



The Influence of Gum Inducer Solution Administration on the Gum Production of the Jaranan Plant (*Lannea coromandelica* (Houtt.) Merr.)

Hidayat Teguh Wiyono^(✉), Selin Monika Prihasinta, Dwi Setyati,
and Nadhea Ayu Sukma

Department of Biology, Faculty of Mathematics and Natural Sciences, University of Jember,
Jember, Indonesia
teguh.unej@gmail.com

Abstract. Jaranan plant (*Lannea coromandelica*) grows massively in the buffer zone and utilization zone of Baluran National Park. This plant produces gum in branches and stems. Local people extract gum by cutting down stems as medicine for diarrhea, typhus, and eye infections treatment. The study aims to test gum extraction techniques without cutting down stems that do not cause serious damage to the plants. The research was conducted in March-June 2020 in Sidomulyo, Sumberwaru Village, Banyuputih Situbondo. The research method is carried out by drilling rods combined with the administration of ethephon as a Gum Inducer Solution (GIS). The design of the study is factorial (2x2) with GIS concentration and rod circumference factors. The plant sample used a population sample of 62 trees. The gum retrieval technique is done by drilling rods, then on each borehole inserted 3ml GIS. Gum collection is done every 7 days for 3 weeks. Data analysis uses Two Way ANOVA and GLM-Repeated Measures (SPSS 17). The results showed no effect on the size of the trunk circumference on gum production ($p = 0.974 > 0.05$) while GIS concentrations of 1.5% produced an average total gum of 33.2 gr/tree, which differed significantly ($p = 0.002 < 0.05$) with a GIS concentration of 1% (21.24 gr/tree). There is no interaction between the size of the bar circumference and the GIS ($p = 0.133 > 0.05$). This study concludes that gum production is not influenced by the size of the circumference of the rod but is influenced by gis concentration.

Keywords: *Lannea coromandelica* · Gum · GIS · Trunk circumference · Ethephon

1 Introduction

Gum is an exudate produced by a plant due to pathological conditions, that contains a mixture of hydrophilic polysaccharides [1]. Gum has long been known as arabic gum, produced by the genus *Acacia* that dominant grows in arid regions such as Arabia, Africa, and India [2]. Commercially produced gums include gum arabic (of the genus

Acacia), ghatti gum (*Anogeissus latifolia*), neem gum (*Azadirachta indica*), karaya gum (*Sterculia urens*), jhingan (jaranan plants) gum (*Lannea coromandelica*), and Mesquite (*Prosopis juliflora*) [3].

Jaranan plants are plants that can produce gum [4]. Jaranan plant gum is known as jhingan gum [3, 5]. This plant has a grayish brown stem surface color, compound-type green leaves that squint odd, and infinitely yellow compound flowers that grow at the ends of stem branches [6, 7]. Jaranan plants will secrete gum when infected with microbes, injuries, and the presence of chemical compounds in the form of ethephon in response to self-defense [8]. Jaranan plant gum is hydrophilic (very soluble in hot water) and cannot dissolve in oils or organic solvents such as hydrocarbons, ethers, and alcohols. Jaranan plant gum is polar and acidic due to the presence of tannins and phenolic compounds [5, 9]. Gum as a natural ingredient is beneficial in maintaining the health of the body, providing nutrients, and as a therapeutic ingredient to prevent or treat many diseases in the body [10]. Gum produced by the jaranan plant is used as a typhus medicine, for eye infections, diarrhea, and sprains [11]. Based on research by Duppala et al. [5] jaranan plant gum tested with 3% iodine in alcohol showed negative results. This indicates that the gum of jaranan plants is no starch and contains polysaccharides.

Gum production is influenced by two factors, internal and external factors. Internal factors that affect gum production include genes, the size of the circumference of the trunk, the height of the tree, and the condition of the header [12]. Some of these internal factors are related to plant physiological activity when under stress. A larger rod circumference can produce more gum. This is because thick logs have more sap channels [2]. External factors that affect gum production are light, temperature, tapping methods, and the use of induction [13].

Jaranan plants many found growing in Sidomulyo, Sumberwaru Village, Situbondo Regency. Gum produced from jaranan plants has long been used as a medicine for diarrhea, typhus, and eye infections by the karangtekok community. Local people collect gum by cutting down plant stems. In terms of ecology, this method has an impact on the reduction of tree stands so that it disrupts the ecosystem on the land. To prevent further damage to the ecosystem, this research was conducted through rod drilling techniques combined with Gum Inducer Solution (GIS). GIS is a synthetic ethylene compound, phosphate, and chloride ion that is widely used as a regulator of plant growth. Ethylene is generally also synthesized in plants in response to environmental stresses, such as drought, waterlogging, salinity, and mechanical injuries [14]. Gum production can increase due to stem wounds induced by the hormone ethylene. Ethylene, which is supplied artificially through the use of GIS, can accelerate the stress response by forming more traumatic ducts [15]. Traumatic ducts are formed from parenchyma cells after the ethephon is applied to plant stems. In the jaranan plant, there is a separation of epithelial cells to form gum secretion channels. Vasishth's [8] research proved that the production of jaranan plant gum increased through a combination of drilling and GIS induction by 66.94 g/tree.

2 Materials and Methods

The research was conducted in Sidomulyo, Sumberwaru Village, Banyuputih Situbondo Subdistrict in March-June 2020. The study design was prepared by factorial (2x2) which

is a factor 1 GIS concentration and factor 2 size of rod circumference. The concentration of GIS used is 1% and 1.5% while the size of the rod circumference used is 30–50 cm and 51–112 cm. The selection of jaranan plants is carried out in uniform environmental conditions. The combination of treatments carried out in this study is as in Table 1.

The research method is carried out by drilling the rod at a point 130 cm from the ground level using a drill bit of 10 mm depth of 4 cm, then in the hole injected GIS as much as 3 ml (Fig. 1). The sample used was a sample of a population of 62 trees.

Gum harvesting had done every 7 days for 3 weeks. Each bottom of the borehole was paired with plastic cups to hold the gum that comes out and prevent the gum from falling to the ground. Gum that was ready to be harvested, was collected in plastic bags that had been given treatment. The gum was obtained, then weighed its weight using digital scales. Abiotic parameters in the form of temperature and humidity of the air in the study were measured using Thermo hygrometers as much as 3 x at different points to support the discussion of gum production of jaranan plants.

Data on gum weight is analyzed statistically using the Two-Way Anova test at the level of signification (0.05) to determine the difference in the effect of GIS dose and rod circumference and the interaction of both of the average gum production of jaranan plants on the treatment given. General Linear Model-Repeated Measures statistical test was conducted to determine the correlation of gum production of jaranan plants with harvest time.

Table 1. Study design factorial (2 x 2)

Rod Circumference	GIS Concentration	
	1%	1,5%
30–50 cm	P1	P2
51–115 cm	P3	P4

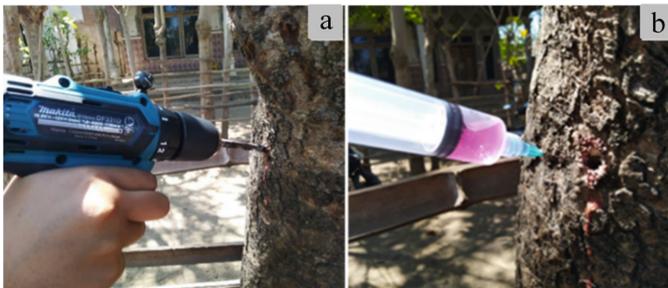


Fig. 1. Gum extraction methods. a) jaranan plant stem drilling, b) GIS injection in jaranan plant stems.

3 Results and Discussion

3.1 Effect of GIS Administration on Jaranan Plant Gum Production

Based on the results of the Two-Way ANOVA test for GIS addition obtained a significance value of $0.002 < 0.05$. The results showed that there was a significant influence of GIS addition on the average total gum production of jaranan plants. The average total gum production of GIS addition of 1% and 1.5% are presented in Table 2.

The use of GIS concentrations of 1.5% resulted in an average total gum production of jaranan plants (31.00 gr) higher than GIS treatment concentrations of 1% (21.23 gr) (Table 1). It is suspected that GIS in jaranan plants will release ethylene gas as exogenous ethylene in the tissue. The greater the concentration of GIS, the more ethylene is released into the xylem and phloem. This statement is supported by Harsh and Tewari’s research [2] with the increasing number of ethylene that will increase the traumatic duct around plant epithelial cells. This increase in a traumatic duct is formed by the presence of chemical induction compounds in the form of GIS that will make the plant become stressed. Stress will cause gum production to increase because stress will increase the synthesis of endogenous ethylene and ethylene is what initiates the formation of gum.

The control treatment or without the use of GIS in this study was unable to produce gum in boreholes (Fig. 2a). This is suspected in the treatment of controls even though it has been given the injuries, but without GIS, the endogenous ethylene produced by jaranan plants may not be able to trigger gum formation. The absence of exogenous ethylene derived from GIS will be hydrolyzed into endogenous ethylene in gum-producing tissue cells, as a result of which ethylene biosynthesis and the formation of gum-producing channels (traumatic ducts) are inhibited (Fig. 2b). It also causes no formation of gum on control treatment [16].

3.2 Effect of Rod Circumference Size on Gum Production

Based on statistical tests showed that for the bar circumference the value $F = 0.001$ with a significance value $p = 0.974 > 0.05$. The results showed that H_0 was accepted and H_1 was rejected meaning that the size of the different stem circumferences did not affect the gum production of jaranan plants. The average total gum production based on the size of the bar circumference is presented in Table 3.

The average total gum production of jaranan plants at a stem circumference of 30–50 cm is 26.071 gr, while the size of the trunk circumference of 51–112 cm produces gum of 26.167 gr. Based on Table 2, the production of jaranan plant gum is not significantly different in different stem circumferences. Other studies have also mentioned that

Table 2. Effect of GIS Concentration on gum production

GIS concentration (%)	Total average. Gum production (g) ± SD
1	21,238 ± 0,76 ^a
1,5	31,000 ± 2,54 ^b

* Different letters on an upper script show a significant difference ($\alpha = 0.05$)



Fig. 2. a) Jaranan plants with control treatment, b) jaranan plants with GIS drilling.

Table 3. Effect of rod circumference on gum production

Size of rod circumference (cm)	Total average. Gum production (g) \pm SD
30–50	26.071 \pm 2,70 ^a
51–112	26.167 \pm 1,30 ^a

Acacia senegal gum production produced no positive correlation with the size of the trunk diameter. Other studies have also mentioned that *Acacia senegal* gum production produced no positive correlation with the size of the trunk diameter. The small diameter of the rod (3–6 cm) produces the highest gum compared to other diameter categories [17]. This is caused by jaranan plants with a trunk circumference of 30–50 cm in this study which is categorized as small in size while the circumference of the stem is 51–112 cm large sizes are categorized as GIS with the same concentration, as a result of which the stress response is different. Jaranan plants with large stem circumferences (51–112 cm) are given the same GIS treatment as jaranan plants that have a small stem circumference (30–50 cm) with lower stress levels, so gum production is no different from gum production at a rod circumference of 30–50 cm.

According to the results of research by Wekesa et al. [18] and Abdalla [19] which states that the root structure and physiological activity of plants affect plant stress levels. Plants that experience stress due to reduced ability to obtain water with large volumes during the dry season. Stress will trigger plants to produce more gum as a self-defense response to a less supportive environment so that the gum produced will be more when injured [18].

3.3 Interaction Between GIS and Bar Circumference Size

Based on the results of the Two-Way ANOVA test, the treatment between GIS and the circumference of the rod there is no interaction between the two indicated with a value of $p = 0.133 > 0.05$ on the correlation between GIS and bar circumference, meaning there is no interaction between GIS doses with the size of the rod circumference.

The results showed that gum production from the circumference of the trunk (51–112 cm) with a GIS concentration (of 1.5%) average gum production is lower at

28.8 g/tree than the circumference of a small trunk (30–50 cm) with a GIS concentration of 1.5% which is 33.2 g/tree. This is thought to be because the GIS concentration of 1.5% has not been able to improve stress conditions in jaranan plants with large rod circumference sizes (51–112 cm). Increased GIS concentrations lead to faster and more traumatic duct formation. This is because the use of GIS in jaranan plants will cause plants to release ethylene gas in the tissue. Increased synthesis of ethylene when plants are stressed will trigger a faster response [20, 21]. Jaranan plants with GIS treatment will cause effects such as water choking that causes plants to stress due to difficulty obtaining water [16]. Therefore, plants with small stem circumferences (30–50 cm) emit more gum than plants with large stem circumferences (51–112 cm).

3.4 Relationship of Jaranan Plant Gum Production with Harvest Time

Harvesting gum jaranan plants are done every 7 days for the next three weeks. The production of jaranan plant gum 3 times the harvest period, decreased (Fig. 3). The highest production of jaranan plant gum is produced in the 1st harvest which is as much as 16.06 g/tree then decreases in the 2nd harvest (8.86 g/tree) and the 3rd harvest (1.36 g/tree). The decline in the production of jaranan plant gum is thought that gum has dried up in the drilling hole.

Based on the results of the General Linear Model Repeated Measure test obtained a significance value for the 1st harvest the value $p = 0.35 > 0.05$; harvest 2nd value $p = 0.861 > 0.05$; harvest 3rd value $p = 0.009 < 0.05$. The results showed the 1st harvest (16.06 g/tree) and the 2nd (8.86 g/tree) which was able to produce jaranan plant gum in large quantities compared to the 3rd harvest (1.36 g/tree). Research by Wekesa et al. [18] also reported the same results that Arabic gum yields in *Acacia senegal* plants decreased

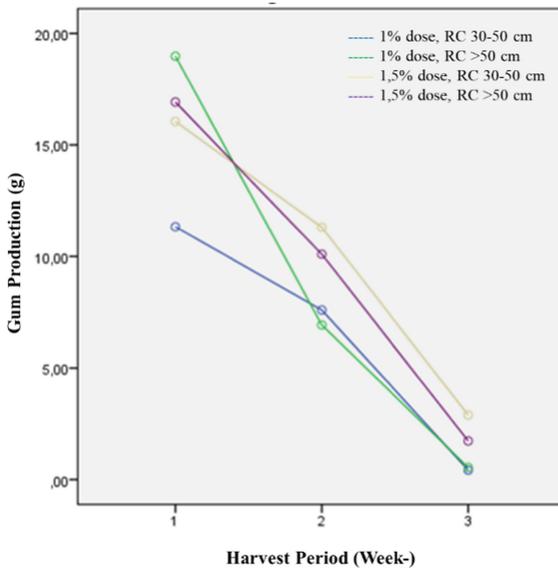


Fig. 3. Graph of jaranan plant gum production during 3 harvests.

from the first harvest of 4.29 g to the second harvest of 3.77 g. The production of the 1st and 2nd gums is an important indicator in obtaining the total results of gum production. The decrease in arabic gum production is thought to be due to tapping in the injuries after some time to make the gum outlet narrow [18, 19, 22]. This is because the injuries given have begun to close due to gum that begins to harden [23].

This study was conducted when the Sidomulyo region entered the dry season with an average temperature of 32.1 °C and an average humidity was 73.3 RH. Based on research by Ballal et al. [22] the temperature of 35 °C is the maximum temperature that causes plants *A. senegal* to experience stress and produce the highest gum production. The high temperature causes the plant to lack water and affects the physiological activity of the plant. Plants will experience water checks and then perform self-defense mechanisms. Therefore, plants will synthesize endogenous ethylene in response to these unfavorable conditions [24].

Research shows that administration ethephon to jaranan plants can trigger gum production. Gum production is not affected by the circumference of the gum tree but is influenced by the concentration of gum given. The highest amount of gum production was obtained in the first week and then decreased until the third week. GIS concentration is not related to tree circumference.

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References

1. Abd-Razig NM, Sabahelkhier MK, and Idris OF, "Effect of Gum Arabic (*Acacia senegal*, L. Willd) on lipid profile and performance of Laying Hens," 2010. [Online]. Available: www.biosciences.ilewa.org
2. L. N. Harsh, J. C. Tewari, H. A. Khan, and M. Ram, "Ethephon-induced gum Arabic exudation technique and its sustainability in arid and semi-arid regions of India," *For. Trees Livelihoods*, vol. 22, no. 3, pp. 204–211, Sep. 2013, doi: <https://doi.org/10.1080/14728028.2013.818514>.
3. G. . and A. Lewis, "Development and Modification of Bioactivity Plant Gum," *J. Nat. Prod.*, pp. 9608–9616, 2010.
4. P. A. Nayak, "Standardization Of Sustainable Gum Tapping Techniques In *Boswellia serrata* (Roxb.) And *Lannea coromandelica* (Merr.) To Obtain Higher Gum Production In Tropical Dry Deciduous Forests," Indira Gandhi Krishi Agricultural University, 2019.
5. L. Duppala, H. N. Durga D, and K. V. R. Murthy, "Physico-Chemical and Microbial Studies of *Lannea Gum*," *Int. Res. J. Pharm.*, vol. 8, no. 4, pp. 50–58, May 2017, doi: <https://doi.org/10.7897/2230-8407.080448>.

6. A. and N. Joshi, "Physicochemical and Phytochemical Investigation of The Roots of *Lannea coromandelica* (Houtt.) Merr," *Am. J. Pharm. Heal. Res.*, vol. 2, no. 2, pp. 80–86, 2014.
7. A. . Joy, J.M., Kumara, C.K.A. and Reddy, "Lannea coromandelica: The Researcher's Tree," *J. Pharm. Res.*, vol. 4, no. 3, pp. 577–579, 2011.
8. A. Vasishth, "Standardization of Tapping Techniques of Gum Extraction in *Lannea coromandelica*: a Valuable Gum Yielding Tree Aloe Vera View Project Acacia Catechu View Project Standardization of Tapping Techniques of Gum Extraction in *Lannea Coromandelica*: a Valuable Gum Yielding Tree," vol. 143, no. 4, pp. 375–379, 2017, [Online]. Available: <http://www.indianforester.co.in>
9. U. Marapana, V. Chandrajith, and R. Marapana, "Physicochemical characters of bark exudates of *Lannea coromandelica* and its application as a natural fruit coating," *J. Pharmacogn. Phytochem.*, vol. 7, no. 4, pp. 1798–1802, 2018, [Online]. Available: <https://www.researchgate.net/publication/326719071>
10. B. N. Singh, B. R. Singh, B. K. Sarma, and H. B. Singh, "Potential chemoprevention of N-nitrosodiethylamine-induced hepatocarcinogenesis by polyphenolics from *Acacia nilotica* bark," *Chem. Biol. Interact.*, vol. 181, no. 1, pp. 20–28, Sep. 2009, doi: <https://doi.org/10.1016/j.cbi.2009.05.007>.
11. W. Ode, I. Indrayangingsih, N. Ibrahim, and S. Anam, "Studi Etnofarmasi Tumbuhan Berkhasiat Obat pada Suku Buton di Kecamatan Binongko, Kabupaten Wakatobi, Sulawesi Tenggara Ethno Pharmacy Study Of Herbal Plant in Buronese, Binongko Sub-District, Wakatobi Regency of South East Sulawesi," 2015.
12. M. Tiwari, J.C and Ram, "Tree gum exudation techniques. Networking project on harvesting, processing, and value addition of natural resins and gums," *Curr Sci.*, vol. 59, no. 23, pp. 1247–1250, 2010.
13. D. Abdullah, A. and Eqbal, "Utilization of Gum Arabic for Industries dan Human Health," *J. Appl. Sci.*, vol. 10, no. 1, pp. 1270–1279, 2013.
14. A. S. El-Beltagy and M. A. Hall, "Effect of Water Stress Upon Endogenous Ethylene Levels in *Vicia faba*," 1974.
15. K. Khan, S., Vidya, B. K., and Pratibha, "Gum tapping technique and anatomical study of ethylene-induced gum duct formation in Dhawda (*Anogeissus latifolia*)," *J. Pharmacogn. Phytochem.*, vol. 1, pp. 124–128, 2018.
16. C. F. Abib, M. Ntoupka, R. Peltier, J. M. Harmand, and P. Thaler, "Ethephon: A tool to boost gum arabic production from *Acacia senegal* and to enhance gummosis processes," *Agrofor. Syst.*, vol. 87, no. 2, pp. 427–438, Apr. 2013, doi: <https://doi.org/10.1007/s10457-012-9564-y>.
17. L. Tadese, S., Galgalo, D., and Mulgita, "Effect Of Tapping Intensity And Tree Diameter On Gum Arabic Yield Of *Acacia Senegal* (L) Wild In Southern Ethiopia," *J. Pharm. Life*, vol. 2, no. 2, pp. 229–338, 2016.
18. C. Wekesa, P. Makenzi, B. N. Chikamai, J. K. Lelon, A. M. Luvanda, and M. Muga, "Gum arabic yield in different varieties of *Acacia senegal* (L.) Willd in Kenya," *African J. Plant Sci.*, vol. 3, no. 11, pp. 263–276, 2009, [Online]. Available: <http://www.academicjournals.org/ajps>
19. G. M. Abdalla, "Improvement of traditional *Acacia senegal* agroforestry. InEcoPhysiological characteristics as indicators for tree-crop interaction on sandy soil in western Sudan," University of Helsinki, 2005.
20. A. Apelbaum², A. Shang, and F. A. Yang, "Biosynthesis of Stress Ethylene Induced by Water Deficit", 1981. [Online]. Available: www.plantphysiol.org
21. J. Beltrano, M. G. Ronco, and E. R. Montaldi, "Drought Stress Syndrome in Wheat Is Provoked by Ethylene Evolution Imbalance and Reversed by Rewatering, Aminoethoxyvinylglycine, or Sodium Benzoate," 1999.

22. M. E. Ballal, E. A. El Siddig, M. A. Elfadl, and O. Luukkanen, "Relationship between environmental factors, tapping dates, tapping intensity and gum arabic yield of an Acacia senegal plantation in western Sudan," *J. Arid Environ.*, vol. 63, no. 2, pp. 379–389, Oct. 2005, doi: <https://doi.org/10.1016/j.jaridenv.2005.01.024>.
23. J. Dioine, M. and Vassal, "Gummosis and Gum Production Cycles in Acacia Senegal L. in Acacia Senegal," M. and H. Campa, C., Grignon, C., Guenye, Ed. 1998, pp. 123–134.
24. K. R. Arya, R and Chaudhary, "Morphological status of Acacia nilotica L. for gum production in an arid region," *Curr. Agric.*, vol. 26, no. 2, pp. 61–62, 2002.

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