

FOOD

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Using baker's yeast to reduce acrylamide formation in foods

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Acrylamide is a Group 2A carcinogen, i.e. is officially designated by the World Health Organisation as “probably causing cancer in humans” and is the inevitable result of the chemical reaction that occurs when the amino acid asparagine is heated above 120 °C in the presence of reducing sugars such as glucose or fructose. The formation of acrylamide occurs in many food processes including bakery products.

This article describes the use of a strain of baker's yeast which significantly reduces the level of asparagine in bread dough, thereby reducing the quantity of the potential carcinogen acrylamide in the final product.



Acrylamide is a colourless and odourless chemical compound that was propelled into the spotlight in 2002 when the Swedish National Food Administration and the University of Stockholm reported considerably high levels of this WHO Group 2A carcinogen in commonly consumed foods such as bread, coffee, potato chips, French fries, baby food and many others. Prior to this discovery, acrylamide was known mainly as an industrial chemical used as an intermediate for polyacrylamide production.

Based on various laboratory studies, clear evidence of the carcinogenic and genotoxic effects of acrylamide and its metabolite glycidamide has been established, although epidemiological studies of the effect of exposure through various foods have not been as clear. A review of all the data has convinced numerous scientific committees and regulatory agencies worldwide that exposure to acrylamide by humans should be limited to the lowest possible level. Most recently (in March 2010), the European Chemical Agency added acrylamide to its list of substances of “very high concern”. Acrylamide was added to the State of California’s Proposition 65 list of carcinogens in 1990.

The main source of acrylamide formation in food occurs when the amino acid asparagine and reducing sugars — such as glucose or fructose — are heated together above 120°C and are transformed into acrylamide. Since asparagine is the limiting precursor for acrylamide and is widely present in many different carbohydrate-rich foodstuffs — grains, potatoes, etc. — reducing its content in food products prior to heating would significantly reduce acrylamide levels.

Harnessing yeast’s natural ability to metabolise asparagine

Numerous approaches have been attempted to reduce acrylamide formation in food. However, no method has yet been accepted as the ideal solution, mainly because major drawbacks still exist. The problems that plague currently

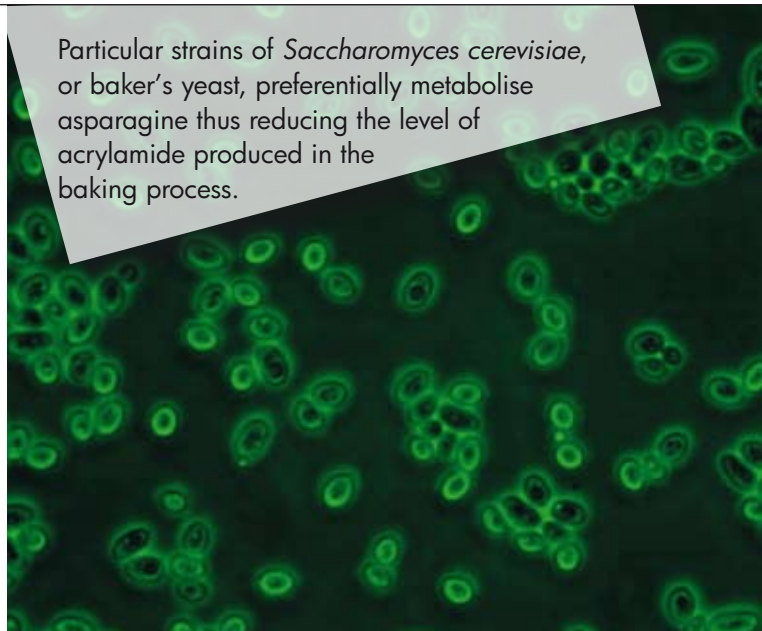
available technologies range from cost, impact on the organoleptic properties (taste, colour, odour and feel) of the food, and/or ineffective acrylamide reduction under typical food production/processing conditions. Yeast presents a low-cost solution to the acrylamide problem.

Using the natural ability of baker’s yeast to metabolise asparagine, yeast strains have been developed with enhanced asparagine degradation properties. Initial tests have shown that these proprietary strains can rapidly reduce asparagine in media and food matrices, thereby dramatically reducing acrylamide formation after heating.

Research

Various yeast strains from Phytterra Yeast (a subsidiary of the Canadian company Functional Technologies) were tested for their acrylamide-reducing (AR) capabilities. The strains were first screened in liquid media for their ability to take up asparagine from test media. Equal cell numbers of each strain were inoculated into separate test tubes containing YEG (yeast extract, glucose)

Particular strains of *Saccharomyces cerevisiae*, or baker’s yeast, preferentially metabolise asparagine thus reducing the level of acrylamide produced in the baking process.



broth spiked with 0.5 g/L of asparagine. An aliquot was taken every hour, and asparagine concentration was determined using an enzymatic kit. Three of the AR strains showed enhanced asparagine degradation under these test conditions. In particular, one strain consumed asparagine to undetectable levels after four hours. In comparison, commercial bread yeast strain reduced asparagine by only 11% in the same time period under the same test conditions.

After determining their ability to reduce asparagine in liquid media, the strains were tested in bread dough. Both the AR and commercial bread-yeast strains were cultured simultaneously in two separate fermenters, and the cells were harvested the following day for dough and baking

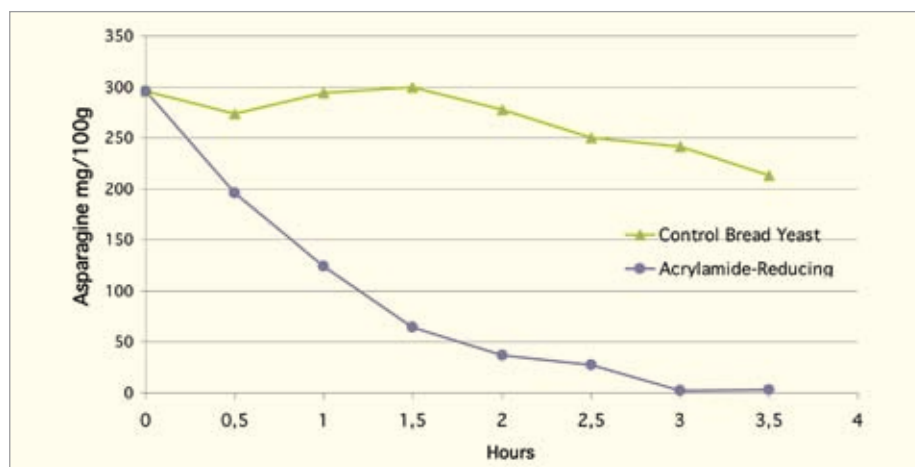


Figure 1. Asparagine reduction by commercial bread yeast (control) versus acrylamide-reducing strain in bread dough.

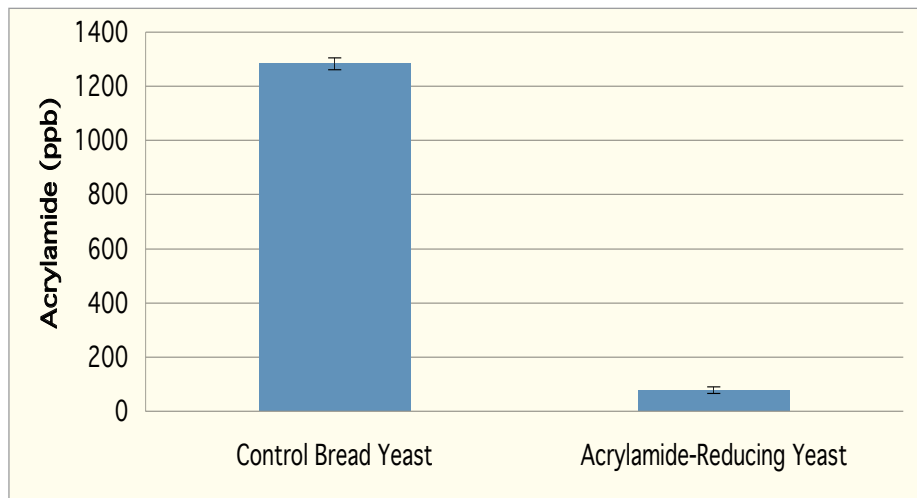


Figure 2. Levels of acrylamide (ppb) in bread made with commercial bread yeast (control) versus acrylamide-reducing yeast using dough containing high levels of asparagine.

trials. Asparagine was added to the dough and asparagine consumption was monitored using enzymatic analysis.

99% reduction in asparagine levels

Once the AR yeast was mixed into the dough, it was found that asparagine levels immediately began to decrease; in contrast, no noticeable decline in asparagine was measured using the control strain. After the dough was formed, samples were taken at 30-minute intervals, starting from the moment the yeast was added, and were assayed for asparagine concentration. This experiment was performed twice; averaged data are shown in Figure 1. After three hours, the AR

strain reduced asparagine concentration in dough by 99.2%; in comparison, the control strain reduced the asparagine by just 18.5%.

The dough from this experiment (which contained higher levels of asparagine) was also used to prepare a baked bread sample in order to determine the acrylamide concentration in the final bread product. Results from this experiment are shown in Figure 2 and show that, under the conditions tested, the AR baker's yeast strain produced bread with approximately ten times less acrylamide than the control baker's yeast. This result is consistent with the asparagine reduction found in the dough analysis.

Effect on bread texture, colour, size or baking process

To reduce acrylamide in food, manufacturers face the challenge of changing their processes and/or product parameters without compromising the taste, texture and appearance of their products. In our latest bread trial, research chefs made various breads using the acrylamide-reducing yeast and the commercial bread yeast control. The final products showed no differences in colour, size or texture [Figure 3]. Importantly, no changes were required in the baking process to achieve these significant reductions in acrylamide formation in bread.

These early results are encouraging, and further work is being carried out to create more strains and further enhance existing strains. Furthermore, the acrylamide-reducing yeast technology is not only limited to bread products: research and development is being conducted to enable this technology to be applied to other types of heat-treated foods, e.g., potato products, biscuits, crackers and other baked snacks.

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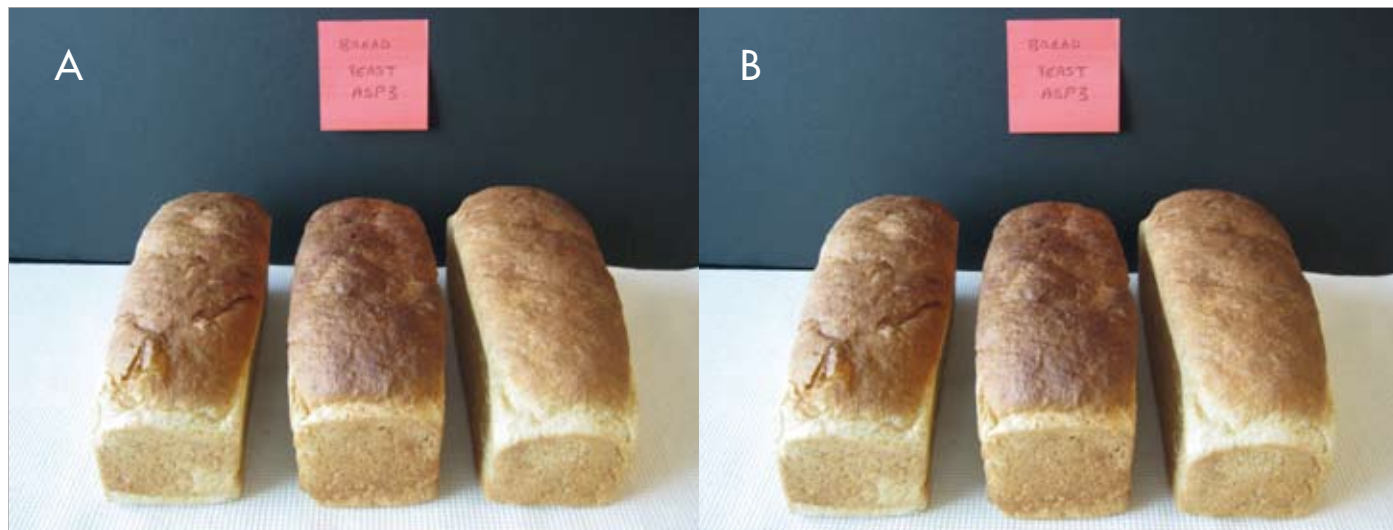


Figure 3. Breads made with commercial bread yeast (a) versus breads made with Functional Technologies' acrylamide-reducing yeast (b).