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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

APPLICATONS

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

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

APPLICATONS

- Bisphenol A (BPA) and polyphenylene oxide (for epoxy and polycarbonate resins)
- Phenolic resins (composite materials)
- Fiber production (caprolactame, cyclohexanol and cyclohexanone)

ECOBIOCAP
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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

**Extension units**

\[ R^1, R^2 = \text{OH or H} \]

\[ R^3 = \text{H, Gal} \]

**Terminal unit**

**Condensed tannins**
Agro-industrial wastes (wine and cider making, fruit juice)

Winemaking Biomass

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

Sawmill co-products and forest biomass

- Barks
- Pine needles, leaves

Conifers (36%) France

French Forest
16 000 000 Ha
2,5 billions m³
**From phenolic models**

- Gallic acid

- Catechin

**From commercial extracts**

- Hydrolysable tannins

- Condensed tannins
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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Perspectives

- **Materials**: thermoplastic; polyester, polyamide, vinylester,... and composite
- **Fine chemistry**: Medicinal, cosmetic
  - Lubricant
  - Surfactant
Thank you for your attention!

Co-workers
Lucas Suc
Guillaume Billerach