BIRCH BARK SUBERIN – POTENTIAL SOURCE OF VALUABLE COMPOUNDS

Bark represent a potential source of green chemicals and provides an attractive opportunity as feedstock for biorefining as it is readily available in very large quantities at the forest industry sites. Birch (Betula pendula) is an important species for pulp production in the Nordic countries. Birch pulp wood bolts contain about 3.4% outer bark which is a rich source of extractives and suberin. Suberin content of birch outer bark is 45% by weight. Suberin is of interest mainly because it constitutes an abundant source of ω-hydroxyfatty acids, α,ω-dicarboxylic acids and homologous mid-chain dihydroxy or epoxy derivatives that, apart from birch bark and cork oak bark, are not abundant in nature. The most interesting applications for suberin components that are being investigated involve their use in the synthesis of polymeric materials, polyols, polyurethanes, and polyesters. Other possible attractive applications presented for suberin monomers according to literature include e.g., applications in cosmetics industry.

INTRODUCTION

Forest industries produce huge quantities of barks that represent a potential source of green chemicals but which, at present, are mainly burned for energy production [1]. Silver birch is the dominant pulpwood species in Northern European countries, especially in Finland and Russia [2]. Birch logs contain about 3.4 % outer bark and about 8 % of inner bark [3,4]. A birch kraft pulp mill, with an annual pulp production of 400,000 ton/year generates about 28,000 ton of outer bark. Based on birch kraft pulp production figures, the total potential of birch outer bark in Finland can be estimated to be 200,000 ton/year.

Birch outer bark is a rich source of suberin. According to Holmbom [3] Silver birch outer bark is composed of about 40 % of extractives, 45 % suberin, 9 % lignin, 4 % hemicelluloses and 2 % cellulose. Among bark components the suberin hydroxy and epoxy derivatives of fatty acids, some of which are relatively rare in nature, may constitute interesting chemical precursors for many applications [2].

Suberinic ω-hydroxyfatty acids could be used in skin-care, anti-aging, hair-care, biodegradable plastics polyesters, individual chemicals for drug design, dietary supplements, anti-cholesterol, and anti-obesity products [5]. Whereas suberinic ω-acids salts could be used in special washing materials, shampoos, and hair care.

ANALYSIS OF SUBERIN FROM PULP MILL BIRCH BARK

Suberin was analyzed from wet debarked pulp mill birch bark consisting both inner and outer bark fractions. Sample collection took place right after debarking. Analysis was performed according to the method originally presented by Ekman and Eckerman [6]. Alkali hydrolysis was done to extractives-free bark sample to liberate the suberin monomers. From the hydrolyzate, sample for gas chromatographic analysis was prepared and qualitative analysis for the suberin monomers was performed (Fig. 1).

Cholesterol was used as internal standard and it was added to the sample prior to the hydrolysis. Peak areas in the figure give estimation of the relative amounts of the monomers formed in the hydrolysis.

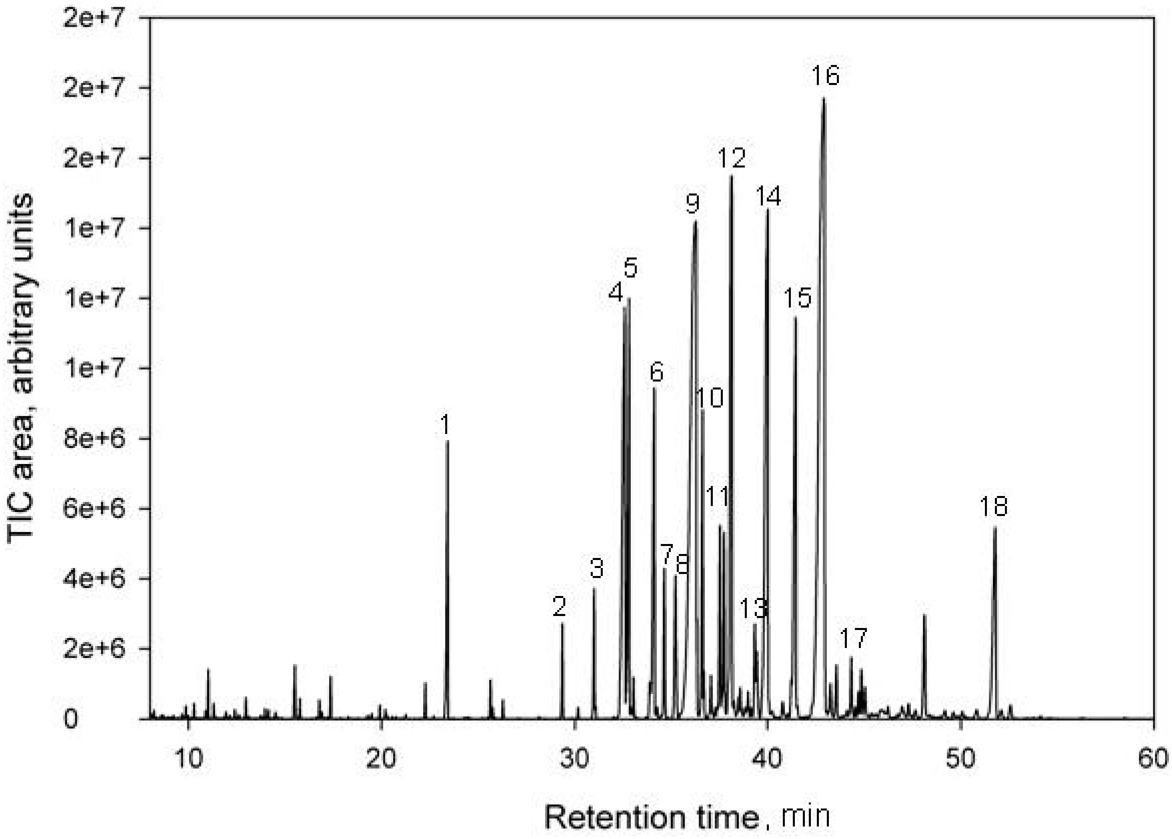

Figure 1. Gas chromatogram of the silylated compounds (suberin monomers and betulinol) from alkaline hydrolysis of wet debarked pulpmill birch bark. Main compounds identified with numbers: 1 = ferulic acid, 2 = 16-hydroxyhexadecanoic acid, 3 = hexadecane-1,16-dioic acid, 4 = 18-hydroxyoctadec-9-enoic acid, 5 = dihydroxyhexadecanoic acid, 6 = octadec-9-ene-1,18-dioic acid, 7 = octadecane-1,18-dioic acid, 8 = 9,18-dihydroxyoctadec-9-enoic acid, 9 = 9,10-epoxy-18-hydroxyoctadecanoic acid, 10 = 20-hydroxyeicosanoic acid, 11 = eicosene-1,20-dioic acid, 12 = eicosane-1,20-dioic acid, 13 = 22-hydroxydocosenoic acid, 14 = 22-hydroxydocosanoic acid, 15 = docosane-1,22-dioic acid, 16 = internal standard, cholesterol, 17 = tetracosane-1,24-dioic acid, 18 = betulinol

From the Fig. 1 it can be seen that the main monomers liberated in alkaline hydrolysis of suberin consist different ω-hydroxyfatty acids, α,ω-dicarboxylic acids and epoxy derivative, namely 9,10-epoxy-18-hydroxyoctadecanoic acid.

CONCLUSIONS

Commercial utilization of suberin requires more research. Literature presents many highly attractive applications e.g., in pharmaceuticals, cosmeceuticals and nutraceuticals which could potentially utilize suberin monomers. It can be concluded that suberin is a cheap renewable resource potentially available in very large amounts in birch bark.

Also, according to the previous research, industrial wet debarking did not cause any remarkable changes to the suberin [7]. This suggests that the pulp mill birch bark would be good material for production of suberin derived components.

Figure 2. Pile of pulp mill birch bark at UPM Pietarsaari mill. The sample for the analysis of suberin was taken right after the wet debarking. The pile in this photo was constructed for the storage experiment where changes in chemical and physical properties of the bark are monitored

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