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The 30/100 Classification System as a Reference for Price of Sandalwood (*Santalum album*) Wood in Sandalwood Oil Industry

Antonius R.B. Ola[1,2], Damianus Adar[3], Anselmus Salu[4], Henderiana L.L. Belli[5], Amor T. Karyawati[6], Aloysius Marawali[5], Dodi Darmakusuma[1,2,7*]

[1]UPT Laboratorium Terpadu, Universitas Nusa Cendana, Kupang, Indonesia
[2]Program Studi Kimia, FST, Universitas Nusa Cendana, Kupang, Indonesia
[3]Program Studi Agribisnis, Faperta, Universitas Nusa Cendana, Kupang, Indonesia
[4]CV. Surya Nirmala, Kupang, Indonesia
[5]Program Peternakan, FPKP, Universitas Nusa Cendana, Kupang, Indonesia
[6]Program Studi Biologi, FST, Universitas Nusa Cendana, Kupang, Indonesia
[7]Program Studi Teknik Pembuatan Tenun Ikat, FST, Universitas Nusa Cendana, Kupang, Indonesia
[*]Corresponding Author: Dodi Darmakusuma

Abstract:- The perfume and cosmetics industry heavily relies on quality raw materials, particularly Sandalwood oil, known for its unique scent and importance in various products. The presence of a reliable Sandalwood oil distillation industry is crucial for meeting industry demands. However, determining the price of Sandalwood wood faces challenges due to quality variations influenced by factors like geographical origin and processing methods. We have proposed a 30/100 classification system developed by CV. Suraya Nirmala and UPT Laboratorium Terpadu of Universitas Nusa Cendana. The aim of this research is to determine the sandalwood oil content of several raw materials with a 30/100 classification system as a basis for determining the price of these raw materials. The classification method involves categorizing sandalwood into four classes (30, 60, 90, and 100) based on visual observations of the brown heartwood area on the cross-section of the wood sample. The comparative analysis of Sandalwood oil volume indicates variations in oil content among the different classes of Sandalwood wood samples. Sandalwood wood class 90 exhibits a 57.49% Sandalwood oil content compared to class 100. Sandalwood wood class 60 demonstrates a 33.44% Sandalwood oil content compared to class 100. Sandalwood wood class 30 showcases a 19.86% Sandalwood oil content compared to class 100. These findings serve as a reference for determining the pricing of Sandalwood wood as raw material in the Sandalwood oil distillation industry. The price of class 100 serves as the Highest Base Price (H_d), with class 90 priced at 0.5749H_d, class 60 at 0.3344H_d, and class 30 at 0.1986H_d.

Keywords:- *Santalum album, Sandalwood Oil, Price of Sandalwood Wood.*

I. INTRODUCTION

The perfume and cosmetics industry heavily relies on the quality of raw materials to produce high-quality end products, with Sandalwood oil being a crucial ingredient known for its distinctive aroma. Sandalwood oil plays a significant role as an export commodity due to its use in many perfume and cosmetic products. Therefore, the business existence and certainty of the Sandalwood oil distillation industry are crucial in meeting the demands of the perfume and cosmetics industry. Sandalwood, recognized for its oil and wood, is extensively studied for over a century, with its heartwood constituents serving as essential raw materials in the fragrance industry. Chemical analysis of Sandalwood involves various extraction methods such as distillation, solvent extraction, or newer techniques like solid-phase microextraction, highlighting its importance in the perfume and cosmetics sector [1,2,3,4].

One of the challenges encountered in the Sandalwood oil distillation industry is the process of determining the price of raw materials. Establishing the price of Sandalwood wood often poses a challenge for producers and entrepreneurs in the perfume industry due to the wide variation in quality influenced by factors such as geographical origin, processing methods, and environmental conditions. Additionally, the lack of an objective classification system for Sandalwood wood quality further complicates matters for this industry. Inaccurate quality classifications may lead to pricing decisions that do not reflect the true value of the Sandalwood wood,

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ultimately affecting the profitability and competitiveness of companies involved.

Therefore, an effective and reliable solution is needed to help determine the price of sandalwood wood raw materials. We have proposed a 30/100 classification system as an answer to these challenges. The system was developed by CV. Suraya Nirmala and UPT Laboratorium Terpadu of Universitas Nusa Cendana. The classification system represents an estimate of the potential yield of Sandalwood oil. The aim of this research is to determine the sandalwood oil content of several raw materials with a 30/100 classification system as a basis for determining the price of these raw materials.

II. MATERIAL AND METHOD

The materials used in this study were Sandalwood (*Santalum album*) wood and water. The equipment utilized included a complete distillation apparatus, a hotplate, and a 10 mL measuring glass. Sandalwood wood samples were sorted into several classes, namely 30, 60, 90, and 100, based on the 30/100 classification system. Each class of powdered Sandalwood wood sample was weighed at 100 grams and placed into a distillation flask along with 500 mL of water. The distillation process was carried out by heating the mixture of Sandalwood wood powder and water to boiling point (100°C). During the distillation process, the steam containing Sandalwood oil would emerge from the mixture and be condensed. The distillation process lasted for 3 hours. The resulting Sandalwood oil was then measured for volume using a measuring glass, and the percentage volume of Sandalwood oil was calculated for each class of Sandalwood wood sample.

III. RESULTS AND DISCUSSION

The 30/100 classification system is a visual method for determining the grade and price of Sandalwood wood raw materials. This method relies on the brown heartwood area on the cross-section of the Sandalwood wood sample. Class 30 represents Sandalwood wood with a brown heartwood area of at least 30% of the cross-sectional area, Class 60 represents Sandalwood wood with a brown heartwood area of at least 60% of the cross-sectional area, Class 90 represents Sandalwood wood with a brown heartwood area of at least 90% of the cross-sectional area, and Class 100 represents Sandalwood wood with a brown heartwood area approaching 100% of the cross-sectional area.

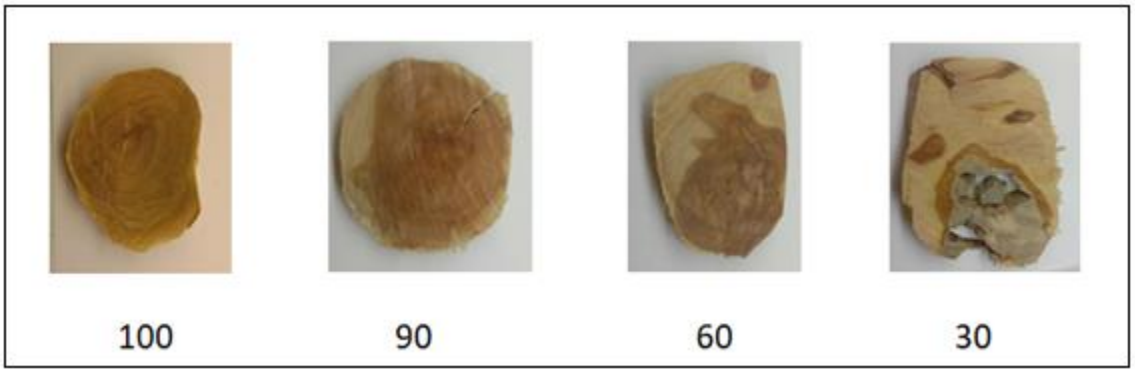

Fig 1. Cross-Sectional Depiction of Sandalwood Wood in Each Class

The following table shows the volume of Sandalwood oil for each class of Sandalwood wood samples.

Table 1. Volume of Sandalwood Oil for Each Class per 100 g Sandalwood Wood Sample

Parameter	Class of Sandalwood Wood			
	100	90	60	30
Average Volume Percentage of Sandalwood Oil (mL)	2.87±0.17	1.65±0.13	0.95±0.14	0.57±0.13

The results of this study provide information regarding the oil content in several classes of Sandalwood wood, namely classes 30, 60, 90, and 100. The comparative analysis of Sandalwood oil volume indicates variations in oil content among the different classes of Sandalwood wood samples. Sandalwood wood class 90 exhibits a 57.49% Sandalwood oil content compared to class 100. Sandalwood wood class 60 demonstrates a 33.44% Sandalwood oil content compared to class 100. Sandalwood wood class 30 showcases a 19.86% Sandalwood oil content compared to class 100. These findings serve as a reference for determining the pricing of Sandalwood wood as raw material in the Sandalwood oil distillation industry.

Based on the percentage of Sandalwood oil content in each class, a method for determining the pricing of Sandalwood wood raw material based on these classes is proposed (Table 2).

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Table 2. Determination of Pricing for Each Class of Sandalwood Wood Samples

Parameter	Class of Sandalwood Wood			
	100	**90**	**60**	**30**
Price	H_d	0.5749 H_d	0.3344 H_d	0.1986 H_d

H_d : Highest Base Price

The price of class 100 is set as the Highest Base Price (H_d). Class 90 is priced at 0.5749H_d, class 60 at 0.3344H_d, and class 30 at 0.1986H_d. This method provides ease and speed in visually classifying Sandalwood wood samples, allowing producers and entrepreneurs to quickly determine the quality of the raw materials they possess. Thus, the 30/100 classification system serves as an effective tool in supporting the process of determining prices for Sandalwood wood raw materials with greater accuracy and efficiency in the Sandalwood oil distillation industry.

The aforementioned results hold significant economic value for the Sandalwood oil distillation industry. By accurately determining the quality of Sandalwood wood raw materials through the 30/100 classification system, producers and entrepreneurs can make informed decisions regarding pricing, thereby optimizing resource allocation and enhancing overall profitability. Additionally, the speed and efficiency offered by this classification system contribute to streamlined operations and improved competitiveness within the industry. Therefore, implementing the 30/100 classification system translates into tangible economic benefits, driving growth and sustainability in the Sandalwood oil distillation sector [5,6,7,8].

In addition to the quantity of Sandalwood oil, the economic value of Sandalwood wood is derived from the presence of santalol, an aromatic compound that imparts its characteristic fragrance. This delightful aroma originates from the essential oil contained within its heartwood. The santalol content in Sandalwood oil is influenced by the age of the tree [9]. Research conducted by Mohankumar *et al*. [10] has identified the primary components of Sandalwood oil, including α-santalol (41.77%), β-santalol (18.02%), (Z)-α-trans-bergamotol (8.50%), (Z)-lanceol (6.57%), and epi-β-santalol (5.78%). Furthermore, studies by Ola [11] have revealed variations in the chemical composition of Sandalwood oil depending on the isolated tree part. Therefore, further research is imperative to determine the santalol content in Sandalwood oil from each class of Sandalwood wood classified under the 30/100 system. This underscores the necessity for additional research to ascertain the santalol content in Sandalwood oil across various classes of Sandalwood wood, thereby enhancing comprehension of oil content and quality variations and refining the accuracy of the pricing system.

IV. CONCLUSIONS

The research aimed to determine the sandalwood oil content of various raw materials using the 30/100 classification system as a basis for setting prices. The classification method involves categorizing sandalwood into four classes (30, 60, 90, and 100) based on visual observations of the brown heartwood area on the cross-section of the wood sample. The comparative analysis of Sandalwood oil volume indicates variations in oil content among the different classes of Sandalwood wood samples. Sandalwood wood class 90 exhibits a 57.49% Sandalwood oil content compared to class 100. Sandalwood wood class 60 demonstrates a 33.44% Sandalwood oil content compared to class 100. Sandalwood wood class 30 showcases a 19.86% Sandalwood oil content compared to class 100. These findings serve as a reference for determining the pricing of Sandalwood wood as raw material in the Sandalwood oil distillation industry. The price of class 100 serves as the Highest Base Price (H_d), with class 90 priced at 0.5749H_d, class 60 at 0.3344H_d, and class 30 at 0.1986H_d.

Further research is necessary to determine the Santalol content in sandalwood oil from each class of sandalwood wood classified under the 30/100 system. This additional research will provide a more comprehensive understanding of the oil content and quality variations across different classes of sandalwood wood, further enhancing the accuracy of the pricing system.

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