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学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

Physical and Chemical Properties of Multiple Varieties of NERICA, Indica and Japonica Types of Rice for Assessing and Enhancing Quality
(米の品質評価と品質向上のための ネリカ米インディカ米ジャポニカ米の複数の品種の物理化学特性)

Rice (*Oryza sativa*), due to its adaptability and high caloric value, feeds more than half of the world population. More than 90% of the world's rice is produced and consumed in developing countries in Asia and Africa. However, in Southeast Asia, postharvest losses of rice equate to approximately 37% of the production market value, and to 50% in Sub-Saharan Africa. These losses are mainly caused by deficiencies in technologies for postharvest processing, which is one of the biggest constraints to the rapid expansion of New Rice for Africa (NERICA) type of rice. On the other hand, in Japan, while per-capita consumption has been decreasing, nearly 66% of Japanese prefer to consume high quality and palatable rice compared to cheaper rice. Appropriate analysis and understanding of physical and chemical properties is useful to both reducing losses in postharvest processing and predicting rice quality. I therefore focused my attention on both physical and chemical properties as basic indicators for assessing and enhancing rice quality. The overall objectives of this research were 1) to provide information for improving the deficiency of technologies for postharvest processing of rice in developing countries and 2) to contribute to the enhancement of the quality and palatability of rice to meet Japanese consumer requirements.

1. Information for improving the deficiency of technologies for postharvest processing of rice in developing countries

Both moisture content and thickness affect the physical properties of rice. The physical properties of NERICA, Indica and Japonica types of rice were therefore assessed and compared considering different levels of moisture content of rough rice and different thickness fractions of milled rice. Dimensional, mass and frictional characteristics were measured for each level of moisture content and each thickness fraction. The results obtained provided information that can be useful for improving the deficiency of technologies for postharvest processing. The NERICA and Indica types were found to be similar in the kernel dimensions of rough rice and in the dimensional, mass and frictional characteristics of milled rice. This result could be applied to developing technology-transfer strategies in countries where NERICA production is expanding.

The information obtained in this study can contribute to a reduction in postharvest losses, thereby relieving constraints to NERICA expansion, increasing production and enhancing grain quality in developing countries.

2. Contribution to the enhancement of quality and palatability of rice to meet Japanese consumer requirements

Amylose and protein content are essential to the high palatability and good taste demanded by Japanese consumers. In previous studies, both constituents have been found to influence the physicochemical properties of Japonica varieties produced in the Kyushu and Honshu areas of Japan during the growing period. This study examined the relationship between physicochemical properties and kernel maturity of rice produced in Hokkaido. The analysis was carried out while the brown rice was being processed by a color sorter machine and during processing in a grain elevator. Samples comprised mostly of translucent sound whole kernels, which were classified as mature, were thicker, heavier and had a higher percentage of amylose content and lower percentage of protein content. This result suggested a relationship among amylose content, protein content and physical properties. Also, there were similarities in protein content between samples comprised mostly of kernels with an opaque region, which were classified as chalky, and samples comprised of mature kernels. This similarity in protein content was caused by similarities in the shape of the mature kernel and chalky kernel analyzed by length to thickness ratio, and width to thickness ratio. The lower percentage of protein content in samples comprised mostly of thicker kernels suggested that protein content could potentially be sorted by thickness fractions.

At grain elevators in Japan, when rice is received from farmers, protein content, moisture content and sound whole kernel rate are automatically inspected using a near-infrared (NIR) spectrometer and a visible light segregator. Ideally, amylose content would be added to the set of properties to predict rice quality. But NIR spectroscopy at grain elevators is not accurate enough at determining amylose content. Based on the relationship between amylose content and physicochemical properties of Japonica non-waxy rice varieties produced in Hokkaido, I developed a calibration model using NIR spectroscopy and physicochemical information. Physicochemical properties were found to improve the accuracy of the calibration model for assessing rice amylose content by NIR spectroscopy. Consequently, the calibration models developed, which are named dual-step calibration models, enable grain quality screening to be done in accordance with rice amylose content at grain elevators. The assessment of rice quality at grain elevators when rice is received from farmers could be improved, contributing to the high palatability and good taste demanded by Japanese consumers.

3. Conclusions

The information obtained from the results of this research can be useful for improving the deficiency of technologies for postharvest processing of rice in developing countries. The assessment of rice quality at grain elevators can be improved, thus enhancing the quality and palatability of rice to meet the requirements of Japanese consumers.