PT-03

DETERMINATION OF STICKINESS CHARACTERISTIC OF COOKED RICE SAMPLES IN RICE INDUSTRY

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Keyword: Cooked rice, Milled rice, Texture, Stickiness

ABTRACT

The objective of this study is to investigate stickiness characteristic of cooked rice samples in rice industry in Thailand. Milled rice samples were collected at a raw material purchasing station of a rice factory, behind a colour sorter and under a storage bin. The cooked rice samples were subjected to a texture analyzer using back extrusion test. Determined parameters, stickiness and adhesiveness, were compared among different types of milled rice and different sampling positions in the factory. These parameters could be further applied to the rice factory and are valuable information for rice exporters, agricultural engineers and rice researchers.

INTRODUCTION

Rice *(Oryza sativa* L.*)* is an important agricultural product in Thailand, both for domestic consumption and export. Rice is a major crop of the country and is a staple food for Thai people. Total rice exported in 2011 was 10.706 million tons which worth 196,117 million baht [1]. Thai rice has genetic variety which could be processed into numerous value-added products, i.e. puffed rice, rice noodles, canned cooked-rice, instant rice, etc.

In general, minimal processing of rice grain in an industrial scale, mostly focusing on physical qualities, consists of raw material cleaning by removing any big pieces of contaminant following by small pieces. The rice is passed through destoning and polishing steps to eliminate bran residuals and to make the rice grain glitter. Size grading is conducted to separate head rice and broken rice prior to a color sorting. Objectionable seeds (i.e. grass kernel) and foreign materials (i.e. small pieces of glass, stone, resin and chinaware) are then removed before. storaging in silo and packing.

Texture of cooked rice can be done by an objective test. Back extrusion method used in Asian Institute of Technology was adapted from Reyes and Jindal [2] of which a spherical indenter of stainless steel and cylinder box were applied. The 3 g of cooked rice sample was put into a cylindrical box. The compression speed was 1 mm/s. The spherical indenter was move down to 1 mm from the bottom of the cylindrical box. Hardness of cooked rice was considered from maximum force [3]. However from the test, other texture parameters such as toughness, stickiness and adhesiveness could be obtained. The stickiness and adhesiveness is important factor for rice processing factory such as rice noodle industries and they are parameters for differentiating new rice and aged rice [4].

This research aimed to determine of stickiness and adhesiveness of cooked rice of different categories, including parboiled rice, new Jasmine rice, aged Jasmine rice and white rice, and at different processes (sampling) positions, including, a raw material purchasing station of a rice factory, behind a colour sorter and under a storage bin, in rice industry. This research could be further applied to the rice factory and are valuable information for rice exporters, agricultural engineers and rice researchers.

MATERIAL AND METHOD

Sample and sample preparation

Thai milled rice of 276 samples was collected from rice improvement factory (C.P. Rice Co., Ltd., Thailand). The rice samples were collected from 3 points in the factory including raw material purchasing station of a rice factory, behind a colour sorter and under a storage bin where the random sampling has been done for quality and processing control of the factory. The milled rice categories fed into the factory included parboiled rice, white rice, new (harvested in 2012) Jasmine rice and aged (harvested in 2006, and during 2007-2011) Jasmine rice (52, 23, 16 and 185 samples, respectively). Each milled rice sample was weighed about 200 g and kept in a plastic zipper bag in ambient temperature until experiment.

Cooking rice by putting rice in beakers in a pot of rice cooker

As reported by Somchai and Panmanas [5], the rice cooking method by putting rice in beakers in a pot of rice cooker was the better method than normal cooking by directly cooking in the pot in term of less variation (lower coefficient of variation) in texture property of cooked rice.

Each rice type were cooked at different water to rice ratio recommended by the factory: 2.5:1; 1.6:1; 1:1 (harvested in 2012); and 1.2:1 (harvested in 2007-2011) and 1.4:1 (harvested in 2006) for parboiled rice; white rice; new Jasmine rice and aged Jasmine rice, respectively. Weighed 25 g milled rice and water as recommended by factory by electronic balance (ARC120, Adventurer, OHAUS) and immediately put in a 100 ml beakers (spread evenly). Put 5 beakers of rice sample in a pot of rice cooker (RC-10 MM (WT) A, Toshiba) and poured 400 g water in the pot. Inserted the thermocouple (FLUKE- 52- 2) into the rice cooker for measuring the cooking temperature while cooking rice. When the temperature reached about 100^{o}C or water vapor came up, waited for another 20 min and then press the "Cancel" button and then left it in the rice cooker for another 10 min. Then put the beakers upside down on the screen and covered with plastic lid and left it for one hour. Then knocked out the cook rice from the beaker and put only the middle portion into plastic cup for 3 g. There were 3 cups per sample.

Fig. 1 Cooking rice by putting rice in beakers in a pot of rice cooker

Texture analysis

As reported by Nuttagorn and Panmanas [6], the back extrusion test was the best objective method compared to other methods such as texture profile analysis and Ottawa test, to measure the texture of cooked rice to be used in research and industry.

The cooked rice samples were subjected to the texture analyzer (TA HD Plus, Stable Micro System, London, UK) using Back Extrusion test platform as shown in Fig. 2. The Back Extrusion test used 3 g cooked rice, compression speed of 1mm/s and moving distance of 99 mm of the 100 mm starting point from the surface of platform. The texture parameters were determined from force-deformation curve. The texture parameters determined were stickiness (N) i.e. maximum negative force and adhesiveness (Ns) i.e. area under curve below zero force. There were 3 replicates per sample.

Fig. 2 Back Extrusion test platform

Statistical analysis

One-Way ANOVA (Duncan's multiple range) was conducted, assuming there were significant differences among the means when the statistical comparison gave $p < 0.05$.

RESULT AND DISCUSSION

Figure 3 shows the stickiness of different cooked rice, including parboiled rice, new Jasmine rice, aged Jasmine rice and white rice, from different stations including raw material purchasing station, behind a colour sorter station and under a storage bin station, in rice industry. The stickiness is the maximum negative force (N) obtained from the force-deformation curve which occurred when the probe was moving back but the sample was stuck to it. The higher the stickiness, the more difficult (more force needed) to separate the rice from the probe. The stickiness of new Jasmine rice was higher than aged Jasmine rice, white rice and parboiled rice, respectively. The Jasmine rice has low amylose content and other categories of rice mostly have high amylose content [7]. As reported by Yu et al. [8], the rice cultivars with high amylose content showed lower adhesiveness (stickiness in our case). Parboiled rice samples were made from white rice which was different varieties of rice which were not Jasmine rice. Because the adhesiveness (stickiness in our case) decreased with storage time [8]**,** the stickiness of new Jasmine rice was higher than aged Jasmine rice.

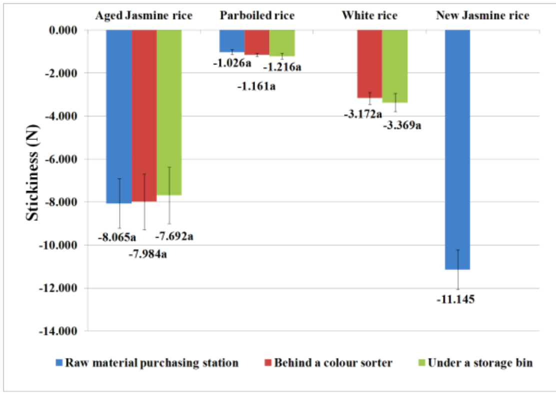

Fig. 3 Stickiness of aged Jasmine rice, parboiled rice, white rice and new Jasmine rice from different stations in rice industry. Each bar represents mean ± S.D. Values not sharing a common letter differ significantly at $P < 0.05$ (DMRT).

From Figure 3 the stickiness of rice at the purchasing station, behind a colour sorter and under a storage bin was not significantly different. This indicated that the stickiness of the rice was not affected by the starch gelatinization of the rice which occurred during polishing process before colour sorting. In the process of polishing, the water spray was fed to the rice which was rubbed against each other in a small chamber and the heat was generated. This induced the starch gelatinization in the rice. The stickiness of rice behind a colour sorter and under a storage bin, was not different because after colour sorter station there was no process that effect on this texture characteristic of the rice only the dust was removed.

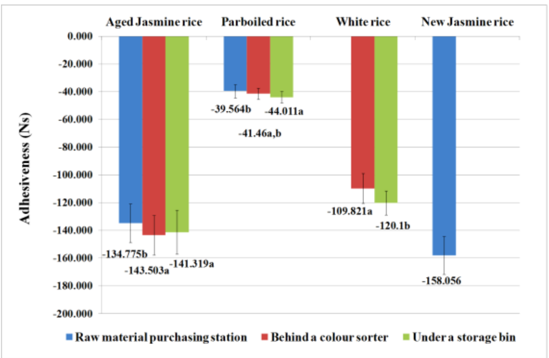

Fig. 4 Adhesiveness of aged Jasmine rice, parboiled rice, white rice and new Jasmine rice from different stations in rice industry. Each bar represents mean ± S.D. Values not sharing a common letter differ significantly at $P < 0.05$ (DMRT).

Figure 4 shows the adhesiveness of different cooked rice, including parboiled rice, new Jasmine rice, aged Jasmine rice and white rice, from different stations including raw material purchasing station, behind a colour sorter station and under a storage bin station, in rice industry. The adhesiveness is the area under curve below zero force (Ns) obtained from the force-deformation curve which occurred when the probe was moving back but the sample was stuck to it. The higher the adhesiveness, the more energy needed for separating the rice from the probe. The adhesiveness of new Jasmine rice was higher than aged Jasmine rice, white rice and parboiled rice, respectively. There has been no report on the relationship between the adhesiveness (energy needed for separating the rice from the probe) and amylose content or any other constituents of rice. In addition, from our study, the correlation coefficient between the stickiness and adhesiveness was calculated and it was 0.20, 0.38, 0.40 and 0.11 for aged Jasmine rice, parboiled rice, white rice and new Jasmine rice, respectively. This indicated that there was very small correlation between the two properties.

The adhesiveness of rice at the purchasing station was lower than behind a colour sorter and under a storage bin. This indicated that the starch gelatinization of rice during polishing process had an effect on the adhesiveness of cooked rice. The adhesiveness of rice behind a colour sorter and under a storage bin, was not different, except for white rice, because after colour sorter station there was no process that effect on the texture of the rice only the dust was removed. It was difficult to give the reason why the white rice samples under the storage bin had higher adhesiveness than at the color sorter. It might be because the rice lost its moisture content during kept in the storage bin which might effect on the adhesiveness.

CONCLUSION

The stickiness and adhesiveness of cooked rice of different categories were different due to it source. They could be the index for differentiate the white rice, aged Jasmine rice and new Jasmine rice. The stickiness and adhesiveness of new Jasmine rice was higher than aged Jasmine rice, white rice and parboiled rice, respectively. The rice processes in rice factory had no effect on stickiness of the rice but on the adhesiveness which was increased during the process. This information could be further applied to the rice factory and are valuable information for rice exporters, agricultural engineers and rice researchers.

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