Journal of Cereal Science 56 (2012) 147–152

Contents lists available at SciVerse ScienceDirect

Journal of Cereal Science

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

Effect of parboiling on physical and chemical characteristics and non-enzymatic browning of emmer (*Triticum dicoccon* Schrank)

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ARTICLE INFO

Article history:
Received 13 June 2011
Received in revised form
26 April 2012
Accepted 15 May 2012

Keywords:
Parboiling
T. dicoccon Schrank
Maillard reaction
Physical and chemical characteristics

ABSTRACT

Parboiling is a popular technology applied to rice to increase its milling yield, nutritional value and resistance to spoilage by insects and mould. This process was applied to *Triticum dicoccon* Schrank to induce physical, chemical and organoleptic modifications in order to increase its use and product diversification.

Hulled and dehulled emmer samples, subjected to different parboiling conditions, were characterized by analyzing the physical and chemical modifications and the non enzymatic browning.

The results showed that although parboiled grains were darker than the untreated reference sample, due to the development of non-enzymatic browning and the diffusion of the pigments contained in the husk and bran, during hydrothermal treatment glumes have a protective action on the caryopsis integrity and against thermal damage.

1. Introduction

Hulled wheat (emmer, *Triticum dicoccon* Schrank) denotes any of the wild or cultivated *Triticum* populations that retain the hull during threshing. Their kernels are covered by tough paleas and spikelet glumes, thus the threshing product is spikelets, and not grains. Emmer predominantly has awn and spikelets consisting of two well-developed kernels and the emmer glumes, which are long and narrow with sharp beaks (Marconi and Cubadda, 2005).

The increasing popularity of hulled wheats (spelt, emmer and einkorn) as environmentally friendly cereal crops for production of niche cereal-based products is stimulating research into their utilization in both traditional and new foods such as pasta, breakfast cereals and extruded products. Parboiled cereals and pseudocereals may also be attractive to consumers as an innovative and nutritious food (Abdel Aal and Hucl, 2005; Cubadda and Marconi, 2001; Fregeau Reid and Abdel Aal, 2005; Hidalgo et al., 2008; Rooney and Awika, 2005; Singh and Dodda, 1979).

Parboiling treatments are generally applied to rice (*Oryza sativa* L.), paddy or brown rice to increase its milling yield, nutritional value and resistance to spoilage by insects and mould (Elbert et al., 2001). During the process, physical and chemical changes in the kernel take place such as reduction of rice stickiness, increase in hardness and starch gelatinization.

The higher nutritional value of parboiled rice compared to non-parboiled rice is due to the migration of bran components (vitamins, minerals) into the endosperm during hydrothermal treatment (Bhattacharya, 2004; Lamberts et al., 2006a), and has prompted researchers to apply a parboiling process to other cereals and pseudocereals (sorghum, millet, oat, barley, buckwheat, wheat, einkorn) (Bayram et al., 2004; Hidalgo et al., 2008; Koksel et al., 1999; Mohapatra and Rao, 2005; Serna-Saldivar et al., 1994; Skrabanja et al., 1998; Young et al., 1990, 1993) to investigate the possibility to obtain rice-like products with nutritional, economic and sensory advantages comparable to those obtained with rice.

This study reports on the possibility to subject hulled wheat to a parboiling process that is traditionally applied to raw rice, as emmer and rice are both hulled cereals. The characterization of emmer during parboiling was carried out by analyzing the chemical-physical composition and specific processing markers of intensity of heat treatments.

2. Materials and methods

2.1. Samples

Hulled and dehulled emmer grains of *T. dicoccon* Schrank (Dicocco Molise, Colli selection) were used for parboiling trials.

Abbreviations: HI, Hardness index; NP, Not Pearled; P, Pearled.

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http://dx.doi.org/10.1016/j.jcs.2012.05.006

2.2. Parboiling tests

The emmer parboiling process was carried out using the model LABPAR (Colombini & Co. srl, Abbiategrasso, Milano, Italy) parboiling pilot plant.

3 kg of hulled and dehulled emmer grains were parboiled following different conditions as reported in Fig. 1.

The first type of parboiled emmer (Fig. 1, scheme 1) was obtained by treating hulled emmer in water at 50 °C for 6 h to favour imbibition; the steeped cereal was treated with steam under pressure (1.5 kg/cm^2) for 20 min and then dried using a vacuum at 50 °C until 12% of the moisture content remained in the grain.

A second type of parboiled emmer was produced by steeping hulled emmer at 50 °C for 6 h (Fig. 1, scheme 2).

At the end of the process, the cereal was subjected to a pre-cooking treatment of 10 min in water at high hydrostatic pressure (1.5 kg/cm^2). The successive steam treatment was carried out using steam under pressure (1.5 kg/cm^2) for 15 min, and then dried under vacuum at 50 °C until the moisture content was reduced to 12%.

Parboiled grains (Fig. 1, schemes 1 and 2) were successively dehulled and then pearled to remove the same amount of outer layers (15%).

A third type of parboiled emmer (Fig. 1, scheme 3) was obtained treating dehulled grains. Emmer was steeped in water at 50 °C for 4 h; it was then treated with steam under pressure (1.5 kg/cm^2) for 20 min followed by drying as for the above samples. At the end of the process, parboiled dehulled emmer was pearled removing 15% of by-product.

The dehulling of different hulled samples (before or after steaming) was carried out by a G.390/R dehuller (Colombini & Co. srl, Abbiategrasso, Milano, Italy).

Successively, 100 g of each parboiled dehulled sample were pearled with G.150/R rice whitening machine (Colombini & Co. srl, Abbiategrasso, Milano, Italy) to obtain pearled products.

2.3. Kernel texture (hardness index)

The emmer kernel texture (degree of hardness or softness) was determined according to AACC method 55-31 (AACC, 2000) by instrumental measurement of the force required to crush emmer kernels. Analyses were carried out on 300 kernels by SKCS (Single Kernel Characterization System) model 4100 (Perten Instruments, Huddlinge, Sweden).

2.4. Test weight

The test weight was determined by a Schopper chondrometer equipped with a 250 mL cylinder.

2.5. Kernel translucency

Kernel translucency and white/opaque core were evaluated on 50 kernels using a farinator, a device that allows 50 kernels to be held firmly while a blade is moved through to cut them transversely (ICC method 129). The percentage of vitreous kernels is determined by examining the cross-section of the kernels. Vitreous kernel appears dark and translucent, while opaque and non vitreous kernel appears starchy.

2.6. Cooking assessment

Two grams of emmer were cooked in 20 mL of water in ordinary-size pyrex test tubes. After the desired cooking period, the tube was cooled in a beaker of water for 1 min. The emmer was then collected over a wire screen, spread, stirred over filter paper sheets for 30 s and weighed. The optimal cooking time was determined removing a few grains at different intervals, and noting the

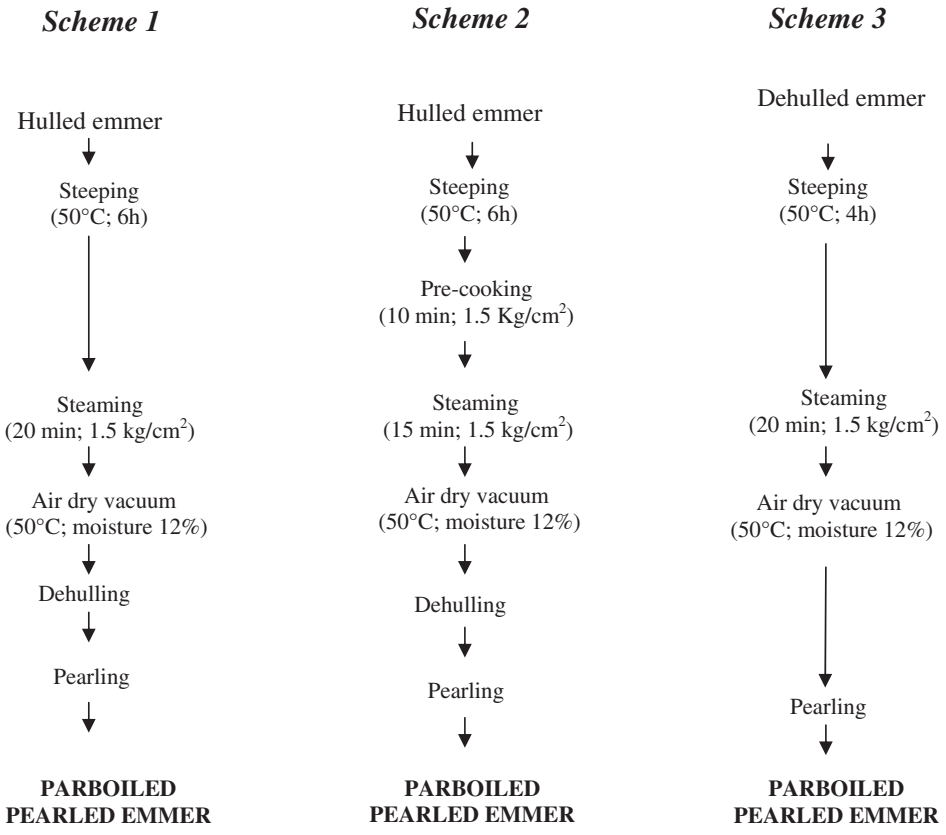

Fig. 1. Conditions used for parboiling hulled and dehulled emmer.