Journal of Cereal Science 69 (2016) 283–289

Contents lists available at ScienceDirect

Journal of Cereal Science

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

Impacts of parboiling conditions on quality characteristics of parboiled commingled rice

Kanokporn Leethanapanich [a], Andy Mauromoustakos [b], Ya-Jane Wang [a,*]

[a] Department of Food Science, University of Arkansas, 2650 N. Young Avenue, Fayetteville, AR 72704, USA
[b] Agricultural Statistics Laboratory, University of Arkansas, Fayetteville, AR 72701, USA

ARTICLE INFO

Article history:
Received 21 December 2015
Received in revised form
4 April 2016
Accepted 7 April 2016
Available online 8 April 2016

Keywords:
Parboiling
Commingled rice
Onset gelatinization temperature
Head rice yield

ABSTRACT

Commingling of rice cultivars with a wide range of onset gelatinization temperatures (T_o) could occur during harvesting, drying, storage, and distribution, and consequently impact parboiled rice properties. This study investigated the effects of commingling, soaking temperature and steaming duration on parboiled commingled rice properties. Rough rice of pureline (Taggart and CL151) and hybrid (XL753 and CL XL745) cultivars were mixed at 1:1 weight ratio to obtain 3 commingled rice lots with a difference in T_o of 1.2, 3.9, and 6 °C. Rough rice was soaked at 65°, 70°, or 75 °C for 3 h, and steamed at 112 °C for 10, 15, or 20 min prior to drying. The effects of soaking temperature and steaming duration were found to vary with commingled rice. Soaking temperature exerted more influence on commingled rice comprising low T_o cultivars. Commingled rice comprising high T_o cultivars was less affected by soaking temperature and steaming duration in terms of head rice yield, deformed kernels and pasting viscosities. Both the difference in T_o among commingled rice cultivars and the T_o relative to the soaking temperature were important in parboiled commingled rice properties. Commingled rice with a wide range of T_o tended to result in parboiled rice with less desirable properties.

© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

Parboiled rice consumption has been primarily of cultural preferences in countries like India, Pakistan, Bangladesh, and Nigeria, and has become popular in many countries in Europe, North and South America (Bhattacharya, 2011). Parboiled rice finds many applications in the food industry such as instant rice, frozen entrees, canned goods, and ready-to-eat meals because of its heat stability and retained nutrients (Luh and Mickus, 1991). The parboiling process includes soaking, steaming, and drying, which all have impacts on the quality of parboiled rice. Parboiling decreases breakage susceptibility of rice during the dehulling and milling processes, resulting in greater head rice yield. However, unfavorable characteristics may develop if rice is not properly parboiled, for example discoloration, off-odor and flavor, deformation, white core, and unsatisfactory sensory attributes (Bhattacharya, 2011).

The effects of parboiling conditions on the qualities of parboiled rice have been extensively investigated. Parboiling resulted in an increase in head rice yield and a decrease in overall pasting profile, swelling and amylose leaching of parboiled rice (Raghavendra Rao and Juliano, 1970; Ali and Bhattacharya, 1980; Islam et al., 2001; Patindol et al., 2008; Gunaratne et al., 2013; Graham-Acquaah et al., 2015). Bhattacharya and Subba Rao (1966a) found that the intensity of parboiled rice color was affected by the severity of the parboiling process, including soaking temperature, soaking duration, steaming pressure as well as steaming duration. Pillaiyar and Mohandoss (1981) reported a decrease in hardness of cooked rice kernels with increasing soaking temperature, whereas longer steaming durations increased the hardness of cooked rice (Kar et al., 1999; Saif et al., 2004). Patindol et al. (2008) reported head rice yield of brown rice was 89.6 and 62.6% when steamed at 100 °C and 120 °C for 20 min, respectively. Longer steaming time reduced the chalkiness and pasting viscosities as well as increased the hardness of cooked parboiled rice. Buggenhout et al. (2013, 2014) suggested that the degree of starch gelatinization, which was affected by severity of parboiling conditions, played an important role in breakage susceptibility of parboiled rice. The presence of white belly and fissured kernels decreased head rice yield because of their tendency to breakage during milling, which was supported

Abbreviations: T_o, onset gelatinization temperature; MC, moisture content; RH, relative humidity; HRY, head rice yield.

* Corresponding author.
E-mail address: yjwang@uark.edu (Y.-J. Wang).

http://dx.doi.org/10.1016/j.jcs.2016.04.003
0733-5210/© 2016 Elsevier Ltd. All rights reserved.

by their lower bending forces compared with the transparent, non-fissured parboiled rice kernels.

Because of a significant increase in rice cultivars, particularly the development of hybrid cultivars in the U.S., an intermingling between rice cultivars with pureline and hybrid and with a wide range of gelatinization temperatures could occur during harvesting, drying, storage, and distribution. Bhattacharya and Subba Rao (1966a) noted the differences in hydration rate of rough rice during soaking and milling yield of parboiled rice as affected by varietal differences, particularly in terms of starch gelatinization temperature. Basutkar et al. (2014) reported significant effects of commingled rice on milled rice yield, head rice yield, and chalkiness of milled rice. However, the effects of commingling on whiteness and yellowness was insignificant. Basutkar et al. (2015) proposed that a large variation in starch onset gelatinization temperature (T_o) of the rice cultivars in commingles may cause inconsistent quality of products because the T_o of commingled rice was determined by cultivars with the lower T_o.

Besides gelatinization temperature, milling characteristics differ among cultivars, which could affect hydration rate and consequently rice quality after parboiling. The bran layer of hybrid rice cultivars was found to be thinner than that of pureline cultivars; therefore, hybrid rice required a shorter milling duration to reach the same degree of milling as pureline (Siebenmorgen et al., 2006; Lanning and Siebenmorgen, 2011; Siebenmorgen et al., 2012). Varietal differences also had an influence on color and cooking quality of parboiled rice (Bhattacharya and Subba Rao, 1966b). Raghavendra Rao and Juliano (1970) attributed changes in pasting characteristics among different rice cultivars from parboiling to the differences in amylose content of individual rice cultivars. Patindol et al. (2008) found that milling, physicochemical, pasting, thermal, and cooking properties of parboiled rice were affected by cultivars in terms of chemical composition and gelatinization temperature.

Because of the aforementioned differences in rice properties among cultivars, the goal of this study was to investigate the impacts of parboiling conditions on the quality of parboiled rice when using commingled rough rice as a feedstock.

2. Materials and methods

2.1. Materials

Long-grain pureline (Taggart and CL151) and hybrid (CL XL745 and XL753) rice cultivars from the 2012 crop year were used in this study and obtained from the University of Arkansas Rice Processing Program (Fayetteville, Arkansas). These cultivars were selected because they had the lowest T_o and the highest T_o among pureline and hybrid cultivars available from the 2012 crop year, as determined by a differential scanning calorimeter, of 72.1, 74.2, 73.3, and 78.1 °C for Taggart, CL151, CL XL745, and XL753, respectively. Three combinations of commingled rice samples were prepared using a 1:1 ratio based on rough rice weight (approximately at 12.5% moisture content, MC). Taggart/CL XL745, CL151/XL753, and Taggart/XL753 represented Low T_o/Low T_o (L/L), High T_o/High T_o (H/H), and Low T_o/High T_o (L/H) commingles with T_o differences of 1.2, 3.9, and 6.0 °C, respectively. The rough rice was accurately weighed and mixed 5 times, 2 min each time, using a rotary rice grader (TRG, Satake, Tokyo, Japan).

2.2. Parboiling conditions

A partially-automated, pilot-scale parboiling unit fabricated by the University of Arkansas Rice Processing Program was used to parboil rice samples. Soaking temperatures, soaking durations, steaming pressure and steaming durations were set before starting the process. Rough rice was soaked at 65, 70, or 75 °C for 3 h prior to steaming at 69 kPa (10 psi, 112 °C) for 10, 15 or 20 min. The selected soaking temperatures were set approximately 3–7 °C below T_o of rice samples. After steaming, rice was dried in an equilibrium moisture content (EMC) chamber at 26 °C and 65% RH for 3 days to reach 12% MC.

2.3. Milling properties

Dried parboiled rice was dehulled using a Satake THU-35 dehusker (THU-35, Satake Corp., Hiroshima, Japan) and milled for 60 s with a McGill No. 2 mill (PRAPSCO, Brookshire, TX) which had a 1.5 kg mass placed on the lever arm at 15 cm from the center of the milling chamber. The head rice kernels were separated from broken kernels by a double-tray sizing device (Seedburo Equipment Co., Chicago, IL). Head rice yield (HRY) was expressed as a percentage of head parboiled rice mass to dried parboiled rough rice mass.

2.4. Color

The whiteness (L^*) and yellowness (b^*) of parboiled rice was measured using a Hunter lab digital colorimeter (Colorflex EZ, Hunterlab, Reston, VA) and determined by CIE color scales. The colorimeter was standardized using a white blank (Illuminant D65 10° Observer, $x = 79.88$, $y = 84.72$, $z = 89.47$) with a 31.8-mm aperture. Approximately 30 g of head parboiled rice was filled in a clear, flat-bottom dish and placed at the center of the sample port. The cup was rotated 180° for the second reading.

2.5. White core

The percentage of white core was determined using an image analysis system (Winseedle™ Pro 2005a Regent Instruments Inc., Sainte-Foy, Quebec, Canada). Several white core and translucent parboiled kernels were scanned and used as references for the system to classify the white core and translucent area based on number of pixels. One hundred random rice kernels were placed in a tray made from a 2-mm thick clear acrylic sheet (Plexiglass) with no grain touching each other, and then imaged with a scanner (Epson Perfection V700 Photo, Model# J221A, Seiko Epson Corp., Japan) (Fig. 1). The system measured the number of pixels and classified them according to the pre-set criteria. White core was expressed as the percentage of the number of pixels as white core area over the number of pixels in total kernel projected area.

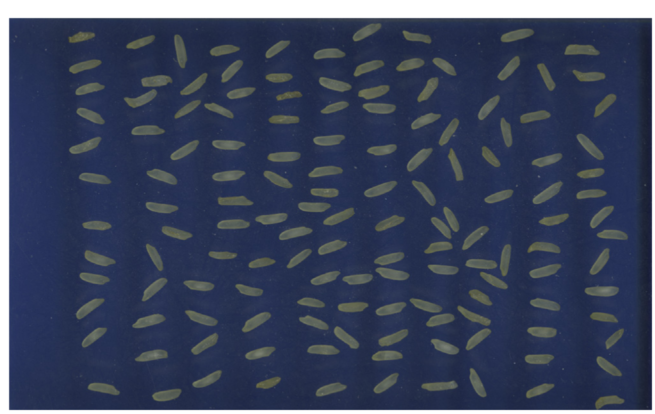

Fig. 1. The scanned image of parboiled rice kernels by using Winseedle for determining the percentage of white core.

Download English Version:

https://daneshyari.com/en/article/4515595

Download Persian Version:

https://daneshyari.com/article/4515595

Daneshyari.com