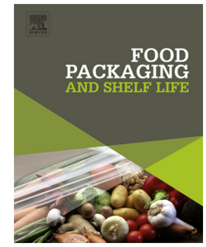
FOOD PACKAGING AND SHELF LIFE 1 (2014) 19–24

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/fpsl



Influence of packaging on the quality maintenance of industrial bread by comparative shelf life testing

Fabio Licciardello, Luca Cipri, Giuseppe Muratore *

Department of Agricultural and Food Productions (DiSPA), University of Catania, via Santa Sofia 98, 95123 Catania, Italy

ARTICLE INFO

Article history:
Received 31 May 2013
Received in revised form
2 October 2013
Accepted 2 October 2013
Available online 13 November 2013

Keywords:
Bread quality
Film thickness
Packaging
Overpackaging
Texture profile analysis

ABSTRACT

The research focuses on the evaluation of the effects of films with different thickness on the quality of industrial durum wheat bread. A comparative shelf life test was performed taking into consideration textural parameters, instrumental crumb colour parameters, crumb moisture and alkaline water retention capacity, considered as indirect indicators of bread staling. Sliced, durum wheat bread was packed into a system made of a thermoformed bottom, with thickness ranging from 225 to 275 μm, and a lid (121–125 μm), with comparable barrier properties. Results demonstrated that it is possible to reduce packaging by about 20% without affecting shelf life standards. The packaging systems showed comparable barrier performances, maintaining the modified atmosphere during 103 days. Texture profile analysis gave comparable results for packages at reduced thickness compared with conventional ones. Also, colour, alkaline water retention capacity and crumb moisture correlated well with bread ageing and did not significantly vary among packaging types.

1. Introduction

The shelf life of cereal products and derivates can be influenced by the packaging materials and technologies used and, with special regards for bread, it is mainly dependent on the staling rate (Cencic, Bressa, & Dalla Rosa, 1996; Del Nobile, Martoriello, Cavella, Giudici, & Masi, 2003; Fava, Limbo, & Piergiovanni, 2000; Lanza, Tomaselli, Muratore, & Pulvirenti, 2000; Latou, Mexis, Badeka, & Kontominas, 2010; Licciardello, Rizzo, Grillo, Venora, & Muratore, 2013; Pagani, Lucisano, Mariotti, & Limbo, 2006; Piergiovanni & Fava, 1997; Rodríguez, Medina, & Jordano, 2000). Shelf life testing can represent a tool for selecting the most suitable packaging systems. In turn, the staling of bread is a complex phenomenon, which cannot be described by one single parameter (Karim, Norziah, & Seow, 2000; Sidhu, Al-Saqer, & Al-Zenki, 1997). For this reason various tests are usually performed simultaneously, supplying complementary information which can be directly or indirectly associated with staling. Karim et al. (2000) reviewed the methods for the study of starch retrogradation, which include those based on the changes in physical and chemical properties.

In the last years, consumers and producers have become more sensitive towards the sustainability of food productions, with special regards for the role of packaging. Estimates of the impact of packaging are in the range of 5–10% of the total environmental impact of a food item (Hanssen, 1998). It is sometimes necessary to increase the packaging environmental impact in order to reduce food losses (Wikström & Wilsson, 2010), however this is not always true and new packaging solutions at lower environmental impact can be able to guarantee certain shelf life standards.

Indeed, packaging users often make unsuitable choices due to scarce knowledge of the materials characteristics and performances and of the product requirements: such choices generally rely on standardized solutions for certain product categories, as it is the case for bakery products. On the other hand, the optimization of packaging would be desired.

* *Corresponding author*. Tel.: +39 95 7580210; fax: +39 95 7141960.
E-mail address: g.muratore@unict.it (G. Muratore).

2214-2894/$ – see front matter
http://dx.doi.org/10.1016/j.fpsl.2013.10.001

Moreover, packaging users tend to maintain the same materials, not considering that the progress in materials science continuously offers new solutions with lower thickness but higher performances in terms of barrier and mechanical properties. As a consequence, the packaging materials adopted are not optimized for the specific product to be packed, and very often they exceed the product requirements: this phenomenon is known as "overpackaging", that is the excessive use of packaging material (Piergiovanni & Limbo, 2010). On the other hand, the difficulty for small and medium food industries to carry out reliable shelf life studies results in a prudential evaluation of the "best-before end" for their products, which underestimates the product shelf life. Such discrepancy causes huge quantities of products to be discarded and disposed well in advance compared to the actual commercial life.

The aim of the present research was to assess the effect of films with different thickness on the quality of an industrial, durum wheat bread, evaluating the possibility of reducing the amounts of plastic materials used without affecting the shelf life standards. This objective was addressed by the comparative study of the shelf life of bread packed with materials having a lower thickness than the conventional one, taking into account texture, crumb colour parameters, crumb moisture and alkaline water retention capacity, considered as indirect indicators of bread staling.

2. Materials and methods

2.1. Sample preparation

Commercially available bread was prepared by Valle del Dittaino Società Cooperativa Agricola a.r.l. (Assoro, EN, Italy), following a consolidated industrial process. In particular, the base ingredient was semolina obtained from durum wheat cultivated in the centre of Sicily, and leavening was performed by the use of sourdough. Two-piece packages were obtained from a bottom film and a lid film possessing the same shape and area ($\approx$280 cm^2). The bottom film was thermoformed into a bowl before inserting the bread. Packages contained 450 g sliced bread and were obtained with different plastic materials, listed and described hereafter with reference to thickness, water vapour transmission rate (WVTR, $g/m^2/24$ h) and oxygen transmission rate (OTR, $cc/m^2/24$ h):

- *Package* A. Bottom film: T6011B, thickness: 275 μm, WVTR $\leq$ 10, OTR = 1; Lid film: T9250B, thickness: 125 μm, WVTR < 10, OTR < 3;
- *Package* B. Bottom film T6090B, thickness: 225 μm WVTR $\leq$ 10, OTR = 1; Lid film: T9250B, thickness: 125 μm, WVTR < 10, OTR < 3;
- *Package* C. Bottom film T12HBL – 230, thickness: 230 μm, WVTR = 3.5, OTR = 1; Lid film: HF00159-A, thickness: 121 μm, WVTR = 6, OTR = 2.

Films for packages A and B were supplied by Cryovac Sealed Air S.r.l. (Passirana di Rho, MI, Italy). Films for packages C were supplied by Hafliger films S.p.a. (Rozzano, MI, Italy).

As conventionally done by the producer, food-grade ethanol (3 mL) was sprayed into the packages, whose atmosphere was replaced with a 70:30 N_2:CO_2 gas mixture. Samples were stored for up to 103 days at 25 °C and the determination of quality parameters was performed at regular intervals on 3 replicates for each batch.

2.2. Headspace gas composition analysis

The internal O_2 and CO_2 composition of packages was monitored during the shelf life testing by a Dansensor Checkpoint portable gas analyzer (Dansensor, Ringsted, Denmark) on three replicates at 2-week intervals, analyzing 10 mL of the package headspace.

2.3. Texture profile analysis

The rheological properties of crumb were evaluated at 2-week intervals by cyclic compression tests using an Instron 3344 Texture Analyzer (Instron, Norwood, MA, U.S.A.), supplied with a 2000 N load cell and a cylindrical probe (diameter: 5 cm) for compression purposes. For each of the three replicated loaves, two samples sized 5 cm × 5 cm × 2.2 cm were obtained from the first two slices. Compression tests were carried out until 40% sample deformation at 5 mm/s speed, with no delay between first and second compression. The following data were stored and elaborated by the Bluehill® 2 software (Instron, Norwood, MA, U.S.A.): maximum force at first and second compression, cohesiveness, springiness and chewiness.

Crumb firmness was fitted to the modified Avrami equation (Armero & Collar, 1998):

$$\theta = \frac{F_\infty - F_t}{F_\infty - F_0} = \exp(-kt^n)$$

where θ is the fraction of the total change in the crumb firmness still to occur. F_0, F_t and F_∞ are experimental values of the property at times zero, t, and infinite (or limiting value), k is a rate constant, and n is the Avrami exponent. All parameters were obtained from the modelling process.

2.4. Colour parameters

The first slice of each sample was scanned by a scanner Canoscan N650U (Canon Computer System, Inc., Costa Mesa, CA, U.S.A.). Images sized 3 cm × 3 cm were acquired at 150 dpi resolution and processed by the software Image Color Summarizer v0.5 © 2006–2011 (Martin Krzywinski, http://mkweb.bcgsc.ca) obtaining the r, g, b (respectively: red, green and blue indexes) and h, s, v (respectively: hue, saturation and lightness indexes) colour coordinates.

2.5. Alkaline water retention capacity (AWRC)

Alkaline water retention capacity was determined according to the method described by Yamazaki (1953), conveniently modified for the analysis of bread crumb as follows. One gram of bread crumb, previously dried until constant weight, was put in 15-mL tubes (W_1), added with 5 mL 0.1 N $NaHCO_3$ and vortexed for 30 s, then let at room temperature for 20 min. The slurry was centrifuged at 3000 rpm for 15 min, the supernatant was discarded and tubes were let drip for 10 min upside down with an inclination of 15°. Dried tubes were then weighed (W_2).