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Fat replacement in soft dough biscuits: Its implications on dough rheology and biscuit quality

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Abstract

In order to develop low calorie soft dough biscuits, fat in the biscuit formulation was reduced from 20% (control) to 10%, 8%, and 6% levels, respectively. Changes in the rheological properties of the dough due to fat reduction were studied using research water absorption meter (RWAM), Brabender Farinograph and Texture analyzer. As the fat level decreased, the dough hardness increased and the extrusion time of biscuit dough, as measured in RWAM, increased from 43 s (20%) to 167 s (6%) and the farinograph biscuit dough consistency increased from 180 to 540 Brabender Units (BU). The texture analyzer showed an increase in dough hardness from 20.78 N to 44.08 N. Replacing fat with equal quantities of maltodextrin and polydextrose reduced the dough consistency and dough hardness, to some extent. Addition of glycerol mono stearate and guar gum had a positive effect on dough consistency and hardness. Effect of fat reduction had a negative effect on biscuits texture. Biscuit texture improved significantly, when fat was replaced with maltodextrin. Further improvement in biscuit texture was noted when either glycerol mono stearate or guar gum was used along with maltodextrin.

Keywords: Biscuit dough; Soft dough biscuits; Fat replacement; Dough rheology; Farinograph; Texture analyzer

1. Introduction

Flour, sugar, fat, water and salt are the main components in a soft dough biscuit formulation (Maache-Rezzoug, Bouvier, Allaf, & Patras, 1998). Fat in a biscuit formulation has a multifaceted function. Fat is the principle ingredient responsible for tenderness, keeping quality, grain and texture and it adds a rich quality to cookies (O'Brien, 2003). Mechanical properties of biscuits are largely dependent on the fat component of the formulation (Baltsavias, Jurgens, & van Vilet, 1999). Fat interacts with other ingredients to develop and mould texture, mouthfeel and overall sensation of lubricity of the product (Giese, 1996; Stauffer, 1998). Fat also influences the rheological properties of cookie dough (Jissy & Leelavathi, 2007).

High fat intake is associated with various health disorders such as obesity, cancer, high blood cholesterol, and coronary heart disease (Akoh, 1998). This awareness has prompted consumers about the amount of fat in their diet (O'Neil, 1993). Due to this reason, in spite of the important role played by fat, there have been continued efforts to reduce the fat content in food products and replace it with various fat replacers.

At present, a wide variety of ingredients are employed as fat replacers to capitalize on the unique properties and qualities of each bakery product. However, the important point is the consideration of the functionality of these replacers in a variety of products to obtain products with similar quality parameters (Kamel & Rasper, 1988). The most difficult part of reformulating with these fat substitutes is obtaining the mouthfeel, texture, taste and lubricity equivalent to that found in the conventional products.

Maltodextrin and polydextrose are two of the most popular carbohydrate based fat replacers. Carbohydrate

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based fat replacers form a gel-like matrix in the presence of substantial levels of water, resulting in lubricant and flow properties similar to those of fats (Yackel & Cox, 1992). Maltodextrin, a non-sweet starch hydrolysate is a bulking agent having no undesirable side reaction (Alexander, 1992). Polydextrose is a complex carbohydrate made from glucose, sorbitol and citric acid and its relatively high viscosity in solution contributes to the mouthfeel and creaminess of fat reduced formulations including biscuits (Mitchell, 1996).

The objective of the present work was to study the effect of fat replacement with either maltodextrin or polydextrose on rheology of biscuit dough and on the quality of biscuits. Secondly, effect of emulsifiers namely, glycerol mono stearate and sodium sterolyl lactylate and a hydrocolloid (guar gum) on the rheology of low fat biscuit dough and the biscuit quality was also studied.

2. Experimental

2.1. Raw materials

Commercially available wheat flour, having moisture, protein and ash contents of 11.48%, 9.65% and 0.5%, respectively, was used in the study. Commercially available emulsified bakery fat 'marvo' (Hindustan Lever Ltd., India), sugar powder and non fat dry milk were used in the formulation. Sodium chloride, sodium bicarbonate, ammonium bicarbonate, and dextrose syrup used in the biscuit formulation were all of food grade. Maltodextrin (DE < 20) was procured from M/s Indras Agencies, Ltd, India. Polydextrose (Litesse II) was procured from Cultor Food Science Inc., Xyrofin GmbH, Germany. Commercially available food grade emulsifiers, namely, glycerol monostearate, sodium steroyl lactylate and food grade guar gum were procured from local markets for use in the studies.

2.2. Preparation of soft dough biscuits

Soft dough biscuits were prepared according to Leelavathi and Haridas Rao (1993). The biscuit formulation consisted of wheat flour 100 g, sugar powder 30 g, fat 20 g, dextrose syrup 2 g, non fat dry milk 2 g, sodium chloride 1 g, sodium bicarbonate 0.4 g, ammonium bicarbonate 1.5 g and water 17% (by volume). For the preparation of low fat biscuits, fat content in the biscuit formulation was reduced by 50%, 60% and 70%, respectively. The corresponding biscuit dough therefore contained 10%, 8% and 6% fat in their respective formulations. Water used in the above three formulations were 19.0%, 21.0% and 22.5%, respectively. Water used in the preparation of maltodextrin, polydextrose, emulsifier and guar gum gels was taken into consideration during dough preparation. Fat and sugar powder were creamed in a Hobart mixer (model N 50, North York, Ontario, Canada) at speed 1 (61 rpm) for 1 min and continued creaming at speed 3 (178 rpm) for 4 min. Dextrose syrup, milk powder made into suspension in water, baking chemicals and sodium chloride dissolved in water were transferred to the above cream and mixed at speed 1 (61 rpm) for 2 min with further mixing for 2 min at speed 2 (125 rpm) to get a smooth cream. Wheat flour was transferred to the above cream and mixed for 2 min at speed 1 (61 rpm) to get the biscuit dough. The dough was sheeted to a thickness of 3.5 mm and cut into round shapes using a 52 mm diameter dough cutter. The cut dough was transferred to aluminum trays and placed in a baking oven and baked at 205 °C for 8 min.

Maltodextrin, polydextrose, glycerol mono stearate, sodium steroyl lactylate and guar gum were added in gel-form during fat-sugar creaming whenever included in the formulation. One volume of emulsifier was transferred to 3 volumes of water heated to 80–85 °C, cooled and stirred into smooth gel. Same method was followed for the preparation of maltodextrin and polydextrose gels, except that water was heated to 45–50 °C and used at a ratio of 1:1. Guar gum was made into gel form in water heated to 40–42 °C at a ratio of 1:2.

2.3. Measurement of biscuit dough consistency

2.3.1. Farinograph studies

Consistency of the biscuit dough was measured using a Brabender Farinograph (CW Brabender Instruments, Duisberg, Germany), according to the method of Olewnik and Kulp (1984). A 300 g capacity mixer bowl was used in the experiment and the third lever position was used to measure the biscuit dough consistency. The mixing speed of the farinograph was 61 rpm. Three hundred grams of biscuit dough pre-mixed in a Hobart mixer was transferred to the farinograph bowl and the instrument was run for 20 min and the farinogram pattern was studied. Biscuit dough consistency and farinogram bandwidth was recorded at 0 min mixing.

2.3.2. Research water absorption meter studies

Studies on the biscuit dough consistency using a Henry Simon RWAM was carried out according to Chandra Shekara, Haridas Rao, and Shurpalekar (1985) with slight modifications. Forty-five grams of biscuit dough was cut into small pieces and packed gently into the dough holder of the instrument. The dough holder was later fixed to the RWAM and a pressure of 2.4 kg was applied to the dough. The time taken by the RWAM to move a distance of 1 cm was recorded in seconds.

2.3.3. Texture analysis of biscuit dough

The texture properties of the biscuit dough were measured in an 'Instron' Universal Testing machine (Model 4301) using an aluminum plunger with 6.0 cm diameter. The load cell used was 50 kg and the crosshead speed was 10 mm / min with a clearance of 1.5 cm. Biscuit dough was sheeted to a thickness of 1 cm and cut to 4 cm diameter and was used for texture measurement. The texture profile