

Original Manuscript

Preliminary Study on the Production of Wood Varnish from Natural *Ambalau* Resin of *Durio Zibethinus* Murr

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ABSTRACT

The resin that natural synthesized from the bark of *Durio Zibethinus* Murr plant called *ambalau* was used as a starting material in the preparation of wood varnish. In this work, the efforts were made to find the suitable solvent to extract the organic compounds from the *ambalau* resin that use to produce the wood varnish and assessed its quality. The properties of *ambalau* resin were compared with that of *Agathis dammara* resin as the commercially available resin. Moreover, the quality of produced varnish was referring to the Indonesian National Standard for wood Varnish. As the results, the *ambalau* resin as the raw material of varnish has similar properties compared to *Agathis dammara* but lower in softening point. The varnish produced from *ambalau* resin had also met the requirement of wood varnish according to the Indonesian National Standard for wood Varnish, despite improvement of a better drying time need to be considered.

Keywords: *ambalau, durian, resin, quality, wood varnish*

INTRODUCTION

Mainly, the economy is highly dependent on the petrochemical industry which relate to energy production or raw materials for industry. Recently, intense efforts are being made to replace fossil resources due to their limited sources and the adverse effects to the environment and humans. The utilization of biomass is become one alternative solutions that offers energy and a variety of chemicals suitable for the synthesis of many materials and products (Akoto and Osei-Brefoh, 2014).

An example of the use of petrochemical derivatives is in the furniture industry. Furniture makers use other products mainly from petrochemicals to polish their products to improve their products aesthetically. However, recently, development and technology have informed the possibility of using bark in making resins which in turn can be used to make varnishes that are relatively cheaper and easier to polish furniture made of wood (Akoto and Osei-Brefoh, 2014).

Bark is a residue from a wood process without prior suitable application. However, it has been found that the bark of some tree species is rich in resin which can be extracted and used as raw material in the manufacture of varnishes. Durian (*Durio Zibethinus Murr*) is an important seasonal plant in tropical countries such as Indonesia, Thailand, Malaysia, Philippines, etc (Sembiring et al, 2018). Durian bark has been producing a resin called "*ambalau*" as the newly explored resin that might be as the source for varnish production.

In this work, the effort to produce a consumable natural varnish from the resin obtained from *ambalau* had done. The objective of this work was to prepare oleoresins varnish using resin synthesized from the bark of durian. The results of this work are expected to be able to enrich the diversification of products derived from natural resources found in Indonesia in accordance with the government program (Azima et al, 2016; Azima et al, 2018).

MATERIAL AND METHODS

The "*ambalau*" as the natural resin of durian bark obtained from the local farmer at West Sumatra Indonesia. The preliminary measurements as solubility, moisture content, ash content, density and softening point of *ambalau* resin was done according to Indonesian Standard Analysis method-RSNI3 7636:2010.

For varnish preparation, Fifteen grams of the resins were grinded and subsequent sieved. The material that passed a 40-mesh standard sieve was collected and was diluted with organic solvent such as methanol, ethanol and acetone with the ratio (3/7). The mixture was stirred vigorously and carefully for 3 hours at a temperature of 70 °C. The resulting viscous solution was cooled to room temperature to obtain the wood varnish. This solution was stored in a tightly covered bottle. The drying time and physical properties such as color, density and viscosity were tested for following the method described by Indonesian Standard Analysis method. The volatile compounds in the varnish were also analyzed by using gas chromatography method by using mass spectrometer detection (Syukri et al , 2019).

RESULT AND DISCUSSION

Table 1 indicates the solubility of *ambalau* natural resin in various organic solvents. This information would guide the application of *ambalau* natural resin whether can be further utilized to produce natural varnish. The data indicated that the solubility of *ambalau* resin was predominant in semi-polar and polar organic solvents. It can be suggested that the main compound of *ambalau* natural resin consist of organic polar to semi-polar compounds. This result might guide that the prefer extraction system for further varnish production from *ambalau* natural resin is by utilizing polar or semi polar organic solvents.

Table 1. The solubility of *ambalau* natural resin in various organic solvents

Solvent	Solubility (g/100 mL)
Hexane	10.8
Acetone	91.3
Ethanol	92.3
Methanol	91.9

Recently, in Indonesia, the natural resin of *Agathis dammara* has recognized as the source of natural varnish commercially. Therefore the results of this study were compared to the characteristic of the natural resin of *Agathis dammara* and its derived varnish. Table 2 indicates the physical properties of natural *ambalau* resin. For the proximate properties such as moisture and ash content, the *ambalau* resin was quite similar as *Agathis dammara* resin. However, for softening point, the *ambalau* resin has the lower value compared to *Agathis dammara* resin. The softening is the basic parameters that relate to the properties of produced varnishes. This point is related to the drying time of varnishes which indicated the aldehydes content in the resins (Gilbert, 2017). The higher softening point would lead the faster drying point of the varnishes product. Although the *ambalau* resin indicated lower softening further quality observation of varnish from *ambalau* resin should be conducted.

Table 2. The physical properties of natural *ambalau* resin

The properties	unit	<i>Ambalau</i> resin	<i>Agathis dammara</i> resin
moisture content	%	1.79	0.65-7.02
ash content	%	0.41	0.01-6.17
softening point	°C	67-68	88 - 126

The desirable characteristics of the varnish preparation resulting in slightly viscous substances and yellow brown colored varnish. The appearance of produced varnish of three utilized solvent seemed similar to each other (Fig.1). Table 3 shows the quality parameters of produced varnished from *ambalau* resin. The observations were done for each extraction solvent (methanol, ethanol and acetone). Based on the results, it can be indicated that the varnish from *ambalau* resin has meet the requirement of Indonesian standard of wood varnish (SNI No. 8161:2015). However, the varnished derived from the solvent of acetone indicated the out of range value on volatile compound percentage, more over the lowest drying time also produced from this product which could be concluded that this varnished has the lowest quality among the observed products. The drying time is the most importance quality of varnish where the desire of

drying time is about 7200 sec (Egbewatt et al, 2014). In this study, although the drying time met the quality requirement, however, the observed drying time was too fast. Therefore further development on the production of varnish from *ambalau* resin need to be considered. The utilization of retarder to prolong the drying time should be conducted further.



Figure 1. The appearance of produced varnish from *ambalau* resin extracted with methanol (A), ethanol (B) dan acetone (C).

Table 3. The quality parameters of produced varnished from ambalau resin

Parameter	Methanol	Ethanol	Acetone	Indonesia Standard
Volatile compound percentage (%)	65.02 ± 0.87	65.20 ± 1.03	56.99 ± 1.49	> 65
Drying time (sec)	271.33 ± 8.08	334.67 ± 10.26	139.33 ± 3.05	<10800
Density (g/mL)	0.8929 ± 0.001	0.8920 ± 0.0009	0.9066 ± 0.004	0.880
Viscosity (Poise)	0.0827 ± 0.004451	0.0841 ± 0.005865	0.1027 ± 0.002754	0.06-0.07
Color (hue value)	70.6 ± 1.35	69.8 ± 0.8	69.1 ± 0.79	-

Table 4 indicated the organic compounds contained in the varnish derived from *ambalau* resin dissolved in ethanol solvent. The organic compounds we identified by using mass spectrometric analysis. The utilization of mass spectrometer has recognized as a suitable tool to identify the name of unknown organic compound in natural product materials (Syukri et al 2014; Syukri et al, 2018). It can be shown that most of the compounds as the hydrocarbons that classify as alkanes, aldehyde and organic acid. These compounds may relate to the quality properties of the produced varnished.

Table 4. The organic compounds contained in the varnish derived from *ambalau* resin dissolved in ethanol solvent

No	Compound name
1	Cyclotetrasiloxane
2	Benzene
3	Dodecane (CAS) n-Dodecane
4	Tetradecane (CAS) n
5	Tetradecane
6	Disilicic acid
7	Cyclopentasiloxane
8	6-Octenal
9	Cyclohexasiloxane
10	Cyclopentasiloxane

Conflicts of Interest

Authors declare that they have no conflicts of interest.

CONCLUSION

It can be concluded that varnish with considerable qualities can be produced from the natural *ambalau* resin that obtained from bark of *Durio Zibethinus* Murr. This result could become the basic data to utilize the natural resource of *ambalau* resin as an alternative solution that offers a variety of chemicals suitable for the synthesis of many materials and products. The quality of varnish produced can be improved if the formula is further developed. The utilization of additional ingredients to improve the quality property such as drying time should be considered.

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First Revision

Dear Editor of Asian Journal of Plant Sciences

Dear Professor,

Subject: **SUBMISSION OF NEW MANUSCRIPT FOR EVALUATION**

I am enclosing herewith a manuscript entitled “[The Production of Wood Varnish form *Ambalau* Resin of Durio Zibethinus Murr : A Preliminary Study]” submitted to “[Asian Journal of Plant Sciences]” for possible evaluation.

With the submission of this manuscript I would like to undertake that the above mentioned manuscript has not been published elsewhere, accepted for publication elsewhere or under editorial review for publication elsewhere; and that my Institute’s [Andalas University] representative is fully aware of this submission.

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The research project was conducted under the supervision of:

[Rini. B]

and the project was run as my

- M.Sc. project
- MS project
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- **Annual research project**

This research project was conducted from 01 July 2019 to 31 March 2020

Starting date Ending date

My Research Project was partially or fully sponsored by {Dr Rini. B dan Professor Anwar Kasim} with grant number {-}.

Detail of the each author with his/her contribution in this paper is as under:

Name of the author and e-mail ID	Types of contribution
Rini B/ rini59@yahoo.com;croptech01@gmail.com	devised the project and the main conceptual ideas
Anwar kasim/ agripro9642@gmail.com	devised the project and the main conceptual ideas
Teguh Tegas Kata/ chemnature3395@gmail.com	performed the experiments
Daimon Syukri/Nomiad81@gmail.com	wrote the manuscript

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This study is the first effort on the production of wood varnish from the *ambalau* resin.

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The findings of this study will be used as a preliminary data for production the varnish from *ambalau* resin commercially.

A paragraph explaining why your manuscript is appropriate for the selected journal

A strong experimental activity was performed in order to investigate the characteristics of varnish from *ambalau* resin. This study is the first effort on the production of wood varnish from the *ambalau* resin. It can be concluded that varnish with considerable qualities can be produced from the natural *ambalau* resin that obtained from bark of *Durio Zibethinus* Murr. This result could become the basic data to utilize the natural resource of *ambalau* resin as an alternative solution that offers a variety of chemicals suitable for the synthesis of many materials and products.

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The Production of Wood Varnish
from *Ambalau* Resin of *Durio Zibethinus* Murr
: A Preliminary Study

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LiveDNA Corresponding author: 62.34385*

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Running title: wood varnish from *ambalau* resin

Author's contribution: Rini B and Anwar Kasim devised the project and the main conceptual ideas, Teguh Tegas Kata performed the experiments, Daimon Syukri wrote the manuscript

Data Availability

Data used to support the findings of the present study are available from the corresponding author upon request.

Conflicts of Interest

Authors declare that they have no conflicts of interest.

Abstract

Background and Objectives: The resin that natural synthesized from the bark of *Durio Zibethinus* Murr plant called *ambalau* was used as a starting material in the preparation of wood varnish. In this work, the efforts were made to characterize the *ambalau* resin that use to produce the wood varnish and assessed its quality.

Materials and Method: The research design of this study was exploratory research design. The properties of extracted *ambalau* resin were analyzed and compared with that of *Agathis dammara* resin as the commercially available resin for varnish production. Moreover, the qualities of produced varnish were also further analyzed and compared with the Indonesian National Standard for wood Varnish.

Results: As the results, the *ambalau* resin as the raw material of varnish has similar properties compared to *Agathis dammara* but lower in softening point. The varnish produced from *ambalau* resin had also met the requirement of wood varnish according to the Indonesian National Standard for wood Varnish, despite improvement of a better drying time need to be considered.

Conclusion: Naturally synthesized resin from *Durio Zibethinus* Murr bark has been discovered to have basic characteristics for the production of wood varnish with further studies.

Keywords: *Ambalau, durian, resin, quality, wood varnish*

INTRODUCTION

Varnish is the substance that importance for wood protection and decoration. Varnish can be produced from both natural and synthetic resins. The utilization of synthetic resin derived from fossil has become the main material for commercially wood varnish. Recently, intense efforts are being made to replace fossil resources due to their limited sources and the adverse effects to the environment and humans. The utilization of natural resin has become an alternative solution that offers energy and a variety of chemicals suitable for the synthesis of many materials and products¹.

The natural resin can be obtained from the bark of tree. Bark is a residue from a wood process without prior suitable application. It has been found that the bark of some tree species is rich in resin which can be extracted and used as raw material in the manufacture of varnishes. To the best of our knowledge, very few studies have studied the production of varnishes from natural materials which may be due to limited raw materials.

In Asian countries, Durian (*Durio Zibethinus Murr*) is an important seasonal plant with a very large distribution². Local people in Indonesia have recognized that Durian bark has been producing a resin called "*ambalau*". This resin has not explored yet which it might be has the potentiality to be developed as the raw material for varnish production. .

Therefore, in this study, the effort to produce varnish form the resin from *ambalau* resin had done. The objective of this work was to characterize the properties of varnished from *ambalau* resin and compared to the commercial ones. The findings of this study will be used as a preliminary data for production the varnish from *ambalau* resin commercially.

MATERIAL AND METHODS

Study area:

The study was carried out during July, 2019-March, 2020. The study was conducted at the laboratory of crop processing engineering, Department of Crop Technology, Andalas University.

Parameters:

The "*ambalau*" as the natural resin of durian bark obtained from the local farmer at West Sumatra Indonesia. The preliminary measurements as solubility, moisture content, ash content, density and softening point of *ambalau* resin was done according to Indonesian Standard Analysis method-RSNI3 7636:2010³.

Research procedure: For varnish preparation, Fifteen grams of the resin were grinded and subsequent sieved. The material that passed a 40-mesh standard sieve was collected and was diluted with organic solvent such as methanol, ethanol and acetone with the ratio (3/7). The mixture was stirred vigorously and carefully for 3 hours at a temperature of 70 °C. The resulting

viscous solution was cooled to room temperature to obtain the wood varnish. This solution was stored in a tightly covered bottle. The drying time and physical properties such as color, density and viscosity were tested for following the method described by Indonesian Standard Analysis method.

Gas Chromatography:

The volatile compounds in the varnish were also analyzed by using gas chromatography method by using mass spectrometer detection⁴.

RESULT AND DISCUSSION

Table 1 indicates the solubility of *ambalau* natural resin in various organic solvents. This information would guide the application of *ambalau* natural resin whether can be further utilized to produce natural varnish. The data indicated that the solubility of *ambalau* resin was predominant in semi-polar and polar organic solvents. It can be suggested that the main compound of *ambalau* natural resin consist of organic polar to semi-polar compounds. This result might guide that the prefer extraction system for further varnish production from *ambalau* natural resin is by utilizing polar or semi polar organic solvents.

Table 1. The solubility of *ambalau* natural resin in various organic solvents

Solvent	Solubility (g/100mL)
Hexane	10.8
Acetone	91.3
Ethanol	92.3
Methanol	91.9

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ambalau resin indicated lower softening further quality observation of varnish from *ambalau* resin should be conducted.

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softening point	°C	67-68	88 - 126

The desirable characteristics of varnish appearances in slightly viscous substances and yellow brown colored varnish could be achieved. The appearance of produced varnish of three utilized solvent seemed similar to each other (Fig.1). Table 3 shows the quality parameters of produced varnished from *ambalau* resin. The observations were done for each extraction solvent (methanol, ethanol and acetone). Based on the results, it can be indicated that the varnish from *ambalau* resin has meet the requirement of Indonesian standard of wood varnish⁶ (SNI No. 8161:2015). In addition of viscosity, density and colour parameters of varnish from *amalau* resin that met the requirement of Indonesian standard of wood varnish, the main concern to indicate the quality of varnishes is shown by the volatile compound percentage and the drying time. The varnish from *ambalau* resin that solved in polar solvents such as methanol and ethanol indicated the volatile compound percentage more that 65%. Although in acetone solution, the volatile compound percentage of produced varnish less than 65 %, some further formula improvement could overcome this condition. Based on the drying time, the time period for the *ambalau* resin varnish to dry was less than 10800 seconds for all solvents. The drying time is the most importance quality of varnish where the desire of drying time is about 7200 sec⁷. In this study, although the drying time met the quality requirement, however, the observed drying time was too fast. Therefore further development on the production of varnish from *ambalau* resin need to be considered. The utilization of retarder to prolong the drying time should be conducted further.



Figure 1. The appearance of produced varnish from *ambalau* resin extracted with methanol (A), ethanol (B) dan acetone (C).

Table 3. The quality parameters of produced varnished from *ambalau* resin

Parameter	Methanol	Ethanol	Acetone	Indonesia Standard (SNI No. 8161:2015)
Volatile compound percentage (%)	65.02 ± 0.87	65.20 ± 1.03	56.99 ± 1.49	> 65
Drying time (sec)	271.33 ± 8.08	334.67 ± 10.26	139.33 ± 3.05	<10800
Density (g/mL)	0.8929 ± 0.001	0.8920 ± 0.0009	0.9066 ± 0.004	0.880
Viscosity (Poise)	0.0827 ± 0.004451	0.0841 ± 0.005865	0.1027 ± 0.002754	0.06-0.07
Color (hue value)	70.6 ± 1.35	69.8 ± 0.8	69.1 ± 0.79	-

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Table 4. The organic compounds contained in the varnish derived from *ambalau* resin dissolved in ethanol solvent

No	Compound name
1	Cyclotetrasiloxane
2	Benzene
3	Dodecane (CAS) n-Dodecane
4	Tetradecane (CAS) n

5	Tetradecane
6	Disilicic acid
7	Cyclopentasiloxane
8	6-Octenal
9	Cyclohexasiloxane
10	Cyclopentasiloxane

A strong experimental activity was performed in order to investigate the characteristics of varnish from *ambalau* resin. This study is the first effort on the production of wood varnish from the *ambalau* resin. Although there were some parameters that need to be improved for better quality, the presented results might guide the researcher or practitioners to further develop the practical technology for production of varnish from natural resources. The identification of the compounds employed in applicable wood varnish provides valuable information for both the knowledge of researcher, practitioners and commercially user. In particularly, identification of terpenoid and fatty acids composition are important for improving the quality of produced varnish^{10,11,12}.

CONCLUSION

It can be concluded that varnish with considerable qualities can be produced from the natural *ambalau* resin that obtained from bark of *Durio Zibethinus* Murr. This result could become the basic data to utilize the natural resource of *ambalau* resin as an alternative solution that offers a chemical suitable for the production of beneficial products. The quality of varnish produced can be improved if the formula is further developed. The more investigation on identification of compound in the resin will guide the improvement of produced varnish. Furthermore, the utilization of additional ingredients to improve the quality property such as drying time should also be considered.

Significance statement

This study discovered the potentiality of *ambalau* resin for development of wood resin. This result can be beneficial for industrial that utilize the raw material from natural resources. This study will help the researchers to further develop the production varnish derived from natural resin that many researchers were not able to explore.

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Second Revision

Evaluation Report

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Article No.: [104113-AJPS-ANSI](#) Article Type: Research article

Table Available: 4 Tables cited: 4

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No.	Part	Comments	Author Response
19.	Coverletter	<ul style="list-style-type: none">Overall OK	The cover letter has revised
20.	Write up	<ul style="list-style-type: none">Overall OK	
21.	Title	<ul style="list-style-type: none">Overall OK	The title has revised
22.	Running Title	<ul style="list-style-type: none">Overall OK	The running title has added
23.	Author's Information	<ul style="list-style-type: none">Overall OK	
24.	Author's Contribution	<ul style="list-style-type: none">Overall OK	The author's contribution has written
25.	Abstract	<ul style="list-style-type: none">Overall OK	The abstract has revised
26.	Keywords	<ul style="list-style-type: none">Overall OK	
27.	Introduction	<ul style="list-style-type: none"><u>Author should add more previous literature at least 7-8 to support his study.</u>Include reviews of the	The introduction has revised, The supporting references have added.

		existing literature already published in the field. Cite articles that reported specific results relevant to your study.	
28.	Materials and Methods	<ul style="list-style-type: none"> Overall OK 	The “study area” has added
29.	Results	<ul style="list-style-type: none"> Overall OK 	The results and discussion has revised
30.	Figures	<ul style="list-style-type: none"> Overall OK 	
31.	Tables	<ul style="list-style-type: none"> Overall OK 	
32.	Discussion	<ul style="list-style-type: none"> <u>Author didn't incorporate the following changes.</u> Include reviews of the existing literature already published in the field. Cite articles that reported specific results relevant to your study. Then correlate your work with at least 7-8 recent publications. 	The result has correlated with previous research on varnish production. The discussion has revised. The references have added.
33.	Conclusion	<ul style="list-style-type: none"> Overall OK 	
34.	Acknowledgement	<ul style="list-style-type: none"> Overall OK 	
35.	Significance Statement	<ul style="list-style-type: none"> Overall OK 	The Significance statement has added
36.	References	<ul style="list-style-type: none"> Author is advised to cite the journal related references in his manuscript, avoid using the reports and other pages as a citation material in manuscript. Replace all the 	The references have revised according to the suggestion.

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The Production of Wood Varnish from *Ambalau* Resin of *Durio Zibethinus Murr*: A Preliminary Study

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Running title: wood varnish from *ambalau* resin

Author's contribution: Rini B and Anwar Kasim devised the project and the main conceptual ideas, TeguhTegas Kata performed the experiments, DaimonSyukri wrote the manuscript

Data Availability

Data used to support the findings of the present study are available from the corresponding author upon request.

Conflicts of Interest

Authors declare that they have no conflicts of interest.

Abstract

Background and Objectives: The resin that natural synthesized from the bark of *Durio Zibethinus Murr* plant can be used to prepare the wood varnish. In this work, the efforts were made to characterize the *ambalau* resin that use to produce the wood varnish and assessed its quality. **Materials and Method:** The research design of this study was exploratory research design. The properties of extracted *ambalau* resin were analyzed and compared with that of *Agathis dammara* resin as the commercially available resin for varnish production. Moreover, the qualities of produced varnish were also further analyzed and compared with the common standard for wood Varnish. **Results:** As the results, the *ambalau* resin as the raw material of varnish has similar properties compared to *Agathis dammara* but lower in softening point. The varnish produced from *ambalau* resin had also met the quality parameter of wood varnish according to the international Standard for wood Varnish, despite improvement of a better drying time need to be considered. **Conclusion:** Naturally synthesized resin from *Durio Zibethinus Murr* bark has been discovered to have basic characteristics for the production of wood varnish with further studies.

Keywords: *Ambalau, durian, resin, quality, wood varnish*

INTRODUCTION

Varnish is the substance that importance for wood protection and decoration. The application of varnish for wood protection is indispensable in Indonesia. Due to the large threat of earthquake, wood become preferred material for construction as well as wood furniture. Unfortunately, wood is susceptible to environmental factors just like other biological materials^{1,2,3}. Surface treatment of wood with proper substances and impregnation has been suggested among the effective methods to decrease the negative effect of weathering on wood^{4,5,6}. The application of varnish is the easiest and most common method for protecting wood against natural weathering⁷. Therefore, the study on varnish production is very applicable to support human life.

Varnish can be produced from both natural and synthetic resins. The utilization of synthetic resin derived from fossil has become the main material for commercially wood varnish. Recently, intense efforts are being made to replace fossil resources due to their limited sources and the adverse effects to the environment and humans. The utilization of natural resin has become an alternative solution that offers energy and a variety of chemicals suitable for the synthesis of many materials and products⁸.

The natural resin can be obtained from the bark of tree. Bark is a residue from a wood process without prior suitable application. It has been found that the bark of some tree species is rich in resin which can be extracted and used as raw material in the manufacture of varnishes. To the best of our knowledge, very few studies have studied the production of varnishes from natural materials which may be due to limited raw materials.

In Asian countries, Durian (*Durio Zibethinus* Murr) is an important seasonal plant with a very large distribution^{9,10}. Local people in Indonesia have recognized that Durian bark has been producing a resin called "*ambalau*". This resin has not explored yet which it might be has the potentiality to be developed as the raw material for varnish production.

In this study, the effort to produce varnish form the resin from *ambalau* resin had conducted. The objective of this work was to characterize the properties of varnished from *ambalau* resin and compared to the commercial ones. The findings of this study will be used as a preliminary data for production the varnish from *ambalau* resin commercially.

MATERIAL AND METHODS

Study area: The study was carried out during July, 2019-March, 2020. The study was conducted at the laboratory of crop processing engineering, Department of Crop Technology, Andalas University.

Parameters: The “*ambalau*” as the natural resin of durian bark obtained from the local farmer at West Sumatra Indonesia. The preliminary measurements as solubility, moisture content, ash content, density and softening point of *ambalau* resin was done according to the method that described in Yustinus¹¹.

Research procedure: For varnish preparation, Fifteen grams of the resin were grinded and subsequent sieved. The material that passed a 40-mesh standard sieve was collected and was diluted with organic solvent such as methanol, ethanol and acetone with the ratio (3/7). The mixture was stirred vigorously and carefully for 3 hours at a temperature of 70 °C. The resulting viscous solution was cooled to room temperature to obtain the wood varnish. This solution was stored in a tightly covered bottle. The drying time and physical properties such as color, density and viscosity were tested for following the method described on International Standard Analysis method.

Gas Chromatography:

The volatile compounds in the varnish were also analyzed by using gas chromatography method by using mass spectrometer detection¹².

RESULT AND DISCUSSION

Table 1 indicates the solubility of *ambalau* natural resin in various organic solvents. This information would guide the application of *ambalau* natural resin whether can be further utilized to produce natural varnish. The data indicated that the solubility of *ambalau* resin was predominant in semi-polar and polar organic solvents. It can be suggested that the main compound of *ambalau* natural resin consist of organic polar to semi-polar compounds. This result might guide that the prefer extraction system for further varnish production from *ambalau* natural resin is by utilizing polar or semi polar organic solvents.

Table 1. The solubility of *ambalau* natural resin in various organic solvents

Solvent	Solubility (g/100mL)
Hexane	10.8
Acetone	91.3
Ethanol	92.3
Methanol	91.9

Recently, in Indonesia, the natural resin of *Agathis dammara* has recognized as the source of natural varnish commercially. Therefore the results of this study were compared to the characteristic of the natural resin of *Agathis dammara* and its derived varnish. Table 2 indicates the physical properties of natural *ambalau* resin. For the proximate properties such as moisture and ash content, the *ambalau* resin was quite similar as *Agathis dammara* resin. However, for softening point, the *ambalau* resin has the lower value compared to *Agathis dammara* resin. The softening is the basic parameters that relate to the properties of produced varnishes. **This point is related to the drying time of varnishes which indicated the aldehydes content in the resin¹³.** The higher softening point would lead the faster drying point of the varnishes product. Although the *ambalau* resin indicated lower softening further quality observation of varnish from *ambalau* resin should be conducted.

Table 2. The physical properties of natural *ambalau* resin

The properties	unit	<i>Ambalau</i> resin	Agathisdammara resin
moisture content	%	1.79	0.65-7.02
ash content	%	0.41	0.01-6.17
softening point	°C	67-68	88 - 126

The desirable characteristics of varnish appearances in slightly viscous substances and yellow brown colored varnish could be achieved. The appearance of produced varnish of three utilized solvent seemed similar to each other (Fig.1 a-c). Table 3 shows the quality parameters of produced varnished from *ambalau* resin. The observations were done for each extraction solvent (methanol, ethanol and acetone). Based on the results, it can be indicated that the varnish from *ambalau* resin has met the standard parameter of wood varnish¹⁴. In addition of viscosity, density and colour parameters of varnish from *amalau* resin that met the quality standard of wood varnish, the main concern to indicate the quality of varnishes is shown by the volatile compound percentage and the drying time. The varnish from *ambalau* resin that solved in polar solvents such as methanol and ethanol indicated the volatile compound percentage more than 65%. Although in acetone solution, the volatile compound percentage of produced varnish less than 65 %, some further formula improvement could overcome this condition. Based on the drying time, the time period for the *ambalau* resin varnish to dry was less than 10800 seconds for all solvents. The drying time is the most importance quality of varnish where the desire of drying time is about 7200 sec¹⁵. In this study, although the drying time met the quality requirement, however, the observed drying time was too fast. Therefore further development on the production of varnish from *ambalau* resin need to be considered. The utilization of retarder to prolong the drying time should be conducted further.



Figure 1. The appearance of produced varnish from *ambalau* resin extracted with methanol (A), ethanol (B) dan acetone (C).

Table 3. The quality parameters of produced varnished from ambalau resin

Parameter	Methanol	Ethanol	Acetone	Varnish quality parameters
Volatile compound percentage (%)	65.02 ± 0.87	65.20 ± 1.03	56.99 ± 1.49	> 65
Drying time (sec)	271.33 ± 8.08	334.67 ± 10.26	139.33 ± 3.05	<10800
Density (g/mL)	0.8929 ± 0.001	0.8920 ± 0.0009	0.9066 ± 0.004	0.880
Viscosity (Poise)	0.0827 ± 0.004451	0.0841 ± 0.005865	0.1027 ± 0.002754	$\pm 0.06-0.07$
Color (hue value)	70.6 ± 1.35	69.8 ± 0.8	69.1 ± 0.79	-

Table 4 indicated the organic compounds contained in the varnish derived from *ambalau* resin dissolved in ethanol solvent. The organic compounds we identified by using mass spectrometric analysis. The utilization of mass spectrometer has recognized as a suitable tool to identify the name of unknown organic compound in natural product materials^{16,17}. It can be shown that most of the compounds as the hydrocarbons that classify as alkanes, aldehyde, organic acid and volatile organic compounds. These compounds may relate to the quality properties of the

produced varnish. For development of friendly varnish products, the characteristic of hydrocarbons and volatile organic compounds are essential parameters that need to be further investigated^{18,19}.

Table 4. The organic compounds contained in the varnish derived from *ambalau* resin dissolved in ethanol solvent

No	Compound name
1	Cyclotetrasiloxane
2	Benzene
3	Dodecane (CAS) n-Dodecane
4	Tetradecane (CAS) n
5	Tetradecane
6	Disilicic acid
7	Cyclopentasiloxane
8	6-Octenal
9	Cyclohexasiloxane
10	Cyclopentasiloxane

Overall, the result of this study could enhance the utility of *Durio Zibethinus Murr*. Although many studies have conducted to explore the utilization of *Durio Zibethinus Murr* for development of natural resources diversity of food and non-food products^{10,20,21}, there are no reports that focused on the potentiality of the bark's resin of *Durio Zibethinus Murr*. The utilization of natural resin has been recognizing as a potential source as the material of wood varnish^{8,22}. Therefore, strong efforts on experimental activity was performed in order to investigate the characteristics of varnish from *ambalau* resin that derived from *Durio Zibethinus Murr* in this study. This is the first effort that could provide the valuable data on the production of wood varnish from *ambalau* resin. Although there were some parameters that need to be improved for better quality, the presented results might guide the researcher or practitioners to further develop the practical technology for production of varnish from natural resources. The identification of the compounds employed in applicable wood varnish provides valuable information for both the knowledge of researcher, practitioners and commercially user. In

particularly, identification of terpenoid and fatty acids composition are important for improving the quality of produced varnish^{23,24,25}.

CONCLUSION

It can be concluded that varnish with considerable qualities can be produced from the natural *ambalau* resin that obtained from bark of *Durio Zibethinus* Murr. This result could become the basic data to utilize the natural resource of *ambalau* resin as an alternative solution that offers a chemical suitable for the production of beneficial products. The quality of varnish produced can be improved if the formula is further developed. The more investigation on identification of compound in the resin will guide the improvement of produced varnish. Furthermore, the utilization of additional ingredients to improve the quality property such as drying time should also be considered.

Significance statement

This study discovered the potentiality of *ambalau* resin for development of wood resin. This result can be beneficial for industrial that utilize the raw material from natural resources. This study will help the researchers to further develop the production varnish derived from natural resin that many researchers were not able to explore.

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Third Revision

Evaluation Report

Final Decision: Reconsider for Evaluation after Modifications and Clarifications

Article No.: [104113-AJPS-ANSI](#) Article Type: Research article

Table Available: 4 Tables cited: 4

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39.	Title	<ul style="list-style-type: none">Overall OK	
40.	Running Title	<ul style="list-style-type: none">Overall OK	
41.	Author's Information	<ul style="list-style-type: none">Overall OK	
42.	Author's Contribution	<ul style="list-style-type: none">Overall OK	
43.	Abstract	<ul style="list-style-type: none">Overall OK	
44.	Keywords	<ul style="list-style-type: none">Overall OK	
45.	Introduction	<ul style="list-style-type: none">Overall OK	
46.	Materials and Methods	<ul style="list-style-type: none">Overall OK	

47.	Results	<ul style="list-style-type: none"> • <u>Author has used GC and MS for analysis. How is it possible that author didn't obtain any spectrum or an graph from GC or MS. Justify with solid reason if "no".</u> • Is there any spectra you obtained for identification of organic compounds. If "yes" then please provide. 	The GC MS chromatogram has added to manuscript
48.	Figures	<ul style="list-style-type: none"> • Overall OK 	
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50.	Discussion	<ul style="list-style-type: none"> • Overall OK 	
51.	Conclusion	<ul style="list-style-type: none"> • Overall OK 	
52.	Acknowledgement	<ul style="list-style-type: none"> • Overall OK 	
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The Production of Wood Varnish from *Ambalau* Resin of *Durio Zibethinus* Murr: A Preliminary Study

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Running title: wood varnish from *ambalau* resin

Author's contribution:Rini B and Anwar Kasim devised the project and the main conceptual ideas, TeguhTegas Kata performed the experiments, DaimonSyukri wrote the manuscript

Data Availability

Data used to support the findings of the present study are available from the corresponding author upon request.

Conflicts of Interest

Authors declare that they have no conflicts of interest.

Abstract

Background and Objectives:The resin that natural synthesized from the bark of *Durio Zibethinus Murr* plant can be used to prepare the wood varnish. In this work, the efforts were made to characterize the *ambalau* resin that use to produce the wood varnish and assessed its quality. **Materials and Method:**The research design of this study was exploratory research design. The properties of extracted *ambalau* resin were analyzed and compared with that of *Agathis dammara* resin as the commercially available resin for varnish production. Moreover, the qualities of produced varnish were also further analyzed and compared with the common standard for wood Varnish. **Results:**As the results, the *ambalau* resin as the raw material of varnish has similar properties compared to *Agathis dammara* but lower in softening point. The varnish produced from *ambalau* resin had also met the quality parameter of wood varnish according to the international Standard for wood Varnish, despite improvement of a better drying time need to be considered. **Conclusion:**Naturally synthesized resin from *Durio Zibethinus Murr* bark has been discovered to have basic characteristics for the production of wood varnish with further studies.

Keywords:Ambalau, durian, resin, quality, wood varnish

INTRODUCTION

Varnish is the substance that importance for wood protection and decoration. The application of varnish for wood protection is indispensable in Indonesia. Due to the large threat of earthquake, wood become preferred material for construction as well as wood furniture. Unfortunately, wood is susceptible to environmental factors just like other biological materials^{1,2,3}. Surface treatment of wood with proper substances and impregnation has been suggested among the effective methods to decrease the negative effect of weathering on wood^{4,5,6}. The application of varnish is the easiest and most common method for protecting wood against natural weathering⁷. Therefore, the study on varnish production is very applicable to support human life.

Varnish can be produced from both natural and synthetic resins. The utilization of synthetic resin derived from fossil has become the main material for commercially wood varnish. Recently, intense efforts are being made to replace fossil resources due to their limited sources and the adverse effects to the environment and humans. The utilization of natural resin has become an alternative solution that offers energy and a variety of chemicals suitable for the synthesis of many materials and products⁸.

The natural resin can be obtained from the bark of tree. Bark is a residue from a wood process without prior suitable application. It has been found that the bark of some tree species is rich in resin which can be extracted and used as raw material in the manufacture of varnishes. To the best of our knowledge, very few studies have studied the production of varnishes from natural materials which may be due to limited raw materials.

In Asian countries, Durian (*Durio Zibethinus Murr*) is an important seasonal plant with a very large distribution^{9,10}. Local people in Indonesia have recognized that Durian bark has been producing a resin called "*ambalau*". This resin has not explored yet which it might be has the potentiality to be developed as the raw material for varnish production.

In this study, the effort to produce varnish form the resin from *ambalau* resin had conducted. The objective of this work was to characterize the properties of varnished from *ambalau* resin and compared to the commercial ones. The findings of this study will be used as a preliminary data for production the varnish from *ambalau* resin commercially.

MATERIAL AND METHODS

Study area: The study was carried out during July, 2019-March, 2020. The study was conducted at the laboratory of crop processing engineering, Department of Crop Technology, Andalas University.

Parameters:The “*ambalau*” as the natural resin of durian bark obtained from the local farmer at West Sumatra Indonesia. The preliminary measurements as solubility, moisture content, ash content, density and softening point of *ambalau* resin was done according to the method that described in Pethe and Joshi¹¹.

Research procedure:For varnish preparation, Fifteen grams of the resin were grinded and subsequent sieved. The material that passed a 40-mesh standard sieve was collected and was diluted with organic solvent such as methanol, ethanol and acetone with the ratio (3/7). The mixture was stirred vigorously and carefully for 3 hours at a temperature of 70 °C. The resulting viscous solution was cooled to room temperature to obtain the wood varnish. This solution was stored in a tightly covered bottle. The drying time and physical properties such as color, density and viscosity were tested for following the method described on International Standard Analysis method.

Gas Chromatography:The volatile compounds in the varnish were also analyzed by using gas chromatography method by using mass spectrometer detection¹².

RESULT AND DISCUSSION

Table 1 indicates the solubility of *ambalau* natural resin in various organic solvents. This information would guide the application of *ambalau* natural resin whether can be further utilized to produce natural varnish. In this experiment, methanol and ethanol were used as the representative of polar solvent, acetone as a semi polar solvent and hexane as a non-polar solvent. The obtained data indicated that the solubility of *ambalau* resin was predominant in semi-polar and polar organic solvents with the value of more than 90 g/100 mL (90%). However, the solubility of *ambalau* resin in hexane was only 10 g/mL which mean it could be categorized as a low solubility¹³. It can be suggested that the main compound of *ambalau* natural resin consist of organic polar to semi-polar compounds. This result might guide that the prefer extraction system for further varnish production from *ambalau* natural resin is by utilizing polar or semi polar organic solvents.

Table 1. The solubility of *ambalau* natural resin in various organic solvents

Solvent	Solubility (g/100mL)
Hexane	10.8
Acetone	91.3
Ethanol	92.3
Methanol	91.9

Recently, in Indonesia, the natural resin of *Agathis dammara* has recognized as the source of natural varnish commercially. Therefore the results of this study were compared to the characteristic of the natural resin of *Agathis dammara* and its derived varnish. Table 2 indicates the physical properties of natural *ambalau* resin. For the proximate properties such as moisture and ash content, the *ambalau* resin was quite similar as *Agathis dammara* resin. However, for softening point, the *ambalau* resin has the lower value compared to *Agathis dammara* resin. The softening is the basic parameters that relate to the properties of produced varnishes. This point is related to the drying time of varnishes which indicated the aldehydes content in the resin¹⁴. The higher softening point would lead the faster drying point of the varnishes product. Although the

ambalau resin indicated lower softening further quality observation of varnish from *ambalau* resin should be conducted.

Table 2. The physical properties of natural *ambalau* resin

The properties	unit	<i>Ambalau</i> resin	Agathis dammara resin
moisture content	%	1.79	0.65-7.02
ash content	%	0.41	0.01-6.17
softening point	°C	67-68	88 - 126

The desirable characteristics of varnish appearances in slightly viscous substances and yellow brown colored varnish could be achieved. The appearance of produced varnish of three utilized solvent seemed similar to each other (Fig.1 a-c). Table 3 shows the quality parameters of produced varnished from *ambalau* resin. The observations were done for each extraction solvent (methanol, ethanol and acetone). Based on the results, it can be indicated that the varnish from *ambalau* resin has met the standard parameter of wood varnish¹⁵. In addition of viscosity, density and colour parameters of varnish from *amalaure* resin that met the quality standard of wood varnish, the main concern to indicate the quality of varnishes is shown by the volatile compound percentage and the drying time. The varnish from *ambalau* resin that solved in polar solvents such as methanol and ethanol indicated the volatile compound percentage more than 65%. Although in acetone solution, the volatile compound percentage of produced varnish less than 65%, some further formula improvement could overcome this condition. Based on the drying time, the time period for the *ambalau* resin varnish to dry was less than 10800 seconds for all solvents. The drying time is the most importance quality of varnish where the desire of drying time is about 7200 sec¹⁶. In this study, although the drying time met the quality requirement, however, the observed drying time was too fast. Therefore further development on the production of varnish from *ambalau* resin need to be considered. The utilization of retarder to prolong the drying time should be conducted further.



Figure 1. The appearance of produced varnish from *ambalau* resin extracted with methanol (A), ethanol (B) dan acetone (C)

Table 3: The quality parameters of produced varnished from ambalau resin

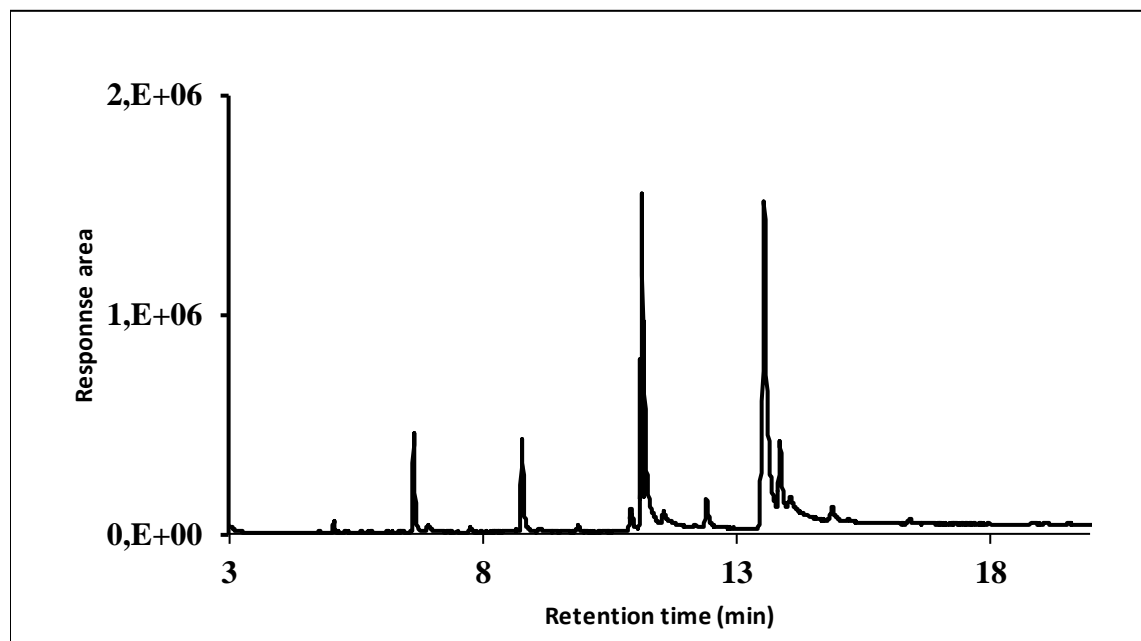
Parameter	Methanol	Ethanol	Acetone	Varnish quality parameters
Volatile compound percentage (%)	65.02 ± 0.87	65.20 ± 1.03	56.99 ± 1.49	> 65
Drying time (sec)	271.33 ± 8.08	334.67 ± 10.26	139.33 ± 3.05	<10800
Density (g/mL)	0.8929 ± 0.001	0.8920 ± 0.0009	0.9066 ± 0.004	0.880
Viscosity (Poise)	0.0827 ± 0.004451	0.0841 ± 0.005865	0.1027 ± 0.002754	0.06-0.07
Color (hue value)	70.6 ± 1.35	69.8 ± 0.8	69.1 ± 0.79	-

Figure 2 indicates the Gas Chromatography Mass Spectrometry (GCMS) chromatogram of organic compounds contained in the varnish derived from *ambalau* resin that was soluble in ethanol solvent. The organic compounds identified by using mass spectrometric analysis. The utilization of mass spectrometer has recognized as a suitable tool to identify the name of unknown organic compound in natural product materials^{17,18}. It can be shown that most of the compounds as the hydrocarbons that classify as alkanes, aldehyde, organic acid and volatile organic compounds. The identification of these identified compounds was according to the

comparison of detected m/z of peak chromatograms with the data bases in GCMS library. In this measurement, the database of national institute standard and technology (NIST) that having more than 62,000 patterns was used as a library of GCMS data base. For example, the major compound from the chromatogram was detected as the peak at retention time at 10,65 min. The compound has m/z as 199. Furthermore, the fragmentation of m/z of 199 was then compared automatically to the data base of many organic compounds in GC MS library. As the result, the name of detected peak would be classified according to the highest similarity index between the detected fragmentation and databases. The peak was identified as tetradecane due the highest similarity index compared to others. Generally, the similarity index value of > 90 is reliable¹⁹. These identified organic compounds may relate to the quality properties of the produced varnish. For development of friendly varnish products, the characteristic of hydrocarbons and volatile organic compounds are essential parameters that need to be further investigated^{20,21}.

Chromatogram

Sample Name : solvent ethanol



No	RT	Compound Name	Area	m/z	Similarity index (%)
1	6,67	Cyclotetrasiloxane	50139,7	483	95
2	8,54	Benzene	50212,7	78	95
3	10,43	Dodecane	21236,5	171	94
4	10,65	Tetradecane	146283,8	199	95
5	10,97	Disilicic acid	20031,2	174	93
6	12,6	Cyclopentasiloxane	31032,4	231	95
7	13,4	6-Octenal	139281,7	127	97
8	13,8	Cyclohexasiloxane	32076,2	445	95
9	14	Cyclopentasiloxane	27232,5	231	95

Figure 2. The GCMS chromatogram of organic compounds in *ambalau* resin that solve in the ethanol solvent

Overall, the result of this study could enhance the utility of *Durio Zibethinus Murr*. Although many studies have conducted to explore the utilization of *Durio Zibethinus Murr* for development of natural resources diversity of food and non-food products^{10,22,23}, there are no reports that focused on the potentiality of the bark's resin of *Durio Zibethinus Murr*. The utilization of natural resin has been recognizing as a potential source as the material of wood varnish^{8,23}. Therefore, strong efforts on experimental activity were performed in order to

investigate the characteristics of varnish from *ambalau* resin that derived from Durio Zibethinus Murr in this study. This is the first effort that could provide the valuable data on the production of wood varnish from *ambalau* resin. Although there were some parameters that need to be improved for better quality, the presented results might guide the researcher or practitioners to further develop the practical technology for production of varnish from natural resources. The identification of the compounds employed in applicable wood varnish provides valuable information for both the knowledge of researcher, practitioners and commercially user. In particularly, identification of terpenoid and fatty acids composition are important for improving the quality of produced varnish^{25,26,27}.

CONCLUSION

It can be concluded that varnish with considerable qualities can be produced from the natural *ambalau* resin that obtained from bark of Durio Zibethinus Murr. This result could become the basic data to utilize the natural resource of *ambalau* resin as an alternative solution that offers a chemical suitable for the production of beneficial products. Furthermore, the utilization of additional ingredients to improve the quality property such as drying time should also be considered.

SIGNIFICANCE STATEMENT

This study discovered the potentiality of *ambalau* resin for development of wood resin. This result can be beneficial for industrial that utilize the raw material from natural resources. This study will help the researchers to further develop the production varnish derived from natural resin that many researchers were not able to explore.

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