PRODUCTION OF BIOPOLYMERS FROM SUGAR BEET PULP

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OBJECTIVES:

- Upgrading of the sugar beet pulp, a important by-product of the sugar industry.
- Extraction of different pectic fractions
- Incorporation of the pectic fraction into biopolymer films
- Study of their thermo-mechanical properties

PRODUCTION AND CHARACTERIZATION OF PECTIN FROM SUGAR BEET PULP

Extraction and chemical properties

Sugar Beet Pulp Cossettes

1°) Acidic extraction (pH 1.25; 80°C; 2 hours)
2°)Filtration, ultrafiltration;
3° Ethanol precipitation
→ Pectin ①

1°) Alkaline extraction (pH 12; 25°C; 2 hours)
2°)Filtration, ultrafiltration;
3° Ethanol precipitation
→ Pectin ④

Pectin ①: High MW 470 kDa, High DE 50%

1°) Pectinase hydrolyse (2 g/ g of pectin; 1 hour)
2°) Ethanol precipitation
→ Pectin ②

1°) pH 11 by a constant addition of NaOH until 2,4 mL per g of pectin
2°) Ethanol precipitation
→ Pectin ③

Pectin ④: Low MW 100 kDa, Low DE 1,5 %

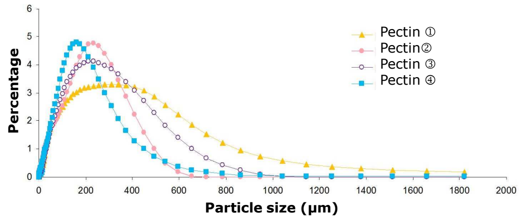
Pectin ②: Low MW 50 kDa, High DE 50 %

Pectin ③: High MW 470 kDa, Low DE 5 %

MW= Molecular weight;
DE= Degree of esterification

Physical properties

- Granulometric curves for the different pectin types:



- Polydispersity of paticle size
→sieving of pectins before their use

INCORPORATION OF PECTINS INTO BIOPOLYMERS FILMS AND STUDY OF THEIR THERMO-MECHANICAL PROPERTIES.

Tests on commercial citrus peel pectin

- Mixing 5, 10, 15 or 20 % of commercial pectin Fluka® with PLA (6 minutes) or PBAT (10 minutes) in a Brabender type mixer:
  - ✓ Thermal deterioration problems → Addition of Ultranox (antioxidant) and TNPP (healing agent)
  - ✓Stability problems→ addition of a compatibilizing agent
- Two compatibilizing agents tested: glycerol and D-sorbitol:
  - ✓Glycerol:

Polyester	Pectin/glycerol/water (%/%/%)	Young modulus (Mpa)	Yield stress (Mpa)	Yield strain (%)
PBAT	0/0/0	93 ±3 MPa	29 ±2 MPa	774 ±31 %
PBAT	25/25/0	87 ± 3 MPa	6 ± 1 MPa	261 ± 36 %
PBAT	16/24/0	63 ± 5 MPa	9 ± 1 MPa	387 ± 62 %
PBAT	20/25/5	61 ±4 MPa	6 ± 1 MPa	292 ± 33 %

Decrease of the yield strain and the yield stress values → very fragile material

Polyester	Pectin/sorbitol/water (%/%/%)	Young modulus (Mpa)	Yield stress (Mpa)	Yield strain (%)
PBAT	0/0/0	93 ±3 MPa	29 ±2 MPa	774 ±31 %
PBAT	25/25/0	271 ± 11 MPa	6 ± 1 MPa	227 ± 10 %
PBAT	30/30/0	314 ± 19 MPa	8 ± 1 MPa	7 ± 1 %
PBAT	35/35/0	389 ± 19 MPa	8 ± 1 MPa	6 ± 1 %
PBAT	40/40/0	486 ± 25 MPa	10 ± 1 MPa	6 ± 1 %
PLA	0/0/0	2152 ± 3 MPa	52 ±5 MPa	5,4 ± 0,7 %
PLA	25/25/0	1555± 66 MPa	23 ± 1 MPa	2,4 ± 0,1 %
PLA	30/30/0	1104± 123 MPa	14 ± 3 MPa	2,1± 0,3 %
PLA	35/35/0	902 ± 58 MPa	11 ± 1 MPa	2,0 ± 0,2 %
PLA	40/40/0	754 ± 165 MPa	9 ± 1 MPa	2,3 ± 0,3 %

Despite decrease of the yield strain and yield stress values, good yield strain for PLA with 50/50 pectin/sorbitol → best mixing

Results with sugar beet pectins

- Use of the best formulations obtained previously → PLA/pectin/ Sorbitol 50/25/25 formulations.

Pectin	Young modulus (Mpa)	Yield stress (Mpa)	Yield strain (%)
PLA/sorbitol	2152 ± 3 MPa	52 ± 5 MPa	5,4 ± 0,7 %
Pectin ①	1245 ±66 MPa	-	-
Pectin ②	1733 ± 103 MPa	-	-
Pectin ③	2001 ± 159 MPa	-	-
Pectin ④	2175 ±7 MPa	24 ± 5 MPa	2,2 ± 1 %

- Best results with pectin ④ (low DM and low MW)
  - *Small size and lack of esterified groups → interactions between pectin chains plastified by PLA and Sorbitol → better cohesion.*

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