**Impact of Packaging on Bread Physical and Chemical Properties**

Camelia CIOBAN, Ersilia ALEXA, Renata SUMALAN, Iuliana MERCE

Banat University of Agricultural Sciences and Veterinary Medicine, Faculty of Food Processing Technology, Calea Aradului, No. 119, 300645, Timișoara, România, camелиациобан@yahoo.com

**Abstract.** The present work presents a packaging system that slows down the degrading and ageing processes of bakery products as well as mould appearance.

There have been selected three packing methods: the packing in PE folio, PP folio, PP punched folio and the packing in a small bag specially designed to preserve bakery products.

The selection has been done function of physical – mechanic and chemical properties of the packaging materials and according to the requirements of a good preservation of the packed product.

The PE folio has a good mechanical resistance, a good permeability to gases and a high impermeability to water vapors.

The PP folio has a greater contraction, a better transparency and better mechanical properties than the polyethylene. The permeability to water and gas vapors is lower than that of the polyethylene.

The complex material based on textile / PE has superior physical and chemical properties and a high impermeability to moisture, gas and flavors.

The experimental bread packaging methods prove a tight link among the permeability to water vapors, the duration of the product freshness and the mould appearance.

The specially designed small bag made of two cotton lays and one polyethylene lay preserves the freshness of sliced bread, because the bread does not get dry or wet.

After a 7-day storage period, the contamination degree with *Penicillium frequetans* of the sample packed in PP punched folio is of 5%.

The contamination degree with *Penicillium nigricans* and *frequetans* of the sample packed in PP folio is of 85%.

The sample packed in the cotton bag is 10% contaminated with *Aspergillus* fumigates, and the one packed in polyethylene folio is 20% contaminated with *Aspergillus versicolor* and *Penicillium frequetans*.

**Keywords:** packaging materials, bread preservation, moulds.

**INTRODUCTION**

Within the experiments, there have been used proper packaging systems to slow down the degrading and ageing processes of bakery products and mould appearance.

The factors that influence the multiplication of fungi are the substratum water content, the temperature and moisture of the warehouse, the light.

The bread is one of the most perishable food products. Its 40% concentration of water leading to a water activity of 0.96 makes susceptible to mould attacks. The micro-organisms that degrade the quality of the bread originate in the flour where they get from the cereals opportunist micro-flora, often accompanied by other microbes arising during milling or flour storing. In the flour, the following microbe categories have been identified: moulds, especially representing *Aspergillus, Penicillium, Rhizopus, Alternaria, Cladosporium and Ustilago* types.
and bacteria, most of them belonging to *Bacillus* type. The representatives of this particular type have the capacity to form endospores resistant to high temperature.

During the baking process, as the interior temperature does not exceed 100°C, the bacteria and mould spores remain in a latent status. Consequently, the conditions of the bread further preservation contribute largely to ensuring high quality products that do not affect the consumer’s safety. (Murat *et al.*, 2005).

The temperature of the storing location was of 22⁰-23⁰C and the air relative moisture was below 80%.

By means of current preservation technologies and systems, the optimum duration for bread preservation on shelves is of 2-3 days. This duration can be extended to 10 days by using a mix of preservation systems, enzymes and expensive packaging. (Moldoveanu *et al.*, 1992).

Thus, the main objective of the present work is to find the best packing material, capable to extend the validity of the product, to maintain the moisture of the core and the wetness of the crust.

**MATERIALS AND METHODS**

In order to establish the best packaging material, there have been chosen three packing methods: the packing in PE folio, PP folio, PP punched folio and the packing in special bags made of two cotton lays and one polyethylene lay.

The samples thus packed have been stored until the first alteration signs appeared.

The selection has been done function of physical – mechanic and chemical properties of the packaging materials and according to the requirements of a good preservation of the packed product.

The PE folio has a good mechanical resistance, a good permeability to gases and high impermeability to water vapors.

The PP folio has a greater contraction, a better transparency and better mechanical properties than the polyethylene. The permeability to water and gas vapors is lower than that of the polyethylene.

The complex material based on textile/PE has superior physical and chemical properties and a high impermeability to moisture, gas and flavors. (Banu, 1999).

**How to determine bread freshness degree**

In view to determine the bread freshness degree and validity term, the products have been submitted to sensorial, physical-chemical and microbiologic tests.

- From a sensorial point of view, the following characteristics have been determined:
  - aspect of core and crust
  - taste
  - smell

- From the physical-chemical point of view, the water content has been determined and, from a microbiologic perspective, the mould content.

  The organoleptic test used to determine freshness degree has been run in conformity with STAS 91-83 standard.

  Establishing Physical and Chemical Properties.

  Establishing the water content.

  The main principle of the methods resides in establishing the loss of water by heating it to 130 ± 2°C. (STAS 91/1983).
RESULTS AND DISCUSSIONS

The bread aging

The bread samples packed in micro-punched folio, after three days presented a hard crust and if cut, one could notice that the core has modified its aspect, ½ of it getting harder from the crust to the centre of the bread.

After seven days, the first mould signs appeared on the inner side of the bread, and the crust and ½ of the core have become very hard. The bread low moisture inhibited the growing of the moulds.

The bread samples packed in non-punched folio presented no important modifications during the first three days. On the 4th day, the samples presented the first mould colonies and on the 7th day, moulds strongly developed covered the whole bread.

The bread packed in complex material preserved its freshness, taste, elasticity, unchanged or low degree of crumbing, a smooth and rigid crust, for 5 days. On the 7th day, the first mould signs appeared.

The bread samples packed in polyethylene folio presented no important modifications during the first three days. On the 5th day, the samples presented the first mould colonies.

Tab.1

Variation of water content at bread samples

<table>
<thead>
<tr>
<th>No. of the sample</th>
<th>Moisture at 3 days</th>
<th>Moisture at 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U% crust/ U% core</td>
<td>U% crust/ U% core</td>
</tr>
<tr>
<td>Sample 1</td>
<td>16.75/28.44</td>
<td>15.23/22.08</td>
</tr>
<tr>
<td>Sample 2</td>
<td>25.07/30.18</td>
<td>26/30.52</td>
</tr>
<tr>
<td>Sample 3</td>
<td>21.30/28.02</td>
<td>23.22/26.6</td>
</tr>
<tr>
<td>Sample 4</td>
<td>22.45/25.01</td>
<td>21.62/32.2</td>
</tr>
</tbody>
</table>

Note: sample 1 - punched PP, sample 2 – PP, sample 3 - complex material, sample 4 - PE.
According to the graphics, the bread packed in PP has the highest degree of moisture, followed by the bread packed in complex material, PE and punched PP.

The results obtained led to the following conclusions:
- the bread packed in punched polypropylene preserves its freshness for 2 days; the mould appears on the 7\textsuperscript{th} day;
- the bread packed in PE preserves its freshness for 3 days; the mould appears on the 5\textsuperscript{th} day;
- the bread packed in PP preserves its freshness for 3-4 days and the mould appears afterwards;
- the bread packed in complex material preserves its freshness for 5 days; the first mould colonies appear on the 7\textsuperscript{th} day.

PP presents a low permeability to water and water vapors as compared to PE, fact that explains the extra one-day duration of bread freshness.

The bread drying rhythm, the smoothing and rigidity of the crust result by packing the bread in complex material.

Microbe modifications during bread preservation

The microbiological test of the bread was performed on four preservation variants at a temperature of 22\textdegree -23\textdegree C and relative moisture of the air in the storage area of about 80%.

Sample 1 - punched polypropylene.
Sample 2 – polypropylene.
Sample 3 - complex material.
Sample 4 – polyethylene.

The microscopic examination established the bread moulding level and the localization of the contaminated area.

The microscopic examination supposed studying the fructifications and their pigmentation in order to identify mould at type level. (Papacostea, 1976)
The confirmation test supposed the isolations on Martin culture environment (Zarnea et al., 1992) and isolations on PYCF environment, for confirming the contamination with Aspergillus flavus. (Atlas et al., 1993).

Culture characteristics established by microscopic examination after 7 days of preservation

<table>
<thead>
<tr>
<th>Sample</th>
<th>Degree of product contamination</th>
<th>Colony</th>
<th>Colonial aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>5%</td>
<td>1.1.</td>
<td>Velvety, no peritheciu or sclerotia, conidiophores start directly from the substrate, no exudates, non-pigmented edge</td>
</tr>
<tr>
<td>Sample 2</td>
<td>85%</td>
<td>2.1.</td>
<td>Velvety, no peritheciu or sclerotia, low growing rate, strong mould smell Velvety, no peritheciu or sclerotia, conidiophores start directly from the substrate, no exudates, non-pigmented edge</td>
</tr>
<tr>
<td>Sample 3</td>
<td>10%</td>
<td>3.1.</td>
<td>Colony with dusty look, uniformly pigmented, with peritheciu</td>
</tr>
<tr>
<td>Sample 4</td>
<td>20%</td>
<td>4.1.</td>
<td>Colony with dusty look, high growing rate, Velvety, no peritheciu or sclerotia, conidiophores start directly from the substrate, no exudates, non-pigmented edge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.2.</td>
<td></td>
</tr>
</tbody>
</table>

Identification of species by isolation on Martin environment and microscopic examination

<table>
<thead>
<tr>
<th>Sample</th>
<th>Fructification aspect</th>
<th>Color</th>
<th>Species identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>Conidiophores with ramifications and globose conidia</td>
<td>Ash green</td>
<td>Penicillium frequentans</td>
</tr>
<tr>
<td>Sample 2</td>
<td>Branched conidiophores similar to mono-verticillata series row brushes Conidiophores with ramifications and globose conidia</td>
<td>Dark grey – olive</td>
<td>Penicillium nigricans</td>
</tr>
<tr>
<td></td>
<td>Conidiophores with ramifications and globose conidia</td>
<td>Ash green</td>
<td>Penicillium frequentans</td>
</tr>
<tr>
<td>Sample 3</td>
<td>Nonsepted conidiophores with conidia rows on vesicle and non-cylindrical conidia</td>
<td>Shades of light to dark green</td>
<td>Aspergillus fumigatus</td>
</tr>
<tr>
<td>Sample 4</td>
<td>Long nonsepted, the conidiophores, apex with circular disposal, small vesicles</td>
<td>Blue – green</td>
<td>Aspergillus versicolor</td>
</tr>
<tr>
<td></td>
<td>Conidiophores with ramifications and globose conidia</td>
<td>Ash green</td>
<td>Penicillium frequentans</td>
</tr>
</tbody>
</table>

Tab. 2 and 3 show that the bread packed in polypropylene foil has the highest degree of contamination, produced by two mould species: Penicillium nigricans and Penicillium frequentans. The moisture of the product maintained at 30% is the decisive factor that favored the growth and development of the moulds.

The bread sample packed in punched polypropylene was protected against microbial degradation due to its reduced level of moisture – 22.08%.

CONCLUSIONS

The experimental bread packaging variants presented above prove a tight link among the permeability to water vapors, the duration of the product freshness and the mould appearance.

The complex material preserves freshness at the highest degree, bread does not get dry or wet. Moreover, the complex material has proved better maintain the crust crunchiness and
the core elasticity for a 5-day storage period. The complex material has superior physical and chemical properties, impermeability to moisture, gas and flavors.

During the first 2-3 storage days, the crust of all bread tests preserved its uniform aspect, with no golden yellow cracks specific for the product. The core is dense with gentle uniform pores, elastic consistency, and nice flavor with no rancid, sour or mould smell, pleasant taste specific for well-baked bread, with no sour or bitter taste.

After 7-day storage period, the smooth and rigid core becomes elastic and soft, the soft compressible core becomes brittle, less compressible and relatively rigid, with a strange mould taste and smell.

After 7-day storage period, the contamination degree with *Penicillium frequentans* of the bread sample packed in punched PP is of 5%.

The contamination degree with *Penicillium nigricans* and *frequentans* of the bread sample packed in PP is of 85%.

The sample packed in complex material is 10% contaminated with *Aspergillus fumigates*, and the one packed in polyethylene folio is 20% contaminated with *Aspergillus versicolor* and *Penicillium Frequentans*.

REFERENCES