Decrease in Extractives of Tree Bark During Storage

Wood bark is a rich source of extractives. However, many initial extractives suitable for potential applications are either rather volatile or chemically unstable. This study focuses on changes in the chemical composition of industrial softwood and hardwood bark during storage of 24 weeks. The main goal is to provide information for the planning of feasible recovery processes

Introduction

The forest industries use annually substantial amounts of wood resources in Finland and Sweden. As a result of this utilization the formation of harvesting and manufacturing by-products such as stumps, branches, and bark is significant. For example, the accumulation of bark in Finland and Sweden was, respectively, 6.5 and about 7 million solid cubic meters in 2011. Bark is currently used mainly for producing heat and power. However, it is probable that a considerable amount of it could also be used for manufacturing various value-added products.

Bark contains 2-6 times more extractives than stem wood. For this reason, it can be considered a potential raw material for refining. However, many initial extracts suitable for potential applications are either rather volatile or chemically unstable. The content of extractives starts to decrease immediately after tree felling and this degradation continues during storage [1,2]. This also means that the chemical composition of the extractives-based fraction changes gradually. The present study focuses on changes in the chemical composition of industrial softwood and hardwood bark during a storage of 24 weeks.

Experimental set-up

The bark material from UPM Pietarsaari pulp mill consisted of mixed softwood (Pinus sylvestris and Picea abies) and hardwood (Betula pendula and B. pubescens) bark. One 150 m3 storage pile was designed for both materials. The sampling frequency was at the time of experiment initiation, 1, 2, 4, and 24 weeks of storage. Four different samples were taken at every sampling time, representing all areas of the pile. The samples were analyzed with respect to their extractives content. Subsequent Soxhlet extractions with two solvents (first with hexane and then with a mixture of acetone:water, 95:5 V:V) were conducted. The extractives in various groups were chromatographically (GC/FID) determined according to the method presented by Örså and Holmbom [3].

Results and Discussion

The total amount of softwood- and hardwood-derived extractives decreased notably and the chemical composition of this fraction changed during storage (Figs. 1-3). It was obvious that the pulp mill birch bark was not fresh based on the difference on the extractives content of the fresh reference birch bark and the BB0 sample (birch bark sample taken before storage). The biggest losses in birch bark extractives content had already occurred before wet-debarking the logs at the mill. Additionally, it is very likely that some water-soluble extractives compounds were lost during debarking. Pulp mill softwood bark seemed to be fresh bark material and biggest extractives losses occurred during the first week of storage. After that the gravimetric extractives amount did not decrease significantly. However, changes in the chemical composition were remarkable till the end of the storage experiment.

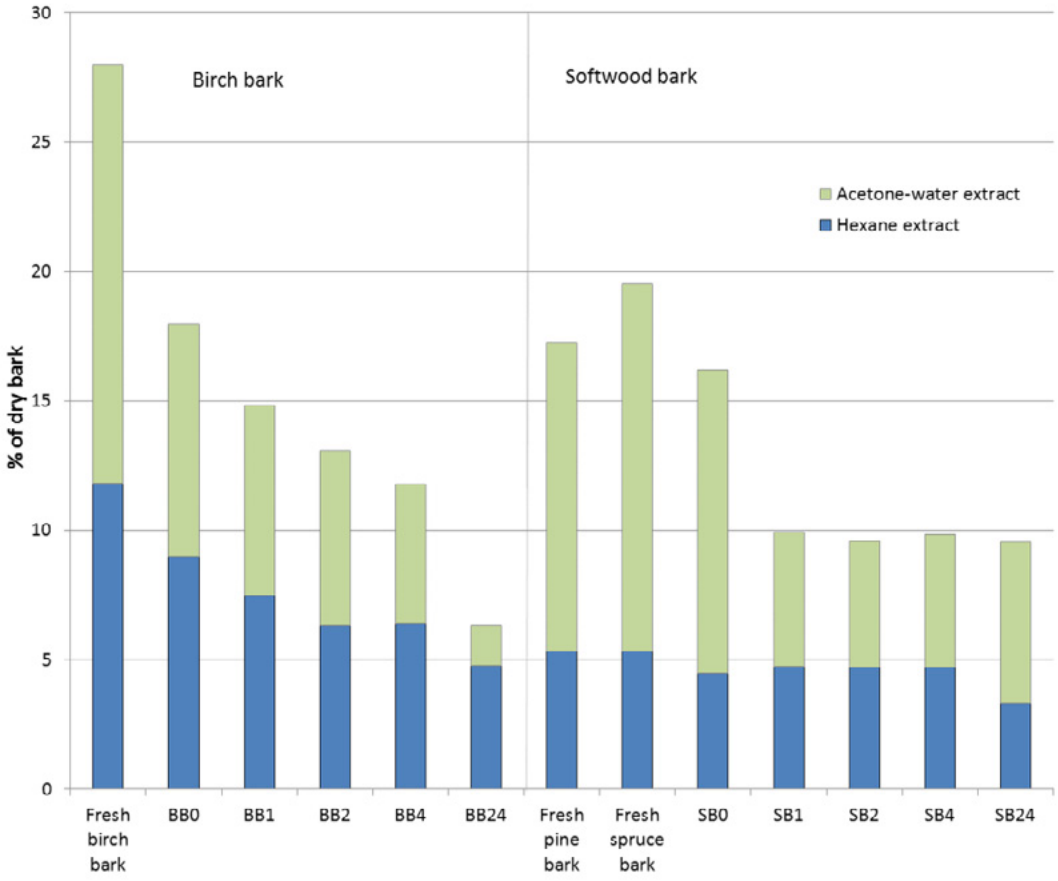

Figure 1. Gravimetric extractives amounts. Key: BB0 = birch bark sample taken before storage, BB1 = after 1 week, BB2 = after 2 weeks, BB4 = after 4 weeks, and BB24 = after 24 weeks. Similarly, SB0 = softwood bark sample taken before storage, SB1 = after 1 week, SB2 = after 2 weeks, SB4 = after 4 weeks, and SB24 = after 24 weeks. Fresh birch, pine, and spruce bark samples were used as references to determine the amount of extractives losses before and during the pulp mill wet debarking.

In the case of birch bark, not only the amount of tri- and diglycerides decreased but also the amounts of interesting compound groups, like lignans, decreased (Fig. 2). The amount of betulinol, the main extractives compound in birch bark, and other bioactive triterpenoids decreased significantly during the storage. It should be pointed out that, pentacyclic triterpenes of lupane structure (including betulin) exhibit e.g. the following remarkable bioactivities: bactericidal, antiviral, anti-inflammatory, cytotoxic and antitumoral [4] activities. Betulinic acid has proven antiviral activity towards type I human immunodeficiency virus (HIV). Thus they have potential to be used as raw material in valuable applications.

In the case of softwood pulp mill bark, similar trends were observed, not only the content of triglycerides and diglycerides were decreasing, but also the content of lignans decreased. Polyphenols, like lignans, have strong antioxidant activity, ability to block enzymatic processes, and to stop fungal growth [4]. They also contribute to antiseptic and antibacterial properties and have a positive incidence on product preservation be it cosmetics, foods or pharmaceuticals. 7-hydroxymatairesinol (HMR) has a retarding influence on the development of breast, prostate and colon cancer. Lignans also help to maintain good cardiovascular health and to moderate other estrogen dependent health problems, i.e.,menopause and osteoporosis.

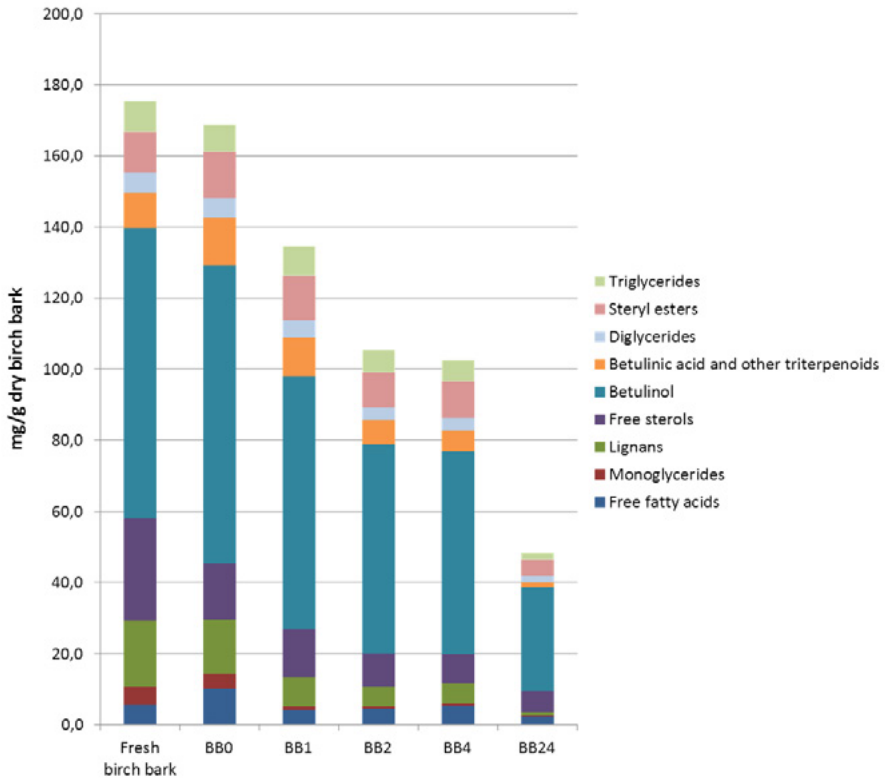

Figure 2. Extractives group analysis for birch bark. Key:
BB0 = birch bark sample taken before storage
BB1 = after 1 week
BB2 = after 2 weeks
BB4 = after 4 weeks
BB24 = after 24 weeks.

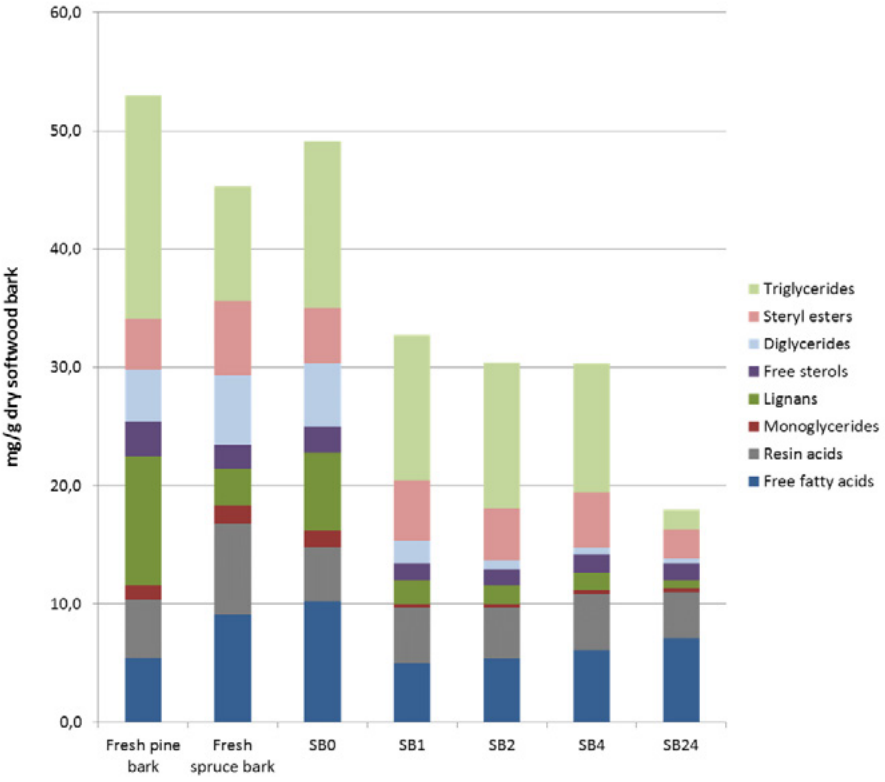

Figure 3. Extractives group analysis for softwood bark. Key:
SB0 = softwood bark sample taken before storage
SB1 = after 1 week
SB2 = after 2 weeks
SB4 = after 4 weeks
SB24 = after 24 weeks.

Conclusions

Specialty chemicals, as well as chemicals which can be used as intermediates for different products, have the potential of truly high value. Additionally, the demand of nature-derived ingredients for the replacement of synthetic chemicals is increasing and there is remarkable growth in the natural health product market in the developed countries.

Data on these general trends provided valuable information for the planning of feasible recovery processes. As the freshness of the feedstock seemed to be of major importance this fact should be taken into consideration in feed stock procurement and process concepts.

Literature

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