It always surprises me that enzymes have become synonymous with the phrase extended shelf life (ESL). To me, that’s just one way to apply enzyme technology to baked goods, and not necessarily the most cutting-edge one.

The U.S. Food and Drug Administration considers enzymes a processing aid, and I think this is a much better way to describe what enzymes are capable of. To the baker on the production floor who’s mixing a new bread formula that contains added oat fiber, resistant starch, and flax seeds on top of a 100% whole wheat dough, processing issues are everything. You can’t begin to worry about ESL until the dough makes it through the divider and reaches the right volume in the oven.

So as an ingredient supplier, researching and creating the best new technology is just step one. We must partner with our clients to solve the problems they’re facing and offer quality solutions. Often, those challenges are related to process and packaging rather than shelf life. Let me give you a few examples.

**Gluten Reduction**

The constant pressure of rising ingredient costs has provided an opportunity for enzymes, particularly within the whole grain segment. Added fiber, bran, nuts, and seeds interrupt the gluten structure of doughs, and as a result bakers typically add quite a lot of additional gluten to compensate. We’ve found that a well-constructed blend of strengthening enzymes (xylanases, oxidation enzymes, and lipases) can replace a portion of that added gluten. Not only is there a cost savings, but also a savings in mix time.

**Frozen Doughs**

For convenience and uniformity, many small retail outlets, from grocery stores to quick service restaurants, bake frozen dough in-house. This reduces inventory and the difficulty of finding experienced bakers. Though frozen dough is convenient, it does pose a few challenges, such as consistently baking to the same volume whether the dough has been frozen for two weeks or twelve. The efficacy of yeast deteriorates over time, and often the quality of the grain, volume, and texture of the bread suffers. Enzymes can help overcome these issues, ensuring that quality is maintained over the full shelf life of the dough.

**Emulsifier Reduction**

A new wave of lipase technology has made it possible to reduce, if not eliminate, emulsifiers such as monoglyceride, sodium stearoyl lactylate (SSL), and diacetyl tartarate ester of monoglyceride (DATEM) from bread formulas. Though I’ve grouped emulsifiers together in one group, they certainly don’t all perform the...
same function and it is essential to use a blend of enzymes to replace the different functionality of each ingredient. Mono- and diglycerides are primarily associated with softness, while SSL and DATEM are considered strengthening emulsifiers. Balanced enzyme systems provide a similar function to SSL and DATEM, giving doughs processing tolerance and ensuring they reach good volume while retaining a fine crumb grain and resilient texture.

“Natural” Breads

The current trend toward what consumers perceive as being wholesome and natural has put pressure on bakeries to eliminate many ingredients from the bread label. We’ve already discussed the current technology to remove emulsifiers from the label, but the final frontier is being able to process dough through a divider without the use of azodicarbonamide (ADA). It’s pretty easy to replace high-fructose corn syrup with cane sugar, or find a natural preservative to replace the less consumer-friendly calcium propionate, but ADA replacement is more challenging. Like its predecessor bromate, ADA gives the protein network in doughs a remarkable ability to bounce back after the wear and tear of processing.

Over two years ago, a baker came to us with a special project. He wanted to make a loaf of bread with eight ingredients, a short ingredient statement he insisted any five-year-old should be able to read: wheat flour, brown sugar, honey, gluten, oil, wheat starch, yeast, and salt. Our company got its start by bringing enzyme-based bromate replacement systems to the U.S. market, so this project appealed to the inner baker in everyone here at Innovative Cereal Systems. Sure enough, it worked—enzyme technology allowed us to take baking back a hundred years. Great-grandma would be proud.

No supplier can expect to be successful by simply trying to sell an ingredient solution. Problem-solving know-how (often called “tech services”) is what bakers want, because bakers are under constant demands to do more with less, and do it faster, with more efficiency. Enzyme technology may sound trendy and mysterious, but our mantra is simplify, simplify, simplify. No baker can afford excess with current rising ingredient costs, and as a supplier it’s our job to help bakers get the most impact for their money. Run lean and mean, with minimal additives, including enzymes.

Last, as a company that strives to be a good business partner, we must look ahead at the consumer trends that may affect bakeries so that we can be of assistance in a changing marketplace. We may not be able to predict the future, but we must be prepared for it. Who can say which trend will be here next: low-salt or eliminating high-fructose corn syrup from labels? Either way, the bread still has to look and taste good. As bakers work to give consumers what they demand, ingredient suppliers of every kind have to be ready to step up to the plate and support them.

Nicole Rees is a product developer for Innovative Cereal Systems, a division of AB Mauri. She can be reached at NicoleR@bakingenzymes.com.

Handling and Use of Enzymes

The following excerpt is taken from the book Enzymes, part of the Eagan Press Handbook Series, by Paul R. Mathewson, p. 20–23.

In discussing appropriate methods for handling and using enzymes, it is useful to review some of the information already presented. Keep in mind that enzymes require a certain environment in which they can operate effectively. This environment is defined primarily by pH and temperature. Extremes of either one can result in significant loss of activity. It is useful to consider that enzymes are “comfortable” under conditions in which humans are most comfortable too. In other words, if the water in which you are about to dissolve the enzyme is too hot to be comfortable to you, it won’t be comfortable for the enzyme either. Water that is too hot will destabilize the enzyme and lead to loss of activity. The same is true for extremes of pH. High pH (>8.0) or low pH (4.5) may lead to enzyme denaturation. Be sure to check the literature accompanying the enzyme preparation to be certain of the conditions that constitute an appropriate “comfort range.” Physical abuse, such as vigorous mixing or shaking, can also lead to loss of activity, as can the combination of any of these conditions.

The handling of enzymes varies tremendously within the food industry, but some guidelines will enable any company to devise an appropriate set of directions for handling and using enzymes for their specific environment. Handling of the enzyme involves all the steps required to get the enzyme from storage to the product makeup site and ready to be added to the product mix. The number of steps in this process should be minimized to avoid potential problems. The larger the quantity of enzyme in a unit package, the more difficult it will be to minimize the steps. The enzyme should be packaged such that one unit contains the appropriate amount of enzyme for one batch of product. This eliminates weighing the enzyme as well as ensuring that there will be no open, partially filled packets of enzyme that cannot easily be resealed and thus protected from changes in humidity and temperature. Also, only the number of packets required for production need be transported to the makeup site.
site. If the enzyme liquid or powder is exposed to situations in which microbial contamination could occur, or where heat or other factors could cause the protein to be denatured, the enzyme will lose its activity.

If the enzyme is in liquid form, several alternatives can be considered. The most desirable is to have the correct amount of liquid enzyme automatically metered into the mixer. This eliminates the need for personnel to handle the enzyme at all during mixing. If this is not practical at a facility, the supplier should be asked to package the enzyme in a liquid carrier compatible with the formulation and in disposable containers holding an amount suitable for use in one batch. The additional packaging required for individual batch use may increase the cost of the enzyme as a raw ingredient, but this cost must be balanced against the convenience and accuracy of use. If this is not practical either, the user should make sure that the container is easily transported and that the contents can be conveniently poured out for weighing or volumetric measurement. A separate area should be designated for such weighing or measurement. The area should be cleaned thoroughly after each measurement of enzyme to prevent contamination between samples and minimize the chances of transfer of enzyme to the operators.

Once the amount of enzyme to be used has been correctly prepared, its use in the formulation depends on the form of the enzyme and the specific procedure called for. For example, when using a liquid enzyme, one usually can add the enzyme directly to the mix. Sometimes it is diluted with additional water to facilitate the homogeneous distribution of the enzyme throughout the entire batch. If the enzyme is in powder form, addition is a bit more involved. Unless the mix to which the enzyme is to be added is already a liquid, the powdered enzyme must usually be dissolved in a liquid, normally water, to ensure complete mixing within the product formulation.

Some Practical Examples

When an enzyme is placed in a situation in which it can catalyze a chemical reaction, it will immediately proceed to do so. The following examples show improper handling.

**Example 1.** The person doing the mixing is a little behind schedule. She must prepare an enzyme solution from powdered enzyme and add it to an upright mixer. She fills a bucket with hot water, not checking the temperature of the water. She then adds the powdered enzyme all at once and, using a mixing device, stirs the solution vigorously. She notices that a foam has appeared on the surface but continues to mix vigorously. She then waits for the mix cycle to stop so she can open the mixer and add the water-enzyme solution to the formulation.

In this example, the operator has made two classic mistakes. The combination of water that is too hot and mixing that is too vigorous will very likely lead to a decrease in the enzyme activity. Thus, the amount of active enzyme actually added to the mixer may well be significantly less than that required to produce an optimal product. To correct this, always be sure that the water temperature used in making up the enzyme solution is not too hot (it will rarely be too cold). You can determine this by using your hand to test the water in which you plan to dissolve the enzyme. If it feels comfortable to you (this will generally be in the range of 60–85°F or 15–30°C), then it will be comfortable for the enzyme.

To efficiently mix the enzyme into the water, add it a little at a time while stirring gently. The enzyme will dissolve readily, without foaming.

**Example 2.** Some products require the addition of several solutions to the mixer. In this case, one of the solutions is the enzyme; the other is ammonium bicarbonate. The operator first prepares the enzyme solution in one bucket, then, in a second container, places the required amount of ammonium bicarbonate followed by water. He mixes the ammonium bicarbonate around and adds it to the mixer. He observes that only part of the ammonium bicarbonate dissolves and that some of the solid ammonium bicarbonate has remained in the bottom of the bucket. To rinse the remaining ammonium bicarbonate out of the bucket, he pours the enzyme solution into the remaining ammonium bicarbonate, swishes it around, and adds the liquid to the mixer.

In this example, the enzyme may be denatured before it even gets into the mixer. The pH of the ammonium bicarbonate is quite basic (~8.2), and extremes of pH tend to destabilize enzymes and lead to denaturation. Thus, ammonium bicarbonate, a commonly used ingredient, can result in loss of enzyme activity if not handled properly.

**Example 3.** A formulation calls for adding two separate enzymes to the same product batch. The operator decides that it would be more efficient to add both enzymes to the same bucket of water.

However, this practice may have very detrimental effects on the activity of the enzymes involved. In general, it is not a good idea to mix enzymes together in the same solution, especially if one or both is a protease. While some proteases are very particular about what proteins they hydrolyze, most commercially available proteases are not at all choosy about what proteins to attack. If mixed with any other enzyme, the protease can attack and inactivate that enzyme. In fact, one protease enzyme in solution can attack and inactivate itself. Enzymes, especially proteases, should not be mixed with other enzymes in water solution and, when dissolved in water, should be added to the formulation as soon as possible.

**Example 4.** Having added powdered enzyme to a bucket of water, the operator gives the enzyme a couple of swishes with a whisk. There are still some pretty big clumps of enzyme floating in the water, but it is time to add the enzyme. The operator dumps the bucket into the mixer.

This example is also a commonly observed situation. The operator has not properly dissolved the enzyme, and the problem will not be as much with the enzyme itself as with the product. The amount of enzyme, either liquid or powder, added to a formulation is a very small percentage. For example, it may vary from about 0.005 to about 0.025% of the flour weight in a formulation. It is difficult to mix this amount of enzyme uniformly throughout the entire mix. However, a liquid is much easier to mix uniformly. That’s why it is so important to add the enzyme in the form of a liquid. Leaving the enzyme in clumps, as this operator did, results in uneven distribution. This will lead to a poorly conditioned dough, which is likely to result in machining problems as well as poor product consistency. The enzyme must be properly mixed into a uniform solution and then the liquid enzyme preparation must be added to the mixer as soon as possible.

To purchase a copy of the full handbook, which is now available for $79, please visit www.aaccnet.org and click “Books” or call 1.800.328.7560 or +1.651.454.7250.

126 / MAY-JUNE 2008, VOL. 53, NO. 3