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Wheat bread enrichment by pea and broad bean pods fibers: Effect on dough rheology and bread quality

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ABSTRACT

Pea and broad bean pods fibers were extracted and incorporated with different levels into dough and breads made from wheat white flour. Incorporation of those two kinds of fibers at 1 g/100 g into low bread-making quality flour leads to the increase of the dough strength to 18.8 mJ and 20.8 mJ for the fiber from pea pods and broad bean pods, respectively. Also, the curve configuration ratio was increased from 0.73 for the control to 1.13 and 1.42 for the fiber from pea pods and broad bean pods, respectively. Bread evaluation revealed that the addition of fibers from pea pods and broad bean pods improved considerably the texture profile of bread. In fact, there is a clear decrease in hardness (15.24 N for the control and 13.83 N and 12.75 N for breads enriched with fibers from pea pods and broad bean pods, respectively) with a slight perfection in adhesion and cohesion. In conclusion, fibers from pea pods and broad bean pods could be recommended as improver in the bread making industry.

1. Introduction

Dietary fiber (DF) is considered as one of the food ingredients with an important contribution to health. Dietary fiber is the edible portion of plants (or analogous carbohydrates) that are resistant to the digestion and the adsorption in the human small intestine with complete or partial fermentation in the large intestine (AACC, 1982; Lattimer & Haub, 2010). The main components of DF are cellulose and lignin, but also the hemicelluloses, pectins, gums and other carbohydrates (Stear, 1990). Dietary fiber is classified into two categories according to their water solubility, soluble dietary fiber (SDF) and insoluble dietary fiber (IDF). SDF such as β-glucan and arabinoxylan can form viscous solutions, resulting in increased viscosity in the intestine slowing intestinal transit, delays gastric emptying and slows glucose and sterol absorption by the intestine (Andersson & Chen, 1986; Wood et al., 1994). Consequently, viscous soluble fiber can lower serum cholesterol, postprandial blood glucose, and insulin levels (Wood, 1991, 2007; Wood, Braaten, Fraser, Riedel, & Poste, 1990). IDF such as lignin, cellulose and hemicelluloses usually have high water-holding capacity which contributes to increased fecal bulk.

Dietary fiber is currently considered as a critical ingredient in food products such as baked goods, beverages, meat, confectionery, dairy and pasta. Most frequently, DF are incorporated into bakery products to prolong freshness due to their capacity to retain water. Many forms of DF have been used in bread making and other cereal based products. In fact, Fibers can modify bread loaf volume, its springiness, the softness of the bread crumb and the firmness of the loaf (Sangnark & Noomhorm, 2004). Addition of some soluble DF at a low level strengthened the structure of dough and improved the quality of bread (Sivam, Sun-Waterhouse, Waterhouse, Quek, & Perera, 2011), but excess amounts of insoluble DF had an adverse effect on the formation of gluten network (Ahmed, Almusallam, Al-Salman, AbdulRahman, & Al-Salem, 2013; Wang et al., 2003) and reduced the quality of bread due to gluten dilution effect or gluten–fiber interaction (Kaack, Pedersen, Laerke, & Meyer, 2006; Noort, van Haaster, Hemery, Schols, & Hamer, 2010). For example, the addition of apple pomace (Sudha, Baskaran, & Leelavathi, 2007a) and insoluble wheat fiber (Bonnand-Ducasse, Della Valle, Lefebvre, & Saulnier, 2010) resulted in stiffer dough, probably

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through a filler-like effect in the dough matrix. Also, potato fiber which containing a high level of insoluble DF led to the increases in hardness and gumminess of bread (Kaack et al., 2006). Compared with control bread, steamed bread enriched with 10 and 20% wheat bran had similar sensory quality (Wu, Chang, Shiau, & Chen, 2012).

To the best of our knowledge, there are no reports on the use of fibers extracted from pea pod and broad bean as a source of DF in bread making. The aim of the present research was to extract fibers from pea and broad bean pods and to investigate their effects and their allowances on the bread-making quality of wheat flour. The quality of baked products has been studied by Alveograph parameters, textural and sensory analysis.

2. Materials and methods

2.1. Materials

In this study, commercial blend of wheat flour (13.6 g/100 g moisture, 0.71 g/100 g ash, 9.95 g/100 g protein, P/L = 0.73 and W = 188) was provided from the Tunisian Company for Food Production (STPA). Seedless pea and broad bean pods were obtained as by-products from kitchen wastes. The flour from these two by-products was first washed in tap water then in distilled water to remove the adhered surface dust particles. It was finally dried at 45 °C and ground in a mixer grinder (Moulinex, France) (Chaari et al., 2012).

2.2. Fiber extraction and preservation

Fibers were extracted from PP and BBP as described by Borchani et al., 2010. In fact, the extraction was realized from pod flours previously maintained in hot water at 70 °C (100 g/600 mL) for 15 min. Then the mixture was filtrated using a thin cloth of 0.3 mm of pore size in order to discard the insoluble residue. Fiber extracts were dried at 100 °C and preserved at 4 °C.

2.3. Proximate composition analysis of fibers from pea and broad bean pods

Dry matter was determined according to the Association of Official Analytical Chemists (AOAC, 1997) method. Total nitrogen content was analyzed by the Kjeldahl procedure (AOAC, 1995). Fat content was determined according to French Association of Standardization using standard NF V03-713 (AFNOR, 1986). Ash content was determined by incineration at 550 °C in a muffle furnace. Dietary fiber was determined according to the AOAC method (AOAC, 1995). Holocellulose, cellulose, hemicelluloses and lignin content were also determined according the standard TAPPI method (T257 om-09 and T222 om-11).

2.4. Functional properties of the fiber from pea and broad bean pods

Water activity (aw) was measured at 25 °C using a NOVASINA aw Sprint TH-500 apparatus (Novasina, pfäffikon, Switzerland). Water retention capacity (WRC) and Oil retention capacity (ORC) was studied according to the method described by Robertson et al. (2000).

2.5. Dough characteristics

2.5.1. Alveograph testing

The viscoelastic behavior of the dough was studied by the alveograph test, using an Alveograph MA 87 (Chopin, Villeneuve La Garenne, France), following the standard method (AACC, 2000). The following alveograph parameters were automatically recorded by a computer software program: tenacity (P), dough extensibility (L), curve configuration ratio (P/L ratio) and the deformation energy (W). Commercial Tunisian soft wheat flour characterized by a low bread-making quality was used as basis for fiber addition from PP and BBP at concentrations of 0, 0.25, 0.5, 0.75 and 1 g/100 g of flour.

2.5.2. Preparation of dough samples and texture profile analysis of dough

Dough was prepared using the following ingredients (percentages on a flour weight): 50 g flour and 60 g/100 g water without yeast. The extracted fiber from PP and BBP powder was added to the bread formula at different concentrations. The dough was prepared by manually mixing the flour and water for approximately 10 min until a homogeneous dough was achieved. Assays were performed in triplicate. Texture analysis was performed using a texture analyser (TA Instrument Lloyd. Fareham. UK). Experiments were conducted on fresh dough of 20 mm thickness from the center of the dough using a 19 mm circular probe and leading a vertical compression of 50% followed by relaxing at a speed of 10 mm/s. The texture profile analysis values reported are the averages of three different determinations.

2.6. Bread-making procedure

Breads were prepared from blends containing different levels (0.25–1g/100 g of flour) of fiber from pea and broad bean pods.

2.6.1. Bread preparation

For the preparation of bread, we used the following formula: 100 g of flour, 2 g/100 g baking powder, 1 g/100 g salt and 60 g/100 g water. The fibers were added at the desired levels. After mixing, the breads are fermented at room temperature for 1 h 30 min and then baked for 20 min at 230° C. Breads were cooled at room temperature (Mnif, Besbes, Ellouze, Ellouze-Chaabouni, & Ghribi, 2012).

2.6.2. Physical characteristics of bread

Volume of breads was measured using rapeseed displacement method (Ayadi, Abdelmaksoud, Ennouri, & Attia, 2009). Weight of the breads was measured and density was calculated by the method described by Ayadi et al. (2009).

2.6.3. Textural properties of bread

Texture analysis test was performed using a Texture Analyser (Texture Analyser: LLOYD instruments, England) equipped with a load cell. Results were determined by the method described by Ayadi et al. (2009).

2.6.4. Crust and crumb color of bread

Crust and crumb colors were measured using a colorimeter (model DP- 410 with chroma meter model CR- 410, Konica Minolta Sensing, Inc., Osaka, Japan) by the method described by Ayadi et al. (2009).

2.6.5. Sensory analysis

The organoleptic characteristics of breads were carried out by 40 panelists who were asked to evaluate the products for crust color, crumb color, flavour, taste, tenderness and overall quality using five point hedonic scale (Sudha, Vetrimani, & Leelavathi. 2007b).

2.7. Statistical analysis

All analytical determinations were curried in triplicate. Values of each parameter are expressed as the mean ± standard deviation (x ± SD). Duncan's multiple range tests provided mean