Evaluation of processing aids for olive oil extraction and quality improvement

Research work funded by Rural Industries Research & Development Corporation

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Boundary Bend Estate Processors Pty Ltd
### Processing aids & techniques

<table>
<thead>
<tr>
<th>Traditional aids</th>
<th>New aids</th>
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<tbody>
<tr>
<td>Talc powder</td>
<td>Microtalc powder</td>
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<tr>
<td>Enzymes</td>
<td>Common salt</td>
</tr>
<tr>
<td>Water</td>
<td>Calcium carbonate</td>
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<td>Enzymes with side activities</td>
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<td>Warm water dipping</td>
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<td>Ultrasound</td>
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</table>
Talc & microtalc powder

- Natural mineral (hydrated magnesium silicate) of laminar structure
- Provokes aggregation of particles and provides structure to the olive paste in the malaxer
- Essential with high moisture fruit or “difficult” pastes
**Talc & microtalc powder**

**Talc powder**
- Oldest powder used in the industry
- Magnesium silicate with high adsorption surface
- $d_{50\%} = 8\mu m$
- Specific surface area = 3.6 m$^2$/gr
- Dose = 0.5-3%

**Microtalc powder**
- New product in the industry
- Same as talc powder, but finer particle size
- $d_{50\%} = 2\mu m$
- Specific surface area = 7.0 m$^2$/gr
- Dose = 0.3-1%
Talc & microtalc powder

Oil extraction (%)

- Control
- Talc 2.0%
- Microtalc 0.3%
- Microtalc 0.6%

Arbequina
Barnea
Manzanilla
Talc & microtalc powder

- Beneficial impact on FFA, PV, K232, K270 & ΔK in Arbequina, Barnea & Manzanilla
- Higher PPH content in Barnea & Manzanilla
- No impact on taste or colour
- Microtalc powder is more cost effective than talc due to less product transport, handling & storage
Common Salt (NaCl)

- High solubility in water. It does not make the oil “salty”
- Action: It changes the density of the water stretching out the gap of water:oil densities
- Greener oils as it increases chlorophyll solubility
- Dose = 1-3%
- Significantly cheaper than talc & microtalc powder
Calcium carbonate

- Natural mineral with crystalline structure (calcite)
- It facilitates flocks agglomeration by adsorption (similar action to Talc powder)
- $d_{50\%} = 2.8\mu m$
- Density = 2.7 gr/ml
- Dose = 1-2%
- Cheaper than Talc powder
- Used in Spain with excellent extraction efficiency results
## Salt & Calcium carbonate

<table>
<thead>
<tr>
<th>Salt &amp; Calcium carbonate</th>
<th>Arbequina</th>
<th>Barnea</th>
<th>Manzanilla</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0%</td>
<td>10.0%</td>
<td>12.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>2.0%</td>
<td>11.0%</td>
<td>13.0%</td>
<td>6.0%</td>
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<tr>
<td>4.0%</td>
<td>12.0%</td>
<td>14.0%</td>
<td>8.0%</td>
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<td>6.0%</td>
<td>13.0%</td>
<td>14.0%</td>
<td>10.0%</td>
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<td>8.0%</td>
<td>14.0%</td>
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<td>12.0%</td>
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<tr>
<td>14.0%</td>
<td>8.0%</td>
<td>10.0%</td>
<td>8.0%</td>
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<tr>
<td>Salt (NaCl)</td>
<td>Calcium carbonate</td>
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<td>------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td></td>
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<tr>
<td>Improves extractability</td>
<td>Aggressive on paste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No impact on taste</td>
<td>Very high extractability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly greener oils</td>
<td>Reduces FFA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher PPH content in oil and slightly higher</td>
<td>Oxidative action (PV, UV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>stability</td>
<td>↓↓ PPH, stability &amp; bitterness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental concerns over CE and Na content</td>
<td>Very green oils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of pomace</td>
<td>Changes in taste</td>
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</tbody>
</table>

- Salt (NaCl) improves extractability, has no impact on taste, results in slightly greener oils with higher PPH content and slightly higher stability. It raises environmental concerns over CE and Na content of pomace.

- Calcium carbonate is aggressive on paste, highly extractable, reduces FFA, affects oxidative action (PV, UV), decreases PPH, stability, and bitterness, resulting in very green oils and changes in taste.
Salt & Calcium carbonate

Peroxide value

- Arbequina
- Barnea
- Manzanilla

Control
Talc 2.0%
Microtalc 0.3%
Microtalc 0.6%
Salt 2%
CaCO3 2%
Enzymes

• Very effective in improving the paste extractability
• Biologically active protein substances that help in degrading the pectin & cellulose of the cell walls & vacuoles
• Same enzymes that the fruit has in its tissues
• Endogenous enzyme system depends on the season, variety & maturity and is inactivated by polyphenols
• Dose = Variable (200-500ml/tn). Higher in dry years
• Water soluble and easily removed by centrifugation
• Absolutely essential when dealing with low maturity fruit
Enzymes

Mode of action of the main pectolytic enzymes

- PECTIN LYASE (PL)
- PECTIN METHYLESTERASE (PME)
- endo POLYGALACTURONASE (PG)

Galacturonic acid
Carboxylic acid
Methyl group
Enzymes

• Very goof results in Arbequina. It was not a solution for high moisture Manzanilla without talc powder
• No alteration of oil quality for better or worse
• No changes in taste and colour
• Best performing enzymes: NZ 33095 & Pectinex Ultra
• The key seems to be: High PG/PE/PL activity with average side activities
• Field trials better than laboratory trials. Abencor limitations
Warm water dipping

- It consists of pre-heating olives before crushing to achieve a higher temperature at beginning of malaxing.
- Technique: Immersion of olives for 3 minutes in warm water at 30-45-60°C.
- Research works in Spain indicate that dipping:
  1. Increases paste extractability
  2. Reduces bitterness
  3. Inhibits LOX enzyme → Delays oil oxidation
  4. Increases chlorophyll content → Greener oils
  5. No changes in taste
Warm water dipping
Warm water dipping

- Simple to implement in small Plants working in “batching” modality. More complicated for larger Plants
- Paste extractability showed slight improvements only at 60°C
- Increase in the moisture content of the fruit, making the extraction process more difficult
- Combined with talc could be interesting
- Oils are greener, but there is a change in taste too
- There is a clear reduction of the bitterness
- There is a reduction of the oxidative stability
**Colour changes**

**Calcium carbonate**

<table>
<thead>
<tr>
<th>Control</th>
<th>CaCO3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbequina</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>Barnea</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>Manzanilla</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>

**Warm water dipping**

<table>
<thead>
<tr>
<th>Control</th>
<th>30°C</th>
<th>45°C</th>
<th>60°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbequina</td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td>Barnea</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
</tr>
<tr>
<td>Manzanilla</td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
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Ultrasound

Enhancing Olive Oil Processing Efficiency and Competitiveness Using UltraSound Technology

Research project funded by HAL

John Allison¹, Leandro Ravetti², Claudia Guillaume², Pablo Canamasas³, Kamalijt Vilkhu⁴, Piotr Sweirgon⁴ and Lloyd Simons⁴

¹Boundary Bend Ltd; ²Modern Olives; ³Boundary Bend Estate Processors Pty Ltd; ⁴Food Science Australia
Ultrasound

- Research in very early stages
- Olive paste is supplied with ultrasound energy in order to break down wall cell and release the oil
- There is a beneficial increase in the paste temperature
- It seems to be more effective on green fruit
- Lab trials showed very good results on paste extractability
- Field trials with variable results. More work to be done here
- No apparent impact on oil quality
Ultrasound – Lab trials

[Image of ultrasound equipment and comparison between US treated and Control samples]

[Graph showing oil evolved vs ultrasonic energy]
Ultrasound – Field trials

Figure 1: Process Flow Diagram
Ultrasound – Field trials
Summary

• Talc & microtalc powder: essential with difficult pastes or high moisture fruit. No impact on oil quality
• Common salt: a cheap option. No impact on oil quality. There could be environmental issues
• Calcium carbonate: another cheap option. High paste extractability. There could be issues with oil quality
• Enzymes: Effective under most conditions. Doses depend on the year and fruit ripeness. No impact on oil quality
• Warm dipping: an option for small plants. Only effective with temperatures above 60°C. It does change the oil
• Ultrasound: Promising technology. No impact on oil quality
• Microtalc powder & enzymes could be an interesting combination
Thank you!

Acknowledgments

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