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Effect of storage temperatures on the head rice yield in relation to glass transition temperatures and un-freezable water

Khongsak Srikaeo [a,*], Chutamas Boonrod [a], Mohammad Shafiur Rahman [b]

[a] Faculty of Food and Agricultural Technology, Pibulsongkram Rajabhat University, Muang, Phitsanulok, 65000, Thailand

[b] Department of Food Science and Nutrition, College of Agricultural and Marine Sciences, Sultan Qaboos University, P.O. Box-34, Al-Khod, 123, Muscat, Oman

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ABSTRACT

Head rice yield (HRY) in relation to glass transition temperatures and un-freezable water of waxy (San-pah-tawng) and non-waxy (Phitsanulok 2) rough rice were studied. Freezing points and glass transitions were measured by differential scanning calorimetry (DSC) as a function of solid fraction. Both waxy and non-waxy rice samples exhibited similar trends in glass transition when solid fraction was decreased. The transition temperature and enthalpy of ice melting decreased as the solid fraction increased. The onset (i.e. initial) glass transition was increased from 27 to 35 °C when solid fraction increased from 0.80 to 0.97. Un-freezable water contents were found to be different for both rice samples. The rate of HRY (i.e. rate constant) increased differently (i.e. higher above glass transition) when rice samples were stored above (i.e. 35 and 45 °C) and below glass transition temperatures. It was found that storage of fissured rice (low HRY) at the temperatures especially above glass transition could relax the strains inside a rice kernel and subsequently improved HRY.

1. Introduction

Rice in the form of milled rice kernels is consumed as staple food by almost half of the world population. Milling, an important processing step of rough rice, is usually performed to produce white polished grain. A commercial rice milling system is a multi-stage process when the rough rice is first subjected to dehusking and then to remove brownish outer bran layer, known as whitening. Finally, polishing is carried out to remove the bran particles and provide surface gloss to the edible white portion. The most important parameters during milling are head rice yield (HRY). Rice kernel with three quarters or more of their original length after complete milling operation is termed as head rice, and higher HRY indicates high quality yield (Yadav and Jindal, 2008). The ultimate goal of the rice industry is to achieve maximum HRY from the milling process. HRY is the current standard to assess commercial rice milling quality. The HRY is related to the pre- and post-harvest stress cracks (fissures) development in the kernels, and the post-harvest drying, handling and storage of the paddy. The rice grain is mechanically strong, but it is susceptible to moisture stress and develops fissures upon rapid hydration or dehydration during harvesting, handling and/or processing (Iguaz et al., 2006). Extensive research has been done for improving milling quality through plant breeding, improved cultural practices and optimization of harvesting and drying conditions (Abud-Archila et al., 2000). It has focused mainly on the pre-milling optimum conditioning especially during drying and tempering within the drying process to maximize the HRY (Sadeghi et al., 2013; Schluterman and Siebenmorgen, 2007).

Rice is largely composed of starch and regarded as a hygroscopic biomaterial. Rice kernel undergoes a glass transition as the kernel goes through temperature and water content change during thermal processing i.e. drying and tempering.

Recently, a great deal of research has been reported on the utility of glass transition to determine foods' stability and their ingredients during storage and processing. The glass transition was also related to the molecular mobility and chemical reaction of foods, thus shelf life could be predicted (Rahman, 2004, 2006; 2009, 2012).

Glass transition temperatures of rice were previously developed and presented in the literature (Perdon et al., 2000; Sablani et al., 2009). Earlier research has shown that glass transition concept can be used to explain rice fissure formation during drying and

* Corresponding author.
E-mail address: khongsak@live.psru.ac.th (K. Srikaeo).

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