Sunflower Pectin: 
Adding Value to Agricultural Biomass

Tony Bacic  
Program Leader

Ming Long Liao  
Program Deputy Leader

CRC for Bioproducts  
School of Botany, The University of Melbourne
Overview of presentation

• What is pectin?
• Why sunflower pectin?
• Market opportunity
• Conclusions
The Market Environment

Key issues facing global food manufacturers

- Consumers resisting artificial & GM additives and ingredients
  ⇒ Food manufacturers want **natural** ingredients

- Ever increasing markets for pre-prepared and convenience foods demand better texture, taste, stability and low fat levels
  ⇒ Food manufacturers want **new functional** ingredients
Pectin: A versatile functional ingredient
Characteristics of Commercial Pectin

- Food additive (code # 440 & E440)
- Several grades marketed for different applications

DE $\geq 50$
- high methoxy (HM)
- rapid, medium or slow set (RS, MS, SS)

DE $< 50$
- low methoxy conventional (LMC)
- low methoxy amidated (LMA)
Cell Wall Pectin Structure

“hairy” region

“smooth” region

[ D-Galacturonic acid ]n

Neutral sugars:
Ara, Gal, Xyl, Glu

4-GalAOMe
4- or 3,4-GalA
2- or 2,4-Rha
Commercial Pectins
(Food Additive Code #440)

- Extracted from

- Composed mainly of
galacturonic acid (–COO⁻), its methyl esters (–COOCH₃)
& amidated (–CONH₂)
## Pectins: Conditions for gelation

<table>
<thead>
<tr>
<th>Conditions</th>
<th>HM</th>
<th>LM</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>≤ 3.5 (range: 1.0–3.5)</td>
<td>1.0 – 7.0 (or higher)</td>
</tr>
<tr>
<td>Soluble solids (S.S.)</td>
<td>≥ 55% (range: 55–85%)</td>
<td>0 – 85% (S.S. affects Ca$^{2+}$ required)</td>
</tr>
<tr>
<td>Ca$^{2+}$</td>
<td>normally not a factor</td>
<td>required !!</td>
</tr>
</tbody>
</table>
Pectin gelation: HM vs LM
Global usage of pectins

- **HM Pectin – Jams**: 68%
- **HM Pectin – Other**: 17%
- **LM Pectin - Fruit pulp**: 5%
- **LM Pectin - Juice, Milk drinks**: 5%
- **Specialty LM pectins**: 5%
LM Pectin: Some special applications

- Reduced/low sugar jams & jellies
- Heat reversible jams, jellies & fillings
- Baking stable fruit preparations
- Cold setting milk jellies
- Fruit preparations for yoghurt
- Control of fruit separation: HM + LM
LM Pectin
Reduced (31%) sugar gel at pH 3 & different Ca$^{2+}$ levels

“SAG” test

Texture analyser

Graph showing:
- Liquid
- Gel
- Syneresis

Jelly grade
Hardness (g)

Graph axes:
- mg Ca / g pectin
- units

Texture analyser
LM Pectin
Heating curves (31% vs 51% S.S.)

Carri-Med Rheometer

(HM requires min. 55% S.S.)
Production of LM Pectin: Traditional

- Citrus / apple HM pectin

- R-COOMe + H₂O → R-COOH + MeOH
  - aq. acid or aq. acid/org. solvent
  - aq. alkali (other than amidation)
  - enzymic

- Conditions
  - quality profile of starting HM pectin

- Minimum cleavage of pectin backbone

- Downstream processing
Sunflower residues
(NOT seeds)

- Sunflower heads
  - pectin (15-25% dw)
  - GaIA content (>65% w/w)

- Source of “natural” LM pectin

- No chemical conversion required

- Reduced product variability

- Supplementary raw material

- Unique properties
Sunflower LM pectin
(Laboratory scale)

- Sunflower heads: (Dr C Lambrides, UQ)
  - Hysun 25 & Hysun 45

- Seed removal, drying, stabilisation

- Protocols: extraction & downstream processing
## Chemical & rheological properties of sunflower head LM pectin

<table>
<thead>
<tr>
<th>LM Pectin</th>
<th>Yield (%)</th>
<th>DE (%)</th>
<th>Hardness (g)</th>
<th>Initial stress (dynes/cm²) x10³</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cold water washing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hysun 25</td>
<td>13.7</td>
<td>41.3</td>
<td>21.2</td>
<td>3.296</td>
</tr>
<tr>
<td>Hysun 45</td>
<td>12.6</td>
<td>37.8</td>
<td>20.3</td>
<td>2.603</td>
</tr>
<tr>
<td><strong>Hot water washing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hysun 25</td>
<td>14.3</td>
<td>41.4</td>
<td>n.d</td>
<td>n.d</td>
</tr>
<tr>
<td>Hysun 45</td>
<td>9.5</td>
<td>38.3</td>
<td>43.0</td>
<td>5.422</td>
</tr>
</tbody>
</table>
Sunflower LM pectin:
Suspending particulates (yield stress)
Market overview: Pectin

• Total global market 30,000 tonnes
  - Australian market 400 tonnes
  - LM pectin (~15%) ~5,000 tonnes

• Overall growth rate 6%
  - LM pectin 10-20%

• Current price (US/EU) HM: US$11.00/kg
  LM: US$12.90/kg
## Global pectin market: High growth applications

<table>
<thead>
<tr>
<th>Application</th>
<th>Growth Rate</th>
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<tbody>
<tr>
<td>Fruit preparations</td>
<td>15 – 20%</td>
</tr>
<tr>
<td>Fruit spreads (low sugar jams)</td>
<td>10% +</td>
</tr>
<tr>
<td>Yoghurt and dairy</td>
<td>15 – 20%</td>
</tr>
<tr>
<td>Acidified milk drinks, high-sugar jams</td>
<td>2 – 5%</td>
</tr>
<tr>
<td>Fruit juices &amp; high calcium drinks</td>
<td>10 – 15%</td>
</tr>
<tr>
<td>Baked goods, confectionary</td>
<td>5%</td>
</tr>
<tr>
<td>Fat replacers</td>
<td>20% +</td>
</tr>
</tbody>
</table>
Pectin: CRC technology package

- Proprietary technology
- Raw material: fresh citrus peel
- Product range
  - HM pectin (RS, MRS, SS)
  - LM pectin: conventional (LMC), amidated (LMA)
- Proposed production plant at Leeton
- Output = ~8% total global market (~2,000 tonnes)
- Key advantages
  - availability of fresh peel and water
  - use of novel separation & drying techniques
  - product quality meets international standards
  - Capital & operating cost savings ~40% compared with traditional process
GRDC Project Proposal: Sunflower LM pectin evaluation

- Feasibility study: collection/stabilisation of biomass
- Alliance with breeding program: quality assessment of biomass
- Extraction & down-stream processing protocols: food or non-food grade pectin
- Integration with CRC technology package
- Structure/function relationship of different pectin lines
- Application studies & product development
Sunflower: Industry players

FARMERS
SEED COMPANIES
(Pacific, Agseed, Pioneer)

CRUSHERS
RESEARCHERS
(ASA, GRDC, Govt)

PROCESSORS
FOOD SERVICE INDUSTRIES

PECTIN PRODUCTION? (CRC for Bioproducts)
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