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Original Article

The effect of pineapple core fiber on dough rheology and the quality of mantou

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ABSTRACT

The consumption of dietary fiber offers the health benefit of lowering the risk of many chronic diseases. Pineapple core fiber (PCF) in this study was extracted and incorporated into dough and mantou (i.e., steamed bread). The effects of PCF substitution and fiber size on textural and rheological properties of dough and mantou were evaluated by a texture analyzer. The substitution of wheat flour by PCF resulted in a stiffer and less extensible dough with or without fermentation. The hardness and gumminess of mantou significantly increased as the PCF substitution increased from 0% to 15%, but the cohesiveness, specific volume, and elasticity significantly decreased with the fiber substitution. Ten percent PCF-enriched dough and mantou with various fiber sizes had similar rheological and textural properties, except for the k_1 and k_2 values. By sensory evaluation, 5% PCF-enriched mantou and the control bread had better acceptability in texture, color, odor, and overall acceptability, compared to mantous enriched with 10% or 15% PCF. Significant correlations existed between the rheological properties of dough and textural parameters of mantou and between the sensory quality and textural parameters of mantou. Therefore, we suggest that fiber-enriched mantou can be prepared with 5% PCF substitution to increase the intake of dietary fiber and maintain the quality of mantou.

1. Introduction

Mantou (i.e., steamed bread) is an important staple food in Asia. Southern-style Chinese mantou has a soft, elastic, and uniformly fine-textured crumb. These characteristics are significantly affected by ingredients and processing variables [1–3]. Rubenthaler et al [1] reported that wheat flour with 10–11% protein and medium gluten strength is best suited for steamed bread. The low-steam generation rate significantly reduces the quality of bran-enriched steamed bread [3].

Dietary fiber (DF) is a group of food components that are resistant to hydrolysis by human digestive enzymes. Dietary fiber intake offers health benefits such as a lower risk for coronary heart disease, type 2 diabetes, obesity, and constipation [4,5]. The additions of some soluble DFs strengthens

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the structure of dough and improves the quality of bread [6], but excess amounts of insoluble DFs have an adverse effect on the formation of the gluten network [7,8] and reduces the quality of bread [9–12] because of a gluten dilution effect or because of gluten–fiber interaction. The addition of apple pomace [13] and insoluble wheat fiber [14] results in a stiffer dough, probably through a filler-like effect in the dough matrix. Ahmed et al [8] report that dough incorporated with insoluble date fiber predominately exhibits solid-like behavior. Potato fiber, which contains a high level of insoluble DF, increases the hardness and gumminess of bread [11]. The addition of 11% apple pomace decreased the quality of bread by sensory evaluation [9]. Wu et al [3] reported that steamed bread enriched with 10% and 20% wheat bran had a similar sensory quality as the control bread, but 30% bran-enriched steamed bread had the lowest sensory quality, which was significant. Increasing the DF intake may be achieved by consuming fiber-enriched mantou. Few studies exist on the properties of dough and mantou enriched with fiber.

Pineapple is one of the most important fruits in the world. In Taiwan, the annual yield of pineapple is more than 400,000 metric tons. In addition to being eaten fresh, pineapples are usually processed into canned fruit, juice, and jam. Pineapple core, the high-fiber part of the pineapple fruit, is a potential DF source [15,16]. The fruit and its pomace contain abundant phytochemicals such as fiber, polyphenols, and flavonoids; it furthermore has good antioxidant activity [17,18]. Prakongpan et al [19] report that purified pineapple core powder contains 99.8% total DF content. Hence, pineapple core is a good DF source for food enrichment.

The aim of this study was to investigate the rheological and textural properties of dough and mantou enriched with different amounts and particle sizes of pineapple core fiber (PCF). Another purpose was to observe the correlations between dough and mantou properties.

2. Methods

2.1. Materials

Wheat flour with medium gluten strength was a gift from Chia-Fha Enterprise Co. Ltd. (Taichung, Taiwan). The approximate composition of wheat flour on a wet basis, as analyzed by the AACC [20] methods, were 12.1% moisture, 11.0% crude protein, 0.6% crude fat, and 0.4% ash contents. Commercial instant dried yeast and sodium stearoyl 2-lactylate were obtained from S. I. Lesaffre Co. (Marcq, France) and Danisco Ingredients (Penang, Malaysia), respectively. Food-grade sucrose and shortening were purchased from Taiwan Sugar Co. (Tainan, Taiwan).

The core of fresh pineapple (*Ananas comosus* L. Merr.) was obtained as a byproduct from a local fruit processing factory. Pineapple core fiber was prepared in accordance with the method proposed by Chien and Kang [16], with some modifications. In brief, pineapple cores were washed, cut (<1 cm thick), blanched (100°C for 15 minutes), drained, air-dried (50°C for 24 hours), and crushed. The crushed samples were then extracted by 80% ethanol for 12 hours. The residues after centrifugation were air-dried (50°C for 24 hours) and milled to a particle size of less than 0.42 mm. Three fractions of PCF with different particle sizes were collected by sieving with 40 mesh, 60 mesh, and 100 mesh. Total, insoluble, and soluble DFs of the PCF were analyzed by AOAC methods [21]. Functional properties (e.g., swelling power and water-holding capacity) were measured by the method of Huang et al [22], with some modifications. The PCF (1 g) was hydrated with 20 mL of distilled water in a calibrated cylinder at room temperature. After equilibration (24 hours), the bed volume was recorded and the swelling power was expressed as milliliters of swollen sample per gram of dry sample. Furthermore, PCF (1 g) was soaked in 10 mL of distilled water for 24 hours and then centrifuged at 1000*g* for 20 minutes. The supernatant was decanted into a graduated cylinder and the volume of excess water was read. Hence, Water-holding capacity was expressed as milliliters of water held by 1 g of PCF.

2.2. Preparation of dough and mantou

Dough and mantou were both prepared with 0–15% PCF by the method of Wu et al [3]. Unless stated otherwise, the basic 10% fiber-enriched dough constituents were wheat flour (90%), PCF (10%), water (54%), yeast (1.5%), sucrose (8%), shortening (5%), and sodium stearoyl 2-lactylate (0.5%). In brief, all ingredients were mixed and kneaded to form dough. The dough was then fermented, sheeted, rolled, divided, proofed, steamed, and cooled. Rheological and quality tests of the dough and mantou were performed at room temperature (approximately 26°C) as soon as possible.

2.3. Extension test of unfermented or proofed dough

A texture analyzer (TA-XT2i; Stable Micro Systems, Surrey, UK) was equipped with a probe of Kieffer dough and gluten extensibility rig, and operated in tension mode. The pretest and test speeds were both set at 2.0 mm/s to avoid vibrations that may occur at high speed. The resistance to the extension (mN) and extensibility (mm) of dough without yeast and proofed dough were determined by recording the maximum force and the distance at rupture. The measurements were conducted in six repetitions.

2.4. Stress relaxation of mantou

The stress relaxation of mantou was measured according to the method proposed by Wu et al [3]. In brief, the center crumb sample ($3 \times 3 \times 4$ cm^3) was removed by cutting. Stress relaxation test of the sample was executed by using a textural analyzer equipped with a P20 cylindrical probe (20-mm diameter). The sample was deformed by penetration to a constant strain of 20% with a test speed of 0.5 mm/s. The data acquisition rate was 10 points per second. The residual force was continuously recorded as a function of time for 480 seconds. The measurements were conducted in triplicate.

The stress relaxation data were analyzed by using the Peleg–Normand model (Equation 1), proposed by Peleg and Normand [23].

$$\frac{F_0 t}{F_0 - F(t)} = k_1 + k_2 t \quad (1)$$