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Substitution of chemical phenols by plant polyphenols for processing phenolic biomaterials

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INTRODUCTION

WORLD ANNUAL PRODUCTION OF PHENOL
2000 : 6 million tons
2010 : 8 million tons
2020 : 12 million tons (prediction)

EUROPEAN PHENOL USE
2 million tons per year; more than 80% for plastic materials and resin

APPLICATIONS
• Plastic materials: thermosetting (polycarbonate, epoxy)
• Plastic fibers: nylon (polyamide)
• Electric isolating
• Bactericid paint
• Hydrophobic coating
• Anionic detergent
• Thermic ink
• Insulating glue

PHENOL MARKET
Market in expansion
New production plant in Nanjing, China (INEOS and SINOPEC) : 400 000 tons (end 2013)

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Need to find quickly alternatives to petroleum-based aromatic compounds to halt the massive contamination of our environment and protect human beings from its negative impacts on health.
Substitution of chemical phenol by natural polyphenols

Lignin

 Condensed tannins

Extension units

R¹, R² = OH or H
R³ = H, Gal

Terminal unit
### Agro-industrial wastes
(wine and cider making, fruit juice)

- **Pomace, fruit marc**

### Sawmill co-products and forest biomass

- **Barks**
- **Pine needles, leaves**

### Conifers (36%)
France

- **French Forest**
  - 16 000 000 Ha
  - 2.5 billions m³

### Winemaking Biomass

<table>
<thead>
<tr>
<th></th>
<th>seeds</th>
<th>pomaces</th>
<th>stems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual output</strong></td>
<td>80 000-140 000 t</td>
<td>700 000 t</td>
<td>300 000 t</td>
</tr>
<tr>
<td><strong>Tannins (% DM weight)</strong></td>
<td>6 -16%</td>
<td>0,04 - 1,2%</td>
<td>3%</td>
</tr>
</tbody>
</table>

**Tannins (% DM weight)**

- Conifers (36%)
- Pomace, fruit marcs

**Reseurch Works**

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26/02/2015
- From phenolic models
  - Gallic acid
  - Catechin

- From commercial extracts
  - Hydrolysable tannins
  - Condensed tannins

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DEPOLYMERIZATION: a key step

- to get an homogeneous raw material or fine chemicals
- to get the same synthons from different tannin sources
- to suppress one step (simultaneous extraction/depolymerization)

Large scale process for production of biobased phenols
DEPOLYMERIZATION: obtention of phenolic synthons

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INRA SCIENCE & IMPACT

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Perspectives

- **Materials**: thermoplastic; polyester, polyamide, vinylester,... and composite
- **Fine chemistry**: Medicinal, cosmetic
  - Lubricant
  - Surfactant

RESULTS

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Thank you for your attention!

Co-workers

Lucas Suc

Guillaume Billerach