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Edited by
Dong Sun Lee & Gi Hyung Ryu

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This Special Issue of the Italian Journal of Food Science collects the presentations given at the “SLIM 2012, Shelf Life International Meeting” organized by the Italian Scientific Group of Food Packaging (GSICA) and Korean Society of Food Science and Nutrition (KFN), held at Changwon, South Korea on May 30-June 1 2012. These papers were reviewed by the Scientific Committee of SLIM 2012 before their presentation but they did not undergo the conventional reviewing system of the Italian Journal of Food Science.

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STRATEGIES FOR THE EXTENSION OF THE SHELF LIFE OF READY TO EAT PRICKLY PEAR FRUITS

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ABSTRACT
The prickly pear fruit (Opuntia ficus indica L. Miller) belongs to the Cactaceae family. The fruit is a berry, composed by an epicarp and the pulp, which represents the edible portion. At maturation, the epicarp turns yellow, red or white, depending on the cultivar. In Italy, the prickly pear is mainly cultivated in Sicily (90% of the national production). The fruit is very sensitive to low storage temperatures (< 5°C) which cause chilling injuries. The fruits can be successfully commercialized as a ready-to-eat product, peeled and suitably packaged. The main limit to its production is the formation of off-flavours due to different factors, such as the growth of microorganism and the action of endogenous enzymes (lipid oxidation). In fact, the oxidoreductases are directly responsible for the lipid oxidation, which has influence on the production of off-flavours, on the structure and on the shelf-life of the fruit. The lipoxygenase (LOX) is a dioxygenase which catalyzes the oxidation of polyunsaturated fatty acids to hydroperoxides. The aim of this work was to compare different packaging technologies to extend the shelf life of ready-to-eat prickly pear fruits. The LOX activity, microbial counts and gas composition were evaluated for non-treated samples packed in ordinary atmosphere and in two modified atmospheres having different O₂ and CO₂ composition (MA1 5% O₂, 2% CO₂, 93% N₂; MA2 2% O₂, 5% CO₂, 93% N₂) and for samples treated either with a blanching or with a blanching followed by a dipping in a citric acid solution. The pretreatment conditions are essential for the LOX activity, in particular the blanching reduced its activity by at least 30% especially in combination with fruit acidification and limited the microbial proliferation. As a result of suitable pretreatment and packaging operations the shelf life of ready-to-eat prickly pears can be successfully extended.

Key words: Blanching, LOX, packaging, prickly pear, shelf life.
INTRODUCTION

Appearance, aroma, consistence and nutritional value are the four main aspects considered by consumers in the choice of a food product. The packaging of minimally processed fruits and vegetables has two main goals: on one hand, to maintain the freshness of the produce without compromising its nutritional and sensory qualities, on the other hand, to obtain a shelf life sufficient to allow distribution and consumption in different geographical areas.

The issue of enzymatic degradations in minimally processed produces is of primary importance. The eventual rupture of cellular structures during processing causes the outflow of cellular components such as enzymes, substrates, metabolites and reserve substances, and the subsequent contact between enzymes and substrates, with an enhanced decay of the quality characteristics of the product. Prickly pear fruits are highly perishable at room temperature and are highly sensitive (chilling injuries) to refrigerated storage temperatures (0-4°C) (Di Cesare et al., 1993). The main limits to storability of prickly pear fruits, indeed, are the loss of consistency and the formation of off-flavours which are due to different factors, such as microbial proliferation, oxidation processes and cellular degradation by endogenous enzymes. Oxidation is the main cause of the off-flavour production in foods containing fatty acids, even during storage at low temperatures.

A recent literature survey has highlighted a lack of researches concerning the study of the enzymatic activities of prickly pear fruits, while no study at all has been carried out on minimally processed prickly pears. The aim of the research was to evaluate suitable packaging solutions for minimally processed prickly pears and to study the shelf life of such product taking into account microbiological and enzymatic aspects.

MATERIALS AND METHODS

Prickly pear fruits were harvested in the area of Paternò, in the province of Catania, Italy. Fruits were manually peeled and packaged in ordinary atmosphere with a barrier film (Control) (PET 30 Melinex 850, permeability \(O_2\) cc/m2/24h: 56, permeability \(H_2O\) g/m2/24h: 13) and in two modified atmospheres having different \(O_2\) and \(CO_2\) composition (\(MA1\) 5% \(O_2\), 2% \(CO_2\), 93% \(N_2\); \(MA2\) 2% \(O_2\), 5% \(CO_2\), 93% \(N_2\)) (Cantwell et al., 1995, Izumi et al., 1996). Also, a part of the samples was treated with a blanching in water at 80°C for 10 min (\(barrier+blanch\)) or in water+2% citric acid (\(barrier+blanch+citric\ ac\)) before packaging in ordinary atmosphere. Each tray contained four fruits. Microbial counts were determined by the official Oxoid methods and lipoxygenase activity was assessed by the colorimetric method by Gordon et al. (2001).

RESULTS AND DISCUSSION

Fig. 1 shows the gas composition in the package headspace. It can be inferred that \(O_2\) in \(MA2\) packages decreases to not detectable levels after 3 days of refrigerated storage, while the same happens after 6 days for \(MA1\). A consequent increase of the \(CO_2\) level was observed. Fig. 2 shows the gas trend inside packages containing fruits which had undergone blanching, in this case the \(O_2\) level is close to zero.
after 9 days, while in fruits subject to blanching with ascorbic acid the same level is reached after 6 days. The CO$_2$ level increased up to about 26%.

Fig. 3 shows the microbiological counts for packed fruits during refrigerated storage. The modified atmospheres (MA1 and MA2) determined only a slight decrease of the total bacterial counts (PCA), but a significative decrease of yeasts and molds (SAB).

Fig. 4 shows the time course for the LOX activity in the different packaging sys-

Fig. 1 - Headspace gas composition variations in packages with ordinary and modified atmosphere O$_2$ (a) and CO$_2$ (b).

Fig. 2 - Headspace gas composition variations inside packages, as a function of pre-treatment: O$_2$ (a) and CO$_2$ (b).

Fig. 3 - Total bacterial counts (PCA) and yeast and molds (SAB) in fresh and stored (12 days), yellow-flesh prickly pears.

Fig. 4 - Total LOX activity during 12 days of storage in differently packed fruits, expressed as the curve integral.
tems. The enzyme was inhibited with the thermal treatment, while the citric acid treatment does not seem to determine significant variations.

The MA-packed samples showed a higher lipoxygenase activity, which is probably due to the higher presence of O$_2$, which slowly decreases with storage together with the increase of the CO$_2$ level.

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