## COMPARISON CHART FOR BIODEGRADABLE MATERIALS

<table>
<thead>
<tr>
<th>Criteria</th>
<th>PLA based film</th>
<th>SUPEREKO film</th>
<th>REMARKS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of product</td>
<td>Corn starch based material</td>
<td>BOPP (polypropylene) film based</td>
<td></td>
</tr>
<tr>
<td>Source of material</td>
<td>Renewable vegetal material</td>
<td>Fossil based</td>
<td></td>
</tr>
<tr>
<td>Type of biodegradability</td>
<td>Hydro biodegradable</td>
<td>Oxo-biodegradable</td>
<td></td>
</tr>
<tr>
<td>Form of biodegradability</td>
<td>Intrinsic biodegradability</td>
<td>Acquired biodegradability</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Cargill, Mitsui, Hycaill, Galactic</td>
<td>Totally Degradable Plastics Additive®</td>
<td>Oxo-biodegradability technology: already used in PE for biodegradable plastic bags for customers like TESCO</td>
</tr>
</tbody>
</table>

### ECO ASSESMENT

- **Base material**: Corn (with question mark on non transgenic origin of corn culture)
  - **SUPEREKO**: Oil

- **Energy consumption to produce**
  - Important energy consumption for PLA:
    - require oil for PLA resin production (polymerization);
    - require oil for Film production (extrusion, biorientation, heating)
  - Thermal valuation during PP production

- **Energetic valuation of waste**
  - None
  - 88% of incinerated tonnage is subject to thermal and electric valuation

- **Requested land surface to produce**
  - 30.7 H per 100 tons of PLA
  - None
  - PLA is requiring very large non food culture expansion

- **Yield**
  - 2.5 kg of corn per kg of PLA
  - Yield very close to 100%

- **Water consumption**
  - 4.45 m³ of water per ton of PLA
  - Negligable
  - PLA: very high water consumption, where some area are with water shortage

- **Pesticides consumption**
  - Assuming corn is non transgenic:
    - 89 kg herbicides/100tons of PLA
    - 2.3 kg pesticides/100 tons of PLA
  - None
  - Source: [http://www.ontariocorn.org/envt/envpest.html](http://www.ontariocorn.org/envt/envpest.html)

- **Fertilizer consumption**
  - 76.76 kg/tons of PLA
    - 50 kg/h N, 100 kg/h P2O5, 100 kg/h K2O
  - None
### ENVIRONMENTAL IMPACT INDICATORS

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<tbody>
<tr>
<td>Green house effect in 100 years concerning : Air</td>
<td>Gas emission for green house effect is 40% more</td>
<td></td>
<td>Same source</td>
</tr>
<tr>
<td>Atmospheric acidification concerning : Air</td>
<td>Acid gas emission is 60% more</td>
<td></td>
<td>Same source</td>
</tr>
<tr>
<td>Initiation of photochemical oxidizing agent concerning : Air</td>
<td>60% less gas emission contributing to photo oxidant oxidizing production</td>
<td></td>
<td>Same source</td>
</tr>
<tr>
<td>Eutrophisation of water : concerning : water</td>
<td>Contribution is 11 times more to surface water eutrophisation</td>
<td></td>
<td>Same source</td>
</tr>
</tbody>
</table>

### BIODEGRADABILITY

**% Waste treatment method** (concerning France only)

- In industrial landfill: 50%
- In composting: 8%
- Incineration and energy recovery: 29%
- Sorting and recovery stations: 13%

**Norms and test method**

- There is no norm concerning biodegradability of plastics, only:
  - ASTM 6400/6868, ASTM D5338 à 58°C et EN 13 432
  - Pass/no pass tests on compostability
  - ASTM 6954 04
    - Standard guide tests that recognize oxo-biodegradability as two step process (degradation then biodegradation)

**Compostability (4 Criteria to be satisfied)** EN 13432

- Composition: Establish a maximum level of volatil solids, heavy metals and acceptable Fluor in initial material
  - Ok
- Disintegration: this is the ability of product to be fragmented under composting condition, with a refuse limit level of 10% of mass above a screen of 2 mm
  - Ok

**For SUPERECO**

- Reference Call recovery Europe Ltd
- Composting of Homo-polymer film in a full scale windrow composting plant

- Same
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<tr>
<td>Quality of final compost and ecotoxicity</td>
<td>Ok</td>
<td>ok</td>
<td>Same</td>
</tr>
<tr>
<td>quality of compost should not be modified by packaging material added to compost and should not be dangerous for environment. Norm ask to make eco-toxicological tests on final compost and require a performance superior to 90% of the one with virgin compost.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conversion of CO2</td>
<td>90% of material should be converted in CO2 in max 180 days</td>
<td>Ok</td>
<td>Non</td>
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<td>Biodegradability (in landfill)</td>
<td>Ok</td>
<td>Non</td>
<td></td>
</tr>
<tr>
<td>No norm at the moment: study are made within three important laboratories to establish test method to measure and then to set up a Norm</td>
<td>Ok</td>
<td>Non</td>
<td></td>
</tr>
<tr>
<td>Conditions: Abiotic chemical degradation in landfill and subsequent biodegradation by microorganisms</td>
<td>Ok</td>
<td>Non</td>
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<tr>
<th>Is the film biodegradable</th>
<th>Yes</th>
<th>Yes</th>
<th>SUPERECO: Stable material whatever humidity level!</th>
</tr>
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<tbody>
<tr>
<td>Film stability before discarding</td>
<td>Very sensitive to high humidity</td>
<td>12 months</td>
<td></td>
</tr>
<tr>
<td>Film stability after discarding (landfill) base 35µ</td>
<td>4 to 6 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degradation</td>
<td>6 month</td>
<td>18 to 24 months</td>
<td>For PLA: Hydro degradation For Supereco: chemical Abiotic degradation</td>
</tr>
<tr>
<td>Biodegradation</td>
<td>Start in the same time as degradation allow to reach small hydrophilic material chains of disintegrated film Final components are: CO2, Water and biomass</td>
<td></td>
<td>SUPERECO: the biodegradation speed is depending from density and nature of micro organisms.</td>
</tr>
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### Criteria | PLA based film | SUPERECO film | REMARKS AND REFERENCES
--- | --- | --- | ---
**Film properties**

| Density | 1.24 | 0.91 | Le SUPERECO has 36% more yield than PLA
| Yield ( for 30µ in m2/kg): | 26.88 m2/kg | 36.63 m2/kg |
| Film behavior during handling | Film gets marks when handled, very crispy and noisy as final packaging | Very flexible and soft film, does not mark and not crispy |
| Film stability before discarding | Very sensitive to high humidity | Film is designed to be stable from production up to the discard in landfill (see above) |
| Thickness range | 20 to 40µ | Wide thickness range 10µ to 80µ |
| Mechanical resistance | medium | Excellent |
| Perforation resistance | weak | Excellent |
| Printability | Difficult | Excellent, same as BOPP |

### Range of products available

- Plain film
- Heat sealable film
- Heat sealable film (20 to 50µ)
- Antifog heat sealable film (25 to 35µ)
- Plain film
- Wrap around label film
- Laminating film (12µ)
- CPP film
- Perforated and white film (under development)
- Metallized film (under development)
- Low heat sealing temperature film

### Water vapor barrier properties (30µ film at 23°C et 85%HR)

- 55 g/m2.day |
- 1 g/m2.day | Supereco: excellent water vapor barrier properties

### Oxygen permeability (30µ at 23°C et 50% HR)

- 500 cc/m2.day |
- 1 500 cc/m2.day

### Processability

- Special adjustment are required
- Narrower operating window
- Same as regular BOPP
- No change in process parameters including on converting machines

### Haze

- <3 |
- 2

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### ECONOMICAL COMPARISON

|                        | Average price per Kg | 4.5 € | 3.00 € |  |
|------------------------|----------------------|-------|--------|  |
| Average price per 100m2 (base 30µ) | 16.74 €             | 8.19 € | SUPERECO is 50% less expensive than PLA |

**Transport cost**

SUPERECO, with same thickness has 36% weight advantage versus PLA, therefore for transport of both virgin films to converter and from converter to end user will be at least 30% more; those costs should be also to Eco assessment!