Cows and Chickens
50 Cows and 20 Ate Chickens
What is an Enzyme?

- Protein
- Reaction catalyst
- Very specific in substrate and product
- Reaction rate depends on several factors
- Enzyme names end in “-ase”
Reaction Factors

- Temperature
- pH
- Amount of substrate(s)
- Amount of enzyme added
- Water activity
- Inhibitors
- Time
Lock and Key model

Fig. 1-4. Schematic representation of an enzymatic reaction. Blue = substrate, red = enzyme.
Enzyme sources

- **Bakery** enzymes come from microorganisms, either fungi or bacteria
- They are neither animal or plant, but fall under the class called microorganisms
Enzyme production
Protease

• Degrade complex proteins into smaller pieces
  – Softening and conditioning the gluten.
  – Provide greater extensibility; improve machining properties.
    – Will reduce mixing requirements.
• Used to replace l-cysteine in “natural” improvers
• Release water for moister crust
• Excess? Sticky, wet, hard to handle doughs; often weak.
• Recent improvements enable better performance with fewer drawbacks
• Generally, but not necessarily non-GMO
**α-amylase**

- Cleaves starch at interior alpha-1,4-glycosidic linkages
- Works on damaged starch granules, converts to sugars
- Optimal pH is between 5 and 6
- **Fungal:** *Aspergillus oryzae*. Optimal temperature is 122 F. Inactivated at 149 F.
- **Bacterial:** *Bacillus subtilis*. Optimal temperature is 158 F. Inactivated at 185 F.
- Generally non-GMO
- Both types are relatively inexpensive
Glucoamylase

- Converts starch granules to glucose
- Enhances crust color
- Both GMO and non-GMO versions available
- By providing additional glucose assists performance of sugar oxidases
Maltogenic Amylase

- Extends shelf life by reducing crumb staling
- Modifies amylopectin in starch after gelatinization
- Reduces and slows recrystallization of structure baking crumb soft and flexible
- Minimal risk of overdose
- First patented in 1983, emerged in the early 1990’s
- Patent expires in March 2018
- Use genetically modified microorganisms
Maltogenic Amylase
Enzyme vs .75 % Double Strength Hydrated Monoglyceride
White Bread no ESL Enzyme

Enzyme vs .75 % DS Hydrated Monoglyceride
White Bread with ESL Enzyme
(49,300 MANU Maltogenic Amylase)
Maltotetrahydrolase

- Anti staling similar to maltogenic amylase along with -
- Improved eating quality of the crumb
- Not inhibited by sucrose
- Better crust hinging
- Improved foldability of flatbreads
Phospholipases

- Strengthen yeast raised doughs by converting fat present in wheat flour to emulsifiers similar to DATEM and SSL
- Genetic technology for production was first introduced in 1984
- Most common type is phospholipase A2, because they turn phospholipids in flour into LysoPhospholipid (= higher polarity) and Galactolipids into lysogalactolipids (= higher polarity)....
- A recent patent expiration has opened the door to more competition, and more product offerings
Dual specificity of lipases

• Lipases generally act on the polar lipids naturally present in wheat flour to improve dough strength and loaf volume. An improvement was made to enable reaction with non-polar lipids as well as polar lipids resulting in further improved dough tolerance and loaf volume.
Xylanase, Hemicellululase, Pentosanase

• Convert insoluble arabinoxylans etc., detrimental to loaf quality, to more desirable soluble starch gels

• Improved extensibility, better processing, improved loaf volume.
Xylanase, Hemicellulase, Pentosanase

• Release bound water.
• Enhance crust dryness, reduce flakiness and improve hinging
• Enhance anti-staling properties of maltogenic amylases
• Non-GMO versions available
Cellulase

Converts cellulose fibrils to starch that can be further converted to sugars
Glucose or Hexose Oxidases

• Use certain sugars to create oxidizers ($H_2O_2$)
• $H_2O_2$ links disulphide bonds of gluten
• Strengthens gluten network to give greater volume. Became prominent with the need for removal of Potassium Bromate and ADA
Glucose or Hexose Oxidases

- Improved dough strength, stability, and tolerance
- Reduced dough stickiness and increased dough absorption
- Increased loaf volume
- Generally slower acting than ascorbic acid or ADA
- Do not work in continuous mix systems
- Non-GMO versions available
Transglutaminase

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Action of Transglutamininase

Glu-C-NH₂+H₂N-Lys → Glu-C-NH-Lys+NH₃

Forms crosslinks between glutamine and lysine in proteins
GMO Free vs Non-GMO
The Product Verification Program uses a process that combines on-site facility audits, document-based review and product testing to verify compliance with the standard at every level of the supply chain, from manufacturing facilities to ingredient suppliers. For a product to be verified and bear the seal, it must undergo a process through which any ingredient at high risk for GMO contamination — soy or corn, for example — has been proven to meet the standard through avoidance practices and testing.
Available classical enzymes

- Protease
- $\alpha$-amylase—fungal and bacterial
- Glucoamylase
- Glucose oxidase
- Xylanase, hemicellulose and cellulase
- Transglutamininse
Classical (Non GMO) Enzymes

Non GMO Enzyme Blend  2 % Vital Wheat Gluten
Key Ingredient Lists

• Whole Foods Product Lists
• Panera Bread No No List
• Non-GMO Project Verified Lists
• UMRI and USDA Certified Organic Lists
• FDA Generally Recognized as Safe
• Canadian Approved Enzymes
Some enzyme benefits in bread

• Cleaner and more simplified labeling
• Stable and often lower formulation costs
• Improved volume
• Improved dough strength and tolerance
• Improved loaf structure
• Greater extensibility
• Increased absorption
• Tighter crumb structure
• Enhanced browning
• Frozen dough stability
• Longer shelf-life thru staling reduction