PELLNATUR

Zeolite tanning agent – sustainability considerations

Francina Izquierdo, *Ivo Reetz*, Pulcra Chemicals
Anna Bacardit, Universitat de Lleida

2 Biodegradability

1 Introduction

3 Compostability

4 LCA

5 Conclusion

Universitat de Lleida

Pulcra

Zeolite tanning agent – sustainability considerations

Francina Izquierdo, *Ivo Reetz*, Pulcra Chemicals
Anna Bacardit, Universitat de Lleida

Zeolite tanning agent - sustainability considerations

Francina Izquierdo, *Ivo Reetz*, Pulcra Chemicals
Anna Bacardit, Universitat de Lleida

PELLNATUR

2 Biodegradability

Biodegradation

1 Introduction

3 Compostability

4 LCA

LCA

GWP

5 Conclusion

Universitat de Lleida

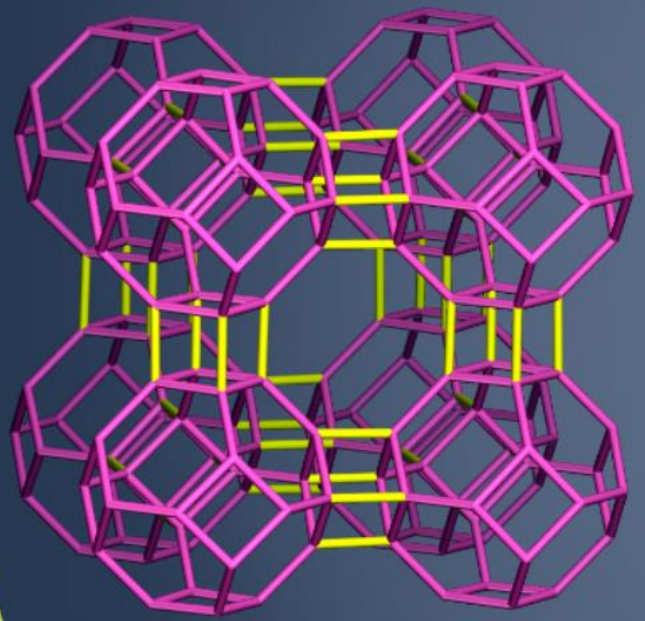
Pulcra

1 Introduction

Zeolites

Products used

Zeolites for Leather



- Zeolites for leather tanning introduced in 1970th
- Initial challenges: limited penetration in thick leathers – primarily used as a co-tanning agent together, e.g., with chrome tannage.
- Recent years: significant progress in product formulation and in application
- Investigation of mechanism of stabilization
- Excellent biodegradability

PELLNATUR®

Products used

Free of Bisphenol, Formaldehyde, chrome and other heavy metals

Strong, lasting tanning effect

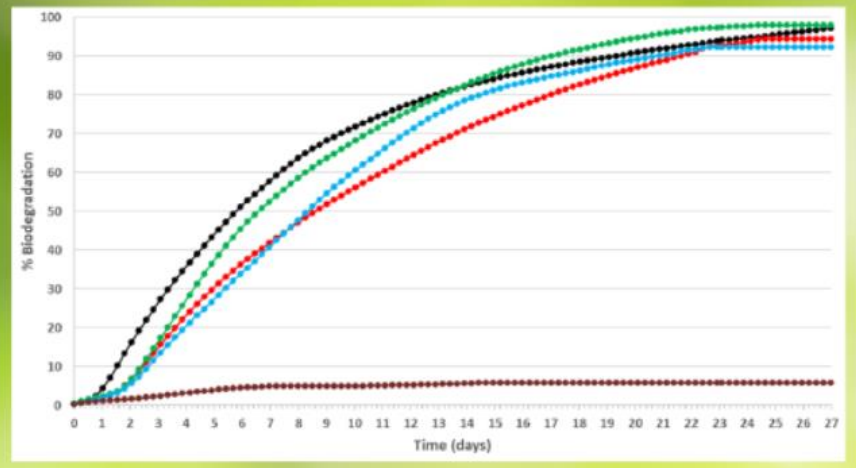
Tanning system with 100% bio-based carbon

	ZP1	ZP2	ZP3
Zeolite content, %	30	30	91
Masking	X	X	X
Bio-based C content, %	100	100	100

Pulcra

2 Biodegradability

Biodegradation

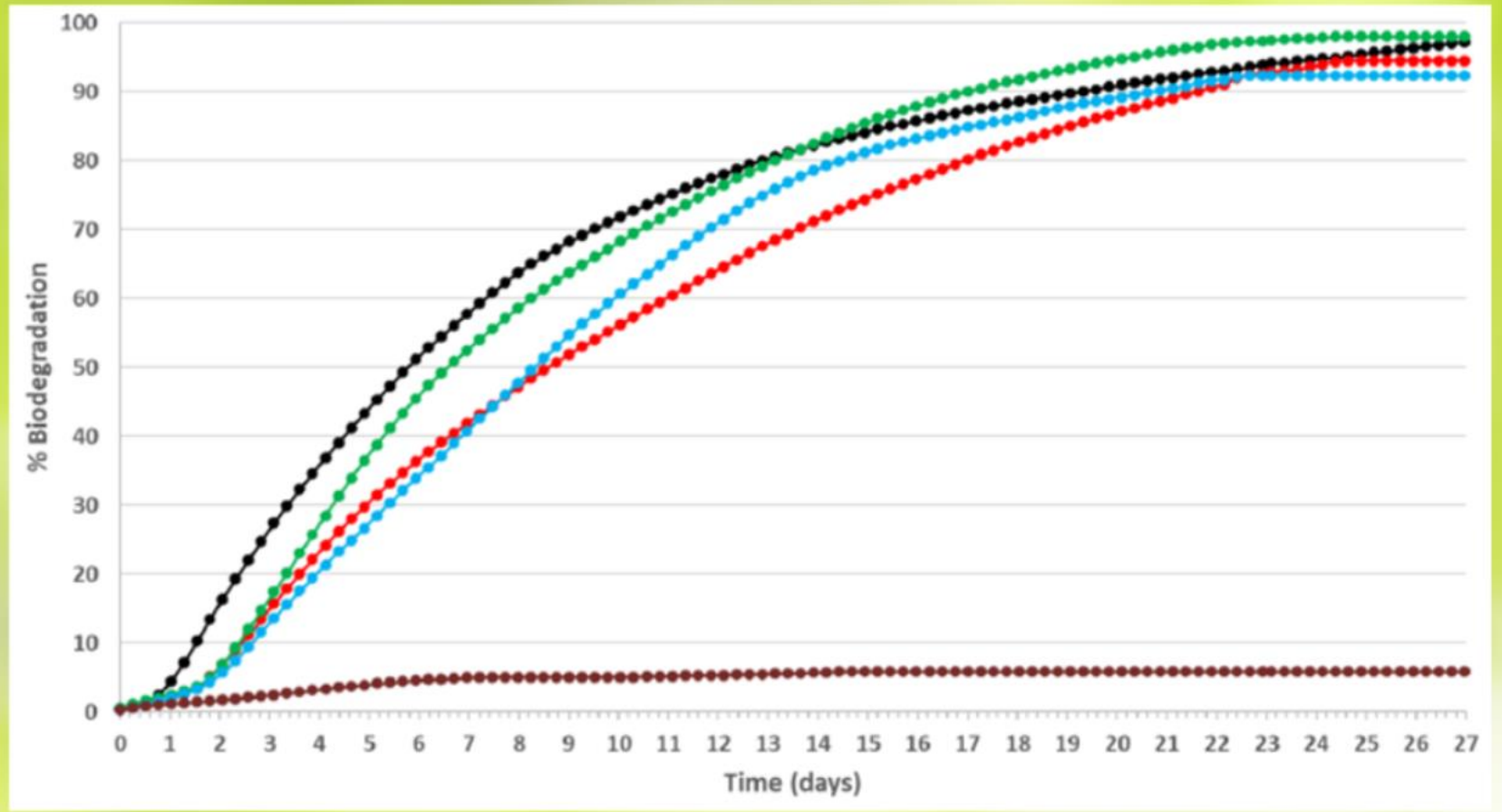


Accumulative average CO_2 evolution over time until plateau for ***Collagen***, ***ZP1***, ***ZP2***, ***ZP3***, ***Cr-Sulf***

Biodegradability according to ISO 20136 – Leather – Determination of degradability by microorganisms.

Product	ZP1	ZP2	ZP3	Cr-Sulf
% Tanning agent	10	10	3	7
Total % Zeolite	3	3	2.7	-
T_s, °C	75	78	60	>100
% rel. biodegradability	94.1	99.8	96.3	6.0

Pulcra



Accumulative average CO_2 evolution over time until plateau for ***Collagen***, ***ZP1***, ***ZP2***, ***ZP3***, ***Cr-Sulf***

Biodegradability according to ISO 20136 – Leather – Determination of degradability by microorganisms.

Product
% Tanning agen
Total % Zeolite
T_s, °C
% rel. biodegradabilit

Product	ZP1	ZP2	ZP3	Cr-Sulf
% Tanning agent	10	10	3	7
Total % Zeolite	3	3	2.7	-
T_s, °C	75	78	60	>100
% rel. biodegradability	94.1	99.8	96.3	6.0

3 Compostability

Results

Leathers

Leathers

Leather	A	B	C	D	E
Zeolite preparation	10% ZP1	10% ZP1	10% ZP1	10% ZP2	3% ZP3
Total Zeolite content	3.0%	3.0%	3.0%	3.0%	2.7%
Vegetable extract	20% Tara	20% Mimosa	-	-	-
Phenolic syntan	10%	10%	30%	30%	30%

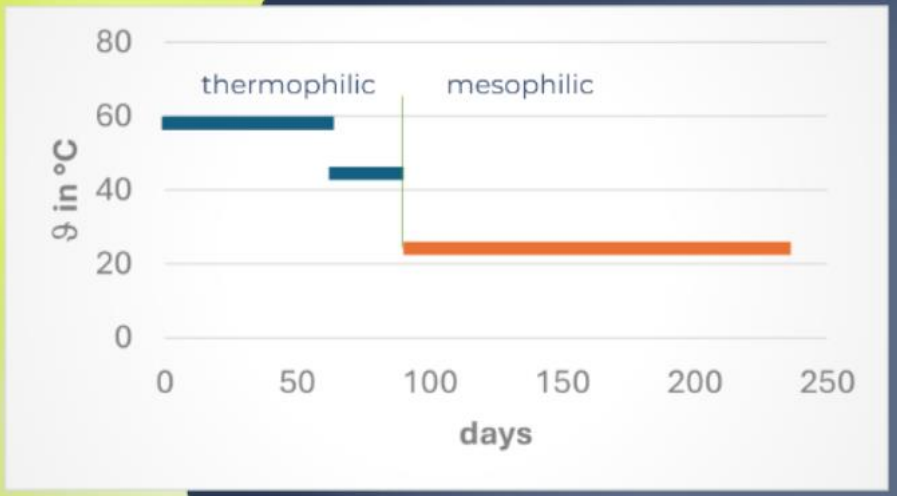
- **F**: Tanned with 7% Cr-Sulf + 30% phenolic syntan
- **G**: Wet blue, retanning with Cr-Sulf + 5% protein auxiliary, 5% acrylic resin and 1.5% naftalensulfonic acid

Sample denomination for compostability testing

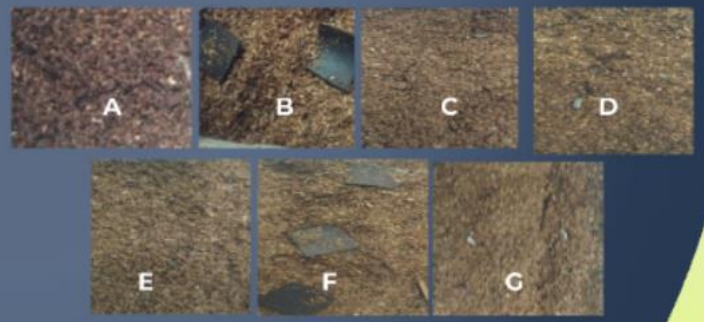
Leather	A	B	C	D	E
Zeolite preparation	10% ZP1	10% ZP1	10% ZP1	10% ZP2	3% ZP3
Total Zeolite content	3.0%	3.0%	3.0%	3.0%	2.7%
Vegetable extract	20% Tara	20% Mimosa	-	-	-
Phenolic syntan	10%	10%	30%	30%	30%

- **F**: Tanned with 7% Cr-Sulf + 30% phenolic syntan
- **G**: Wet blue, retanning with Cr-Sulf + 5% protein auxiliary, 5% acrylic resin and 1.5% naftalensulfonic acid.

Compostability



initial



35d

UNE-EN ISO 20200:2023 – *Plastics – Determination of the degree of disintegration under simulated composting conditions in a laboratory-scale test.*

Compost

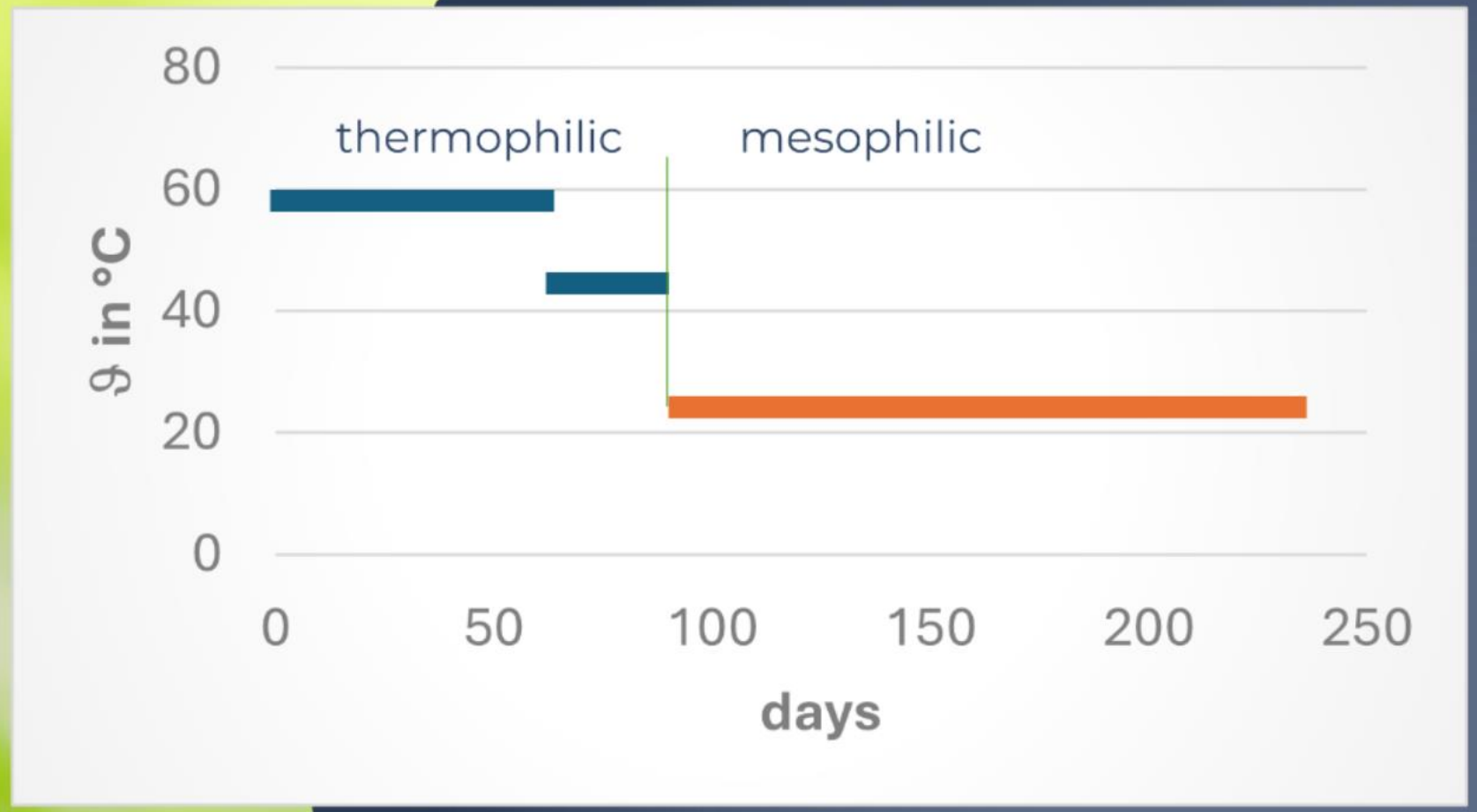
Leachate

Conclusion

Universitat de Lleida

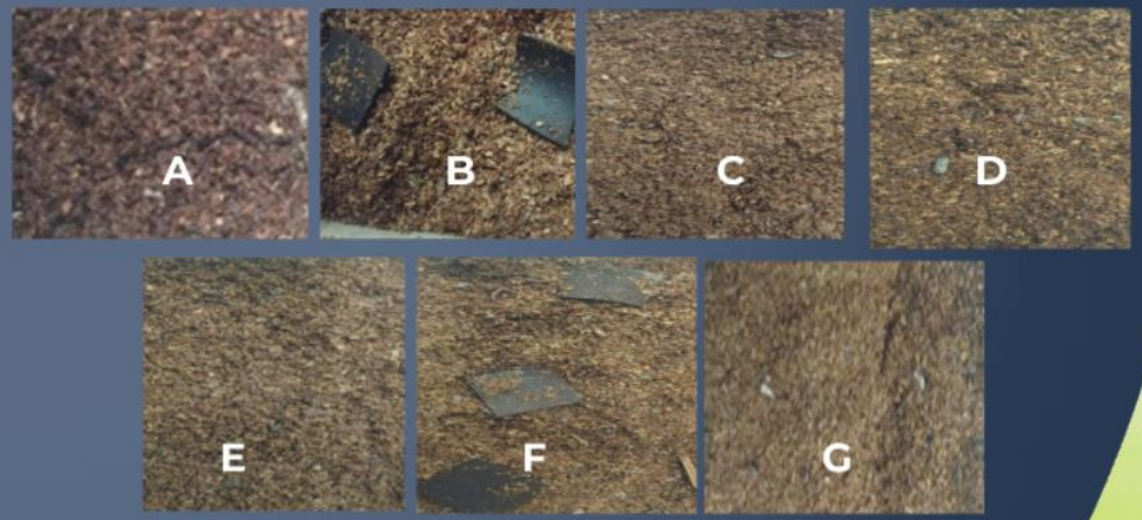
Pulcra

Compostability



initial

initial



35d

Compost

Leachate

Conclusion

Compost

Parameter	A	B	C	D	E	F	G	Blank (t=60d)	Unit
Incubation	1	1-3	1	1	1	1-3	1	1	
Degradation time	28	-	14	10	14	-	37	-	days
Decomposition rate	100	0	100	100	100	0	100	-	%
Test Rottegrade	V	V	V	V	V	V	V	V	Grade
Organic Material	68	68	68	80	80	89	76	80	%
Total Organic Carbon	33	44	33	40	41	45	38	40	%
Kjeldhal Nitrogen	1.5	1.8	1.4	1.5	1.5	1.8	1.5	1.4	%
Relation C/N	23	24	24	27	28	25	26	29	%
Dry weight	47	44	49	46	47	52	40	36	%
Humidity	53	56	51	54	53	48	42	64	%
Ash content (550°C)	4.7	5.5	4.1	3.5	3.5	5.6	3.5	3.7	%
pH	7.7	7.6	7.5	7.6	7.7	7.6	7.6	7.9	
				Heavy metals					
Cd	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	mg/kg
Cu	13.2	12.3	13.3	10.3	10.3	12.6	17.6	8.0	mg/kg
Zr	<12	<12	<12	<12	<12.0	<12	<12	<12	mg/kg
Cr	6.2	6.1	6.2	5.3	7.1	45.6	513	4.1	mg/kg
Zn	37	54	36	32	34	45	7	25	mg/kg
Fe	481	712	503	429	446	839	513	501	mg/kg
Ni	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	mg/kg
Pb	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	mg/kg

Parameter	A	B	C	D	E	F	G	Blank (t=60d)	Unit
Incubation	1	1-3	1	1	1	1-3	1	1	
Degradation time	28	-	14	10	14	-	37	-	days
Decomposition rate	100	0	100	100	100	0	100	-	%
Test Rottegrade	V	V	V	V	V	V	V	V	Grade
Organic Material	68	88	68	80	80	89	76	80	%
Total Organic Carbon	33	44	33	40	41	45	38	40	%
Kjeldhal Nitrogen	1.5	1.8	1.4	1.5	1.5	1.8	1.5	1.4	%
Relation C/N	23	24	24	27	28	25	26	29	%
Dry weight	47	44	49	46	47	52	40	36	%
Humidity	53	56	51	54	53	48	42	64	%
Ash content (550°C)	4.7	5.9	4.1	3.5	3.5	5.6	3.9	3.7	%
pH	7.7	7.8	7.8	7.8	7.7	7.6	7.8	7.9	
				Heavy metals					
Cd	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	mg/kg
Cu	12.2	12.3	12.3	10.3	10.3	12.8	17.6	8.0	mg/kg
Zr	<12	<12	<12	<12	<12.0	<12	<12	<12	mg/kg
Cr	6.2	6.1	6.2	5.3	7.1	45.6	513	4.1	mg/kg
Zn	37	54	36	32	34	45	7	25	mg/kg
Fe	491	712	553	429	446	628	513	501	mg/kg
Ni	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	mg/kg
Pb	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	mg/kg

Leachate

Parameter	A	B	C	D	E	F	G	Blank (t=60d)	Unit
pH	7.8	7.4	7.8	8.2	8.0	8.1	8.1	8.2	
COD	2.8	1.6	2.7	3.1	2.5	2.0	3.2	2.8	g/L
BOD 5d	420	--	154	288	256	--	295	275	mg/L
Conductivity 25°C	3.4	4.1	3.9	4.3	4.3	3.9	3.6	3.1	mS/cm
Total nitrogen	463	474	454	284	386	480	654	606	mg/L
Nitrogen-amonia	55	15	87	35	35	12	47	81	mg/L
Anions									
Cl-	1.285	917	873	838	885	806	733	735	mg/L
SO_4^{2-}	1.316	921	1.096	1.262	946	589	663	1.190	mg/L
NO_3^-	<10	<10	<10	<10	<10	<10	<10	<10	mg/L
Heavy metals									
Ti	<12	<12	<12	<12	<12	<12	<12	<12	mg/L
Al	71.4	1.9	64.3	50.2	47.7	1.5	42.9	52.7	mg/L
Zr	<12	<12	<12	<12	<12	<12	<12	<12	mg/L
Cr	<3.0	<3.0	<3.0	<1.0	<3.0	<3.0	13.5	<3.0	mg/L
Zn	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	mg/L
Fe	22.5	<3.0	23.8	18.1	19.2	<3.0	22.3	21.8	mg/L

Parameter	A	B	C	D	E	F	G	Blank (t=60d)	Unit
pH	7.8	7.4	7.8	8.2	8.0	8.1	8.1	8.2	
COD	2.8	1.8	2.7	3.1	2.5	2.0	3.2	2.8	g/L
BOD 5d	420	--	154	258	256	--	295	278	mg/L
Conductivity 25°C	3.4	4.1	3.9	4.3	4.3	3.9	3.6	3.1	mS/cm
Total nitrogen	463	474	454	284	395	480	654	606	mg/L
Nitrogen-amonia	55	15	87	35	35	12	47	81	mg/L
Anions									
Cl^-	1.285	817	873	858	885	806	733	735	mg/L
SO_4^{2-}	1.316	971	1.096	1.262	946	589	663	1.190	mg/L
NO_3^-	<10	<10	<10	<10	<10	<10	<10	<10	mg/L
Heavy metals									
Ti	<12	<12	<12	<12	<12	<12	<12	<12	mg/L
Al	71.4	1.9	64.3	50.2	47.7	1.5	42.9	52.7	mg/L
Zr	<12	<12	<12	<12	<12	<12	<12	<12	mg/L
Cr	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	13.5	<3.0	mg/L
Zn	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	mg/L
Fe	22.5	<3.0	23.6	18.1	19.2	<3.0	22.3	21.8	mg/L

Conclusion

Modern Zeolite Tanning Agents

- Provide excellent compostability.
- Combination with condensed vegetable tanning agents is critical.
- Combination with syntans shows less adverse impact.

Chrome-tanned leathers are less compostable, but still acceptable if not heavily re-tanned with phenolic syntans.

Conclusion

Modern Zeolite Tanning Agents

- Provide excellent compostability.
- Combination with condensed vegetable tanning agents is critical.
- Combination with syntans shows less adverse impact.

Chrome-tanned leathers are less compostable, but still acceptable if not heavily re-tanned with phenolic syntans.

3 Compostability

Leathers

Results

PELLNATUR

Zeolite tanning agent - sustainability considerations

Francina Izquierdo, *Ivo Reetz*, Pulcra Chemicals
Anna Bacardit, Universitat de Lleida

2 Biodegradability

1 Introduction

3 Compostability

4 LCA

5 Conclusion

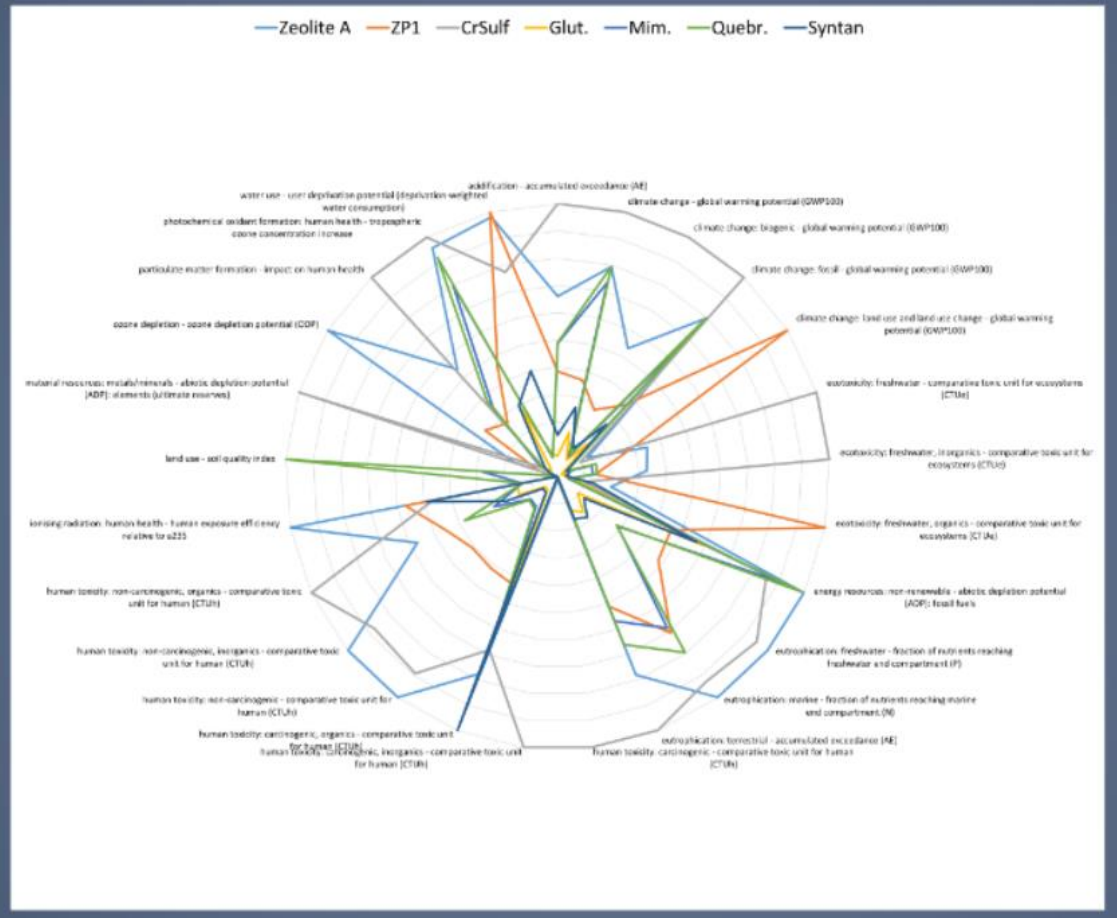
Universitat de Lleida

Pulcra

4 LCA

LCA

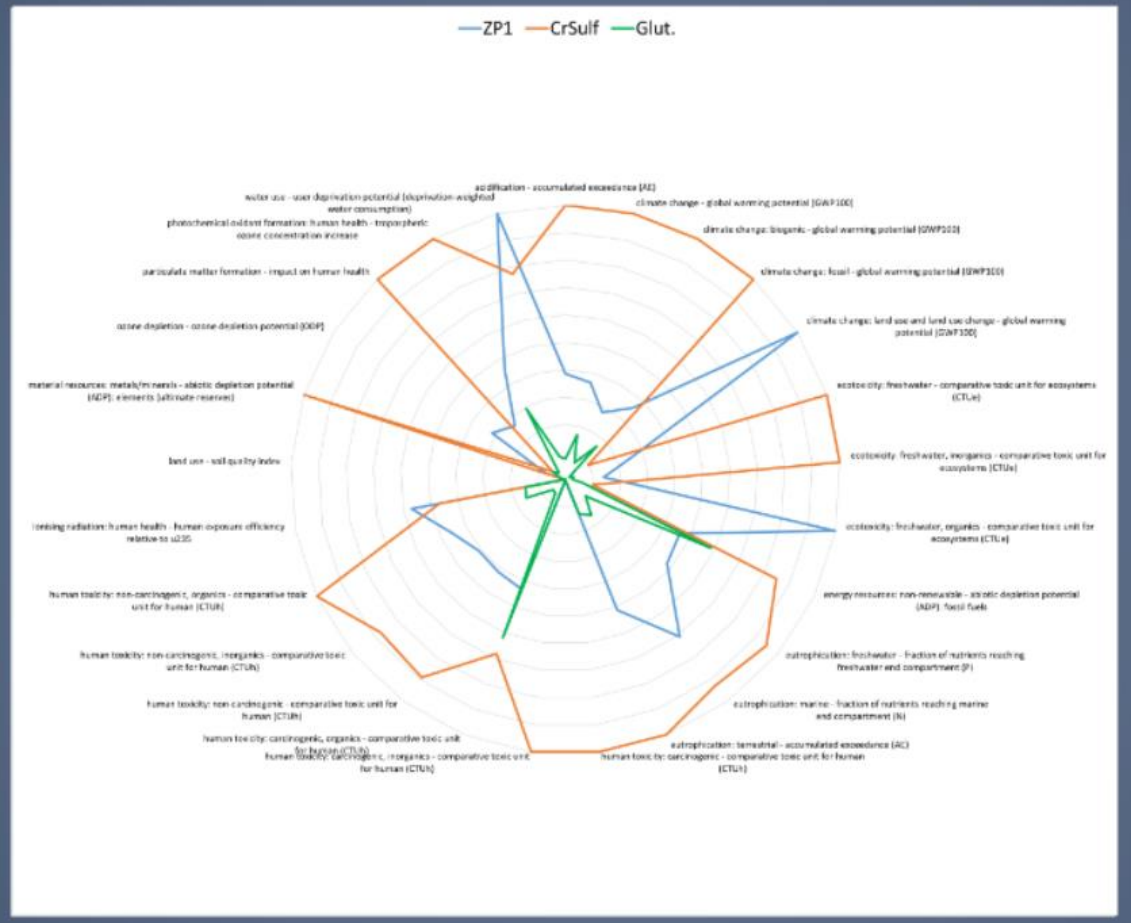
GWP



Performed at A3 Leather Innovation Center of the Universitat de Lleida according to ISO 14040:2006

Pulcra

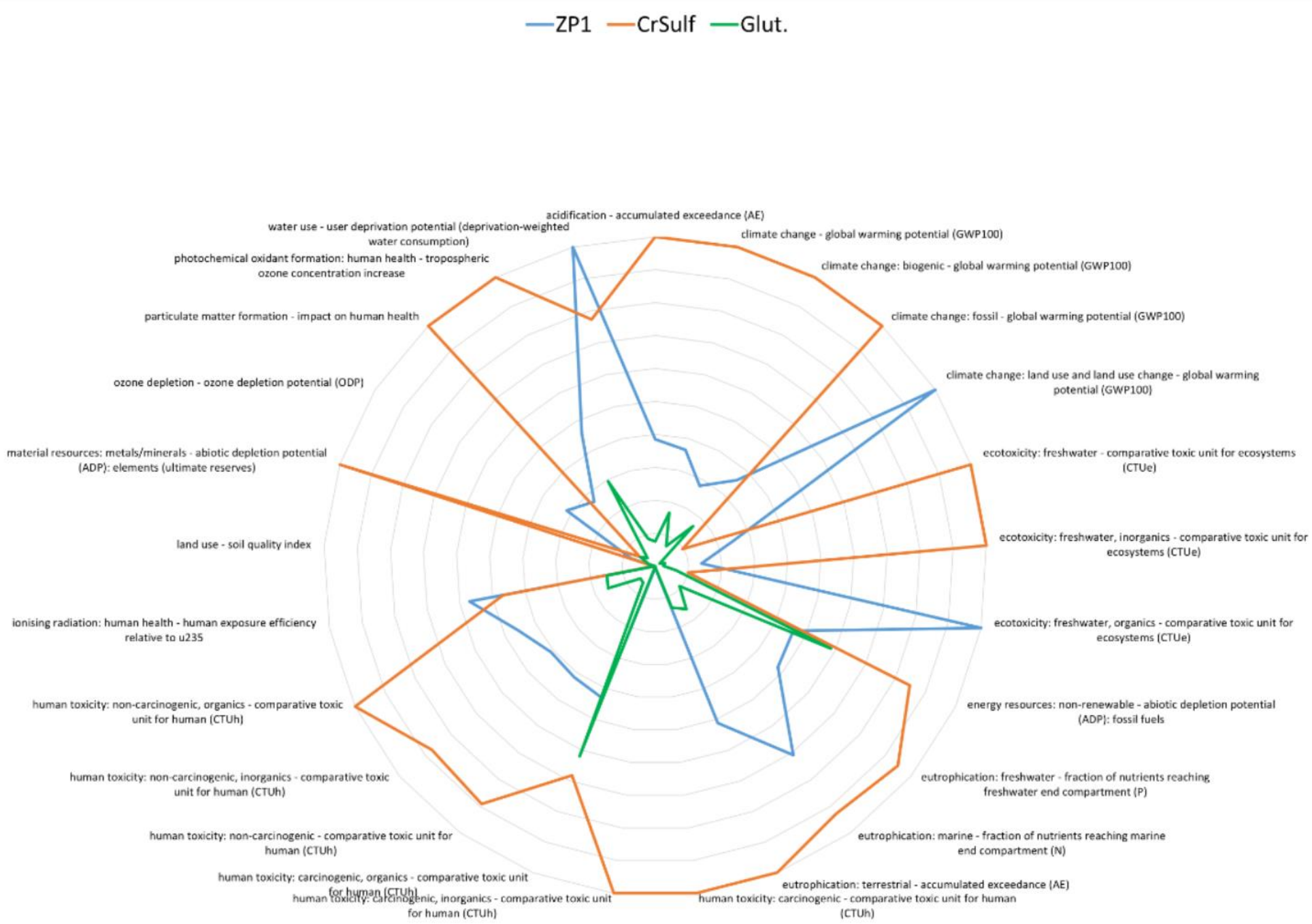
Universitat de Lleida



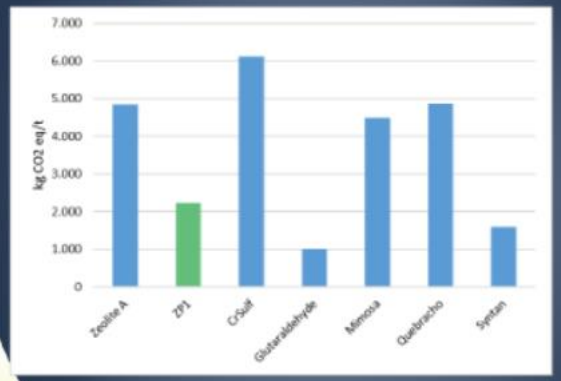
Performed at A3 Leather Innovation Center of the Universitat de Lleida according to ISO 14040:2006

Pulcra

Universitat de Lleida

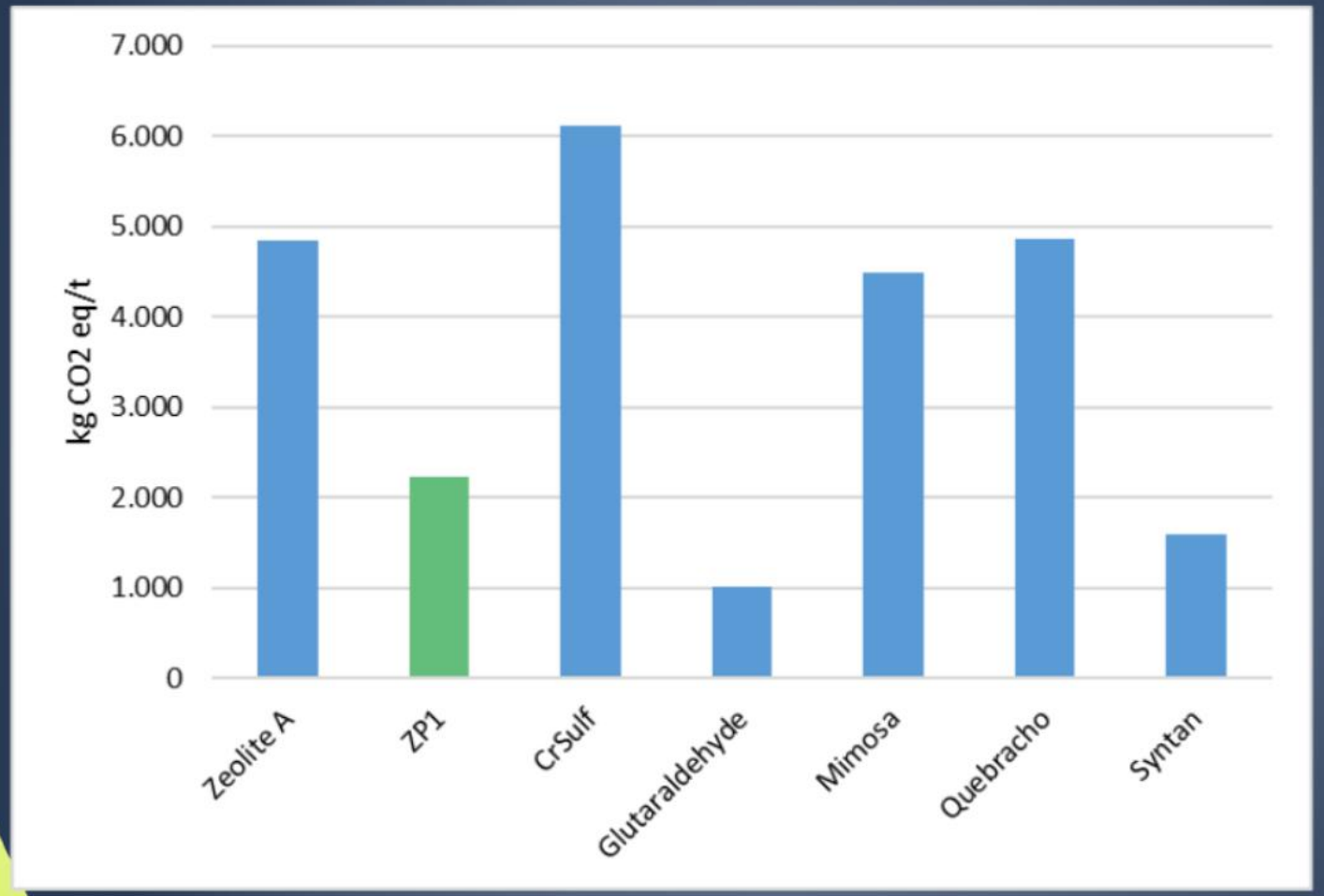

ZP1
CrSulf
Glut.
acidification - accumulated exceedance (AE)
climate change - global warming potential (GWP100)
climate change: biogenic - global warming potential (GWP100)
climate change: fossil - global warming potential (GWP100)
climate change: land use and land use change - global warming potential (GWP100)
ecotoxicity: freshwater - comparative toxic unit for ecosystems (CTUe)
ecotoxicity: freshwater, inorganics - comparative toxic unit for ecosystems (CTUe)
ecotoxicity: freshwater, organics - comparative toxic unit for ecosystems (CTUe)
energy resources: non-renewable - abiotic depletion potential (ADP): fossil fuels
eutrophication: freshwater - fraction of nutrients reaching freshwater end compartment (P)
eutrophication: marine - fraction of nutrients reaching marine end compartment (N)
eutrophication: terrestrial - accumulated exceedance (AE)
human toxicity: carcinogenic - comparative toxic unit for human (CTUh)
human toxicity: carcinogenic, inorganics - comparative toxic unit for human (CTUh)
human toxicity: carcinogenic, organics - comparative toxic unit for human (CTUh)
human toxicity: non-carcinogenic - comparative toxic unit for human (CTUh)
human toxicity: non-carcinogenic, inorganics - comparative toxic unit for human (CTUh)
human toxicity: non-carcinogenic, organics - comparative toxic unit for human (CTUh)
ionising radiation: human health - human exposure efficiency relative to u235
land use - soil quality index
material resources: metals/minerals - abiotic depletion potential (ADP): elements (ultimate reserves)
ozone depletion - ozone depletion potential (ODP)
particulate matter formation - impact on human health
photochemical oxidant formation: human health - tropospheric ozone concentration increase
water use - user deprivation potential (deprivation-weighted water consumption)

GWP



GWP 100 results for different tanning agents

GWP



GWP 100 results for different tanning agents

5 Conclusion

Conclusion

Sustainability advantages of modern zeolite tannage

- Biodegradability strongly superior to Cr-Tanning
- Compostability in many cases better, less sensitivity to combination with syntans
- Low PCF in LCA

PELLNATUR

Zeolite tanning agent - sustainability considerations

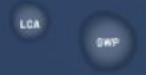
Francina Izquierdo, *Ivo Reetz*, Pulcra Chemicals
Anna Bacardit, Universitat de Lleida

2 Biodegradability

1 Introduction

3 Compostability

4 LCA



5 Conclusion

Universitat de Lleida

Pulcra

PELLNATUR®

Zeolite tanning agent - sustainability considerations

Francina Izquierdo, *Ivo Reetz*, Pulcra Chemicals
Anna Bacardit, Universitat de Lleida

2 Biodegradability

1 Introduction

3 Compostability

4 LCA

5 Conclusion

Universitat de Lleida

Pulcra

Thank you!