



Tannins as replacing biocides and in leather tanning

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Interreg
Baltic Sea Region



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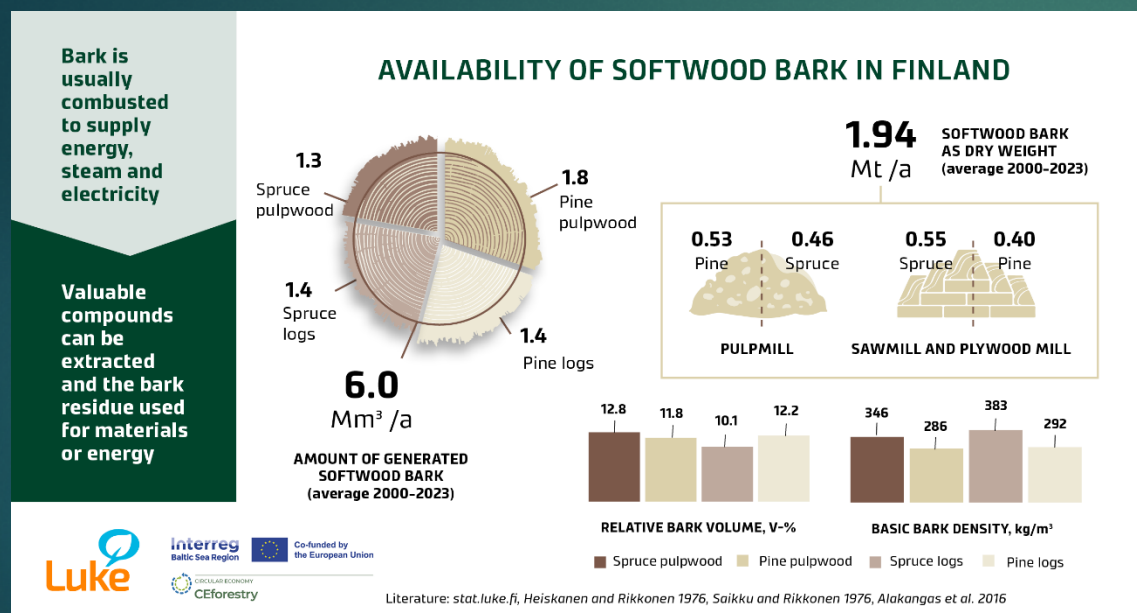
CEforestry



Content

- ▶ Tannin containing side streams in forest industry
- ▶ Effect of storage and other challenges
- ▶ Tannin separation
- ▶ Case 1 Replacement of biocides
- ▶ Case 2 Leather tanning

Tannin containing side streams in forest industry



Softwood bark (2000–2023)

Pulp industries (bark from pulpwood)

- ▶ Pine 0.53 Mt/a
- ▶ Spruce 0.46 Mt/a

Wood-products industries (bark from logs)

- ▶ Pine 0.40 Mt/a
- ▶ Spruce 0.55 Mt/a

SUM 1.94 Mt/a

Softwood tannins

Softwood tannins are so called condensed tannins

- ▶ Procyanidins and prodelphinidins
- ▶ Spruce and pine bark contains ca. 4–5 % condensed tannins

Tannins from bark (2000–2023)

- ▶ Spruce 50 kt/a
- ▶ Pine 40 kt/a
- ▶ Birch inner bark 30 kt/a
 - ▶ Tannin content ca. 4.6 %

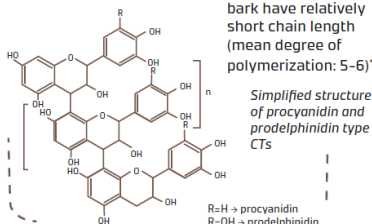
Tannins in bark of Norway spruce and Scots pine are condensed tannins (CTs)

Part of the CTs in bark can be extracted and the residue can be used for materials or energy

TANNIN CONTENT AND COMPOSITION OF SOFTWOOD BARK

COMPOSITION

- CTs are oligomers and polymers of flavan-3-ol units
- Scots pine bark CTs are essentially procyanidins
- Norway spruce bark CTs are mainly procyanidins with a few percent prodelphinidins
- CTs of spruce and pine bark have relatively short chain length (mean degree of polymerization: 5–6)*



Condensed tannin potential of spruce bark in Finland as dry weight (average 2000–2023)

ca. **50** kt/a

Condensed tannin potential of pine bark in Finland as dry weight (average 2000–2023)

ca. **40** kt/a

CONTENT

Pine and spruce bark contain **4–5 w-% CTs (dry weight)***

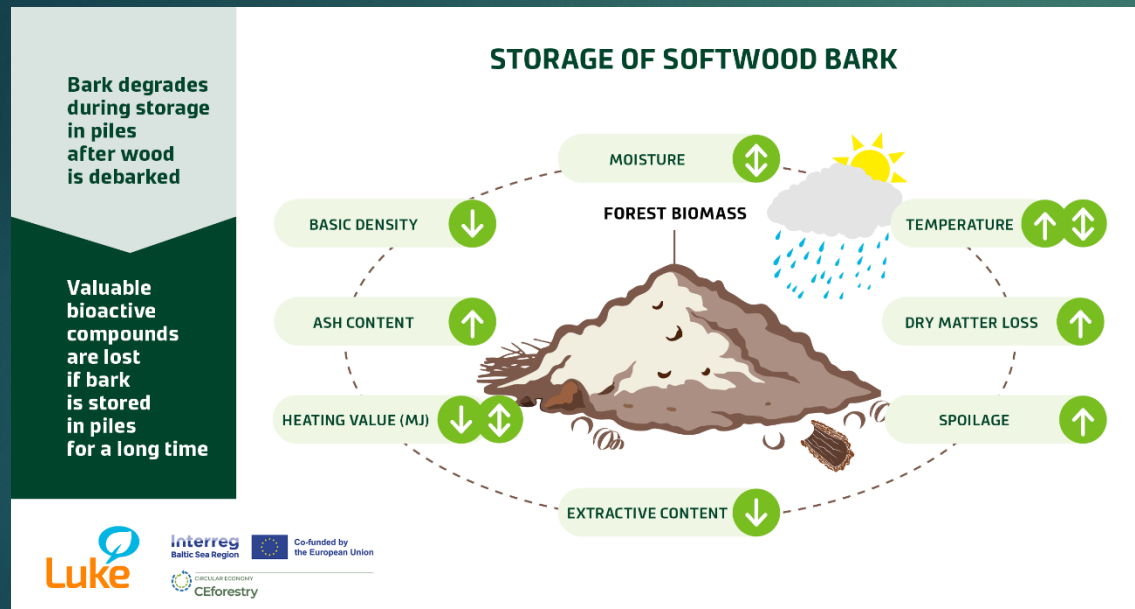
- Part of the CTs are bound covalently to cell walls and are thus non-extractable with conventional solvents

CT content in extracts of bark varies due to factors such as solvent and extraction conditions

- With hot water extraction CT content in spruce bark extract can reach **25 w-% (dry weight)***

Literature: *Matthews et al. 1997, *Tienaho et al. 2025, stat.luke.fi, Heiskanen and Rikkinen 1976, Saikku and Rikkinen 1976, Alakangas et al. 2016

Effect of storage on softwood bark



- ▶ Storage affects the properties and chemical composition of bark
 - ▶ Changes occur particularly rapidly during summer
 - ▶ The content of extractives and tannins decreases already within a couple of weeks of storage (bark pile)
- ▶ Bark should be utilised as soon as possible after debarking while still fresh

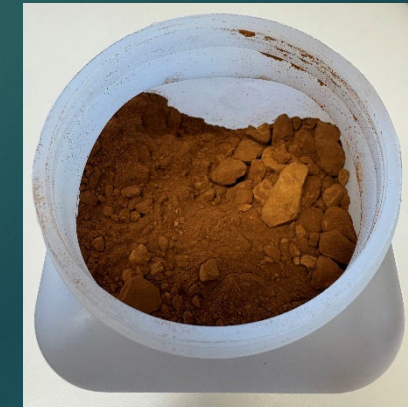
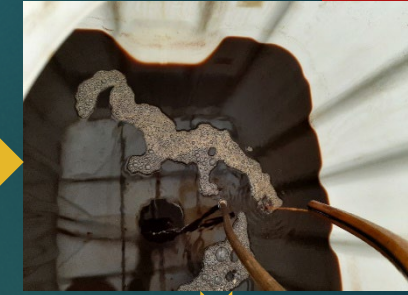
Challenges in the use of industrial bark

- ▶ Debarking processes have been developed and optimised for **wood** utilisation
 - ▶ Pulp (chips), plywood, sawn timber, etc.
- ▶ Bark is mainly considered as fuel
 - ▶ Moisture content is used as a measure, which affects its combustion value
- ▶ Bark also contains wood material
 - ▶ The cleaner the desired wood material (e.g., chips), the more wood ends up in the bark mix
 - ▶ Wood material does not contain tannins, so the total amount of tannins decreases



Separation of tannins

- ▶ Tannin separation is relatively easy
- ▶ In CEforestry project:
 - ▶ 300-l extraction vessel
 - ▶ Ca. 93 kg fresh spruce bark
 - ▶ Water as solvent
 - ▶ Extraction temperature 92 °C
 - ▶ Extraction time 40 min
 - ▶ Obtained ca. 227 kg tannin containing extract which was concentrated by ultrafiltration to ca. 30 kg
 - ▶ Concentrate can further be dried to powder (freeze-drying or spray drying)

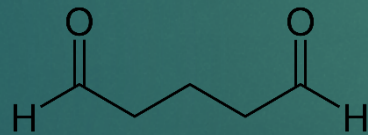
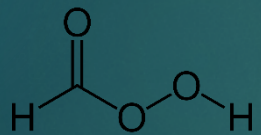


Case 1 Replacement of biocides



Microbial control in paper mills

- ▶ Synthetic biocides are used in the paper industry to control microbial growth
- ▶ Their purpose is to prevent the formation of biofilm, slime, and microbial growth in paper machines and process waters
- ▶ Examples include peracetic acid and glutaraldehyde

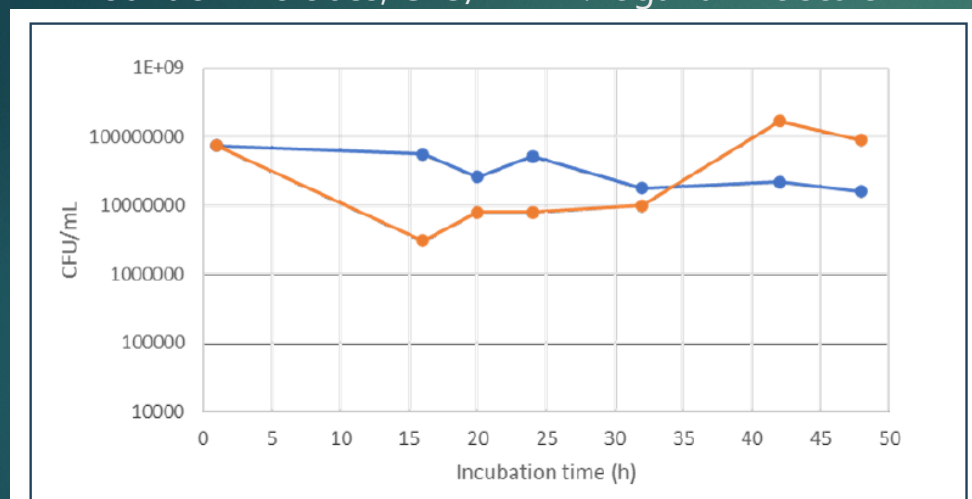


- ▶ Microbes also produce various gases: H_2 , CO_2 , and H_2S , which are harmful or toxic

- ▶ In the CEforestry project, concentrated tannin-rich spruce bark extract was tested as a biocide substitute in a paper mill using recycled fiber
- ▶ Bark extract was added to pulp samples, and gas formation was monitored
- ▶ The bark extract significantly reduced the amount of microbes and gas formation

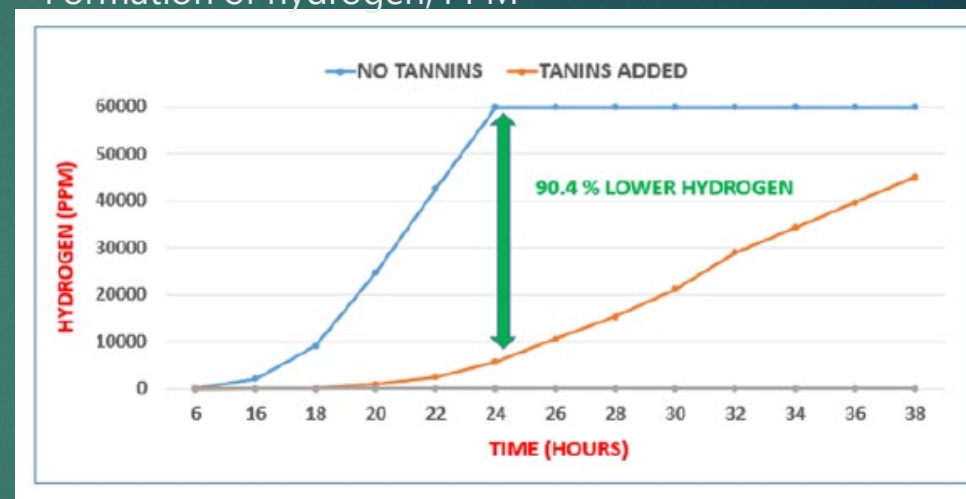
Results from Swedish University of Agricultural Sciences

Amount of microbes, CFU/ml NB! logarithmic scale



Water
Spruce bark extract

Formation of hydrogen, PPM



Water
Spruce bark extract

Case 2 - Leather tanning

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Photo: Hanna Nore

Leather tanning with plant-based tannins

- ▶ 80–90% of leather is typically tanned using chromium(III) salts
- ▶ Commercially available plant-based tannins are also on the market:
 - ▶ Quebracho (South America)
 - ▶ Mimosa (South America, South Africa, and Australia)
 - ▶ Chestnut (South Europe)
- ▶ The CEforestry project studied tannin-rich extract obtained from spruce bark:
 - ▶ The tannin-rich extract was used as-is
 - ▶ Carbohydrates were removed from the tannin extract using a resin treatment
 - ▶ Additionally, an industrially produced and dried tannin-rich spruce bark extract was studied
 - ▶ The leather tanning experiments were conducted by traditional master tanner Hanna Nore

Thoughts from the experiments on spruce bark extract

- ▶ Spruce bark extract (in powder form) can be refined into an excellent product for vegetable tanning of leather!
- ▶ The product development requires further testing under industrial production conditions
- ▶ Especially Nordic entrepreneurs and artisans in the field are a potential customer base for the product, as spruce bark has traditionally been used in the region for leather tanning

Results

- ▶ The tannin-rich extract obtained from spruce bark functions as a leather tanning agent, even without the removal of sugars
- ▶ A local supply chain can be established, where, for example, a valuable product can be made from domestic by-products of the wood processing industry, eliminating the need for imports

From one tree grows a thousand possibilities. Södra is to add tannin to its range of forest-based products and seeks partners to develop new tannin-based sustainable alternatives to fossil products in a range of applications.

Södra is investing in a production line at its Värö facility in Sweden, which will create a vegetable tanning agent from bark. This new tannin can be used to process leather in a more environmentally friendly way. The line will have the capacity to produce tannin for millions of square metres of leather.

“Now is the time to unite and maximise the potential of every tree, exploring innovative applications for tannin collaboratively. Together, we can develop fossil-free products and contribute to a more sustainable future,” said Viktor Odenbrink, Sales Director, Södra Bioproducts.

Using bark for tanning is not new, but Södra is now industrializing the process in which the tanning substance is extracted from the bark and transformed into a product for tanning leather. Södra will produce large volumes of this type of tannin for the market and is also open to possible new markets where this sustainable tannin could be used to do good. Therefore, we would like to hear from potential partners who have an idea how our tannin could make a difference to their operation and to the transition to a fossil-free society within or outside the leather industry.



SpruceTannin™

A natural phenolic extract from upcycled Norway Spruce bark, rich in tannins, lignans, and flavonoids. Ideal for glues, leather tanning, and animal feed additives, offering both functionality and sustainability.

Key Features:

- Rich in polyphenols: Contains tannins, lignans, and flavonoids of woody origin
- Water-soluble & hydrophilic: Easily integrates into formulations
- Antioxidative & bioactive: Offers potential antimicrobial and antiparasitic benefits

Available as a dry powder or liquid water concentrate.

SpruceTannin™ is a scalable, cost-efficient material designed to meet large industrial demands with sustainability.

Conclusions and further thoughts

- ▶ The potential availability of tannins from forest industry side stream, bark, is considerable
 - ▶ Debarking and storage have an effect of quality and quantity
- ▶ Tannin containing extracts are relatively easy to obtain using hot water
 - ▶ Further concentration steps are needed
- ▶ Tannin-containing extracts are effective in leather tanning and can serve as substitutes for biocides in paper mills
 - ▶ Economical aspects should be taken into consideration
 - ▶ Aalto University will have speech on techno-economic feasibility of tannins



Thank you

Time for a question