PENGARUH HORMON GIBERELIN (GA_3) DAN WAKTU PERENDAMAN TERHADAP PERKECAMBAHAN BENIH KOPI ARABIKA (*Coffea arabica* L.)

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ABSTRACT

Arabica coffee seeds have a long time to germinate and dormancy. Dormancy is caused by the physical state of the seed coat, the physiological state of the embryo or a combination of the two condition. This research aimed to find out the effect of gibberellin (GA_3) and immersion time to accelerating the time of the dormancy breaking and viability of arabica coffee seed (Coffea arabica L.). The research was carried out in the Biological Seedling Field, Faculty of Biology University of Medan Area (UMA) start from October to November 2020. The experimental was arranged using randomized block design (RBD), with 2 factors and four replicate. The first factor was four level of GA_3 concentration : 0 ppm, 200 ppm, 400 ppm, dan 600 ppm. The second factor was four seed imbibition period : 12 hour, 24 hour, 36 hour and 48 hour. The parameter to observed is the potential growth, the time of leaves appear, the hypocotyl length, the number of roots and the root length. The results showed the treatments of combination immersion time and gibberellin have a real impact for the potential growth, the time of leaves appear and the root length.

Key words : Coffea arabica* L., *seed, GA_3, imbibition, concentration

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I. INTRODUCTION

1.1 Background of Study

Coffee is an important plantation product for people all around the world. This commodity survives in the global market due to its limited adaptation area but is demanded by anyone. Coffee with a distinctive aroma and taste is known as Arabica coffee, making the price relatively high (Ichsan et al., 2013).

In 2014, Indonesia had a total area of 1,230,495 hectares of coffee plantations (330,687 ha are for Arabica coffee plantations), while in 2016 the area of Indonesian coffee plantations increased to 1,233,294 hectares (321,158 ha are for Arabica coffee). In 2014 alone, the area of coffee plantations in North Sumatra reached a total of 81,644 hectares (59,620 ha are for Arabica coffee), and in 2016 the area for coffee plantations in North Sumatra increased to 82,158 ha (59,850 ha are for area for Arabica coffee). It is estimated that the plantation area will continue to increase along the local and global demands (Directorate General of Plantations, 2015).

Quality coffee beans are produced from quality plants. An essential part of coffee plant cultivation worth to study is the seeding or propagation process. Seedling is deemed important because this process will affect the condition or productivity of coffee plants after maturity.

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The use of superior seeds, manufacture, and maintenance of seeds should be considered in order to obtain healthy and productive plants.

Arabica coffee seeds (*Coffea arabica* L.) have a hard seed coat that is impermeable to water. Germination of coffee seeds in the lowlands with a temperature of 30°C - 35°C consumes 3-4 weeks, while in the highlands with relatively lower temperatures takes 6-8 weeks (Devi et al., 2016). The germination process is influenced by several factors including seed dormancy. Dormancy is a state of seeds with rest period and is difficult to germinate regardless of the environment allowing them to grow. Dormancy breaking is necessary to accelerate germination and it can be carried out physically and chemically.

Seed dormancy breaking can be done using the hormone gibberellin (GA_3). GA_3 compounds can stimulate hydrolytic enzyme activity so that sufficient nutrients are available for shoots to grow quickly. The findings of the study by (Rusmin et al., 2011) show that a single GA_3 and seed soaking for 48 hours could accelerate the germination of pruatjan seeds (*Pimpinella pruatjan* Molk.) by 1.70%, however it used a high concentration of 400 ppm.

Based on previous research, the best soaking time treatment for 24 hours could increase the percentage of seed germination, hypocotyl length, and body weight of Robusta coffee seeds and soaking seeds with the best gibberellin (GA3) at a concentration of GA3 1500 mg.l-1 (1500 ppm) could increase power germination, percentage of seed germination, and hypocotyl length of Robusta coffee seeds (Novi et al., 2015).

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Based on the description above, it is necessary to conduct research on the variation of soaking time and concentration of gibberellic acid (GA_3) on the germination and growth of Arabica coffee seeds (*Coffea arabica* L.).

1.2 Formulation of Study

Based on the background described above, the formulation of the problem in this study is as follows :

a. How is the effect of GA dose and soaking time or both interaction on time?
b. How is the effect of GA dose and soaking time or both interaction on viability?

1.3 Objectives of Study

Based on the formulation of the problem above, the objectives of this study are as follows:

a. To determine the effect of GA dose and soaking time or both interaction on time.
b. To determine the effect of GA dose and soaking time or both interaction on viability.

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1.4 Significance of Study

This research is expected to provide data and information regarding the optimal seed soaking time and the concentration of gibberellins to increase the viability of Arabica coffee seeds for further researchers and relevant institutions in the context of their development and management.

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II. LITERATURE REVIEW

2.1 Biology of Arabica Coffee

Arabica coffee is the first known and developed coffee in the world. Arabica coffee is a traditional type of coffee with the best flavor. Most of the coffee available is composed using this coffee bean. This coffee was originated from Ethiopia and is now cultivated in various parts of the world, from Latin America, Central Africa, East Africa, India, and Indonesia (Lagita, 2013). The classification of Arabica coffee plants is as follows: Kingdom: *Plantae*, Division: *Spermatophyta*, Class: *Dicotyledonae*, Order : *Rubiales*, Family: *Rubiaceae*, Genus: *Coffea*, Species: *Coffeaarabica* L.

Arabica coffee plant is a plant with two embryo (dicotyledons) and has a taproot. At the taproot, there are several small roots that grow sideways (expanding) which are often called lateral roots. The lateral roots have primary roots, root hairs, and root caps (Panggabean, 2011). Arabica coffee is an upright shrub or small tree that grows from 5 m to 6 m high and has a diameter of 7 cm when it grows as tall as an adult's chest. Arabica coffee is known by two types of branches; ortho-geotropic that grows vertically and plagio-geotropic branches that have different orientation angles in terms of main stem. Furthermore, Arabica coffee displays a gray bark, is thin, and splitting as well as rough when aged (Hiwot, 2011).

Arabica coffee leaves are dark green and with a shiny wax-like coating. These leaves are four to six inches long and oval or oblong in shape. Arabica coffee leaves are simple leaves with short stalks and Arabica coffee leaf life span

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is less than a year (Hiwot, 2011). Arabica coffee trees have bilateral leaf arrangement; two leaves grow from the nodes opposite each other (Roche and Robert, 2007). Commonly, coffee plants will begin to flower after the age of ± 2 years. At the first phase, these flowers come out of the leaf axils located on the main stem or reproductive branches. However, flowers from these parts usually do not develop into fruit, are limited in number, and only produced by seedlings. Flowers in large numbers will develop of the leaf axils located on the primary branch. This flower comes from secondary and reproductive buds that alter their function into flower buds. The flower buds then develop into flowers simultaneously and in clusters (Agency for Agricultural Research and Development, 2008).

The fruit of the coffee plant consists of pulp and seeds. The flesh of the fruit consists of three layers, namely the outerskin (exocarp), the flesh portion (mesocarp), and the parchment layer (endocarp). Coffee cherries contain two beans, sometimes one bean or even have no bean (empty) (Budiman, 2012). Coffee beans consist of silverskin and bean. The bean or endosperm is the part that can be processed as an ingredient to make coffee (*Karya Tani Mandiri* Team, 2010).

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2.2Habitat of Arabica Coffee

2.2.1 Climate

The best zone for growing Arabica coffee is between 200 North Latitude and 200 South Latitude. Most of the coffee areas in Indonesia are located between 0 - 100 latitude, such as in South Sumatra, Lampung, Bali, South Sulawesi, and a small portion live between 0 - 50 latitude, as in Aceh and North Sumatra. Climatic elements that affect Arabica coffee cultivation are elevation (altitude), temperature, type of rainfall, humidity, and wind (Sihaloho, 2009).

Altitude suitable for growing Arabica coffee is approximately 1,000 – 1,700 meters above sea level (asl). If it is at an altitude of < 1000 meters above sea level, Arabica coffee will be susceptible to Hemileia vastatrix disease. Whereas, if it is at > 1,700 meters above sea leve it will make Arabica coffee production not optimal because vegetative growth is greater than generative (Karya Tani Mandiri Team, 2010).

Temperature is the most important climatic factor that greatly affects the growth and development of coffee plants. Arabica coffee can withstand temperature fluctuations, if not immoderate. The ideal temperature average is between 15°C and 24°C, nevertheless it is able to tolerate temperatures below or above these limits properly for short periods. Higher temperatures can cause fallen flower and temporary reduce fruit formation, slow growth, stunted and uneconomical, secondary and tertiary branch production becomes probable (Hiwot, 2011).

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2.2.2 Soil

Arabica coffee plants require soil with a deep surface layer (± 1.5 m), loose, fertile, abundant humus, and permeable, or in other words, the soil texture should be adequate. Soil with good structure/texture is soil derived from volcanic ash or contains sufficient sand. In such soil, the circulation of air and water in the soil will work properly (Karya Tani Mandiri Team, 2010). Soil structure that allows good drainage is the essential property for Arabica coffee plant growth. As a matter of fact, Arabica coffee plants cannot tolerate waterlogged soil and will reduce yields by a large amount and kill coffee trees if prolonged (Hiwot, 2011).

The average recommended soil pH is 5 – 7. If the pH is too acidic, add Ca(PO)2 or Ca (PO3)2 (dolomite lime) fertilizers. Meanwhile, to lower the pH from alkaline to acidic, Urea should be added. It is to sprinkle lime or urea sufficiently according to soil conditions and check the acidity of the soil with a pH meter. Urea should be added if the soil pH is still alkaline or include lime if it is too acidic until the soil pH stays at 5-7 (Panggabean, 2011).

2.2.3 Germination

Germination is the boundary between seeds that are still dependent on food sources from their parents and plants that are able to take nutrients. Therefore, germination is the last step in the seed handling process. Germination is determined by seed quality (vigor and germination ability), initial treatment

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(dormancy breaking) and germination conditions such as water, temperature, media, light, and zero pests and diseases (Utomo, 2006).

According to Sutopo (2002), the seed germination process consists of several stages. The first stage of seed germination begins with the process of absorbing seed water, softening the seed coat, and adding water to the protoplasm until it becomes watery. The second stage begins with the activities of cells and enzymes as well as an increase in the respiration rate of the seed, resulting in cell division and penetration of the seed coat by the radicle. The third stage is the stage of breaking down materials such as carbohydrates, proteins, and fats into a soluble form and are translocated to growing points. The fourth stage is the assimilation of materials that have been described in the meristematic area to produce energy for the activities of component formation and new cell growth. The fifth stage is the growth of the sprouts through the process of division, enlargement, and division of cells at the growing point. Imbibition causes the seeds to expand and break the coat and trigger metabolic changes in the embryo so it continues to grow. Enzymes will hydrolyze the materials stored in the cotyledons and the nutrients inside. The significant enzymes in the hydrolysis of food reserves are α-amylase, β-amylase, and protease enzymes. The α-amylase enzyme is able to break down starch into dextrin and maltose which are important for seed growth/germination.

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2.2.4 Seed dormancy

Seeds are deemed dormant if the seeds are active but do not germinate even despite they are placed in a favorable situation for germination (Sutopo, 2012). Dormancy in seeds can last for several days, seasons, or up to years depending on the type of plant and the type of dormancy (Sutopo, 2012).According to Schmidth (2002), seed dormancy indicates a state of healthy (viable) seeds that fail to germinate when under conditions that are normally appropriate for germination, such as adequate humidity as well as appropriate temperature and light.

2.2.5 Seed soaking

According to Sutopo (2012), the structure of the seed coat also constructs a layer of thick-walled polysade-like cells, especially on the outermost surface, and a shiny layer of cuticle material. On the inside, it will result in low permeability. Processes in plants such as diffusion, osmosis, and imbibition are strongly influenced by the percentage of soaking time, as well as the interaction between GA3 concentration and soaking time (Novi, 2015)

The highest percentage of seeds germinated during the 24-hour soaking time and the lowest number of seeds is in the 12-hour soaking time. This is presumably because the time is longer so that the parchment becomes softer. The softer the parchment layer, the faster the plumule and radicle grow (Novi, 2015).

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2.3Gibberellin Hormone (GA_3)

Gibberellins (GA3) are hormones that can be found in almost all plant life cycles. This hormone affects seed germination, stem elongation, flower induction, seed development, and pericarp growth. In addition, this hormone also plays a role in the response to stimuli through physiological regulation related to the mechanism of GA biosynthesis. Biologically active gibberellins (bioactive GAs) control various aspects of plant growth and development, including seed germination, stem elongation, leaf expansion, and flower and seed development.

Gibberellin Acid (GA) is a group of naturally occurring plant hormones. It functions in the initial process of germination in terms of the activity of enzyme production and transport of food reserves. In conjunction with dormancy, GA regulates the effect of inhibitory substances such as coumarins or ABA. The use of gibberellins transforms overcoming temperature dormancy, light dormancy, and dormancy due to the inhibitory substances. Furthermore, GA has a positive effect on shoot development and vigor (Utomo, 2006).

Gibberellins play a role in the initial process of germination by producing enzymes that behave in the reshuffle of food reserve materials, such as carbohydrates, proteins, and fats so they are more effortlessly absorbed by the embryo. Additionally, gibberellins can induce enzymes that hydrolyze the organic matter required for seed germination. The results of the reshuffle of food reserves produce energy for the component formation and the growth of new cells, such as the emergence of radicles and plumules from seed coats.

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The results of Gusnita's research (2017) show that there was an interaction between the scarification treatment of cutting the tip of the seed and soaking the seeds in gibberellin (GA_3) 60 ppm to break the dormancy of noni seeds, which was for 48 days and the percentage of germination was 48.5%. Meanwhile to Nurshanti (2009), seeds palm king using the hormone gibberellin (GA_3) with a concentration of 75 ppm obtained a higher percentage of live sprouts, which was 32% compared to other concentration treatments.

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III. RESEARCH METHODS

3.1. Time and Site

This research was conducted from October 2020 to November 2020 at the Field Experiment of Biology, Faculty of Science and Technology, Universitas Medan Area, North Sumatra.

3.2. Tool and Material

3.2.1 Tool

The tools used in the research consist of GPS software via a smartphone to determine the original altitude of the coffee seeds under the study and the altitude of the research area, polybags as a container for planting seeds, UV plastic and coconut fiber as] shade, spatula for mixing, beaker glass as a container for mixing seeds and GA_3 solution, handsprayer for watering plants, scissor for cutting the necessary materials, a calculator, a camera for research documentation, and writing instruments for taking notes.

3.2.2 Material

The materials used in this study are Arabica coffee beans (*Coffea arabica* L.), Gibberellic Acid (GA_3) as a growth regulator, aquades as a gibberellin diluent, sand-soil mix as a planting medium, and labels as markers.

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3.3. Methods

This research was conducted using the experimental method of Randomized Block Design (RBD). The data were analyzed by analysis of variance (ANOVA) and followed by a partial test (t) with a 95% confidence level with 2 factors and 5 replications. The first factor was the four levels of GA_3 administration, encompassing: 0 ppm, 200 ppm, 400 ppm, and 600 ppm. Subsequently, the second factor tested was four levels of seed imbibition time, including 12 hours, 24 hours, 36 hours, and 48 hours.

Factor I: GA hormone (4 levels)	Factor II : Soaking time (4 levels)
1. GA 0 ppm = G1	1. 12-Hour Soaking = R1
2. GA 200 ppm = G2	2. 24-Hour Soaking = R2
3. GA 400 ppm = G3	3. 36-Hour Soaking = R3
4. GA 600 ppm = G4	4. 48-Hour Soaking = R4

Observed parameters :

1. Growth potential
2. Time of leaf emergence
3. Hypocotyl length
4. Number of roots
5. Root length

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V. CONCLUSION AND SUGGESTION

A. Conclusion

Based on the results of the research carried out, all things considered, the treatment of gibberellin hormone (GA) and soaking time on the germination of Arabica coffee seeds (*Coffea Arabica* L.) had a significant effect on the parameters of growth potential, time of leaf emergence, and number of roots, and root length. Also, it did not affect the parameters of the hypocotyl length.

B. Suggestion

The suggestion based on the analysis conducted is that for further research, it is encouraged to add research time in order to obtain more complete data. In addition, further research should address better environmental conditions for seed development in order to yield better results.

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