Innovative Food Science and Emerging Technologies 13 (2012) 207–214

Contents lists available at SciVerse ScienceDirect

Innovative Food Science and Emerging Technologies

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

Use of endoxylanase treated cereal brans for development of dietary fiber enriched cakes

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ARTICLE INFO

Article history:
Received 13 May 2010
Accepted 8 August 2011

Editor Proof Receive Date 22 September 2011

Keywords:
Endoxylanase
Cake quality
Cereal bran
Functional properties
Batter viscosity

ABSTRACT

Oat and rice bran were treated with different levels (0, 70 and 700 ppm) of an endoxylanase enzyme and added to cakes on 30% flour weight basis. The water binding and holding capacity of brans were decreased while their soluble dietary fiber content was increased. This enzyme treatment was found to be effective in reducing the initial crumb firmness and water activity and in increasing the batter viscosity, gelatinization temperature, specific volume, porosity and sensorial characteristics of the cakes. No differences were observed in the batter's specific gravity and the cake crumb's moisture content and Browning Index (BI). The level of endoxylanase treatment did not alter significantly ($P<0.05$) the functional properties of the brans and the quality characteristics of the cakes probably because the treatment time (30 min) was too short to indicate a significant effect. The optimum cake characteristics were obtained when oat bran treated with 70 ppm endoxylanase was used. Overall, endoxylanase treated brans could be incorporated into cakes and improve their nutritional and quality characteristics.

Industrial relevance: The objective of the present study was to evaluate the effect of the enzyme (xylanase) treatment of 2 commonly used cereal brans (oat and rice) in order to develop a functional bakery product. By using cereal bran one can upgrade agricultural products and by-products for use as food ingredients without any additional cost. Furthermore, the treatment of raw cereal brans with xylanase alters the composition and functional properties of brans, influencing the characteristics of the final product as well. Endoxylanase treated brans were found to have improved functional properties that are essential for a successful incorporation, as well as higher nutritional value. The results of the study show the potential of using enzymes to modify underutilized sources of raw materials that can be properly incorporated in baked goods, improving their nutritional value and quality characteristics. The developed procedure and results can be used by the bakery industry to make high fibre and low cost bakery products with improved sensorial characteristics that are appealing to the consumers.

1. Introduction

Dietary fiber (DF) is one of the most important components of cereal grains due to positive health effects, with a recommended DF intake of 30–35 g/day for adults. As bakery products are widely consumed, they can be used as vehicles for incorporation of DF from various cereals. Commonly, DF is consumed via cereals, fruits and vegetables, as well as is added in purified form to prepared foods. Sources of fiber are natural with no additional processing (e.g. bran), isolated (e.g. cellulose and various gums), modified (e.g. carboxymethylcellulose), or non-plant (e.g. xylans and polydextrose). Cereal bran (CB) is one of the most common ingredients used for increasing the DF content of foods due to its low cost, availability, familiarity, functionality and acceptable sensory characteristics.

CBs are milling fractions, containing pericarp, testa, aleurone, germ and part of the starchy endosperm. CBs are rich in DF, with arabinoxylan (AX), b-glucan, cellulose and lignin as major components. AXs are complex polymers composed of a (1/4)-b-D-xylopyranosyl backbone chain substituted with a-L-arabinofuranose residues at the C(O)2 and/or C(O)3 positions which may themselves be further linked to glucuronic acid residues and/or ferulic acid groups (Fincher & Stone, 1986). AXs are categorized into soluble water-extractable (WE-AXs) and insoluble water-unextractable arabinoxylans (WU-AXs) which differ to their physicochemical properties. WE-AXs have high molecular weight and lead to highly viscous solution when brought in aqueous, whereas WU-AXs are characterized by strong water holding capacity (Courtin & Delcour, 2001).

Enzymes are considered useful aids used instead of chemical means; they are regarded as clean label compounds, finding thus several applications in food technology. In particular, cell wall-

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doi:10.1016/j.ifset.2011.08.001

degrading enzymes can be used to loosen up the AX structure, thereby improving both the nutritional value and baking properties of CB. Endo-b-1,4-xylanases (EX) (E.C. 3.2.1.8) alter AX physicochemical properties by rendering WU-AXs to soluble, resulting in a loss of water holding capacity of the WU-AXs and to an increase in the viscosity of the aqueous medium due to the solubilized AXs (Courtin & Delcour, 2001). In addition, EX degrade WE-AXs to lower molecular weight, thereby lowering the viscosity involving properties (Courtin & Delcour, 2001). As far as the degradability of AXs is concerned, it depends on the distribution of arabinose side groups and the amount of disubstitution, as well on the cell wall ultrastructure (Andersson, Eliasson, Selenare, Kamal-Eldin, & Aman, 2003).

The addition of CBs in adequate amounts to exploit their physiological benefits, often impacts negatively on the quality attributes of the relative enriched baked goods. To solve these problems and improve the quality of DF rich products, addition of certain enzymes, additives and/or new fiber sources have been proposed (Van Hung, Maeda, Fujita, & Morita, 2007). Pretreatment of the bran with AX-degrading enzymes could additionally improve the nutritional properties, by increasing the soluble fiber percent (Andersson et al., 2003). Such a treatment has great importance since the consumption of soluble DF can significantly lower blood cholesterol and help to stabilize blood glucose levels, while consumption of insoluble DF helps to protect against colon cancer and other bowel disorders of the intestinal tract (Van Hung et al., 2007).

Regarding bran addition to breads and its detrimental effects, several studies have been conducted (Katina, Salmenkallio-Marttila, Partanen, Forssell, & Autio, 2006; Laurikainen, Harkonen, Autio, & Poutanen, 1998). The improvement of structure and quality of high-fiber enriched breads and biscuits has also been approached by several researchers by inducing enzymes into the bread making process (Caballero, Gomez, & Rosell, 2007; Katina et al., 2006; Laurikainen et al., 1998; Poutanen, 1997).

In order to increase the fiber content of cakes and muffins, several materials such as bran and outer layers of cereals (Hudson, Chiu, & Knuckles, 1992; Lebesi & Tzia, 2011; Shafer & Zabik, 1978) have been used. In the present work two sources of CBs were used in cakes, rice bran (RB) and oat bran (OB). RB is a by-product obtained from the outer rice layers; it constitutes about 10% of rough rice grain, is hypoallergenic and readily available. This by-product is generally discarded or used in animal feeding. The non food use of RB constitutes an economic loss since it is rich in bioactive compounds which can be isolated and used as value added materials. OB, the edible outermost layer of the oat kernel, is another widely used CB. It is produced by grinding clean groats or rolled oats after the separation of flour so that more than 50% of the starting material is obtained (Committee on Oat Bran, 1989).

The objective of this study was to add OB and RB into cakes and examine the potential use of an EX enzyme to improve the functional properties of the brans and the cake quality characteristics. As to the best of our knowledge there is no published work on the impact of EX enzymes on the quality of cakes enriched with enzyme treated brans, our results are compared with ones from relative studies involving bread or cakes with different DF sources.

2. Materials and methods

2.1. Materials

Wheat flour (moisture 14%, protein 9.8%, gluten 20%), sodium bicarbonate, monocalcium phosphate and sodium acid pyrophosphate were supplied by Dakos Mills (S.A. Greece); sugar (Hellenic

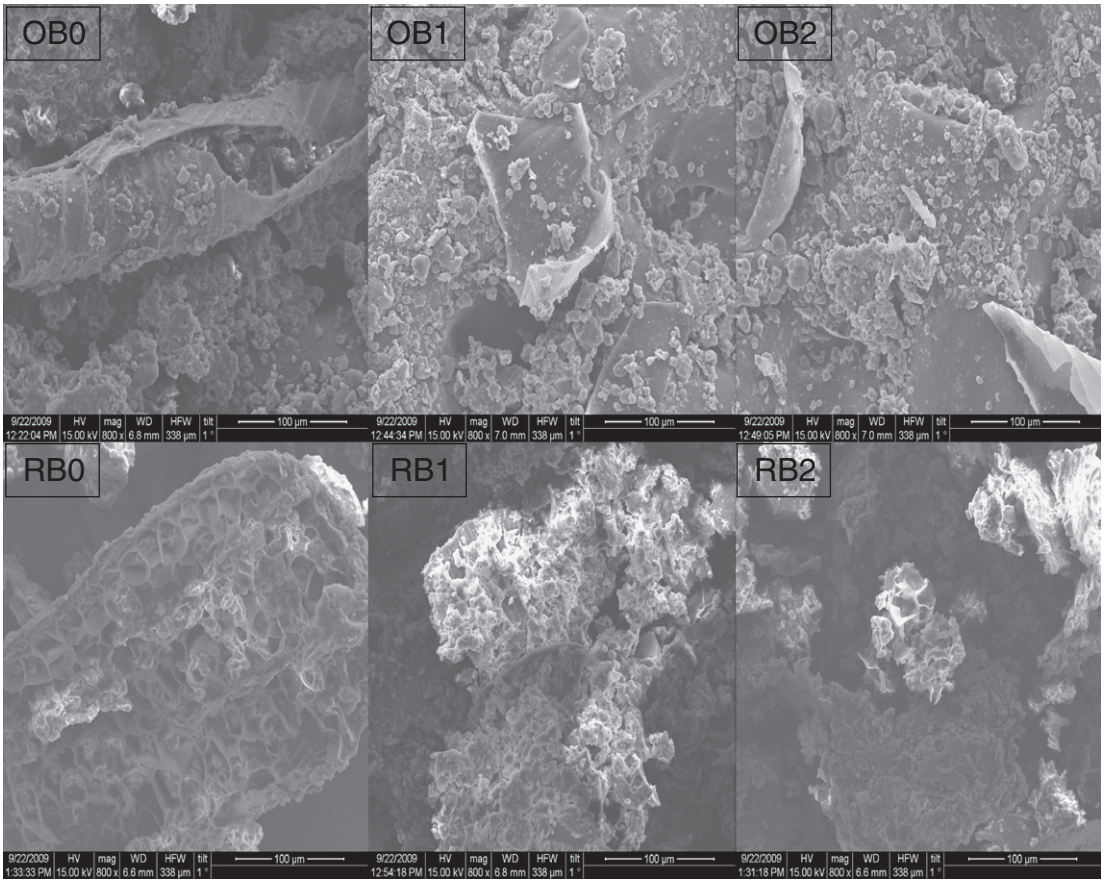

Fig. 1. Scanning electron microscopy analysis (800×) of OB and RB, with and without endoxylanase treatment.