The enhancement of added value of agarwood by diversification product

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Abstract. Non-timber forest products are one group of commodity forest products that need to be optimally used because they are generally high value and can be utilized directly and cultivated by communities around the forest. One of the commodities is agarwood, in which the value varies greatly. Its price per kg ranges from 10 thousand to 10 million. The price of low-quality aloes, or often called kemedangan, also varies greatly from 10 thousand to several million rupiahs for each kg. Until now, agarwood is only obtained from natural products, in which its potential is depleting and has been included in Appendix II Cites IX in Florida. Kemedangan has the opportunity to increase its utilization, such as the isolation of chemical components by distillation (essential oil) and extraction using organic solvents (extracts) or diversification of products such as the manufacture of the synthetic aloes (black magic wood / BMW), incense, makmul, and hio. This paper presents, in general, the profile of Indonesia's agarwood and the prospect of increasing added value through diversification of products, such as efficient refining, extraction, and manufacturing of finished products.

1. Introduction
Agarwood (Gaharu) is one of the commodities of non-wood forest products (NTFPs), which plays an important role in the acquisition of foreign exchange. Besides, gaharu is a direct source of income from people living around the forest. Gaharu is proclaimed to be a national NTFP commodity that needs to be developed on a larger scale [1-3]. Gaharu is one of the reliable non-timber forest products, especially when viewed from very specific prices compared to other commodities. Because of its fragrant and distinctive aroma, gaharu has long been traded as an elite commodity for the needs of fragrances, cosmetics, makmul, incense, hygiene, and medicine [4]. The value of gaharu always increases from year to year. Most gaharu products in Indonesia are still obtained as natural products. Still, in the gaharu trade, it emerges and later becomes complex because the products traded are from various species. Products are traded in various forms such as chunks, chips, powders, distillates, oils, and finished products like makmul, incense, hio, and perfume. Makmul and hio are a type of candle with a distinctive aroma and sed in religious processions. So far, there are no technical guidelines or instructions that can be referred for each traded gaharu product. The function of gaharu is the content of chemical components that can be isolated through distillation to obtain gaharu oil and extraction methods to obtain gaharu extract. In this study, the main ingredients discussed were the value-added increase of the kamedangan class of gaharu, which has a low value and is very voluminous. Besides, there are not much scientific data found on the process of increasing the benefits of gaharu, such as
refining, extraction, making new products from kemedangan, and the data quality of the commodities produced. After we know that the refining techniques are easy, inexpensive, and can be applied by the community, it is expected to increase the product value and selling value. This paper aims to explain the technology of increasing the benefits of kamedangan (Figure 1a) through the process of distillation and extraction of dregs using effective organic solvents or the manufacture of new products that have a selling value.

2. Materials and methods

2.1. Product processing and diversification
Gaharu processing was carried out in a very simple way by separating the wood from the place where the gaharu product accumulated, using a special knife (Figure 1b) that is sharp and slightly curved. The results were sorted and collected based on equivalent quality.

![Figure 1. Examples of kamedangan and gaharu knife.](image)

There are some gaharu traded directly. However, if gaharu is processed further, it will increase the sale value, including isolation of gaharu oil and extracted material, making makmul, hio, and so on. When gaharu is extracted, it will produce fixative, fragrant, and soft gaharu oil needed by some elite perfume factories from Europe and America. The extraction process should be carried out on materials with a certain class quality because using high-quality grade material will make it have no added value. Conversely, using materials with low-class quality will make productivity low and uneconomical. Suhartono [4] suggested that the gaharu oil extracted from Laos was valued at around US$ 122.00/gram, or equal to IDR 736 million/kg. The quality of the gaharu distillation at the Center of Forest Products Research and Development produces an oil with a yield that varies between 0.1-0.5%. In other words, 1 kg of kamedangan will produce about 1-5 grams of gaharu oil. It was estimated that kamedangan, which suitable for refining, contained more than 0.3% oil. Residue or distillation dregs can be used as material for making similar products. In several regions in 2017, the price of refined dregs was around IDR 5000-10,000/kg.

2.2. Distillation techniques
Distillation or refining can be interpreted as a separation of the volatile chemical components based on differences in the vapor pressure of each chemical component contained in the material. Refining can be done in three ways: distillation with water, distillation with steam and water, and direct distillation with steam. In principle, the distillation consists of a steam boiler, leaf boiler, condensor (condensers and coolants), oil containers, and separators. Boilers containing water act warmly as a steam source carrying essential oils. The condenser is used to condense steam (a mixture of water vapor and essential mint) to obtain a mixture of water and essential oils. A flourentine flask can automatically separate water and oil.

The metal used for the manufacture of distillation equipment should be adjusted to the raw materials and essential oil products. Iron is an easily corrosive metal, so it is necessary to avoid
making refiners. Metals that are suitable for distillation materials are stainless steel, galvanized steel, aluminum, and tin. The content of essential oils from raw materials that will be distilled will decrease or shrink during the storage process due to the process of evaporation, oxidation, resinification, respiration, fermentation, and other chemical and biological processes. Thus, the raw materials to be processed for extraction. Extraction needs to be maintained in the environmental conditions, so as not to reduce the quality and yield obtained. Kamedangan diversification varies from the derivatization process such as isolation by distillation to obtain essential oils known as gaharu oil, isolation by extraction using organic solvents to obtain gaharu extract. Also, diversification can also be done by making finished products such as making hio, makmul or setanggi. The distillation process has been carried out by many people in several regions in Indonesia, producing gaharu oil. Gaharu oil has a high value because it is suitable and needed by manufacturers for good quality perfume with very high prices.

Gaharu oil contains 27% of 2-2-4 methoxyphenyl ethyl chrome, 15% of 2-2-phenyl ethyl chrome, 5% of o xoagaropiroli, and 3% of 9, 11 eremofiladien. The other components are selina, kusunol, jinkohol, and agarospirol. Micro components such as selina, kusunol, alcohol, and agarospirol are difficult to extract if the temperature and pressure are not correct. Those components determine the aroma of gaharu oil.

3. Results and discussion

3.1. Gaharu chemical components

The chemical components of gaharu are estimated to be more than 30 kinds. The cause of aloes fragrant nature is the guai-dienal compound, selina-dionone, and selina-dionel. The compound of sesquiterpene alcohol causes gaharu to spread a distinctive aroma when it is burned. When chromone compounds are burned at a temperature of 150℃, they can produce methoxybenzaldehydida and benzaldehydida compounds, which will spread the scent during burning. Some of these compounds at room temperature do not emit a scent, but they will give off the distinctive aroma of gaharu when they are burned. Ng et al. [5] stated that aloes from Kalimantan contained various chemical compounds such as agatroterol, iso-agaro-tetrol, hydroxy-chrome, dimethoxy chrome, and many other chemical components.

Chemical components of gaharu contain furan compounds and other groups of esters, which cause a fragrant aroma with a concentration that is not much different. According to Nakanishi et al [6], the main fragrance in gaharu is a group of sesquiterpene and phenyl ethyl chromon derivatives. The presence of sesquiterpene content varies greatly in high-quality gaharu. There are three sesquiterpenes that have a fragrant aroma, namely α-agaroturan, (-)-10-epi-gamma-eudesmol, and o xoagaropiroli. Besides, sesquiterpenes gaharu from Aquilaria malaccensis from Indonesia contain the main component of aloes oil in the form of chromon. Chromon is what causes the fragrant aroma of gaharu when it is burned [7]. Furan groups producing fragrant aromas include α-Agarofuran, β-Agarofuran, Dihydro-β-agarofuran, (1,2,6,9)-6,10,10- Tri methyl-11-oxatricyclo (7,2,1,01,6) dodecane -2-spiro-2′-oxirane (epoxy-agarofuran), 4-Hydroxy-dihydro-agarofuran, 3,4-Dihydroxy-dihydroagarofuran, Baimuxinol, Isobaimuxinol Dehydrobaimuxinol, and nor Ketoagarofuran [8].

3.2. Improvement of added value

There is a gaharu class in trading, which has the lowest economic value and does not belong to any class. Gaharu that belongs to this group gets less attention and tends not to be attracted by the market. The existence of the gaharu group class is generally caused by the sale of gaharu stems, even though they do not produce gaharu. Low-quality aloes such as kamedangan should be processed into other forms of high-value products such as isolation of gaharu oil, isolation of extracted material, making of makmul, hio, and other setanggi. Extracted gaharu will produce gaharu oil, which is fixative, fragrant soft, and needed by some elite perfume factories in Europe (France, Portugal, Spain, Italy, England) and the United States. The extraction process should be carried out on materials of a certain class quality because using high-quality grade materials will make the price too high, so there will be no added value. Conversely, if the quality is too low, the productivity will be low, so the process is not
economical. Suharto [4] stated that Laos extracted agarwood oil by fluorescence, which cost around the US $ 122.00/2 grams or 1 kg of oil was valued at around IDR 736 million. Distillation of gaharu quality at the Center of Forestry Research and Development produces an oil with varied yields ranging from 0.1-0.5%. It means that from 1 kg of kamedangan will be obtained about 1-5 grams of gaharu oil. It is suspected that the kamedangan quality that is suitable for refining contains more than 0.3% oil content. Residue or refining dregs can be used as an ingredient in making a setanggi-like product. In Berau and Riau (in 2005), 1 kg of pulp was sold at IDR 2000–4000 thousand. Darmawan's [9] suggested that aloes refining waste still contains a resin, which can be used as an ingredient in the manufacture of gaharu scented extract formulations with ethanol. Products in the form of beeswax scented extracts are preferred by 2% of respondents rather than aloes-flavored charcoal products. Wahyuni [10] reported the waste of gaharu refining could be used for manufacture mosquito repellent. The best composition of mosquito repellent with raw material for gaharu refining waste powder is the comparison of 80%:20% and 75%:25% of gaharu and gemor with the addition of candlenut powder and 10% of gewang starch from the total mixture [10]. The sample size extracted by the Soxhlet method affected the yield of resin (oleoresin) produced, wherein the size of 80 mesh produced the highest yield.

Figure 2. Improved low-quality gaharu into black magic wood (BMW).

Gusmailina [11] stated about efforts to improve the quality of the lowest grade gaharu by penetrating gaharu extract solution with impregnation technology, in a trade known as Black magic Wood (BMW) (Figure 2). The results obtained indicate that low-quality gaharu can be improved in quality based on the parameters of color, specific gravity, resin content, and the volume of the solution that enters the gaharu. The average density of gaharu increases between 0.03 to 0.20. Gaharu resin content after processing increased three to five times compared to control, ranging from 29.5 to 52.0%. It is expected that the results of this preliminary study can improve low-quality gaharu, so the value and selling price will undoubtedly increase.

Figure 3. Utilization of gaharu refining waste into cone/makmul incense and gaharu hydrosol.

Waste powder of refining gaharu oil can be made into an incense cone (makmul / Figure 3a). The refining waste powder is made into size + 80 mesh, then added 5% tapioca stirred flat, printed using a hot press with a pressure of 10 kg / cm², and a temperature of 70°C for ten minutes. Incense properties
of cones have a burning duration of + 20 minutes, moisture content + 7% with a density of 0.19 to 0.27 gr / cm$^3$.

Gaharu/distillate hydrosol in the form of residual/distillation process (Figure 3b), which has properties with pH 3-4 and has the aroma of gaharu, can be used as a useful therapeutic aroma to smooth and prevent irritation to the skin.

Efforts to increase the added value of the production process through the use of waste by making by-products are ways to increase the value and price. Thus, it will increase the efficiency of the production process.

4. Conclusion
Gaharu is a reliable commodity, especially when viewed from particular prices compared to other commodities. Because of its fragrant and distinctive aroma, gaharu has long been traded as a high-value commodity, so it needs to be used optimally. Low-quality gaharu, often called kemedangan, can be upgraded to a new product known as black magic wood (BMW). Thereby, it can increase the added value and selling prices.

5. References
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