Sour Wort - The new member in our product family
Intention of the Weyermann®/ Doehler Sour Wort cooperation for Beer Brewing

Natural and flexible pH-value adjustment to optimise the brewing process and beer quality in accordance with the German Purity Law

→ Easy availability and usage - significant benefits
Agenda

1. Biological Acidification
2. Sour Wort – Production
3. Sour Wort – Specification
4. Sour Wort – Application
5. Dosage Quantities in Mash/Wort
6. Pilot Tests under Practice Conditions
7. Conclusion – Product Advantages
8. Sales information
Significant Improvements in Brewing Process and Beer Quality by biological acidification

- Biologically produced lactic acid for acidifying mash and/or wort
  → Optimization of the brewing process and beer quality
- Biological acidification represents a natural way to adjust mash and wort pH
  → In compliance with the German Purity Law (clean labelling)
- The reduction of mash and wort pH leads to an improvement of …
  → … brew house yield (high enzyme activity)
  → … fermentation performance (reduced fermentation time)
  → … filtration performance (lower viscosity)
  → … beer quality (increased flavor stability)
State-of-the-Art Fermentation Technology and Aseptic Filling

Malt is produced from barley through steeping, germination and kilning in order to completely break down cell walls, partially break down proteins and generate enzymes.

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Using a classical infusion mashing process, the valuable substances of malt grist are brought into solution. The final mash is filtered resulting in the so-called wort.

Under CO2 atmosphere, the sugar in the wort is converted into lactic acid by a pure culture of lactic acid bacteria, namely L. amylolyticus.

With the help of an aseptic filling machine, the sour wort is filled in optimal packages (Bag-in-Box 20 kg).

The sour wort is concentrated by performing a gentle vacuum evaporation (water).

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Our Product – specification in accordance with the German Purity Law

- Raw materials used for sour wort production
- Sour wort fermentation
- Concentration of produced sour wort

conform to the German Purity Law

<table>
<thead>
<tr>
<th>Weyermann® / Doehler Sour Wort - Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Lactic acid</td>
</tr>
<tr>
<td>pH</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td>Brix</td>
</tr>
</tbody>
</table>

Shelf-life (unopened package): 360 days – Storage at 20°C
Biological Mash and/or Wort Acidification in the Brewhouse

### Mash acidification
- Enhanced enzymatic degradation of materials
- Higher levels of growth-promoting substances
- Suppression of lipoxygenase activity
- Better lautering performance
- Enhanced redox potential, i.e. reduced susceptibility to oxygen

### Wort acidification
- Less color formation
- Enhanced protein coagulation/precipitation
- Improved sensory quality
- Increased chemical-physical stability
- Enhanced microbiological stability

**Mash tun**
- pH = 5.6 – 5.8

**Mash acidification**
- pH = 5.2 – 5.4

**Wort kettle**
- pH = 5.3 – 5.7

**Whirlpool**
- pH = 5.0 – 5.2

**Sour wort**
- Water
- Malt

**Hops**
- Sour wort

**Sour wort**
- OR

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## Efficient Dosage of Lactic Acid by means of Weyermann®/Döhler Sour Wort

<table>
<thead>
<tr>
<th>Δ pH</th>
<th>Needed quantity of lactic acid (80%)</th>
<th>Use of sour wort (0.8% lactic acid)</th>
<th>Use of Weyermann®/Döehler Sour Wort (5.5% = 55 g/L lactic acid)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[L/t Malt]</td>
<td>[L/hL SB]</td>
<td>[L/t Malt]</td>
</tr>
<tr>
<td>0.1</td>
<td>0.4</td>
<td>0.007</td>
<td>36</td>
</tr>
<tr>
<td>0.2</td>
<td>0.7</td>
<td>0.013</td>
<td>73</td>
</tr>
<tr>
<td>0.3</td>
<td>1.1</td>
<td>0.020</td>
<td>109</td>
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<td>0.4</td>
<td>1.5</td>
<td>0.026</td>
<td>145</td>
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### Mash acidification

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<td></td>
<td>[L/t Malt]</td>
<td>[L/hL SB]</td>
<td>[L/t Malt]</td>
</tr>
<tr>
<td>- 0.1</td>
<td>0.6</td>
<td>0.01</td>
<td>60</td>
</tr>
<tr>
<td>- 0.2</td>
<td>1.2</td>
<td>0.02</td>
<td>120</td>
</tr>
<tr>
<td>- 0.3</td>
<td>1.8</td>
<td>0.03</td>
<td>180</td>
</tr>
<tr>
<td>- 0.4</td>
<td>2.4</td>
<td>0.04</td>
<td>240</td>
</tr>
</tbody>
</table>

### Wort acidification

<table>
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<tr>
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<th>Needed quantity of lactic acid (80%)</th>
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</table>
# Practical test of the Sour Wort in a Medium-Sized Brewery

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
<th>Brew 1</th>
<th>Brew 2</th>
<th>Brew 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grist load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilsner malt</td>
<td>kg</td>
<td>2,850</td>
<td>2,850</td>
<td>3,000</td>
</tr>
<tr>
<td>Sour malt</td>
<td>kg</td>
<td>150</td>
<td>150</td>
<td>0</td>
</tr>
<tr>
<td>Percentage</td>
<td>%</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Cast-out wort</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extract</td>
<td>%</td>
<td>12.0</td>
<td>11.9</td>
<td>12.1</td>
</tr>
<tr>
<td>Volume</td>
<td>hL</td>
<td>199</td>
<td>199</td>
<td>198</td>
</tr>
<tr>
<td>Weyermann®/Doehler Sour Wort</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Addition to mash</td>
<td>kg</td>
<td>0</td>
<td>0</td>
<td>51.5</td>
</tr>
<tr>
<td>Mash pH</td>
<td>-</td>
<td>5.35</td>
<td>5.36</td>
<td>5.35</td>
</tr>
<tr>
<td>Addition to wort</td>
<td>kg</td>
<td>0</td>
<td>57.6</td>
<td>62.2</td>
</tr>
<tr>
<td>Cast-out wort pH</td>
<td>-</td>
<td>5.32</td>
<td>5.02</td>
<td>4.98</td>
</tr>
</tbody>
</table>

**Brew 1:** Mash acidification using sour malt (Reference)

**Brew 2:** Mash acidification using sour malt, wort acidification using Weyermann®/Doehler Sour Wort (boiling)

**Brew 3:** Mash and wort acidification using Weyermann®/Doehler Sour Wort
Results | Aging Indicators in Fresh/Forced-Aged Beer

**Brew 1:** Mash acidification using sour malt (Reference)

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**Brew 3:** Mash and wort acidification using Weyermann®/Doehler Sour Wort

- **Fresh beer**
  - Brew 3 → lowest concentration of aging indicators

- **Forced-aged beer**
  - Reduction of aging indicator levels by using Weyermann®/Doehler Sour Wort in mash and/or wort

**Conclusion:**
Application of Weyermann®/Doehler Sour Wort in mash and/or wort significantly increases the flavor stability of beer
Results | Sensory Analysis of Fresh/Forced-Aged Beer

- Aroma
- Purity of taste
- Fullness of body
- Carbonation
- Quality of bitterness

**Fresh beer:**
Brew 2 and Brew 3 → better sensory quality compared to reference beer

**Forced-aged beer:**
Brew 3 → best sensory test result

**Conclusion:**
Application of Weyermann®/Doehler Sour Wort in mash and/or wort increases the „drinkability“ of beer

**Brew 1:** Mash acidification using sour malt (Reference)

**Brew 2:** Mash acidification using sour malt, wort acidification using Weyermann®/Doehler Sour Wort (boiling)

**Brew 3:** Mash and wort acidification using Weyermann®/Doehler Sour Wort
Conclusion: Our new Product – an efficient & flexible alternative or addition to Sour Malt or Self-Production

• Standardised and cost-effective quality product:
  • Production of Weyermann®/Döhler Sour Wort using state-of-the-art fermentation technology
  • No cost-intensive installations; no time-consuming handling of lactic acid bacteria cultures in the brewery, etc.

• High microbiological stability and long shelf-life of the Sour Wort due to aseptic filling

• Easy handling and dosage due to optimal, recloseable packaging type

• Low dosage quantities: Only 15% of the amount of traditionally used sour wort required

• Application according to the German Purity Law for naturally reducing the pH of mash and wort

• Significant improvement of flavor stability and „drinkability“ of beer
Sales unit

- Reclosable 20 kg Bag-in-box (16 liter BiBs) box size (mm) = 28 x 28 x 25
- Full pallet = 48 x 20 kg BiBs/pallet
Specification sheet

- Includes all necessary information for you and your customer
  - Product description
  - Dosage recommendation
  - Product parameters
  - Shipping units and storage conditions
  - Shelf life information
  - HACCP explanation
- All in one reference sheet
- Batch-specific analyses available on request
## Specification

### WHEYERMANN® SOUR WORT

This biologically derived **SOUR WORT** can be used during the beer production for the natural pH value adjustment of both mash and wort. It is a nonalcoholic fermented barley malt extract and shows a hazy, brown appearance as well as a typically malty, acidic taste.

**Usage:** Brewing and beverage industry.

**Recommended Quantities:**

- **Mash acidification:** Addition of 10 l / 1000 kg malt (USA: 1.2 US-gallon / 1000 lbs.): 0.1 pH ↓
- **Wort acidification:** Addition of 6 l / 1000 kg malt (USA: 0.72 US-gallon / 1000 lbs.): 0.1 pH ↓

**Shipping units and storage conditions:**

The product is aseptically packed in a bag in a box (16 l / 4.23 US-gallon, 20 kg / 44.09 lbs.). It should be stored cool, dry and protected from extreme heat and cold.

**Shelf life:** in unopened original packaging a shelf life of 360 days (at 20 °C / 68 °F) is given.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>lactic acid</td>
<td>52</td>
<td>58</td>
<td>g / l</td>
</tr>
<tr>
<td>pH value</td>
<td>2.9</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>density</td>
<td>1.271</td>
<td>1.317</td>
<td>g / cm³</td>
</tr>
<tr>
<td>refractive index</td>
<td>58.0</td>
<td>65.0</td>
<td>°Bx</td>
</tr>
</tbody>
</table>

The following values are subject to harvest-specific variations:
Thank you very much for your attention!

Ulrich Ferstl
Teamleader Customer Service and Food Department

E-Mail: ulrich.ferstl@weyermann.de