



# **VALUE ADDED WHEAT CRC PROJECT REPORT**

## **Grain Science in Pacific Rim Countries**

### **Report on AACCC Pacific Rim Meeting 17 – 10 March 2003**

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**Grain Science in Pacific Rim Countries:  
Report on AACC Pacific Rim Meeting,  
17-19 March, 2003**

**D.Miskelly<sup>1,2</sup> and C.W.Wrigley<sup>2,3</sup>**

**INTRODUCTION**

The conduct of occasional 'Pacific Rim Meetings' fits with the stated mission of the American Association of Cereal Chemistry (AACC) of 'advancing grain science worldwide'. The 2003 Pacific Rim Meeting was one of a series of conferences in the Pacific region with varying degrees of AACC involvement. In this case, the meeting was wholly sponsored by the AACC.

The theme was 'Wheat Quality Management and Processing into the 21<sup>st</sup> Century', so papers dealt solely with wheat, its marketing, processing and chemistry, the accent obviously being on the countries surrounding the Pacific. Countries represented included Argentina, Australia, Canada, China, India, Japan, South Korea Thailand, USA, as well as Belgium, England, Hungary, Spain and Sweden. The meeting was described as 'cosy' (by comparison with the Annual AACC Meeting) with about 80 delegates. The program consisted of 35 lectures (all about 20 minutes) and 34 posters (according to the list of abstracts). The book of abstracts is available for loan from Di Miskelly or from Colin Wrigley. Items of specific interest to individuals in the CRC have been passed on to them directly.

**MARKETING**

An initial accent of the program involved descriptions of the changes that are occurring in international wheat markets, with speakers from America (Henry Stevens), Canada (Graham Worden) and Australia (Bob Cracknell). All spoke of the 'non-traditional exporters' entering the market, namely, India, Pakistan, and Black Sea countries. They have been able to undercut the 'big three' (USA, Canada and Australia) in price, though with a commodity that lacks consistency of quality, due to their lack of infrastructure. It is thus becoming important for the traditional exporters to meet market requirements more precisely than ever.

The USA has previously prided itself on having low-cost handling, but there is now the need for better quality testing at the elevator, and for 'identity preservation' through storage and transport, but they lack the diagnostic tools to achieve these goals. Most needed are tests for gluten quality and starch quality. In the near future, 'high standard-deviation wheat' will be low priced wheat and 'low standard-deviation wheat' will be premium wheat. Stevens admitted in questions that the US problems with quality variability are greater than those of Canada or Australia.

Graham Worden described the major change that is starting to alter the traditions of the Canadian wheat industry, namely, a move away from their four 'pillars':-

- their kernel visual distinction (KVD) system of visual identification of varieties into four distinct classes;

- a system of variety registration that requires any new variety to be visually distinguishable from others of a different class (a system that greatly limits the ability of breeders to improve yield and quality);
- a rigid grading system involving separate grades;
- a grain-handling system designed to maintain grade distinctions, with on-farm storage at 9,000 farms, through to primary and terminal elevators.

The new system, to be introduced gradually, involves:

1. Class eligibility lists of varieties.
2. A declaration (legal affidavit) that the wheat delivered is one of the list accepted for the designated grade (as in Australia, except that we require the actual variety to be nominated).
3. Monitor all shipments for varietal identity, using sample retention.
4. Applying variety testing, such as gel electrophoresis, for 'trace-back' checking.
5. Accountability, involving penalties and advantages that are enforceable.
6. Export certification, providing assurances that a shipment contains only eligible varieties.
7. A cost-benefit review before registration of 'non-KVD' varieties.

All these stages of implementation will be subject to review and consultation with the industry. Asked about methods of varietal identification being examined by Canada, Worden saw the 'conventional method' of protein gel electrophoresis being used for some time, with the possibility of DNA methods being 'some years off'. A particular concern is the identification of non-approved US varieties creeping over the border.

Bob Cracknell's description of the Australian industry started with the changes in AWB Ltd, still a 'single-desk exporter', listed on the Stock Exchange with a market capitalization of \$1.2 billion. He indicated that a problem for the Australian wheat industry is the cost of storage, handling and transport, which at \$1.4b/year is high by international standards. Currently this problem is being addressed by changes in BHCs and by AWB Ltd getting involved financially in storage (now owing 50% of the Melbourne Port Terminal) and in 'contract trains'. Further changes anticipated include the merging of GrainCo and GrainCorp. Other changes are exemplified by the recent diversification of GrainCorp into milling with Cargill.

## **GRADING AND HANDLING**

Again, speakers were the 'big three', in the sequence of market size (US, Canada and Australia). Marianne Plaus (USDA GIPSA, Washington, DC) described developments to extend the capabilities of NIR via artificial neural networks, especially addressing calibration in this way for protein testing. She described the increasing difficulties of effective use of visual examination to determine quality classes with new varieties and increased blending. These trends thus lead to the ongoing need to develop new objective diagnostic tools, especially involving the USDA labs at Manhattan, KS, and the need to revise traditional wheat-quality standards.

Jim Dexter (Canadian Grain Commission) sketched some historic background for the Canadian wheat industry, especially for their inspection system, leading into current difficulties and changes in their inspection system, based on the concept of delivering quality as customer specification of functional properties, with the overall goal of 'uniformity and consistency'. Sprouting, long a Canadian problem, is now classified at two levels – 'sprouted' and 'severe sprouted'. Fusarium-damaged kernels (FDK) is still a big problem, and tolerances

have been tightened. FDK is now admitted to damage processing (this was questioned in some earlier GRL papers). In the near future, there will be a further decentralization, with the expansion of service offices. They plan to use the RVA to predict Falling Number; an  $r^2$  of 0.96 has been obtained in an extensive survey with SEP of 13 seconds (also see poster abstract #1). Jim saw a future for image analysis, especially to assess hard vitreous kernels in durum, with a roll-out for evaluation soon. This would be especially relevant to the introduction of a new extra-strong durum variety, Navigator. DNA-based technologies for rapid objective testing at low cost on-site was described as still 'a dream'.

Bob Cracknell started his presentation with history, starting with Guthrie, explaining the 1923 decision to confine registration to white wheats, progressing through the 'filler' role of Australia's FAQ wheat (mid century) to the concentration of effort on targeting niche markets for quality. In question time, Bob described the goal of providing a test for gluten strength as 'the Holy Grail' of cereal chemistry – and a great industry need. Others agreed.

## **BREEDING**

Ron DePauw (Canada Ag, Swift Current) claimed that breeding could solve problems of abiotic stress, specifically for his region involving non-hard vitreous kernels and loss of protein content. On the other hand, he did not see any possibility of breaking the impasse between grain yield and protein content, because of the thermodynamics of grain metabolism, with 1 gram of glucose producing either 0.83 g starch, or 0.40 g protein or 0.33 g lipid. He emphasised Fusarium as an 'explosive' consumer problem. Improved methodologies in breeding include doubled haploids, molecular markers, and in the long-term, he includes GMO methodologies. He sees marker-assisted breeding as helping more with traits that are difficult to evaluate, considering markers more relevant to screening for Fusarium tolerance than for dough strength, testing for which with glutenin subunits is relatively straightforward.

Tony Blakeney described the current transition in Australia from breeding by state-government agencies to a 'corporate model based on competing companies'. Corporate changes in handling, marketing and processing were also described. Noodle wheats were described as an example of a specialized end-use of Australian wheat. He saw molecular markers playing an important role in the selection of suitable breeding lines. Another tool relevant to wheat breeding is the use of micro-NIR analysis, currently applicable to rice samples, involving single grains, half grains or as little as 20 mg meal.

The move into white wheats in North American was again described by Bob Graybosch, (USDA Lincoln, Nebraska) specifically in relation to the Great Plains winter-wheat area, mainly hard grained. Breeding there is based in government institutions. White wheats presently represent about 15%, but stable at that. Kharkof (rye lines) have contributed to a 150% increase in yield (calculated on the basis of 1931 data), without decreases in protein content or test weight. Current breeding objectives are winter hardiness (especially for seasons when there is poor snow cover to moderate the effects of winter cold). Russian wheat aphid has not been so severe a problem as was earlier anticipated. He predicts that Clearfield wheats (from BASF) will become more common because of their herbicide resistance, permitting the spraying for weed grasses, especially goat grass. Marker-assisted selection is valuable for leaf rust, virus resistance, fusarium, sprouting resistance, but not so useful for yield generally nor for dough strength. He sees a future for transgenics in relation to Roundup resistance, Fusarium head blight and for modified dough properties. His main methods for quality screening are NIR, PPO, RVA, and Mixograph - even at early generation, using a 1-7 score, based on time to peak and mixing tolerance.

China is the world's largest producer of wheat at 110 m tonnes per year. Recently, production has been reasonably stable, with the result that China has not needed to import much wheat. He Zhonghu, based in CIMMYT and the Chinese Academy of Agricultural Sciences, Beijing, described breeding in China. Many varieties have the 1B/1R translocation, with resultant poor dough quality, plus 80% of the varieties having glutenin subunits 2 + 12, adding dough weakness and poor extensibility. They have additional problems with noodle wheats due to high levels of PPO. All these deficiencies are being addressed, using local and Australian germplasm (especially Eradu, Gamenya and Sunstate). Current goals are to eliminate 1B/1R, to lower PPO levels, to optimise glutenin-subunit composition (HMW and LMW) and to make use of Wx-1B genes. The government is starting to provide additional funding for breeding research and for marketing.

## **MILLING**

In the milling session, participants reviewed their industries in the US, Japan and Australasia. Glen Weaver, Vice President of Technical Services and QA/QC for Conagra, described challenges to the US industry in terms of keeping consistency of ingredients, assisting their customer base to improve their product quality and in improving mill profitability by being a preferred supplier. There is increasing pressure on mills in terms of nutrition, microbiology, fumigation, product recalls, audits, allergens, HACCP, GMO's kosher certification and SAP. These are the same challenges faced by most mature markets worldwide. The US segregates wheat only on protein, not on variety, as in Australia. Production is increasing, but mills are operating at about 85% capacity utilisation.

Japanese consumption of wheat has stabilised at 32kg/head over the last few years, according to Satoshi Nomura from Nisshin Flour Mills, one of the big 4 Japanese millers. Major products are bread (40%), noodle (32%), confectionery (14%), household (4%) and industrial (2%). Flour whiteness is valued, hence many flours are low ash. Much milling research is focused in understanding baking performance and quality requirements for udon and ramen noodles. Food manufacturers are facing strong competition and expending technology and marketing efforts to compete with the traditional dietary culture.

Both the Australian and New Zealand milling industries have undergone extensive rationalisation over a number of years (Di Miskelly, Allied Mills). NZ millers operated under a regulated market until 1986, purchasing local wheat. Now 50% of the total milling requirement of 330,000 tonnes is imported, mainly from Australia. Australian mills have been rationalising since the 1950's, and currently there are 31 mills remaining. 90% of the market is in the hands of three milling companies. Per capita flour consumption is 67kg in Australia, 70kg in NZ, and 65kg in US.

## **BAKING**

The baking session reviewed the same three countries, with additional papers on frozen doughs, innovation in micro-ingredients, the Australian developed small-scale dough processing and image-analysis systems for bread quality.

Ken Kainuma, Manager of the Central Laboratory, Yamazaki Baking, stated that the Japanese baking industry had shown no growth over the past decade. Generally, unit price has declined, following the long-term recession. However, there is an increase in consumption of ready-to-eat or fast foods containing bread. Following reports of food poisoning, detection of over use of agriculture chemicals, GMO's and BSE in domestic cattle, food safety has now become the

number-one concern of consumers, above taste, price, nutrition, value and energy value. In response, the Japanese Institute of Baking Technology has introduced the AIB Food Safety Standards, based on GMP. Food processing companies must now label with GMO and allergens information. Recent new technologies include scalded dough and use of anti-mould sponge-and-dough improved shelf life of bread.

The US industry has seen many changes (Maureen Olewnik, American Institute of Baking), but there are signs that the recent spate of mergers is slowing. This has seen the formation of mega companies, who must bow to the “Walmart factor”, where supermarkets dictate the terms of how business is done (83% of US consumers shop at Walmart or Sams). Some recent trends:

- decreases in claims for reduced fat, calories, high fibre, low salt and low sugar
- increases in fortified food sales (and added nutrient, organic, added calcium, all natural)
- soy for men’s and women’s health
- extended shelf life – bread staling rates cut by half, shelf life now 7-10 days
- allergens – three million Americans have peanut allergy
- trans fats – labelling coming
- industry pressures eat at margins
- FDA has an acrylamide plan, very quick response after publication
- 50% of consumers comfortable with GMO

Australia has seen a decline in the number of plant bakeries (Ken Quail, BRI) with an increase in in-store bakeries and franchised hot bread shops. Bakers Delight now has 500 stores in Australia. There have been a number of new products developed, including high-fibre white breads, and breads containing soy and omega-3 fatty acids. BRI has been involved with energy benchmarking and using NIR to measure dough mixing.

Daihachi Iga, from the Japanese Institute of Baking Technology reported on the use of freeze-tolerant yeast in frozen doughs. A survey of different types of freeze-tolerant yeasts showed a big variation in fermentation, operation in sponge-and-dough vs no-time doughs, different sugar levels, bread crust colour and dough freeze-thaw stability. Frozen doughs now account for 6% of total bread sales in Japan.

As reported by Maureen Olewnik, extended shelf life (ESL) breads have become big business in the US. Larry Skogerson of American Ingredients Company, expanded on the benefits of ESL to large baking companies – including a 5% reduction in returns and 10% reduction in routes, resulting in an increase in profits. ESL breads develop off-flavours after three weeks. The enzyme system used is critical, with high doses needed, adding a 3x factor to the costs. Other items to consider in ESL are bakery sanitation and use of anti-microbial agents.

Frank Bekes, from CSIRO and formerly QWCRC, presented the range of small-scale dough testing technologies, partly developed through the QWCRC. These included the micro mill, Z-arm mixer, micro-extension tester, texture analyser, 4g-noodle machine and 2g baking.

Sue Salmon, Campden & Chorleywood FRA, described the capabilities of the C-Cell, image analysis software for evaluation of crumb cell structure and its application in white and wholemeal bread, pizza, baguette and cake. It has been used for looking at wheat variety effects, changes in mixer work input, vacuum mixer pressure variations and variations in crumb-cell structure throughout a loaf. The software is not cheap in \$AUD, but looks very powerful.

## **NOODLES AND PASTA**

This session overviewed the Canadian durum industry, the Asia Pacific noodle industry, how research has helped shape the quality of noodle wheat in WA, and reported on ready-to-eat noodles in Japan.

Tony Tweed from the Canadian International Grains Institute (CIGI) discussed the variation in world-wide pasta consumption. He went on to describe the use of a debranner prior to milling (Dexter *et al*, Cereal Chem. 1994 and 1996) and market quality (higher protein, stronger gluten, better semolina/pasta quality, improved milling yield), as well as varietal differences between Canadian durums. The question was posed as to whether there is an upper limit to the degree of yellowness required by the customer, given there is genetic potential to increase yellowness. There have been improvements in processing with the introduction of the Buhler Polymatik press, designed as a clean-in-place system to improve plant hygiene. CIGI have a state-of-the-art pilot pasta plant.

Noodle processing in the Pacific Rim was reviewed by Dave Hatcher from the Canadian Grain Commission GRL (also see poster abstract #2). Three million tonnes of Canadian wheat is used in noodles (CWRS 1 and 2, CPSW and CWHN). The Canadians (and US) have recognised the market preference for white-branned wheat for noodles, a number of new varieties were discussed elsewhere during the conference. General noodle specifications include white wheats with a Falling Number of >300secs. Flours are milled from mixed grists, and millstreams selected to give best quality at the lowest price. Particle size should be less than 130 microns. Flour is sold bagged in many countries. There are various sized noodle producers with different techniques. One trend is the movement of products between countries, and another the demands on both wheat and flour specifications to match evolving markets. Recent advances include vacuum mixers and the use of wavy rollers. Australian noodle-wheat breeders and chemists need to be aware of the developments in North American white-noodle wheats which could challenge the Australian market lead.

Graham Crosbie (WA Department of Agriculture) reviewed WADA research work, initially in collaboration with Japanese research workers, the recognition of the importance of starch quality to udon noodles and the development of the FSV test for the breeding program. This underpinned the successful WA noodle-wheat segregation and the continuing development of new noodle wheats.

Ready-to-eat noodles, chouli-men, have been an important category in Japan since the 1980's (Tom Moro, Nippon Flour Mills). Chouli-men are cooked noodles of all types packed with meat, vegetable and condiments, sold in the chilled foods section of convenience stores. They are favoured by young people, and those who eat alone, and mainly consumed in autumn and spring. Textural properties are important, as well as a balance between noodles and the other ingredients. Shelf life is 2-3 days. Research to improve quality has focussed on vacuum mixing and the use of subsidiary ingredients such as tapioca starch.

## **ID/MARKERS**

George Lookhart (USDA, Manhattan, Kansas) described his interactions with the USDA Federal Grain Inspection Service, and their need for varietal identification. He receives samples for variety checking 'every week or two'. His main method of identification at present is capillary electrophoresis (he called it 'high-performance capillary electrophoresis' (HPCE)). Alternative methods that he has used in his lab are reversed-phase high-

performance liquid chromatography (RP-HPLC) and polyacrylamide gel electrophoresis (PAGE). He estimated costs for these three methods of identification:

- HPCE takes less than 4 minutes, with capital cost of US\$50k and \$1 per sample.
- RP-HPLC takes 20 minutes with capital cost of \$50k and \$3 per sample.
- PAGE takes 4-10 hours with capital cost of \$5k and \$10 per sample.

George recommended HPCE for the identification of 1A/1R AND 1B/1R lines, but described some difficulties caused by biotypes within a variety having different HPCE profiles. He is interacting with a scientist in the Department of Chemistry at KSU on 'Lab-on-a-Chip', for the next generation of HPCE, which should provide a one-minute identification.

George Lookhart also displayed a poster (#7) on a simplified method for determining dough quality, involving a double extraction with 50% 1-propanol, followed by nitrogen-combustion analysis (Leco). The procedure can cope with 100 samples per day, with good reproducibility, providing good correlations between dough-strength parameters and the amounts of the pellet and % pellet protein (pellet protein/flour protein).

Background on the origins of varietal identification was provided by Colin Wrigley (as requested by the organisers), leading into descriptions of traditional and novel methods of identification. This provided the opportunity of describing methods developed in the CRC. The micro-gel method contrasted with George Lookhart's assessment of PAGE, providing much faster identification. There was considerable interest in the CRC's range of immunoassay methods, with requests for more information to be supplied.

The description of functional genomics by Geoff Fincher (Waite, SA) involved the example of cell-wall arabinoxylans, and the use of gene-silencing methods to inhibit cellulase synthase, leading to the weakening of cell walls and the 'ballooning out' of tissue. Geoff also described efforts in the Australian Centre for Functional Genomics to use genes from grasses of the Simpson Desert to develop drought tolerance in cereals, and the use of anti-freeze proteins from the Antarctic hair grass to confer frost tolerance.

The presentation on NIR analysis by Brad Seabourne (USDA, Manhattan, Kansas) commenced with the quote from Phil Williams that NIR could determine any aspect of grain quality except Fusarium scab. Brad went on to describe 'what's new' in NIR, namely,

- a portable whole-grain analyser (Zeltex ZX-50);
- continuous on-line NIR used on a harvester, with GPS, to map grain quality as well as yield;
- IR microscopy, for use with very small items, such as starch granules;
- networking of instruments to provide calibrations for a range of plant and animal products, thus to greatly extend the analytical range;
- 'chemometrics' using artificial neural networks for process control;
- the Buhler on-line system for flour milling;
- the combination of NIR and colour vision with the Perten SKCS equipment;
- the AIB's real-time dough analysis system, using NIR to monitor dough development.

## **OTHER TOPICS**

Perhaps the first topics in this session could have been entitled "Development of white wheats in Canada and the US", because the common theme was that white, rather than the traditional red wheats, were necessary to remain competitive in the Asian market. The remaining papers

concentrated on a miscellany of topics, including folic acid fortification, market development training and strategies to manage the release of transgenic wheats.

Craig Morris (USDA-ARS Western Wheat Quality Laboratory) gave a comprehensive run-down on strategies for new soft-wheat varieties in the Pacific North West (PNW). Their soft wheats are subdivided into two classes – soft and club. Both are comprised of winter and spring types, which are co-mingled for marketing purposes. 80% of PNW wheat is exported. Soft white has medium to strong dough properties and club wheat is weak. Besides the more traditional milling methods, they use NIR, milling and Mixograph tests, SKCS, solvent retention capacity, PPO, SDS, RVA and SV tests in the breeding program. Udon noodle quality is also targeted. The website ([www.wsu.edu/~wwql/](http://www.wsu.edu/~wwql/)) is worth a look.

Continuing on the theme of white wheats, Odean Lukow described the development of Canadian hard white spring wheat varieties, Kanata and Snowbird. These are aimed at the Asian YAN market, and domestic whole-wheat bread and tortillas. It is claimed that there will be 11 million acres of hard white winter wheat sown by 2005. See also the poster paper (#22) by Humphreys *et al.* appended to this report. Odean claimed that 82% flour extraction for a red-grained wheat is equivalent in flour colour to 86% extraction for a white wheat. In a study she performed at UC Davis, she found that children had a 2:1 preference for whole-grain bread made from white wheat compared to red wheat.

Australia has emerged as a major competitor to US wheat exports, according to Okky Chung. In support of this claim, she described how, in the 10 years 1987-1997, exports of US wheat have declined 40%, and exports of Australian wheat have increased by 100%. Four wheat-quality laboratories work with breeders to test end-product quality, develop reliable small-scale early-generation tests and undertake research into the contribution of flour biochemical components to end-product qualities. The number of end-product tests has expanded in recent years to include Asian noodles, flat breads, tortillas and crackers. Hard white wheats have been developed, with 200,000 acres sown. The US is targeting the traditional Australian markets of the Middle East and Asia.

Changing the theme, Peter Ranum claimed that micronutrient malnutrition is the most prevalent and solvable world health problem. Iron and folic acid are the two most significant deficiencies. Folate was added to wheat flour in the US and Canada in 1997. Since that time, serum folate has increased by a factor of 3, neural-tube defects have halved, and blood-serum homocystine levels reduced (important as elevated levels associated with heart disease and stroke). Australia and NZ are currently considering folic acid fortification.

Pat Berglund (Northern Crops Institute, Fargo, North Dakota) described her institute's involvement in making 'connections to the global market place' for growers, marketers and visitors from overseas. She contrasted their success with 'virtual meetings' (distance), on-site personal meetings, and lecturers going to a remote site to deliver courses.

The final lecture (Ann Blechl, USDA, Albany, California) described a USDA program to define the risks of the GMO process (many of these were spelt out) and to develop strategies to overcome objections to GMOs, while preserving the potential advantages (the Biotechnology Risks Assessment Program). This involves refining the transformation process to have better control of the process, minimising the use of superfluous foreign DNA, and developing new promoters with distinct activities in edible *versus* inedible parts of the plant.

For example, they can now remove marker genes after transformation. The results of this research will be in the public domain, and thus generally available.

## **POSTERS**

Appended to this report are print-outs of some of the posters, namely:-

- #1. Use of the RVA to predict Falling Number: the Canadian experience – D.W.Hatcher
  - #2. Investigation of a small scale centrifugal mixer for the evaluation of Asian noodles. - D.W.Hatcher and K.R.Preston
  - #22. New Canadian hard white spring wheat varieties for producers and end-users – D.G.Humphreys, T.F.Townley-Smith and O.M.Lukow
  - #24. Proteomics as a means of identifying protein markers of variety and quality type. – D.J.Skylas, Y.Mak and C.W.Wrigley
  - #29. Measuring bread dough development with a new rapid mixer – R.I.Booth and M.L.Bason
- 

## **OUTSTANDING IMPRESSIONS**

Successive North American speakers extolled the virtues of white wheats, almost as if this were a new discovery, following up with descriptions of new varieties being implemented, and their export potential. Accordingly, Australian breeders and chemists need to be aware of the developments in North American white-noodle wheats, which could challenge the Australian market lead. Thus, we can expect to see the emergence of new noodle-wheat varieties which will challenge Australia's dominance in the noodle area.

There was a recurring theme of changes in the wheat marketing and processing industries, with ongoing pressures on increased efficiencies being required.

Changes in international markets for the 'big three' exporters indicate that all three will become increasingly focussed on the same perceived value-added markets in Asia. These developments highlight the need and opportunities for providing better diagnostic test systems. We could well give early attention to the suitability of our diagnostics to Canadian varieties, and to the US varieties that are creeping north over their border.

There was significant interest in our immunoassays, both for rapid kits and 96-well ELISA formats, although there was a degree of ignorance of the need for concern about late-maturity amylase, or even for practical analysis of the null-4A aspect of starch quality. Both US and Canadian speakers expressed the need to go beyond visual examination, including renewed interest in the RVA (Canada) to predict Falling Number and in extended application of NIR (USDA FGIS).

Clearfield varieties were mentioned as increasing in agronomic importance in North America.

The speaker from Nisshin Flour Mills (Satoshi Nomura) mentioned the addition of tapioca starch to improve the quality of flour for frozen noodles. Might our starch-modified wheats be useful in this type of application?

There is a USDA program to develop strategies to overcome objections to GMOs, while preserving the potential advantages.

# The use of RVA to predict Falling Number: The Canadian experience

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## Abstract

The Rapid Visco Analyser (RVA) starchometer model (Skovport Biotech, Australia) was evaluated for the prediction of Hagberg Falling Number (Falling Number) in Canadian wheat. The RVA was used to analyse 1000 samples of Canadian Western Red Spring (CWRS) wheat grown in 2000 and 2001. The RVA was used to predict Falling Number (FN) with a standard error of prediction of 12.8 s. This predictive model was applied to over 4000 samples of CWRS and other winter wheat classes in 2002 and 2003. The RVA was used to predict FN in 2002 and 2003. The correlation coefficient (r) was 0.87 and 0.85, respectively. The different polynomial relationships from CWRS yielding  $r^2 = 0.87$ , but with an SED of 12.8 s.

## Introduction

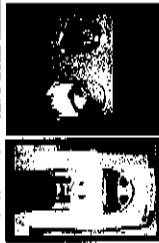
To determine the feasibility of using the RVA Starchometer to predict Hagberg Falling Number in Canadian Western Red Spring (CWRS) and Canadian Western Amber Durum (CWAD) wheat on a large scale, fallow

## Conclusions

The Canadian grading system utilizes a visual assessment of grain to determine kernel damage. This is a time intensive procedure, ~30 min per sample, and a major constraint to the rapid movement of grain from 100 to 600,000 metric tonnes in 107 (one) weeks in Alberta. Anytime a sample is taken from a large lot, it is not representative of the whole lot. Such a sample is not representative of the whole lot. Visual means making the Hagberg Falling Number test an ideal method for wheat commerce. However, the use of the Hagberg test is labor intensive. The Rapid Visco Analyser offers the ability to carry out the same measurement in a matter of 3 min. To date the use of the RVA to analyze wheat samples has been confined to small studies using less than 1000 samples.

## REFERENCES

Equipment  
A preliminary study indicated that the RVA Starchometer (Skovport Biotech, Australia) offered the desirable combination of ruggedness and accuracy for the analysis of multiple classes of Canadian wheat (Figure 1).



## Wheat samples

Samples were secured from individual miller increments of CWRS to determine and verify Canadian poor positions in 2000, 2001 and 2002. Additional samples of CWRS and CWAD from the 2002 harvest were acquired from primary elevators through the active participation of members of the Canadian grain industry in the study.

## Sample analysis

Individual wheat samples were thoroughly mixed prior to being passed through 16 mesh sieve to secure representative sample fractions. The samples were then divided into two equal portions. One portion was used for the RVA analysis. The other portion was stored for the Hagberg Falling Number analysis. The samples were thoroughly cleaned with a vacuum and both between each sample. Moisture content of the ground wheat meal was determined using 100°C oven-dry method for individual classes of Canadian wheat. The RVA was used to predict FN in 2002 and 2003. The correlation coefficient (r) was 0.87 and 0.85, respectively. The different polynomial relationships from CWRS yielding  $r^2 = 0.87$ , but with an SED of 12.8 s.

## Reproducibility

Method reproducibility studies were carried out on two CWRS wheat samples (high and low Falling Number) by the RVA Starchometer. A single grain (about 2100 grains) per run was used. The results are shown in Table 1. The results are shown in Table 1. The results are shown in Table 1. The results are shown in Table 1.

Run	High Falling Number	Low Falling Number
Run 1	780	24.8
Run 2	758	26.8
Run 3	758	26.8
Run 4	758	26.8
Run 5	758	26.8
Overall SD	108	27.2

A range of three different machine using three (3) samples with significantly different falling numbers also yielded excellent machine to machine reproducibility (Table 2).

Sample	Machine	FVN	SD	SE	SEd
Sample 1	A	78.7	10.1	1.4	
	B	74.2	6.2	0.8	
	C	79.2	13.9	1.8	
Sample 2	A	113.0	11	0.1	
	B	118.7	11	0.1	
	C	118.3	11	0.1	
Sample 3	A	148.7	16.9	1.8	
	B	15.6	14.1	0.9	
	C	152.3	20.2	1.9	

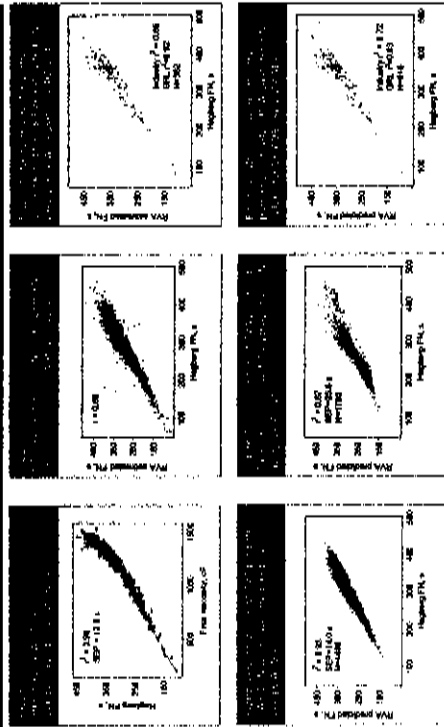
Previous investigations using 2000 and 2001 CWRS wheat samples indicated that the calibration formula provided by Skovport Biotech was based upon either Australian or American wheat samples and was inappropriate for predicting Falling Number in Canadian wheat. An ideal analysis of over 1000 samples of 2000 and 2001 CWRS wheat was required to predict FN in 2002 and 2003. The calibration formula provided by Skovport Biotech was used in the polynomial calibration was required as they displayed  $r^2 = 0.80$ .

The calibration derived from the 2002 and 2001 samples was then used to predict the FN values of CWRS samples grown in 2002. The results are shown in Table 3. The results are shown in Table 3. The results are shown in Table 3. The results are shown in Table 3.

Class	FVN	SEd	SE
1-15	41	42.2	6.9
16-30	58	75.1	36.0
31-45	113	86.4	9.7
46-60	11	55.2	5.5
>60	7.1	13.0	1.6

Difference	Industry pattern	ORL
1-15	41	42.2
16-30	58	75.1
31-45	113	86.4
46-60	11	55.2
>60	7.1	13.0

## Figure 1



## Conclusion

Under ORL necessary conditions the Starchometer RVA appears to offer a fast and reliable means to predict Hagberg FN values in Canadian CWRS and CWAD wheat. Further research will be required to ensure the accuracy of the RVA in predicting FN values from the operational environment of a primary or terminal grain elevator.

## Acknowledgements

The author gratefully acknowledges the contributors and financial contributors to this project by Agriculture Canada, Con Agri Grain Ltd, The Saskatchewan Wheat Pool and Cargill Ltd. The financial contributors of the Canadian Wheat Board and AGRI Inc. are appreciated.

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AMERICAN ASSOCIATION OF CEREAL CHEMISTS. 2002. Approved Method of AACCC. (In use). Approved method 16-01 B and 22-01 B. The Association of C. C. Chem.

The reason for the higher than desirable SED in CWAD has been investigated. The issue lies in the hardness of the CWAD as compared to common wheats. Studies carried out with the ORL have shown that the hardness of the CWAD is a major factor in the prediction of FN. The hardness of the CWAD is a major factor in the prediction of FN. The hardness of the CWAD is a major factor in the prediction of FN.

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# New Canadian Hard White Spring Wheat Varieties for Producers and End Users

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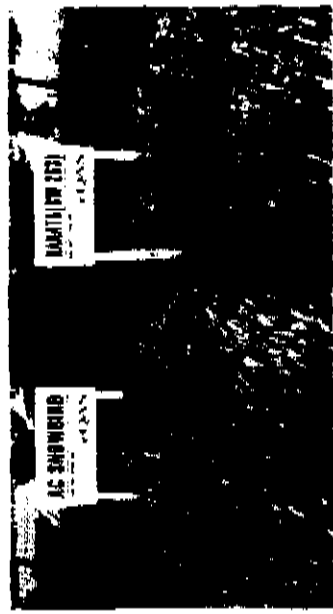
## Overview of agronomic attributes, disease resistance, milling and baking quality of two new hard white spring wheat varieties

### INTRODUCTION

Canada Western Red Spring (CWRS) is the largest class of wheat in Canada, and is sold to end-users around the globe. However, in some markets, white-seeded wheat is preferred to red-seeded wheat, even though end-user requirements may be the same. Markets that prefer white wheat are presently difficult to access for Canadian wheat marketers. Further, white wheat offers advantages to millers and consumers (Symons and Cogswell, 1991; McCaure, 1995). In response to this, a new class of white wheat is under development in Western Canada. To date, two new white spring wheat varieties have been registered: Snowbird and Kanata. Domestic grain production of these varieties is projected to be over 500,000 t by 2005. These lines are agronomically well adapted to Western Canada with favourable disease resistance. The objective of this poster is to outline the agronomic attributes, disease resistance, and milling and baking quality of these new hard white spring wheat varieties.

### PROGRESS AND BREEDING

Snowbird and Kanata were selected from the cross between a white-seeded isogenic line of the sprouting resistant line RL4137 and the CWRS variety AC Blandin. The white-seeded isogenic line derives from the cross RL4137/6/Thatcher/Boo48, where Boo48 is the source of white seed colour. The final cross was made in 1994 at the Agriculture & Agri-Food Canada Cereal Research Centre, Winnipeg. Doubled haploid lines were produced using the maize pollination procedure from F<sub>2</sub> plants. Doubled haploid lines were grown in a disease/dormancy nursery in 1996, and 30 lines were entered into the Hard White Beta test in 1997. Snowbird and Kanata were evaluated in the Central Bread Wheat cooperative test between 1998 and 2000. Snowbird and Kanata were registered for production in Western Canada in 2001.



### AGRONOMICS

Table 1: Agronomic performance of hard white wheat varieties against CWRS check varieties (CBW cooperative test 1998-2000).

Entry	Mean Grain Yield (t/ha)			Maturity (LH)	Lodging (LH)	Height (cm)	Test Weight (kg/hL)	1000 Grain Weight (g)
	1998	1999	2000					
Humphreys	3.650	3.330	3.970	95.1	3.2	1017	71.2	30.6
Boo48	3.520	3.170	3.010	93.1	2.1	983	70.1	30.5
AC Blandin	4.130	4.620	4.430	95.5	2.1	983	78.3	32.2
AC Boreal	3.660	3.880	4.300	95.7	2.1	997	78.0	33.0
Kanata	3.660	3.430	3.980	95.0	1.9	94.0	78.7	31.4
LSO (P=0.05)	3.950	4.060	4.240	95.6	2.1	957	78.1	31.2
LSO (P<0.001)	0.293	0.305	0.271	0.6	0.4	1.9	0.3	1.1

- Snowbird has higher grain yield than most currently grown CWRS varieties
- Kanata is earlier maturing than most CWRS varieties which is useful for short growing season areas
- Kanata has shorter and stronger straw than most CWRS varieties
- Good test weight compared to CWRS varieties

### DISEASE RESISTANCE

Table 2: Disease ratings for hard white wheat varieties and CWRS checks (CBW cooperative test 1998-2000).

Entry	Stem Rust		Leaf Rust		Common Bunt		Fusarium Head Blight		TAN Spot	
	R	VS	R	VS	R	VS	R	VS	R	VS
Humphreys	R	VS	R	VS	R	VS	R	VS	R	VS
Boo48	R	VS	R	VS	R	VS	R	VS	R	VS
AC Blandin	R	VS	R	VS	R	VS	R	VS	R	VS
AC Boreal	R	VS	R	VS	R	VS	R	VS	R	VS
Kanata	R	VS	R	VS	R	VS	R	VS	R	VS
LSO (P=0.05)	R	VS	R	VS	R	VS	R	VS	R	VS

- Snowbird and Kanata are resistant to moderately resistant to leaf rust
- Snowbird and Kanata are moderately resistant to moderately susceptible to stem rust, loose smut and fusarium head blight
- Snowbird and Kanata are moderately susceptible to susceptible to common bunt and tan spot



### QUALITY

Table 3a: Grain and milling quality for hard white wheat varieties and CWRS checks from composite samples from the CBW cooperative test (1998-2000).

Entry	Test Weight (kg/Hl)	LSD (P=0.05)	LSD (P<0.001)	Grain Protein (%)		Flour Protein (%)		Falling Number (sec)		Other Milling (%)	
				Grain	Flour	Flour	Falling	Other	Other		
Humphreys	80.3	32.1	14.5	13.2	6.8	30.5	74.3	0.45	73.3	56.1	
Boo48	79.3	34.1	14.5	14.6	6.7	318	74.5	0.44	73.0	54.3	
AC Blandin	80.9	33.3	13.7	14.0	6.7	412	75.6	0.44	74.0	53.3	
AC Boreal	81.9	33.6	14.4	13.7	6.7	395	74.8	0.45	73.7	51.0	
AC Boreal	81.9	34.7	14.3	13.5	6.7	420	74.2	0.44	74.0	50.0	
Kanata	81.2	31.8	14.7	13.8	6.8	417	74.4	0.45	74.3	50.2	
LSO (P=0.05)	81.2	34.1	14.3	13.6	6.8	428	74.4	0.44	74.3	50.9	
LSO (P<0.001)	0.6	1.5	0.3	0.3	0.1	5	0.7	0.25	2.8	1.7	

- Snowbird and Kanata have high test weight, protein content and preharvest sprouting resistance comparable to Neepawa and AC Boreal
- Snowbird and Kanata have milling quality similar to the best CWRS varieties with moderate hardness, high flour yield and excellent flour colour

Table 3b: Dough and baking quality (Farinograph and Canadian Short Process) for hard white wheat varieties and CWRS checks from composite samples from the CBW cooperative test (1998-2000).

Entry	Farinograph				Canadian Short Process (150gpm AU)			
	Stability (min)	MI (g/h)	MI (g/h)	MI (g/h)	Stability (min)	Peak (min)	Crumb Fall (g)	Crumb Fall (g)
Humphreys	65.9	4.4	32.7	4.5	1147	7.9	58.3	10.1
Boo48	64.4	7.6	28.2	7.2	1150	8.5	70.7	10.5
AC Blandin	66.5	5.1	36.7	4.3	1111	8.2	70.3	13.2
AC Boreal	67.4	5.1	38.3	7.0	1072	8.3	71.3	11.8
AC Boreal	63.3	5.7	36.7	6.3	1115	8.5	64.0	11.1
Kanata	65.6	5.2	34.0	6.3	1067	8.7	69.2	12.6
LSO (P=0.05)	64.2	5.2	35.0	7.3	1071	8.1	69.3	14.0
LSO (P<0.001)	3.1	0.7	5.2	1.3	32	0.3	2.0	2.7

- Snowbird and Kanata have high water absorption and dough quality is towards the stronger end of the CWRS wheat type (i.e. Robin)
- Snowbird and Kanata have good loaf volume and crumb colour

### ACKNOWLEDGEMENTS:

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# Measuring Bread Dough Development with the doughLAB and High Speed Mixer

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## 1 INTRODUCTION

Traditional laboratory dough mixers have enjoyed long-standing use in baking and related industries. However, modern bakeries employ high-energy commercial mixers that are not well matched by the laboratory systems. A new instrument, the doughLAB (Fig. 1), has been introduced, designed to measure dough development during standard or high energy mixing. In this study we report preliminary findings on the effect of varying mechanical and thermal energy inputs on bread dough mixing properties as assessed by the doughLAB.



Figure 1. The doughLAB

## 2 METHODOLOGY

- Prototype doughLAB fitted with standard 50g mixing bowl
- Bulk commercial wheat flour samples branded Défiance and Fabulous
- AACC Method 54-21 modified for speed and temperature as follows
- Effects of speed and temperature tested separately and together (Table 1)
- Model fits and statistical analysis by Minitab 13.

Table 1: Central composite RSM experimental design

Temp. (°C)	Speed (rpm)				
	63	80	121	163	180
25.0			✓		
26.5		✓			✓
30.0	✓		✓✓✓✓		✓
33.5		✓			✓
35.0			✓		

Table 2: RSM model fits of effect of speed and temperature

Dep Variable	Significant Terms <sup>a</sup>	R <sup>2</sup> <sub>adj</sub> <sup>b</sup>	SE <sup>c</sup>
Peak Torque	Int, S, S <sup>2</sup> , T, T <sup>2</sup>	0.999	3.1 gm/5
Peak Time	S, S <sup>2</sup>	0.988	9.5 s
Bandwidth	S, S <sup>2</sup>	0.897	4.0 gm/5
Softening	S, S <sup>2</sup> , T <sup>2</sup>	0.994	3.9 gm/5

<sup>a</sup>Int = intercept, S = speed (rpm), T = temperature (°C)

<sup>b</sup>Adjusted R<sup>2</sup>

<sup>c</sup>Standard error of the fit

## 3 RESULTS AND DISCUSSION

- Water absorption determined by the standard method (30 °C, 63 rpm) was 62.6% for Défiance and 63.2% for Fabulous.
- Both samples yielded strong mixing curves with poor peak resolution under standard mixing at 63 rpm (Fig. 2).
- Increasing mixer speed significantly improved peak resolution, reduced time to peak, reduced bandwidth at peak and stability, and increased softening (Figs. 2 & 3, Table 2).
- Increasing temperature significantly decreased peak torque and softening (Figs. 2 & 3, Table 2).
- Repeatability was good for all measurements (Table 2).

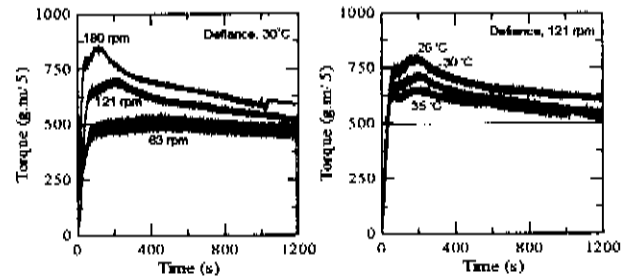


Figure 2. Effect of speed or temperature on mixer curves

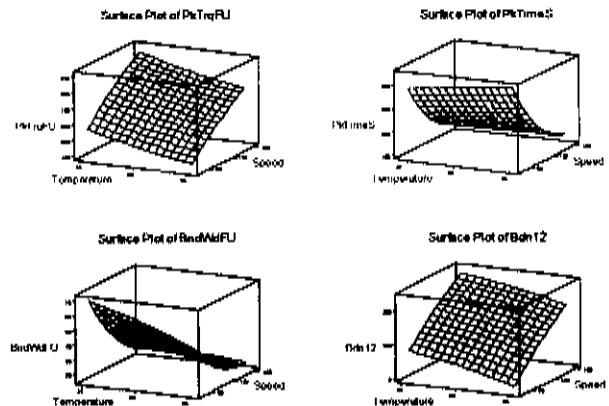


Figure 3. Effect of speed and temperature on mixer curve values of peak torque, peak time, bandwidth and softening.

- The doughLAB is a new instrument for measuring flour and dough quality under standard and high-energy mixing conditions
- Mixing at process-relevant high speed reduces test time and enhances measures of dough peak and tolerance
- High speed results can be related back to standard methods
- Temperature affects dough rheology so must be controlled

We are grateful to Steve Neit, Colin Butcher, Jenny Dang and Richard Knorr for their assistance in this study.