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THE EFFECTIVENESS OF BIOSERUM INJECTION ON AGARWOOD RESIN (*Aquilariamalaccensis*) FORMATION WITH SEVERAL INJECTION HOLE DISTANCES

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Abstract

Agarwood has so high value that can trigger an excessive agarwood encroachment in nature; it threatened the agarwood availability. Agarwood cultivation was the right solution to overcome the Agarwood insufficiency. Currently, bioserum has been found to form Agarwood rapidly. It was found by Kusnadi and introduced to the public by BPDASHLWSS (The watershed management and protection forest inquiry). The formation and effectiveness process of bioserum has not been researched yet scientifically. Therefore, this study aimed to determine the success rate of Agarwood formation and the quality of Agarwood with combined injections treatments on tree branches of Aquilariamalaccensis. This research used a complete randomized design with 3 treatments. Each treatment consisted of several vertical injection hole spaces: 5 cm, 10 cm, and 15 cm. The horizontal space for these three treatments was the same, 5 cm. The result showed that the best vertical range of injection was 10 cm. Therefore, each injection hole would produce separate agarwood chips. A 10-cm vertical range injection also made the rest wood between the injection holes not too wide. This Agarwood was classified into kamedangan class with the average weight of 2 g/chips.

Keywords: Agarwood; Bioserum; Lampung inoculant

INTRODUCTION

Agarwood was first discovered in 7th century by people in Assam - India, originating from species *Aquilariaagaloccha* Rottb. Agarwood derived from the word "*aguru*" meaning heavy wood (sinking). In Indonesia, agarwood was widely known around 12th century, as shown with the existence of trading activities in the form of barter between South Sumatra and West Kalimantan people, and traders from the Chinese, Kwang Tung (Sumarna, 2013).

Gaharu-producing plants naturally grow in South Asian and Southeast Asian areas. Several names were given to gaharu: *agarwood*, *aloeswood, gaharu* (Indonesian), *ood*, *oudh*, *oodh* (Arab), *chenxiang* (China), *pau d'aquila* (Portuguese), *bois d'aigle* (French), and adlerholz (German) (Suharti, 2009).

The high value of natural agarwood leads to a worry that the group of gaharu-producing plants (Thymelaeaceae family) will be extinct. It is because the natural harvesting pattern occurs by cutting down all the trunks of tree just to take out the agarwood.

Aquilariamalacensis Lamk. is a species producing agarwood products, so that it is classified into Non-Timber Forest Products (NTFPs). This species is one of gaharu producing plants with high quality and commercial value (Suhartati, 2011).

In Sumatra, gaharu wood can be found in almost all regions: Belitung, South Sumatra, Riau, Bengkulu, Jambi, Lampung and Padang. The types of gaharu wood commonly found in Sumatra are *Aquilaria malaccensis*, *Aquilaria beccariana*, *Aquilaria microcarpa*, *Aquilaria hirta* and *Aquilaria agallocha* (*The watershed management and protection forest inquiry*/BPDASHLWSWS, 2015).

One of the technologies to develop agarwood invented by BPDASHLWSWS is to use bioserum. Bioserum is a formula to form agarwood resin induction produced by Kusnadi (an agarwood practitioner) and widely introduced to the public by BPDASHLWSS. Bioserum, according to the manufacturer's explanation, consists of organic materials. Inoculants introduced by the Lampung Agarwood Team BPDASHLWSWS are called "Bioserum Lampung Agarwood" or Bio Gaung (BGL). This technology is the latest method to produce agarwood resin with the greatest success rate of infection (BPDASHLWSWS, 2015).

The results of preliminary study using bioserum on some gaharu-producing plants (*Aquilariamalaccensis*, *Aquilariabeccariana*, *Aquilariamicrocarpa*, *Aquilariahirta* and *Aquilariaagallocha*) in several locations (Lampung Province, Palembang, Jambi, Riau, Aceh, Kalimantan or Borneo, Medan, Padang, South Sulawesi, Malang, Wonogiri and Bogor) showed success rate of 95% (BPDASHLWSWS, 2015).

In this study, resin harvesting would be carried out on tree branches. Through this method the gaharu farmers would be able to harvest annually by cutting down the branches injected. With this harvesting system, the resin on the stem could be harvested longer with better quality.

Although bioserum had been trialed several times, there has been no research studying it yet. So, more studies are needed to study the quality of agarwood produced by bioserum with various injection hole treatments. This study aims to determine the success rate of agarwood resin formation with bioserum combination hole injection on Aquilaria malaccensis branches.

RESEARCH METHODS

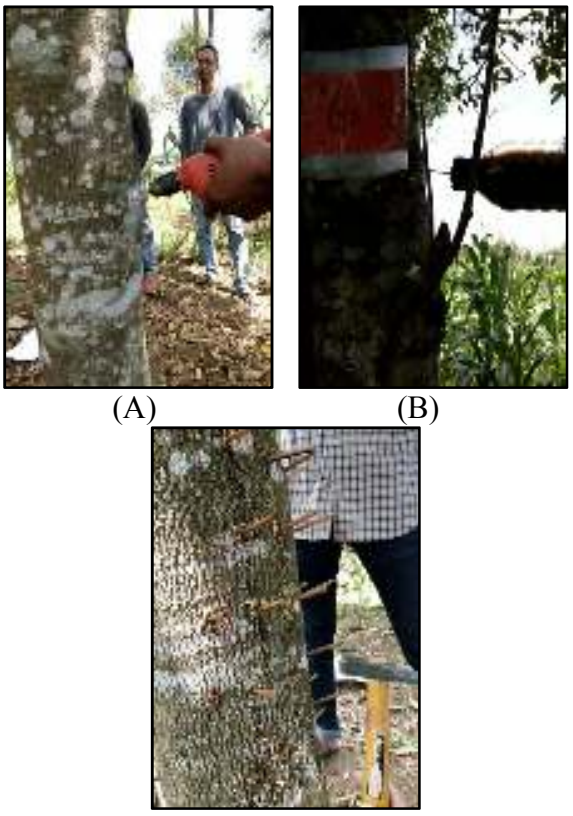
This research took place in Jojog Village, Pekalongan Sub District, East Lampung Regency, from August to November 2016. The tools and materials used were bioserum, 7-year old agarwood tree, electric drill with 4 mm drill bits, bamboo stick(L: 4cm, D: 4mm), generator sets, knives, hammers, and nails.

The inoculation technique was started with drilling the tree trunks horizontally with hole distance of 5 cm, beginning at ± 50 cm from the ground surface with a 30 degree drill position, as shown in Figure 1 (A). The depth of drill hole was adjusted to the 1/3 diameter of trunk/branch. Horizontal injection of small diameter branches (7 cm - 10 cm) was not circular but was enough with one or three holes and tried not to penetrate or blend it. The Bioserum was injected into a hole, let to stand for about 10 minutes, as shown in Figure 1 (B). Then, the hole was closed using a bamboo stick that has been soaked with bioserum, as shown in Figure 1 (C).

Observation on the results of bioserum injection was conducted by harvesting sapwood on the branch. The branch injected was cut and then separated from each of injection hole to see the agarwood form. The parameters observed were shape, color, weight and scent of agarwood. The evaluation on agarwood was intended to compare aloes resulting from bioserum inoculation with the natural agarwood. In addition to those four parameters, the mortality rate of tree injected with bioserum was also observed.

This study consisted of three vertical injection distance treatments on tree trunks and branches: Ao = vertical injection distance of 5 cm, A1 = vertical injection distance of 10 cm, A2 = vertical injection distance of 15 cm. Each treatment consists of

five repetitions with two trees for each treatment. So, the number of trees needed was: 2 x 5 x 3 = 30 trees.



(A) (B)

(C)

Figure 1. The procedure of injecting agarwood trees (A) Drilling of injection holes on agarwood trees, (B) Injection of bioserums on borehole, and (C) Holes closed with bamboo stick that has been soaked in bioserum.

RESULTS AND DISCUSSION

The process of gaharu tree inoculation lasted for 5 days, with sunny weather and daily temperature of 30^0C-31^0C. Ecological factors such as temperature, according to Kozlowski (1979) (in Sumarna, 2008), will affect metabolic and permeability processes and also viscosity of plant organ cells. Therefore, recording the temperature and weather in inoculation activity aims to determine its effect on sapwood formation. Fitter and Hay (1992) (in Sumarna, 2008) stated that the need for temperature parameters in tall plants range between 10^{o}C and 60^{o}C, that at optimum condition will contribute to biochemical process and enzyme work system.

Sunlight intensity volume reaching the forest floor plays a major role in metabolic system, photosynthesis process and respiration volume in producing developmental energy for the trees (Larcher, 1975 in Sumarna, 2008). Sunlight intensity received by agarwood tree affects the formation of sap in it. From the comparison between the sapwood on tree trunk and on branch, it turns out that the best sapwood occurs on the branch. It is because the sap on the branch receives full sunlight exposure from morning to evening, compared with the sap on the stem. Considering this, in this study the checking of agarwood product was carried out on tree branches, because the change of infection from bioserum can be seen more clearly.

Three days after the inoculation process, around the injection hole and bamboo stick covered by *Acremonium* sp. (Figure 2), *Acremonium* sp. fungus could stayed for 5 to 7 days. *Acremonium* sp. fungus proved that cultivated agarwood by Lampung Bioserum inoculant produces agarwood was similar to natural agarwood. As stated by Wulandari (2009), *Acremonium* sp. is a fungus that can stimulate agarwood trees to create Terpenoid compounds as defense substances for agarwood trees that can produce aloes resin.

Figure 2. *Acremonium sp.* fungus grows around the injection hole, 3 days after inoculation

A week after inoculation, the bark around the injection hole was skinned indicating the development of inoculation result. If the inoculation marks change its color into brown/black, it can be ascertained that the process of agarwood formation has occurred (Figure 3). The signs of agarwood formation are characterized by the changing color of the stem from yellowish white (pale) into brown and into blackish brown around the borehole (Winarsih, 2011).

Figure 3. The discoloration of gaharu wood *Aquilariamalaccensis* 1 week after injection

Table 1. The results of observation on the vertical injection treatments with distance of 5 cm, 10 cm, and 15 cm

No	Observation result	Injection distance		
		5 cm	**10 cm**	**15 cm**
1.	Sapwood	Formed	Formed	Formed
2.	The shape of the sapwood	Lengthen	Chips	Chips
3.	Sapwood color	Light brown	Light brown	Light brown
4.	Chips grade	Kamedangan	Kamedangan	Kamedangan
5.	Chips scent	Soft	Soft	Soft
6.	Tree mortality rate	0	0	0
7.	Number of injection holes	15000	7000	3500
6.	Number of bioserums (liters)	7	4,5	2,5
7.	Number of bamboo stick(pieces)	15.200	7.200	3.600

An infected *Aquilaria* tree do not show any signs or symptoms of infection and it can be found out only by cutting the *Aquilaria* tree trunk (Persoon, 2007; lung, 2011; in Kee, 2015). Agarwood is unlike other resin products, gaharu is not tapped, but accumulates inside the tree and impregnates wood tissue to form aromatic nodules called gaharu wood. Gaharu wood is produced by trees infected with a fungal pathogen only inducing resin formation (Bose 1938; Bhattacharya et al. 1952; in Paoli et al, 2001).

The result of observations shows that 3 (three) vertical inoculation treatments with distances of 5 cm, 10 cm, and 15 cm using bioserum successfully create agarwood sapwood. All vertical injection holes with distances of 10 cm and 15 cm produce agarwood chips with 4 cm length, 3 cm width and 0.8 cm thickness. At the injection distance of 5 cm, the sapwood produced by all injection holes fuses, so that the shape of the agarwood chips lengthens.The Agarwood chips resulting from the three injection distances are included into kamedangan category. Kamedangan is wood coming from trees or parts of agarwood-producing trees, containing mastic with a weak scent, characterized with its grayish-white to brownish color, coarse fiber, and soft wood. (Winarsih, 2011).

Figure 4. The Agarwood created after 3-months inoculation at a vertical distances of 5 cm, 10 cm, and 15 cm. (A) The shape of Agarwood with injection distance of 10 cm, (B) The agarwood with distance of 15 cm, and (C) The agarwood with a distance of 5 cm

Figure 5. 3-month old Agarwood Chips, with inoculation distances of 10 cm and 15 cm

Figure 6. 3-month old Agarwood chips, with inoculation distance of 5 cm

The Chips of agarwood produced by Bioserum injection at distances of 5 cm, 10 cm, and 15 cm do not show different color and odor. The agarwood chips produced is light brown, and the smell of burned sap can be felt, although it is not so strong. At a distance of 5 cm, agarwood is not in the form of chips but the resin formed is fused into other chips in each injection hole (lengthen). At injection distances of 10 cm and 15 cm, the agarwood sap formed is in the form of chips weighing 1.3 g/chips to 1.8 g/chips. However, at both distances there is enough space between the injection holes.

Considering the result of preliminary surveys and interviews with several agarwood practitioners in various locations (Jakarta, Bogor, Lampung, Bangka, Kalimantan, Papua), it can be seen that the current market demand for cultivated agarwood is based on 4 criteria: shape, weight, color and smell. These criteria refer to majority eaglewood consumers' taste in which consumers want agarwood in the form of small chips to be controlled easily in the term of quality. Harvesting is conducted at least 24 months after injection. At that time, the resin formed will be thicker and black (Kusnadi, 2017 personal communication). The current selling price of the 3 month agarwood chips is IDR 200,000/kg at farmer level and IDR 700,000 in national market (Agarwood practitioner).The selling price of 2-year old agarwood is quite high, starting from IDR. 2,500,000 / kg at the farmer level to IDR. 5,000,000/kg in the market. More than-2 year old Agarwood resin will be thicker and blacker in color with the selling price IDR. 20,000,000 / kg in the market

Herlina, (2017) stated that the blacker the color of the agarwood, the higher is the quality. The blacker and shinier agarwood indicates the high resin level contained in it. The color and resin criteria can be determined quantitatively so that the determination of quality can be more objective.

Determination of agarwood quality is currently subjective and not uniform, so that the quality of agarwood produced depends

on the person specifying it. Thus, agarwood with the same quality likely has a different quality because people specifying it differently. As a result, the price of agarwood is also different. It is possible that high-quality agarwood has low price because there is no specified provision to asses the quality of agarwood (Winarsih, 2011)

CONCLUSION

The success rate of eaglewood formation using Bioserum is 90%, with the most effective vertical distance of 10 cm. The quality of agarwood sap produced using Bioserum at the three vertical injection distances belongs to kamedangan class. The best sapwood is found in the branch of tree. It is expected further researches can be carried out at a vertical injection distance of 10 cm with different time ranges in order to find out the quality of aloes created.

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