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# Norway spruce storage experiment

## - bark and knot composition under scrutiny

*Experimental setups for spruce bark and knot storage studies were constructed February 7 and May 29 2017 in Kälviä, Western Finland. Researchers from Luke and SeAMK participated in construction of experimental setups. This study focuses on changes in the chemical composition of bark and knots during a storage period of 24 weeks. The main aim of the experiment is to provide valuable knowledge to be used in biomaterial supply management.*

### VALUABLE BUT VOLATILE CHEMICALS

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

Tree bark and knots are abundant sources of useful extractives. For example the inner and outer bark of Norway spruce contains about 39 % and 25-34 % of extractives, respectively. This is a significant difference when compared to the 1.0-2.5 % of extractives found in spruce stem wood [1, 2].

The amount of extractable phenolic compounds in the heartwood of spruce knots can be close to 30 %, wet basis (w/w), but on average it is around 15 % (w/w) [3,4]. The amount of phenolic compounds in knot heartwood is usually 50–100 times that found in the stemwood. For this reason, these tree parts can be considered as attractive raw materials for the refining industry.

However, many initial extracts suitable for potential applications are rather volatile or chemically unstable. The content of extractives starts to decrease immediately after the tree is cut and this degradation continues during storage [5,6]. This also means that the chemical composition of the extractive-based fraction is constantly changing.

Having a general idea of the chemical composition of the wood material in each stage of the storage period can

***Figure 1.*** *Trees are being cut and the stems are delimbed and cross-cut.*

be a great benefit to the decision making regarding the raw material supply chain and logistics – thus, in order to value-optimize the raw materials.

## HOW CHEMICALS CHANGE DURING STORAGE?

This study focuses on changes in the chemical composition of spruce bark from saw logs and knots from pulpwood. Both the saw logs and pulpwood were stored undebarked during the study.

One of the main aims was to compare the results of this study to the results of the bark pile studies made in the previous project Forest Refine. If bark is stored this way, i.e., intact in the stem wood, it is possible that outer bark protects the inner bark to some extent from environmental conditions, such as precipitation and UV light.

It is known from literature that the content of hydrophilic compounds is greater in the inner bark compared to the outer bark [7]. Based on published studies we already know that the physical form of the biomass (e.g. particle size) greatly effects the rate of decomposition reactions of extractives [6].

Thus, the overall aim is to gain knowledge on how much the form of the storage effects the chemical composition of the stored spruce bark.

Another important aspect regarding this experimental setup is that we will gain knowledge on the behaviour of valuable spruce knot lignans during storage. The reaction mechanisms of lipophilic compounds during storage are well understood, whereas the decomposition reactions of phenolic extractives seems to be a less addressed topic in literature.

Thus, the main focus of these experiments is on the behavior of phenolic extractives compounds during storage. It needs to be pointed out that this is also the extractives fraction which includes the compounds that have truly valuable potential applications, i.e., in pharmaceuticals and as ingredients in functional foods and cosmetic products.

*Table 1. Sampling time table.*

| 1st experimental setup: winter time, sample | Sawlog [pcs] | Pulpwood [pcs] | Sampling date |
|---|---|---|---|
| 0-sample from fresh logs | 2 | 2 | 7.2.2017 |
| after 4 weeks of storage | 2 | 2 | 7.3.2017 |
| after 12 weeks of storage | 2 | 2 | 2.5.2017 |
| after 24 weeks of storage | 2 | 2 | 25.7.2017 |
| **2nd experimental setup: summer time, sample** | | | |
| 0-sample from fresh logs | 2 | 2 | 29.5.2017 |
| after 4 weeks of storage | 2 | 2 | 26.6.2017 |
| after 12 weeks of storage | 2 | 2 | 22.8.2017 |
| after 24 weeks of storage | 2 | 2 | 13.11.2017 |

## MATERIALS AND EXPERIMENTAL SETUP

Freshly felled saw logs and pulpwood of Norway spruce (*Picea abies*) were used for the study (Fig 1).Two different setups were established in order to study the effect of the season on the extractives and to their behavior during the storage (Table 1).

The following measurements were made for each tree used in the storage study: height of the tree, diameter at breast height, and age of the tree. Sample discs for calculation of tree ages were taken from the remaining stumps. The stems were bucked to approximately 4.5 m (saw logs) and 5.0 m (pulpwood). However, their exact lengths were measured as well. Diameters from the cut stems were measured at the butt end, the middle and the top of the stems. The results of these measurements will be presented together with the analysis results in a forthcoming info-sheet.

The stems of the storage study were placed on top of the tree trunks in such manner that they did not touch the ground during the storage period (Figs. 2 and 3). The idea was also to prevent them from being buried under the snow during winter, or covered by vegetation during

*Figure 2. Setup for the 1st single stem saw log storage study. The weather station can be seen in the background.*

summer. Weather station was placed in the location of the storage study. Temperature, precipitation, wind and UV radiation were measured by the weather station.

The knot samples for lignan analyses were taken from the three lowermost living branches of the pulpwood crown. The height of these branches from the bottom of the trunk were measured and their locations marked out prior to moving the stems on their place for storage study. Sample discs, including these knots, were sawn and the separation of the knots from the discs will be done at laboratory.

The sampling frequency was (in addition to a sample when establishing the experiment) after 4, 12, and 24 weeks (Table 1). Samples from two stems were taken at every sampling, both for the bark and for the knot extractives analysis.

For the bark samples three sample discs were cut from saw logs as shown in Fig. 4. The bark samples will be analyzed with respect to their extractives composition and contents. Carbohydrate analysis is performed for the fresh samples and for the samples after 24 weeks of storage. From the knot samples lignans will be analyzed.

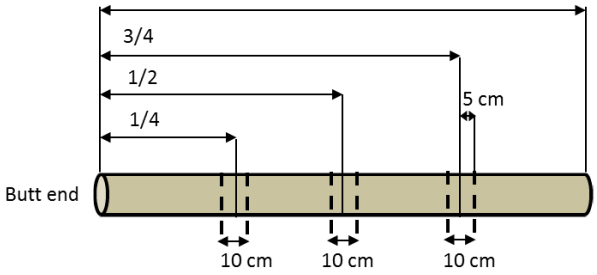


*Figure 4. Three sample discs were cut from saw logs for bark analysis. Separation of bark from the discs was done manually.*

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*Figure 3. Setup for the single stem pulpwood storage study.*

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