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Studies on cake quality made of wheat–chickpea flour blends

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Abstract

Legume flours, due to their amino acid composition and fibre content are ideal ingredients for improving the nutritional value of bread and bakery products. In this study, the influence of the total or partial replacement of wheat flour by chickpea flour on the quality characteristics of two kinds of cake was analyzed. The effects of the chickpea variety and the kind of flour used (white or whole) were also considered. Volume, symmetry, chroma, and crust and crumb L^* diminished when increasing the amount of chickpea flour. The replacement of wheat flour by chickpea flour also induced an increase in the initial firmness but cohesiveness and resilience diminished, increasing the tendency to hardening. Among the studied varieties, Pedrosillano and Sinaloa produced cakes with the highest volume. Those varieties also gave layer cakes with the lowest firmness, gumminess and chewiness. White flours produced sponge cakes with higher volume and symmetry than whole flours. No significant differences, however, were observed in layer cakes between white and whole flours. In both layer and sponge cakes, white flour produced cakes with lower firmness, gumminess and chewiness than whole flours.

Keywords: Composite flours; Chickpea; Cake quality; Texture properties; Staling

1. Introduction

Pulses have been at the heart of many traditional cuisines for thousands of years. Legumes have been known as "a poor man's meat". They supply protein, complex carbohydrates, fibre and essential vitamins and minerals to the diet, which are low in fat and sodium and contain no cholesterol. Legumes have been identified as low glycaemic index foods (Bornet, Billaux, & Messing, 1997). Selecting foods of low glycaemic index is very important in the dietary treatment of diabetes mellitus, increases satiety, facilitates the control of food intake and has other health benefits for healthy subjects in terms of post-prandial glucose and lipid metabolism (Rizkalla, Bellisle, & Slama, 2002). Regular consumption of pulses may have important protective effects on risk for cardiovascular disease (Anderson & Major, 2002). Moreover, pulses contain a rich variety of compounds, which, if consumed in sufficient quantities, may help to reduce tumour risk (Mathers, 2002). In fact, most health organizations encourage their frequent consumption (Leterme, 2002). These nutritional benefits are related to the reduced digestibility of legume starch and dietary fibre content of legumes, mainly located in their husk fractions. The low digestibility of legume starch has been attributed to its amylose, which is considerably branched and of high molecular weight (Tharanathan & Mahadevamma, 2003).

In the last decades, attitudes and perceptions towards legumes have been changing, bringing about a revival of interest on the part of consumers (Morrow, 1991). The annual per capita consumption of pulses in 1999 was 5.9 kg worldwide,

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and 2.8 kg in Europe. These consumption figures rose by 10% from 1989 to 1999 but they could increase even further if the food industry and professional organizations take up the challenge to incorporate grain legumes in novel, convenient and healthy food products (Schneider, 2002). The addition of legume to cereal-based products could be a good alternative for increasing the intake of legumes. In addition, legume proteins are rich in lysine and deficient in sulphur containing amino acids, whereas cereal proteins are deficient in lysine, but have adequate amounts of sulphur amino acids (Eggum & Beame, 1983). Therefore, the combination of grain with legume proteins would provide better overall essential amino acid balance, helping to combat the world protein calorie malnutrition problem (Livingstone, Feng, & Malleshi, 1993).

Several studies about the influence of the addition of legume flours on the functional properties of bread dough and final bread quality have been reported in the last 30 years. Among the legumes tested, it is worth mentioning the addition of chickpea flour (Dodok, Ali, Hozová, Halasová, & Polacek, 1993; Iyer & Singh, 1997; Singh, Harinder, Sekhon, & Kaur, 1991), germinated chickpea flour (Fernandez & Berry, 1989), germinated pea flour (Sadowska, Blaszczak, Fornal, Vidal-Valverde, & Frias, 2003), lupin flour (Campos & El-Dash, 1978; Dervas, Doxastakisk, Hadjisavva-Zinoviadi, & Triantafillakos, 1999; Doxastakis, Zafiriadis, Irakli, & Tananaki, 2002; Lucisano & Pompei, 1981; Pollard, Stoddard, Popineau, Wrigley, & MacRitchie, 2002), fermented lentil flour (Sadowska, Fornal, Vidal-Valverde, & Frias, 1999), lentil and bean flours (Finney, Morad, & Hubbard, 1980; Lorimer, Zabik, Harte, Stachiw, & Uebersax, 1991; Morad, Leung, Hsu, & Finney, 1980; Shehata, Darwish, El-Nahry, & Andel-Razek, 1988) to wheat flour for obtaining bread. However, despite the good results obtained with bread, those studies have not been extended to other cereal baked products.

The aim of this study was to determine the effect of the partial or complete replacement of wheat flour by chickpea flour on the quality of cakes. The effects of the chickpea variety and the kind of flour (white or whole) used were also tested.

2. Materials and methods

2.1. Materials

Cake flour (9.8% protein) was supplied by *Harinera Castellana* S.A., Medina del Campo (Spain); sucrose, sunflower oil, milk, fresh whole eggs, emulsifier and double-action baking powder were purchased from the local market.

Chickpeas (Andaluz, Pedrosillano, Lechoso and Sinaloa varieties) were supplied by Alimentos Naturales S.A., León (Spain) and milled in a stone mill in Harinera Los Pisones, Zamora (Spain). After milling, the flour with particle size lower than 210 μm was referred as white chickpea flour; and the coarse fraction was ground again in a laboratory mill (3100, Perten Instruments, Sweden). The flour from the second milling was blended with the white chickpea flour in order to obtain the whole chickpea flour.

2.2. Proximate analysis of flours

Wheat and chickpea flours were analyzed following the AACC (2000) methods for moisture (method 44-15A), crude protein (method 46-13), crude fat (method 30-25), crude fiber (method 32-10) and ash (method 08-01).

2.3. Pasting properties of flours

The Rapid ViscoTM Analyser (RVA) (Newport Scientific Pty Ltd., Australia) was used to determine the pasting properties of the chickpea flours. Pasting properties were determined following the standard Newport Scientific Method 1 (STD1). The heating cycle was 50–95 °C in 282 s, holding at 95 °C for 150 s and then cooling to 50 °C. Each cycle was initiated by a 10-s mixing at 960 rpm paddle speed, and 160 rpm paddle speed was used for the rest of the test. The RVA studies were carried out using 3.0 g of sample and 25 ml water in an aluminium canister. The parameters recorded were peak viscosity (PV), trough or hot paste viscosity (HPV), final or cool paste viscosity (CPV), breakdown (PV–HPV), and setback (CPV–HPV). Flour samples were run in triplicate.

2.4. Cake preparation

Two kinds of cakes were elaborated: a layer cake, and a sponge cake. The recipes used are described in Table 1. In layer cake elaboration, a single-bowl mixing procedure was used. All ingredients were mixed during 10 min at speed 6 using a Kitchen–Aid Professional mixer (KPM5). Two hundred grams of cake batter were placed into 120 mm diameter and 45 mm height, metallic, lard coated pan, and were baked in an electric oven for 25 min at 200 °C.

In the sponge cake making, a creaming mixing procedure was used. All ingredients, except for the flour and milk, were mixed for 2 min at speed 6 using a Kitchen–Aid Professional mixer (KPM5). After the addition of the milk and the flour, the mixing process continued for 3 min at speed 8.150 g of cake batter were placed into pans and baked as described above.

Wheat flour was substituted by chickpea flour, based on the following experimental design with 17 formulations: control (wheat flour), chickpea flour substitution (50; 100%), chickpea varieties (4), and chickpea flour types (white; whole).

Table 1
Cake formulations

Ingredients	Layer cake		Sponge cake	
	(g)	(%)	(g)	(%)
Flour	700	27.5	490	26.5
Egg	350	13.8	688	37.3
Sugar	840	33	481	26
Powder milk	42	1.6	50	2.7
Water	378	14.9	110	6
Oil	210	8.4	–	–
Emulsifier	–	–	28	1.5
Baking powder	21	0.8	–	–