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FINAL REPORT

QWCRC Project 4.1.4

Optimisation of the Processing Strategy for Utilisation of Australian Wheat in Instant Noodles

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Summary

Instant noodles are perhaps the fastest growing product in the international food industry, yet, on commencement of this project, the raw material specifications had not been well defined. In this project we sought to identify which Australian wheats are the most suitable for this market and to establish criteria by which to select new wheats with enhanced quality in the future.

A variety of wheat samples from 4 regions of Australia was collected, to study the suitability of Australian wheat varieties for instant noodle production, and to optimize the processing strategy for utilization of Australian wheat in instant noodles.

Protein content from a range of varieties planted at different sites showed large variations, mainly due to environmental effects. Starch quality showed consistent trends, indicating a greater genetic influence than environmental effect. Protein content, dough strength and extensibility were positively correlated with noodle firmness and overall sensory scores.

Soft wheats were not found suitable for the production of instant noodles.

Dr Nasir Azudin extended his testing of the set of varieties to commercial instant noodle manufacturers overseas, and found that the preference for wheat varieties varied with different regions:

- Tests on wheat varieties in Indonesia showed that medium to high protein, hard grained wheat varieties of good yellow colour were preferred. Varieties producing firm noodle texture, with high textural stability when left in hot soup were preferred over those with poor textural stability.
- In Korea, wheat varieties such as Batavia and Goldmark attained high acceptance when tested for the production of instant noodle. Contribution to noodle texture and the bright creamy colour of the noodles are some of the quality attributes sought after by the Korean consumers.

The use of commercial starch as partial replacement for flour in instant noodle production was investigated. It was observed that the addition of starch contributed to higher sheet brightness, lower redness and lower yellowness. There was a good correlation between flour brightness and sheet brightness, and a strong correlation between flour yellowness and sheet yellowness.

The effect of adding other ingredients on the quality characteristics of instant noodles was also investigated.

Introduction

This project was designed to investigate commercial processing protocols, with the aim of trouble-shooting any problems that might be faced by manufacturers in using Australian wheat in their processes. Competitor wheat was to be benchmarked against Australian wheat. Other forms of instant noodles, which are increasing in popularity, were also to be investigated, namely, steamed-only instant noodles and quick-cooking cup noodles.

The specific aims of the project were:

- to develop processing protocols, and sensory and objective tests for instant noodles,
- to identify wheat and flour properties which relate to instant noodle quality in terms of both sensory and processing characteristics: i.e. the influence of genetic makeup, protein quality (HMW, LMW proteins and ratios), and starch quality (amylose / amylopectin ratios) on the processing and eating quality of instant noodles,
- to match optimum instant noodle quality with the most appropriate Australian wheat,
- to investigate the impact of other ingredients (alkaline salts, polyphosphates, starches, gums emulsifiers and oil) on the quality characteristics of instant noodles with the aim of substituting these with the appropriate wheat varieties/type,
- to study the quality characteristics of steamed-only instant noodles and quick cooking cup noodles, and
- to continue selecting suitable Australian wheat varieties and blends to achieve quality attributes in instant noodles, as required by specific target markets.

The anticipated outcomes were:

- standardised processing and evaluation protocols for instant noodles,
- a database of information on the performance of reference wheat cultivars for the production of instant noodles,
- resolution of the contributions of genotype, environment and G x E interactions for instant noodles,
- an understanding of the relationship between inherent wheat characteristics and the sensory and physico-chemical characteristics of instant noodles, and
- generation of information for the segregation of wheat varieties suitable for the production of instant noodles.

Commercial Benefit:

In 1996, world consumption of instant noodles was estimated at 40 billion packs per year. This constitutes a total wheat requirement of over 4.6 million tonnes. It was expected to rise to 6 million tonnes by year 2000, with Australia supplying about 50% of this demand. However, there are additional niche markets that require high quality specialised instant noodles wheat. Ability to capture 5% of this increase would lead to an increase in demand of 300,000 tonnes of special wheat segregation. This project produced the relevant technical information for selection of wheat of required quality characteristics for these high quality instant noodles.

This provided an opportunity for Australia to capitalise on the expanding market by introducing the correct segregation for this specialised market. There was also a possibility of obtaining a $5 premium for this specialised wheat, which would create additional revenue of $1.5 million to the farmers.

Methods

Wheat samples were planted in:

- Moree
- Narrabri
- Horsham
- Walpeup
- Yeelanna
- Narracote
- Parkersville
- Wongan Hills
- Avondale
- Meredin

These were delivered to the Academy of Grain Technology by January 1996.

Other sites, i.e. Roma, Biloela and Meandarra, were affected by frost damage and no samples were collected.

100kg of each variety was collected, i.e.:

- Batavia
- Hartog
- Janz
- Trident
- Machete
- Suneca
- VF302
- VF508
- Vectis
- Katunga
- Tammin
- Cadoux
- Eradu

All samples were cleaned and analysed for wheat protein. Sub-samples were milled and complete flour analyses were conducted for 4 selected sites representing the 4 agro-economic regions of Australia, namely:

- Horsham
- Yeellanna
- Moree
- Wongan Hills

(Queensland was omitted due to absence of samples).

Wheat analyses included:

- test weight
- 1000 kernel weight
- grain oven moisture
- wheat ash

- Falling Number
- wheat protein

Flour analyses included:
- PSI (Particle Size Index)
- extraction rate
- moisture
- protein
- ash
- damaged starch
- diastatic activity
- Minolta flour colour
- Farinograph
  - water absorption
  - development time
  - stability
  - breakdown
- Extensograph
  - extensibility
  - max ht area
- amylograph
  - peak viscosity
  - gelatinisation temperature
  - breakdown

Instant noodles were made from these samples. Analysis included their processing (mixing, sheeting, cutting) and handling behaviours (smoothness and stickiness of dough sheet); colour of noodle sheet at time 0 and 30min; colour of fried noodle blocks and cooked noodles; cooking times; fat uptake; water absorption and noodle texture.

Based on the analysis, wheat varieties were selected for the 1996 planting season. Year 1996/97 harvest was better than the previous year, with successful harvesting of Queensland samples. All samples were delivered to the AGT (Academy of Grain Technology), where they were analysed and instant noodles were produced.

Instant noodle analysis

South Australia

Instant noodles were made from wheat flour provided by South Australian Research and Development Institute (SARDI). Altogether 31 wheat varieties were tested which ranged from soft to hard wheat with protein content level ranging from 9.7% to 12.6%.

The analysis consisted of measuring L,a,b colour using the Minolta Chromameter on raw noodle block, on crumbs and sheet at times of 0, 30min and 24hr, and on cooked noodle. Cooking time, percent water absorption, and texture using the Lloyds texture meter were also measured. Varieties like 11/7 Krichauff, 11/9, Meering, Dollarbird, Halberd and Ouyen were given a high ranking visually, and were closely followed by RAC779, WI94063, K2011-5, Janz, WI94091, Spear and Machete.

Victoria

Instant noodles were also made from wheat flour samples provided by the Victorian Institute of Dryland Agriculture. 18 samples were tested which were mainly Rosella and Yanac from different sites. Texture results indicated that Yanac samples were generally higher than Rosella in terms of noodle texture, cooking times and water absorption.

Pilot milling of samples from Victoria, SA and NSW at BRI Australia

Instant noodles were also made using wheat flour made from pilot millings at the BRI. These included APW samples from Victoria, South Australia and New South Wales, and Krichauff. Noodles were processed in Jakarta at the commercial instant noodle plant. Results indicated that the APW samples from South Australia and Victoria produced acceptable instant noodles. Krichauff has very good colour but had some problems with swelling after 10 min. in soup.

Protein content of wheat samples from 1996/97 harvest was analysed. In general, all samples had lower protein content than those obtained from the previous season.

Instant noodle production protocol

Trials in Indonesia

A commercial trial of a range of wheat varieties for the production of instant noodles was conducted in Indonesia. Samples tested included APW (Vic, NSW, SA), AH (SA), Halberd, Arnhem, Leichardt, Sunlin, Krichauff and Rosella/Yanac blends using a commercial pilot instant noodle plant. Results indicated that the APW samples and Krichauff produced instant noodles of good quality - as good, or better than the present commercial flour brand used in Indonesia. Results were consistent with those generated at the AGT under this project. Halberd (straight run) was found to be unsuitable for the production of instant noodles from the Indonesian market. Further studies were planned for commercial testing of other varieties.

Trials in Korea

Trials were conducted with Korean flour millers and a Korean instant noodle manufacturer to assess some key varieties for the production of instant noodles for the Korean market. Studies included modification of the instant noodle processing protocol and formulation to suit the Korean commercial processing protocols. Starch and oil were used in the formulation, and the steaming temperature was reduced slightly, to 94^{o}C. There was also an added step of water rinsing prior to the frying process. Samples tested included Goldmark, Batavia, Krichauff and ASW noodle blends for the Korean market. Follow up testing was planned in Korea later in the year.

Some trials from the 1995/96 samples were repeated to check on the consistency of the results. Samples from the 1995/96 harvest were sent to John Skerritt for testing of amylose / amylopectin ratios and protein subunits.

Noodles were processed from the 1996/97 harvest samples after all analytical data on the wheat and flour was completed. There had been a significant reduction in protein content throughout all planting sites. Preliminary results indicated a significant reduction in noodle firmness and an increase in colour (yellowness) amongst 1996/97 harvest samples. Results from preparation and testing of instant noodles, produced from 1996/97 harvest samples planted at 4 different sites, indicated the quality of wheat from this harvest was not as good as that from 1995/96. Protein content for all samples was low, resulting in problems with texture (firmness) of instant noodles. However, the overall trend of quality characteristics of the different varieties was similar to those observed for 95/96 season.

Effect of starch on the processing and eating quality of instant noodles

Starches were isolated from a total of 28 samples (14 varieties) grown at two different sites (Horsham and Yeelanna) during the 1995/96 planting trials. The total amylose content in the prime starches ranged between 24.7 - 30%. The gelatinisation temperatures were measured by differential scanning calorimetry (*Perkin-Elmer DSC 7*). Considerable differences in T_p, T_o and T_c were observed between starches. The enthalpy of gelatinization associated with the transitions varied between 3.31 and 4.78 J/g. T_o (onset temperature) ranged between 60.58 - 64.5^oC, T_p (gelatinization temperature) ranged between 65.3 - 69.2^oC and T_c (conclusion temperature) ranged between 70.9 - 75.3^oC. Significant positive correlations were observed with T_p ($r = 0.7$, $P<0.01$) and T_c ($r = 0.798$, $P<0.001$) of the same variety grown at two different sites.

Other physical properties such as starch paste peak viscosity were measured. Significant varietal differences were observed between starch paste peak viscosity, which varied between 65 and 229 RVA units. A highly significant linear correlation ($r = 0.97$, $P<0.001$) was observed between starch paste peak viscosity of the same variety grown at two different sites. These results suggest that starch paste viscosity is predominantly affected by variety and not by growing conditions and location.

The starch granule size distribution of prime starches with and without tailings was also measured. The percentage of A-type granules in the purified starches with tailings ranged between 63.3 - 69.04, %B-type granules (12.79-21.57) and %C-type granules (12.39-19.58). By comparison, the %A-type granules in the purified prime starches without tailings ranged between 83.03 - 92.28, %B-type granules (3.96-11.15) and %C-type granules (3.31-8.21).

The physicochemical properties of prime starches and the relationship to texture characteristics of instant noodles and Japanese Udon noodles was investigated. A significant positive linear correlation ($r = 0.54$, $P<0.05$) was observed between the %A-type starch granules (prime starches with tailings) and the firmness (maximum load) of instant noodles. In addition, a significant positive linear correlation ($r = 0.86$, $P<0.001$) was observed between the firmness of instant noodles of the same wheat variety grown at two different sites.

Effect of addition of commercial starches in instant noodles

The use of commercial starch as partial replacement for flour for instant noodle production was investigated. Two common types of starches used in commercial instant noodle manufacture were looked at, namely tapioca and potato starch. The four types of tapioca starches used were

Native Tapioca, National 7, Purity 90 and Amioca (the last 3 being modified starches) and the three types of potato starches were Native Potato, Avebe NS-450 18% and Perfectamyl AC (the last 2 being modified starches also). Levels of addition investigated were 5%, 10%, 15% and 20% respectively for each starch type.

It was observed that the addition of starch contributed to higher sheet brightness, lower redness and lower yellowness. There was a good correlation between flour brightness and sheet brightness and a strong correlation between flour yellowness and sheet yellowness. For both types of starches, the native ones seemed to contribute to lower sheet brightness and higher sheet yellowness than the modified ones.

As for noodle block colours, there were good positive correlations between flour yellowness and noodle block yellowness, however, correlations between brightness of flour and noodle block were poor. There was no specific trend for the noodle block colours and cooked noodle colours and this could to due to the effect of the amount of fat absorbed (a positive relationship between fat content and noodle block yellowness and cooked noodle yellowness was established in the previous study). However, it was very noticeable that the modifed potato starch, Perfectamyl AC, exhibited bright colours with low redness and low yellowness compared with the other samples. Correlations between flour colours and cooked noodle colours were not good and this was also observed in the previous study.

Various texture parameters were measured using the Lloyd Texturemeter LXR 2K5: firmness, hardness, springiness, cohesiveness and chewiness. Noodles were cut across 7 strands on a plate with a probe for the measurement of firmness. For the tapioca starches, firmness of noodles increased and peaked at between 5-10% addition. The modified tapioca starches did not seem to be as firm as the native one. However for the potato starches, the modified ones were firmer than the native at all addition levels. At 5% addition, firmness was very similar to the sample without starch and decreased as the level of addition increased.

Hardness, springiness, cohesiveness and chewiness were measured using a texture profile analysis program, Nexygen Ondio, with the 7 strands of noodles compressed twice to 50% of their original thickness. There were no specific trends observed with these results for both tapioca and potato starches.

Effect of protein sub-units on instant noodle quality

Using SE-HPLC, glutenins, gliadins, and soluble and insoluble polymeric proteins were extracted from straight run flour obtained from 50 wheat varieties grown at 4 different locations. The samples ranged in protein content from 9.7- 15.2%.

No significant correlations were observed between extracted protein fractions and fried or cooked noodle colour, however, an inverse relation was observed between flour protein and fried and cooked noodle yellowness.

Cooking time was positively correlated with flour protein content and the different protein fractions, while oil uptake had a negative correlation with the same parameters and cooked noodle firmness demonstrated a poor correlation.

Table 1 shows the correlation coefficients of measured end product quality parameters and protein fractions.

Table 1: Correlation coefficients of measured end product quality parameters - instant noodles

	Fried Noodle			Cooked Noodle			Cooking time	Oil Uptake	%Yield	Firmness
	L	a	b	L	a	b				(N)
% Protein	NS	NS	-0.75 ***	0.43 **	NS	-0.70 ***	0.81 ***	-0.71 ***	0.4 **	0.44 **
% Glutenins	NS	NS	-0.71 ***	0.39 *	NS	-0.66 ***	0.65 ***	-0.63 ***	NS	0.43 **
% Gliadins	NS	NS	-0.63 ***	0.42 **	NS	-0.61 ***	0.74 ***	-0.60 ***	0.47 **	0.43 **
% Soluble	NS	NS	-0.65 ***	0.37 *	NS	-0.59 ***	0.49 ***	-0.53 ***	NS	NS
% Insoluble	NS	NS	-0.69 ***	0.37 *	NS	-0.65 ***	0.66 ***	-0.60 ***	NS	0.42 **

*Statistical Significance: P<0.05 *, P<0.01 **, P<0.001 ****
n = 49
NS: Not Significant

Effect of alkaline salt on instant noodle quality

The effect of 4 alkaline salts, (potassium carbonate, sodium carbonate, potassium : sodium carbonate 6:4, and sodium hydroxide), and two commercial alkali salts in concentrations ranging from 0.2 –2.0%, were tested on quality of instant noodles.

The alkaline salts of sodium and potassium decreased brightness and increased yellowness on the intermediate (crumb and sheet) and final (noodle block, cooked noodle) products, but this trend was not observed with NaOH.

Cooked noodle firmness, water absorption, and cooking time increased with increasing concentration of alkaline salt, although the increase was not necessarily a continuous linear relationship.

Figures 1 and 2 depict changes to cooked noodle brightness and yellowness, respectively, with increasing concentration of different alkali salts. Figures 3 and 4 represent changes to cooked noodle firmness and cooking time with increasing concentration of a range of alkali salts.

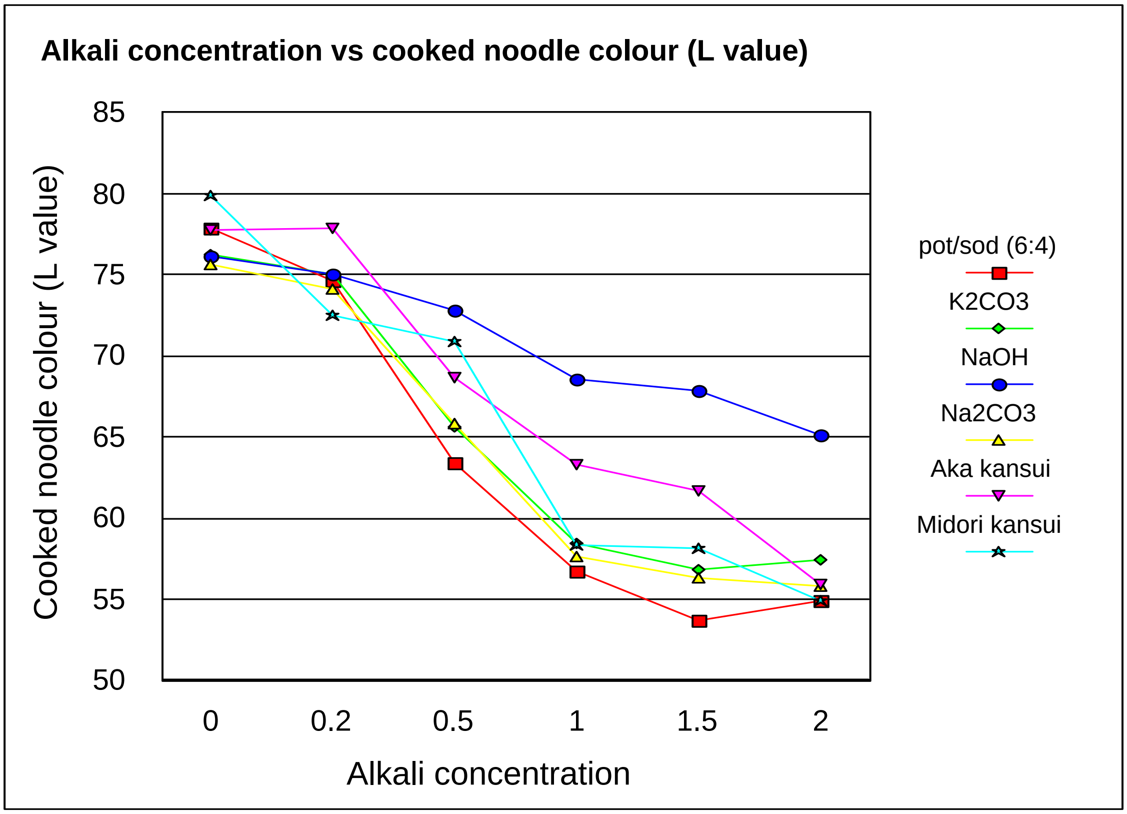

Figure 1: **Effect of alkali on cooked noodle brightness (L)**

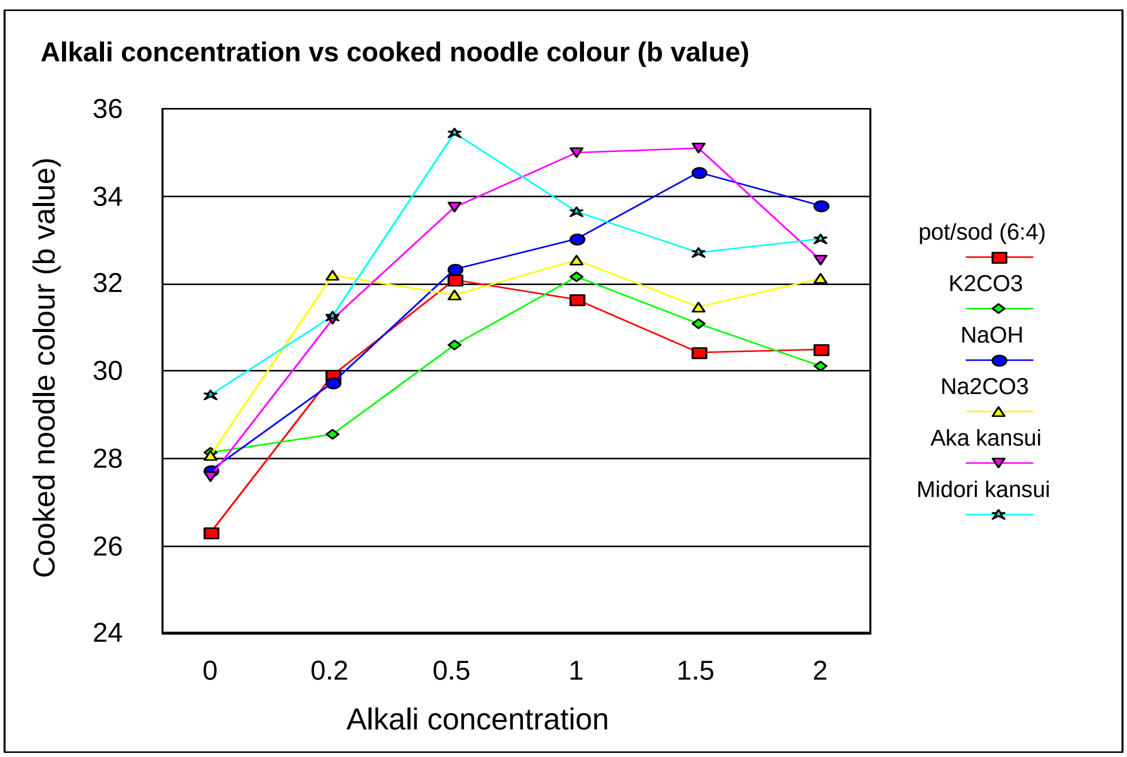

Figure 2: **Effect of alkali on cooked noodle yellowness (b)**

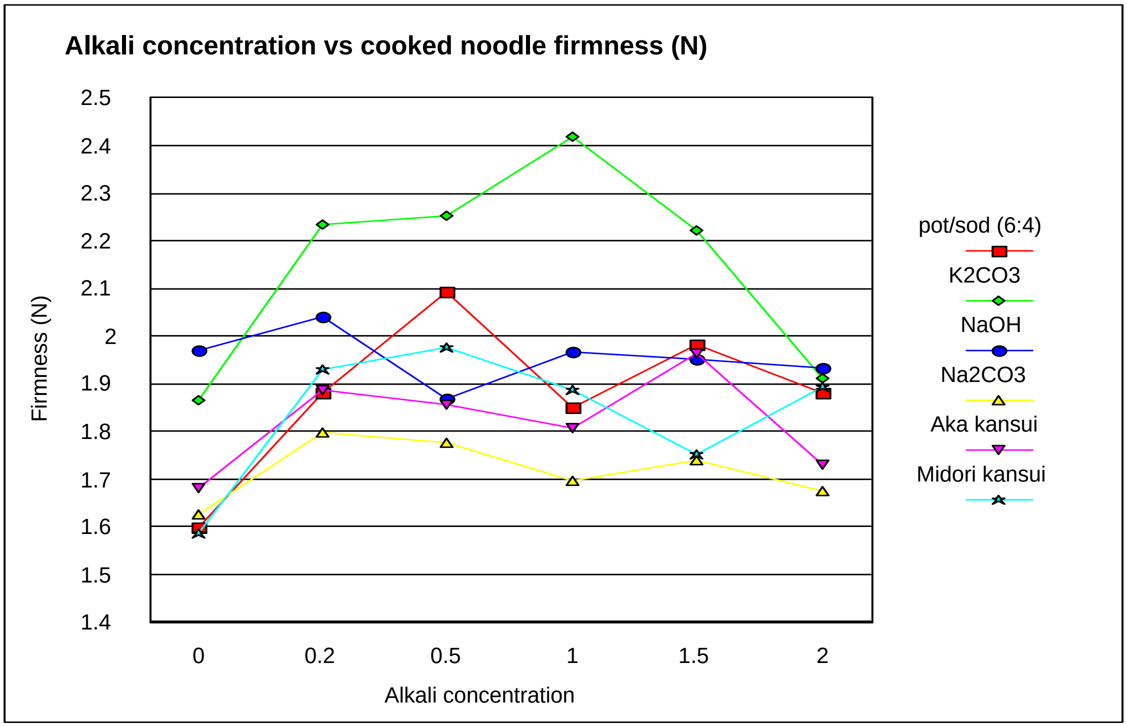

Figure 3: Effect of alkali on cooked noodle firmness

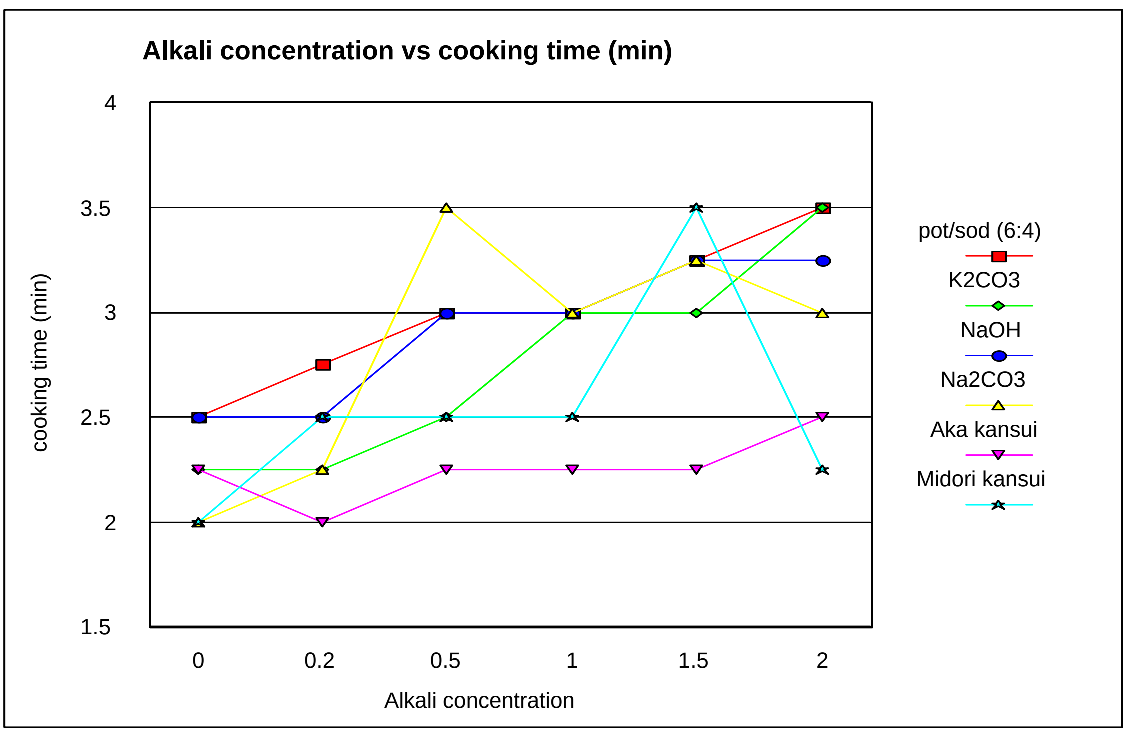

Figure 4: Effect of alkali on cooking time of noodles

Effect of commercial ingredients on instant noodle quality

Straight run flour from sound wheat (Sunco, 9.3% protein) was substituted at 0.5%, 1.0% and 1.5% with commercially-sourced stabilizers, such as sodium carboxy-methyl cellulose (CMC), guar gum (GG), sodium tri-polyphosphate (TPP) and Perfectamyl AC (AC) to review the effect on instant noodle quality.

CMC, GG and TPP did not improve dough handling, processing characteristics, cooking time or noodle separation in boiling water.

TPP improved cooked noodle brightness, yellowness and firmness, and was marginally superior to GG and CMC.

Table 2: Quality parameters affected by commercial ingredients

	Cooked Brightness (L*)	Cooked Yellowness (b*)	Oil Uptake	Cooked Firmness (N)	Total Sensory Score
CMC	++	NC	--	--	--
TPP	++	++	++	++	++
GG	--	NC	++	++	NC
AC	++	--	--	--	NC

++ (increase), -- (decrease), NC (no change)

Effect of emulsifier (lecithin) on instant noodle quality

Instant noodles were produced from straight run flour (Camm, 9.2% protein), which was substituted with lecithin at 1 to 5% levels using wet and dry methods. Lecithin improved dough handling characteristics at lower levels of substitution, but the positive effects were reversed at higher levels of substitution using the dry mix method. Brightness of noodles decreased with substitution and so did cooked noodle firmness, stability and elasticity. Substitution also caused a 32% increase in oil uptake, making the product unappealing to panellists. Overall, lecithin (Centrolex G) did not enhance the quality of instant noodles produced in the laboratory.

Production of steamed and dried noodles

With an increase in awareness of health and lifestyle issues among the population, there is a need to produce convenience products that do not compromise on taste or nutrition. Steamed and dried products fulfill both these requirements, since they cook rapidly and are low in fat.

The laboratory method to produce steamed and dried noodles from hard wheat flours has been standardised, with the final product having water activity (Aw) of < 0.6, moisture content of 10% and acceptable colour.

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