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Reduction of the glucose syrup browning rate by the use of modified atmosphere packaging

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Abstract

Effects of modified atmosphere packaging (MAP) on browning in glucose syrups stored at 25 °C and 45 °C were studied. Different atmosphere such as air, 100% N_2, 90% N_2/10% O_2, 25% CO_2/75% N_2, 75% CO_2/25% N_2 and vacuum were examined. The glucose syrups stored at 45 °C and pH 5 were completely brown after 26 weeks under vacuum packaging while they were brown after 15 weeks at that temperature and pH 6 under air packaging system. No color formation was observed in glucose syrups stored at 25 °C during this work. As so glucose syrups kept under CO_2 gas had no significant effect on browning.

Keywords: Glucose syrups; Browning; Modified atmosphere packaging (MAP); Shelf life

1. Introduction

Shelf life is the duration of that period between the packaging of a product and its use, for which the quality of the product remains acceptable to the product user or the shelf life refers to the time for which a food can remain on both the retailer's and consumer's shelf before it becomes unacceptable (Robertson, 1993). Product shelf life can be controlled by three factors: (i) product characteristics, (ii) the environment to which the product is exposed during distribution, and (iii) the properties of the package.

The shelf life of a product can be altered by changing its composition and form, the environment to which it is exposed, or the packaging system (Harte & Gray, 1987).

In the case of glucose syrup, the major factor affecting the shelf life is brown color formation. Maillard reactions are the main causes of brown color formation in glucose syrup. Non-enzymatic browning reactions between amino acids and reducing sugars are the basis of the Maillard reactions. This reaction in food is actually a complex network of chemical reactions which usually takes place during food processing or storage. Maillard reactions play an essential role in food acceptance through the ways they influence quality factors such as flavor, color, texture and nutritional value (Rizzi, 1994). In glucose syrups, the formation of color and odors determines the sensorial properties such as taste and flavor and also provides an index of purity. Color formation in glucose syrups during the manufacture of high boiled candies can be serious problems for the confectionery industry as it may lead to the loss of acceptable color and to the development of off-flavors (Kearsley & Brich, 1985).

Mechanism and kinetic of color formation and factors affecting color development in glucose syrups during storage such as time of storage, temperature, pH, dextrose equivalent and sulfur dioxide, have been previously studied (Ramchander & Feather, 1975; Kearsley, 1978; Sapers, 1993; Bostan & Boyacioglu, 1997). In this work, effects modified atmosphere packaging (MAP) on the color formation and shelf lives of glucose syrups were determined.

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2. Materials and methods

Glucose syrup with 42 DE, 82.5° Brix and pH 4.78 were donated by Glucosan Co., Tehran, Iran. The used glucose syrups were produced from acid hydrolysis of corn starch. The physical and chemical characteristics of this syrup present in Table 1. Chloride acid and sodium hydroxide (Merck grade) were used for pH adjustment.

The pH was measured with a Jenewy pH-meter which was calibrated according to the method of the Corn Refiners Association CRA (1985).

The soluble solids were measured in degree of Brix with an Abbe refractometer at 25 °C. The Brix data were related to the total solids content of the syrup using the Critical Data Tables prepared for syrups with know DE values.

Color indices of the syrups were measured by their absorbance at 295 nm on Perkin–Elemer model 550 UV/VIS double beams spectrophotometer using a 1 cm path length cell. The wavelength used was based on the wavelength maximum obtained from spectral scans of aged syrup (Meydav, Saguy, & Kopelman, 1977).

The protein contents of glucose syrup samples were determined by Kjeltec Auto 1030 Analyzer according to the method of ISI (1999).

The carbohydrate profiles were determined by Jasco High Pressure Liquid Chromatography (HPLC) instrument using a carbohydrate analysis column and RI detector. The solvent system was a mixture of acetonitryle and deionized water (80/20) and the flow rate was 2 ml/min.

For preparation of samples, at first pH of syrup was adjust to 4, 5 and 6 with the addition of 0.1 N NaOH and 0.1 N HCl, then they were put into polyethylene/aluminum/polyester pouch then packed with Henkelman 200A vacuum machine under six different atmospheric condition of air, 100% N_2, 90% N_2/10% O_2, 25% CO_2/75% N_2, 75% CO_2/25% N_2 and vacuum. Finally samples were stored in thermostatic ovens of 25 and 45 °C.

3. Results and discussion

Browning rate was measured as changes in absorbance values of glucose syrup samples at 295 nm as a function of time. Each package was opened and tested at two week interval times during storage of the samples in thermostatic oven at 25 °C and 45 °C. At absorbance value of 0.9 syrups had a light yellow color while at absorbance value of 3.72 syrup color was completely brown. Thus, the shelf life was defined as the time taken for the absorbance of stored glucose syrup samples to reach the later value. Browning rate of syrups under four atmospheric condition of air, 100% N_2, 90% N_2/10% O_2 and vacuum at pH 4 and temperature of 25 °C and 45 °C are shown in Figs. 1a and 2a, respectively. As shown in these figures, the browning rate in syrups stored at 45 °C was higher than those stored at 25 °C. Another result can be mentioned from these figures, browning rate in all syrups increased when oxygen content in package increased. Browning rate in syrups which stored under air condition was maximal, and also it was higher under 90% N_2/10% O_2 than 100% N_2.

These observations showed that oxygen can be accelerated non-enzymatic browning. The accelerate effect of oxygen on the rate of browning may be attributed to the fact that oxygen is required for formation of some interme-

Table 1
Chemical and physical characteristics of glucose syrups

Characteristics	Amount
DE	42
PH	4.78
Soluble solids	82.5%
Glucose	24.38%
Maltose	13.87%
Protein	0.03–0.05%

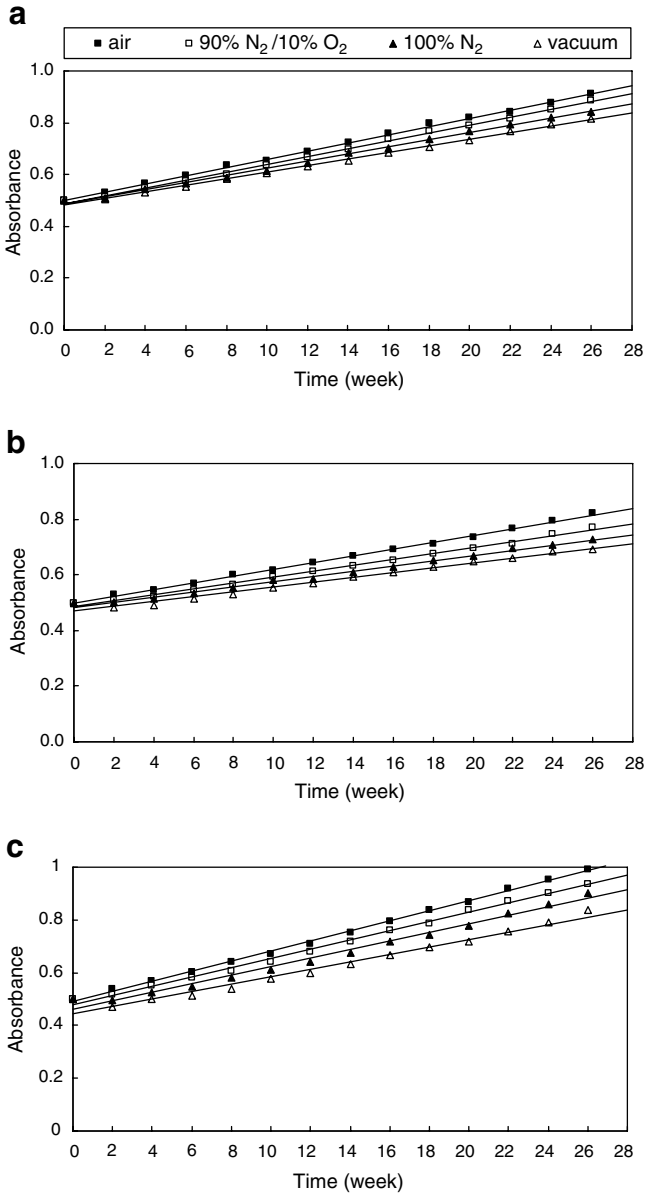

Fig. 1. Influence of packaging atmosphere on color formation in glucose syrups stored at 25 °C: (a) pH 4, (b) pH 5 and (c) pH 6.