International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Conservation and Sustainable Use of Gaharu Producing Plants

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Abstract

Agarwood is the elite non timber commodity forest products that have had a potency as an industrial raw material. Family Thymeleaceae is a family of plant potential to produce aloes. In their natural habitats and on woodland plant, not all kinds of these would yield aloes. It was estimated that only about 10 percent that are able produce aloes resin. But the price agarwood product is high so intense hunting of these plants resulted in a number of species of the family of this making on the criteria nearly extinct according to cites criteria. Due to the reason, it has been thought there should be technique cultivation of the aloes crop properly so that in nature they would exist. Besides that there should be policies regulation on its trade and the use of these plants to ensure the availability of agarwood products.

Keywords: Agarwood; conservation; silviculture.

1. Introduction

Gaharu is a commodity of non-timber forest products (NTFP) having high economic value with consumer prices vary from 30 USD to 3500 USD/kg for quality double super [1]. This is because gaharu having resin fragrant called scent of God, despite the use of these products are not restricted only on product perfume course [2,3].

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Gaharu is also used for drug substances as an analgesic and anti-inflammatory [4,5]; toothache, kidney, arthritis, diarrhea, diuretic, liver, hepatitis, malaria, anti-poison, anti-microbial, a stimulant in nervous works and digestion [6,2,7,8,9] Further, gaharu is used in religious rituals such as rosaries and praise, and also in religious ceremonies. The purpose of the use of gaharu often is used as the basis to identify the quality of gaharu. Various criteria were used in the determination of the quality of gaharu such as the color of gaharu, levels of a resin, the density, and levels of oil, levels of fragrant, size, the form of flakes and the arrangement of the fibers [10]. The more black the color of gaharu, the higher the quality so the first quality of gaharu to be having the color of the blackest. The criteria which deals with the color is the density and of the resin content. The more solid the content the more compact the gaharu resin and its derivatives. Gaharu with blackest color and shiny show the high levels of resin contained in it. Color criteria and the resin can be determined quantitatively so that the determination of the quality is more objective. The oil well determined by gaharu color, the black the gaharu the higher the levels of oil compared to less black color [10]. Reference [11] stated that the determination of the quality of currently in nature is subjective and often not uniform, so that the quality of gaharu produced depending on ones who evaluates it. As such, there is a possibility gaharu who is supposed to have the quality of being same, but because one who appraises is different, the quality value become different. As a result the price gaharu is also different. It is possible high quality gaharu have less price because sellers do not how method of determining its quality. Hence the determination of the quality of gaharu quantitatively is indispensable. Some parameters that could be referred to for ascertaining the quality of gaharu quantitatively among them were levels of resin, levels of oil, the number of ester or standard extractive. High quality gaharu containing levels resin, levels of oil, the number of ester or high standard extractive. Thus the standard determination of value gaharu quantitatively and qualitatively can be determined precisely and the sustainability of gaharu product can be maintained.

2. Sylviculture the gaharu producing plants

The development of the various usage and an increase in demand in the market for gaharu product continues to rise, thus this might have a direct impact on the availability of the gaharu in nature. Approximately, 70% of gaharu needs are obtained by traditional community. Concerns on potential extinction of producing gaharu has led to the need for supervision and control in trade arranged in CITES systems through restrictions trade quotas. Other than that increasing efforts in cultivation of plants/trees producing gaharu and development of inoculation technique is expected to artificially increase gaharu production.

Product of gaharu, resin is the result of interaction between a fungus with plant of Spermatophyta, Class: Dicotyledoeneae with 3 families: Thymeleaeceae, Euporbiaceae, and Leguminoceae [12,13]. Among all the families, 6 genus were derived from the family Thymeleaceae namely: *Aquilaria*, *Aetoxylon*, *Enkleia*, *Gonystylus*, *Wikstroemi*a, and *Girynop*s. Family Euporbiaceae has only genus *Dalbergia* while family Leguminoceae has genus *Exocaria* which is potential to produce gaharu[14].

Gaharu producing trees generally grow upon the low plains until the height of 750 meters above sea level [15]. But there is some of the crop of gaharu can grow in lowland forests with latitude between 140- 700 meters above sea level depending on the plant, for example *Girinops verstegii.* These plants are able to live at an altitude of 1.700 meters above sea level (ASL). Reference [16] stated that the condition of ecological location the spread of place growing the types of tree producing gaharu be at air temperature between 24-32^{0}C with moisture between 80-90%, with precipitation between 1000-1500 mm/yr. The nature of the land to grow mostly are podsolik type with the soil structure loam/ clay sandy/road, texture-land marginal to topography from the lowland and or mountains with an altitude between 0 - >700 meters above sea level. Of the crop of gaharu we herbs pioneer who at phase vegetative growth need the shade, so it does not require specific land, even often found several different kinds of trees producing gaharu growing on marginal road land and hilly that is optimal [17].

Morphology of gaharu producing plants generally have oblong leaves with length between 5 – 8 cm, width 3-4 cm, pointed tipped, and dark green shiny. Flowers are at the edge of or armpit up and down leaves. Fruit be in pods shaped ovoid or tapering, in length about 5 cm and width 3 cm. Ovoid acorns covered feathers silky fur reddish colored [18]. But morphology specific in each species of plants shows differences in between species, even in one species by this environmental condition different we will find some sighting morphology different [19].

The flowering the types of the crop of gaharu generally started the dry season and fruit cook on the beginning of rainy season [15]. Size diameter plants start flowering varied, for certain kinds of *Aquilaria becariana* the process of flowering happens when start sized plant in diameter < 10 cm, different with a kind of *Aquilaria malacensis* who reached the level of ripeness reproduction on the size diameter of the stem 35 cm [15,20]. A single crop it is estimated that capable of producing 19,000 seeds. Viabilitas seeds lasting less more than one weeks and germination took place between 15-60 days [21]. The level of the germination of seeds different in any species. Seeds of the crop of gaharu are rekalsitran [15]. Seeds rekalsitran generally fast sprout and cannot be kept for long periods [22].

The growth rates seedling under plants carrier in the natural forest are generally relatively low. Various environmental factor and biology expected affect the level of growth and development sprouts. Thickness litter in the forest floor believed to be factors barrier main the success of the development of sprouts. Distribution pattern of seedlings in the forest shows distances that were quite diverse between the parents with saplings underneath. This indicates that light is an important factor that influences the level of growth the beginning of type of the crop of gaharu [20].

Hatchery activities for gaharu producing plant needs to be conducted to deal with scarcity crops in nature. It is estimated that only 10% of plants in nature forest containing sapwood as the result of infection naturally [23]. For this hatchery breeding and the plants producing gaharu is required.

Development of gaharu producing trees do not yield a wood but to produce a resin gaharu formed from the interaction of plants with microorganisms. The cultivation of the gaharu producing crops really need the input science and technology to grow and producing optimal gaharu resin. Knowledge and technology supports are very much related to the aspect of a nursery until inoculation to stimulate proper gaharu [24]. The development of inoculation techniques on the crop of gaharu has been developed [25], for the purpose of improving the production of gaharu .

3. The formation of gaharu

Gaharu is non timber forest product (NTFP) of resin resulting from several different kinds of trees producer gaharu who interact with microorganisms especially of a group of fungi [23] and producing accumulative resin in the tissues plants. The process of the gaharu in tree producing gaharu, until now is still observed. Nevertheless, the researchers believed that there are three elements cause the process of an infection in tree producing gaharu, which are (1) an infection caused by pathogenic, (2) wound on plants and (3) the non-phatology process.

Pathogenic plants are activity microorganisms that infects and disturbing physiological plants in continuous then adapt and develop in the bodies a host so as to cause plant disease. In the process of infection this plant will do inhibition in the tissues a plant either mechanically and chemically [26]. Based on that response, so mechanism resistance crop can be based on two groups:

1. Mechanism of passive resistance if the this mechanism existed before inoculated herbs pathogens and serves to prevent do not come in or to prevent the development of pathogenic further .Herbs have passive security have the structures morphology that causes difficult infection by pathogenic .For example , they have the cuticule thick epidermis , the layers candles and have slightly stomata .

2. Mechanism of active resistance happened after plants were attacked by pathogenic. Mechanism arising in the system genetic of a host and pathogens interact with reaction a host [27] to prevent the development of pathogenic own. Generally the method of survive active occur more frequently. For example, defensive structure cell walls. Defensive structure cell walls covering change morphology in the cell walls or the changes caused by the reaction cell walls because of the attacks pathogenic .Mechanism active security is the result the physical and chemical properties herbs that limits the development of pathogenic.

The mechanism formation of gaharu in tree producing gaharu until now has still not been well understood, but the formation is allegedly part of a defense mechanism plants to a series of patogenesis [28]. To the mechanism of induction, pest or pathogenic will trigger plants form as immune system.

Attack and pathogenic infection in this case *fusarium* sp can disrupt physiological process resulting in the change the morphology of plants [29]. The changes can be local symptoms and systematic symptoms. Local symptoms is a symptom that there is only in the primary inoculation, that can be seen with supervise morphological change. While systemic symptom is a symptom that occurs deep from the inoculation so that their observations needs to be undertaken by using the microscopic tools to observe changes that occur in anatomical aspect of the gaharu producing plants [27].

The cells and tissues plant will react to destruction caused both by pathogenic and chemical agent and, through a series of biochemical reactions devoted to isolate disorder and to heal the wound. The repercussions often connected to the production of substance of toxic fungis all over wound site. Toxin substance produced by plants is a compound fitoaleksin in the tissues of plants. Fitoalexin produced by cells healthy adjacent with the damage and necrotic in response to a substance diffuses from the damaged cell. Fitoalexin accumulates around tissue necrosis that are vulnerable and hold. Plant security happens when one kind of fitoalexin or more reached concentration sufficient to prevent pathogenic developing.

Fitoaleksin production in plants is stimulated by the presence of the substance of certain pathogens called elicitor [26]. Next [26] said that some elicitor are unspecific are pathogenic in a race that has no fitting and cause heaping fitoaleksin without regard to cultivars of herbs .However some elicitor fitoaleksin are specific, because of the accumulation of fitoaleksin caused elicitor parallel by suitability or incompatibility cultivars of herbs. While most of elicitor fitoaleksin allegedly came directly from pathogens, but there were several elicitor produced by plants as responsive to infection or released from the cell walls of a plant after some reshuffle cell walls of plants by an enzyme in the cell walls of resulting pathogens.

The results of the observation conducted by [13] shows differences in the anatomical characters in gaharu plants of *Microcarpa* which is inoculated and not inoculated with Fusarium. This difference in plants inoculated, wood color is mainly around the injection spot a bit more dark compared with the plant not inoculated. The change of wood color becomes of the chocolate color (browning) can be caused by assault pathogenic (boletus and damage physical [30]. The change of color wood from white to blackish brown is an early symptom in the establishment of the gaharu compound [31].

Indication of engineering success in the formation of gaharu through inoculation characterized by the occurrence of a change physiological processes caused by the factors that cause the disease so clear can be seen from the symptoms that is the change of color of the stem from yellowish white (livid to blackish brown and discoloration of the or form to leaves which yellowing or dwarf [18]. Tissue stems a colorless tanned around a drill whole showed accumulation of fitoaleksin compound has happened and sesquiterpenoid as response wounding or fungal infection of *Fusarium sp* [25]. The success of engineering the formation of gaharu closely related between the performance of disease (of fungi with the condition of ecological, edafis and the local micro-climate that is a physiological response herbs towards an attack from microorganisms.

Sesquiterpenoid is found in the formation of gaharu known as a compound defense type fitoaleksin in plants. This compound is a metabolite secondary produced by plants and serves as defense to external influences such as environmental influences and disease [28]. A metabolite secondary or substance extractive plants can act effectively against pathogens and agent disease due analogous to certain vital components of systems cellular signals, or could be involved with vital enzymes and impeded the metabolism [32]. A metabolite secondary on a terrace wood can defense plants to destroyer agent although the impact very varied at a great variety of habitats [33]. The concentration of a metabolite secondary varied between species, tissues, trees in the same species, and across season. Response given by plants as interaction happened with blight is conducted synthesis various molecule toxic good protein molecules and non-protein that serves as a protection against a pathogen [26]. Wound of plant tissue is expected to induce synthesis of certain phytochemical compounds as response in plants [34].The networks in accumulating resin in Aquilaria have been known [35], but the network which secretes it is unknown [36]. Expected tissue that secrete resin is parenkima phloem consisting of living cells storing starch, fat, and organic compounds, and accumulates some of metabolite secondary as tannin and resin [37]. Reference [18] said that a disease in the form of gaharu have physiological ties between the tree with the condition of ecological environment according to scatterred growing trees, because all the biological objects in accordance with endemic value and edifies center place of having of closeness by the process bio-physiology growth rate growing. This is in accordance with previous research about gaharu more focused in specific fungi to stimulate the establishment of the gaharu .Some research in fungi caused of the establishment of the gaharu different from on each tree.

The success of inoculation and stressing also closely to do with the ability of formed antibodies if trees are troubled by biological disease. If phenols as an antibodies succeed against the disease, the formation process of gaharu be stunted or not even is to be formed gaharu. In contrast if the disease succeed against antibodies tree phenols will target gaharu resin gaharu with chemicals component of alpha-betha agarofurol [18].

4. Conservation Strategy

Increasing demands of gaharu from year to year with high price of selling caused the the higher and uncontrolled intensity of wild harvested derived from natural forest, especially the high quality type of gaharu. This resulted in the scarcity of several species of the gaharu producing crops in the wild due to the uncontrolled and disregard the conservation factors. The lack of knowledge to differentiate gaharu producing trees and not also worsening the condition of these plants in nature because the gaharu collector cutting down trees in a speculative perspective. If finally the tree do not containing gaharu after shelled and enumerated, the tree was left. The way hunting continues so the population of gaharu producing crop be on the verge of scarcity. Furthermore, all species within the genus *Aquilaria* are now listed in Appendix II of CITES (Convention on International Trade of Endangered Species) on wild flora and fauna since 1994, including all gaharu related products [2;18]. This means that a permit is required for export or import of gaharu from genus *Aquilaria* because gaharu resulting from this type produce the high quality of resin and hence is very interested in by traders and gaharu consumers.

Reference [18] reported that traditional gaharu collection by the community was not supported by knowledge related to features and the nature of the physiological of a tree producing gaharu and speculative in nature. Any trees were directly cut down, then enumerated of all over the tree such as stems, branches and roots to find gaharu parts. The condition would cause a significant decrease in the potential of the gaharu crop growing naturally.

Conservation activity is a natural resource management for its use has to be done wisely to ensure the continuity in order to maintain and improve the quality of diversity and value. Although control strict has been in place through cites in its trading, demand for gaharu steadily increased and encouraged excessive harvesting. This needs to be done in a gaharu trade system to be more transparent and responsible to address the threatening factors for its sustainability. It is stated in CITES convention that the gaharu exporting countries must be able to secure its sustainability through restriction efforts and control. The effort to control these trades could be done through the determination of quotas based on harvest in each exporting country.

5. Conclusion

Gaharu producing plants are becoming limited in nature due to uncontrolled hunting. Therefore, it is neccessary to cultivate this special plant by determining plant characteristic and suitable growing area. In addition, the government should control and regulate the harvesting and provide socialization to local community on the process of gaharu formation in this plant to address uncontrolled hunting so then the quantity can be maintained.

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