Breadmaking

Yeast-raised products include various types of bread, rolls, and buns. They owe their texture to a network of chemically bonded protein molecules, found in gluten, held together by disulfide bonds.

In the baking process, leavening takes place when the gluten is relaxed and its disulfide bonds are broken. The sulfhydryl groups generated from this process must then be re-oxidized at the end of the proofing (fermentation) process and during baking in order to generate a good product. This produces disulfide bonds between the different protein molecules in gluten.

A large amount of disulfide bonds reduces dough stickiness, strengthens the dough and makes it easier to handle. It also improves the volume, strength and uniformity of the finished product, despite variations in flour quality.

The baking process and the ingredients used are designed to optimize the formation of these disulfide bonds while reducing production time.

This datasheet describes the factors that affect disulfide bond information with a particular emphasis on the role of oxidizing agents.
Factors affecting product quality

The extent of disulfide bond formation depends on many factors.

- Wheat variety, milling conditions, and flour age - In general, high extraction younger flours develop less disulfide bonds. Maturing agents can be added to flour to increase the ability of the proteins to relax, stretch out, and then bond to each other. Some of the products used can also act as bleaching agents.

  These maturing agents condition the flour within 24-48 hours, and have eliminated the old practice of long term storage of the flour. Several oxidizers are allowed for use in this application in the USA and Canada.

- Amount of protein in the dough - Flour suitable for yeast-raised products should contain at least 12-14% protein. However, this is often insufficient and gluten must be added to the mix in order to provide additional strength to the dough.

  This is particularly important in the case of specialty breads that contain other grains. The flour must be of sufficient strength to carry the grains, which are considered non-functional or inert ingredients.

- Extent of dough relaxation - This affects the number of sulfhydryl groups available for re-oxidation. Relaxation occurs by mechanical action and can be enhanced by the addition of reducing agents such as L-cysteine hydrochloride, sodium sulfite or protease enzymes. These products hydrolyze the disulfide bonds in gluten, reducing its resistance to extension, and making the dough more plastic.

- Addition of dough conditioners - Some emulsifiers can interact with gluten to strengthen the dough by increasing the level of crosslinking in the protein molecules. This helps the dough withstand the mechanical abuse of processing and improves its rheological properties.

  Oxidizers enhance disulfide bond formation between different protein molecules by oxidation of the sulfhydryl groups. This adds volume and strengthens the dough.

- Baking process - No-time dough processing tends to develop less disulfide bonds and requires a higher level of oxidizers.
Dough Conditioning Overview
Application Data Sheet

Oxidizing agents
Addition of oxidizing agents to enhance dough properties has been an industry practice for many years. As mentioned above, oxidizing agents can have several functions.

- Improvement of dough-forming properties
  - Initiation of yeast growth
  - Dough strengthening
  - Reduction of dough stickiness
  - Ease of handling
  - Improved dough tolerance
  - Water retention during baking

- Promotion of new disulfide bond formation in gluten
  - Increase in volume of finished product
  - Better uniformity despite variability in flour quality
  - Strengthening of final product
  - Improvement of texture and symmetry
  - Improvement of breadcrumb and its porosity
  - Increased shelf life

- Bleaching

The less time allowed for fermentation, the greater the need for oxidizers. In a no-time dough for example, much more dough conditioning is required.
Dough Conditioning Overview
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Due to its slow oxidation rate, the best dough conditioner used in the past was potassium bromate. It was not used up at the mixing stage, and disulfide formation started at the end of the proofing process and during baking. However, health concerns have led to the use of alternative oxidizers.

Most other oxidizing agents approved for use as dough conditioners in bread act faster than potassium bromate, making them less effective and versatile.

- **Potassium iodate** is a fast oxidizer with limited tolerance to inconsistent dosing. It is very soluble in water and can prematurely form the disulfide bonds prior to the completion of the proofing process.

- **Calcium iodate** is fairly similar to potassium iodate but with a limited solubility in water leading to a slower reaction than potassium iodate. It would be used when the target is the reduction of mixing time without imparting much strength to the dough. Calcium iodate has low toxicity, but may cause allergic reactions (blackherbals.com).

- **Azodicarbonamide (ADA)** is a yellow powder, with limited solubility. It is also a fast oxidizer, but because of its limited solubility, it is a slower oxidizer than iodate. It is best used if oxidation is desirable near the end of mixing. It requires accurate dosing and has a limited tolerance to variability in dosing. Its dust was found to cause asthmatic reactions in some cases. On oxidation, the product is converted to biurea.

- **Ascorbic acid** itself is a reducing agent. In the absence of oxygen, it breaks the disulfide bonds in gluten and increases dough extensibility. In the presence of oxygen, ascorbic acid is converted to dehydroascorbic acid which functions as an intermediate oxidizer.

Ascorbic acid requires the oxygen generated from other oxidizers in order to exert its oxidizing properties. It is relatively stable when dry, but degrades rapidly when exposed to air in solution.

- **Calcium peroxide** is another fast oxidizer that is commonly used in industry. In addition to the advantages of oxidizers mentioned above, calcium peroxide has the following benefits in breadmaking:
  - IXPER® 75C Calcium Peroxide allows the surface of dough to be drier. This is quite valuable in the case of the production of buns such as hamburger buns since they are typically made with sticky dough. When IXPER® 75C Calcium Peroxide dries the surface of the dough, the dough becomes less sticky and more machinable with less operational problems. This also reduces crimping, and allows for higher production rates and decreased downtime. This also reduces the amount of dusting flour required to reduce the stickiness of the dough.
IXPER® 75C Calcium Peroxide allows the dough to hold more water. This produces a softer dough that is more machinable. It also results in higher flour yields.

IXPER® 75C Calcium Peroxide is a bleaching agent, and can produce lighter crumb color.

To reduce the rate of oxidation during dough production, oxidizers are usually used in conjunction with ascorbic acid. There are many varieties of dough conditioning blends in the market for different applications such as no-time or frozen dough.