Characterization

by . Syahidah

IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

Characterization of the polarity of cempedak wood extractive (*Artocarpus integer* (Thunb) Merr.

To cite this article: Syahidah and Djamal Sanusi 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **575** 012127

IOP Conf. Series: Earth and Environmental Science **575** (2020) 012127 doi:10.1088/1755-1315/575/1/012127

Characterization of the polarity of cempedak wood extractive (*Artocarpus integer* (Thunb) Merr.

Syahidah and Djamal Sanusi

Forest Product Utilization and Processing Lab., Faculty of Forestry, Hasanuddin University

Email: syahidah@unhas.ac.id

Abstract. Recently, timber utilization originating from community forests has become an alternative to replacing commercial timber species from natural forests. The utilization efficiency of the wood must be in accordance with their basic properties, such as the extractive content, which greatly affects the natural durability of wood. Extractive content is compounds that can be extracted using polar and non-polar solvents. *Cempedak* wood (*Artocarpus integer* (Thunb) Merr is one type of wood from community forests, which is commonly found in South Sulawesi with various uses. The aim of this study is to analyze the polarity of extractive compounds of *cempedak* wood. The parameters measured in this study, namely extractive compounds, including tannin, polyphenols, and flavonoid from the n-hexane and methanol extracts. The results show that the extractive content of *cempedak* wood is classified as high (12.16%), the solubility of extractive content in polar solvents (methanol, 11.07%) is higher compared to the solubility in non-polar solvents (n-hexane, 1.09%). The highest levels of tannin, flavonoids, and polyphenols sequentially were found in the fraction of sapwood residue, butanol heartwood fraction and sapwood fraction. Therefore it can be concluded that the extractive content of *cempedak* wood is dominated by polar compounds.

1. Introduction

Wood is used for various purposes, not only for interior purposes but also for exterior purposes. Utilization of wood must pay attention to its nature, including chemical components and durability, because both of these properties play an important interaction [1]. Nowadays, the ability of natural forests to produce timber is decreased while the population tends to increase. The lack of wood supply from natural forests opens up opportunities for wood coming from community forests as an alternative to replacing commercial wood species like Teak [2] and Mahogany [3]. It is important to develop knowledge about the type of wood and its basic properties. Determination of the properties and chemical compounds of wood is one of the basic research about the utilization of wood [4–6]. Extractive content is non-structural parts of the wood that can be extracted using polar and non-polar solvents. The role of extractive content in wood, such as a natural color, odor, and durability of wood. Because the presence of extractive content can be affected by the woodworking process, knowledge about these compounds is important to find out the manufacture and utilization of wood appropriately. Extractive content can influence the gluing process in the plywood, fiberboard, particleboard, and pulp and paper industries. The resistance and durability of wood against deterioration organisms can be determined by analysis of the percentage of polar and non-polar extractive compounds in wood. Extractive substances that were classified polar compounds such as tannins, flavonoids, lignin, stilbene, and tropolone while extractive substances that were classified non-polar compounds such as fats, waxes, and resins [7].

Community forest wood has become an alternative to supply raw materials for the community and timber industry, in line with reduced wood supply from natural forests. One of the obstacles in using wood from community forests is the quality of wood varies greatly, and users often facing difficulties in choosing the species to be used. *Cempedak* wood is one of the wood species originating from community forests that are mostly found in South Sulawesi. This plant is fruit-producing plants and has used in traditional medicine such as hypertension, diabetes, and other diseases [8].

As explained previously, the polar and non-polar components of wood extractives affect the natural durability of wood against wood-deterioration organisms, so it is important to conduct a research on the analysis of polar and non-polar wood extractive. By knowing the percentage of polar and non-polar extractive content of wood, it can be considered in determining the appropriate use of wood.

2. Materials and Method

2.1. Materials Preparation

A 39-year-old tree with a diameter of 32 cm has been cut and taken the base of the tree, then cut into small pieces, made into powder with a size of 40-60 mesh. Prior extraction, the powder is dried and obtained the water content. The solvents used were n-hexane, 90% methanol, dichloromethane, Na_2SO4, 10% Na_2CO_3, HCL and butanol, ethanol, Folin Denis, NaOH, 10% $AlCl_3$.

2.2. Determination of Extractive content

This method referred to Lukmandaru (2012) [9] with some modifications. Lukmandaru used the powder as much as 2 g equivalent of the oven-dry weight, extracted for 6 hours, then the extract dried in an oven (± 100 ^oC). In this study, a wood powder used equivalent to 100 g of the oven-dry weight, extracted with n-hexane and 90% methanol as a solvent sequentially by the maceration method. Each extraction was carried out for three days. The extractive content was determined by removing the solvent. Then the extract was dried in an oven at 45^{o}C for 24 hours and then weighed. A total of extractive content is obtained from the amount of extractive content dissolved in n-hexane and methanol solvents.

2.3. Determination of Tanin Levels

The extract weighed ± 0.1 g, dissolved with 100 ml of distilled water, then put into a measuring flask and added distilled water to a volume of 10 ml. As much as 1.0 ml sample pipette, put into 10 ml measuring flask, Folin Denis reagent 0.5 ml of was added, allowed to stand for 3 minutes, 1.0 ml of Na_2CO_3 was added, calculated using standard curves so that the concentration of the sample is known. Further is blank solution preparation aims to neutralize. The solution preparation by added 0.5 ml Folin Denis reagent and 1.0 ml of Na_2CO_3, put into the measuring flask, then adding distilled water until it reaches 10 ml [10].

2.4. *Determination of Polyphenol Levels*

The extract weighed as much as 0.1 g dissolved in 100 ml of methanol, then 0.05 ml of solution pipetted, put in 10 ml measuring flask, added as much as 2.5 ml Folin Denis reagent and NaOH 2 ml then added distilled water to reach a volume of 10 ml. Further, a blank solution was made using 2.5 ml of Folin Denis reagent and 2 ml of NaOH in a 10 ml measuring flask, using distilled water to reach the sufficient volume [11]

IOP Conf. Series: Earth and Environmental Science **575** (2020) 012127 doi:10.1088/1755-1315/575/1/012127

2.5. *Determination of Flavonoid*

The extract was dissolved in 100 ml of ethanol solvent, then 1.0 ml solution pipetted, put into 10 ml measuring flask, added 100 ml CH_3COONa, and 100 ml $AlCl_3$, added distilled water to reach sufficient volume of flask. Furthermore, a blank solution was made using 200 ml CH_3COONa and 200 ml $AlCl_3$ to reach a sufficient volume of measuring flask using distilled water [12].

3. Result and discussion

3.1. Total Extractive Content

The number of extractive compounds dissolved in the n-hexane solvent was 1.09%. The solubility value of the dissolved extractive compound in methanol solvent was 5.47% in the sapwood section and 5.60% in the heartwood with a total extractive substance of 11.07%. These results are consistent with Sayuti's opinion (2017) [13], which states that methanol solvents produce more yields than the n-hexane because of methanol can dissolve almost all organic compounds both polar and non-polar because methanol has a polar group (-OH) and a cluster non-polar (-CH). Based on the results, it was found that the total extractive content of the heartwood section was 6.15%, and sapwood was 6.01%. These results show that the extractive content in the heartwood and sapwood sections were almost the same even though it was theoretically stated that the heartwood had higher of extractive content than sapwood, as stated by Krisdianto and Sumarni (2006) [14] and also the heartwood section has a dark color and a sharp odor because of deposits of extractive compounds. This is probably due to the age of the trees that are old. Therefore the total extractive content of *cempedak* wood is 12.16%, consisting of the amount of polar and non-polar solvent extractives.

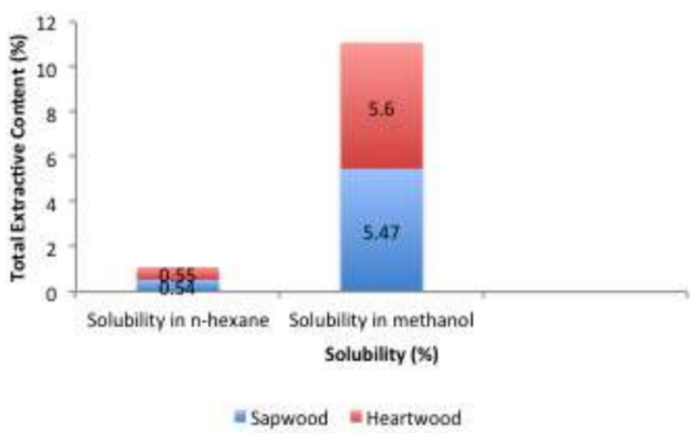

Figure 1. Total Extractive Content

The figure above shows the solubility of extractive substances affected by the polarity of the solution. This is in accordance with what Lukmandaru stated (2017) [9] that in order to know the amount or composition of polar and non-polar compounds, it is necessary to extract using solvents with different polarity, where the number of extractive substances that can be extracted depending on the type of solvent.

Based on FAO criteria (1980) about criteria used to evaluate wood properties as raw material for pulp in Syafii and Siregar (2006) [15], the extractive content that can be tolerated in the pulp and paper industry is <7%, while the extractive content of the *cempedak* in this study is 12.16% (>7%) so this wood species is not suitable to be used as raw material for the pulp and paper industry. Higher extractive content, the higher the consumption of chemicals needed in the pulping process and can cause pitch-problems, namely the occurrence of spots on the resulting pulp sheet [15].

3.2. Fractionation of n-hexane and methanol extracts

The fractionation of n-hexane extract produced neutral and free acid fractions, where the yield of neutral fractions from sapwood (NPG) was greater than that of the heartwood (NPT). The same trend also occurs in the free acid fraction, where sapwood (APG) produces a yield, which is also higher than that of the heartwood (APT). Furthermore, the fractionation of methanol extract obtained three fractions, namely the dichloromethane fraction of sapwood (DPG) and heartwood (DPT), where the yield on sapwood is greater than that of heartwood. The second fraction is the butanol fraction, where the yield on sapwood (BPG) is lower compared to the yield on heartwood (BPT). The third fraction is residue, where sapwood has less residue than heartwood (RPT).

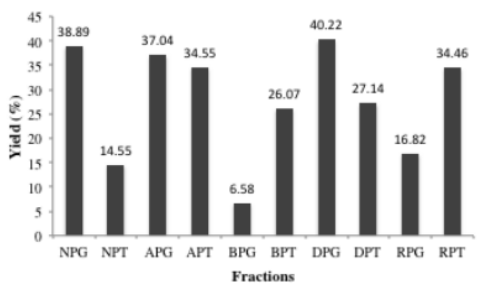

Figure 2. Results of n-hexane and methanol fraction

**Note* : *NPG: Neutral sapwood; NPT: Neutral heartwood; APG: Acid sapwood; APT: Acid heartwood; BPG: Butanol sapwood; BPT: Butanol heartwood; DPG: Dichloromethane sapwood; DPT: Dichloromethane heartwood; RPG: sapwood residue; RPT: heartwood residue*

The order of the yield of each fraction is based on its value, namely the free acid fraction, the dichloromethane fraction, the neutral fraction, the residual fraction, and the butanol fraction. This shows that methanol extract is generally dominated by polar compounds which are seen in the butanol fraction and residue, while the dichloromethane dissolved fraction of methanol extract is a non-polar substance that has not been dissolved in n-hexane because of differences in polarity, then butanol will dissolve the molecular polyphenols low whereas the residue dissolves high molecular polyphenolic. In n-hexane extract, neutral fraction generally contains a mixture of acids (fats and resins), free acid fractions consist of fatty acids and resin acids [9]. Therefore, because the yield of n-hexane fraction is lower than that of methanol, it should be assumed that *cempedak* wood extractives contain fewer non-polar compounds compared to polar compounds.

IOP Conf. Series: Earth and Environmental Science **575** (2020) 012127 doi:10.1088/1755-1315/575/1/012127

3.3. Tannin content
The tannin levels contained in each fraction were NPG fraction 0.10%, NPT 0.42%, APG 0.04%, APT 0.02%, BPG 1.62%, BPT 1.64%, DPG 0.52% , DPT 0.56%, RPG 1.67%, RPT 1.52%. The highest tannin content was found in the sapwood residue fraction (RPG) of 1.67%. And the lowest is in heartwood acid fraction (APT), which is 0.02%.

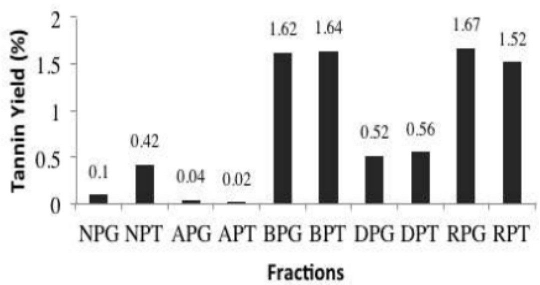

Figure 3. The tannin content of each fraction

Tannins are active compounds of secondary metabolites that have benefits as astringent, antidiarrheal, antibacterial, and antioxidant. Tannin compounds are a member of polyphenol compounds that were found in plants. Tannin is a polar compound because it has a hydroxy group, and it is required polar solvents to extracted it [10]. The neutral fraction, which tends to be high in tannin analysis, is thought to be caused by the addition of sodium sulfate to the n-hexane fraction, which does not bind water completely so that there are still polar compounds in the fraction. The dichloromethane fraction, which tends to be high, is in accordance with Sayuti's statement (2017) [13] that the methanol solvent can dissolve almost all organic compounds, both polar and non-polar because methanol has polar (-OH) and non-polar groups (-CH).

3.4. Flavonoid content
Based on the analysis of flavonoid content obtained the average of flavonoid content successively, from sapwood to the heartwood of each free acid fraction namely 0.11% and 0.02%, neutral fractions 0.03% and 0.01%, dichloromethane fraction 8.39% and 17.99%, butanol fractions 19.78% and 18.19%, and residues 5.39% and 16.82%. These results show that the highest content of flavonoids is in the polar fraction, namely in the butanol fraction and the residual fraction, this is consistent with Sayuti's statement (2017) [13] that polar compounds will dissolve in polar solvents. Flavonoid compounds are non-polar compounds, but flavonoids have sugar groups that cause readily soluble in polar or semi-polar solvents [16]. Kar *et al*. (2006) also state that flavonoid compounds are non-polar compounds and are commonly found on plant stems [17].

IOP Conf. Series: Earth and Environmental Science **575** (2020) 012127 doi:10.1088/1755-1315/575/1/012127

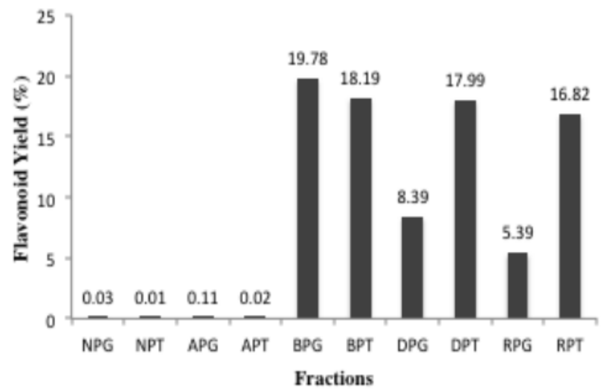

Figure 4. Flavonoid content in each fraction

Flavonoids are a group of secondary metabolites produced by plants that are included in a large group of polyphenols. This compound is found in all parts of the plant, including leaves, roots, wood, and bark. Flavonoids have the ability to capture free radicals and inhibit lipid oxidation [18].

3.5. Polyphenol content

Analysis of polyphenol content of each fraction of n-hexane and methanol extracts from sapwood to core wood, namely free acid fraction 0.06% and 0.48%, neutral fraction 9.2% and 12.6% residual fraction 0.6 % and 0.8%, dichloromethane fractions 1.4% and 8.6%, butanol fraction 1.1% and 4.0%.

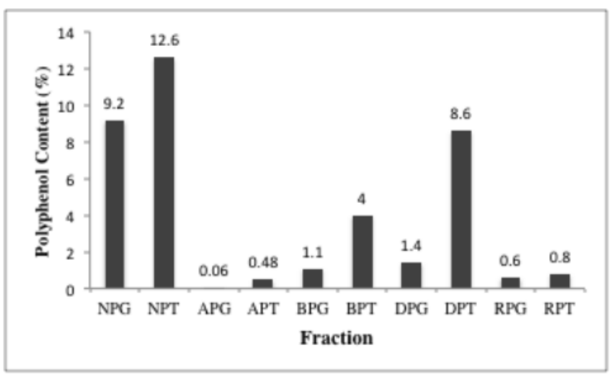

Figure 5. Polyphenol content in each fraction

A neutral fraction in the heartwood has the highest polyphenol content, while the lowest average polyphenol content is in the sapwood acid fraction. The high neutral fraction value is probably caused by the fact that water has not been properly bound when fractionated with n-hexane. Polyphenols are one of the natural antioxidant compounds in plants that have pharmacological effects such as anti-inflammatory, anticancer, antibacterial, and antiviral properties [19]. Total phenol analysis aims to determine the total phenolic compounds contained in the sample. The higher phenolic content, the higher the antioxidant activity will be. Polyphenols are closely related to antioxidants because polyphenol compounds play a role in preventing oxidation events [20]. Most of the antioxidants in plants are polyphenol compounds.

4. Conclusions

According to research results, the total extractive content of *cempedak* wood is 12.16%, consisting of the amount of extractives in the heartwood (6.15%) and the sapwood (6.01%). *Cempedak* wood extractive consist of polar extractives content (11.07%) and non-polar extractives content (1.09%). The extractive content is classified high based on FAO criteria (1980) for criteria used to evaluate wood properties as raw material for pulp so that this wood species do not make suitable as raw material for pulp and paper industry.

Acknowledgment. The authors thank Ulfa Islamiyah for her assistance in conducting this research.

References

[1] Verma S R and Dwivedi U N 2014 Lignin genetic engineering for improvement of wood quality: Applications in paper and textile industries, fodder and bioenergy production *South African J. Bot.* **91** 107–25

[2] Larekeng S H, Gusmiaty, Restu M, Arsyad M A and Dermawan R 2019 Morphophysiological analyses on Teak (*Tectona grandis* Linn. f.) from three provenances *IOP Conf. Ser. Earth Environ. Sci.* **235** 012048

[3] Larekeng S H, Restu M, Arsyad M A and Mutia 2019 Observation of morphological and physiological characteristics on Abangares Mahogany (Swietenia macrophylla King .) In South Sulawesi *IOP Conf. Ser. Earth Environ. Sci.* **270** 012022

[4] Supartini. 2009 Komponen Kimia Kayu Meranti Kuning (Shorea macrobalanos) *J. Penelit. Dipterokarpa* **3** 43–50

[5] Bossu J, Beauchêne J, Estevez Y, Duplais C and Clair B 2016 New insights on wood dimensional stability influenced by secondary metabolites: The case of a fast-growing tropical species Bagassa guianensis Aubl. *PLoS One* **11**

[6] Bockel S, Mayer I, Konnerth J, Harling S, Niemz P, Swaboda C, Beyer M, Bieri N, Weiland G and Pichelin F 2019 The role of wood extractives in structural hardwood bonding and their influence on different adhesive systems *Int. J. Adhes. Adhes.* **91** 43–53

[7] Sjöström E and Sastrohamidjojo H 1995 *Kimia kayu: dasar-dasar dan penggunaan* (Gadjah Mada University Press)

[8] Nauw A J R, Fatem S M, Husodo S B and Sagrim M 2016 Pemanfaatan tumbuhan cempedak (Artocarpus champeden) oleh masyarakat Kampung Sabun Distrik Aitinyo Tengah Kabupaten Maybrat, Papua Barat *J. Ilmu Kehutan.* **10** 46–56

[9] Lukmandaru G 2012 Komposisi ekstraktif pada kayu mangium (Acacia mangium) *J. Ilmu Tek Kayu Trop* **10** 150–8

[10] Mukhriani M, Nonci F Y and Mumang M 2017 Penetapan kadar tanin total ekstrak biji jintan hitam (Nigella sativa) secara spektrofotometri UV-Vis *J. Farm. UIN Alauddin Makassar* **2** 154–8

[11] Sayyidah and Triastinurmiatiningsih 2017 Kadar Polifenol dan Uji Aktivitas Antioksidan Ekstrak Etanol Ganggang Coklat (Padina australis). *J. Online Mhs. Bid. Biol.* **3**

[12] Azizah D N, Kumolowati E and Faramayuda F 2014 Penetapan kadar flavonoid metode AlCl3 pada ekstrak metanol kulit buah kakao (Theobroma cacao L.) *Kartika J. Ilm. Farm.* **2** 33–7

[13] Sayuti M 2017 Pengaruh perbedaan metode ekstraksi, bagian dan jenis pelarut terhadap rendemen dan aktifitas antioksidan bambu laut (Isis hippuris) *Technol. Sci. Eng. J.* **1**

[14] Krisdianto K and Sumarni G 2006 Perbandingan persentase volume teras kayu jati cepat tumbuh dan konvensional umur 7 tahun asal Penajam, Kalimantan Timur *J. Penelit. Has. Hutan* **24** 385–94
[15] Syafii W and Siregar I Z 2018 Sifat Kimia dan Dimensi Serat Kayu Mangium (Acacia mangium Willd.) dari Tiga Provenans. Chemical Properties and Fiber Dimension of Acacia mangium Willd. from Three Provenances *J. Ilmu dan Teknol. Kayu Trop.* **4** 28–32
[16] Firdiyani F, Agustini T W and Ma'ruf W F 2015 Ekstraksi senyawa bioaktif sebagai antioksidan alami Spirulina platensis segar dengan pelarut yang berbeda
[17] Kar P, Laight D, Shaw K M and Cummings M H 2006 Flavonoid-rich grapeseed extracts: a new approach in high cardiovascular risk patients? *Int. J. Clin. Pract.* **60** 1484–92
[18] Zuraida Z, Sulistiyani S, Sajuthi D and Suparto I H 2017 Fenol, flavonoid, dan aktivitas antioksidan pada ekstrak kulit batang pulai (Alstonia scholaris R. Br) *J. Penelit. Has. Hutan* **35** 221–30
[19] Saxena 2014 Save the red rice: a unique gift of nature *Int. J. Curr. Res. Biosci. Plant Biol* **1** 32–4
[20] Hermawan H, Sari B L and Nashrianto H 2018 Kadar Polifenol Dan Aktivitas Antioksidan Ekstrak Etil Asetat Dan Metanol Buah Ketapang (Terminalia Catappa L.) *J. Online Mhs. Bid. Farm.* **1**

Characterization

ORIGINALITY REPORT

%12	%10	%9	%7
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Lancaster Student Paper	%4
2	Submitted to Cypress Fairbanks Independent School District Student Paper	%2
3	Syahidah, N Subekti. " Biological Activity of Mangrove Leaves Extract (.) ", IOP Conference Series: Earth and Environmental Science, 2019 Publication	%1
4	id.123dok.com Internet Source	%1
5	pertambangan.fst.uinjkt.ac.id Internet Source	%1
6	baadalsg.inflibnet.ac.in Internet Source	%1
7	www.ncbi.nlm.nih.gov Internet Source	%1
8	ejournal.forda-mof.org Internet Source	%1

9	Opiyo, S.A.. "7@a-Acetylugandensolide and antimicrobial properties of Warburgia ugandensis extracts and isolates against sweet potato pathogens", Phytochemistry Letters, 20110615 Publication	<%1
10	Farah Fatimah, Natalia Christin Larasati, Rumpoko Wicaksono, Rifda Naufalin. " Optimization of temperature and time of extraction of kecombrang stem and leaf based on the quality of product bioactive components ", IOP Conference Series: Earth and Environmental Science, 2019 Publication	<%1
11	www.tandfonline.com Internet Source	<%1
12	www.scielo.br Internet Source	<%1
13	A Laga, Darmawan, F Bastian, Muhpidah, M Djalal. "The effect of liquefaction time and temperature on the quality and anthocyanin content of purple sweet potato maltohemidextrin", IOP Conference Series: Earth and Environmental Science, 2020 Publication	<%1
14	G.I. ONWUKA. "SOAKING, BOILING AND	<%1

ANTINUTRITIONAL FACTORS IN PIGEON PEAS (CAJANUS CAJAN) AND COWPEAS (VIGNA UNGUICULATA)", Journal of Food Processing and Preservation, 10/2006

Publication

EXCLUDE QUOTES	ON	EXCLUDE MATCHES	< 5 WORDS
EXCLUDE BIBLIOGRAPHY	ON		