Food Bioscience 7 (2014) 11–18

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/fbio

Processing, characterization and bread-making potential of malted yellow peas

*Martin Mondor, Evelyne Guévremont, Sébastien Villeneuve**

Agriculture and Agri-Food Canada, Food Research and Development Centre, 3600 Casavant Blvd West, Saint-Hyacinthe, QC, Canada J2S 8E3

ARTICLE INFO

Article history:
Received 23 October 2013
Received in revised form
17 March 2014
Accepted 1 May 2014

Keywords:
Yellow peas
Germination
Malting
Dough mixing properties
Bread

ABSTRACT

Over the last few years, none of the studies aiming the fortification of wheat breads with germinated legume flours have been conducted according to the best practices in malting (e.g. steeping, germination and drying). The impact of supplementing breads at a 10% level with non-malted and malted yellow pea flour was studied. Microbiological monitoring was performed throughout the malting process. Fine flours were processed and characterized for their fineness, protein content and ash content. Dough mixing properties were determined prior to bread preparation. Results showed that malting process slightly increased the protein content and changed the microbiological profile of yellow peas; the highest density in population was achieved by psychrophilic bacteria and the occurrence of *Enterobacteriaceae* considerably increased. Dough mixing properties of yellow pea flours were barely affected by the malting process leading to a promising bread-making potential when compared to un-substituted flour.

1. Introduction

Over the last few years, many studies aiming the fortification of wheat breads with ingredients like legume flours were carried out. Fortification of breads can lead to the production of nutritionally enhanced products like bread with high protein content. Many studies have been made on the supplementation of wheat flour with legume-based ingredients like lupin flour (Campos & El-Dash, 1978; Dervas, Doxastakis, Hadjisavva-Zinoviadi, & Triantafillakos, 1999; Doxastakis, Zafiriadis, Irakli, Marlani, & Tananaki, 2002; Pollard, Stoddard, Popineau, Wrigley, & MacRitchie, 2002; Paraskevopoulou, Provatidou, Tsotsiou, & Kiosseoglou, 2010), pea flour (Morad, Leung, Hsu, & Finney, 1980; Sadowska, Blaszczak, Fornal, Vidal-Valverde, & Frias, 2003; Hsu, Leung, Finney, & Morad, 1980), navy bean flour (Lorimer, Zabik, Harte, Stachiw, & Uebersax, 1991), chickpea flour (Mohammed, Ahmed, & Senge, 2012) and soy protein flour or protein fractions (López-Guel et al., 2012; Dhingra & Jood, 2004; Mohamed, Rayas-Duarte, Shogren, & Sessa, 2006) to produce enriched bread. Fortification with legume-based flours allows to improve bread protein content and to compensate wheat deficiencies in lysine and threonine, two essential amino acids (Pollard et al., 2002; Kies & Fox, 1970; Abdel-Aal & Hucl, 2002). It also improves the moisture retention and firming rate of bread (Patel, Chand, & Venkateswara Rao, 1996).

The impact of supplementation is dependent on the legume processing i.e. fermentation (Sadowska, Fornal, Vidal-Valverde, & Frias, 1999, Hallén, Ibanoglu, & Ainsworth,

*Corresponding author. Tel.: +1 450 768 3335; fax: +1 450 773 8461.
E-mail address: sebastien.villeneuve@agr.gc.ca (S. Villeneuve).

http://dx.doi.org/10.1016/j.fbio.2014.05.002
2212-4292/

2004), germination (Morad et al., 1980; Sadowska et al., 2003; Hsu et al., 1980; López-Guel et al., 2012; Hallén et al., 2004; Fernandez & Berry, 1989; Frias, Fornal, Ring, & Vidal-Valverde, 1998) or roasting (Patel & Venkatesvara Rao, 1995; Silaula, Lorimer, Zabik, & Uebersaxma, 1989)), on the legume from which origins the flour and on the level of substitution. However, substitution of wheat flour with legume-based ingredients at a 10% level or more is generally harmful to the processing of bread. It can lead to reduced dough stability (Sadowska et al., 2003), decreases in loaf volume (Pollard et al., 2002) and increase in crumb hardness (Paraskevopoulou et al., 2010). The effects of addition of germinated grain flour to wheat flour on the dough mixing properties and structure of breads was only considered in a few studies (Morad et al., 1980; Sadowska et al., 2003; Hsu et al., 1980; López-Guel et al., 2012; Hallén et al., 2004; Fernandez & Berry, 1989; Frias et al., 1998). For yellow pea flours, it is generally reported that the water absorption is slightly higher for dough supplemented with non-germinated pea flour than with germinated pea flour, while the inverse is observed for the stability time (Sadowska et al., 2003). However, the impact of the type of flour (germinated vs non-germinated) on the development time is less clear (Sadowska et al., 2003). In terms of bread specific volume, in general, breads supplemented with germinated yellow pea flour have a lower specific volume than their counterparts supplemented with non-germinated flour (Morad et al., 1980; Sadowska et al., 2003; Hsu et al., 1980).

The aforementioned studies helped to improve our understanding of the impact of germination process on the dough mixing properties and on the bread specific volume, when wheat flour is substituted at different levels with germinated yellow pea flours. However, from a processing point of view, none of those studies have been conducted according to the best practices in grain malting. The malting process can be divided into three operations: steeping (the soaking of grain in water), germination and drying. For all aforementioned studies, steeping operations were conducted without aeration or using an air-rest approach in order to provide oxygen to peas. In addition, freeze drying has been used to stop modification in germinating peas, probably to preserve enzyme activity. However, in industrial applications, it is more likely that mid-high temperature drying conditions (80–100 °C) such as with fluidized bed dryer would be used to dry the grains and inactivate the enzymes present in the peas. Besides malting processing conditions, when microbiological growth has been addressed (Hsu et al., 1980), no detailed descriptions of microflora development during the malting process have been reported.

Thus the objective of this work was to study the impact of supplementing breads at a 10% level with pea flour produced from non-malted yellow peas, yellow pea flour produced from malted peas dried at room temperature, and yellow pea flour produced from malted peas dried in a fluidized bed at 80 °C to inactivate the enzymes. Effect of enrichment was studied on dough mixing properties and on the breads specific volume. Peas steeping operations were conducted with aeration using an air-rest approach in order to provide oxygen to peas and microbial growth during the malting process has also been characterized by performing total counts for aerobic mesophilic and psychrophilic bacteria, sporeforming (aerobic and anaerobic) bacteria, yeast and mold, *Enterobacteriaceae*, and lactic bacteria.

2. Materials and methods

2.1. *Raw materials*

Standard bread flour (Robin Hood KEYNOTE 80 Bleached Enriched Flour; Horizon Milling, Montreal, Quebec, Canada) was used. Both non-malted and malted pea flours were produced from certified #1 Eclipse Yellow peas purchased from Wagon Wheel Seed Corporation (Churchbridge, SK, Canada).

2.2. *Malting process*

Steeping and germination were conducted in an automated laboratory-scale system (Fig. 1), consisting of a peristaltic pump with flow control (MasterFlex Model LS 7550-10, Cole-Parmer Canada Inc., Montreal, QC, Canada) used to supply water (MasterFlex silicone tubing platinum L/S-18, Cole-Parmer Canada Inc., QC, Canada) to the system, along with a 28L thermostatically controlled water bath (Model 1187P, VWR Scientific Products, Radnor, PA, USA), connected to a double-bottom bin placed inside a temperature-controlled incubator (Isotemp incubator Model 146E, Fisher Scientific, Pittsburgh, PA, USA). A 3500 $cm^3\ min^{-1}$ air pump controlled with an electronic timer (Model TH-868C, UnberHaus, Rona inc., Boucherville, QC, Canada) was also connected to the bin to aerate the peas during the steeping step. Before starting the malting process, the water temperature was set to 15 °C and 2 kg of yellow peas were placed in the bin, which was then placed in the incubator at 15 °C (temperature selected for the malting process). Two tubes were placed in the bin: one used to fill the bin with water at a flow rate of 1 L min^{-1} for 10 min; and the other to permit respiration of the peas.

Yellow peas were soaked using a typical schedule for barley malting: (soak-air rest-soak-air rest-soak). They underwent an initial soaking at 15 °C for 5 h, after which the water was removed and the peas were allowed to breathe for 2 h. A second soaking took place at 15 °C for 16 h, after which the water was removed and the peas were allowed to breathe for 2 h. After a final soaking at 15 °C for 2 h, the water was removed and the peas were left to stand at 15 °C for 96 h to allow germination. The germinated peas were then dried for at least 96 h at room temperature (22 °C) in a four-tray dryer (Model 52979; National Drying Machinery Co., Philadelphia, PA). After drying, the brittle acrospires of peas were removed by sieving. In addition, 500 g of malted peas were further processed in a fluidized bed dryer (Sherwood Scientific Ltd, Cambridge, UK) at 80 °C for 15 min in order to inactivate enzymes such as amylases that may still be active after the malting process. Malting process was performed in duplicate.

2.3. *Germination count*

The germination count is a standard method used in the industry (ASBC method Malt-2F, 1992) for evaluating the