



Arctic Innovation

Interreg Nord IV seminar in Luleå
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Innovation in the arctic?

- ▶ What is an innovation?
- ▶ Very many definitions, you can pick the most suitable for you! (compare to Buzzword like "digitalization")
- ▶ Innovation is an idea which has been developed into a product, something new or improved that you can sell
 - ▶ Innovation is crucially important for companies, usually stated in company "Vision"
 - ▶ Ideas are inexpensive, turning them into commercial products is usually expensive!
- ▶ Some selected innovations in Scandinavia

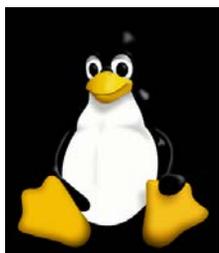
Adjustable wrench, J. Johansson, 1891



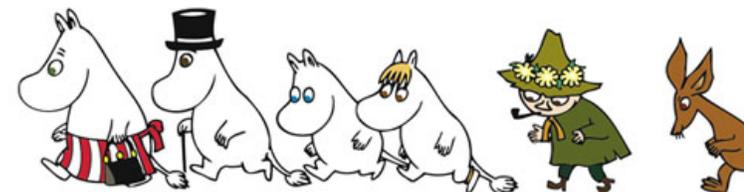
Cheese plane in 1925



X-BOW, ship hull for harsh arctic seas, 2004, Norway



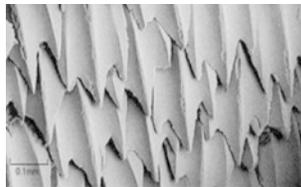
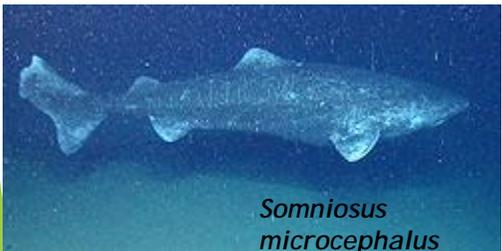
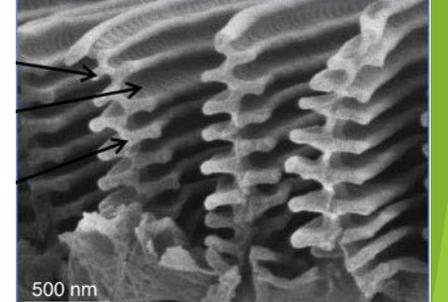
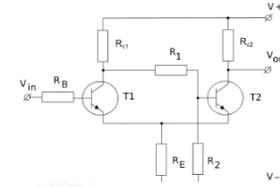
Pacemaker, In 1958, R. Elmqvist



Nokialainen kuumakoira 1960s

Nature from an engineer's perspective

- ▶ During the 1950s O. Schmitt developed the concept of "biomimetics"
- ▶ What's the point? Evolution uses a sort of "trial and error" method, if enough time (millions of years) is provided the most efficient form will evolve and survive
- ▶ Around the world this has been expressed in many different forms, nature is a vast treasure chest that we can learn from!
- ▶ In the arctic nature has developed own peculiarities that could be adopted and learned from! Possible candidates?
 - ▶ Adaptation of animals and plants to cold weather?



Motivation for the WAX project

- ▶ Why we are paying so much for refined berry products that are processed abroad? Couldn't we do it here in the arctic? What technical development and innovations this requires? In WAX project we try to answer these questions
- ▶ Currently, 97% of global wax production is based on paraffin (side product from petroleum industry), only 3% is natural waxes (e.g. Carnauba wax, beeswax, Candelilla wax). Natural wax properties are far superior to synthetic ones but they are much more expensive to produce!
- ▶ The appeal of "Pure arctic nature" should be better capitalized, what we think as a normal environment (meaning freezing, darkness) is exotic to foreigners



\$23.99/ 6 grams



EUR 41.63/100g



US \$28.76/100 g



Aims for the project

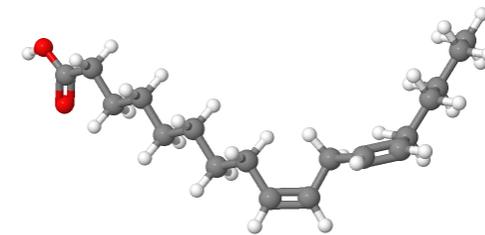
- ▶ Currently, much of the wild berry harvest is left to rot in the forests (it is estimated that only about 5% is picked of the annual harvest)
 - ▶ Promote sustainable growth and economic development based on arctic resources
 - ▶ Use environmentally sustainable, non toxic -processes to extract wax from industrial residues
 - ▶ Develop new ways to utilize the natural wax from our wild berries
 - ▶ Analyze what is different in the arctic wild berries and what biochemical and genetic processes are involved in berry ripening
 - ▶ Find ways to increase the value of the arctic resources and promote the local wild berries industry. It is not the best business to sell them as raw resource (compare paper industry, cellulose vs. paper).

- ▶ Problems: Really needs a multidisciplinary project (How to synergise technology, biochemistry, plant biology, business opportunities?)

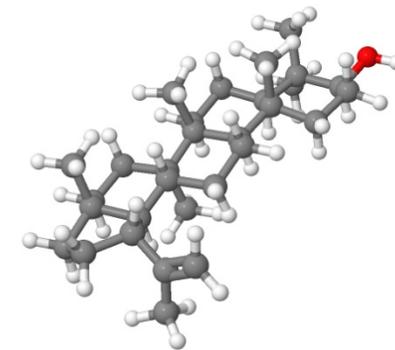
Compound
Levulinic acid
Benzoic acid
Octadecane
Lauric acid
Benzyl alcohol
(Z)-Cinnamic acid
Myristic acid (C14:0)
(E)-Cinnamic acid
Pentadecanoic acid (C15:0)
Azelaic acid
Palmitic acid (C16:0)
7-Hexadecenoic acid (C16:1)
Palmitoleic acid (C16:1)
Tricosane (C23)
Margaric acid (C17:0)
Stearic acid (C18:0)
Oleic acid (C18:1)
Elaidic acid (C18:1)
Linoleic acid (C18:2)
γ-Linolenic acid (C18:3)
Arachidic acid (C20:0)
11-Eicosenoic acid (C20:1)
Heptacosane
Heneicosanoic acid (C21:0)
Docosanal
Arachic alcohol (C20)
Behenic acid (C22:0)
Heneicosyl alcohol (C21)
Nonacosane
Tetracosanal
Lignoceric acid (C24:0)
Hentriacontane
Other
α-Tocopherol
Campesterol
β-Sitosterol
β-Amyrin
Unidentified triterpenoid
α-Amyrin
Lupeol
Lanosterol
Taraxasterol
Other
Total

Examples of interesting biochemicals contained in wild berries and leaves

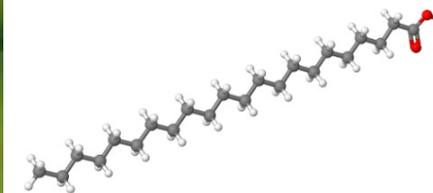
- 21 - 28% "Linoleic acid has become increasingly popular in the beauty products industry because of its beneficial properties on the skin. Research points to linoleic acid's anti-inflammatory, reductive, and moisture retentive properties when applied topically on the skin." [1]
- 25 - 27% " Gamma-Linoleic acid from primrose oil or other sources (blackcurrant oil) has a long-standing history of folk use for allergies. Women and children who are prone to allergies appear to have lower levels of GLA in breast milk and blood. However, there is no solid scientific evidence that taking GLA helps reduce allergy symptoms. More research is needed." [2]
- 6.68% " Lupeol has a complex pharmacology, displaying antiprotozoal, antimicrobial, anti-inflammatory, antitumor and chemopreventive properties." [3]
- 2% " Commercially, behenic acid is often used to give hair conditioners and moisturizers their smoothing properties." [4]



Linoleic acid



Lupeol molecule



Behenic acid

Taxus brevifolia



Hirudo medicinalis



Artemisia annua

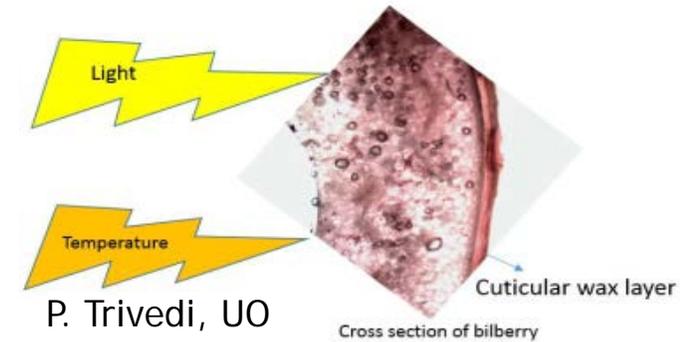


Silybum marianum



What we have learned so far

- ▶ The wild berry residue (pressed cakes) from food industry still contains valuable raw materials that can be extracted
- ▶ Development for wax based applications are underway. Potential customers: cosmetics, biocomposites, dietary supplements, biomedical compounds, food additives, packaging industry, optical coatings
- ▶ Analyzing the value chain from wild berry picking to end user (business and market opportunities analyzed by UOAS)
- ▶ We study how the light ("midnight sun") is affecting the berries. Phytochrome experimenting in NiBio Norway.
- ▶ Based on scientific analysis the genetic pathways how wax is formed in lingonberry is under study with preliminary results, it seems that berries grown in arctic have different composition of biochemicals than their southern counterparts.



Wax Biosynthesis

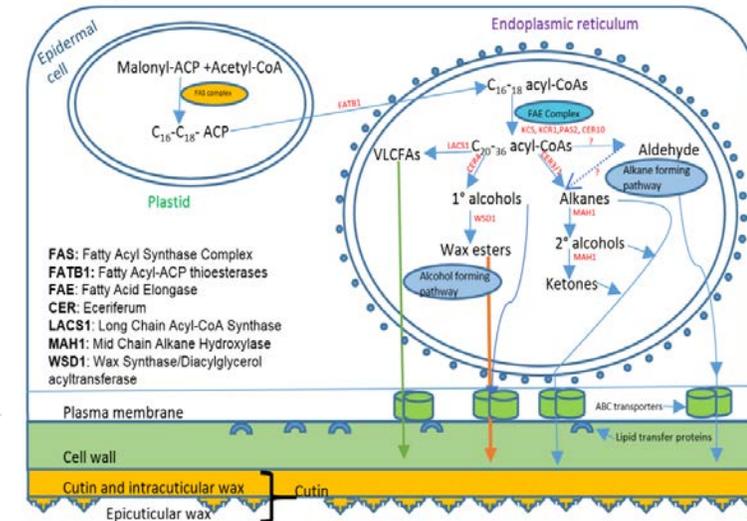


Fig 1: Wax biosynthetic pathway (Samuels et al., 2003; Joubès et al., 2013)

Conclusion

- ▶ It is possible to develop new high refinement value products from waste. In WAX project we are studying natural wax that the wild berries and leaves contain and we have successfully demonstrated an extraction process for this, further refinement of the process is underway. Furthermore, we study other applications (ideas, not innovations!) for wax including optics, packaging and coatings
- ▶ Products based on arctic nature have good marketing possibilities, these appeal to customers. Marketing studies in Europe are underway. It seems the we don't appreciate the Arctic nature enough (sort of snow blindness?) We should take better advantage of "Innovation" based on our arctic location, it sure is possible!

Thank you!



X-Ray picture of crowberry by Prof. Roberts Joffe from LTU

Wax project partners:

Lead Partner: Center of Microscopy and Nanotechnology and Genetics and Physiology Unit, University of Oulu, FINLAND

Business unit of Oulu University of Applied Science, FINLAND

Polymer Composite Materials research area, Department of Engineering Sciences and Mathematics, Luleå University of Technology, SWEDEN

Norwegian Institute of Bio economy Research (NIBIO) and Climate laboratory at Holt Trosnø, NORWAY

Co-operation with Riga University in Latvia

Industrial cooperation with cosmetic producers and berry industry