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Development and application of edible film of active potato starch to extend mini panettone shelf life

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ABSTRACT

Physicochemical properties may determine quality attributes and consumer acceptability of mini panettones. To reduce the conservatives added in food, this study developed active edible films of potato starch, inverted sugar and sucrose to coat mini panettones. All three variables significantly affected ($p < 0.05$) moisture, aw, hardness and elasticity of panettones. The selected formulation (46 g/kg starch, 14 g/kg inverted sugar and 7 g/kg sucrose) was added to potassium sorbate (1 g/kg), citric acid (10 g/kg) and both additives (1 g/kg sorbate + 10 g/kg citric acid and 0.5 g/kg sorbate + 5 g/kg citric acid). From 16 to 24 days (35 °C/60% RH), panettones without coating and without additives (controls) showed growth of mold/yeast; while with both additives coating, fungal growth was observed from 40 days. When using potassium sorbate, mold/yeast was not detected until 48 days. During storage, there was reduced water activity, moisture, elasticity and cohesiveness of panettones with additives, while the reverse occurred in controls. The incorporation of food-graded antimicrobial compounds in the packaging films of potato starch coatings in concentrations lower than those normally used for mini panettones increased up to 130% their shelf life and may contribute to product loss reduction during storage.

1. Introduction

Consumers are increasingly interested in the quality of products consumed. Such quality depends on characteristics that can be altered during storage and selling processes (Guilbert, Gontard, & Gorris, 1996). Food manufacturers hold packages as allies for having a protective function, providing greater shelf life and ensuring the quality of purchased products (Wen-Xian, Avena-Bustillos, Sui Sheng & Tara, 2011).

Although panettones are seasonal products, the mini panettone is a choice for addressing the current desires of consumers coming in single doses or individual portions.

In the bread industry, several additives are used to improve dough properties, bread quality and tolerance processes, in particular the optimization of shelf life (Benejam, Steffolani, & León, 2009). Thus, new alternatives to increase the shelf life of products, while keeping characteristics similar to a freshly prepared product, are of great interest to industries.

In bread-making products, the growth of certain microorganisms begins or is more intense at the surface, what makes the use of edible films and coats a choice for maintaining the quality of these products (Appendini & Hotchkiss, 2002).

The development and the application of films and active edible coatings in bread-making products becomes a viable alternative to meet the demands of the market by offering products with quality

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and safety, maintaining the desired sensorial characteristics and reducing loss caused by growth of molds and yeasts (Devlieghere, Vermeiren, & Debevere, 2004; Padgett, Han, & Dawson, 1998; Soares, Rutishauser, Melo, Cruz, & Andrade, 2002).

To reduce the total amount of conservatives added to food, edible coatings are used as surface of active agents retention to maintain a high effective preservative concentration where such microorganisms tend to contaminate and/or grow; i.e. on the coating surface. The advantage is requiring a lower amount of conservative agents. In response to the consumers' demand for conservative-free food, as well as more natural, disposable, biodegradable and recyclable food-packaging materials, the objective of this study was to develop and characterize edible coatings of potato starch, inverted sugar and sucrose to coat mini panettones and select the formulation to incorporate synthetic active additives in the conservation of this product during storage.

2. Materials and methods

Edible coatings were prepared with potato starch (Yoki®, São Paulo – SP, Brazil – 220 g/kg amylose and 780 g/kg amylopectin), inverted sugar (INVEX 60 Guarani®, São Paulo – SP, Brazil – 76–78%°BRIX, 90% inversion and pH 4.5–5), sucrose (União, Sertãozinho – SP, Brazil), potassium sorbate and citric acid (Pantec, São Paulo – SP, Brazil).

The mini panettones were prepared with wheat flour, margarine, water, sugar, egg yolks, whole milk powder, glucose, sodium chloride, yeast, emulsifier (lecithin), chocolate chips and essence of panettone; all purchased on the local market (Salvador – Bahia, Brazil). They were baked at 180 °C for 35 min, coated with edible coatings and stored using bi-axially oriented polypropylene metal packaging (BOPP) (Polo Films, Montenegro – RS, Brazil).

2.1. Experimental design

Seventeen formulations of filmogenic solutions with variations in potato starch, inverted sugar and sucrose concentrations (Table 1) were developed following a rotatable central composite design (RCCD) with a model of order 2^3. Solutions were applied as coats in mini panettones and compared with mini panettones without coating (control). From the results, a Pareto chart was designed to determine the influence of independent variables on sensorial, physicochemical and physical parameters of mini panettones. Out of the 17 formulations, one was selected for the additive to be added. Results that showed significant influence from Pareto charts were evaluated by ANOVA considering pure error and a 95% confidence interval.

2.2. Preparation of filmogenic solutions and application of coatings on mini panettones

The filmogenic solutions were prepared by dissolving potato starch (46–73 g/kg), plasticizers invert sugar (9–19 g/kg) and sucrose (4–10 g/kg) in distilled water. Dispersions were shaken at 68 ± 2 °C with constant stirring under water bath, followed by cooling at room temperature (25 ± 2 °C). Filmogenic solutions were applied to the mini panettones with the aid of a confectionery brush. Four layers were brushed at all the surface of baked mini panettones with three-minute intervals between applications. Thereafter, coated panettones were brought to the oven at 180 °C for five minutes to dry the coating. For comparison, the control panettones (without coating) were also heated to 180 °C for 5 min.

2.3. Sensorial, physical and physicochemical characterization of mini panettones with edible coatings

2.3.1. Sensory evaluation

The flavor, texture and dissolution of mini panettones were evaluated by using an acceptability test. A total of 60 untrained taster's were recruited. The evaluations were carried out in individual booths under artificial daylight at temperature between 22 and 24 °C and air circulation. The samples were evaluated in a monadic way. Each taster evaluated the eighteen samples of mini panettones in six sessions, according to an experimental design of complete balanced and randomized blocks. The samples (1 unit) were served on disposable plates, coded with random 3 – digit numbers.

A 9-cm non-structured hedonic scale was used in the acceptability test with extremes of "(1) extremely disliked" and "(9) extremely liked" (Stone & Sidel, 2004).

The study plan was evaluated by the Ethics in Research Committee of College of Nursing, Federal University of Bahia. Salvador, Bahia, Brazil, resolution number 01 of 13/06/1988-CNS, who presented favorable opinion for the development of this study (number 921.004).

2.3.2. Water activity (a_w) and moisture (M)

The a_w was measured using a decagon (Lab Masster, Novasina – TECNAL, SP/Brazil), with a CM-2 electrolyte measuring cell and prepackaged samples at 60% RH and 25 °C (Veiga-Santos, Oliveira, Cereda, Alves, & Scamparini, 2005). Moisture content (g/kg) was determined by infrared drying (Mettler LTJ) (IAL, 2005).

2.3.3. Texture

The hardness, cohesiveness, elasticity and chewiness were evaluated using a CT3 Texture Analyzer (Brookfield, Middleboro/USA) according to the AACC 74 – 09 method (AACC, 2000).

2.4. Incorporating of synthetic additives to the selected edible coating

To the selected the base formulation four concentrations of additives were incorporated in isolation and in the following combinations: ASF_1 (1 g/kg potassium sorbate), ASF_2 (10 g/kg citric acid), ASF_3 (1 g/kg potassium sorbate + 10 g/kg citric acid) and ASF_4 (0.5 g/kg potassium sorbate + 5 g/kg citric acid). After preparing the filmogenic solution (see item 2.2), additives were solubilized, followed by cooling at room temperature (25 ± 2 °C).

2.5. Monitoring of the microbiological, physical and physicochemical stability of mini panettones with additive edible coatings

After packaged in foil BOPP metallic packages and stored in a climatic chamber (TECNAL) for 48 days (60% RH, 35 °C), mini panettones with active edible coatings were monitored every 8 days by evaluating a_w, moisture, texture and count of molds and yeasts. Mini panettones without coating and edible coating without additives were also packaged under the same conditions for results comparison.

2.5.1. Microbiological analysis

Analysis was performed from the homogenization of a 25 g sample with 225 mL of 1 mg/L peptone water in stomacher for 2 min. Afterwards, decimal serial dilutions were carried out in triplicate, and the plating was performed on a Dichloran Rose-Bengal Chloramphenicol (DRBC) surface for researching yeasts and molds. The plates were incubated at 25 °C for 5 days (King,