zbadania wpływu pakowania z modyfikowaną atmosferą (MAP) na jakość owocników trzech gatunków boczniaka *P. ostreatus*, *P. sajor-caju* i *P. eryngii* zapakowano całe owocniki w dwa rodzaje folii polietylenowej o małej gęstości Vileda Freshmate (A) i 52 PE LV Amcor (B), po czym przechowywano je w temperaturze 4°C. Jakość i trwałość owocników zapakowanych w MPA była oceniana podczas przechowywania poprzez określenie składu atmosfery w opakowaniu (O_2, CO_2), zawartości części rozpuszczalnych, utraty masy, tekstury, koloru powierzchni owocników i pomiar ekskudatu. Stwierdzono, że w siódmym dniu gatunki *P. ostreatus* i *P. sajor-caju* charakteryzowały się identyczną jakością przy zastosowaniu obu rodzajów folii, a następnie obserwowano pewne oznaki psucia. Podobnie w wypadku *P. eryngii*, oba typy folii pozwalały utrzymać tę samą jakość do końca okresu przechowywania.

Słowa kluczowe: grzyby, warunki pakowania, folie polimerowe, przechowywanie, okres trwałości

Accepted for print – Zaakceptowano do druku: 10.12.2009

For citation – Do cytowania: Sapata M.L., Ramos A.C., Ferreira A., Andrada L., Candeias M., 2009. Changes of quality of Pleurotus ssp. carpophores in modified atmosphere packaging. Acta Sci. Pol., Technol. Aliment. 8(1), 17-22.