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Baking study: Investigating the quality of some historical and modern Australian wheat varieties

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Key findings

- Targeting improvements in key quality attributes is producing superior baking varieties in Australian wheat breeding programs.

Baking study rationale

Variety selection

A set of 172 historical and modern wheat varieties released between 1860 and 2015 were grown at Collingullie, NSW in 2016. From these, a set of 39 baking-quality varieties were selected. Even though it was regarded as a weak dough type, Ghurka was included due to its importance as a widely grown variety in southern Australia in the 1930s. Modern soft grained varieties were excluded. The selected samples underwent large scale milling and dough testing and were then assessed for baking quality.

Baking quality

To be regarded as having good baking quality in the modern context, a wheat variety must possess a number of key attributes – not only superior baking performance – that combine to make it attractive to wheat processors. These attributes include a:

- high extraction rate (yield of flour as percentage of grain weight milled)
- high water absorption (amount of water as a percentage of flour weight to produce dough of a specific consistency)
- strong but extensible dough (producing a gluten network that can trap and expand around gases produced during fermentation stage of bread-making)
- bright white flour colour (flour yellowness in Australian wheats is regarded as a quality defect).

These qualities form the basis of specifications for the Australian Prime Hard (APH) premium wheat grade.

Test baking methods

The Australian wheat classification system includes three different baking methods: rapid dough, straight dough, and sponge and dough (S&D). Varieties are assessed for performance in one or more of these methods depending upon the classification grade being sought.

To attain an APH grade, varieties must perform satisfactorily in the S&D and straight dough baking methods. Due to long fermentation times, these methods favour a dough with greater gluten strength.

In this study, a modified version of the straight dough baking method was applied, and the historical varieties' performance compared with modern varieties released with an APH classification grade in southern NSW.

Materials and methods

Wheats were milled using a Buhler MLU-202 laboratory test mill. Flours were assessed for dough water absorption (Perten DoughLAB 2500), and dough strength and extensibility (Brabender extensograph 8600).

Baking used a two-hour fermentation method, adapted from the standard Australian classification straight dough testing method. Doughs (50 g flour basis) were mixed in a DoughLAB at 120 rpm until optimum gluten was developed, divided into two 40 g dough pieces and fermented in sealed

containers at 30 °C. After 95 minutes, the doughs were gently knocked down and run through a Domex bun moulder, and returned to sealed containers for a further 25 minutes fermentation. Doughs were again run through bun moulder, and placed in open square tins for proofing at 85% relative humidity (RH) and 34 °C for 45 minutes. Loaves were baked for 15 minutes at 215 °C, removed from the tin and cooled for 45 minutes, when loaf volume (rapeseed displacement) was determined.

The following day a central 20 mm slice was removed from each loaf and crumb colour measured using a Minolta chromameter CR200 (with an 8 mm head) before being subjected to a standard texture profile analysis (Stable Microsystems TA-XT2) using 50% compression.

From the original set of 39 varieties that underwent baking, this paper reports on the baking quality of historic wheat varieties (defined as those released before 1967 when the Australian Wheat Board (AWB) first introduced classification grades) compared with 12 modern varieties awarded an APH grade on release, as listed in Table 1.

Table 1. Varieties included in baking study in order of release.

Variety name	Release date
Steinwedel	1890
Gluyas Early	1898
Pusa4	1916
Ghurka	1924
Ranee	1924
Dundee	1927
Gabo	1945
Insignia	1946
Stockade	1960
Festiguay	1963
1967: AWB Australia-wide grading system introduced	
Timgalen	1967
Cook	1977
Banks	1979
Janz	1988
Batavia	1991
Chara	1999
EGA Gregory	2004
Bolac	2006
LongReach Spitfire	2010
Wallup	2011
Suntop	2012
LongReach Lancer	2013

Results and discussion

Significance of wheat grading

From the 1890s through to the 1960s, the only quality measure applied to the Australian wheat crop were regional standards of fair average quality (f.a.q.). Based purely on bushel weight alone (now known as hectolitre or test weight), f.a.q. standards were determined each year from grower-supplied samples and used as the basis to trade wheat both interstate and overseas. Since no premium was paid for milling or baking quality, there was no incentive to grow wheats better than f.a.q. and accordingly yield remained the major driver. By the 1950s, technical developments in the bread making industry

meant there was greater emphasis placed on wheat and flour quality in both domestic and overseas markets. The *Wheat Research Act 1957* enabled state based wheat research funding, and by 1967 the AWB had introduced an Australia-wide wheat grading system, thus forming the basis of the modern Australian wheat classification system based on varietal segregation (eligibility) and protein content.

Quality improvement

APH is the premium export grade, and eligible varieties should possess very good overall quality. Comparing historical and modern varieties means we now better understand how the emerging quality targets in breeding programs has affected the varieties that make up the Australian wheat crop.

A number of key quality attributes and crumb texture characteristics are listed in Table 2, along with the change in average values between the historical and modern wheat groups. All parameters registered a positive change, indicating comprehensive improvement in quality over time as breeding programs sought to deliver varieties suited to discerning markets. Flour extraction (FE) rates in particular have improved greatly, a response to the dollar value placed on this trait by flour millers. Insignia FE was lowest of all varieties at just 66.1%, while Chara$^{\Phi}$, EGA Gregory$^{\Phi}$ and Suntop$^{\Phi}$ exceeded 76%.

Table 2. Changes in key quality traits and bread crumb texture parameters over time.

Quality trait	Historical average	Modern average	Overall average
Flour extraction (%)	70.6	75.1	73.0
Dough strength (Rmax, BU)	306	435	367
Dough extensibility (cm)	17.5	19.7	18.7
Bake water absorption (%)	59.6	61.5	60.7
Loaf volume (cc)	132	144	139
Crumb yellowness (b)	13.4	12.6	13.0
Crumb firmness (g force)	494	445	467
Crumb resilience (area ratio)	0.24	0.27	0.25

Individual variety performance

Although all traits showed improvement in average values, these improvements were not uniform, with individual varieties in both groups either underperforming or outperforming in particular traits. The early variety Pusa4, for example, had exceptional dough strength. Timgalen, the first APH variety released, compares poorly in most traits with the later releases, but did have what, at the time, was considered good dough strength, as indicated by an extensograph Rmax of 360 BU (Figure 1).

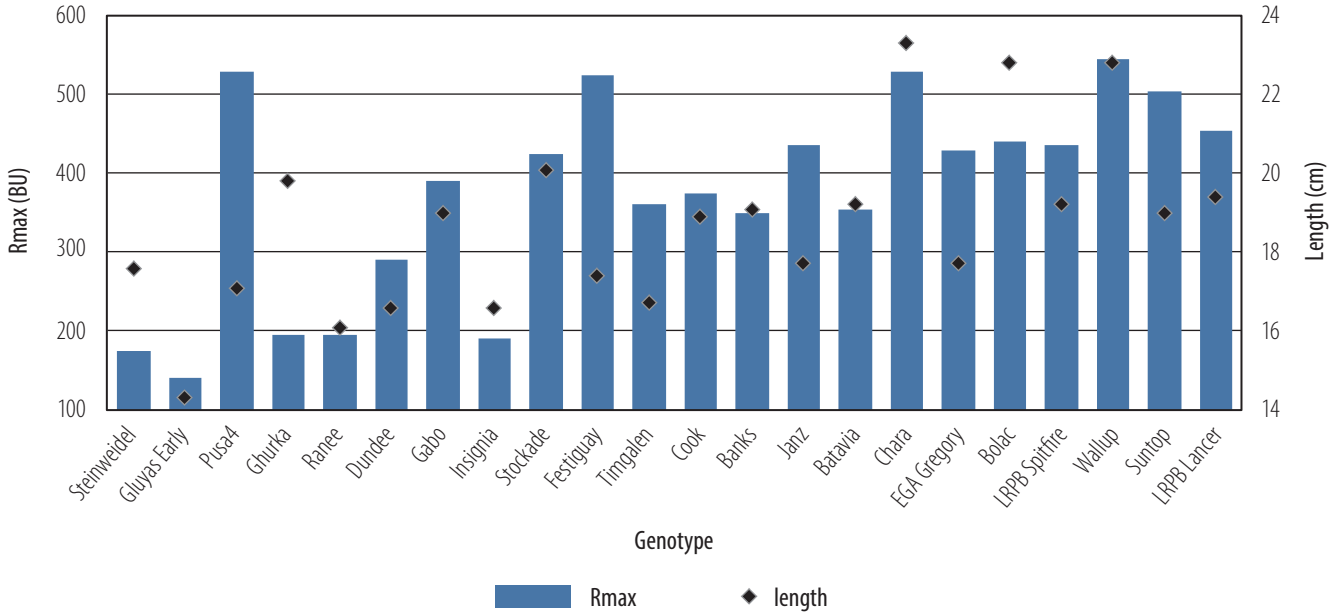

Figure 1. Dough strength (Rmax) and extensibility (length) in year-of-release order.

By 1999 however, the release of Chara$^{\Phi}$ with an Rmax of 530 BU illustrates the new target for APH dough strength as Australian wheat breeders responded to market demand. Even the less than desirable bake water absorption (BWA) of 59.6% was overlooked as the imperative of increased strength was pursued. Chara$^{\Phi}$ and the early APH release Timgalen aside, the modern varieties show consistently high BWA in accordance with market requirements (Figure 2).

The average loaf volume increased in the modern varieties but Janz, EGA Gregory$^{\Phi}$, LongReach Spitfire$^{\Phi}$ and especially Suntop$^{\Phi}$ appeared to underperform in this baking study, while Bolac$^{\Phi}$ produced the greatest loaf volume of all varieties. The historical variety Ghurka had an unexpectedly high loaf volume given its very weak dough strength, while the high dough strength of Pusa4 was not balanced with extensibility as illustrated in Figure 1, resulting in low loaf volume (Figure 3).

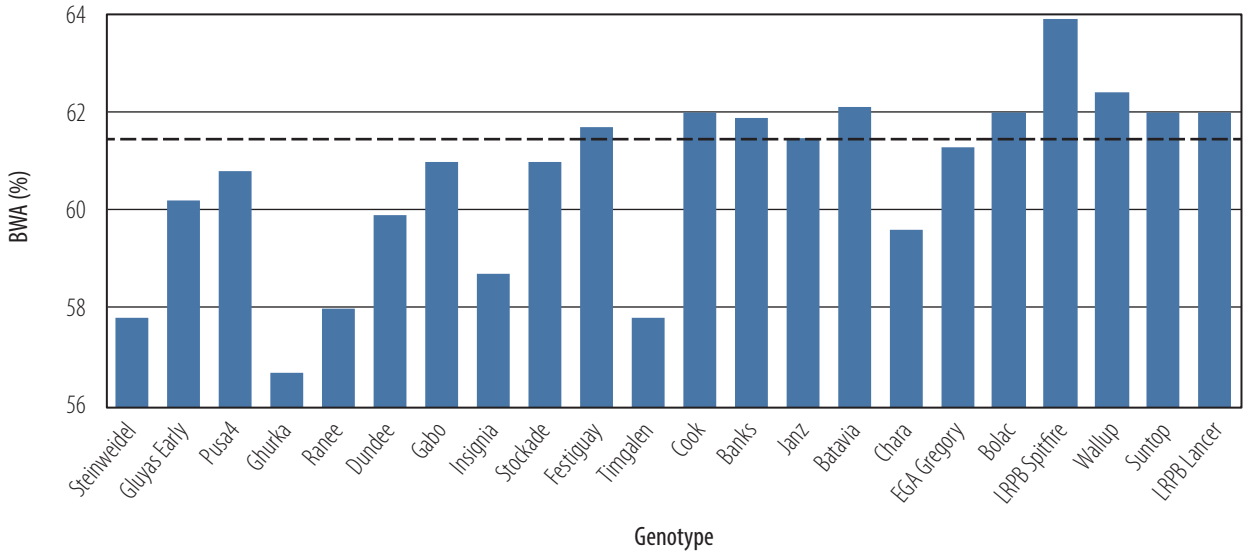

Figure 2. Bake water absorption in year-of-release order (dotted line = average of modern varieties).

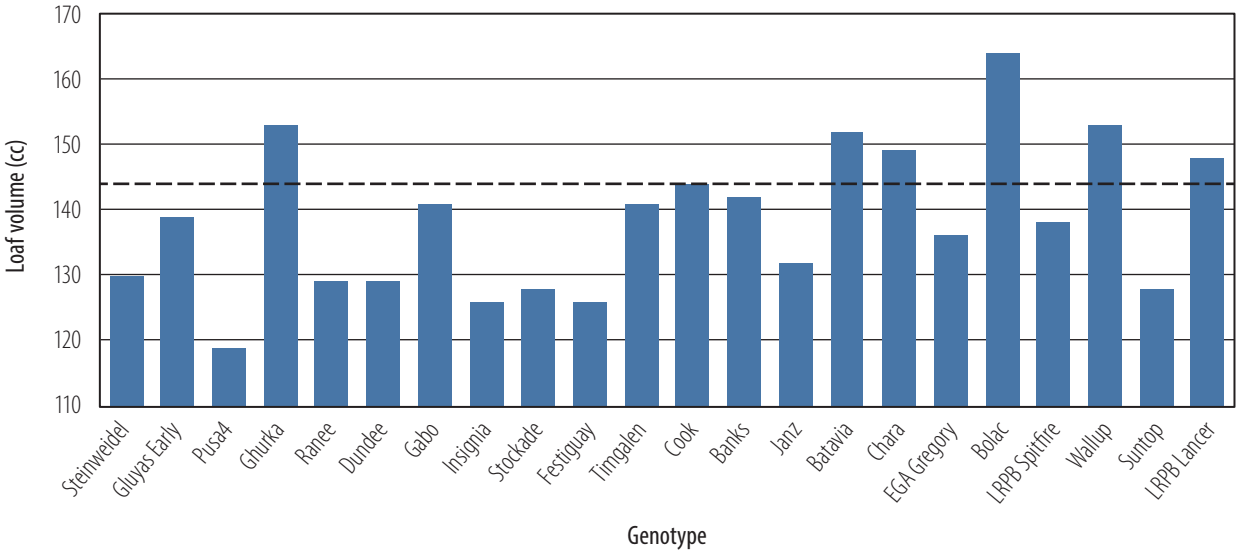

Figure 3. Loaf volume in year-of-release order (dotted line = average of modern varieties).

Best performing varieties

Using the overall average in each quality trait as the benchmark, Bolac$^{\Phi}$, Wallup$^{\Phi}$ and LongReach Lancer$^{\Phi}$ were the best performing modern varieties, exceeding the average in all eight traits. Of the historical varieties, Gabo was the best performer exceeding the average in five of the eight traits. Released in 1945, Gabo is credited with beginning Australia's reputation as a supplier of high quality baking wheat. Through targeted improvement in key quality attributes, Australian breeding programs have continued to produce superior baking quality wheats, shown by the modern varieties' improved performance observed in this study.

Reference

O'Brien L, Blakeney AB and Allen HM (eds) 2015. *The history of cereal chemistry in Australia.* Australasian Grain Science Association, Australia.

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