Rice whole grain milling yield by near infrared transmittance

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Introduction

The value of a sample of paddy rice is determined by the amount of whole grain white rice that can be milled from it. As broken milled rice is worth only about half as much as whole grain milled rice, the ability to rapidly estimate the whole grain milling yield of a sample of paddy rice would be of considerable economic value.

Experimental rice milling is really a series of procedures through which a sample is taken, rather than a precisely defined analytical method. The result is a measure of the potential milling quality of the rice sample provided that the bulk from which it was obtained is dried and stored in a similar way to the test sample. Traditionally, the analysis for whole grain involves drying paddy to 12–14% moisture, cleaning the sample of empty glumes, hulling, aspirating, batch friction milling and separating the whole and broken grain using an indent cylinder. The process is complex, tedious and can be influenced by operator technique and sample handling procedures. Trained operators can obtain consistent results but operator skill remains a considerable factor in the accuracy and reproducibility of the analysis. Good rice test millers usually have a reproducibility of between 1% and 2% whole grain.

Rice whole grain milling yield is influenced by two major factors. The first is the presence of stress cracks in the paddy rice. Stress cracks, also known as checking or sun-cracking, occur when rice is stored under conditions that allow the development of large gradients in moisture content to occur within individual grains.[1] These cracks occur along the lines of the endosperm cell walls in translucent grains and result in the presence of obvious fracture planes.[2]

The second major influence on whole grain milling yield is the presence of chalky or opaque areas within the endosperm of rice grains. The opaque appearance of the endosperm is due to light refracting from the air spaces that are caused when cells are incompletely filled with starch. These air spaces result in a reduction in the strength of the cells and a tendency for cracks to occur through the cells themselves. The tendency to develop chalky centres is genetically determined but can be strongly influenced by climatic conditions. Some varieties never develop chalk whereas other varieties may have a majority of clear translucent grain in some seasons and in others be badly chalked.

We have previously been able to demonstrate that rice whole grain milling yield can be estimated using near infrared (NIR) on ground paddy rice.[3] This approach could not however be adapted to load-by-load receival testing as much of the Australian rice crop is usually received at moisture contents near or above 20%.[4] At these moisture levels, grains are difficult to grind. The recent adoption of NIR transmittance instruments for moisture segregation at receival by the Australian Rice Industry[4] encouraged us to attempt NIR transmittance calibration for rice milling yield.

Materials and methods

To investigate the possibility of determining the whole grain milling yield using NIR transmittance analysis, samples of paddy rice were obtained from retention samples held by Ricegrowers' Co-operative Mills Ltd at their Quality Appraisals Laboratory. Samples representing a full range of whole grain milling yield from the Australian medium grain variety Amaroo were selected.

The Grainspec near infrared transmittance instrument, developed by Foss Electric (UK), (Radiometer Pacific, Terrey Hills, NSW) was used. A calibration was developed using the Tracker software provided with the instrument. This software uses the partial least squares (PLS) technique.

It is difficult to assess how clean a sample is because rice is a covered grain. Samples with large numbers of flatheads, or sterile glumes, can give inconsistent results due to different packing density. To improve the cleanness of samples presented for testing, a cascading aspirator (Kice DT-2 mini-aspirator, Kice Industries Inc., Wichita, Kansas) was used. It has improved the accuracy of all NIR transmittance testing. All NIR transmittance calibrations and verifications were done using paddy rice cleaned through the Kice Aspirator.

Whole grain milling yield of these samples was determined by a procedure similar to that described by Adair.[5] A 1200 g sample was de-hulled through a Satake testing husker model THU35A (Satake Corporation, Hiroshima-ken, Japan) and the resultant brown rice polished using a M^{c}Gill No. 3 Miller (HT M^{c}Gill Co., Houston, Texas) using time and weight settings appropriate to each variety. The total white rice obtained was separated into whole grain and broken rice using a motorised indent cylinder of our own manufacture.

Calibration

The calibration obtained with the Tracker software using seven PLS factors is shown in Figure 1. This calibration compares favourably with those previously obtained by NIR reflectance of

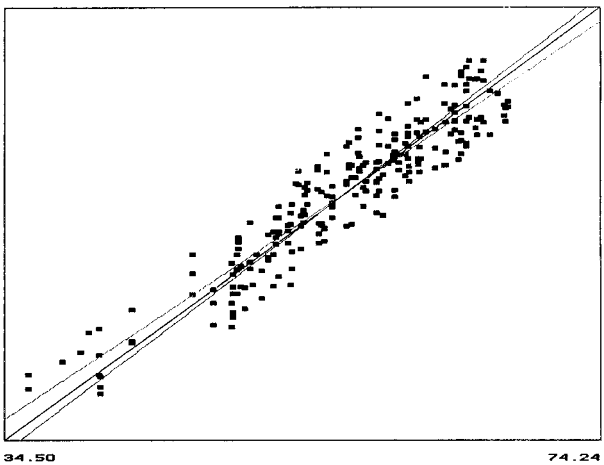

Figure 1. Calibration for whole grain milling yield in rice developed on Tracker software.

Table 1. Whole grain milling yield calibrations by NIR reflectance and NIR transmittance.

Calibrations	r^2	*SEC*	*SEP*
Milling yield by ground grain NIR reflectance (all varieties)	0.92	3.24	4.34
Milling yield by ground grain NIR reflectance (variety—Pelde)	0.87	1.97	2.71
Milling yield by whole grain NIR transmittance (variety —Amaroo)	0.87	2.92	3.19

ground rice (Table 1).[3] Rices from different seasons and growth areas do not verify as well as rices from within a season and the storage history of samples may also influence the results. We are continuing to work on calibrations of this type and hope to be able to use this analysis system next season to evaluate the dried retention samples from farmers' deliveries.

Conclusion

Calibrations for the full range of varieties grown by the New South Wales rice industry[6] or an all-variety calibration will need to be developed. The present medium grain calibration is very encouraging and may be of direct use in the post-harvest estimation of rice milling quality. For direct receival, segregation calibrations need to be developed on freshly harvested rice. We are encouraged by the knowledge that for effective practical segregation, classification will only need to be into good, intermediate and poor milling classes.

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