Potravinarstvo, vol. 6, 2012, no. 2, p. 42-45
doi: 10.5219/194
Received: 27 February 2012. Accepted: 6 March 2012.
Available online: 1. April 2012 at www.potravinarstvo.com

CHANGES IN THE PHYSICAL PROPERTIES OF BREAD DURING STORAGE

Paulina Pająk, Celina Habryka, Teresa Fortuna

ABSTRACT

The aim of this work was to compare the physical properties of breadcrumb during five days of storage in vacuum containers and polyethylene bags. On the basis of result it was stated, that storage of baguettes in vacuum condition and in polyethylene foil did not prevent the staling of breadcrumb. Hardness of breadcrumb stored in plastic bags on the fifth day was higher than hardness of bread stored in vacuum containers. The others texture values did not differ significantly on the fifth day of storage between packaging methods. The changes in water activity values both in vacuum containers and polyethylene bags were negligible during storage. Increase in lightness and decrease in yellowness were observed over the storage period, regardless of packaging method, while the values of a* remained essentially unchanged.

Keywords: breadcrumb, TPA, water activity, colour measurement

INTRODUCTION

Staling of bread is a phenomenon that is not yet fully understood. Some authors showed that bread staling is associated to starch retrogradation, however others suggested that it is due to an increase in interactions between starch molecules and gluten proteins **(Puhr &D`Appolonia, 1992; Ribotta & Le Bail, 2007; Ronda & Roos, 2011)**. Staling involves changes in textural properties (e.g. hardening, decrease in elasticity or cohesion), sensory attributes and colour characteristic **(Rasmussen & Hansen, 2001; Wagner et al., 2007)**.

Vacuum packaging is one of the way to extend the food's shelf-life because it removes air (oxygen) from around the ***product*.** More often bread is packed and stored in plastic bags. However packaging is used to limit moisture loss or evaporation, which influence physicochemical changes in bread during storage. Several reports were found in the literature on the effects of packaging in modified atmosphere on the properties of bread **(Rasmussen & Hansen, 2001; Ceglińska et al., 2004)**. Although there is a lack of information about the impact of vacuum packaging or in plastic bags on the physical properties of bread.

The aim of this work was to compare changes in texture – TPA, water activity and colour parameters of breadcrumb during five days of storage in vacuum containers and in polyethylene bags.

MATERIAL A METHODOLOGY

The materials subjected to analysis were bread concentrate "Chleb swojski żytni": mix of wheat and rye flours, ***dried sourdough*** starter and salt, purchased in the local market.

Sample preparation: The dough formulation comprised: 1000 g of concentrate, 550 g of water and 10 g of fresh yeast. Mixing, dough rise and baking were carried out in Moulinex Home Bread Ow 6000 Baguette & Co. After 70 min of mixing and resting, dough was divided in portions of 190±5g and baguettes were formed. The pieces of dough were baking in Moulinex for 47 min. Samples were packed in a glass containers in vacuum condition and in polyethylene bags and were stored during 5 days at room temperature. Samples were duplicate.

The analysis of the breadcrumb involved determination of textural properties using TPA test (Texture Profile Analysis). Textural properties were made with a Texture Analyser EZ Test (Schimadzu, Japan). On the test days, breadcrumb in cylindrical shape (4 cm height, 1 cm diameter) were compressed to 50% (20 mm) using stainless steel plunger having a diameter of 30 mm and height of 5 mm. The samples were tested at plunger speed 25 mm/min. Following magnitudes were determined during measurements: hardness [N], elasticity [mm], cohesiveness [-], guminess [N] and mastication[N·mm].

The water activity (aw) of the crumb was measured by using LabSwift-aw (Novasina, Switzerland). The breadcrumb was loaded in a sample dish and put in the measurement chamber. The equilibrium air humidity over a sample (water-vapour pressure) which is proportional to the aw-value was measured.

Parameters of colour L*a*b* were determined in CIELAB system ($10^{o}/D_{65}$ colour spaces, gap 10mm) by using spectrophotometer X – Rite Color i5. The colour parameters of the breadcrumb were expressed as L* (lightness; from 0=black, to 100=white), a* (+a=redness, -a=greenness) and b* (+b=yellowness, -b=blueness).

RESULTS AND DISCUSSION

Texture parameters of breadcrumb depends on many factors: recipe, baking condition, storage period and temperature **(Ceglińska et al., 2004)**. The changes in hardness and elasticity for the baguettes stored in vacuum containers compared to polyethylene bags are shown in Fig.1 and Fig.2. On the basis of the results obtained in this work, it was stated that crumb hardness stored in vacuum conditions increased during the first three days of storage (starch retrogradation occured). On the fifth day of storage reduction of crumb hardness was observed. Such behaviour may probably be due to remigration of water

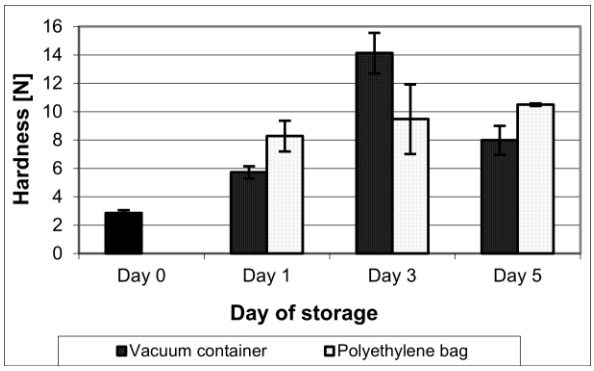

Fig. 1 Hardness of breadcrumb stored in vacuum containers and polyethylene bags during five days

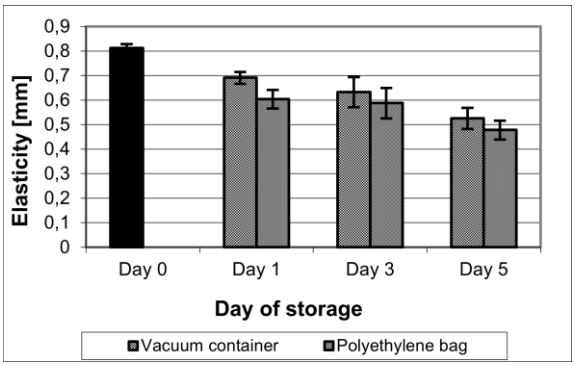

Fig. 2 Elasticity of breadcrumb stored in vacuum containers and polyethylene bags during five days

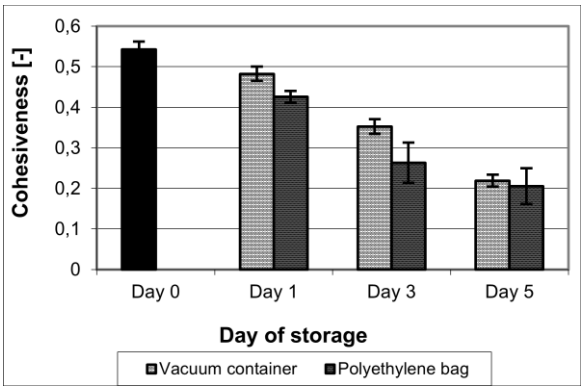

Fig. 3 Cohesivenesss of breadcrumb stored in vacuum container and polyethylene bags during five days

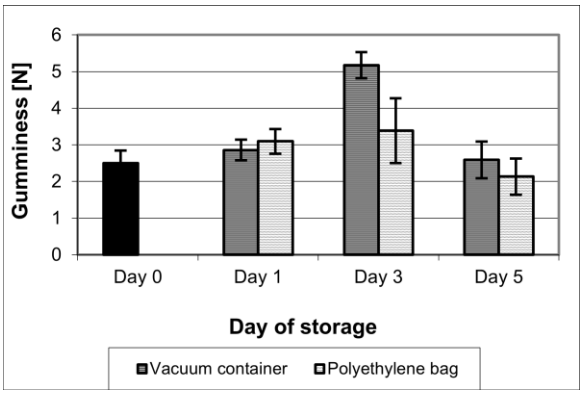

Fig. 4 Gumminess of breadcrumb stored in vacuum container and polyethylene bags during five days

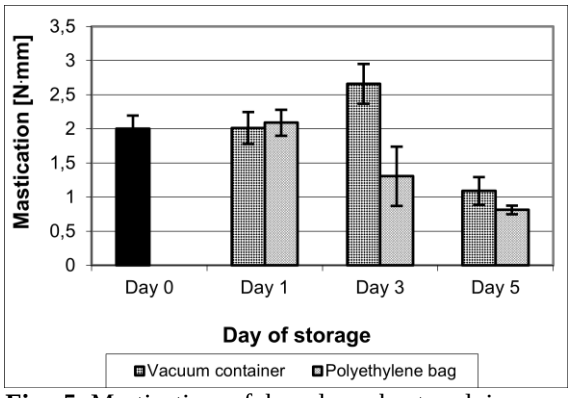

Fig. 5 Mastication of breadcrumb stored in vacuum container and polyethylene bags during five days

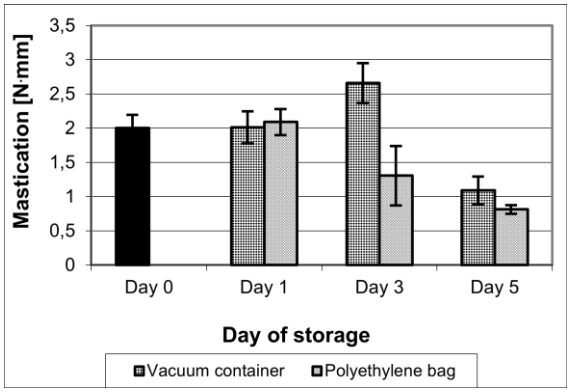

Fig. 6 The water activity (a_w) of the breadcrumb during storage in vacuum container and polyethylene bags during five days.

from the crust to the crumb in closed container. **Rasmussen & Hansen (2001)** reported that in the case of bread stored in modified atmosphere increase in firmness was linear with time during the first three days of storage, and then the firming rate decreased with time. The authors suggested that bread firmness is influenced by both the crystalisation behaviour of starch and by changes in hydration. **Puhr & D`Appolonia (1992)** reported that high crumb moisture retarded hardening rate.

Hardness of breadcrumb stored in plastic bags on the fifth day was higher than hardness of bread stored in vacuum containers. It may suggest that vacuum packaging is more efficient in delaying bread staling than polyethylene bags. Elasticity (Fig. 2) decreased gradually over time, this behaviour was similar, irrespective of the type of packaging.

Cohesiveness (Fig. 3) of bread stored in vacuum containers significantly decreased from 0.543 in fresh baguette to 0.219 at the fifth day of storage. Slightly lower values of cohesiveness showed breadcrumb stored in polyethylene bags, however on the fifth day of storage cohesiveness was similar (0.205). The aging of bread diminishes cohesiveness usually due to the loss of intermolecular attractions between ingredients that cause the crumbling of crumb, and that is usually associated with the loss of water **(Ronda & Ross, 2011)**.

Gumminess and mastication values of breadcrumb during storage are presented at Fig. 4 and Fig. 5. The changes in these parameters in the case of bread stored in vacuum condition were similar to hardness behaviour. Slight increase in gumminess was observed during three days of

Tab. 1 Changes in colour parameters of breadcrumb during storage

Day of storage	L*		a*		b*	
	vacuum container	polyethylene bag	vacuum container	polyethylene bag	vacuum container	polyethylene bag
Day 0	63.40±0.54	63.15±0.22	3.36a±0.61	3.57a±0.54	19.59±0.36	19.73±0.27
Day 1	67.43a±0.65	65.00±0.20	3.38a±0.15	3.76a±0.12	18.75a±0.49	18.87a±0.19
Day 3	67.29a±0.46	66.41±0.42	3.35a±0.26	3.62a±0.15	18.41a±0.33	18.67a±0.48
Day 5	68.99±1.25	68.69±0.77	3.42a±0.25	3.60a±0.07	17.47±0.36	16.62±0.17
NIR	1.21	0.87	0.56	0.54	0.53	0.57

*Within columns. values followed by the same small letters do not differ significantly at p=0.05

storage, followed by a sharp decline on the fifth day. Mastication values of bread stored in polyethylene bags decreased gradually over time. Although on the fifth day of storage texture parameters did not differ, irrespective of packaging method.

The water activity of breadcrumb is summarized at Fig. 6. After one day of storage both in vacuum containers and polyethylene bags there were no statistical differences in water activity values comparing to value of fresh crumb. Some statistical variation has been seen after three (vacuum) or five (foil) days of storage. Although, the changes in water activity values were very small (from 0.958 on the day of baking to 0.944 after 5 days of storage). Similar small changes in water activity presented **Puhr & D`Appolonia (1992)** for wheat breadcrumb stored in polyethylene bags at room temperature. However these values were a bit higher (changes from 0.995 to 0.975). In parallel there was not significant reduction in breadcrumb moisture during the same five-day storage period (data not shown). The relationship between water activity of breadcrumb and its moisture is known in literature **(Puhr & D`Appolonia, 1992)**.

The final product colour can be usually associated with ingredients, processing factors, quality and shelf-life of the product **(Lucisano at al., 2010)**. Packaging lengthen the shelf-life of bread, but do not prevent the staling process, which can manifest in colour alteration. In this study the changes in lightness values (tab.1) were significant over the whole storage period.

The 9 percent increase in lightness during the five days of storage were determined both in vacuum and plastic conditions. These values were much lower than lightness of breadcrumb measured by **Lucisano at al. (2010)**, although similar to lightness of breadcrust obtained from frozen partially baked breads **(Altamirano-Fortoul & Rosell. 2011)**. There were no changes in a* (redness) values during storage period. while b* (yellowness) slightly decreased from 19.59 to 17.47 and from 19.72 to 16.62 respectively for vacuum and foil stored bread.

CONCLUSION

Storage of baguettes in vacuum containers and in polyethylene bags did not prevent the staling of breadcrumb.

Hardness of breadcrumb stored in plastic bags on the fifth day was higher than hardness of bread stored in vacuum containers. The others texture values did not differ significantly on the fifth day of storage between packaging method.

The changes in water activity values during five days of storage both in vacuum containers and polyethylene bags were negligible.

Increase in lightness and decrease in yellowness were observed over the storage period. irrespective of packaging method. while the values of a* remained essentially unchanged.

REFERENCES

ALTAMIRANO-FORTOUL, R., ROSELL, C. M. 2011, Physico-chemical changes in breads from bake off technologies during storage. In *LWT – Food Science and Technology*, vol. 44, 2011, p. 631-636.

CEGLIŃSKA, A., HABER, T., WICHOWSKA, M. 2004. Wpływ opakowania na jakość i trwałość pieczywa. In *Przegląd Piekarski i Cukierniczy*, vol. 4, 2004, p. 2-5.

LUCISANO, M., CAPPA, C., FONGARO, L., MARIOTTI M. 2010. Methods for the characterization of breadcrumb. an important ingredient of stuffed pasta. In *Journal of Cereal Science*, vol. 51, 2010, p. 381-387.

RASSMUSEN, P. H., HANSEN, A. 2001. Staling of wheat bread stored in modified atmosphere. In *Lebensm.-Wiss. U.-Technol.*, vol. 34, 2001, p. 487-491.

PUHR, D. P., D`APPOLONIA, B. L. 1992. Effect of baking absorption on bread yield. crumb moisture and crumb water activity. In *Cereal Chemistry*, vol. 69, 1992, p. 582-586.

RIBOTTA, P. D., LE BAIL, A. 2007. Thermo-physical assessment of bread during staling. In *Lebensm.-Wiss. U.-Technol.*, vol. 40, 2007, p. 879-884.

RONDA, F., ROOS, Y. H. 2011. Staling of fresh and frozen gluten-free bread. In *Journal of Cereal Science*, vol. 53, 2011, p. 340-346.

WAGNER, M. J., LUCAS, T., LE RAY, D., TRYSTRAM, G. 2007. Water transport in bread during baking. In *Journal of Food Engineering*, vol. 78, 2007, p. 1167-1173.

WANG, X., CHOI, S-G., KERR, W. L. 2004. Water dynamics in white bread and starch gels as affectes by

water and gluten content. In *Lebensm.-Wiss. U.-Technol*., vol. 37, 2004, p. 377-384.

Contact address:

Paulina Pająk. PhD. University of Agriculture, Department of Food Analysis and Quality Assessment, Balicka Street 122, 30-149 Krakow, Poland, E-mail: p.pajak@ur.krakow.pl

Celina Habryka, University of Agriculture, Department of Food Analysis and Quality Assessment, Balicka Street 122, 30-149 Krakow, Poland, E-mail: celhab@wp.pl

Teresa Fortuna, University of Agriculture, Department of Food Analysis and Quality Assessment, Balicka Street 122, 30-149 Krakow, Poland, E-mail: rrfortun@cyf-kr.edu.pl