Control of Wheat Flour Quality by Improvers

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Ahrensburg, Germany
## Diversity of Baking Procedures

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<th>Time [min]</th>
<th>Germany RMT (rolls)</th>
<th>China Steam bread</th>
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<th>Ghana Sugar bread</th>
<th>India Parothas</th>
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### Temperature
- 15°C
- 18°C
- 20°C
- 25°C
- 30°C
- 35°C
- 40°C
- 45°C
- 50°C
- 60°C
- 80°C
- 100°C
- 200°C
- 220°C
- 230°C
- 250°C

Wt Wheat

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**Note:** The table above illustrates the diversity of baking procedures across various countries, detailing the timeline and conditions for each step in the baking process.
Flour Improvers

Standardization and optimization of flour quality with micro-ingredients
Reasons for Application of Flour Improvers

- Equilibrate fluctuations of flour properties due to:
  - grain from new harvest or
  - different varieties or
  - different lots
  - grain damage

- Improve baking performance

- Diversify applicability

- Suit customers specifications
Additives Used in Flour Improvers

1 – 100 ppm on flour
- Enzymes
- Oxidizing agents
- Ascorbic acid
- Reducing agents

500 – 3,000 ppm on flour
- Emulsifiers
- Acidity regulators
- Malt flour
- Vital wheat gluten
- Hydrocolloids
- Soy flour
- Preservatives
Oxidizing Agents
Reasons for the Use of Oxidation

- Modern milling technology (roller mills instead of stones) reduces thermal and oxidative stress
- Short storage of flour / just-in-time production reduces maturation period
- Air-tight packaging material or silo storage reduce access of oxygen
- Industrial bakers requiring very constant flour properties, and
- Higher dough tolerance
- Bleaching effects on flour and/or bread crumb
- Wheat varieties and high protein levels requiring / allowing for more oxidative maturation (?)
Oxidizing Agents as Flour Improvers

- Potassium bromate
- Potassium iodate
- Calcium bromate
- Calcium iodate
- Azodicarbonamide
- Calcium peroxide
- Ammonium persulfate
- Potassium persulfate
- Sodium perborate
- Sodium percarbonate
- Acetone peroxide
- Chlorine & chlorine dioxide
- Hypochlorite
- Benzoyl peroxide
- Ascorbic acid, resp.
- Dehydro-ascorbic acid
- Sodium hypophosphite
- Cystine
- Hydrogen peroxide
- Oxygen
- Ozone
Ascorbic acid

Ascorbic acid under the microscope

Source: www.microscopy.fsu.edu/micro/gallery/vitamin/vitamin.html
Reactions of Ascorbic Acid in Dough

\[
\frac{1}{2} O_2 \xrightarrow{\text{Ascorbate oxidase}} \text{Ascorbic acid} \xrightarrow{\text{Glutathione oxidase}} \text{Glutathione dimer} \xrightarrow{\text{Glutathione oxidase}} \text{Reduced glutathione} \xrightarrow{\text{Protein-SH HS-Protein}} \text{Protein-SS-Protein}
\]

(modified from Grosch and Wieser, 1999)
General Directions for Use of Ascorbic Acid in Flour Improvement

**Typical dosage:**
2 – 6 g per 100 kg flour = 20 – 60 ppm

High and soft protein: 60 – 100 ppm
High and short protein: 20 – 40 ppm
Low and soft protein: max. 60 ppm
Low and short protein: 20 ppm
Low Falling Numbers (below 220 s): Increase dosages by 50 %
Effects of Ascorbic Acid in Baking

- Compensates lack of flour maturation
- Improves dough stability
- Improves fermentation tolerance
- Increases dough elasticity
- Reduces dough extensibility
- Reduces dough stickiness
- Improves dough handling properties and machinability
- Results in finer crumb structure (smaller pores)
- Increases volume yield
Effect of Ascorbic Acid on Baking Results

Wheat flour T 55
Ash 0.497 %
Protein d.b. 13.3 %
Wet gluten 34.3 %
Falling no. 314 s
Water abs. 58.8 %
Gluten index 89

ELCO C-100
3.5 g/100 kg

without treatment
Azodicarbonamide
(ADA)
Possible Actions of Azodicarbonamide

\[ \text{Azodicarbonamide} \quad \xrightarrow{2 \text{ Prot-SH}} \quad \text{Biurea} \]

\[ \text{GSH} = \text{reduced glutathione} \]
\[ \text{GSSG} = \text{oxidized glutathione} \]
\[ \text{Prot-SS-Prot} = \text{gluteline} \]
Properties of Azodicarbonamide

- Fast oxidizing effect
- Results in bucky doughs
- Improves dough stability
- Improves crumb structure, but
- Sometimes a few larger holes
- Bread surfaces rough when insufficient relaxing time
- Recommended max. level in bread flour 45 ppm
Enzymes
Nature’s all-purpose tools
No Baking without Enzymes!

- In all baking processes, enzymes are involved, because
  - flour contains cereal enzymes
  - yeast has enzymes to convert flour components into fermentable substances

- Flour & bread improvers contribute additional enzymes to the baking process.
  - for standardization of optimization of the flour’s baking performance and for improvement of the end product quality

- If all enzyme activities shall be avoided, the flour has to be treated by chemicals (f.i. chlorine) or heat in order to inactivate the enzymes.
  - An accordingly treated flour could only be used to produce flat bread, chemically leavened bread, soft biscuits or the like
  - Some extruded snack products can be made from enzyme-inactive flour.
# Sources for Industrial Food Enzymes

## Plants
- Figs → Ficin
- Pineapple → Bromelain
- Papaya → Papain

## Animals
- Pigs, calves → Pancreatin, Chymosin
- Hen eggs → Lysozyme
- Milk → Lactoperoxidase

## Microbes
- Yeast → Invertase, Lipase
- Moulds → Amylase, Xylanase, Protease, Oxidase
- Bacteria →
Energy of Activation & Enzyme Catalysis

Activation energy (spontaneous reaction)
Activation energy (enzymatic catalysis)

Substrate
Enzyme
Reaction time
Enzyme Activity Depends on Many Factors

- Enzyme activity
- Temperature
- pH
- Substrate concentration
- Enzyme concentration
- Enzyme specificity
- Mixing intensity
- Inhibiting substances (fat, sugar)
- Water activity

Enzyme activity depends on many factors.
Typical Compositions of Doughs and Batters

- **Wheat Bread**
  - Flour: 100%
  - Water: 60-70%
  - Fat: 3-5%
  - Sugar: 3-5%

- **Cookies**
  - Flour: 100%
  - Water: 20-25%
  - Fat: 20-30%
  - Sugar: 10-15%

- **Cracker**
  - Flour: 100%
  - Water: 20-25%
  - Fat: 10-15%
  - Sugar: 10-15%

- **Hard Biscuits**
  - Flour: 100%
  - Water: 20-25%
  - Fat: 10-15%
  - Sugar: 10-15%

- **Flat Wafers**
  - Flour: 100%
  - Water: 40-50%
  - Fat: 10-15%
  - Sugar: 0-2%

The graph represents the typical compositions of the mentioned baked goods, showing the percentage of flour, water, fat, and sugar used in each.
Amylolytic Enzymes
Amylolytic Enzymes used in Baking

Glucose (Dextrose)

Maltose

β-amylases

α-amylases

Glucoamylases

Glucose
Effect of α-Amylase on Dough and Baked Good

- Break-down of hydrated starch (only mechanically or thermally damaged starch)
- Release of water
  - Reduction of dough viscosity/consistency
  - Improved extensibility
  - May cause stickiness, large pores or weak crumb if used in excess
- Produces “limit dextrins” (branched fragments) and short linear dextrins and finally maltose from linear sections of the starch molecule
  - Improved browning
  - Improved shelf life
  - Better fermentation
- Enhanced volume yield and bread aspect
Dosage Recommendation for Fungal α-Amylase

Minimum dosage (ppm) of Alphamalt VC 5000 (5,000 SKB/g) estimated from Falling Number and extraction rate

<table>
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<th>Falling number</th>
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<th>Type 812 / 1050, 80-85 % extraction</th>
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<td>&gt;380</td>
<td>&gt; 100</td>
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Strong gluten allows for higher dosages
Hemicellululases

Pentosanases, Xylanases and Co.
Enzymatic Hydrolysis Sites in Wheat Xylan

Arabinose
Xylose
Coumaric acid
Ferulic acid
α-L-Arabinofuranosidase
Endo-1,4-β-xylanase
Coumaric acid esterase
Ferulic acid esterase
Effect of Various Xylanases on Pentosan* Viscosity

Break-down of WUX
Break-down of SWUX and WEX

Viscosity (%)

Xylanase concentration (uDNS/mL)

WUX – water-unextractable xylans  WEX – water-extractable xylans
SWUX – solubilized water-unextractable xylans

*Pentosan from wheat starch tailings
Summary of the Effects of Xylanases

- Break down xylan backbone
- Soften gluten-xylan network
- Hydrolyse soluble and insoluble pentosans
  - initial increase of water absorption → dough drying
  - release of water → softening of gluten
- Improve extensibility
- Dough softening
- Volume increase of baked goods
- Can be used to achieve finer or coarser crumb
- May cause stickiness if not suitable or overdosed
Oxidases
Some Oxidizing Enzymes

- Glucose oxidase
- Galactose oxidase
- Hexose oxidase
- Sulfhydryl oxidase
- Phenoloxidase (laccase)
- Peroxidase
- Katalase
**Effects of Glucose Oxidase in Dough**

\[
\text{Glucose} + \text{O}_2 + \text{H}_2\text{O} \xrightarrow{\text{GOD}} \text{Gluconic acid} + \text{H}_2\text{O}_2
\]

- **Ascorbic acid**
  - \(\text{H}_2\text{O}_2\)
  - \(\text{H}_2\text{O}\)
- **Dehydro-ascorbic acid**
- **Glutathion dimer**
  - \(\text{Glutathione oxidase}\)
- **Reduced glutathion**
- **Protein-SH**
- **HS-Protein**
- **Protein-SS-Protein**

\[
\text{H}_2\text{O}_2 + \text{H}_2\text{O} \xrightarrow{\text{(Peroxidase)}} \text{Oxidative gelation}
\]

**Pentosan**

**LP01022012**

34
Effect of Glucose-Oxidase on Dough Development

Time (min) vs. Resistance (BU)

- Reference
- Glucose Oxidase

The graph shows the time (in minutes) on the x-axis and the resistance (in BU) on the y-axis. The line for Glucose Oxidase starts at a lower resistance than the Reference and remains lower throughout the time period shown.
Comparison of Glucose Oxidase in Germany Breakfast Rolls (over-fermented)

Wheat flour: German soft wheat; SOX from pilot scale production
Summary of the Effects of Oxidases

- Create hydrogen peroxide
- Cause cross-linking of proteins and pentosans
- “Inactivate” softening (reducing) substances such as cysteine or glutathione
- Increase water absorption
- Result in dryer dough surfaces and hence better handling properties
- Improve the opening of the cut, f.i. of baguette
- Improve dough stability
- Help to preserve the dough shape in long fermentations
Carboxyl Esterase

Lipase, Phospholipase, Galactolipase & Co.
Simplified Classification and Distribution of the Main Lipids in Wheat Flour (averages; % d.s.)

Wheat flour lipids
2.7

Free lipids
0.9

Bound lipids
1.8

Nonpolar
0.7

Polar
0.2

Nonpolar
0.6

Polar
1.2

Glycolipids
0.14

Phospholipids
0.05

Glycolipids
0.25

Phospholipids
0.95

Modif. from Pomeranz & Chung, 1978, using data from Chung & Ohm, 2009
Effect of Wheat Lipids on Volume Yield of Defatted Wheat Flour

Bread volume (ml/100 g flour)

0 0.3 0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3.0

Re-added wheat lipid (g/100 g flour)

0 660 600 530 460

polar lipids
non-polar lipids

Modif. from MacRitchie & Gras, 1973
Effect of Dosage and Proof Time on Baguette Rolls with **Alphamalt EFX Super** (Carboxyl Esterase)

Basic treatment: FAA, 1 SKB/g ADA, 40 ppm Asc., 160 ppm SSL, 0.3 %

<table>
<thead>
<tr>
<th>Dosage (ppm)</th>
<th>1.5 h, normal proof</th>
<th>2 h, over-proof 1</th>
<th>2.5 h, over-proof 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ppm</td>
<td>743</td>
<td>803</td>
<td>863</td>
</tr>
<tr>
<td>10 ppm</td>
<td>748</td>
<td>852</td>
<td>937</td>
</tr>
<tr>
<td>25 ppm</td>
<td>787</td>
<td>882</td>
<td>965</td>
</tr>
<tr>
<td>50 ppm</td>
<td>856</td>
<td>935</td>
<td>1015</td>
</tr>
</tbody>
</table>

Volume yield, mL/100 g flour
Bleaching Mechanism of Triacyl Lipase

Triglyceride $\xrightarrow{\text{Triacyl Lipase}^{(1)}}$ FFA + Lyso-Lipid

FFA + $O_2$ $\xrightarrow{\text{Lipoxygenase}^{(2)}}$ R-OOH (hydro peroxide)

R-OOH bleaches the flour pigment and oxidizes the thiol groups of proteins

$^{(1)}$ Intrinsic or added triacyl lipase
$^{(2)}$ Flour lipoxygenase type 1
FFA – free fatty acid (R-H)
Summary of the Properties of Carboxyl Esterases

- Produce emulsifier-like substances from lipids
- Enhance dough stability
- Increase volume yield
- Result in fine porer structure
- Enhance crumb whiteness be physical (shallower shadows) and chemical (indirect bleaching) effects
- Improvement of initial crumb structure & bread volume
- Improved crumb softness after storage
- May cause off-flavour if not compatible with involved lipids
Enzymes Summary
## Typical Effects of Enzymes on Bread Quality used at common dosages

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>WA&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>Volume&lt;sup&gt;(2)&lt;/sup&gt;</th>
<th>Stability&lt;sup&gt;(3)&lt;/sup&gt;</th>
<th>Cut&lt;sup&gt;(4)&lt;/sup&gt;</th>
<th>Colour&lt;sup&gt;(5)&lt;/sup&gt;</th>
<th>Crumb&lt;sup&gt;(6)&lt;/sup&gt;</th>
<th>Shelf-life&lt;sup&gt;(7)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>α-Amylase, fungal</td>
<td>o</td>
<td>++</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>α-Amylase, cereal</td>
<td>-</td>
<td>+</td>
<td>--</td>
<td>-</td>
<td>++</td>
<td>--</td>
<td>+</td>
</tr>
<tr>
<td>α-Amylase, bacterial</td>
<td>-</td>
<td>(+)</td>
<td>(-)</td>
<td>o</td>
<td>o</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>α-Amylase, maltogenic</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>++</td>
</tr>
<tr>
<td>Xylanase&lt;sub&gt;WUX&lt;/sub&gt;</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>o</td>
<td>+</td>
<td>(+)</td>
</tr>
<tr>
<td>Xylanase&lt;sub&gt;WEX&lt;/sub&gt;</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>o</td>
<td>-</td>
<td>o</td>
</tr>
<tr>
<td>Protease</td>
<td>o</td>
<td>(+)</td>
<td>(+)/-</td>
<td>+</td>
<td>o</td>
<td>(-)</td>
<td>o</td>
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<tr>
<td>Oxidase</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>o</td>
<td>+</td>
<td>(+)</td>
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<tr>
<td>Carboxylesterases</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>o</td>
<td>++</td>
<td>+</td>
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<tr>
<td>Transglutaminase</td>
<td>o</td>
<td>o</td>
<td>+</td>
<td>+</td>
<td>o</td>
<td>o</td>
<td>o</td>
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</tbody>
</table>

<sup>(1)</sup> Water absorption  <sup>(2)</sup> Baking volume yield  <sup>(3)</sup> Shape stability  <sup>(4)</sup> Opening of the cut, shred  <sup>(5)</sup> Crust colour  <sup>(6)</sup> Crumb fineness  <sup>(7)</sup> Non-microbial shelf-life

WUX – water-unextractable xylans  WEX – water-extractable xylans
Combined Effect of Ascorbic Acid Enzymes

German wheat flour Type 550, harvest 2003

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Volume Yield in mL per 100 g flour</th>
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<tr>
<td>Untreated</td>
<td>490 mL*</td>
</tr>
<tr>
<td>Asc. 4 g</td>
<td>820 mL</td>
</tr>
<tr>
<td>Asc.+Amyl. 8 g + 30 g</td>
<td>950 mL</td>
</tr>
<tr>
<td>Asc.+(Amyl.+Xyl.) 8 g + 10 g</td>
<td>970 mL</td>
</tr>
</tbody>
</table>

* Volume yield in mL per 100 g flour
Carboxyl Esterase Boosts the Baking Results

ELCO C 100K: Ascorbic acid, 100 %
Alphamalt A 15140: Amylase, 140,000 SKB/g
Alphamalt HC 13045: Hemicellulase
Alphamalt Gloxy 14080: Glucose oxidase
Alphamalt EFX Mega: Carboxyl esterase

Reference  ELCO, 50 ppm A 15140, 10 ppm  ELCO, 50 ppm A 15140, 10 ppm  ELCO, 40 ppm A 15140, 10 ppm
HC 13045, 30 ppm  HC 13045, 30 ppm  HC 13045, 30 ppm
Gloxy 14080, 20 ppm  EFX Mega, 10 ppm
Effects of Flour Improvers on Rheology
Falling Number
Effect of Amylases on Falling Number

North American hard wheat

German soft wheat

Dosage [g/100 kg flour]
A New Amylase for Falling Number Control

Dough consistency: 0 = soft; 5 = firm
Pore structure: 0 = fine; 5 = coarse

Dough consistency
Pore structure
Crust color
Volume yield
Bloom

Alphamalt A
Alphamalt FN
Effect of Rowelit on Falling Number and Baking

![Graph showing the effect of Rowelit dosage on Falling Number and Volume yield. The graph plots the dosage of Rowelit (g/100 kg flour) on the x-axis and the falling number and volume yield on the y-axis. The wheat flour used is T550 with 12.6% protein content.](image-url)
The Farinogram  [Mixolab Curve]
Farinograph Examples for Weak & Strong Flour

Mixed time (min)

Weak

Very strong
Effect of Glucose Oxidase on the Farinogram

Resistance (BU)

Time (min)

German wheat flour
10 ppm Alphamalt Gloxy 5080

Reference

Glucose Oxidase
Effect of Alphamalt BX on the Farinogram

Graph showing the effect of Alphamalt BX on the resistance of German wheat flour over time. The graph compares the resistance of flour with no treatment and with 400 ppm BX. The resistance is measured in Brabender Units (BU) and the time is measured in minutes. The graph indicates that Alphamalt BX reduces the resistance compared to the control.
# Effect of Flour Treatment on Farinogram

<table>
<thead>
<tr>
<th>Oxidation, ppm</th>
<th>Enzyme, ppm</th>
<th>WA %</th>
<th>Developm. min</th>
<th>Stability min</th>
<th>Softening B.U.</th>
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<td>untreated</td>
<td></td>
<td>59.8</td>
<td>3.0</td>
<td>4.5</td>
<td>30</td>
</tr>
<tr>
<td>AA, 10</td>
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<td>59.8</td>
<td>3.5</td>
<td>10.0</td>
<td>10</td>
</tr>
<tr>
<td>AA, 20</td>
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<td>59.8</td>
<td>3.0</td>
<td>12.0</td>
<td>0</td>
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<tr>
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<td>59.8</td>
<td>2.5</td>
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<td>AA, 80</td>
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<td>20</td>
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<tr>
<td>PBr, 10</td>
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<td>30</td>
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<td>60.1</td>
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<td>20</td>
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<td>A 10033, 50</td>
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<td>50</td>
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<td>60</td>
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<td>A 10033, 100</td>
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<td>2.5</td>
<td>3.0</td>
<td>30</td>
</tr>
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<td>AA, 40</td>
<td>A 10033, 100</td>
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<td>AA, 80</td>
<td>A 10033, 100</td>
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<td>45</td>
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<td>BX, 100</td>
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<td>59.5</td>
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<td>10.5</td>
<td>20</td>
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<td>BX, 200</td>
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<td>59.6</td>
<td>2.5</td>
<td>8.5</td>
<td>25</td>
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<td>BX, 400</td>
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<td>59.3</td>
<td>3.0</td>
<td>7.0</td>
<td>70</td>
</tr>
</tbody>
</table>

AA=ascorbic acid, PBr=potassium bromate, A 10033=amylase/xylanase compound, BX=multiple enzymes/maturing agents compound
The Alveograph
## Effect of Various Flour Additives on Alveograms

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P</th>
<th>L</th>
<th>P/L</th>
<th>W</th>
<th>Remarks</th>
</tr>
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<tbody>
<tr>
<td>untreated</td>
<td>83</td>
<td>97</td>
<td>0.86</td>
<td>209</td>
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<tr>
<td>Ascorbic acid (1)</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Potassium bromate</td>
<td>++</td>
<td>-</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>Cysteine (2)</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Sodium metabisulfite</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>alpha-Amylase (3)</td>
<td>--</td>
<td>++</td>
<td>--</td>
<td>-</td>
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<tr>
<td>Hemicellulase, AN</td>
<td>-</td>
<td>o</td>
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<tr>
<td>Hemicellulase, TR</td>
<td>--</td>
<td>+</td>
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<tr>
<td>Hemicellulase, BS</td>
<td>-</td>
<td>-</td>
<td>+</td>
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<tr>
<td>Protease, fungal (4)</td>
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<tr>
<td>Glucose oxidase (5)</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>o</td>
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<tr>
<td>Alphamalt A 6003</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Alphamalt A 9029</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Wafer enzyme (6)</td>
<td>--</td>
<td>+</td>
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<tr>
<td>Alphamalt BX</td>
<td>++</td>
<td>--</td>
<td>++</td>
<td>+</td>
<td>softer than BX</td>
</tr>
<tr>
<td>Alphamalt BX + cysteine</td>
<td>++</td>
<td>--</td>
<td>++</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Vital wheat gluten (7)</td>
<td>+</td>
<td>-/o</td>
<td>+</td>
<td>++</td>
<td></td>
</tr>
</tbody>
</table>

(1) ELCO C-100  (2) EMCEsoft P  (3) Alphamalt A 4050  (4) Alphamalt Pro  (5) Alphamalt Gloxy 4092  (6) Alphamalt LQ 4020  (7) EMCEvit C

AN = Aspergillus niger  TR = Trichoderma reseei  BS = Bacillus subtilis
Effect of Various Enzymes on the Alveogram

VC 5000 = alpha-amylase from *Aspergillus oryzae*, 5,000 u/g (SKB)
HCF = hemicellulase from *Trichoderma reesei*
B 2000 (Alphamalt Pro) = protease from *Aspergillus oryzae*
Gloxy 4090 = glucose oxidase from *Aspergillus niger*, 1,500 u/g
Effect of Ascorbic Acid on Alveograms

After Faridi & Rasper, 1987
Effect of Alphamalt BX on the Alveogram

US flour

- untreated
- 200 ppm
- 400 ppm
Replacement of Potassium Bromate

Reference 7 g bromate, 10 g VC 5000 40 g Alphamalt BX
The Extensogram
Effect of Protein Content on Alveo- & Extensograms

**DIPLOMAT (normal, silky)**

<table>
<thead>
<tr>
<th>Protein</th>
<th>%</th>
<th>WA, %</th>
<th>DP</th>
<th>VY</th>
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<tbody>
<tr>
<td>low</td>
<td>11.5</td>
<td>51.8</td>
<td>16</td>
<td>598</td>
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<tr>
<td>high</td>
<td>18.0</td>
<td>59.6</td>
<td>9</td>
<td>863</td>
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</table>

**W, P/L, G, E, R/E**

<table>
<thead>
<tr>
<th>W</th>
<th>P/L</th>
<th>G</th>
<th>E</th>
<th>R/E</th>
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</thead>
<tbody>
<tr>
<td>245</td>
<td>0.56</td>
<td>25</td>
<td>134</td>
<td>2.2</td>
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<tr>
<td>158</td>
<td>0.56</td>
<td>22</td>
<td>130</td>
<td>7.1</td>
</tr>
</tbody>
</table>
Effect of Ascorbic Acid on the Extensogram

![Graph showing the effect of different concentrations of Ascorbic Acid on the extensogram.](image)

**Graph:**
- **X-axis:** Extension (mm)
- **Y-axis:** Resistance (BU)
- Curves for different concentrations:
  - 0 ppm
  - 30 ppm
  - 60 ppm
  - 120 ppm
  - 300 ppm

135 min
The MC Navigator

A Quick Guide through the Action of Flour Improvers
The MC Navigator, an Orientation Chart for Baking & Rheology Additives

1 MC Navigator Baking

2 MC Navigator Rheology
### 1 MC Navigator Baking (1)

<table>
<thead>
<tr>
<th>Enzyme Systems</th>
<th>ALPHAMALT V</th>
<th>ALPHAMALT VC 5000</th>
<th>ALPHAMALT A 5070</th>
<th>ALPHAMALT F 9023</th>
<th>POWERZYM 5000</th>
<th>POWERZYM 6000</th>
<th>ALPHAMALT A 5005</th>
<th>ALPHAMALT A 6003</th>
<th>ALPHAMALT T 8006</th>
<th>ALPHAMALT A 9029</th>
<th>ALPHAMALT A 14888</th>
<th>BETAMALT 25</th>
<th>ALPHAMALT GA 5071</th>
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<td>MC quality</td>
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<tr>
<td>DOSAGE per 100 kg flour</td>
<td>5 - 40 g</td>
<td>2 - 10 g</td>
<td>0.5 - 2 g</td>
<td>20 - 60 g</td>
<td>6 - 12 g</td>
<td>6 - 15 g</td>
<td>10 - 20 g</td>
<td>8 - 15 g</td>
<td>10 - 20 g</td>
<td>10 - 20 g</td>
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<td>10 - 50 g</td>
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<tr>
<td>Improving the production of baked goods</td>
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<td>Dough setting and mixing time</td>
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<td>Dough stability</td>
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<td></td>
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</tbody>
</table>
1 MC Navigator Baking (2)

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>Enzyme Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amylases</td>
</tr>
<tr>
<td></td>
<td>Amylase–hemicellulase complexes</td>
</tr>
<tr>
<td></td>
<td>Beta–amylase</td>
</tr>
<tr>
<td></td>
<td>Glucoamylase</td>
</tr>
</tbody>
</table>

### Improving the baked goods
- Browning and colour
- Shelf-life
- Volume
- More stable / more elastic
- Crumb structure
- Texture
- Fine
- Tenderness (biscuits)
- High

### Problem flours / composite flour
- Low-enzyme flour
- Low-protein flour
- Bug-damaged flour
- Sprout-damaged flour
- 10% cassava flour
- 90% rice flour

### Biscuit flours / wafer flours
- Prevention of breakage
- Browning
- Prevention of shrinkage
- Extenibility

The diagram illustrates the effectiveness of different enzyme systems in improving baked goods and addressing flour issues. Each cell indicates the level of improvement, with symbols representing the degree of effectiveness.
1 MC Navigator Baking (3)

- Strongly raising, increasing effect
- Slightly raising, increasing effect
- No significant change
- Slightly lowering, reducing effect
- Strongly lowering, reducing effect

- Use not recommended
- Benefit doubtful
- Use recommended