Journal of Cereal Science 62 (2015) 45–49

Contents lists available at ScienceDirect

Journal of Cereal Science

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

Effects of semidry flour milling on the quality attributes of rice flour and rice noodles in China

Li-Tao Tong [a], Xiaoxu Gao [b], Lizhong Lin [c], Yejia Liu [c], Kui Zhong [a], Liya Liu [a], Xianrong Zhou [a], Li Wang [b], Sumei Zhou [a, *]

[a] Institute of Agro-Products Processing Science and Technology, Chinese Academy of Agricultural Sciences/Key Laboratory of Agro-Products Processing, Ministry of Agriculture, Beijing 100193, China
[b] The State Key Laboratory of Food Science and Technology, School of Food Science and Technology, Jiangnan University, 1800 Lihu Road, Wuxi 214122, China
[c] Hunan Jinjian Cereals Industry Co., Ltd., Changde City, Hunan Province 415001, China

ARTICLE INFO

Article history:
Received 24 July 2014
Received in revised form
19 November 2014
Accepted 13 December 2014
Available online 3 January 2015

Keywords:
Rice noodles
Semidry-milling
Characteristics of rice flours
Rice noodles qualities

ABSTRACT

To investigate the effects of semidry-milling on the quality attributes of rice flour and rice noodles, the properties of rice flours and cooking properties of rice noodles prepared with wet-, dry- and semidry-milled rice flours were characterized. The level of starch damage of semidry-milled rice flour at 30% moisture was significantly decreased to the level of wet-milled rice flour ($P < 0.05$); the whiteness of dry-milled rice flour was decreased compared with wet-milled rice flour ($P < 0.05$), while that of semidry-milled rice flour was not; the wet- and semidry-milled rice flours showed similar morphology and water hydration properties; the dry milling method reduced significantly the hardness, chewiness, and resilience of rice noodles ($P < 0.05$) compared with wet-milling, but semidry-milling did not; the cooking qualities of rice noodles produced by semidry-milling were comparable to wet-milling. It indicated the semidry-milling at 30% moisture may provide the protective effects on the characteristics of rice flours, which could be used to produce similar qualities of rice noodles to the wet-milling.

1. Introduction

Rice noodles produced from Indica rice, which are very popular in South-east Asian countries, such as China, Thailand, Sri Lanka, etc., are classified into fresh, dried, or frozen products in various thicknesses and shapes (Fu, 2008). Since traditional rice noodles with unique taste are coveted by consumers as a result of a long history of their consumption, most of the rice noodle processing is still traditional in China (Lu et al., 2003). In this traditional process, wet-milling of rice following an overnight soaking in water is commonly used as a material processing stage (Lu et al., 2005). However, the long soaking time results in bacterial growth in rice, leading to a serious degradation in product quality (Charles et al., 2007). Therefore, the dry-milling method is used to break rice granules which needs more energy and increases the content of damaged starch in comparison to wet-milled rice flour (Kumar et al., 2008). In addition, the extra heat leads to a reduction in the whiteness of rice flours, thereby affecting the sensory appeal of rice noodles (Takahashi et al., 2005). Chiang and Yeh (2002) and Heo et al. (2013) have reported that dry-milled rice flour has poor pasting and hydration properties in comparison to wet-milled rice flour. Therefore, the quality of rice noodles produced from dry-milled rice flour is not acceptable to consumers, despite the fact that dry-milling presents fewer health risks and improves the stability of rice products.

Rice proteins do not form a stable network structure, so that the viscoelastic quality of rice noodles depends primarily on the properties of the starch component (Sandhu and Mukesh, 2010; Kim et al., 2014). However, the dry-milled method has a bad effect on starch structure. So, dry-milled flour is often unable to meet the requirements of the rice noodle processing. Numerous studies have confirmed that the addition of strengthening agents and specific treatments, such as fermentation, hydrothermal and enzyme treatments, can improve the network structure for producing rice noodles (Gujral et al., 2003; Yang and Tao, 2008; Hormdok and Noomhorm, 2007). Obviously, the addition of strengthening agents is a convenient and inexpensive method, but this may results in the overuse of additives to enhance product quality. Similarly, many countries such as Thailand and other

* Corresponding author. Tel./fax: +86 10 6281 3477.
E-mail address: sumeizhoucaas@gmail.com (S. Zhou).

http://dx.doi.org/10.1016/j.jcs.2014.12.007
0733-5210/

South-east Asian countries are faced with the similar processing problems of rice products (Cham and Suwannaporn, 2010). In order to reduce the adverse effects of dry-milling on characteristics of rice flour and cooking qualities of rice noodles, the present study was initiated to focus on the semidry-milling method. The semi-dry milling method may singly get similar rice noodle qualities to wet milling without adding additives.

In our study, rice flours were prepared from wet-, dry- and semidry-milling methods, and their physicochemical characteristics were measured. Furthermore, rice noodles prepared with these different milled rice flours were used to determine their relative texture profile and cooking qualities.

2. Materials and methods

2.1. Materials

The rice used for this study was early polished Indica rice of the *Hunan fragrant rice* variety (harvested in 2013.07) which was provided by Hunan Jinjian Cereals Industry Co., Ltd. (Changde, China). This product contained 6.40% protein, 1.63% crude fat, 0.35% ash, 88.69% total starch and 24.03% amylose. The protein and crude fat of rice were determined using the analytical method of Association of Official Agricultural Chemists (AOAC, 984.13 and 945.16). Total nitrogen content of rice was determined by the Kjeldahl method using a Kieltec analyzer (Foss Tecator AB, Höganäs, Sweden), and a conversion factor of 5.95 was used to estimate the protein content. The total starch content was determined using a Total Starch Assay Kit (JKY/K-TSTA 07/11, Megazyme International Ltd., Wicklow, Ireland) by the American Association for Clinical Chemistry (AACC) approved method 76.13. The amylose content was determined using an Amylose/Amylopectin Assay Kit (JKY/K-AMYL 07/11, Megazyme International Ltd., Wicklow, Ireland). The chemical compositions of rice were determined in triplicate for each rice sample, and all results were reported on a dry weight basis.

2.2. Preparation of wet-, dry-, and semidry-milled rice flour

For wet-milled flour, 1 kg polished rice (14% moisture content) was steeped in 2 L deionized water at 25 °C for 24 h, and then milled by using a grinder (YU8022, Wet miller, Hebei, China) and a homogenizer (JMS-30A, Langfang Langtong Machinery Co., Ltd., China). In order to confirm the right moisture content, we tested moisture content at 24 h. The soaked rice contained 32% moisture. For dry-milled flour, rice was ground into flour using a cyclone mill and passed through a 100 mesh sieve (CT410, FOSS Scino (Suzhou) Co., Ltd., Suzhou, China). In the case of semidry-milled flours, a 1 kg portion of rice was infiltrated with deionized water to get the 18%, 22%, 26%, and 30% moisture, and each hydrated sample was incubated at 25 °C for 24 h. Then, the rice samples were ground into flour using the same cyclone mill as mentioned above. All rice flours were freeze-dried to obtain the rice flours with 5% moisture and stored at 4 °C for further analysis.

2.3. Starch damage

The degree of starch damage of different rice flours was measured using the enzymatic colorimetric method with a Starch Damage Assay Kit (K-SDAM, Megazyme International Ltd., Wicklow, Ireland).

2.4. Determination of colour of rice flour

The CIE L^* (lightness), a^* (redness), and b^* (yellowness) of the various rice flours were measured using a Hunter Lab D25LT colorimeter (Hunter Associates Laboratory, Inc., Virginia, USA) according to a reported method (Pongjaruvat et al., 2014). The rice flour samples (100 g) were placed under a plate glass for measurement. The colorimeter was set to an illuminant condition D65 and a standard observer of 10°. The hunter whiteness was calculated using the following formula based on reports (Hsu et al., 2003; Torbica et al., 2012).

$$\text{Hunter whiteness} = 100 - \left[(100 - L^*)^2 + a^{*2} + b^{*2}\right]^{1/2}$$

2.5. Scanning electron microscopy (SEM)

The morphology of the rice flour samples was examined using a Scanning Electron Microscope (SEM Hitachi S-570, Hitachi, Co., Ltd., Tokyo, Japan). The rice flour samples were spread directly on the surface of an aluminum stub and dried in an oven at 40 °C for 4 h. The samples were coated with gold and examined in the scanning electron microscope under an acceleration voltage of 15 kV and a magnification of 1500×.

2.6. Water hydration properties

The water absorption index (WAI), water solubility index (WSI) and swelling power index (SPI) of the rice flour samples were determined according to a reported method (Ohishi et al., 2007; Heo et al., 2013). Briefly, 0.1 g rice flour was dispersed in 20 mL deionized water and agitated at 25 °C and 100 °C for 30min, respectively. After centrifuging the dispersion at 15,000 g for 30 min, the supernatant was dried in a hot air oven at 105 °C until a constant weight was obtained. WAI, WSI and SPI were calculated by the following formulae.

$$\text{WAI} = \text{wet sediment weight}/\text{dry sample weight}$$

$$\text{WSI}\ (\%) = \text{dry supernatant weight}/\text{dry sample weight} \times 100$$

$$\text{SPI} = \text{wet sediment weight}/[\text{dry sample weight} \times (1 - \text{WSI})]$$

2.7. Preparation of rice noodles

The rice noodles were prepared using a GY-MF rice noodle machine (Guangzhou National Institute Machinery Equipment Manufacturing Co., Ltd., Guangzhou, China), which mainly consists of an extruder wrapped with a heating mantle whose temperature is greater than 95 °C and an electric fan for the cooling process. Deionized water was added into rice flours to keep the total water content at 55%. Pouring rice milk into the extruded pipe and starting the machine and electric fan, the rice milk was extruded through a multiple opening (0.2 cm diameter) in a circular die, and air-cooled by an electric fan, then stored at 4 °C for further analysis.

2.8. Texture profile analysis (TPA) of rice noodles

The texture profile of the rice noodles was determined using a TA-XT 2i/5 Texture Analyser (Stable Micro System Ltd., Godalming, England) according to a reported method with some modifications (Charutigon et al., 2008). The rice noodles were cooked in boiling deionized water for 2 min, followed by cooling to room temperature with deionized water at room temperature, and drained for 5 min before the measurement. Five samples of rice noodles, 4 cm in length with similar diameter, were prepared. Specific measurement parameters were: P/50R probes at the test speed of 1.0 mm/s,