Impact of par-baking, natural antifungals and packaging on the microbial quality of par-baked wheat bread

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1. Introduction
2. Results
   • Baking technology
   • Sourdough
   • Plant extracts/essential oils
3. Conclusion
1. Introduction

2. Results
   • Baking technology
   • Sourdough
   • Plant extracts/essential oils

3. Conclusion
Is it safe to eat moldy bread?

Source:
npr – The Salt: Is it safe to eat moldy bread?
Clean label products are winning across the store
Categories seeing the highest dollar growth

Source: It’s clear transparency is winning in the US retail market. Nielsen Clean Label Report, Aug. 2017
E471  E422
E466  E412

2 – 5 days

E472e  E282
E202  E300

≥ 6 weeks

E450  E500
• **Safety** of E-numbers

• Clean label strategies are sometimes meant to **trick** people.

Examples:
• use of beet or spinach extract to replace E250 (nitrite)
• use of pomegranate to replace E300 (ascorbic acid/vitamin C)
• use of bamboo fibers in meat to increase the water holding capacity
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3. Conclusion
Impact of par-baking time, temperature and packaging on mould/yeast count + sourdough

Debonne et al. (2018), Impact of par-baking and packaging on the microbial quality of par-baked wheat and sourdough bread, Food Control
Impact of par-baking time, temperature and packaging on mould/yeast count + sourdough

<table>
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<tr>
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<th>0 g SD / 100 g bread dough</th>
<th>30 g SD / 100 g bread dough</th>
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<td>T (°C)</td>
<td>Time</td>
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<td>MA-packaged</td>
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<td>6.3 ± 0.6&lt;sup&gt;b&lt;/sup&gt;</td>
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Debonne et al. (2018), *Impact of par-baking and packaging on the microbial quality of par-baked wheat and sourdough bread*, Food Control
Production of composite dough for the enrichment of bread crust with antifungals

Crumb dough + blue colorant

Crust dough + antifungals

Debonne et al. (2018), *Optimization of composite dough for the enrichment of bread crust with antifungal active compounds*, LWT
Production of composite dough for the enrichment of bread crust with antifungals

Debonne et al. (2018), Optimization of composite dough for the enrichment of bread crust with antifungal active compounds, LWT
Production of composite dough
For the enrichment of bread crust with antifungals

Sourdough

DY = 166.5

*Lactobacillus sanfranciscensis*

*Kazachstania humilis*

Visual mould-free shelf-life of bread with sourdough in the crust layer.

Debonne et al. (2018), *Optimization of composite dough for the enrichment of bread crust with antifungal active compounds*, LWT
Antifungal activity of sourdough
Mode of action of organic acids

- pH effect? ...
- NO
- Only indirect antifungal effect ...
- Weak organic acids
  - Acetic acid
  - Lactic acid
  - Phenyllactic acid
- Undissociated acid ($C_{HA}$)
- Henderson-Hasselbalch Equation
  \[ \text{pH} = pK_a + \log_{10} \frac{[A^-]}{[HA]} \]
Antifungal activity of sourdough
Mode of action of organic acids

- \( C_{HA} \)
  - mmole HA/kg bread
  - mmole HA/L aqueous phase of bread

- Water soluble components
  - active in the aqueous phase
  - e.g. 33% moisture content (1/3)
  - \( \Rightarrow \) conc x 3 in active phase

- Comparison of ...
  - *In-vitro* antifungal activity
  - Bread baking trials
In-vitro growth/no-growth models of acetic and lactic acid: Macro-dilution, 20 days at 22°C with bread moulds

- $C_{HA} \text{ acetic acid} \geq 150 - 200 \text{ mmole/L}$

Debonne et al. (2019), Validation of in-vitro antifungal activity of the fermentation quotient on bread spoilage moulds through growth/no-growth modelling and bread baking trials, LWT
Comparison of antifungal activity of acetic acid in-vitro versus in chem. acid. bread/ sourdough bread (air-packed at 22°C)

- $C_{HA}$ acetic acid 150 – 200 mmole/L in SD bread
  - *L. sanfranciscensis*
  - *S. cerevisae*

- No significant difference between SD bread and chemically acidified wheat bread

- Acetic acid is the main antifungal active component in sourdough bread.

Debonne et al. (2019), *Comparison of antifungal activity of undissociated acetic and lactic acid in chemically acidified wheat breads and sourdough breads*, Submitted.
Antifungal activity of thyme essential oil

- Active concentration
  - mmole /kg bread
  - mmole /L aqueous phase of bread

- Oil soluble components
  - Antifungal active in aqueous phase
  - Partitioning to water – oil (+ inert phase)
    - e.g.
      - water: 33% in bread
      - Oil: 57% (free lipids) of 1.2% lipids in flour
      - Inert: other

- Modified Henderson- Hasselbalch equation
  - With assumption of 100% thymol

\[
C_{thymol, \text{aqua}} = \frac{n_{TOT,\text{thymol}}}{m_{TOT} \cdot \left( K_p \frac{r}{\rho_{oil}} + \frac{1 - r}{\rho_{aqua}} \right)}
\]

with

- \(n_{TOT} = \text{mole/L thymol}\)
- \(m_{TOT} = \text{total mass of oil/water system}\)
- \(r = m_{oil}/m_{TOT}\)
Antifungal activity of thyme essential oil
In-vitro G/NG model for *P. paneum* with pH 6 and $a_w$ 0.97

Debonne et al. (2019), Growth/no-growth models of in-vitro growth of *Penicillium paneum* as a function of thyme essential oil, pH, $a$, temperature, Food Microbiology
Antifungal activity of thyme essential oil
In-vitro G/NG model for *P. paneum* with pH 6 and $a_w$ 0.97

In-vitro:
± 1 µL thyme oil / mL medium

In bread system:
4.8 – 7.2 µL thyme oil / mL

- Preferential binding with oil in bread matrix = loss of activity
- Volatile behavior of thyme oil during baking and storage
- Technological and sensorial aspects of thyme essential oil???

Debonne et al. (2019), *Growth/no-growth models of in-vitro growth of Penicillium paneum as a function of thyme essential oil, pH, a, temperature, Food Microbiology*
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Preservative-free
Consumer awareness
E-numbers

Clean label

Product quality?
Shelf-life
Sensorial
Physico-chemical

Plant extracts/ EOs
Optimized screening method
Modelling of oil soluble compounds in water-based medium

Sourdough
Undissociated acid
Aqueous phase of medium
Acetic acid

Baking technology
Composite dough
Time/ temperature/ packaging
Sourdough as ingredient

CONCLUSION
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