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Effect of Psyllium fibre content on the textural and rheological characteristics of biscuit and biscuit dough

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ABSTRACT

It is well supported that a significant intake of dietary fibre reduces the risk of several chronic diseases. The development of staple foods enriched with fibre is an important contribution to a broader supply of food products with health beneficial effect. In this sense, the objective of this work is the development of biscuits enriched with Psyllium fibre.

The maximum level of Psyllium incorporation was studied. The effect of this fibre and wheat flour content on rheological behaviour and texture of the dough, and respective biscuits' texture and colour were evaluated. Psyllium incorporation was tested from 3% to 15% (w/w), and the maximum fibre incorporated in this product was 9% (w/w), due to the high water holding capacity of Psyllium (17 g/g at 25 °C) and the mechanical characteristics of dough. For higher levels of fibre incorporation the dough fails to be moulding (the idea is malleable).

1. Introduction

Regular consumption of fibre is an important factor to prevent many types of diseases and is associated with a standard balanced diet (Rosell, Santos, & Collar, 2009). The beneficial role of the dietary fibre (DF) in health and nutrition is associated with the reduction in chronic illnesses as cardiovascular disease, certain types of cancer and constipation (Lairon et al., 2005; Schaafsma, 2004). The insoluble fraction of fibres (IDF) has been related to the intestinal regulation, whereas soluble fibres (SDF) are associated to the decrease in cholesterol levels and the absorption of intestinal glucose (Rodríguez, Jiménez, Fernández-Bolaños, Guillén, & Heredia, 2006).

Psyllium is obtained from the seeds of the plant genus *Plantago*, the latter has more than 200 species. India dominates the world market, being responsible for the production of about 39,000 t of Psyllium seed each year. This represents 85% of the world market. Psyllium husk is the main product separated from the seed and the rest is usually used as animal feed. From the seed coat of Psyllium a mucilage is obtained, by mechanical milling. It is a white fibrous hydrophilic material and forms a clear colourless mucilaginous gel. Psyllium, prepared from the seed husk of *Plantago* genus contains about 80% soluble fibre and is an excellent dietary source of both soluble and insoluble fractions (Bijkerk, Muris, Knottnerus, Hoes, & de Wit, 2004). Its average composition is 23% arabinose, 75% xylose (molar basis) and traces of

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other sugars. With about 35% of non-reducing terminal residues, the polysaccharide is highly branched acidic arabinoxylan containing both (1→4) and β-(1→3) glycosidic linkages in the xylan backbone (Fischer et al., 2004). Dietary fibre Psyllium has been reported as a medicinally active gel forming natural polysaccharide, successfully used for the treatment of high cholesterol, diabetes, obesity in children, remediation of constipation, diarrhoea, inflammation bowel diseases and ulcerative colitis (Singh, 2007).

The Psyllium consumption is very popular in India, and is now widespread in the USA, mainly since the FDA approved a health claim posting that Psyllium soluble fibre is associated with the reduced risk coronary heart disease (FDA, 2012). The demand in Europe has increased in recent years. However, the intake of Psyllium in developed countries results essentially from capsules and other dietary preparations. The consumption of Psyllium as a medicine has a limiting target, and its real contribution for the general population could be amplified by the incorporation of Psyllium on common staple foods – emulsions, foams, gels, pasta and biscuits. The incorporation of Psyllium in these food products as a bioactive ingredient, can contribute to increase the commercial offer of food products enriched in special fibres, with direct benefits on health.

Psyllium husks have technological limitations, since they originate products with a high viscosity, resulting from its extremely strong water uptake and gelling capacities – each gram of Psyllium retains about 10 g of water (Kristensen & Jensen, 2011). The incorporation of Psyllium in food formula, at the levels required for health claim on the label can be great challenge (Cheng, Blackford, Wang, & Yu, 2009). Therefore, this limitation reduces the incorporation levels of Psyllium and consequently the effectiveness of the final product as a healthy promoting agent. Many physical, chemical, mechanical and enzymatic approaches have been tried to overcome this major drawback on the manufacture of the food products (Yu, Perret, Parker, & Allen, 2003 and Cheng et al., 2009). The hydrolysis of the polysaccharides, in order to decrease the water uptake may form other ingredients and intermediates with a different impact on health (Yu et al., 2003). There are USA patents about the use of Psyllium in pasta, cakes and biscuits (Bedard, Lai, Wullschleger, & Kincaid, 1995), but a pretreatment of Psyllium is applied.

Biscuits are one of the most popularly consumed bakery products widely consumed around the world, mainly resulting from their ready to eat nature, affordable cost, good nutritional quality, availability in different tastes and longer shelf life (Gandhi et al., 2001; Ajila, Leelavathi, & Rao, 2008). Several reports are available on the use of oat, wheat and rice bran as a source of dietary fibre content in bread and other bakery products (Laurikainen, Harkonen, Autio, & Poutanen, 1998; Saunders, 1990; Sidhu, Al-Hooti, & Al-Saqer, 1999; Sudha, Vetrimani, & Leelavathi, 2007).

The incorporation of solid components on the biscuit dough has serious implications on their structure and therefore there are technological limitations for the total fibre content. This limitation was previously studied for the same type of traditional biscuits used in this work, by the incorporation of vegetable fibre from different sources by Piteira, Maia, Raymundo, and Sousa (2006) and for the incorporation of *Chlorella vulgaris* biomass (Gouveia, Batista, Miranda, Empis, & Raymundo, 2007) and *Isochrysis galbana* microalgae biomass (Gouveia et al., 2008).

The present study intends to test the levels of Psyllium incorporation in the production of biscuits with no previous treatment, using whole commercial Psyllium. To attain this purpose it was carried out the rheological and textural characterisation of dough and the textural monitoring of biscuits.

2. Materials and methods

2.1. *Ingredients*

Psyllium fibre (Solgar, USA) was purchased in local market, such as wheat flour (T65), sugar, margarine, baking powder and distilled water.

Psyllium was ground and the fraction with particle size between 0.5 and 1 mm was used for all formulations.

2.2. *Biscuits preparation*

The biscuits were prepared according to a previous optimised formulation (Piteira et al., 2006), using flour (from 39% to 54%, depending on the Psyllium content), 15% sugar, 14% margarine, 16% water, 1% of baking powder and Pyllium fibre (from 3% to 15%) – all composition in a weight/weight base.

Dough was manually mixed for 5 min, sheeted with a rolling pin to a thickness of 4 mm. Then the dough was shaped and cut with a 60 mm diameter wire-cut and baked in an electrical air oven (Garbin – 23 MX-UMI, Italy), at 180±10 °C during 21 min. After cooling, biscuits were kept inside plastic bags, in sealed glass jars, at room temperature and protected from light until testing.

2.3. *Physicochemical characterisation of Psyllium and biscuits*

Dimensions of the biscuits (diameter – *D* and thickness – *T*) were evaluated using a caliper on a set of 4 biscuits for each recipe. Spread ratio (SR) was estimated by calculating the ratio *D*/*T* values.

Before the following chemical determinations, biscuits were crushed to homogenise samples.

Psyllium and biscuits were analysed for their moisture according to AOAC935.29 (1998) and ash (NP518, 1986), based on gravimetric methods. Total lipid analysis was carried out according to NP4168 (1991) and protein content was determined according the Kjeldahl, following ISO20483 (2006), using nitrogen conversion factors 6.24 for Psyllium and 5.70 for biscuits (Guo, Cui, Wang, & Young, 2008). Carbohydrate content was determined by difference to 100% of main constituents (moisture, ash, protein and fat).

Soluble, insoluble and total dietary fibre contents of Psyllium were evaluated according to AOAC 991.43 (1998) with the modifications specific for Psyllium fibre suggested by Lee, Rodriguez, and Storey (1995).