Biblid: 1821-4487 (2010) 14; 2; p.98-101
UDK:621.798:664

Original Scientific Paper
OrIginalni naučni rad

THE INFLUENCE OF THE PACKAGING MATERIALS ON THE STABILITY OF THE MODIFIED ATMOSPHERE
UTICAJ AMBALAŽNIH MATERIJALA NA STABILNOST MODIFIKOVANE ATMOSFERE

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ABSTRACT

The contemporary technological developments involving the use of modified atmosphere make it possible to preserve and prolong the nutritive quality of food products produced by different technological procedures. Depending on the barrier characteristics of the packaging materials, an adequately prepared combination of the modified atmosphere allows the controlled permeability of the molecules of oxygen, nitrogen and carbon dioxide, thus providing the optimal protection and long-term viability of the packaged products. The paper provides the results of the packaging material quality analysis, the production and hermetic quality of the food product packaging, as well as the stability of the applied modified atmosphere.

Key words: *packaging materials, barrier characteristics, modified atmosphere packaging (MAP).*

REZIME

Za izuzetne zahteve duže održivosti kvaliteta proizvoda, savremena tehnološka dostignuća omogućavaju da se nutritivna vrednost prehrambenog proizvoda, proizvedenog različitim tehnološkim postupcima, očuva i produži primenom modifikovane atmosfere. Adekvatno primenjena kombinacij modifikovane amtosfere, u zavisnosti od barijernih svojstava ambalažnih materijala, omogućava kontrolisanu propustljivost molekula kiseonika, azota i ugljendioksida i na taj način pruža optimalnu zaštitu i dugotrajnu održivost upakovanog sadržaja. U radu su dati rezultati analize kvaliteta ambalažnog materijala, načina formiranja i hermetizacije ambalaže za pakovanje prehrambenih proizvoda i stabilnost primenjene modifikovane atmosfere.

Key words: *ambalažni materijali, barijerne karakteristike, pakovanje u modifikovanoj atmosferi (MAP).*

INTRODUCTION

The viability of the fruit product quality depends on the type of the applied packaging material, the sort of packing, as well as the applied conditions of packing (*Heiss, 1980, Lazić, at.all., 1993, Gvozdenović, at.all., 1995, 2002, 2007, Achour, 2005, Murator, at.all., 2006*). Apart from the effective presentation, the adequate choice of the combined packaging material together with the barrier characteristics of the packing and the process of packing make it possible to preserve the original quality of the packaged products (*Gvozdenović, Curaković, 1993, Živanović, 1996, Vasiljević, 1999).* The packaging in the modified atmosphere prolongs the technological quality of the food products and accordingly reduces possible biochemical changes (*Exama, at.all., 1993, Mamapperuma, and Sich, 1994, Gvozdenović, at. all., 1993, 2007, 2008, Gvozdenović, Lazić, 2007, Gordon, Robertson, 2006).*

MATERIAL AND METHOD

The conducted examinations involved the use of the combined packaging materials which are most often used in the food industry (PAP/PE, PAP/AL/PE, PET/PE i PET/AL/PE) (*Lefaux, 1972, Heiss, 1980, Gvozdenović, Curaković, 1993, Robertson, 1993, Pringer, Baner, 2000, Gvozdenović, at.all., 2007).*

The materials were identified on the basis of the determined characteristics of the individual monomaterials from the combination (*Haslam, Willis ,1965*) and determining the quality of the combinations by examining the surface mass (*SRPS G.S2.702*) and thickness of the monomaterials (*SRPS G.S2.703*).

The permeability of gases was determined according to the isostatic gas-chromatographic method (*DIN 53380*), using the apparatus Lyssy GPM-200 with the corresponding gas chromatograph Gasukuro Kogyo GC-320 and integrator HP 3396A. The results of the permeability determination are expressed in $ml/m^2/day$ at pressure difference of 1 bar.

In order to ensure the stability of quality, the production of packing was conducted in the food factories.

The packaging in the modified atmosphere was conducted in the laboratory conditions by using the Audio Elektron machine ND, whereas the proportion between the gases in the modified atmosphere was based on the data already given in literature (*Blakiston, 1999, Brody, 2000*).

The examination of hermetic quality was conducted by testing the microporous properties of thermosealing (*Curaković, at.all., 1992*).

The examination of the stability of the modified atmosphere was first conducted after the packaging and then after the interval of 1, 3, and 5 months.

RESULTS AND DISCUSSION

The examination of the quality of the packaging materials

The examination results of the surface mass and thickness of monomaterials are given in Tables 1-4. Sample 1: combined material št/PAP/PE

Table 1. Surface mass (g/m²) and thickness (μm)

	MATERIAL				
No.	print	PAP	PE	d	št/PAP/PE
1	10,97	58,32	26,17	28	95,46
2	9,61	59,47	27,07	29	96,15
3	10,40	58,02	26,08	28	94,50
4	9,63	59,00	25,92	28	94,55
5	9,89	58,88	25,88	28	94,65
Σ	10,10	58,74	26,22	28	95,06

Remark: PAP – paper, PE – polyethylene, d – total thickness
Napomena: PAP -papir, PE - polietilen , d- ukupna debljina

The results given in Table 1 indicate the stable and unified structure of the examined material. The paper which was used had the surface mass of 60 g/m^2, whereas the polyethylene had the thickness of 30 μm. The total thickness and surface mass of the combined material did not significantly vary, which was expected considering the technology of the production of this combined material (*Alvenainen, 2003*).

Sample 2: combined material št/PAP/PE/Al/PE

Table 2. Surface mass (g/m^2) and thickness (μm)

	MATERIAL								
No.	print	PAP	PE	d	Al	d	PE	d	št/PAP/PE/Al/PE
1	8,22	45,65	13,60	15	19,05	7,1	19,25	21	105,77
2	9,12	45,30	13,82	15	19,03	7,0	19,20	21	106,47
3	8,15	46,00	13,05	14	19,00	7,0	19,60	21	105,80
4	8,57	46,13	13,72	15	18,58	6,9	19,37	21	106,37
5	8,13	45,25	13,72	15	18,72	6,9	19,42	21	105,24
Σ	8,44	45,67	13,58	15	18,88	7,0	19,37	21	105,93

Remark: PAP – paper, PE – polyethylene, d – total thickness, Al – aluminium foil.

Napomena: PAP -papir, PE - polietilen, d- debljina materijala, Al - aluminijumska folija.

The results given in Table 2 also idicate the stable and unified structure of the combined material with rather insignificant fluctuation in the total surface mass, resulting from the technology of production (*Lefaux, 1972, Heiss, 1980*). The paper which was used had the surface mass of 45 g/m^2, whereas the polyethylene used as adhesive had the thickness of 15 μm. The aluminum foil used in the combination had the thickness of 7 μm, whereas the polyethylene on the inner surface of the combination, whose function was to provide the compact and hermetic quality of the thermosealing, had the thickness of 20 μm (*Gvozdenović, at.all, 1990*). The total thickness and surface mass showed insignificant fluctuation, which was expected considering the technology of the production of this combined material.

Sample 3: combined material PET/št+adh/PE

Table 3. Surface mass (g/m^2) and thickness (μm)

	MATERIAL					
No.	PET	d	št+adh	PE	d	PET/št+adh/PE
1	17,44	12	1,83	44,77	49	64,04
2	17,36	12	1,71	45,00	49	64,07
3	17,56	13	1,56	44,86	49	63,98
4	17,42	12	1,80	43,92	48	63,14
5	17,54	13	1,68	45,12	49	64,34
Σ	17,46	12	1,72	44,73	49	63,91

Remark: PET – polyester, št+adh- print and adhesive PE – polyethylene, d – total thickness,

Napomena: PET -poliestar, št+adh- štampa i adheziv PE - polietilen, d- debljina materijala

Considering the identification of the used materials (*Haslam and Willis, 1965*) as well as the obtained values, it can be concluded that the combination involved the use of polyester with the thickness of 12 μm and the polyethylene with the thickness of 50 μm. The print and adhesive were between the two materials ("in sandwich").

Sample 4: combined material PET/št+adh/AL/PE

In order to improve the barrier properties, the combination PET/PE involved the use of the aluminium foil whose stable crystal structure prevents the permeability of the gas molecules (*Lefaux, 1972, Heiss, 1980, Gvozdenović, at. all., 1995*). In order to achieve the optimal protection and stability of the packing, the polyethylene with the thickness of 80 μm was used as the inner layer.

Table 4. Surface mass (g/m^2) and thickness (μm)

	MATERIAL					
No.	PET	d	št+adh	PE	d	PET/št+adh/PE
1	17,44	12	1,83	44,77	49	64,04
2	17,36	12	1,71	45,00	49	64,07
3	17,56	13	1,56	44,86	49	63,98
4	17,42	12	1,80	43,92	48	63,14
5	17,54	13	1,68	45,12	49	64,34
Σ	17,46	12	1,72	44,73	49	63,91

The examination of the barrier characteristics of the packaging materials

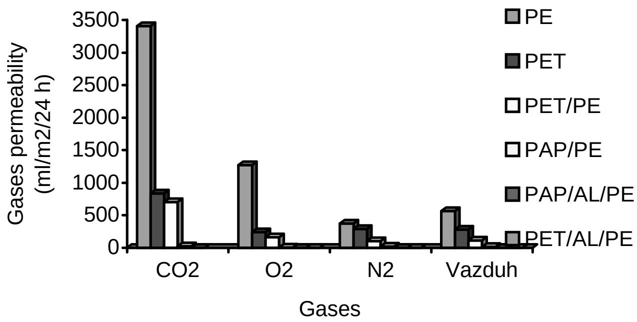

Fig.1. Gases permeability

The highest permeability to carbon dioxide and oxygen was observed in the case of the material PE. The material PET had better protective characteristics. The gas permeability of PET/PE and PAP/PE combinations were low, whereas the barrier characteristics of the combinations PAP/AL/PE and PET/AL/PE were significantly better. The different gas permeability can be attributed to different barrier characteristics of the used monomaterials. The best barrier characteristics were observed in the combinations with aluminium which, being a metal, has stable crystal structure. Due to the fact that it provides the best protection from possible oxidation and photo-oxidative changes, the combination with the aluminium foil was most suitable for packaging the sensitive food products.

The examination of the stability of the modified atmosphere

If the microbiological contamination of the packaged product takes place, the concentration of CO_2 in the modified atmosphere should be as high as possible. A larger increase in the gas pressure of CO_2, would lead to the imbalance in the hermetic quality. The most typical modified atmosphere has 30-60% of CO_2 and 40-70% of N_2 (*Exama, at. all., 1993, Blakistone, 1999, Brody, 2000, Ahvenainen, 2003).* The modified atmosphere with 30% of CO_2 and 60% of N_2 was used in the experiment. The rest of the modified atmosphere contained O_2 included in the packing. The results of the examination are given in Figure 2.

The modified atmosphere was changed depending on the type of the combination as well as the permeability of the packaging materials to O_2, CO_2 and N_2 molecules.

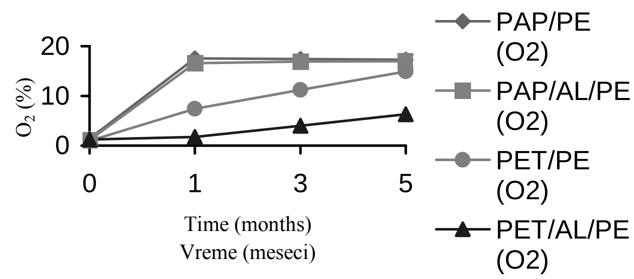

Fig. 2. The change of oxygen concentration in MAP

The most significant changes were observed immediately after the first month in PAP/PE combinations, which points to better barrier properties of PET and its combination with the aluminium foil.

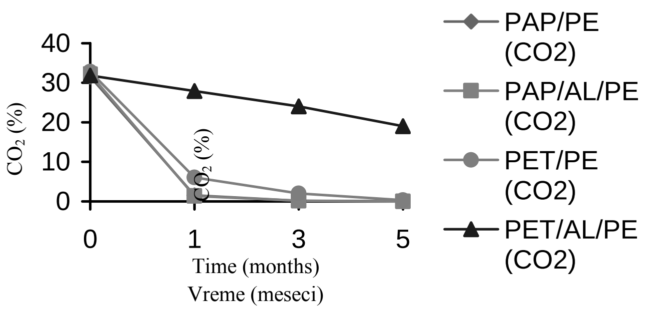

Fig. 3. The change of carbon dioxide concentration in MAP

The combination PET/AL/PE showed the smallest change in CO_2 concentration, which further supports good barrier characteristics of this packaging material. Other combinations showed more significant changes in CO_2 concentration immediately after the first month.

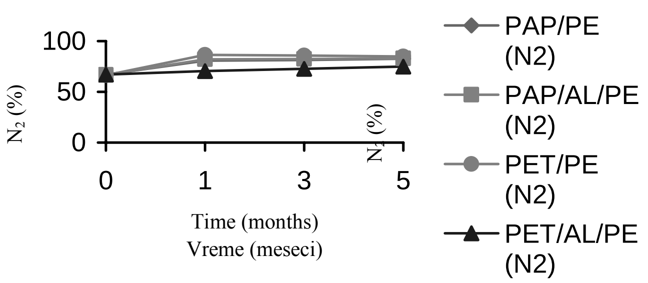

Fig. 4. The change of nitrogen concentration in MAP

The smallest changes in the nitrogen concentration were observed in the combinations PET/AL/PE, whereas other combinations showed insignificant increase in the nitrogen concentration in MAP.

CONCLUSION

The results of the research show that the oxygen concentration increases over time, which is conditioned by the barrier characteristics of the used combinations of the packaging materials as well as the initial oxygen concentration of the packing. This further suggests that the viability of the packaged product heavily depends on the choice of the packaging materials, the quality of packing as well as the applied modified atmosphere.

ACKNOWLEDGEMENTS: This work is a part of the ProjectsTR20065 ("The Quality of Dried Fruit Production") and TR -20120 ("The Improvement of Viability and Functional Characteristics of the Dietary Products such as Spreads with High Nutritive and Protective Values") supported by the Ministry of Science and Technological Development of the Republic of Serbia.

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Received:18.03.2010. Accepted:07.04.2010.