reverdia

sustainable solutions
powered by DSM + Roquette

# Biosuccinium
# Made in Italy, Enabling Sustainable Materials Globally

Richard Janssen
Ramspec
October 2nd, 2014

# Content

- Biosuccinium™ - biobased succinic acid made in Italy
- How can Biosuccinium™ enable more sustainable materials and products
- An opportunity for you ?

reverdia

# Global Megatrends Drive the Need for Sustainability

## Sustainability / Renewability

- Long-term maintenance of planet's well being
- Drives the growth of jobs & the economy

## Decreasing Oil Dependency

- Scarcity
- Price volatility
- Energy security

## Environmental Concern

- Consumer demand for sustainability
- Governmental regulation on climate change

reverdia

# Examples: Sustainable / Bio-based Products

DANONE

Launches sustainable Ingeo Activia yogurt cup in the German market


Coca-Cola

30% plant-based, 100% recyclable bottle

SUNTORY

Globio® for Suntory Natural Mineral Water bottles

PUMA

Puma – degradable shoe

Timberland

Developed Green Index™


NIKE

Nike Green Speed soccer shoe

# Governments and NGO's: Defining, Promoting and Requiring Sustainable Products or Services

US Department of Agriculture BioPreferred Program

BioPreferred℠

US Department of Agriculture voluntary labeling program for bio-based products

USDA CERTIFIED BIOBASED PRODUCT
PRODUCT 57%

LMI identified bio-based products as a lead market

Lead Market Initiative for Europe

World Wide Fund for Nature endorses bio-based products

WWF

Italy bans non-biodegradable plastic bags in shops

reverdia

# Reverdia

## Producer of Biosuccinium™ sustainable succinic acid in Italy



Biosuccinium provides a new non-fossil resource that allows customers to choose a bio-based material with an improved environmental footprint to develop superior sustainable products like polyurethanes for footwear and new polymers for packaging

reverdia

# Biosuccinium™ Production Integrated in Roquette's Biorefinery in Cassano Spinola, Italy

## Optimum Synergy, Shipping Product Globally

### Facts and Figures

- Employees: ~460
- Surface: 40 hectares
- Corn grinding capacity: 2.200 t/d
- Activity:  620 kt corn/year

### Benefits to Customers

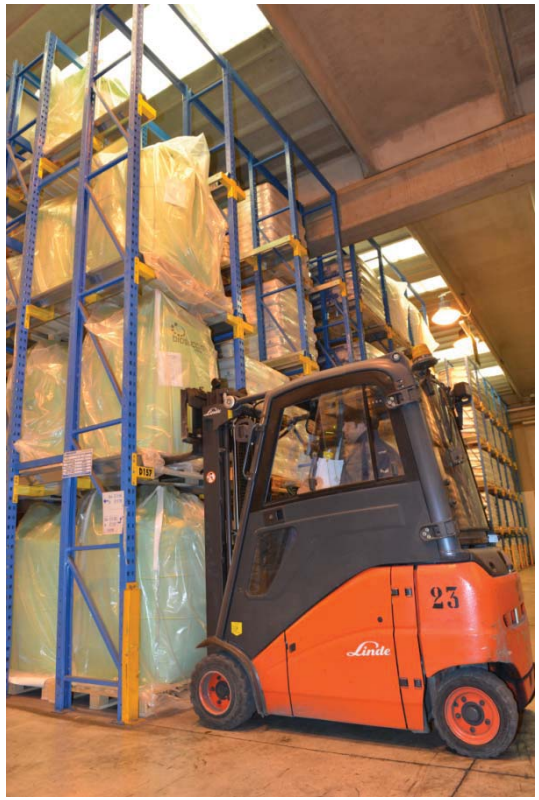
- Existing fully integrated biorefinery
- Ships product globally today
- Largest plant in Europe producing high quality Bio-based succinic acid using only a fraction of its available feedstocks

reverdia

# Reverdia 10 kta Facility in Cassano, Italy
# In operation since December 2012

reverdia

# Product Packaging and Distribution



reverdia

# Improving Sustainability Characteristics of Materials

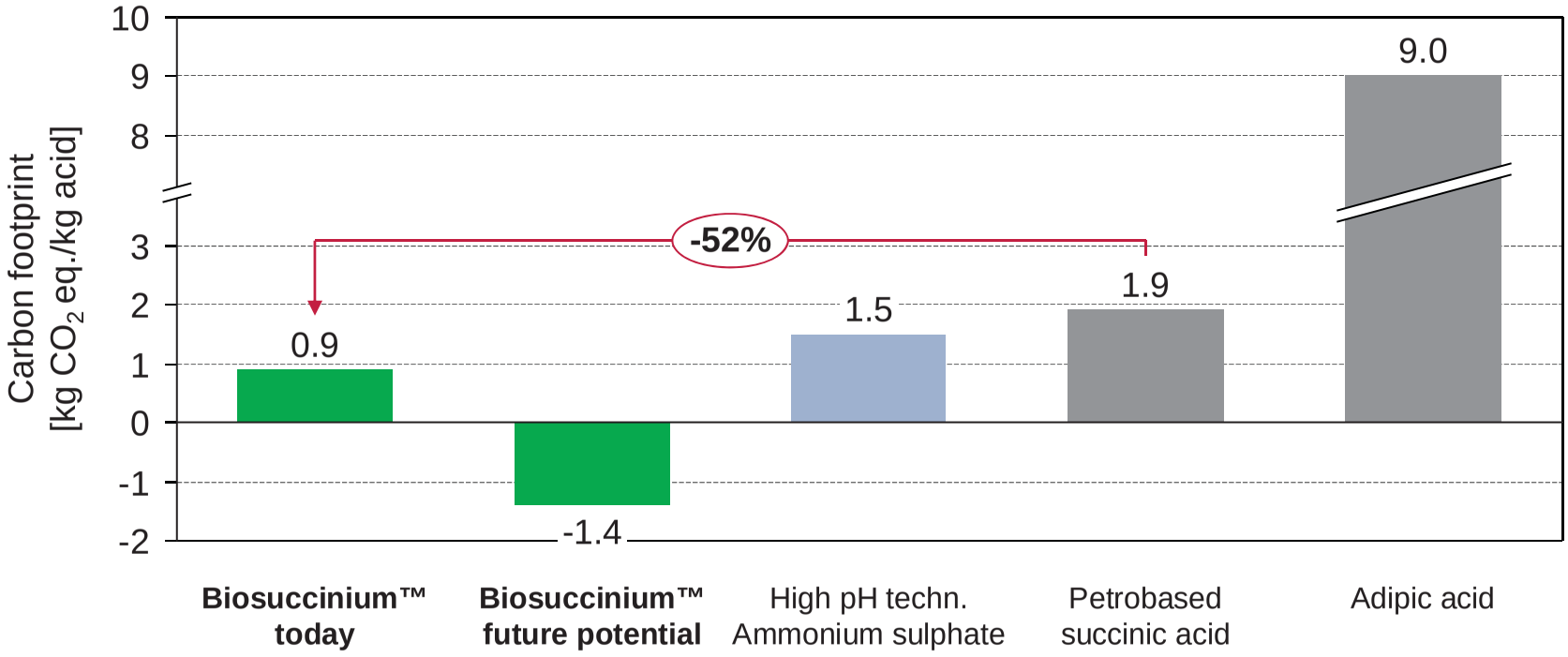
## Renewable Raw Materials Impact Total Value Chain


- 100 % biobased (ASTM D6866)
- Improved carbon footprint
- Act today to build a sustainable supply chain for the future

reverdia

# Large $CO_2$ reduction potential with Biosuccinium™

## Technology, feedstock and location dependent




The Biosuccinium™ Cradle-to-Gate study was executed by Dr. M. K. Patel, Dr. A. L. Roes and B. Cok , MSc. at the Copernicus Institute of Sustainable Development at Utrecht University, the Netherlands (For full study visit: http://onlinelibrary.wiley.com/doi/10.1002/bbb.1427/abstract)

reverdia

# Biosuccinium™ Qualified in Multiple Applications

## Polyurethanes

- Running Shoes
- Automotive Textiles
- Wheels
- Wood & Furniture coatings
- Construction

## Resins

- Coatings Resins
- Composite Resins

## Polybutylene Succinate (PBS)

- Plastic Utensils
- Disposable Cups
- Food Packaging
- Agricultural Films
- Non-wovens Fibers

## 1,4 BDO/THF

- Elastic Fibers
- Engineering Plastics

## Pyrrolidones

- Solvents
- Cables

## Miscellaneous

- Pharmaceuticals
- Food Flavor
- Metal Plating
- Lubricants

## Plasticizers

- Polymer Modification

# Example of Biosuccinium Use: Biobased TPU for footwear

## Technical Feasibility in collaboration with Brand Owners and TPU manufacturers

| | Footwear requirements | Partly Biobased TPU's Offered | | | | | | Requirement met |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | |
| Hardness | 75 – 95 Shore A | 77 | 86 | 90 | 95 | 80-95 | 95 | ✓ |
| Renewable content % | ? | 60 | 58 | 24 | 24 | >50 | 52,9 | ✓ |
| Density [g/cm$^3$] | 1,2 | | | 1,18 | 1,2 | 1,12-1,18 | 1,27 | ✓ |
| Tensile strength [MPa] | min 32 | 36,6 | 46,5 | 34,2 | 33,0 | >30 | 40 | ✓ |
| Elongation at break [%] | min 400-600 | 800 | 520 | 409 | 363 | >350 | 350 | ✓ |
| Tear strength [N/mm] | min 40 | 57,9 | 77,8 | 102 | 117 | >90 | 150 | ✓ |
| Abrasion loss [mm$^3$] | max 50 | 65 | 48 | 40 | 38 | <50 | 50 | ✓ |
| Hydrolysis | 80 – 100 % after 7 days 95%RH, 70 C | | | 85%(1) | 87%(1) | >80%(1) | >80%(2) | ✓ |

[1]: 2 weeks
[2]: 80 C

Disclaimer: Data is based on information from TPU producers and is shown here for illustrative purposes only. All data needs to be confirmed by the actual TPU producers.

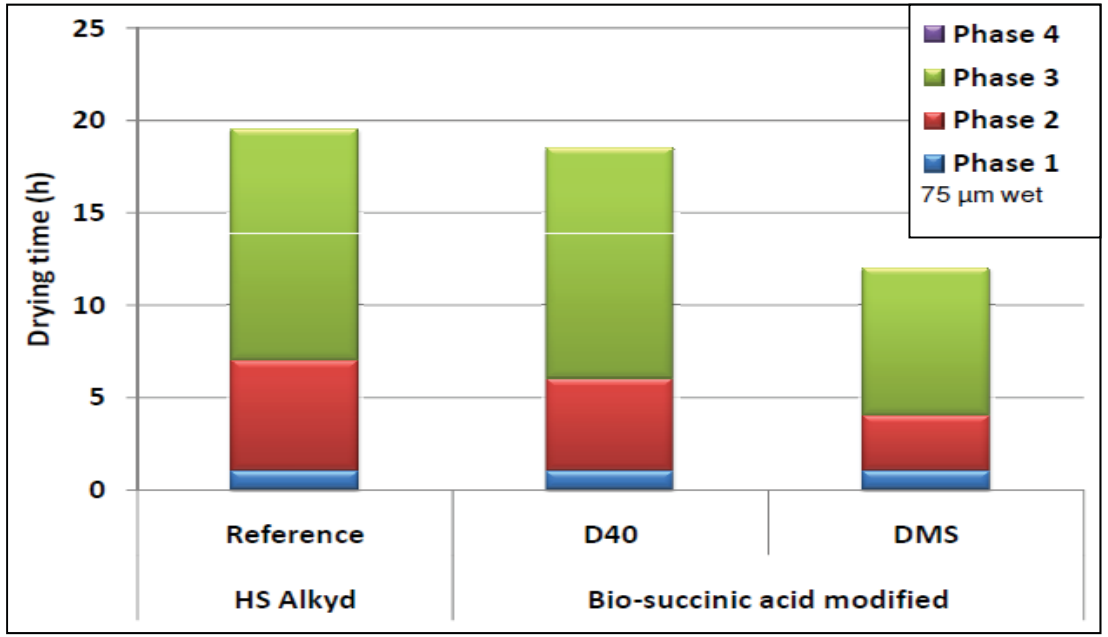
Differentiated performance identified: improved chemical resistance

reverdia

# Example of Biosuccinium Use: Paint – Alkyd Resin

## Biobased Alkyds Commercialized

- Resin:
  - biobased from 66% to 96%
  - several renewables used
- Coating with dimethyl succinate solvent:
  - reduction drying time ~40%.
  - hardness developed faster

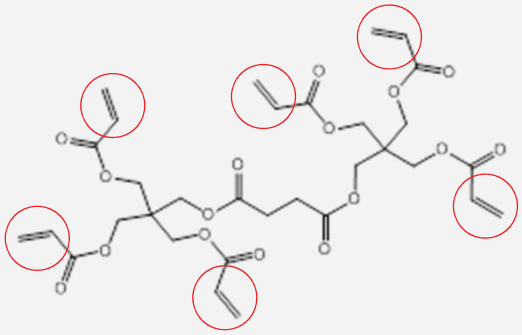



reverdia

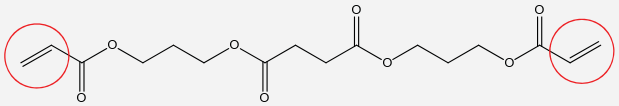
# Example of Biosuccinium Use: Paint – UV curable acrylate

## Biobased monomers with fossil-based acrylic acid

- Oligomeric polyester:
  - Biobased carbon content 44%
  - Biosuccinium content: 12%
  - Excellent appearance and hardness
  - Excellent chemical resistance
- Reactive diluent:
  - Biobased carbon content 63%
  - Biosuccinium content 25%
  - Excellent appearance / good hardness
  - Excellent chemical resistance



Biosuccinium and bio-penta



Biosuccinium and bio-PDO

reverdia

# Example of Biosuccinium Use: Biosuccinium Esters for Plasticizers

- Improved sustainability characteristics
  - Phthalate-free plasticizers
  - Partly renewable because Biosuccinium is 100 % biobased
  - Opportunity for improved environmental footprint
    - Biosuccinium carbon footprint is 90 % lower than that of adipic acid !
- DEHSu
  - Indications are that performance is quite similar to DOA (di-octyl adipate)
    - Good plasticizing efficiency, fast fusing properties, very good low temperature flexibility behaviour
  - Uses migth be in flooring, food wrap film, coatings and low-temperature applications
- DPHSu
  - Performance expected close to DOA (di-octyl adipate)
  - Properties to be evaluated
- DTDSu
  - Performance to be evaluated
    - Relatively high molecular weight

# Example of Biosuccinium Use: PBS – a New Thermoplastic Polymer

- PBS is an aliphatic, biodegradable polyester
  - Flexible, high elongation
  - Good temperature resistance
  - Easy processing
- Ideal blend partner
  - bring flexibility / impact resistance to PLA based compounds

Table 1: Indicative performance comparison of a selection of biopolymers and fossil-based polymers

| Property | Units | PBS | a-PLA | c-PLA | PBAT | PE-LD | PE-HD | PP | PS |
|---|---|---|---|---|---|---|---|---|---|
| Morphology semicrystalline - amorphous | - | SC | A | SC | A | SC | SC | SC | A |
| Melting temperature | [°C] | 115 | ~58 | >150 | ~115 | 110 | 130 | 165 | - |
| Heat Deflection Temp-B | [°C] | 85 | 55 | <100 | 40 | 50 | 75 | 105 | 90 |
| Tensile modulus | MPa | 550 | 3500 | 3500 | 80 | 200 | 1000 | 1500 | 3000 |
| Tensile elongation at break | % | 300 | 3 | 2 | 600 | 400 | 150 | 150 | 1,6 |
| Processability | | fast | fast | slow | fast | fast | fast | fast | fast |

# Helm-Reverdia Collaboration

## Leveraging market development

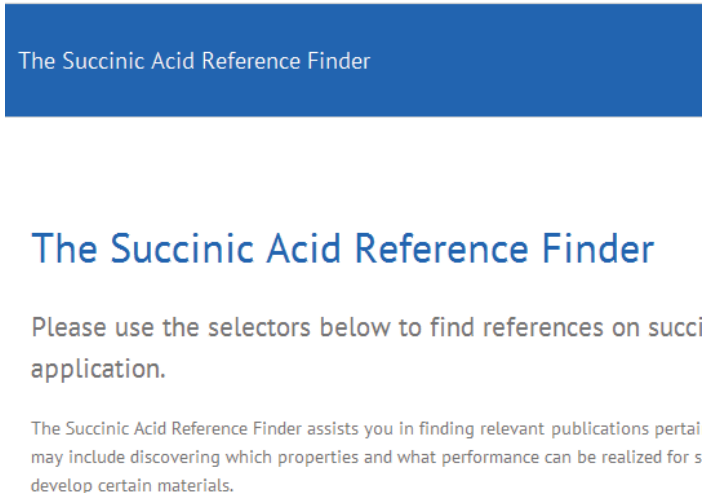
- Reverdia and Helm AG partner for Biosuccinium™ distribution and market development in Europe
- Building on Helm's strong position as a marketing enterprise and distributor
- Making Biosuccinium™ available for a broad range of markets and applications


reverdia

# Easy to Learn More

## Succinic Acid Reference Finder & Sample Order Tool

*Online reference database for uses of succinic acid*




*Quick and Easy online ordering of Biosuccinium™ samples*


*www.reverdia.com*

reverdia

# Biosuccinium™: we are ready !

- Validated sustainable low pH process
- Availability of high quality product from demo plant to bridge to 2012
- Commercial manufacturing as of 2012 in Cassano Spinola
- Reach/TSCA compliant
- Logistics in place
- Customer support team
- Global NBD team (EU, China, Japan, USA)
- Committed organization

reverdia

# For more information

## Visit us in the B2B area at the Ramspec


www.reverdia.com
Richard.Janssen@reverdia.com

reverdia

# Thank You

reverdia
sustainable solutions
powered by DSM + Roquette