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Yield and Components of Pine (*Pinus merkusii*) Turpentine Among Age Class Differences Tapping by Borehole Method

Agus Sukarno[1]*, Anisa Zairina[1], Yani Quarta[1], Risca Kurniasari[2], Sumardi[1] and Amin Setyo Leksono[3]

[1]Faculty of Forestry, Malang Agriculture University, Malang, Indonesia;
[2]Faculty of Agriculture, Malang Agriculture University, Malang, Indonesia;
[3]Faculty of Mathemathics and Natural Sciences, Brawijaya University, Malang, Indonesia
*Corresponding author: Agus Sukarno, email sukarnoagus59@gmail.com

Abstract

Tapping pine oleoresin using the borehole method produces clean oleoresin, so that the yield of turpentine increases. Turpentine produced by the oleoresin processing manufactory, raw materials come from several age classes of pine. This study aims to determine the yield and component of turpentine derived from tapping the oleoresin using the borehole method. The research was conducted in the Batu production forest area, East Java, Indonesia. A total of 150 pine trees for each age class IV, V and VI were sampled from each plot. Drill bit size using a 16 mm, and oleoresin drilling is done in the morning. Furthermore, the oleoresin that comes out is accommodated using a plastic bag for two days. Oleoresin pine is then distilled with temperatures of 160-180oC. The average yield of turpentine derived from pine age class IV was 19.52%, age class V was 19.93% and age class VI was 20.94%. Turpentine component was analyzed using Gas Chromatography MS to determine its content. The results of the analysis showed that the component of turpentine which had a large percentage in each age class consisted of, α-pinene, β-pinene, limonene, trans-2 carena, α-terpinolene, *benzenemethanol* and trans-pinocarveol. However, β-pinene was not found in the age of class VI and trans-2 carena was not found in the age of class IV.

Keywords: age class pine, turpentine, borehole method, alpha pinen

INTRODUCTION

Oleoresin pine (*Pinus merkusii* Jungh et de Vriese), is a raw material for producing gum rosin and turpentine. Recently, the gum rosin and turpentine, have been widely used in idustry for various purposes such as coating material for release control fertilizer, rubber solvent in the manufacture of plastics, and manufacturing of paper, paint, soap and printing ink. China is the world's fourth largest gum rosin user and exporter as an industrial material for paints, drugs, antiseptics and varnishes. Turpentine is used as a solvent for organic oil and industrial polish, oil paint and the manufacture of synthetic camphor [1]. If it is produced as a derivative, it will have a higher selling value. Indonesia is a gum rosin and turpentine exported to several countries, including India, the United States, France, Cameroon and the Netherlands

The area of pine plantations in Java is 476,126 ha, ranked second after Teak, which covers an area of 1,074,270 ha [2]. The role of pine forests, both of timber and non-timber forest products, is now increasingly important. Attention to pine, initially aimed at efforts to improve the shape of the trunk which is generally bent crooked. These efforts have borne fruit through tree improvement activities at Seedling Seed Orchard Sempolan Jember. Along with the increasing role of the oleoresin, the current concern is the non-wood product, the oleoresin, because it has a high economic value. Perum Perhutani since 2012 has been expanding pine plantations with high oleoresin production [3]. Oleoresin pine production is influenced by genetic factors, meaning that not always large-sized trees have a lot of oleoresin, there were also trees that were smaller in size but high in oleoresin production [4].

Tapping oleorein pine which has been done so far using the quare method, this method was chosen because operationally the implementation is easy and does not require expensive costs. However, the resulting oleoresin is mixed with various kinds of dirt and wounds tapping wide. Dirty oleoresin, has implications for low yield, because a lot of material is lost. At the time of cooking the oleoresin, it is necessary to clean the dirt repeatedly, the dirty oleoresin will also affect the quality of the gum rosin and turpentine associated with indicators of

Correspondence address:
Agus Sukarno
Email : sukarnoagus59@gmail.com
Address : Faculty of Forestry, Malang Agriculture University, Malang, Indonesia

impurities. Wide tapping wounds will have an impact on the declining quality of the wood so that the selling value of wood at the end of the cycle is low and when there is strong winds the tree can easily collapse. In order to obtain clean oleoresin and the wood does not collapse easily, the tapping of pine resin is carried out using a drill, so that the tapping wounds were small [5].

The turpentine produced so far has been produced by the Perum Perhutani gum rosin and turpentine processing manufactory (PGT), the raw material comes from the oleoresin obtained from various age classes of pine as well as various regions of pine origin. Research on the specific yield and content of turpentine originating from each of the pine age classes, is currently never conducted. Is the oleoresin derived from pine trees with different age classes, there were differences in yield and turpentine content. Information about the content of turpentine is very important, because it is needed specifically as an industrial material. The content of turpentine such as α-pinene, β-pinene, delta caren and limonene, is actually found in the young age class or in the old age class, this information also has no definitive information. This research is expected to find out the turpentine content in each pine age class.

The purpose of this study was to determine the yield and components of turpentine in different age classes of pine through tapping the oleoresin by means of a borehole method.

MATERIAL AND METHOD

Pine samplings were conducted in the Batu production forest area, East Java, Indonesia with a height of 1,250 m above sea level, geographical location 7°55' S - 112°31' E forest area 11.7 ha. The study was conducted from April to October 2019.

The tools used during the research, consisted of: crank drill, drill bit size 16 mm, PVC pipe, plastic bag, 6 kg capacity electric scales, distillation equipment, 250 mm measuring cup, camera, Gas Cromatography-MS QP-2010S / Shimadzu, stationery. The research objects were pine trees of age class IV (2001 planting year, 18 years old), age class V (1995 planting year, 24 years old) and age class VI (1990 planting year, 29 years old). The 150 trees of each age class were sampled randomly as many as

a. Oleoresin tapping

The oleoresin tapping using a drill with a drill bit size of 16 mm [6]. The oleoresin that comes out, directly flowed through the guttering from the PVC pipe into a plastic bag. The oleoresin was collected two days after tapping.

b. Oleoresin processing

The oleoresin obtained was then transferred to a laboratory. The samples were distilled to find out the yield of turpentine. The amount of oleoresin needed to meet the capacity of the device was 1400 gr. Distillations were done using a direct heating method with temperature range 160° to 180°C. The turpentine pro-duced was then stored in a measuring cup.

The observations in this study consisted of the yield of turpentine and turpentine content. The yield of turpentine coming out of the distillation instrument was accommodated in a measuring cup, so that the volume can be detected directly. Turpentine was on top, while the water was at the bottom because the specific gravity of the water was greater than turpentine. Observation of turpentine content, through a chromatogram printed on GC-MS. The turpentine content that was observed was only a large percentage.

Statistical analysis

Analysis of turpentine yield using a completely randomized design (CRD), if there were differences between treatments, will be followed by a 5% LSD test. Analysis of turpentine component using Gas Chromatography Mas-spectrometry, conducted in the chemical laboratory of the Faculty of Mathematics and Natural Sciences, Brawijaya University.

RESULT AND DISCUSSION

Yield Turpentine

Yield (%) was the ratio of the final result of the amount of raw material minus the material after going through the cooking process. The results of the analysis of variance showed that there was a difference between the yield of pine age classes. The results of the distillation of sap, obtained a yield of turpentine for the age class IV (19.52%), age class V (19.93%), while the age class VI (20.94%), as presented in **Figure 1**.

Figure 1. Yield of turpentine in the age class IV, V and VI.

LSD test results of 5% yield of turpentine for age class IV, age class V have the same potential, whereas with age class VI there were significant differences (Table 1).

Table 1. Average yield of turpentine

No	Yield	Average
1.	Age class IV	19,52a
2.	Age class V	19,93a
3.	Age class VI	20,94b

Note: A number followed by the same letter do not differ at the test level LSD 5%

Age class VI was the range between age 26 to 30 years, so that pine at that age, in this study produced the highest yield, when compared with age class IV and age class V. Water content in turpentine of the three age classes, namely IV, V and VI this was very low at less than 5 ml, this was presumably because the tapping time of the oleoresin was carried out in the dry season. The second factor is, cooking the oleoresin was done 10 days after tapping, so that the water content in the oleoresin has evaporated. These results also show a greater range than the yield of turpentine produced by the gum rosin and turpentine processing manufactory (PGT). The yield of turpentine produced by PGT Rejowinangun Trenggalek in 2010 was 13.4%, PGT Garahan Jember in 2010 was 13.2%, while the standard set by Perum Perhutani was 12% [7]. This difference was presumably due to the oleoresin processed at the plant originating from the sap of tapping the sap by quare which conditions were mixed with various kinds of impurities such as pine leaves, bark chips, insects and other materials that follow. If tapping was done during the rainy season, the oleoresin was mixed with water. The processing of the oleoresin in the factory, so that the sap was ready to be cooked, needs to be filtered repeatedly, filtering rough materials and fine materials, then in the final stage washing the sap. The process makes the raw materials reduced a lot. This causes the yield produced by the factory to be lower. Actually the results of the sap through tapping by quare can be clean, but it needs an additional cover on the oleoresin container so that the dirt does not enter into it.

The oleoresin that was produced through the drilling of the sap by means of a drill, the sap that comes out of the tree was directly flowed through the PVC to the plastic bag, so that the condition was clean (without mixing dirt). The sap material according to the requirements, no longer requires filtering, so it can be cooked immediately. The results of pine resin yields originated from West Sumatra was reported ranged from 22-27% [8]. The oleoresin before being distilled was stored first in a place made of aluminum-plastic material. The factors that influence the yield include, how to distillate, time of research, the biophysical condition of the tree, the treatment of the material to be distilled [8].

Components Turpentine

The results of the turpentine component analysis using GC-MS, were successively detected on chromatograms that turpentine originating from age of IV class was 25 peaks, age class V was 28 peaks and age class VI was 25 peaks (**Figure 2**). Details of the turpentine component on the chromatogram that were known by name and the percentage were quite large from each age class as presented in Table 2.

Table 2 showed that turpentine has different component among the pine age classes. The α-pinene and limonene components were found in the three observed age classes, the highest α-pinene in the V age class was 15.4%, the highest limonene in the age class IV was 5.2%. This showed that α-pinene, and limonene were the main ingredients because they were always present in turpentine, both in the age classes IV, V and VI. The next component found was β-pinena, but in the age class VI the β-pinena component was not found, the highest content in age class V was 12.7%. Carena trans-2 components were found in turpentine age class V and VI. Carena trans-2 components were present in small amounts at 2.47%. Another component found was α-terpinole with a large enough amount of 32.7% in age class IV and 37.0% in age class VI. The difference in the content of turpentine, might be caused by several factors, including the age of the tree and the season when the sap was taken, but also from the pine tree species [9].

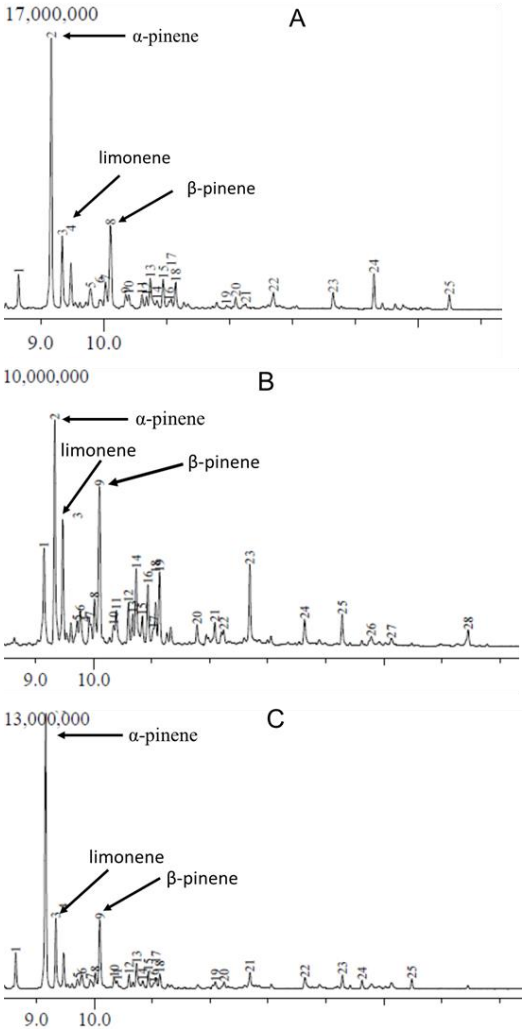

Figure 2. Cromatogram components turpentine of each age class A) class IV, B) class IV, C) class V

The results of the research by Sukarno [4], of turpentine originating from Aceh's provenance pines (Takengon, Blangkejeren, Jantho) and Jember land race pines, the main constituent components include α-pinene (73.3-87.2%) and Δ 3 carenes (7.3-19.3%) [2]. Components in small amounts consist of β-pinene, champene, myrcene, sabinene and limonene. The main content of turpentine in Pinus sylvestris found in needles and wood was α-pinena 3-carene, needles contain a concentration of monoterpenes five times higher than that of wood [10]. The components of sabinene was not present in turpentine originating from the pine race in the Jember and Blangkejeren and limonene fields not in the province of Aceh (Takengon) [4]. The main content of Pinus sylvestris L derived from Denizhi Turkey was α-pinena, β-pinena, champhene, longifolene, Δ 3 carene, limonene and β-caryophyllene [11]. The main content of Pinus merkusii turpentine from Sumatra and Java consists of α-pinene, Δ 3 carene and β-pinena [12].

Table. 2. The components of each age class

Component	Age of Class IV %(R.time)	Age of Class V %(R.time)	Age of Class VI %(R.time)
α-pinena	8.2(9.3)	15.4(9.3)	9.8(9.3)
β-pinena	11.5(10.1)	12.7(10.1)	-
Limonena	5.2(9.5)	1.5(9.9)	4.9(9.5)
Trans-2 carena	-	2.5(10.3)	1.8(10.5)
α-terpinolene	32.7(9.2)	7.9(9.2)	37.0(9.2)
Benzenemethanol	4.3(10.7)	6.2(10.7)	4.2(10.7)
Trans-Pinocarveol	3.51(10.0)	3.31(10.0)	2.3(10.0)

The benefits of turpentine were initially only as paint thinners, so the price was cheap [13]. Currently the use of turpentine has changed, namely in the form of derivatives for various uses. The combination of α-pinena and β-pinena was needed as an adhesive (transparent tape). Components of α-pinena and champena were needed for the manufacture of pesticides and diseases (insecticides). The α-pinene content was also needed for the manufacture of synthetic scents, such as orange flavor, nutmeg, menthol and cosmetic cooling effects (lipstick). Furthermore Terpineol was the result of the synthesis of α-pinene which was a material that can be used as a chemical for cosmetics industry mixtures such as perfume, pesticide industry as an anti-fungi and insects [14]. Terpineol can also be used as a shampoo and soap industry and household products such as cleaners and detergents.

CONCLUSION

Based on the objectives and stages of the study it can be concluded:

1. The average yield of pine turpentine of age class IV was 19.52%, age class V was 19.94% and age class VI was 20.94%.
2. Turpentine components found consisted of, α-pinene and limonene found in all age classes observed, while β-pinene was not found in the age class VI. The other content consists of trans-2 carena, *benzenemethanol* and trans-pinocarveol. The α-terpinole content was found in large quantities in the range of 37%

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