APTEFF, 38, 1-190 (2007) UDC: 621.798.188:664.854
DOI:10.2298/APT0738021G BIBLID: 1450-7188 (2007) 38, 21-28
Original scientific paper

INFLUENCE OF PROTECTIVE CHARACTERISTICS OF PACKAGING MATERIAL ON PACKED DRIED FRUITS

Jasna J. Gvozdenović, Ajka R. Aljilji, Vera L. Lazić, Aleksandra N. Tepić, and Gordana V. Svrzić

Dried fruits are very delicate to biochemical changes during storage, due to low water content, as well as low a_w value. The shelf life of these products depends on a_w value. Materials for dry fruits packaging are necessary to have appropriate barrier characteristics for water, oxygen, nitrogen and carbon dioxide molecules, as well as for electromagnetic rays, especially those with low wavelengths in UV region. During storage of packed dry fruits, qualitative changes, influenced by different packaging materials, may occur. The results of tested characteristics of different packaging materials, combination and their barrier features, as well as the qualitative changes of packaged dried apples are presented in this paper. The qualitative changes of colour and sensory characteristics of packaged dried apples point out to influence of the type, combination as well as the barrier features of used packaging materials.

KEYWORDS: Dried apples, packaging materials, biochemical changes during storage

INTRODUCTION

There has been a great interest in dried products, especially of fruits, widely spread raw materials in the region of Balkans. In a variety of dried fruits, apple occupies a very important place (1-3).

Dried apples are very sensitive to color changes, influenced by drying (e.g. temperature and oxygen), as well as storing conditions of packed product (4-6).

Polymeric materials for packing of dried fruits need to have appropriate barrier characteristics for microorganisms, water, oxygen, nitrogen, and carbon dioxide molecules, as well as electromagnetic radiation, especially from the UV spectral range (1, 4, 7, 8).

Dr. Jasna J. Gvozdenović, Assoc. Prof ., Ajka R. Aljilji, B.Sc. Dr. Vera L. Lazić, Assoc. Prof., Aleksandra N. Tepić, M.Sc., Assist., and Gordana V. Svrzić, B.Sc. Faculty of Technology, University of Novi Sad, Bulevar Cara Lazara 1, 21000 Novi Sad , Serbia, e-mail: ambipak@uns.ns.ac.yu

EXPERIMENTAL

Packaging material

Five sorts of packaging materials were used to investigate the influence of packaging on qualitative changes of packed dried apples.

Bags were made of:

- polyethylene, 95 g/m^2, (PE)
- oriented polypropylene metalized, 20 g/m^2, (OPPmet)
- combinations: oriented polypropylene/polyethylene, 20/50 g/m^2, (OPP /PE),
- combinations: oriented polypropylene metalized/polyethylene, 20/50 g/m^2, (OPPmet/PE)
- combinations: polyester/oriented polypropylene metalized/polyethylene, 12/38/50 g/m^2, (PET/OPPmet/PE).

Methods of investigation of packaging materials

- Light permeability of materials was determined using a UNICAM SP 800 UV spectrophotometer, according to JUS G.C8.511(9).

- Water vapour permeability was determined according to method ASTM E 96. The results of permeability determination are expressed in g/m^2 (9).

- Gas permeability was determined according to 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 permeability determination are expressed in ml/m^2/day at pressure difference of 1 bar (9).

Dried apples

Apples were dried in semi-industrial drier (IVERAK, Serbia), by indirect hot air drying.

Methods of chemical analyses of dried apples

- a_w value was determined using a Termoconstater-Novasina, type TN2 (RTD) Switzerland.

- Changes of dry matter content, e.g. moisture, of packed dried apples were determined by drying at 105ºC in an oven equipped with air circulation (10).

- Hydroxymethyl furfural content was determined according to Winkler's method (10).

- Polyphenolic compounds were determined according AOAC (measurement of optical density of extract obtained by the Folin-Ciocalteu: 20%$NaHCO_3$ solution) (10).

The changes in dry matter content, a_w value, characteristic color, polyphenols and HMF content were measured immediately after the production and packing, and after 15, 30, 90, and 120 days of storage at room temperature and exposed to daylight. The results are given as the average of measurements performed on five samples of content from packaging units, for every opening.

RESULTS AND DISCUSSION

Light transmittance of the packaging materials

The percents of transparency of the packaging materials are presented in Fig. 1.

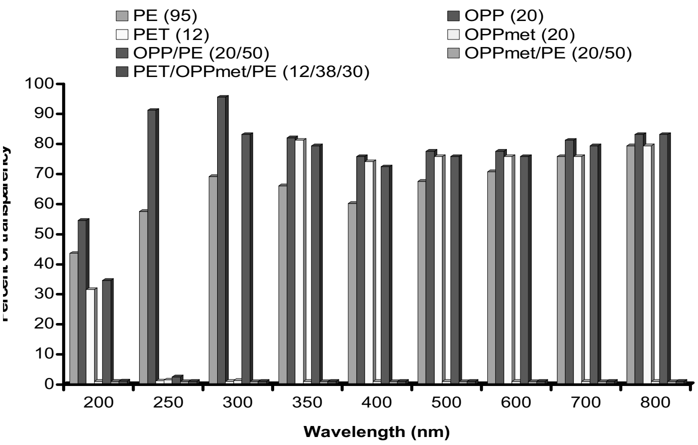

Fig. 1. Permeability of light in different packaging materials

As can see from Fig. 1, all monomaterials PE, OPP, PE, as well as OPP/PE, showed high percent of transparency in VIS range of spectra, like expected.

In the UV range, features of the materials differed. Namely, monomaterial OPP and its combination (OPP/PE) showed again high T%, while the transparency of PET decreased significantly. Due to the metalization of OPP - packaging material OPPmet, OPPmet/PE, and combined material PET/OPPmet/PE a significantly lower permeability of light was observed.

Gases permeability of the packaging materials

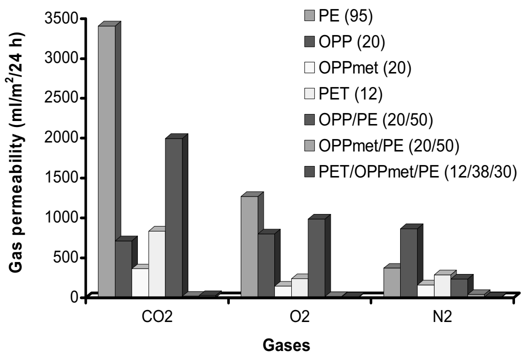

Fig. 2. Gas permeability of different packaging materials

Highest permeability of oxygen was recorded for monomaterials PE, OPP. The protective characteristics of OPPmet, combination OPP/PE and monomaterials PET were better. The barrier characteristics of the combinations OPP met/PE and PET/OPPmet/ PE were significantly better.

Water vapour permeability of the packaging materials

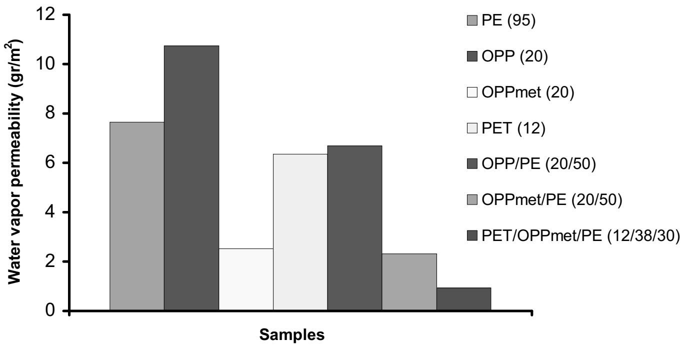

Fig. 3. Water vapour permeability of different packaging materials

The investigations of water vapour permeability (Fig. 3) showed that the protective properties of monomaterials OPP and PE were the poorest. The protective properties of monomaterials PET and of the combination of packaging materials OPP/PE were slightly better. The good protective characteristics of packaging materials OPP met, OPPmet/ PE and PET/OPPmet/PE were improved by the metalization of OPP and the permeability of water vapour of this packaging materials was significantly lower.

Dry matter content and a_w values in foods

The shelf life of every kind of food depends on its water content. Water absorption capacity of a product depends on the hygroscopic components water affinity, i.e. water activity, a_w (11-14).

It can be stated that microbial spoilage is not being developed under usual storage conditions (20°C temperature, 72-75% equilibrium moisture content) (1,4).

By decreasing the equilibrium moisture content, nonenzymatic browning reactions between carbohydrates, proteins and their decomposition compounds (peptides and amino acids) can take place (Fig. 4) (13-15).

At a further decrease of the water content (Fig. 4), autooxidative reactions begin to take place. There is an optimal range of moisture content for every food, where the overall changes are minimized and the food is ought to have a long shelf life (1, 4, 9, 15).

Dried apple had 0.73 a_w value, and 17.86% water content at the beginning of experiment. During storage of 120 days no significant changes in these parameters were measured.

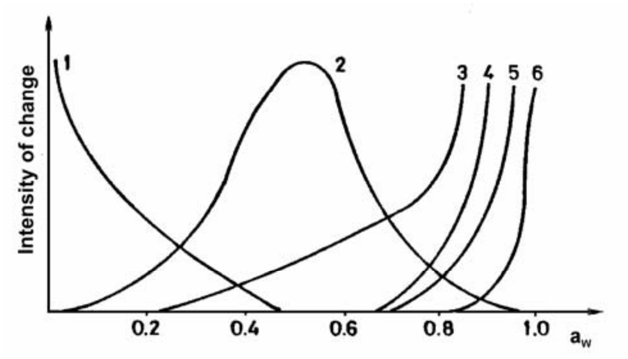

Fig. 4. Quality changes of packed food during storage

1. Oxidative changes	4. Yeasts
2. Nonenzymatic changes	5. Moulds
3. Enzymatic changes	6. Bacteries

Taking into consideration a_w and moisture content of these samples, moulds can develop during storage. Therefore, in order to prolong the shelf life, it is necessary to choose packaging materials which would enable keeping the product airtight. These materials need to have good barrier characteristics for gases and water molecules.

After 90 days of storage, moulds were detected at the surface of dried apples packed into PE, OPPmet and OPP/PE bags, the most intensively with the samples in PE and OPPmet, which confirmed the influence of qualitative and barrier characteristics of these materials.

Color quality changes

Hydroxymethilfurfural (HMF) is one of the first Maillard reaction products. HMF is a very reactive compound, which enters reactions with the other nonenzymatic reaction products, so that during some period of time its content decreases (1, 4, 15-17).

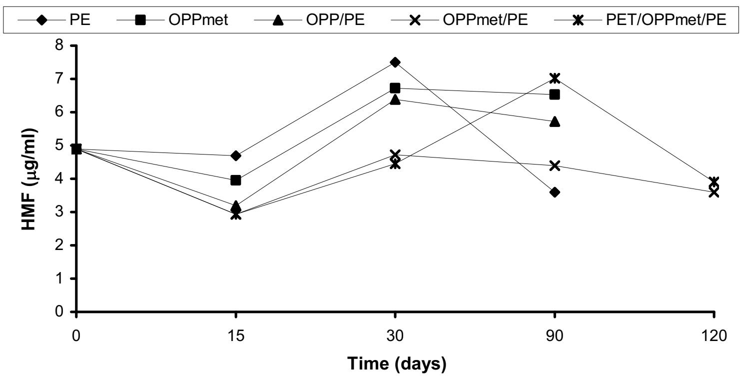

Fig. 5. Changes of HMF content during storage of dried apples

In the period of 15 to 30 days of storage, an increase in HMF content was observed. Intensity of the increase depended on the packaging material used. After 30 days of storage, the HMF content decreased in all samples. After 120 days, HMF was detected in samples packed in monomaterials PE, OPPmet and OPP/PE combination.

Polyphenolic compounds content

Polyphenols are water soluble compounds that easily undergo nonenzymatic browning reactions, creating dark coloured polymers or discolouring the pigments (1, 4, 16, 17).

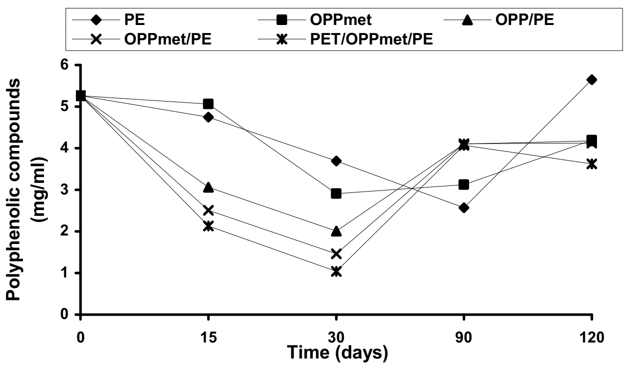

Fig. 6. Changes of polyphenols content during storage of dried apples

Measurements of polyphenols content changes pointed out to cyclic changes, depending on the type of the packaging materials and storage time. An increase in polyphenols content was detected in samples packed to monomaterials PE, OPPmet and OPP/PE combination (1, 4, 17, 18).

CONCLUSION

On the basis of the performed investigations, it can be concluded that the choice of packaging that is the sort and combination of packaging materials, e.g. their barrier characteristics, has a great influence on the preservation of the overall quality and nutritive properties of packed products.

The packed dried apples were in the optimal range of water activity, which prevented the nonenzymatic processes and microbial spoilage.

The qualitative changes of characteristic color, polyphenolic compounds and HMF, microbial condition and sensory characteristics of packed dried apples, point out the influence of type, combination as well as the barrier features the used packaging materials.

The qualitative changes of packaged dried apples and increase of colored matter degradation under the influence of degradation products of nonenyzmatic processes, show that the quality of packaging materials combinations significantly influences the qualitative change.

On the basis of investigations performed it can be concluded that the combination of PET/OPPmet/PE packaging materials showed the best barrier and protective properties for packed dried apples.

ACKNOWLEDGEMENT

This work is part of Project No. 341002 B, supported by the Ministry of Science and Environmental Protection of the Republic of Serbia.

REFERENCES

1. Gvozdenović, J and Curaković, M.: Ambalaža i njen uticaj na održivost sušenog voća i povrća, Monografija, Tehnološki fakultet, Novi Sad , 1993.
2. Gvozdenović, J. and Curaković, M.: Pakovanje sušenog voća i povrća, Zbornik radova za Savetovanje jugoslovenske industrije za preradu voća i povrća, Tehnološki fakultet, Novi Sad, 1984, pp 153-161.
3. Gvozdenović, J., Curaković, M., Vujković I.: Primena kombinovanih ambalažnih materijala za pakovanje dehidriranih proizvoda, VI Kongres o ishrani naroda Jugoslavije, Novi Sad, Savremeno pakovanje **23,** 5 (1982) 20-24.
4. Heiss, R.: Verpackung von Lebensmitteln, Springer Verlag, Berlin-Heidelberg-New York, 1980, p. 306.
5. Nijhuis, H. H.; Torringa, H.M.; Muresan, S.; Yuksel, C.: Approaches to improving the quality of dried fruit and vegetablles, Tehnology **9** (1998) 13-20.
6. Akanbi, T.C.; Adeyemi, R.S.; Ojo, A.: Drying characteristics and sorption isotherm of tomato slices, J. Food Eng. **73** (2006) 157-163.
7. Gvozdenović J., Curaković M., Lazić V. :Stability of nutritive characteristics of packed tomato powder, 8th. European Nutrition Conference, Lillehammer, Norway, 1999, Book of Abstracts, p. 49.
8. Gvozdenović.J., Curaković.M., Lazić.V.: Change of Nutritive Value of Powdered Garlic During Storage, 16th International Congress of Nutrition, 251, Montreal, Canada, 1997, Book of Abstracts, p. 251.
9. Curaković, M.,Vujković, I., Gvozdenović, J., Lazić,V., Praktikum kontrola ambalažnih materijala i ambalaže, Tehnološki fakultet, Novi sad, 1992, 84, 86-88.
10. Ćirić, D., Vujičić, B. and Bardić, Ž.: Priručnik za kontrolu kvaliteta sirovina i proizvoda od voća i povrća, Tehnološki fakultet, Novi Sad, 1975, 22, 83, 153.
11. Dirim, S.N., Ozden, O.H., Bayindirli, A., Esin, A.: Modification of water vapour transfer rate of low density polyethylene films for food packaging, J. Food Eng. **63** (2004) 9-13.
12. Lewicki, P.P.: Water as the determinant of food engineering properties, J. Food Eng. **61** (2004) 483-495.
13. Risbo, J.: The dynamics of moisture migration in packaged multicomponent food systems I: shelf life predictions for a cereal-raisin system, J. Food Eng. **58** (2003) 239-246.
14. Sablani, S.S., Kasapis, S., Rahman, M.S.: Evaluating water activity and glass transition concepts for food stability, J. Food Eng. **78** (2007) 266-271.

15. Achour, M.: A new method to assess the quality degradation of food products during storage, J. Food Eng. **75** (2006) 560-564.
16. Gvozdenović, J., Curaković, M.: The Influence of Packaging and Storage Time Colour of Dehydrated Raspberry, Acta Alimentaria **243** (1995) 257-268.
17. Gvozdenović, J., Popov-Raljić, J., Curaković, M.: Investigation of caracteristic Colour Stability of Powdered Orange Base Juice, Food Chem. **70** (2000) 291-301.
18. Labuza, T.P., Saltmarch, M.: The nonenzymatic browning reaction as affected by water in foods, in Properties of water related to food quality and stability. Eds. Rockland, L.B. and Stewart, G.V. Academic Press, London, New York, San Francisco, 1980, p. 360.

УТИЦАЈ ЗАШТИТНИХ КАРАКТЕРИСТИКА АМБАЛАЖНИХ МАТЕРИЈАЛА НА ПАКОВАЊЕ СУШЕНОГ ВОЋА

Јасна Ј. Гвозденовић, Ајка Р. Аљиљи, Вера Л. Лазић
Александра Н. Тепић и Гордана В. Сврзић

Сушено воће због ниског садржаја воде и мале a_w вредности представља производ врло осетљив на биохемијске промене током складиштења. Од a_w вредности зависи интензитет промене квалитета, тј. трајност такве врсте производа.

Амбалажни материјали за паковање сушеног воћа морају имати одговарајућа баријерна својства на пропустљивост молекула водене паре, молекула кисеоника, азота и угљен-диоксида, као и на пропустљивост електромагнетног зрачења нарочито нижих таласних дужина у области UV зрачења.

Током складиштења код упакованог сушеног воћа могуће су квалитативне промене проузроковане различитим амбалажним материјалима.

У раду су дати резултати испитивања различитих комбинација амбалажних материјала, њихових баријерних својстава, као и квалитативне промене упаковане сушене јабуке.

Квалитативне промене карактеристичне боје и сензорних карактеристика упаковане сушене јабуке зависе од типа и комбинације као и баријерних својстава примењених амбалажних материјала.

Received 24 January 2007
Accepted 28 February 2007