bio hub INFOSHEET

JANUARY 2018 | # 13

Storage Studies of Spruce Stumps

The experimental setup for spruce stump storage study was constructed May 20-21.2017. Researchers from Luke participated in the construction of the experimental setup. This study focuses on changes in the chemical composition of stump-root system and root-neck extractives during a storage period of 24 weeks. The main goal of the experiment is to provide information for the planning of feasible recovery logistics.

STUMPS ARE UNDERUTILIZED SOURCE OF BIOMASS

The forest industries use annually substantial amounts of wood resources in Finland and Sweden. As a result of this utilization the accumulation of harvesting and manufacturing by-products such as stumps, branches, and bark is significant.

Stumps are an underutilized source of renewable forest biomass, and are rich in their chemical composition in comparison to stemwood. The roots and stumps of Norway spruce are a vast source of biomass potentially containing many bioactive polyphenolic extractives [1].

However, this biomass is currently used for low-value energy production only. With existing harvesting techniques, roots and stumps could be utilized as a source of commercially valuable biochemicals. Latva-Mäenpää et al. (2014) found relatively high concentrations of lignans in the root neck of Norway spruce (approximately 10 % of total dry weight)[2].

Lignans have attracted much interest due to their broad range of biological activity [3]. Lignan 7-hydroxymatairesinol (HMR), has been stated to have a positive influence on preventing the development of breast, prostate and colon cancer [4]. Lignans also help to maintain good cardiovascular health and to moderate other estrogen dependent health problems (menopause, osteoporosis). Lignans and oligolignans are strong antioxidants and radical scavengers, however according to tests performed by Välimaa et al. (2007), these mechanisms are not directly associated with antimicrobial effects [5].

However, the content of extractives starts to decrease immediately after tree felling and this degradation continues throughout storage [6,7]. This also means that the chemical composition of the extractives-based fraction changes gradually. In order to utilize these valuable compounds as raw material for biorefining we need knowledge of their behavior during the supply chain.

WHAT HAPPENS TO CHEMICALS DURING STORAGE?

This study focuses on the changes in the chemical composition of spruce stumps. The stumps used in this experiment originated from the final felling and they were cut from 2- 4 pieces prior to building of the stump pile.

This setup will provide us with valuable information about the changes in extractives of stump-root system, both regarding the lipophilic and hydrophilic compounds. The composition of the valuable lignan fraction from the rootneck and the changes in lignan concentration will be studied closely.

FINAL FELLING STUMPS STORED FOR 6 MONTHS

Spruce stumps (*Picea abies*) were used for the study. The stumps orginated from the final felling and they were lifted right after the trees were felled. Stumps were cut from 2-4 pieces and subsequently a pile was constructed from the pieces (Figs. 1 and 2). Older stumps were placed on the bottom of the pile to prevent the fresh stumps touching the ground.

Figure 1. *Storage pile of spruce stumps. Photo taken 19.6.2017.*

Figure 2. Stump-root system.

Figure 3. Crushing of stump-root systems for sampling 22.5.2017.

Table 1. Sampling timetable. Unless otherwise stated, all the samples were taken during the same day.

Sample	Sampling date
0-sample from fresh stumps	22.5.2017
after 1 month of storage	19.6.2017 [1] & 21.6.2017 [2]
after 3 monts of storage	15.8.2017
after 6 months of storage	14.11.2017 [1] & 16.11.2017 [2]

1) Taking samples from crushed stump-root systems.

2) Taking "rootneck" samples and "rootneck heartwood" samples.

Figure 4. Crushed stump-root sample.

The sampling frequency was (in addition to the zero sample when establishing the experiment) after approximately 1, 3, and 6 months (Table 1).

During each sampling time 12 stump pieces were chosen for sampling. Three of the pieces were crushed as such (the stump-root system) (Figs. 3 and 4). Four of the pieces were cut according to Fig. 5a) to take sample from the "bottom" of the stump (so called root-neck area). Five pieces were first cut according to Fig. 5a) and then the "heartwood of rootneck" was separated according to 5b).

The sampling was originally designed based on the article by Latva-Mäenpää et al [2], but later it was modified to some extent in order to better serve the mechanical fractioning studies of this project, and possibly to better illustrate the situation that might actually be achieved in mechanical fractioning of this kind of material. Photos of the actual samples can be seen in Fig. 6

The samples originating from the crushed stump-root system were analyzed regarding the content and composition of both lipophilic and hydrophilic extractives (including lignans). From the other samples only lignan content and composition of this fraction was analyzed.

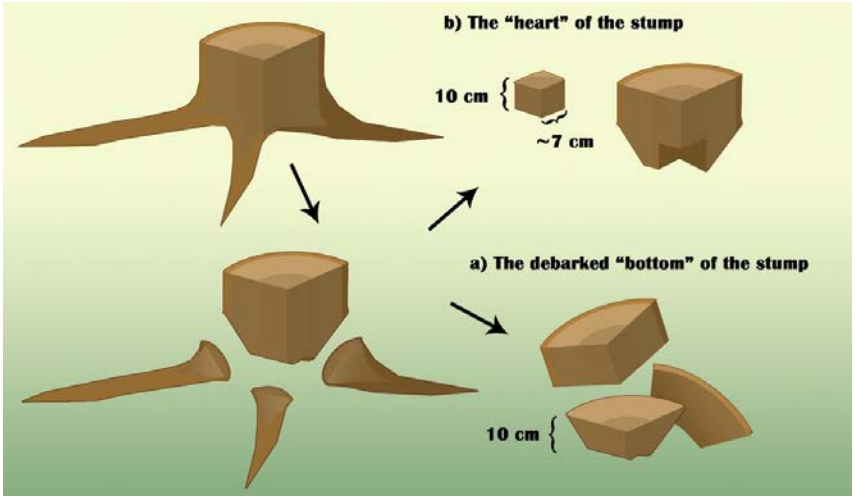

Figure 5. Taking a) rootneck samples and b) rootneck heartwood samples from stumps.

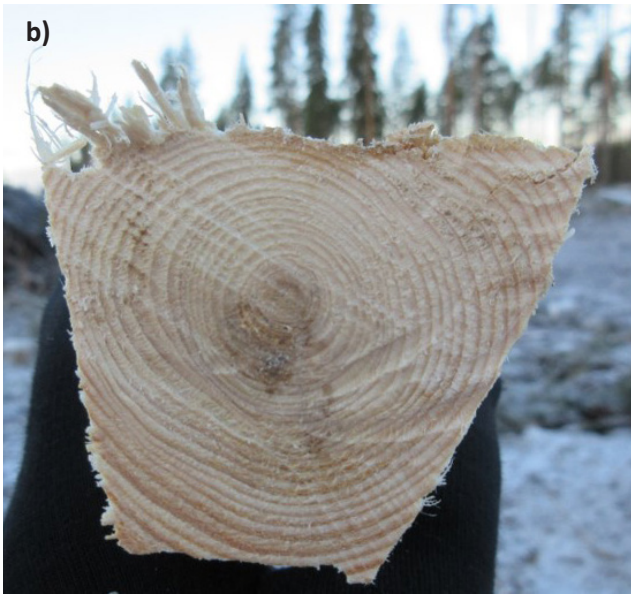

Figure 6.

a) Depending on a stump taken for sampling the sizes and shapes of rootneck samples varied a lot. Only the height of the samples was a variable that could be kept constant.

b) Rootneck heartwood sample.

c) Stump from which rootneck area has been sawn out.

SUMMARY

The roots and stumps of Norway spruce are containing many bioactive polyphenolic extractives. These high-value chemicals could be used in e.g. medicines and healts foods. Currently stumps and roots are for low-value energy production only. The content of extractives starts to decrease immediately after tree felling. In this study, the Spruce stumps originated from final felling and they were lifted right after felling the trees. Stumps were cut to 2-4 pieces and piled. Samples were taken from fresh stumps and then after 1, 3 and 6 months of storage. Three different samples were taken from the stumps. From these crushed samples, the content and composition of lipophilic and hydrophilic extractives (including lignans) were analysed

AUTHORS

Hanna Brännström, Juha Nurmi & Eelis Halmemies
Natural Resources Institute Finland (LUKE)
firstname.lastname@luke.fi

2018.01.08

References:

[1] Latva-Mäenpää, H. 2017. Bioactive and protective polyphenolics from roots and stumps of conifer trees (Norway spruce and Scots pine). Academic Dissertation. Chemistry Faculty of Science University of Helsinki Finland, p.74.

[2] Latva-Mäenpää H, Laakso T, Sarjala T, Wähälä K, Saranpää P. 2014. Root neck of Norway spruce as a source of bioactive lignans and stilbenes. Holzforschung;68(1):1–7.

[3] Välimaa A, Honkalampi-Hämäläinen U, Pietarinen S, Willför S, Holmbom B, von Wright A. 2007. Antimicrobial and cytotoxic knotwood extracts and related pure compounds and their effects on food-associated microorganisms. Int J Food Microbiol. 115(2), p. 235–243.

[4] Eklund PC, Willför SM, Smeds AI, Sundell FJ, Sjöholm RE, Holmbom BR. A new lariciresinol-type butyrolactone lignan derived from hydroxymatairesinol and its identification in spruce wood. J Nat Prod. 2004;67(6):927–931.

[5] Holmbom B. 2011. Extraction and utilization of non-structural wood and bark components. In: Alén R, ed. Biorefining of forest resources. Helsinki, Finland: Paperi ja Puu Oy, p. 178–224.

[6] Alén R (2000). Structure and chemical composition of wood. In P. Stenius (Ed.), Forest Products Chemistry). Fapet Oy: Helsinki, Finland, p. 12.

[7] Ekman R (2000). Resin during storage and in biological treatment, In E.L. Back, (Ed.); Pitch Control, Wood Resin and Deresination, Tappi Press: Atlanta, USA, pp. 37-76.

Interreg Botnia-Atlantica EUROPEAN UNION European Regional Development Fund
Österbottens förbund Pohjanmaan liitto
REGION VÄSTERBOTTEN
Landstinget Västernorrland