

Short Communication:

Variation in chemical constituent of *Styrax sumatrana* wood growing at different cultivation site in North Sumatra, Indonesia

APRI HERI ISWANTO^{1,*}, YENNI SUHAIDA SIREGAR¹, ARIDA SUSILOWATI², ATMAWI DARWIS³,
RUDI HARTONO¹, BASUKI WIRJOSENTONO⁴, HENTI HENDALASTUTI RACHMAT⁵, ASEP HIDAYAT⁵,
WIDYA FATRIASARI⁶

¹Department of Forest Product, Faculty of Forestry, Universitas Sumatera Utara. Jl. Tri Dharma Ujung No 1, Kampus USU Padang Bulan, Medan, North Sumatra, Indonesia. Tel./fax.: +62-61-8220605. *email: apriheri@yahoo.com

²Department of Silviculture, Faculty of Forestry, Universitas Sumatera Utara. Jl. Tri Dharma Ujung No 1, Kampus USU Padang Bulan, Medan 20155, North Sumatra, Indonesia

³Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara. Jl. Tri Dharma Ujung No 1, Kampus USU Padang Bulan, Medan 20155, North Sumatra, Indonesia

⁴School of Life Sciences and Technology, Institut Teknologi Bandung. Gedung Labtex XI, Jalan Ganesha 10, Bandung 40132, West Java, Indonesia

⁵Forest Research and Development Center. Jl. Raya Gunung Batu No. 5, Bogor 16118, West Java, Indonesia

⁶Research Center for Biomaterials, Indonesian Institute of Sciences. Jl. Raya Jakarta-Bogor No.Km 46, Cibinong, Bogor 16911, West Java, Indonesia

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Abstract. Iswanto AH, Siregar YS, Susilowati A, Darwis A, Hartono R, Wirjosentono B, Rachmat HH, Hidayat A, Fatriasari W. 2019. Variation in chemical constituent of *Styrax sumatrana* wood growing at different cultivation site in North Sumatra, Indonesia. *Biodiversitas* 20: 448-452. Kemenyan Toba (*Styrax sumatrana*) is known as endemic resin-producing trees that naturally grow in North Sumatra and distributed throughout five districts within the province. Different growing site may constitute to different characteristics of the species, e.g. morphological differences, chemical constituent, bioactive substances, etc. Different characteristics of wood chemical constituent are an important factor determining further utilization and potential use of wood in wider spectrums. Information about wood chemical constituent of *Styrax sumatrana* growing from different site has not been determined yet. Therefore, the objective of this research was to analyze the characteristics of chemical constituent of *Styrax sumatrana* wood originated from North Tapanuli and Pakpak Bharat according to axial direction of stem (bottom, middle, and top). Chemical properties such as hollocelulose, α -cellulose, hemicellulose, Acid Soluble Lignin (ASL), acid insoluble lignin (AIL), and non-structural component (extractive content in ethanol benzene 1: 2 and ash content) were observed. Results showed that different growth location would yield in different wood chemical constituent. The wood chemical constituent from North Tapanuli and Pakpak Bharat were 52.72 and 69.80% (hollocelulose), 25.94 and 39.87% (α -cellulose), 26.78 and 29.92% (hemicellulose), 5.49 and 4.33% (Acid Soluble Lignin), 4.37 and 20.43% (Acid-Insoluble Lignin), 10.95 and 2.42% (extractive content), 1.37 and 0.8% for ash content.

Keywords: Chemical constituent, North Tapanuli, Pakpak Bharat, *Styrax sumatrana*

INTRODUCTION

Styrax sumatrana is one of the most popular resins originated from North Sumatra Province, Indonesia. Kemenyan trees grow naturally in North Sumatra and can be abundantly found in District of North Tapanuli, Humbang Hasundutan, Pakpak Bharat, Toba Samosir, and Dairi. Among those areas of distribution, North Tapanuli is known as the biggest producer of Kemenyan resin in North Sumatra. Resin produced by the species provides many uses such as materials for pharmaceuticals, preservatives, perfumes, cosmetics, aromatherapy, incense, and a mixture of clove cigarettes (Widyastuti 1989).

Previous study related to Kemenyan plants from North Sumatra have been carried out by several researchers. Iswanto et al. (2016), and Pasaribu et al. (2013) conducted a study of the physical and mechanical properties of Kemenyan wood. While the potency of its resin as anti-oxidant has been reported by Hidayat et al. (2018).

Furthermore, Kiswandono et al. (2016) carried out a study of cinnamic acid content of kemenyan resin originated from North Tapanuli, while study focusing on the phylogenetic study of kemenyan grown in North Sumatra has been reported by Susilowati et al. (2017a). Furthermore, the genetic structure of the endemic *Styrax sumatrana* has also been determined (Rachmat et al. 2017). The macrocutting technique as one of potential propagations for the species has also been reported (Susilowati et al. 2017b). Furthermore, researches on morphological aspect, flowering and fruiting phenology of kemenyan plant also have been reported (Kholibrina et al. 2018; Susilowati et al. 2018).

The genetic study of this species based on population origin showed that Humbang Hasundutan, North Tapanuli, and Pakpak Bharat own their unique haplotype (Rachmat et al. 2017). Field survey also indicated that there was morphological characteristic found between Kemenyan Toba growing at North Tapanuli, Humbang Hasundutan,

and Pakpak Bharat. However, information on chemical constituent of Kemenyan Toba growing in North Sumatra currently has not been available yet. Differences observed in their morphological character, and genetic identity may consider the reflection of different chemical composition from its wood. Study by Blankenhorn et al. (1983) found that growing site would affect the differences in chemical composition of poplar woods. Another result by Zhang et al. (2015) found out that chemical constituent of any particular wood is affected by several factors such as site origin and genetic identity. This study was conducted to fill in the gap for the information of chemical constituent of Kemenyan Toba wood based on its site origin.

Study on the variation of chemical constituent in certain wood is important especially for further use of the utilization of unproductive timber. When Kemenyan producing trees grow too old and no longer productive for its resin production, local people usually cut the trees and use the wood only for firewood. This is due to the lack of information of wood utilization and wood characteristics of this species (Pasaribu et al. 2013). Chemical properties of wood are needed as baseline knowledge for further or potential utilization of Kemenyan wood. The objective of this study was to analyze the chemical constituents of cell wall and extractive content of Kemenyan Toba wood cultivated in North Tapanuli and Pakpak Bharat.

MATERIALS AND METHODS

Materials

Samples were collected from Kemenyan Toba (*Styrax sumatrana*) tree originated from North Tapanuli and Pakpak Bharat District. Wood samples were ground into sawdust as seen in Figure 1.

Methods

Samples preparation

Kemenyan wood from bottom, middle and top position of the stem was ground into powder as shown in Figure 1. Afterward, the wood powder was measured its moisture content and this shall not be exceeding 14%. The methods for samples preparation were in accordance with TAPPI T 264 cm-07.

Analysis of wood chemical properties

Wood chemical analysis was observed based on cellulose, hemicellulose, lignin, and extractive content. The observation was conducted using previous research and standard. Lignin content was measured using Acid Lignin Insoluble (AIL) and Acid Soluble Lignin (ASL) analysis based on LAP NREL 003 standard. Holoellulose was analyzed based on Paper Trade J by Wise et al. (1946), while α -Cellulose analysis using CRC Press methods according to Rowell (2005). The extractive content was measured based on extractive content in (1: 2) Ethanol Benzene refers to TAPPI T 204 cm-97. The ash contents analysis according to TAPPI T 211 om-02. The observation data then classified refers to Anonim (1976) as shown in Table 1.



Figure 1. Kemenyan sawdust sample collected from North Tapanuli (above) and Pakpak Bharat Districts, North Sumatra, Indonesia (below)

Table 1. Chemical constituent of hardwood

| Chemical constituent | Classification | | |
|------------------------|----------------|--------|-------|
| | High | Middle | Low |
| Cellulose (%) | >45 | 40-44 | <40 |
| Lignin (%) | >33 | 18-32 | <18 |
| Pentosan (%) | >24 | 21-24 | <21 |
| Extractive content (%) | >3 | 2-3 | <2 |
| Ash content (%) | >6 | 0.22-6 | <0.22 |

RESULTS AND DISCUSSION

Wood chemical constituents

Acid Soluble Lignin (ASL) and Acid-Insoluble Lignin (AIL)

Lignin is one of the second largest substances in wood with a percentage ranging from 17 to 32% (Casey 1960). Fengel and Wegener (1984) stated that high lignin content is caused by low holocellulose content. The acid soluble lignin and acid insoluble lignin value of Kemenyan wood from North Tapanuli and Pakpak Bharat were shown in Figure 2.

Based on Figure 2, ASL and AIL content of Kemenyan wood have different value and trend between the site. According to the axial direction, ASL and AIL content of Kemenyan wood from Pakpak Bharat decreased from bottom to the top. Meanwhile, for kemenyan wood from North Tapanuli, it showed the opposite trend. The higher lignin content at the top position according to Fengel and Wegener (1984) is due to the fact that top of stem contains more early wood which contains more lignin and less cellulose when compared to latewood. The tendency of increasing lignin content at the top of stem was similar to research conducted by Yunanta et al. (2014) and Latib et al. (2014). According to Easty and Thompson (1991), Akiyama et al. (2005) that ASL content in hardwood ranged from 3 to 5%. Meanwhile, the AIL content of kemenyan wood in this study ranged between of 3.69 to 6.07%.

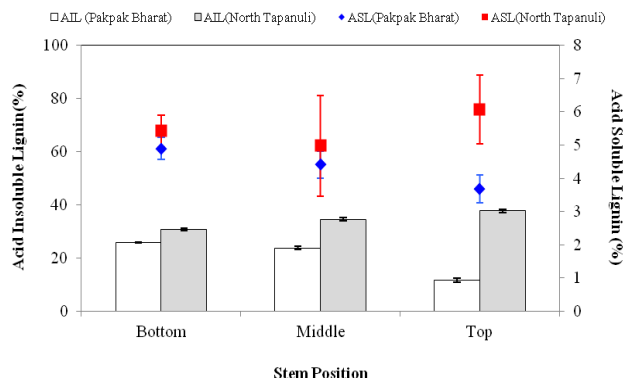


Figure 2. Lignin content of Kemenyan from North Tapanuli and Pakpak Bharat Districts, North Sumatra, Indonesia based on stem position

Lignin compounds have similar function with cellulose. It gives strength to cells because in wood these compounds are present in each layer of cell wall and middle lamella in the cell wall (Haygreen and Bowyer, 1982). According to Table 1, lignin content value of this study from Pakpak Bharat was 20% in the medium category and 34% in North Tapanuli meaning as in the high category. The lower content of lignin component from the sample originated from Pakpak Bharat might because of its landscape texture. Pakpak Bharat is much more mountainous and hilly. This finding was supported by previous statement from Stout et al. (2014) who stated that lignin slightly increased on the mountainous site compared to productive site.

Lignin content of plant was influenced by various factors. Poisa et al. (2011) stated that lignin content influenced by the interaction of various factors: when the samples were taken, the sowing period, the variety and the N-fertilizer rate application. Another research conducted by Boateng et al. (2006) also found that the genetic biomass plant background, the period when samples are taken and the growing environment, influence the lignin content in plants. Higher lignin component of Kemenyan Toba originated from North Tapanuli showed the prospective utilization of this wood as construction wood materials as that stated previously by Iswanto et al. (2016).

Holocellulose

The average of holocellulose content in this study was presented in Figure 3. Rowell (1984) stated that holocellulose is total polysaccharide contained in wood. Based on Figure 3, trend of holocellulose content increased from bottom to the top for Kemenyan Toba originated from North Tapanuli. Similar study also conducted by Latib et al. (2014). This higher of holocellulose content on the top position in stem was due to the low α -cellulose and high hemicellulose content. According to Panshin and Carl de Zeuw (1980) hemicellulose content of wood varied from 40 to 80%. Meanwhile, Rowell (2005) states that holocellulose in wood is generally 65-70% based on dry weight of wood. In this study, the average value of holocellulose from Pakpak Bharat was 69%, and North Tapanuli was 52%. The high level of holocellulose indicates that the yield of pulp production will be high.

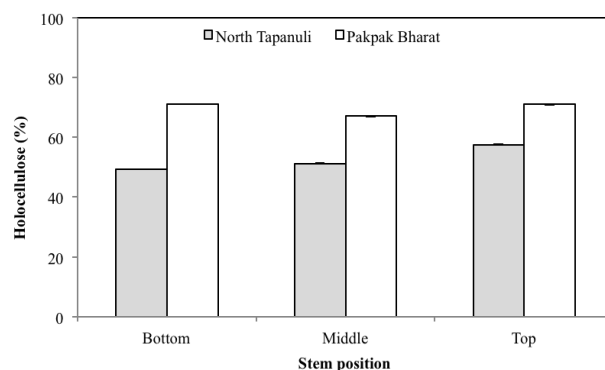


Figure 3. Holocellulose content of kemenyan from North Tapanuli and Pakpak Bharat Districts, North Sumatra, Indonesia based on stem position

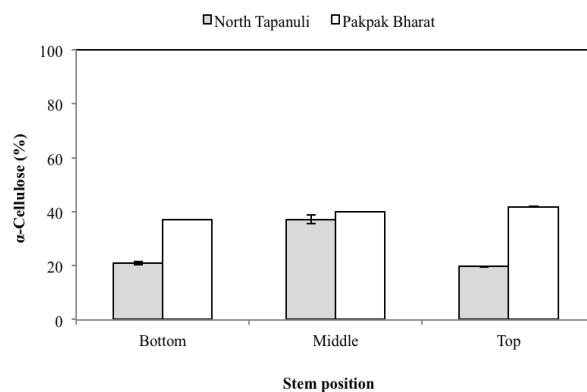


Figure 4. α -Cellulose content of kemenyan from North Tapanuli and Pakpak Bharat Districts, North Sumatra, Indonesia based on stem position

Alpha-Cellulose (α -Cellulose)

The average of α -Cellulose content in this study was presented in Figure 4. Alpha cellulose is insoluble cellulose in 17.5% NaOH solution, the basic material of alpha cellulose is glucose. Glucose molecules connect to each other to form molecular chains of cellulose (Dumanauw 1982). Based on Figure 4, the α -Cellulose content of Kemenyan wood from North Tapanuli was lower than Pakpak Bharat. Fengel and Wegener (1984) stated that generally, the alpha cellulose production depended on wood species and especially on the isolation and determination processes. According to Haygreen and Bowyer (1982), many factors cause variation in type, number, size, shape, physical structure, and chemical composition of wood elements. Sjöström (1981) stated that cellulose content ranges from 40 to 50%. Casey (1960) indicated that cellulose content in wood could be used to estimate the amount of pulp yield produced in the pulping process, where the greater of cellulose content in wood results in the greater of yield pulp. Overall, the average value of α -Cellulose from Pakpak Bharat was 39%, and North Tapanuli was 26%. Based on the obtained results, α -Cellulose content of Kemenyan wood from both locations was classified into low category.

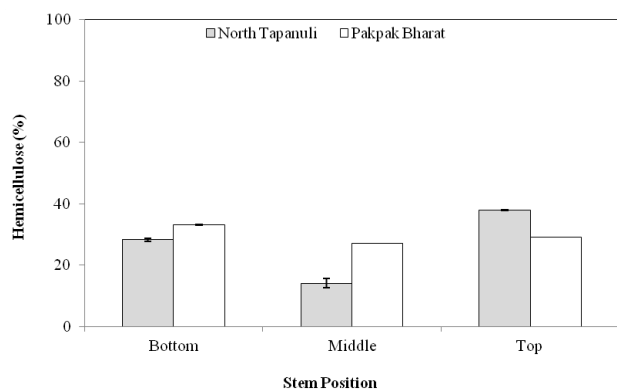


Figure 5. Hemicellulose content of kemenyan from North Tapanuli and Pakpak Bharat Districts, North Sumatra, Indonesia based on stem position

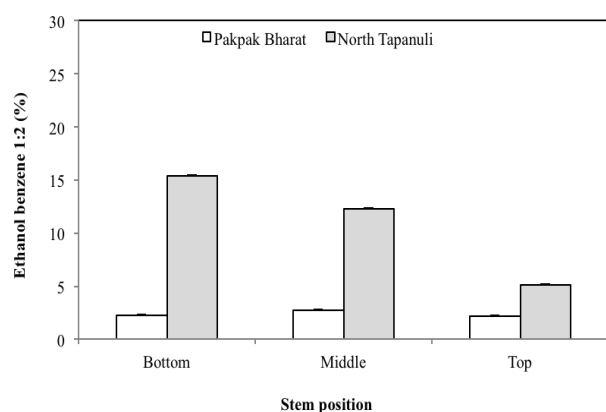


Figure 6. Extractive content in 1:2 ethanol benzene of kemenyan from North Tapanuli and Pakpak Bharat Districts, North Sumatra, Indonesia based on the stem position

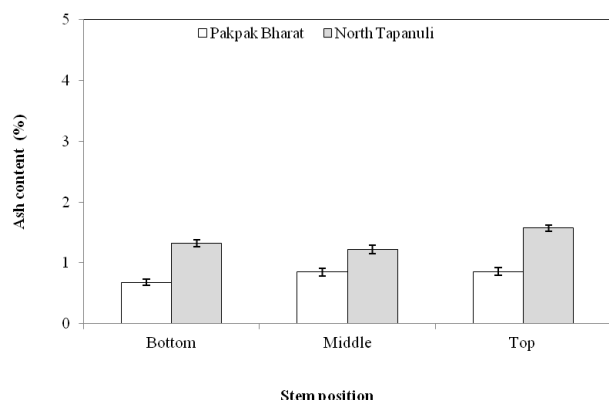


Figure 7. The ash content of kemenyan from North Tapanuli and Pakpak Bharat Districts, North Sumatra, Indonesia based on stem position.

Hemicellulose

The average of hemicellulose content in this research was shown in Figure 5. Hemicellulose is a low molecular

weight of polysaccharide found in the cell wall. Hemicellulose is different from cellulose because it has a shorter branch of molecular chain. Hemicellulose in hardwood is dominated by xylan with content from 25 to 35%, whereas softwood is dominated by mannan with content between 15 and 25% (Fengel and Wegener, 1984).

Based on Figure 5, the average value of hemicellulose from Pakpak Bharat was 29% and North Tapanuli was 26%. The value of hemicellulose content of Pakpak Bharat was higher than North Tapanuli, it was due to the higher content of holocellulose for that region. Based on axial direction of stem, it could be seen that hemicellulose content of middle part was smaller than others in both locations. The tendency of varying hemicellulose content in wood is relatively small and not the same as hemicellulose types. Since it is known as hardwood, the hemicellulose consisted of glucuronoxylan and glucomannan (Sjostrom, 1981).

Chemical constituents of non-structural wood

Extractive content in Ethanol Benzene

The average extractive content in this research was presented in Figure 6. According to Figure 6, the extraction value in 1:2 extraction of ethanol benzene, Kemenyan wood from North Tapanuli was higher than that of Pakpak Bharat. This could be also seen from color of wood test sample (Figure 1), Kemenyan wood from North Tapanuli had a reddish brown color. According to Tsoumis (1991), the extractive content varied not only in different species but also in the same tree with different stem positions. Overall the extractive content in 1:2 ethanol benzene of Pakpak Bharat was 2%, which was classified into medium while North Tapanuli was 10%, which was classified into high category.

Ash content

Ash materials show the content of inorganic materials of wood, which are remained after the burning process of organic matter. Ash could be traced due to the presence of unburned compounds containing elements like calcium, potassium, magnesium, manganese and silicon (Bowyer et al., 2003). The average of ash content in this research was presented in Figure 7.

According to Figure 7, the ash content of kemenyan from North Tapanuli is higher than that of Pakpak Bharat. Based on the stem position, ash content tended to increase from bottom to top. This possibility is due to the top position had a high portion of earlywood and sapwood. Sapwood is a living part of wood that is still carrying out physiological activities so that there are inorganic materials from the soil deposited in cell walls of sapwood (Yunanta et al., 2014). Overall, the average value of ash content for Pakpak Bharat was 0.7% and North Tapanuli was 1.37%. Based on the obtained results, Kemenyan wood from both areas classified into medium category.

Our research pointed out that, Kemenyan Toba originated from North Tapanuli has higher lignin, extractive and ash content compared to Kemenyan Toba from Pakpak Bharat. Meanwhile, higher content of alpha cellulose, hemicellulose, and holocellulose was produced in

that of Pakpak Bharat District. Based on their chemical constituent characteristics, Kemenyan Toba wood originated from North Tapanuli was good to be utilized as light construction materials while that originated from Pakpak Barat was good for pulp and paper raw materials.

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