New tools for precise & efficient grain evaluation

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IN A RICE HULL

- The rice chemistry team endeavours to adopt new tools and technologies to improve the current grain quality evaluation procedures
- With the purchase of a new grain inspector 'Cervitec' and the implementation of new molecular techniques, quality parameters of breeding lines can now be assessed more precisely, thus assisting rice breeders to develop new varieties more quickly

Rice breeders at Yanco Agricultural Institute develop new rice varieties suited to different niche markets and a wide range of cuisines. The rice chemistry team at Yanco plays a pivotal role in evaluating the grain quality parameters of various crossbreds and providing precise and timely information to breeders. To improve the efficiency and precision in assessing various quality traits, the team is evaluating the capabilities of latest instruments and embracing appropriate new technologies.

Each year the rice chemistry team evaluates a range of quality parameters on grain harvested from field trials at different stages of the rice breeding program (Table 1).

2004–05 highlights

Some of the highlights of the quality evaluation program from the last season are as follows:

Installation of a new grain inspector 'Cervitec'

In July 2005, the new grain inspecting instrument 'Cervitec' was commissioned at Yanco for evaluation of grain morphological features. The grain inspector is directly hooked up to a bar-code reader (Figure 1) that can record the encoded details of each sample on the database before it is analysed for grain quality parameters.

The new instrument is capable of evaluating four different parameters in one go, namely, percentage intact and broken grains (milling yield), grain dimensions (length and width), percentage chalk and grain cracking. These traits are marked with an * in Table 1. In the past, these evaluation procedures were labour intensive and accurate estimation of grain cracking was not feasible. Thus additional informationand efficiency in grain quality evaluation means a valuable set of data can be provided to breeders in a timely manner, so that they can make informed decisions in

Table 1
Grain quality parameters analysed in the 2004–05 harvest season

	Traits analysed	Number of lines tested (approx)
1.	Milling yield*	4500
2.	Grain dimensions*	4500
3.	Chalk*	4500
4.	Cracking*	4500
5.	Colour	4500
6.	Gelatinisation temperature	1600
7.	Pasting properties of rice flour	400
8.	Texture of cooked rice gel	300
9.	Amylose content	300
10.	Molecular marker for *Waxy* gene/amylose content	1600
11.	Molecular marker for fragrant/non-fragrant gene	300
12.	Chromatographic analysis for fragrant compounds	80

* these traits are measured simultaneously on the new grain inspecting 'Cervitec'

selecting crossbred lines for further progression through the breeding program.

New molecular markers for genetic evaluation

The use of DNA markers provides a valuable tool for analysing the genetic make-up of crossbred lines. For the past few years a *Waxy* gene marker has been successfully utilised in the quality evaluation program, to follow the pedigree of various crossbreds and to predict the grain quality-type of the crossbreds. *Waxy* gene controls the synthesis of amylose, which is an important component of starch and dictates as to whether the cooked rice will have soft, firm or gluggy texture. Recently at Yanco, we have designed a new set of markers that provide better resolution between different types of the *Waxy* gene present in various crossbred lines.

In addition to the *Waxy* gene markers, a new set of molecular markers for detecting the presence of a gene for fragrance in aromatic rices has been successfully implemented. This gene marker, developed at Southern Cross University, can detect if the fragrant gene is present or not and if the crossbred is a pure breeding type (homozygous) or mixed type (heterozygous) (Figure 2). The mixed type crossbred needs to be grown for further generation(s), to make it pure.

The main advantages of this fragrance gene marker testing is its objectiveness and precision, replacing the old test of chewing the grain. Implementation of this new marker system means that the presence of the fragrant gene and its homozygous or heterozygous nature can be determined in a single test, which utilises the same DNA sample isolated for the *Waxy* gene marker. Thus breeders can have reliable information on the genetic make-up of their fragrant crossbreds.

New techniques to extract and analyse aromatic compounds from fragrant rice

Aromatic rice is an important product as it fetches premium dollars in both local and export markets. The fragrance characteristics of aromatic rice are determined by the quality and quantity of various aromatic compounds present in the grain. Two of the advanced fragrant lines (YRF208 and YRF209), which are close to release as new varieties, have some differences in their taste and aroma. Since it is crucial to determine the quantity of various aromatic compounds present in rice grain, the chemistry team has established methods to extract and analyse them. It is anticipated that this chromatographic technique would allow detection of minor chemical differences between the two fragrant lines, which was not feasible by the simple grain tasting.

Grain storage and pasting properties

The effect of grain storage temperatures (4°C and 20°C) on cooking properties of rice was assessed in three varieties namely Amaroo (soft, medium grain), Illabong (risotto rice) and Doongara (firm, long grain). The cooking (or pasting) properties of rice are evaluated by a Rapid Visco Analyser (RVA), where a mixture of rice flour and water is gradually heated and then cooled, and the resulting change in its viscosity is measured as a pasting curve (Figure 3). The difference between the final peak and the first peak of a pasting curve indicates as to whether the cooked rice will have a soft or firm texture. Over the 8-month period, the first peak of the pasting curve increased (Figure 3, red line) over the original peak (black line) in Amaroo stored at 20°C, while the samples stored at 4°C did not show any change in the peak height (blue line, Figure 3).

A similar trend was observed with Illabong samples (data not shown). It was interesting to note that storage of Doongara at 20°C did not show any change in its pasting curve (red line, Figure 3) over time, which is a unique feature observed so far only in the Basmati type rice. Moreover, its storage at 4°C resulted in decreased peak height (blue line). These samples will be further analysed to understand the physico-chemical and functional changes occurring during grain storage, particularly in Doongara rice.

Evaluation of new instruments for grain quality attributes

Grain samples of Amaroo, grown at four levels of nitrogen (0, 90, 180 & 270 kg N/ha) were analysed for various

Figure 1 *The newly set up 'Cervitec' with a bar-code reader at Yanco Agricultural Institute*

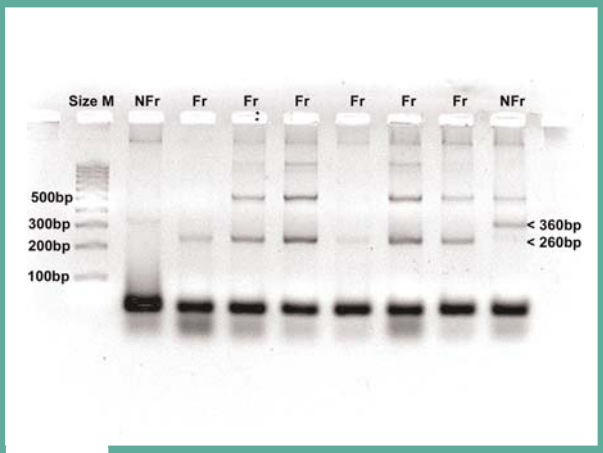

Figure 2 *Analysis of rice lines using the fragrant gene markers. The fragrant lines (Fr) contain a unique band of 260 bp while the non-fragrant lines (NFr) contain a unique band of 360 bp. Size M = Molecular weight marker.*

quality parameters. There were no apparent differences in amylose content or gelatinisation temperature in these samples. However, the cooking properties assessed by the RVA at Yanco showed some interesting patterns. One of the chemistry staff has taken these samples to International Rice Research Institute (IRRI), where she will test these samples on a rheometer (an advanced instrument available in that lab) and compare them with the RVA results. It is anticipated that this scientific visit and the opportunity to analyse grain samples at the international laboratory would not only allow us to evaluate the capabilities of the new instrument but would also foster links between the Yanco and IRRI labs.

Further research work

At present, the other research areas being pursued in the rice chemistry team are:

- *Understanding the genetic basis of grain cracking that makes one genotype more prone to cracking than the others*
- *Identifying the limiting factor in rice lines that show higher percentage of chalkiness*

Experiments are in progress where detailed chemistry and structure of grains from parent lines known to be resistant or sensitive to cracking and chalkiness are being analysed and the unique features examined in their crossbreds.

- *Understanding the effects of nitrogen application and its timing on grain quality features*

Glasshouse experiments are in progress to assess the possible effects of different nitrogen levels and split and non-split applications on grain composition and cooking quality of rice. As the main component of rice grain is starch, expression patterns of various starch biosynthetic enzymes are being examined to understand how nitrogen nutrition affects the cooking properties.

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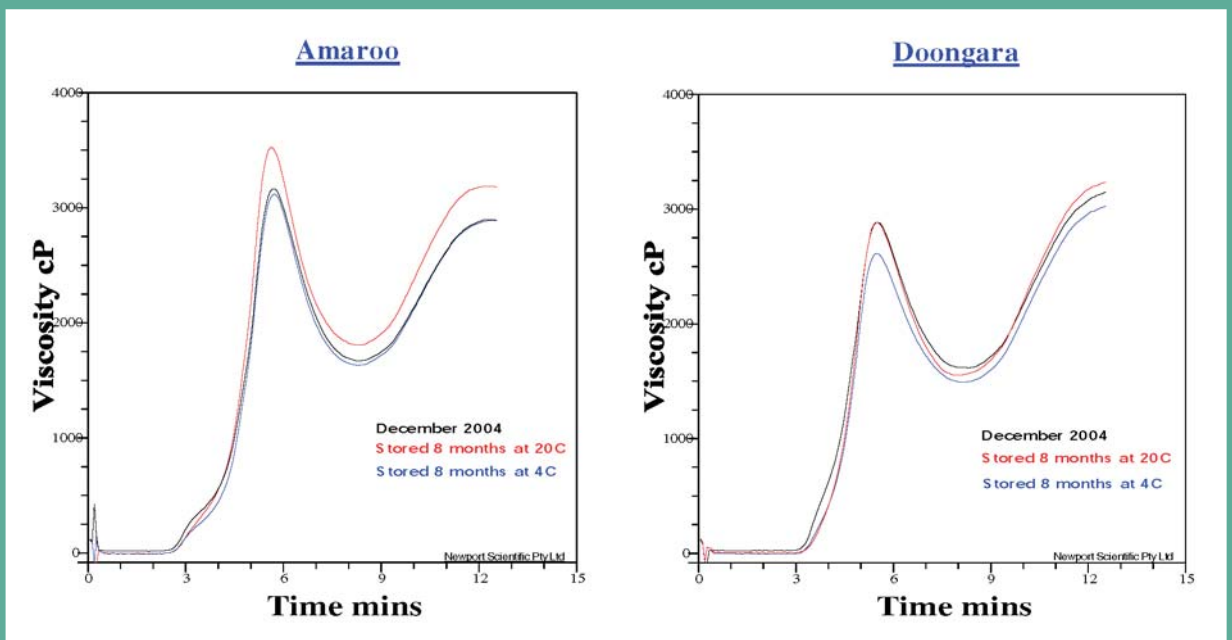

Figure 3 *The effects of storage time and temperature on cooking properties, indicated by RVA curves, for Amaroo and Doongara rice flours, from fresh grain samples (black), grain stored at 20°C (red) for eight months and grain stored at 4°C for eight months (blue). For softer cooking rice such as Amaroo, the final peak is always lower than the first peak, while it is the reverse for the harder cooking rice like Doongara.*