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The effects of banana ripeness on quality indices for puree production

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ABSTRACT

The physical and chemical compositional changes of Cavendish bananas were investigated according to the ripening stages determined by peel colour as classified in the Banana Ripening Guide. There is a need for the utilization of second grade bananas that are deemed unsuitable for retail sale, but are still appropriate for human consumption, for the long term sustainability of the banana industry. The optimum stage of ripeness of banana for puree making for food product development was determined through comparisons of the physical, chemical and sensory qualities. Banana pulp samples were analysed for texture, total soluble solids, starch, sugar, total ash, and potassium and magnesium contents at different ripening stages. At stage 5 ripeness, banana pulp had potassium (584 mg/100 g), magnesium (58 mg/100 g), total sugar (5.2 g/100 g) and starch (1.8 g/100 g) contents. Stage 5 ripened bananas were found to be the most suitable for puree production. Sensory acceptability results showed that the puree produced with second grade test bananas was rated significantly better compared to a commercial puree.

1. Introduction

Banana accounts for approximately 15% of the world's total fresh fruit production (FAO, 2015). Bananas are the world's fourth most important crop after rice, wheat and maize. They play a key role in food security in developing countries (FAO, 2006). Cavendish, the most traded bananas, account for half of the world's banana production (FAO, 2003).

It is estimated that about 20–25% (10–15 million tonnes) of banana fruit is rejected annually due to its failure to meet quality standards (mainly appearance) making them unsuitable for retail sale (Pillay & Tenkouano, 2011). The banana industry has been looking for commercially feasible applications for rejected bananas (Horticulture Australia, 2010). Alanis-Lopez, Perez-Gonzalez, Rendon-Villalobos, Jimenez-Perez, and Solorza-Feria (2011) produced biodegradable starch laminates from second grade bananas for possible food packaging applications. Martelli, Barros, de Moura, Mattoso, and Assis (2012) produced banana puree films from overripe bananas. Flores-Silva, Rodriguez-Ambriz, and Bello-Perez (2015) and Sarawong, Rodríguez Gutiérrez, Berghofer, & Schoenlechner (2014) produced a gluten-free snack and pasta with bananas, and Liao and Hung (2015) studied the starch digestibility of green banana powder.

At present, the banana industry uses a banana ripening guide as a visual distinction of the seven stages according to peel colour (United Fruit Sales Corporation, 1964). As the ripeness stage of banana fruit has an effect on flavour and acceptability, there is a need to determine the quality indices to understand the changes that occur during ripening. Yan et al. (2016) determined the optimum ripeness stage to extract carotenoids from second grade banana peel for possible food applications. However, studies are yet to identify the optimum ripeness stage for banana puree production. Bananas that are considered second grade due to not meeting the required dimensions for retail sale can be used as a food ingredient for the production of various foods. Banana puree is the main commercial processed banana product that is widely used all over the world (Pillay & Tenkouano, 2011), especially in the manufacturing of foods such as baby foods, dairy and bakery products. The optimum ripeness stage is critical to determine the

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best characteristics of the ingredient.

2. Materials and methods

2.1. Samples

Second grade Cavendish bananas (bananas that fell outside of the size requirements of 150–220 mm in length and thickness of 30–40 mm) were harvested from a single location (farm) in the Carnarvon area supplied by Sweeter Banana Co-operative (Carnarvon, Western Australia, Australia). These bananas were of good quality except failing to meet the size requirement. The bananas (10 kg) were harvested at ripeness stage 1 (normal harvesting stage for retail). Samples were taken for analysis the rest were held at 18 ± 2 °C and monitored until they reached the required ripeness stages before been withdrawn for analysis (at each stage 1 kg was withdrawn for analysis).

Bananas were classified into the different stages of ripening according to the classification shown in Fig. 1 (United Fruit Sales Corporation, 1964). All physical and chemical analyses were conducted in triplicate. All chemicals used in the study were analytical grade and purchased from Sigma-Aldrich, New South Wales, Australia.

2.2. Banana puree production

Blanching whole unpeeled bananas were performed by placing them in boiling water for 1 min (Ditchfield, Tadini, Machoshvili, & Penna, 2006). to inactivate the polyphenoloxidase. The bananas were then peeled and pureed to a smooth consistency in a blender (Sunbeam, model Oskar II LC026C, France) at setting 1 for 1 min. The pH of the puree was adjusted to 4 with 0.5 mol/L citric acid. The puree was then cooled to 20 ± 2 °C and packed into plastic bags, heat sealed and stored at 3 ± 2 °C until required for analysis. The banana puree production process is shown in Fig. 2.

2.3. Quality indices – physical tests

2.3.1. Colour

Banana fingers (3) were randomly selected from each ripeness stage and the colour of their peels were determined using a Minolta Colourimeter (Minolta Spectrophotometer CM-508i, Minolta Corp, Osaka, Japan). The colour was measured at three different parts – top, middle and end. Values were recorded in terms of CIE values (CIE-Lab), where L* represents brightness from black (0) to white (100), a* represents green to red (−80 to +80) and b* represents blue to yellow (−80 to +80). The colourimeter was standardized with the black and white calibration tiles before each measurement. For puree the colour was measured on three random points

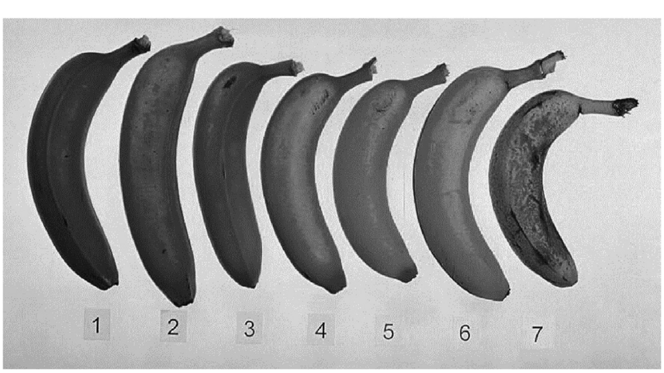

Fig. 1. The banana ripeness grading pictorial scales.

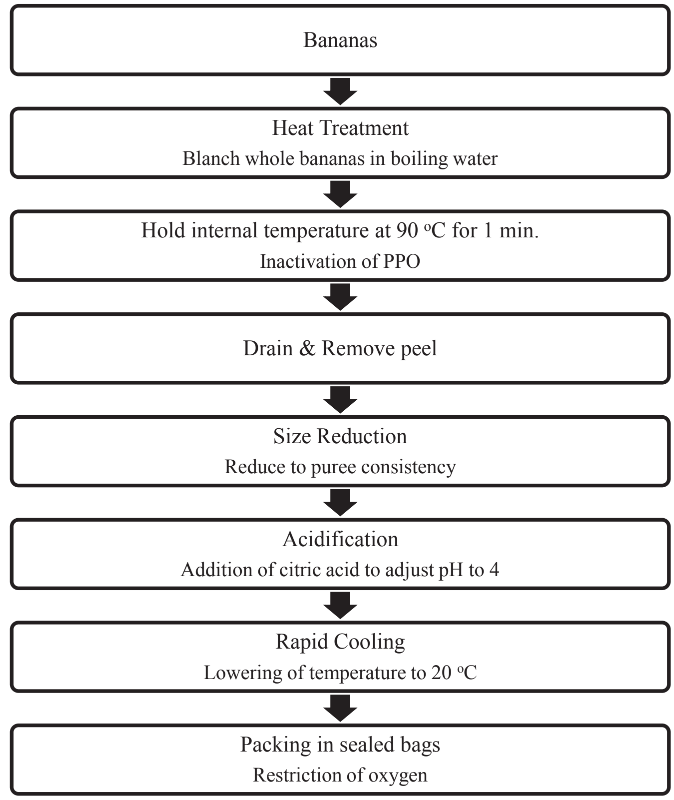

Fig. 2. The banana pure production process flow diagram.

of the pack and the changes in colour were recorded over a 14 d period.

2.3.2. Firmness of the banana pulp

A penetrometer (Stanhope-Seta 1700 universal penetrometer, Surrey, UK) with a needle and penetration weight of 100 g was used to measure the firmness of the peeled banana fruits. Measurements were taken at three different areas (top, middle and end) of the flesh.

2.3.3. Viscosity of the banana puree

Viscosity of banana puree was measured using a viscometer (Brookfield RVT DV-I, Brookfield AMETEK, Massachusetts, USA) with the use of spindle 7. The spindle speed used was 20 rpm for 5 min based on the reading was then converted to centipoises (cP). The puree was placed in a 600 mL beaker and measurements were done at room temperature (Bourne, 2002; Coorey, Tjoe, & Jayasena, 2014).

2.4. Quality indices - chemical tests

2.4.1. Moisture content and water activity

Moisture content was determined according to the AOAC Method 930.04 (1998) by drying in an oven at 105 °C until a constant weight. Moisture content was calculated by weight difference. The water activity was measured with the use of a water activity meter (Aqualab model series 3 TE, AquaLab, Washington, USA), with 5 g of sample.

2.4.2. Titratable acidity

Titratable acidity was measured according to the AOAC Official Method 942.15 (1998) by the titration of diluted banana pulp or