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Ideas and information from milling and baking research

Milling & Baking News
NEW ZEALAND

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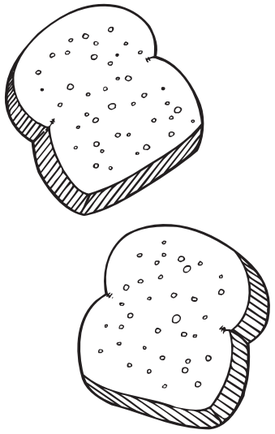
Quality improvement of wholemeal bread



A. Wilson, D. Every, M. Ross, S. Kavale, S. Morrison, I. Waters. June 2001. Crop & Food Research confidential report no. 416, funded by the Baking Industry Research Trust (BIRT).

This was the second part of our investigation to find the causes of the inconsistent quality of wholemeal bread made from wholemeal concentrates. Unfortunately for this research, although not for bread production, our work was hampered by a lack of serious quality problems in the wholemeal concentrates.

'Good' and 'bad' wholemeal concentrates were chemically analysed and studied using fractionation and reconstitution. However, the difference between 'good' and 'bad' wholemeal concentrates was too small to allow us to identify any factors that would cause quality problems. Although the wholemeal concentrates differed in their content of reducing substances, these differences did not consistently relate to baking quality.

Two new ingredients were tested for their ability to improve wholemeal bread quality. When particular protein fractions were used in place of the normal gluten, they increased water absorption, bake quality and crumb strength while reducing the required work input. Transglutaminase greatly improved the crumb strength and should therefore improve slicing quality without increasing moulding problems or reducing baking quality.

The key to making good quality 100% wholemeal bread is to use flour and gluten strong enough to 'carry' the wholemeal concentrate. The ability of individual batches of gluten to do this differs, so they should be tested for this quality. Lastly, if bakers are having problems with ingredients it would be a good idea to save 1 kg samples of the relevant ingredients for testing and analysis. For wholemeal bread, samples of flour, gluten and wholemeal concentrates should be tested.

Photo: Wholemeal bread, wheat and grain.

The Flour Milling and Baking Industry Research Trusts publish this newsletter with Crop & Food Research to present the results of levy-funded research and other information relevant to New Zealand industry.

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FLOUR MILLING & BAKING RESEARCH PROJECT REPORTS

Several research projects have been completed in the last six months and short summaries of the project reports are presented below. The results of the millstreams project (Crop & Food Research confidential report no. 431) were explained in the Spring industry Research Bulletin.

Flour properties for pasta manufacture

W. Harvey, M. Morgenstern. May 2001. Crop & Food Research confidential report no. 419, funded by the Baking Industry Research Trust (BIRT).

The report reviewed the technical, scientific and trade literature on flour and semolina milled from bread or durum wheat and the properties of flour and semolina required to make good pasta.

In flour and semolina for pasta, critical properties are protein content, gluten strength and gluten quality. Proteins are important in pasta because they form an insoluble network that traps swollen starch granules during cooking. This prevents disintegration of the pasta surface that makes it soft and sticky. There is a trend towards making pasta from finer flour (<350 micrometres) to allow shorter mixing times. Pasta texture can be measured instrumentally or evaluated by trained taste panels. The amount of starch that is damaged is critical because too much damage makes the starch vulnerable to amylase attack and reduces pasta quality. Other factors are ash (mineral content), carotenoid pigments, lipoxygenase and polyphenol oxidase activity.

In pasta processing, critical aspects are: moisture content in the mixer, even hydration in the mixing chamber of the extruder, good control of temperatures (<50°C) in the extruder barrel, removal of the entrapped air from the extruder barrel, maintenance of an even flow rate through the extruder die, and good control of the drying rate to prevent cracking, checking and browning.

NIR protein measurements - the 2001 harvest calibration check round

J. Cummack and L. Simmons. July 2001. Crop & Food Research confidential report no. 434, funded by the Flour Millers Research Trust (FMRT).

Consistent measurement of protein is critical for the fair pricing of wheat so FMRT supports a regular check of NIR protein calibrations. The grain foods laboratory of Crop & Food Research tested NIR calibrations using 31 samples from the 2001 wheat harvest with proteins ranging from 8.6-14.2%. Twenty-five measurements from each laboratory were compared to results determined by the Dumas combustion method. The standard deviations for the laboratories varied from 0.18-0.45. Results from all the laboratories except those with the highest two standard deviations were satisfactory, showing that the level of accuracy remained high by world standards.

Confocal microscopy sheds new light on the bubbles in dough

The bubble structure of dough determines important quality attributes such as the crumb texture and volume of baked products. Although the original model for bubble formation and expansion in doughs dates back to Baker and Mize in 1941, many aspects remain unclear. A better understanding of this area could bring large improvements to mixer design and dough processing.

Transmission microscopy has been used to study bubbles in dough but has many drawbacks and the sample preparation process often produces artefacts. Confocal microscopy is much more suitable because it can form images of live biological materials in three dimensions and in real time. Scientists of the Crop & Food Research cereal group and the University of Canterbury Department of Plant and Microbial Sciences recently collaborated in a project to investigate dough structure using this powerful technique. This project was funded by the Australian Quality Wheat CRC and was introduced in NZ Milling & Baking News no. 10 in Autumn 2000. The project developed methods for producing high quality images of the bubble structure of doughs as they expand.

Bread doughs were made in a 10 g MDD mixer with 3% yeast and slack doughs were used because they provided the best images. To produce images, small samples of dough were placed on a cover slip and maintained at 40°C. The confocal microscope produced good images at depths of between about 25 and 65 µm (micrometers) below the dough surface. The laser of the confocal microscope emits intense blue light that excites a fluorescent dye in the sample so that it emits green light that is captured to form an image.

The images make impressive video clips and six successive images have been printed below in Figure 1 to illustrate the changes occurring in proving doughs. The photograph shows images of doughs made at regular time intervals as the bubbles expanded. MDD mixing with yeast produced doughs containing many small bubbles but no new bubbles formed after mixing ceased.

Dough images were digitally analysed to produce measurements of gas cell size and area, and their frequency distribution. The measurements from these dough images are illustrated in Figure 2. Early in proof the number of bubbles decreased as small bubbles expanded and amalgamated. However, the total gas volume (measured by bubble area) continued to increase for 40 minutes, corresponding to the optimum proof time in baking tests. After this time the number of bubbles and their volume began to decrease as they were reabsorbed into the dough.

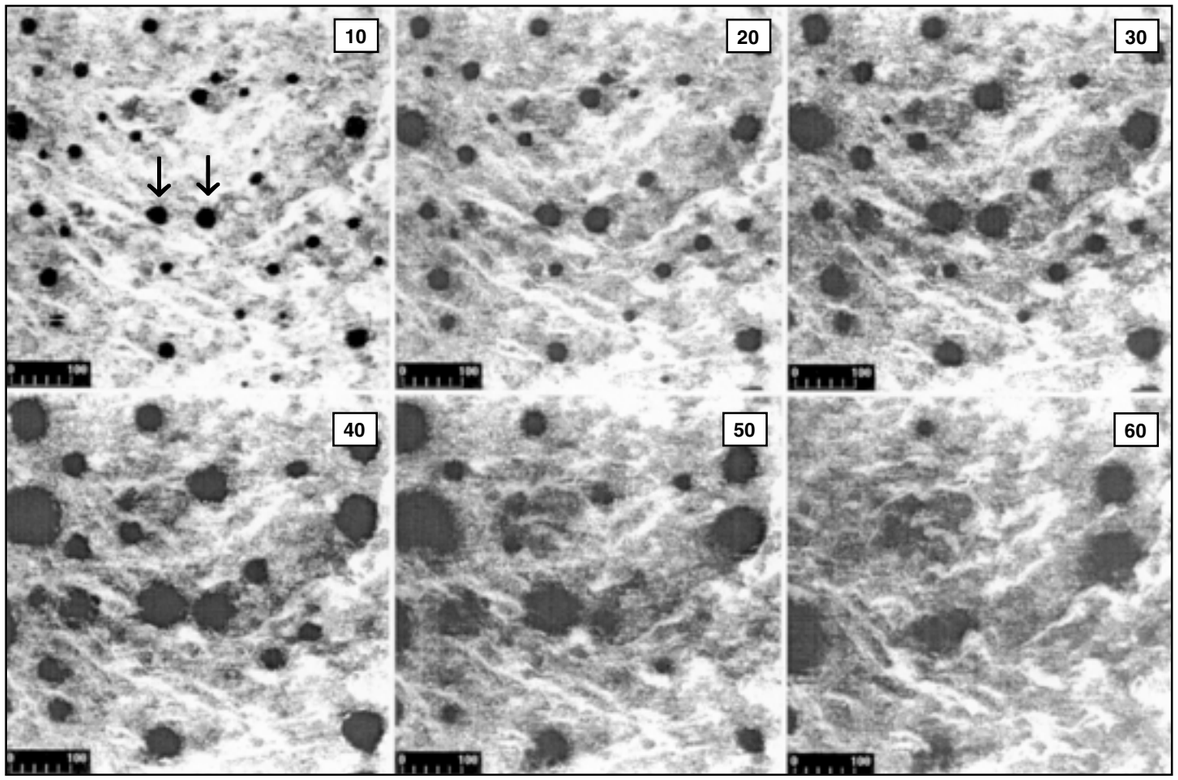

Figure 1: Magnified images of yeasted dough pieces as they prove. Labels show proof times, 10-60 minutes, with 40 minutes optimal. The gas bubble structure clearly begins to degrade after 40 minutes and by 60 minutes has collapsed completely. This is easiest to see if you look at the two bubbles marked by arrows and follow them in successive images. The images should agree with the results that bakers see in dough on a larger scale. The scale represents 100 µm.

The effects of process changes were studied by comparing results from MDD mixed yeasted doughs to those from MDD mixed unleavened dough, dough leavened with baking powder, and sheeted unleavened dough. Baking powder leavened doughs showed a similar pattern to bread dough but expanded much faster, reaching peak volume in 15 minutes, as illustrated in Figure 3. Initially, baking powder leavened doughs contained more bubbles and they were smaller than in yeasted doughs.

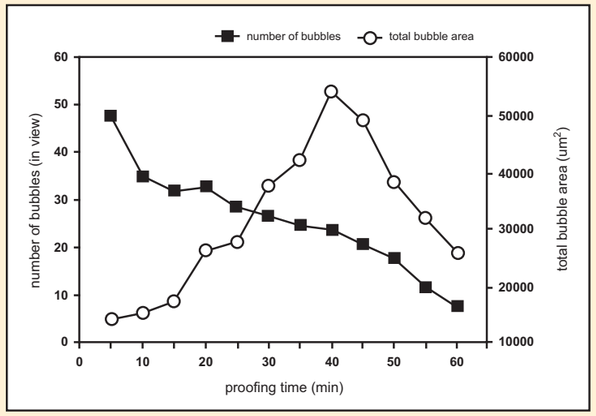

Figure 2: Number and total area of bubbles in an image of yeast-leavened dough.

Although it was difficult to produce good images of sheeted unleavened doughs, the results are very interesting. Doughs developed by sheeting appeared to have more and smaller bubbles than MDD developed doughs. The dough components tended to be elongated in the direction of sheeting, particularly after repeated sheeting, as shown in Figure 4. Folding and turning the dough between sheeting passes seemed to increase the size of bubbles in unleavened dough, presumably by trapping more air between the dough layers. If further studies confirm this, it will be of great significance for laminated pastry production because trapped air is not usually considered a method of aeration.

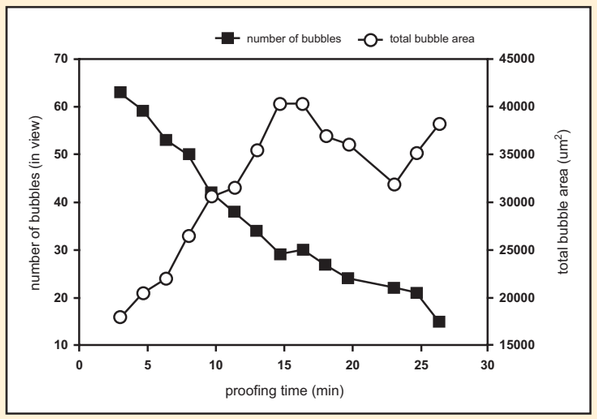

Figure 3: Changes in the number and total area of bubbles in an image of baking powder leavened dough.

Figure 4: Confocal microscope image of a sheeted dough. Arrow indicates sheeting direction.

This article originated from a paper presented at the 2001 RACI Cereal Chemistry Conference, Dough gas cell structure imaged by confocal microscopy. K. Sutton, L. Simmons, M. Morgenstern, A. Chen (Crop & Food Research), and T. Crocker (University of Canterbury Department of Plant and Microbial Sciences). We acknowledge the assistance of the staff of the confocal microscopy unit of the University of Canterbury Department of Plant and Microbial Sciences and funding from the Australian Quality Wheat CRC.