Food Chemistry xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Food Chemistry

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

Effect of hemicellulose from rice bran on low fat meatballs chemical and functional properties

Guohua Hu [a,b,*], Wenjian Yu [a]

[a] State Key Laboratory of Bioreactor Engineering, Department of Food Science and Engineering, East China University of Science & Technology, Shanghai 200237, PR China
[b] Shanghai Collaborative Innovation Center for Biomanufacturing Technology, Shanghai 200237, PR China

ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Rice bran
Hemicellulose
Dietary fibre
Functional
Meatball

ABSTRACT

The paper study the functional properties of hemicellulose B (RBHB) and rice bran insoluble dietary fibre (RBDF) to develop an acceptable low fat meat product enriched with high content fibre from defatted rice bran. Meatballs were produced with three different formulations including 2%, 4% and 6% RBHB or RBDF addition. The total trans fatty acids were lower and the ratio of total unsaturated fatty acids to total saturated fatty acids was higher in the samples with added RBHB than in the control meatballs. Meatballs containing RBHB had lower concentrations of total fat and total trans fatty acids than the control samples. Sensory evaluations revealed that meatballs with 2%, 4% and 6% RBHB were overall acceptable. This confirms that the RBHB preparation from defatted rice bran has great potential in food applications, especially in development of functional foods including functional meat products.

1. Introduction

Rice bran is a by-product obtained from outer rice layers and is a good source of protein, mineral, fatty acids and dietary fibre (Mccaskill & Zhang, 1999). Also rice bran is used for the enrichment of some foods, due to its high dietary fibre content. Since the middle of the 1970s, the role of dietary fibre in health and nutrition has stimulated a wide range of research activities and caught public attention. Accumulating evidence favours the view that increased intake of dietary fibre can have beneficial effects against diseases, such as cardiovascular diseases, gastrointestinal disease, decreasing blood cholesterol, diverticulosis, diabetes and colon cancer (Burton, 2000; Cara et al., 1992; Chen & Anderson, 1986; Cummings, 1985; Dukehart, Dutta, & Vaeth, 1989; Spiller et al., 1980; Wrick et al., 1983). In addition to the physiological benefits provided by high fibre foods, studies have shown that fibre components can give texture, gelling, thickening, emulsifying and stabilizing properties to certain foods (Dreher, 1987; Sharma, 1981).

In meat products, fat contributes to the flavour, texture, mouthfell and overall sensation of lubricity of the product. Fat reduction can, therefore, significantly affect the acceptability of a product (Giese, 1996) and increase the toughness of meat products (Mendoza, Garcia, Casas, & Selgas, 2001). The American Heart Association and other health organizations have recommended that consumers should reduce total dietary fat intake to lower serum cholesterol concentrations (AHA, 1986).

Rye bran, oat bran and barley fibre have been compared as additives in low-fat sausages and meatballs. Oat bran was the best alternative in low-fat sausages due to its gelling ability upon heating. These sausages exhibited low process and frying losses, and high values of firmness and sensory acceptance (Karin, Ophélie, Ann-Charlotte, & Eva, 2014). The addition of oat bran to meatballs at levels of 5%, 10%, 15% and 20% would improve their nutritional value and health benefits. The total trans fatty acids were lower and the ratio of total unsaturated fatty acids to total saturated fatty acids was higher in the samples with added oat bran than in the control meatballs. The oat bran added samples were lighter and yellower than the control meatballs; however, all treatments had highly acceptable appearances. There is no significant difference among the meatball samples with respect to sensory properties (the addition of) 15% or 20% oat bran can be recommended in traditional meatball production as a dietary fibre source (Yılmaz & Dağlıoğlu, 2003).

Some of the fatty acids found in meat play important roles in metabolism. Recent interest in *trans* fatty acids (TFAs) was sparked off by epidemiological evidence linking *trans* fatty acids to higher plasma total cholesterol and low density-lipoprotein (LDL) cholesterol and increased the incidence of coronary heart disease (CHD). Irradiation of food can effectively reduce or eliminate pathogens and spoilage microorganisms. On the other hand, irradiation

* Corresponding author. Address: Meilong Road 130#, School of Biotechnology, East China University of Science and Technology, Shanghai 200237, PR China. Tel./fax: +86 21 64253503.
E-mail address: hgh@ecust.edu.cn (G. Hu).

http://dx.doi.org/10.1016/j.foodchem.2014.07.063
0308-8146/

treatment brings about some biochemical changes. The *trans* fatty acid contents of the ground beef samples increased with more irradiation dosages (Yılmaz & Umit, 2007).

Not much work has been done on rice bran and its dietary fibre in China. Rice bran is mostly burnt off at the rice mills and very little is used in animal feed. By understanding functional properties of dietary fibre, one can increase its use in food applications and aid in developing food products with high consumer acceptance. We systematically studied the chemical constituents and functional properties of dietary fibre from rice bran (Hu, 2001; Hu & Huang, 1998, 2003; Hu, Huang, Cao, & Ma, 2009; Hu, Yang, Ma, & Zhou, 2007). Rice bran hemicellulose B (RBHB) had been reported to have many biological activities including decreasing blood cholesterol and preventing colon cancer (Hu & Yu, 2013; Hu et al., 2007).

The objective of the paper is to study the functional properties of RBHB and rice bran insoluble dietary fibre (RBDF) to develop an acceptable low fat food enriched with high content fibre from defatted rice bran.

2. Materials and methods

2.1. Materials

Rice bran (Nanchang Liangwan grain-processing plant, Nanchang, Jiangxi Province, PR China) was milled to pass through a 600 mm sieve. Defatting was immediately carried out using of Soxhlet apparatus utilising *n*-hexane as a solvent. The dry defatted rice bran was then kept in a sealed container in a desiccator until further treatment was performed. The other raw materials used were meat, seasonings, water, and salt obtained from a local market in Shanghai, PR China.

2.2. Extraction of RBDF and RBHB preparation

The insoluble dietary fibre (RBDF) was prepared from defatted rice bran after protein and starch were removed with some enzyme as described by Prosky et al. (1985) with some modifications. Five kilogrammes of defatted rice bran was soaked with 50 L of deionized water for 12 h and treated with proteinase, and amyloglucosidase according to the method of Prosky et al. (1985). The residue was oven-dried overnight (60 °C, 16 h) in an air oven and then weighed to obtain RBDF (Hu et al., 2009). Hemicellulose B was prepared from rice bran after lipids were removed with organic solvents and extracted with sodium hydroxide as described by Siegel (1968). The defatted rice bran was digested with protease (60 °C, 3 h), followed by digesting with amyloglucosidase (60 °C, 2 h) to remove protein and starch. Twenty volumes of 4% NaOH were then added to extract hemicelluloses at room temperature for 18 h under N_2 flow, followed by filtration. The filtrate was then neutralised with 5% acetic acid. After dialysis, four volumes of 95% ethanol were then added to the filtrate. The precipitate was oven-dried overnight (60 °C, 16 h) in an air oven and then weighed providing RBHB (Hu et al., 2009, Fig. 1).

Pretreated rice bran
↓
Soak in 4% NaOH 18h, N_2, 25°C
↓
Filtration
↓
Filtrate
↓
(+) 50% acetic acid
pH 5.0
↓
Centrifuge
(Precipitate Hemicellulose A)
↓
Supernatant
↓
Dialyzed
↓
(+) 95% ethanol
↓
Filtration
(Precipitate Hemicellulose B)
↓
Filtrate
↓
Concentrated vacuum
(Hemicellulose C)

Fig. 1. Flow chart of extraction procedure for hemicellulose A, B and C.

2.3. Determination of crude protein, moisture, ash, oil, dietary fibre and FAME

The recommended methods of the Association of Official Analytical Chemists (AOAC, 1990) were adopted to determine the levels of crude protein, moisture, ash, salt, fat and pH. Nitrogen content was determined using the Kjeldahl method (Kjeldahl, 1883) and multiplied by a factor 6.25 to determine the crude protein content. Moisture content was determined by drying the samples at 105 °C to a constant weight. Ash was determined by the incineration of 1.0 g samples placed in a muffle furnace, maintained at 550 °C for 5 h. Crude fat was determined by the Soxhlet method. Crude fat was obtained by exhaustively extracting 5.0 g of each sample in a Soxhlet apparatus using petroleum ether (boiling point range 40–60 °C) as the extractant. Dietary fibre content of the defatted samples was determined by decomposing starches with acids and proteins, with base, and then filtering (Nielsen, 1998). Starch was obtained by difference. All results were expressed on a dry weight basis.

Fatty Acid Methyl Esters (FAME) were prepared after alkaline hydrolysis, followed by methylation in methanol plus BF3. The final concentration of the FAME was approximately 6 mg/ml in heptane (AOAC, 1990).Analyses of the FAME by capillary GLC were carried out on a Hewlett-Packard 6890 chromatograph, equipped with a flame-ionisation detector (FID) on a split injector. A fused-silica capillary column (CPTM-sil 88, 50 m × 0.25 mm (i.d.) × 0.21 mm film, Chrompack) was used. The column was operated isothermally at 178 °C, injector and detector were kept at 250 °C. The carrier gas was helium at a flow rate of 1 ml/min.

2.4. Functional properties of RBDF and RBHB preparation

The swelling capacity (SC) measurement was made using 0.15 mol/L NaCl, as described by Guillon, Barry, and Thibault (1992). The water-binding capacity (WBC) was determined according to the method described by Sosulski, Humbert, Bui, and Jones (1976) and Auffret, Ralet, Guillon, Barry, and Thibault (1994) with some modifications. Samples (300 mg) were weighed and left to stand for 1 h in distilled water (10 ml) at room temperature (25 °C) before being centrifuged for 20 min at 14,000g. The residues were left for 30 min, dried overnight at 110 °C, and weighed. WBC and SC were expressed as ml of water held per gram of sample. Fat binding capacity (FBC) was measured using a method adapted from Lin, Humbert, and Sosulski (1974). The fat binding capacity was expressed as ml of absorbed oil per gram of sample. Viscosity of the dietary fibre was determined using the method of Frost, Hegedus, and Glicksman (1984). The viscosity was measured using a NDJ viscometer (NDJ-1 Model (Hu et al., 2009).

Please cite this article in press as: Hu, G., & Yu, W. Effect of hemicellulose from rice bran on low fat meatballs chemical and functional properties. *Food Chemistry* (2014), http://dx.doi.org/10.1016/j.foodchem.2014.07.063