Bread chemistry

Breadmaking can be considered as one of the oldest food processing methods, dating back to Ancient Egypt (1300-1500) before the Common Era (CE). The breadmaking process essentially aims to convert wheat flour and other ingredients into an aerated, light, and palatable food product, explains **Dewald Botha**, scientist: innovation & formulation and **Alister Sutton**, executive innovation bakery, Synercore.

WHEAT FLOUR AND YEAST

These characteristics can be influenced by the quality of two main ingredients namely wheat flour and yeast. The addition of water and mechanical energy (kneading) to wheat flour promotes the formation of the viscoelastic proteinaceous network known as gluten. Several chemical, physical as well as physicochemical modifications occur during dough kneading. As the dough is kneaded, it becomes more cohesive to the point where a threshold is reached. However, over kneading leads to weakening of the gluten network, collapsed and overly sticky dough in addition to increased dough mobility.

Once formed, the viscoelastic gluten network allows for the capture and retention of carbon dioxide produced via anaerobic fermentation by yeast in a step known as proofing. Commercially produced breads make use of the Chorleywood bread process, developed in the 1961 by the British Baking Industries Research Association, and utilises reducing agents such as ascorbic acid in combination with high-speed mixing and the use of pans for baking. Although the Chorleywood process allows for more rapid production of bread when compared to the bulk fermentation process, it allows for reduction of the proving time to roughly 60 minutes limiting the time available for dough inflation via fermentation.

DOUGH PROOFING STAGES

During proofing the dough is inflated with carbon dioxide resulting from the anaerobic fermentation of glucose by yeast during production of bread. The glycolytic pathway whereby yeast catabolises glucose to produce two molecules of ethanol and two molecules of carbon dioxide. The ethanol produced is evaporated during baking while, during proofing, the carbon dioxide is captured in the gluten network resulting in inflation of the dough. The availability of glucose is therefore a major requirement which directly influences the yeast activity and, resultingly, the carbon dioxide production under anaerobic conditions. Glucose is not readily available in wheat flour, rather it is sequestered in a complex plant carbohydrate storage molecule known as starch. Additionally, glucose can be liberated from these starch molecules through enzymatic hydrolysis.

Starch is a polymer composed of carbohydrates bound via α-1-4 glycosidic bonds containing branches attached via α-1-6 glycosidic bonds. In plants starch is a carbohydrate storage molecule and is not readily available for yeast metabolism. However, in plants fermentable sugars are liberated from starch by various starch degrading enzymes, including α-amylases, ß-amylases and glucoamylases. Maximising the available glucose for yeast utilisation, several of these enzymes can be added to bread formulation, thereby increasing the yeast fermentation abilities. However, the activities of these starch degrading enzymes differ in terms of their specificity and molecular characteristics. αAmylases are fast-acting glycosidases which catalyse random hydrolysis of α-1-4 glycosidic bonds, resulting in the formation of carbohydrate polymers of varying lengths. ß-Amylases, on the other hand, catalyse liberation of disaccharides (such as maltose) from the non-reducing which can directly be assimilated by yeast. Glucoamylases are inverting exo-acting starch hydrolases that catalyse the hydrolysis of both α-1-4 and α-1-6 glycosidic bonds, resulting in the formation of ß-D-glucose from the non-reducing end of starch molecules. A combination of these enzymes can result in a synergy, producing larger yields of utilisable carbohydrates for fermentation purposes.

In addition to a carbohydrate source, yeast also requires various other prerequisites to allow for optimal yeast activity in bread. This includes essential vitamins (such as biotin) and minerals (such as zinc, magnesium, calcium and potassium) and a source of yeast assimilable nitrogen. Utilising the knowledge of the metabolic requirements of yeast to allow for optimal fermentation and yeast proliferation can ultimately lead to faster proofing and reduction in the required amount of yeast needed for optimal proof height. •

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