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Research Paper

Engineering

Evaluation of PATP Impact on Aesthetic Qualities of Food Packaging Materials

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ABSTRACT

The impact of PATP (pressure-assisted thermal processing) treatment on the aesthetic qualities of some food packaging materials was studied. Different commercially packaging films, such as: 5PAO/EVE 60, GVA 70 and GVA 150 were pressurized at 600 MPa for 10 min, at temperature of 70 °C. The results showed that the combined pressure-heat treatment can alter the aesthetic qualities of the tested food packaging materials. Opaque areas and bubbles were a general consequence of the pressure-assisted thermal processing of multilayer polymeric films.

KEYWORDS: pressure-assisted thermal processing, food packaging films, opaque areas

INTRODUCTION

There is a growing consumer interest for fresh and mildly processed food, high quality and more fresh-like products (Caner, Hernandez, Pascall, Balasubramaniam, and Harte, 2004; Galotto et al., 2008; Guillard, Mauricio-Iglesias, and Gontard, 2010). In response to consumer demand, novel food preservation techniques such as: microwave pasteurization, irradiation, UV-light, ozone, electric fields, cold plasma treatments, high pressure treatment and PATP (pressure-assisted thermal processing) have received considerable attention during the last few decades (Schauwecke, Balasubramaniam, Sadler, Pascall, and Adhikari, 2002; Caner, Hernandez, Pascall, Balasubramaniam, and Harte, 2004; López-Rubio et al., 2005; Galotto et al., 2008; Guillard, Mauricio-Iglesias, and Gontard, 2010; Ayvaz et al., 2012). Among these novel food preservation technologies, PATP is receiving a great deal of attention due to its advantages, including: greater retention of colour, flavour and nutrients in comparison to thermal processing (Nguyen & Balasubramaniam, 2011).

Food packaging is an integral part of food processing operations (Majeed et al., 2013). To increase the efficiency of food processing, the package must be carefully selected (López-Rubio et al., 2005). Single and combinations of PE (polyethylene), PA (polyamide) and EVOH (ethylene vinyl alcohol) films are some of the commonly used as packaging materials for high-pressure (Ayvaz et al., 2012). These materials have to present sufficient flexibility to compensate for the collapse of the head space and for the possible volume reduction of the food inside the package (López-Rubio et al., 2005; Galotto et al., 2008; Bull, Steele, Kelly, Olivier, and Chapman, 2010; Guillard, Mauricio-Iglesias, and Gontard, 2010; Ayvaz et al., 2012; Mensitieri, Scherillo, and Iannace, 2013).

Moreover, the choice of the polymeric materials for flexible films to be used in high pressure should guarantee that the high pressure and severe stress regime associated with the treatment process do neither affect package integrity nor its functional properties (Caner, Hernandez, Pascall, Balasubramaniam, and Harte, 2004; Mensitieri, Scherillo, and Iannace, 2013).

Very limited information is available on impact of combined pressure-heat treatment on packaging material during PATP treatment (Ayvaz et al., 2012; Mensitieri, Scherillo, and Iannace, 2013). In fact, high pressure treatment has been proven to produce in some cases undesirable effects on flexible polymeric packaging films (Mensitieri, Scherillo, and Iannace, 2013). In the case that high pressure is combined with high temperature the packaging materials and structures need to provide extra performances (Mensitieri, Scherillo, and Iannace, 2013). In this context, really relevant issue is that multilayer flexible films can, in some cases, display delamination phenomena leading to unacceptable modifications of the aspect as well as of the integrity of the packaging structure (Mensitieri, Scherillo, and Iannace, 2013). Furthermore, the aesthetic qualities of the packaging should not be compromised (Bull, Steele, Kelly, Olivier, and Chapman, 2010).

The aim of this research was to investigate the impact of PATP treatment (600 MPa, 70°C/10 min) on aesthetic qualities of different packaging materials (5PAO/EVE, GVA 70 and GVA 150) used for the high pressure treatment.

MATERIALS AND METHODS

Three commercially packaging films supplied by Sudpack Verpackungen were analyzed for their performance under PATP conditions: 5PAO/EVE 60 (combination of biaxially oriented polyamide with coextruded barrier film of the structure PE/EVOH/PE) GVA 70 and GVA 150 (coextruded high barrier multilayer film with the structure PA/EVOH/PA/PE).

To perform the PATP experiment, the polymeric films were treated at PATP in a pilot unit built by Resato (Netherlands). The PATP treatment at constant pressure of 600 MPa was carried out at 70°C for 10 min. Six hundred MPa pressure is considered by many authors as threshold value and also is considered to be economical and microbiologically safe at the pasteurization level (Nguyen & Balasubramaniam, 2011; Ayvaz et al., 2012; Majeed et al., 2013) and combined with high temperatures, such as the ones selected for the current experiment, it lead to a sterilization effect. PATP treatment was carried out in duplicate for each type of film.

RESULTS AND DISCUSSION

Visual evaluation.

Each pouch was examined for visual defects, such as: delaminations, opaque areas, pits, bubbles or other pressure-temperature induced defects. All the pouches were showing after the treatment visible changes, such as: opaque areas and bubbles. These changes are presented in Figures 1-3.

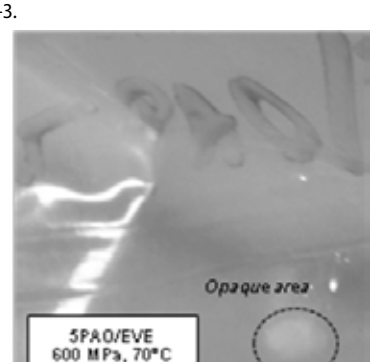

Figure 1: Opaque area on 5PAO/EVE 60 film, after 600 MPa, 70°C.

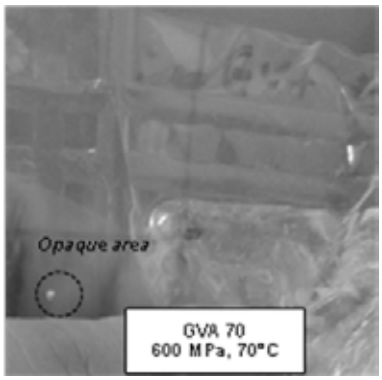

Figure 2: Opaque area on GVA 70 film, after 600 MPa, 70°C.

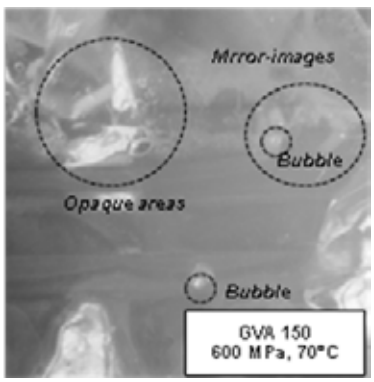

Figure 3: Opaque areas and bubbles on GVA 150 (c) after 600 MPa, 70°C.

After PATP processing, some of the multilayer films showed white opaque areas (Figures 1-3) and in few cases bubbles (Figure 3) were presented.

The opaque areas are far more prevalent in GVA 150 packaging film, compared to the other films. The opaque areas could be a consequence of incompatibility between layers in multilayer films (Martucci & Ruseckaite, 2010) and/or a rapid and explosive decompression of solubilized gases (nitrogen and oxygen) within material (Fairclough & Conti, 2009; Bull et al., 2010). These opaque areas could not be removed by pressing down the films and other marks in the form of bubble, were also irreversible. Some opaque areas were surrounding the bubbles (Figure 3). Juxtaposed, mirror-image was observed on GVA 150 (Figure 3) film.

The presence of the bubbles on GVA 150 film could be attributed to amount of gas available for absorption into the film. When the gas is compressed, it dissolves in the packaging film. At the ultimate pressure, the system is one of a highly compressed gas inside a film. As the pressure is rapidly removed, the solubility of the gas in the film is reduced and causes the formation of bubbles (Fairclough & Conti, 2009). These bubbles are of the order of a few microns and therefore scatter light, resulting in an opaque film (Fairclough & Conti, 2009).

Film thickness's evaluation.

The thickness was measured by a Quanta 200 microscope (FEI Company, Netherlands). Measurements were taken at five different locations on the film sample and a mean thickness was calculated (Hernández-Muñoz, Villalobos, and Chiralt, 2004). The films thicknesses before and after the PATP treatment are reported in Table 1.

TABLE - 1
THE MULTILAYER POLYMER FILMS' THICKNESS (µm)

Packaging material	Control	600 MPa 70°C
5PAO EVE	62.55±0.34	60.90±0.42
GVA 70	69.94±0.58	70.23±0.38
GVA 150	134.5±0.77	139.38±0.67

It is known that the high pressure treatment can accelerate the mass transfer through, from or into packaging materials (Guillard, Mauricio-Iglesias, and Gontard, 2010). From the Table 1 data it can be observed that the 5PAO/EVE's thickness decrease from 62.55µm to 60.90µm. Nevertheless, in this case it should be taken into account a mass transfer (migration) phenomenon from the packaging material (non-volatile migrants: monomers, additives: plasticizers, light stabilizers or other volatiles compounds) to the food matrix. The migration increases with the increase of the fat content because most of the plastic material constituents are lipophilic rather than hydrophilic (Martucci & Ruseckaite, 2010). There is little information on the effect of high pressure on the properties of complex packaging materials and possible package-foodstuff-environment interactions (Martucci & Ruseckaite, 2010).

In addition, with the absence of experimental data for film's solubility at experimental PATP parameters, to support these statement further studies are needed, such as: GS (gas chromatography) and GS-MS (GS-mass spectrometry).

In case of GVA 70 film, the thickness remains practically constant, but in case of GVA 150 film an increase in thickness could be observed. GVA 150 is a multilayer complex structure (PA/EVOH/PA/PE) that can display interlayer failure phenomena.

CONCLUSIONS

In general, the results showed that the combined pressure-thermal treatment alters the appearance of the tested films. Studied films don't represents options for packaging foods treated PATP with an equivalent effect to sterilization, because the changes in the packaging materials, even the small opaque areas and bubbles noticed after the treatment, could severe compromise the integrity and the stability of treated foods.

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