Agarwood: diseases, applications and history



CHAPTER 2

2. OLITERATURE REVIEW

2. 1History

Agarwood, or locally known as gaharu is the world's most high-priced agroproduct from karas trees. The tree is suitable for cultivations in almost all agro-climatic conditions, especially for the climate in and around mountain area. Its cultivation is an amazement in each and every condition right from the less expenses, no maintenance costly, non-labour oriented with high returns and huge global market. There are five genera that were believed to produce agarwood. Two primary genera sold in markets are Aquilaria sp. and *Gyrinops* sp. within the family of Thymelaeaceae (Order: Myrtales and Class: Magnoliopsida). The number of species within each genus had been reported slightly differences. On the other hand, Gunn *et al*., (2003) had studied that there are 25 species belonging to the genus Aquilaria and 8 species belonging to the genus *Gyrinops*. These *Aguilaria* sp. trees usually grow in at least 12 countries: Bangladesh, Bhutan, Cambodia, Indonesia, Lao PRD, Malaysia, Myanmar, Philippines, Thailand, Vietnam and Papua New Guinea. Besides that, agarwood is a forest trees that grow rapidly which starts developing from the lower part of the Himalayas to the woodland of Papua New Guinea. Other than that, A. malaccensis is either of the 15 Aquilaria trees species at the Indo-Malaysia area. It is a immense evergreen tree that will grow up from 15 to 40 m tall and 0. 6-2. 5 m in diameter besides have white flowers (Chakrabarty et al., 1994) . Periodically, A. malaccensis and other species in the genus Aquilaria sp. were produce resin-impregnated

heartwood that is aromatic and can be highly expensive depend on the quantity of the resin of the wood.

Agarwood is one of the most valuable natural crude materials in the world, with the prices in consumer countries are range from a few dollars per kg for depressed condition material to the higher than US \$30, 000 per kg for good condition wood like first grade agarwood. Moreover, agarwood oil fetches also same in high prices. The *Aquilaria* trees frequently become infected with the major fungi such as *Phaeoacremonium* spp. and the parasite fungus or mold (*Phialophora parasitica*). Therefore, in response to this fungal attack of the tree, the aromatic resin will be produced.

A. malaccensis is distributed in south-east and south Asia. There is some distinct reports on the countries in which it occurs. *A. malaccensis* is found in 10 countries that are Bhutan, Bangladesh, Indonesia, India, Malaysia, Iran, Philippines, Myanmar, Thailand and Singapore. This tree species is suitable to live in various habitats, including the rocky area, calcareous or sandy, well-irrigated ridges and slopes also land near marsh. This karas tree growth between altitudes of 0-850 m and will increase to 1000 m, in the area with average temperatures is 20-22 °C (Keller and Sidiyasa, 1994; Wiriadinata, 1995).

2. 2 Species of Agarwood

2. 2. 1 Aquilaria malaccensis

One of the most important agarwood producing trees is *Aquilaria malaccensis.* The colour of the flower is green to dirty yellow. In Botanical

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Garden, Indonesia, the flower season occurs between September and December. Besides that, flowering season in plantation area is 2 km north of Bogor occurs April to December (Soehartono and Newton, 2001). In natural forest, seed production of *A. Malaccensis* are greater than 40 cm dbh declines, while in Botanical Garden trees of 10-30 cm dbh showed to produce more seeds than those of different sizes grown in natural forest. It was estimated that this species of 20-60 cm dbh produced less seeds than A. microcarpa, among 3, 900 and 13, 270 seeds/tree. The seeds start to germinate 15 days after sowing (Soehartono and Newton, 2001). A. malaccensis can be established in Burma, India, Philippines, Malaysia and Indonesia. In Indonesia, this trees species found mostly in Sumatra (Bangka, Sibolangit, Riau, Jambi and South Sumatra), Sulawesi, Kalimantan, Papua and Moluccas. It has been found in primary and secondary forests, especially in lowland and on hillsides at altitude of 200-750 m feet. It also grows well in sandy soils and the areas that having Keppel climate temperatures that among 14 °C to 32 °C and annual rainfall of 2, 000-4, 000 mm.

A. malaccensis can reached up from 20 m to 40 m tall and 60 cm in diameter. Other than that, the young bark will appear in light brown colour with delicate hairs while older bark is slippery and white in colour. Without resin, wood's colour is white, soft and light. However, resinous wood is compact, become dim and heavy. The leaves are characterized by it shape whether lanceolate, alternate or elliptic besides appear 3-3. 5 cm wide and 6-8 cm long with 12-16 pairs of veins. The inflorescence a terminal or axillaries umber. Its flowers are hermaphroditic, until up to 5 mm long, have smelling pleasant and white or yellowish green in colour. Besides that, fruit is green in colour, egg-shaped capsule and durable exocarp with delicate hairs which have 2. 5 cm wide and 4 cm long. Each fruit have two seeds which the colour is blackish brown, ovoid shape and densely coated with red-brown hair. There are about 1, 500 seeds per kg. The tree starts flowering and fruit a terminal or axillaries umber and medium size tree is expressed to produce about 1. 5 kg of seed during valuable seed years. Dry seasons are seasons that suitable for flowering and fruiting. Flowering and fruiting season in Sumatera is twice a year. The seasons are July-August and March-April for flowering while had matured fruits in November-December and July-August, respectively. The colour of mature fruits is blackish brown colour and they should be collected directly from the tree (Soehartono and Newton, 2001).

2. 3Kingdom Fungi

Fungi are eukaryotic organism and have been evolved from the past billion years ago. According to Wearing (2010), there were approximately 98, 000 of fungal species have been named and scientifically described besides new species were described at the rate of approximately 1200 per year (Kirk *et al.*, 2008). Besides that, scientist believed that kingdom fungi are various and more species can be exposed.

Fungi can be differentiate with other organism by a few distinct characteristics such as the presence of mycelium, dimorphic, producing spore, heterotrophy and reproduce both sexually and asexually (Wearing, 2010). There are four major groups (phyla) of true fungi under subdivisions of Kingdom Fungi which are Ascomycota, Basidiomycota, Chytridiomycota and Zygomycota. After some recent studies, additional phylum Glomeromycota has been added as the one of the major group of fungi (Alexopoulos *et al* ., 1996; Webster and Weber, 2007).

Phylum Ascomycota is known as fungi that presence of ascospore that is important for reproduction while Basidiomycota often refer to club fungi. Phylum Basidiomycota usually consist of growing mushrooms such as shitake, button mushroom and others. Phylum Chytidiomycota is a phylum with the formation of zoospores. These phyla are differing with other fungi by the presence of zygospores. Lastly, phylum Glomeromycota formed endomychorrhizae which mutualistic association (Carris *et al* ., 2012).

2. 4Diseases and pest of karas

Nowadays agarwood products have high demanded by agarwood seekers, due to their expensive prices, where the price of super agarwood can reach Rp. 40 million/kg at Indonesia. As the quite-high price, it has seduced the agarwood seekers more intensive to acquire it. Currently, the agarwood seekers have focused on finding it in Papua Island, where its natural potency at there is still quite high rather than to those in Kalimantan and Sumatra islands. With the growing limited of the karas trees in the field besides induced with its high prices, the forestry researchers, foresters and ordinary community begin planting or cultivating the agarwood trees outside their native habitats. Other than that, quite a lot of farmers as well as town people begin cultivating the karas trees in small-scale effort beginning from just several trees to thousands of trees. Furthermore, the cultivating of karas trees with monoculture system and situated outside their native habitats are usually exposed to the pest and disease attacks. For the previous two years, there are few centres of agarwood-yielding plants which suffered from the leaf pests attacked known as *Heortia vitessoides Moore*. The centre site for those agarwood plants, which were attacked by such pests and had been reported occurred in Forest Area for Special Purpose (FASP) of consecutively Carita (in 2008), Sanggau (2007), Mataram (2009) (Sitepu *et al*., 2011).

2. 4. 1 Genus Aspergillus

According to Geiser *et al* . (2006), *Aspergillus* is one of the oldest genera of fungi under phylum Ascomycota. This genus is known well as their easiness grows on laboratory media and economic importance from several of its species. Until now, there are around 250 species of *Aspergillus* (Geiser *et al.*, 2007) and more species to be classified.

Aspergillus can undergo fermentation process and produce various types of enzymes and organic acids. The production of secondary metabolites from *Aspergillus* is either harmful to human or pathogenic towards animal and plants (Machida *et al* ., 2010).

2. 4. 1 Genus Trichoderma

Trichoderma species often known as the greatest isolated soil fungi. They have capability to defend the plants and contain pathogen populations under different soil conditions. Besides that, these fungi have been universally studied and economically marketed as bio-pesticides, bio-fertilizers and soil amendments. Trichodermaspp. also produces abundant biologically active mixtures, including cell wall debasing enzymes and secondary metabolites (Vinale *et al*., 2008). 2. 5 Artificial inoculation (Agarwood bio induction technology)

There are many versions on how agarwood is formed and these had showed strongly been wrapped in myth and history. In last few decades, there are more scientific methods have been conducted. Scientists with helping from the locals tried to belief the mechanism that involved in the formation ofagarwood and conducted research based on their understanding. The experiments were including laboratory works and manifestations of plots have been entrenched in some countries, including Thailand, China, India, Cambodia and Indonesia. Generally, there are many different treatments to induceagarwood formation, such as by making some injuries. There are some extensive researches about the injured of the tree.

2. 5. 1Deliberate tree wounding using mechanical tools

The most common method is creating a wound on karas trees using hammering of nails or make injury by using blade onto the trunks has been used broadly in the past, however agarwood harvest from this treatment is commonly of inferior condition and the desired market demand cannot be meet (Persoon, 2007). Many of years are needed before a high condition agarwood is produce. However, agarwood hawker in Papua New Guinea, such as Imnai village people (Yapsiei) that knowing karas trees that injured is attempt to encourage agarwood production reported that after three year, they were able to produce agarwood of B and C grades by using this treatment (Gunn *et al* ., 2003). They thought that, according these injuries, muddy water will enter the tree through the injury are that is accountable for agarwood production. The numerous mechanical technique in encourage agarwood formation including make wounding using chisels, making a holes with screws, and bark removal with hatchets. The study showed that methods of injury had induced the agarwood or locally known as gaharu formation and was determined that during rainy season agarwood formation faster than dry season. However, by using this method, agarwood production was reported to only yield pale pleasant smell and small portion of essential oil.

2. 5. 2Deliberate tree drilling and chemical injection

This method involves making of hole in the trees and storage the wound open by put the plastic pipe in those holes followed by the injection of chemical liquid to encourage tree defence mechanism that could produces resin. The first project of this method was begun in Vietnam under guidance from Prof. Robert Blanchette, an expert pathologist from the University of Minnesota who make collaboration with local farmers and Buddhist monks. They formed exploratory plots to encourage the formation of agarwood and after done many experimental, this treatment produced agarwood. Blanchette (2003), said that this imitation induction could produce agarwood ten times speedy than natural establishment. This finding has increase tribute and has been treated as one of the most successful discovery (Persoon, 2007). This treatment had made tree responded in two defence mechanisms that are chemical and physical. Firstly the phloem cells form callus and the second callus establishment should prevent the production of the resin from the tree. Besides that, another country like Thailand is being a huge manufacturer and user of agarwood traditionally. They conducted related investigation and entrenched of agarwood tree plantation. The https://assignbuster.com/agarwood-diseases-applications-and-history/

progression of agarwood in this country has declined because of the accelerated drop in agarwood inventory from the nature. At Southest Thailand, the Krissana Panasin Company in Chantaburi has progression agarwood plantation of 700 hectares. Similar project has been made which involved experimental of much kind of methods to treat the trees in Merauke, Indonesia, Papua New Guinea and Papua by a Catholic Church.

2. 6Morphological characteristics

The major fungi that attacked on the agarwood will produce the resin that forms difference of morphological characteristic such as types of spore: macroconidia, microconidia and chlamydospores. Besides that, microconidia are smaller shape conidia. Basically, the shape of conidia can be found in the club form, reniform, obovoid, pyriform, napiform, globes or fusiform (Leslie and Summerall, 2006). Microconidia are produced in a scattered manner at the aerial mycelium and will form conidiogenous cell.

2. 7Molecular approach

Quick and simple methods were used to determine the species constitution of fungal society depended on the sequencing of particular regions of the fungal genome that proved a dependable alternative to the traditional methods. Nowadays, researcher now can immediately and precisely recognize all fungal species present within a society by using targeted amplification of specific regions of the fungal genome via the polymerase chain reaction (PCR) (Horton and Burns, 2011). According to Gardes *et al* . (1991), the spacers regions and ribosomal genes within the fungal genome had showed great candidates for amplification via PCR because they https://assignbuster.com/agarwood-diseases-applications-and-history/ preserved tracts with heterogeneous regions in between. Besides that, there are some molecular fungal species identification depend on the amplification and sequencing of the internal transcribed spacer (ITS) region of the fungal genome, which is high of changing between species or even populations of the alike species (Horton and Burns, 2011).