Trials of frankincense harvesting using organic stimulants

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Abstract. Generally, frankincense resin is used as a raw material of the cosmetic and pharmacy industry and is often used as traditional rituals related to mystical things. However, the information related to the stimulant application on frankincense tapping is lacking even not available yet. This article aims to provide the initial information on frankincense tapping technic using three organic stimulants. The trials were conducted in one of the community forests in Dolog Sanggul, North Sumatera. The trees sampled were 40 with an average diameter of 17.07 cm that adjusted with the variable used. Organic stimulants used in this study were wood vinegar, galangal, and lime. The result showed a) the organic stimulant was potential to be applied in frankincense harvesting based on the productivity of produced resin; b) the application of three organic stimulants in frankincense harvesting affected the resin production compared to the control (without stimulant), and c) the resin yield varied between 0.177-1.051 gr with a harvesting period of one month. As an illustration, the resin yield of one frankincense tree averagely 0.1-0.5 kg per year with a harvesting period of 3-4 months without stimulant. The innovation of frankincense harvesting is necessary to improve the efficiency and effectiveness of the stem wounding process and stimulant application.

1. Introduction
Frankincense resin is widely used as cosmetic and pharmaceutical materials. In the industrial sector, frankincense is used as a perfume binder so the fragrance does not quickly disappear. By the Javanese people in ancient times, frankincense was used for a cigarette mixture (klembak cigarettes). Furthermore, it was also used in traditional rituals (funerals) and many benefits of frankincense were associated with the mystical world.

Indonesia was once one of the exporting countries of frankincense resin. The export volume of frankincense from North Tapanuli reached 1913 tons or equivalent to 601,000 guilders in 1939 [1]. Meanwhile, in 1978, the export volume of frankincense decreased to 323.6 tons that equivalent to US$ 143,800 [1]. Then, frankincense production continued to decline until 1996, as much as 66.8 tonnes or equivalent to US$ 186,001 that exported from North Sumatra.

Furthermore, it was explained that frankincense from North Tapanuli has been marketed 80% to Java Island and 20% exported to Malaysia and Singapore [2]. During 1991-1993, frankincense plantation in the North Tapanuli area reduced from 17,466 ha to 17,299 ha. It was due to the absence of replanting efforts of frankincense plants by farmers or related agencies. Meanwhile, its exploitation continued to increase every year [3]. The area decrease of frankincense plantation in the community forest of North Tapanuli from 2001-2009 elaborated by Table 1 [4]. It shows that the area of frankincense plantation highly declined in 2002-2003, which was around 24.28%. In the following years, areas of frankincense plantation in North Tapanuli did not show a significant increase.
**Tabel 1.** The area changes of frankincense plantation in North Tapanuli District year of 2001-2009.

| Year | Total area (ha) | Area of frankincense plantation in community forest (ha) |
|------|---------------|----------------------------------------------------------|
| 2001 | 379,371       | 21,387                                                   |
| 2002 | 379,371       | 21,417                                                   |
| 2003 | 379,371       | 16,217                                                   |
| 2004 | 379,371       | 16,282                                                   |
| 2005 | 379,371       | 16,282                                                   |
| 2006 | 379,371       | 16,395                                                   |
| 2007 | 379,371       | 16,414                                                   |
| 2008 | 379,371       | 16,414                                                   |
| 2009 | 379,371       | 16,414                                                   |

The frankincense tapping method used by the local people is injuring tree trunks using particular tools and then covering the wound back. This method has been used for generations. The imbalance between resin production and potential frankincense stands from year to year threatens its management sustainability in the future. Moreover, the distribution area of frankincense is limited to Sumatra and Kalimantan. Generally, the frankincense stands are cultivated by the community around the forest. Economic demands and increasing market demand on frankincense resin have triggered overexploitation to resin harvesting. It indicates that the sustainability of the frankincense stands management is not guaranteed.

On the other hand, the production of sap or resin of sap/resin-producing plants, such as pine, rubber, and jelutong, can be increased through applying stimulants [11-13]. It intends to stimulate the release of more sap/resin from the sap/resin ducts. All this time, information about the stimulant application on frankincense resin tapping is still lacking. It might be caused by there is no stimulant application yet on the tapping process or the absence of scientific information. Therefore, a trial on stimulant applications on frankincense tapping that are safe and environmentally friendly is needed to increase the production and quality of the resin produced and ensure the sustainable management of the frankincense plant.

2. Materials and Methods

2.1. Study site
The research site is located in the community forests of Pollung District, Humbang Hasundutan Regency, North Sumatra Province. Humbang Hasundutan is located between 2°1'-2°28' N latitude and 98°10'-98°58' E longitude (Figure 1). The total area of Pollung District is about 32,736 ha with an altitude range between 1000-1500 m above sea level [5]. Pollung District has an average rainfall of 180.13 mm per month. Frankincense is the main commodity of smallholder plantation crops in Pollung District. In 2019, Pollung becomes the number one frankincense producer in Humbang Hasundutan Regency with an area of frankincense plantation reaching 1772.5 ha and annual production reaching 1804.91 kg ha⁻¹ year⁻¹ [6].

2.2. Materials
The materials used in this study are matured frankincense trees (*Styrax sp.*), galangal (*Alpinia galanga*), wood vinegar, and lime (*Citrus aurantifolia* Swingle). The tools used in the study are measuring tape, bark shaver, freshening knife, ax, resin container, clear plastic bag, scales with a measurement accuracy of 0.1 g, stationaries, machete, whetstone, hammer, and nails to hold the resin container.
2.3. Data collection and analysis

Organic stimulants used in this study were wood vinegar, galangal, and lime. The replication of the sample trees used was ten sample trees. Therefore, the total number of trees sampled with the treatment and control trees observed were 40 frankincense trees with an average diameter of 17.07 cm. We measured 40 tree samples during October-November 2014. In this study, the selection of tapped trees was left to the tappers and frankincense resin harvested after one month tapped.

The results of the resin production based on those treatments then analyzed by ANOVA. The significant difference of each treatment was analyzed by the F test value of the ANOVA. Furthermore, if it was significant, so the Least Significant Difference (LSD) test was performed. It was to determine a significant difference between each treatment combination.
3. Results and Discussion

3.1. Frankincense harvesting in Pollung Sub district

Generally, frankincense trees are tap when they are flowering or fruiting. Frankincense was tap after the tree's diameter is about 20-30 cm or ten years old. Generally, frankincense was tap when the tree is flowering or fruiting. The tapping wounds were executed on the main trunk about ±20 cm until ±3 m above the ground with an alternating pattern (right-left). The distance between tapping wounds was about 20-30 cm. The tapping wound was established by slicing the bark, not until the barks fell off (Figure 2). The slice was about 3-4 cm parallel to the length of the stem using a tapping tool, namely the panutuk. Then, the wound was covered with the bark that was cut earlier and beaten used the panutuk about 3-4 times. The tapping of frankincense practiced by farmers in Pollung normally does not apply stimulants.

![Panutuk, Agat, Guris](image)

Figure 2. The wounding process on frankincense tapping (a), tapping and harvesting tools used by the Pollung farmers (b), and harvested frankincense resin (c).

After getting injured, the tree left for about 3-6 months to harvest the resin produced. The harvesting of frankincense resin was performed using a particular tool called agat. Tapping wounds which covered by the bark would be open again. Its resin would be stuck on the bark and the tapping wound (Figure 2). The resin was very sticky to be touched.

3.2. Stimulants application on resin production

The frankincense resin produced by the trees that getting treatment of organic stimulant is presented in Table 2. It shows that the resin produced is varied, either by applying stimulants or without stimulants. The tapped frankincense stands harvested within one month have produced resin. The variation of the frankincense resin produced is an average of 0.177-1.051 grams.
The harvesting of frankincense resin is usually carried out after 3-4 months after the tree got injured [7,8]. It helps the resin getting drier and gain the resin yield. Generally, the frankincense resin produced from one frankincense tree is an average of 0.1-0.5 kg per year [7]. The frankincense tree tapping has
been performing without stimulants. A long period enough (3-4 months) between wounding time and resin harvesting indicates that resin discharge did not occur at the time of injury. This condition is different from pine, rubber, or jelutong. Its sap/resin will immediately come out from the tapping plane or the injured part. It is a kind of tree self-defense from outside attacks such as insects, fungi, or other germs.

Observations on the anatomical structure of tapped frankincense wood showed that the resin ducts formed when the tree getting injured, those resin ducts are known as traumatic resin ducts [9]. These traumatic resin ducts did not find in trees that have not been tapped or attacked by insects. Furthermore, it also reported that large traumatic resin ducts were found on the initial timber growth boundary [10]. Resin ducts produce resin to cover wounds caused by tapping. In other words, the resin produced is the secretion from traumatic resin ducts of the frankincense tree as defend.

4. Conclusion
Wood vinegar, galangal, and lime are potential organic stimulants for improving the efficiency and effectiveness of frankincense harvesting. The application of those stimulants affected resin production of frankincense compared to without stimulants. The frankincense resin yield varied between 0.177-1.051 g with a harvesting period of one month. In most cases, one frankincense tree produced resin of about 0.1-0.5 kg per year with a harvesting period of 3-4 months without stimulant. Therefore, organic stimulants are also potentially shortening the harvesting period on resin harvesting.

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