Prolongation of table olive shelf-life by combining edible coating application and modified atmosphere packaging (MAP)

Panagiota Moutsatsou\textsuperscript{a}, Constantina Tzia\textsuperscript{a}, Thanasis Kerasiotis\textsuperscript{b}, Dimitris Skondras\textsuperscript{b}

\textsuperscript{a} Laboratory of Food Chemistry and Technology, School of Chemical Engineering, National Technical University of Athens, 5 Iroon Polytechniou St., 15780, Athens, Greece, (e-mail: p.moutsatsou@gmail.com, tzia@chemeng.ntua.gr)

\textsuperscript{b} Gaea Products S.A., 171, Syngrou Av., 17121 Athens, Greece, www.gaea.gr, (e-mail: thanasisk@gaea.gr, dimitriss@gaea.gr)

ABSTRACT

Olives (olea europaea) are of the oldest cultivated fruits, largely found in the Mediterranean countries. After fermentation they are usually stored in brine in plastic or glass containers and in cans. The aim of this study is to introduce a new type of preservation and packaging of table olives which can maintain their quality characteristics by using combinations of edible coatings application and modified atmosphere packaging (MAP). Green and brown table olives preserved in brine were treated with aqueous solutions 1% of hydroxy-propyl-methyl-cellulose (HPMC) and chitosan, then packed in normal or modified atmospheres (100% N\textsubscript{2}, 80% CO\textsubscript{2} - 20% Air) and stored at ambient temperature (25\textdegree C). During storage the olives were examined for their colour, texture (firmness), weight loss, pH, titratable acidity (expressed as lactic acid/100mg of olive pulp) and were assessed for their sensory characteristics. The shelf life of the coated packaged olives was also estimated.

The coating resulted in reducing of weight loss, maintenance of colour and firmness and extension of shelf life of the olives. Comparing the two coatings, chitosan in most cases proved more efficient than HPMC in olive preservation. As for the packaging atmosphere, good preservative results were obtained for the coated olives even when they were packaged in 100% Air. Moreover, the 80% CO\textsubscript{2} - 20% Air proved more efficient in coated olives maintaining their quality characteristics (except for the colour of green olives), while the N\textsubscript{2} preserved the colour but not the firmness of the olives.

Keywords: Edible coatings; modified atmosphere packaging; table olives; chitosan;

INTRODUCTION

Table olives are one of the most principle sources of unsaturated lipids of Mediterranean diet. The world production of table olives reaches 1.500.000 tn/year. Because of their high nutritional value, table olives are considered to be an inseparable element of the Mediterranean diet. The interest of scientific research about table olives is strongly arisen in the last years, especially for the minor compounds. For table olives consumption, fruits are opportunely processed and served as an appetizer or as a complement to salads, pasta, pizza and other foods. There are three basic commercial preparations in the international market, namely Spanish style green olives, naturally olives (Greek-style) and black ripe olives (Californian style), for which elaboration processes are well-established in the literature. In general, any processing method aims to remove the natural bitterness of the fruit, caused by the glucoside oleuropein. Microorganism plays an important role in the generation of natural compounds, particularly in the field of food aromas. The primary purpose of table olive fermentation is to achieve a preservation effect and to enhance the organoleptic properties of the final product [1, 2].

Edible coatings have long been used to preserve and extend shelf life of fresh fruit and vegetables. According to this method a semipermeable membrane/film is formed on the surface suppressing respiration, controlling moisture loss, and providing other functions. The application of the coating on fresh agricultural products is commonly carried out by dipping in or spraying [3]. Ingredients used in edible films and coatings are proteins, polysaccharides, and lipids, which include natural waxes and resins. In addition, emulsifiers and plasticizers are added to improve coating performance. Edible films and coatings can also act as carriers of food additives, including colourants, flavoring agents, antioxidants, or antimicrobial compounds [4]. The success of an edible coating for meeting the specific needs of fresh and minimally processed vegetables and fruits strongly depends on its barrier property to moisture, oxygen and carbon dioxide [5].
Modified atmosphere packaging (MAP) is also one of the most important food preservation methods that maintain the natural quality and extend the storage life of fruits and vegetables. The modification of carbon dioxide and oxygen concentrations in the packages could help to maintain freshness and visual appearance of fresh produce by reducing respiration and ethylene production, and/or physiological and pathological deterioration during storage [6].

Chitosan was chosen for the coating of olives as it is a high molecular weight cationic polysaccharide that exhibits antibacterial and antifungal activity as well as film-forming properties. Chitosan has already become a common food ingredient in Japan, and its official approval is currently pending in Europe, where it has achieved a major breakthrough in dietetics as a fat trap involved in the reduction of the absorption of cholesterol by the human body by 20-30% and as a fiber involved in the modulation of the duration of the intestinal transit. Due to its ability to form active edible or biodegradable films, chitosan coating can be expected to limit contamination on the food surface [5].

Hydroxypropylmethylcellulose was also chosen for the coating of olives as from previous studies it is shown that there is great potential in the use of cellulose derivatives as edible films intended for regulating moisture transfer in food systems. Cellulose ether films cast from aqueous or aqueous-ethanol solutions of methylcellulose (MC), hydroxypropylmethylcellulose (HPMC), hydroxypropylcellulose (HPC) and carboxymethylcellulose (CMC) tend to have moderate strength, are resistant to oils and fats, and are flexible, transparent, odourless, tasteless, water-soluble and moderate barriers to oxygen and moisture [7].

MATERIALS & METHODS

In the coating experiments green and brown olives in brine and two edible films based on hydroxy-propylmethyl-cellulose (HPMC) (1% w/v) and chitosan (0.8% w/v) were examined. HPMC was easily dissolved in hot water (~80°C) and chitosan was dissolved in an aqueous solution of 1%v/v glacial acetic acid. The coating was applied by dipping the olives in the coating solution. The coated olives were packed in normal or modified atmospheres of low oxygen (100% N₂, 80% CO₂ - 20% Air) and stored at ambient temperature (25°C). During storage the olives were examined for their colour (MINOLTA CR-200), texture (Texture Analyser XT2 Stable Microsystems), weight loss, pH, titratable acidity (expressed as lactic acid/100 mg of olive pulp) and their sensorial characteristics. The shelf-life of the coated packaged olives was also evaluated based on the overall acceptance.

RESULTS & DISCUSSION

Weight loss was calculated as following: Weight loss = (Initial weight – weight after storage) / Initial weight

Weight loss was significant for control samples without coating and/or stored at normal atmosphere as shown in figures 1 and 2.

![Figure 1. Weight loss of brown olives](image1)

![Figure 2. Weight loss of green olives](image2)

Weight loss of olives was mainly due to loss of water, which was visible in the packaging after many days of storage.

The pH and titratable acidity values mostly maintained stable during storage. However, near the end of the olives shelf-life, the pH values presented significant elevation (approaching values near 7), resulting in taste loss as detected by sensory evaluation.

Skin and flesh firmness of both green and brown olives reduced during storage, especially for the uncoated samples and those which were stored at normal atmosphere. Packaging in 80% CO₂ - 20% Air appeared to have a significantly positive effect on the firmness of both varieties of olives as shown in figures 3 and 4.
Chitosan proved to maintain better the skin colour (parameter L) of both green and brown olives. Green olives maintained their colour under 100% N₂ storage. Uncoated green olives stored at normal atmosphere, presented a darker brownish colour probably due to oxidation provoked by the presence of oxygen in the package. Colour measurements results are presented in figures 3 and 4.

Both modified atmosphere packaging and use of HPMC and chitosan as edible coatings, protected the olives from spoilage and extended their shelf-life as shown in figure 5. The estimation of the shelf life of the olives was based on the overall acceptability as it proved to be most indicatable of the quality and acceptability of olives compared to the objective measurements. Results show that packaging in modified atmosphere of 100% N₂ seems to be more effective for coated samples as it is shown in diagram 5.
Sensory evaluation results were in accordance with objective measurements and the shelf life of the olives was determined based on the overall acceptance. The sensory profile of brown and green olives after 80 days of storage is presented in figures 6 and 7. After 80 days of storage uncoated green olives stored at normal atmosphere are already not acceptable from the panelists as shown in figure 6. For both green and brown olives the use of coating at all atmospheres tested seems to provide the best results. It is worth noticing here, that the modified atmosphere packaging alone didn’t have as good effect as the coating (either HPMC or chitosan) alone especially concerning the freshness and firmness of the olives. Moreover, HPMC coated samples appear to have a defective appearance compared to chitosan coated samples. This may be attributed to the drying stage after coating, which sometimes resulted in the formation of white pigments on their surface.
CONCLUSION

Both MAP and coating presented a positive impact on the sensory quality of olives. The modified atmosphere packaging (100% N₂ and 80% CO₂ - 20% Air) and the use of chitosan and HPMC coatings appear to act synergistically for the preservation of table olives. However, comparing the two preservation methods based on the shelf-life and the sensory evaluation, the application of edible coatings proved to be much more effective than the modified atmosphere packaging (MAP).

REFERENCES