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The Effect of Immersion Time at Initial Water Temperature of 50°C and Gibberellin Concentration on Viability of Arabica Coffee Seeds (Coffea arabica L.)

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ABSTRACT

The coffee nursery process takes a relatively long time hence it can affect the production period of coffee plants because of it a seed treatment is needed before planting i.e. immersion with the initial water temperature and in the gibberellin solution. This research aim was to obtain the immersion time of the seeds at the initial water temperature of 50°C and the optimal gibberellins concentration to increase the viability of Arabica coffee seeds. The method used was Factorial Randomized Group Design with two factors and three replications. The first factor was the immersion time with an initial water temperature of 50°C with 4 levels, namely; 0, 10, 20, and 30 minutes. The second factor was the gibberellins concentration with 4 levels, namely; 0, 50, 100 and 150 ppm. The results showed that an increase in the immersion time of the seeds at the initial water temperature of 50°C was able to accelerate the germination rate and accelerate the time of leaves appearance. The increased of gibberellin concentration can accelerate germination rates, increase the percentage of normal sprouts, decrease the percentage of dead seeds, increase the vigor index, increase hypocotyl length, increase root length, accelerate leaf emergence and decrease the percentage of abnormal sprouts but reduce the percentage growth potential. The treatments interaction can increase the viability of Arabica coffee seeds, namely germination rate for 21.74 days, the percentage of abnormal germination by 0%, vigor index of 0.85 germinating seeds/day, and root length of 8.78 cm.

Keywords: Arabica coffee seeds, gibberellins, immersion time, initial water temperature, viability

INTRODUCTION

Coffee is a plantation product that is consumed by people throughout the world, this commodity remains in the global market because of its limited adaptation area but is demanded by everyone. Coffee which has a distinctive aroma and taste known as Arabica coffee hence this coffee has a relatively high price (Ichsan et al., 2013).

Quality coffee beans are produced from good quality coffee plants. The aspect of coffee cultivation that is quite important to learn is the process of plant breeding or propagation. Nurseries are considered important because this process will affect the condition or productivity of coffee plants in adulthood. The use of superior seeds, seedlings making and tending must be considered in order to obtain healthy and productive plants (Sari, 2016).

The coffee nursery process takes a relatively long time hence it can affect the production period of coffee plants. This is because coffee seeds have hard seed shells that are impermeable to water. Coffee seed germination in the lowlands with a temperature of 30°C –

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35°C takes around 3-4 weeks, while in the highlands with relatively cooler temperature takes longer time around 6-8 weeks (Putra et al., 2011).

Coffee seed germination needs to be maximized in various ways before planting. Treatment of seeds can be done in various ways, including mechanical, physical and chemical methods. The stratification method can be said to be the most practical method because it only saturates the coffee beans with high-temperature water at certain times. Immersion using high-temperature water is tested effective removing the germination inhibitors and trigger the formation of growth hormones hence the seeds can germinate (Raharjo, 2002).

Chemical treatment is also done often to accelerate the period of seed dormancy, one method that is often used is by adding growth hormones. The growth hormone that is often used is gibberellin (GA_3), this hormone plays a role in the germination process to stimulate the formation of amylase in seeds (Salisbury and Ross, 1995).

Based on the description above, it is necessary to do research on the immersion time with the initial water temperature of the immersion and the concentration of gibberellins on Arabica coffee beans (Coffea arabica L.)

MATERIALS AND METHODS

This research was conducted at the Seed Technology Laboratory of the Faculty of Agriculture, University of Sumatera Utara Medan with an altitude of ± 25 meters above sea level, from April to June 2018. The materials used in this research were Arabica coffee seed as an observation material for germination, hot water for seeds immersion, GA_3 as a growth regulator, 70% alcohol as a solvent, sand as a planting medium, labels as markers, water for cleaning seeds, aquades as solvents and rubbing ashes to clean the mucus in Arabica coffee seed, aluminum foil to coat the surface of the beaker glass containing a GA_3 solution.

The tools used in this research were sprout tubs as a container for planting seeds, beaker glass as a container for seeds immersion, spatulas as stirrers, hotplates as containers for dissolving GA_3, analytical scales for weighing, buckets as containers for cleaning seeds, handsprayers for watering the plants, scissors to cut necessary material, gunny sacks as harvested coffee containers, calculators, cameras to document the research, and stationery to record data.

The research used a randomized block design with 2 treatment factors. The first factor was the immersion time with the initial water temperature of 50°C with 4 levels, namely 0, 10, 20, and 30 minutes, the second factor was the concentration of gibberellins with 4 levels, namely 0, 50, 100 and 150 ppm and an observations were carried out every day to the 60th day after planted in the tub of germination.

Data were analyzed by analysis of variance, the significant variance was continued using Duncan's Multiple Rage Test with a level of $\alpha = 5\%$ (Sastrosupadi, 2000)

RESULTS AND DISCUSSION

Germination Rate

The fastest germination rate was in the combination of P_0G_3 treatment, it was a combination of treatment with immersion time at the initial water temperature of 50°C for 0 minutes (control) and gibberellin concentration immersion of 150 ppm (P_0G_3) which was

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significantly different from other treatments. The combination of the P_0G_0 treatment produced the longest germination rate that was significantly different from the other treatments. From the research results, the fastest germination rate of Arabica coffee seeds was obtained with immersion time at an initial water temperature of 50°C for 30 minutes (P3). This can be seen from the fastest germination rate in the P3 treatment with an average of 22.74 days compared to the other treatments (Table 1). The coffee nursery process takes a relatively long time because the coffee seeds have hard seed shells which are impermeable to water which causes coffee seeds to experience dormancy hence it is difficult to germinate. Arabica coffee seeds immersion with an initial or certain water temperature can soften the seed shell hence the water can enter the seeds and trigger the formation of growth hormones to make the seeds germinated. This was in accordance with Rahardjo's (2012) literature which stated that the method of stratification can be said to be the most practical method because it only soaks coffee beans with certain water temperature at certain times. Immersion using temperature water was effective to remove germination inhibitors and trigger the formation of growth hormones hence the seeds can germinate. Based on the research results, the fastest germination rate of the Arabica coffee seeds was obtained with the Gibberellin concentration of 150 ppm (G3). This can be seen from the fastest germination rate in the G3 treatment with an average of 21.79 days. The application of 150 ppm concentration (G3) treatment was a good concentration in accelerating germination of arabica coffee seeds. Gibberellins have the ability to accelerate the germination of almost all plant seeds and spur vegetative growth. This was in accordance with Abidin (1987) literature which stated that the application of synthetic gibberellins in seeds aims to add and activate endogenous gibberellins in the seeds hence they can stimulate ribonuclease enzymes, amylase, and proteases in seed endosperms.

Table 1. The germination rate of Arabica coffee seeds in the immersion time treatment at the initial water temperature of 50°C and Gibberellins concentration.

Immersion Time 50°C (minute/s)	Gibberellins Concentration (ppm)				Average
	G_0 (0)	G_1 (50)	G_2 (100)	G_3 (150)	
	.....day/s.....				
P_0 (0)	30,18 a	23,76 cd	21,81 fg	20,46 h	24,05
P_1 (10)	24,74 bc	21,74 fg	22,71 def	23,64 de	23,21
P_2 (20)	25,17 b	23,09 de	22,75 def	21,40 g	23,10
P_3 (30)	24,80 bc	22,57 ef	21,95 fg	21,65 fg	22,74
Average	26,22	22,79	22,30	21,79	

Description: The number followed by the same letter showed no significant difference in the Duncan Multiple Range Test at the level of $\alpha = 5\%$.

Vigor Index

The highest Arabica coffee seed vigor index was obtained from the combination of P_3G_1 treatment which was not significantly different from the P_0G_2 and P_0G_3 treatments, but was significantly different from other treatments (Table 2). The results showed that the

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highest Arabica coffee seed vigor index was obtained with 50°C immersion time for 30 minutes (P3). This can be seen from the highest vigor index in P3 treatment with an average of 0.79 germinating seeds/day. The seed vigor index is closely related to the germination rate of a seed group. The high vigor index indicates that the germination rate of seeds was also high and more resistant to adverse environmental conditions. Sutopo (2002) also added that immersion in water can facilitate the absorption of water by seeds, hence the seed shell becomes lysis and weak, besides that it can also be used for washing seeds hence the seeds are free of pathogens that inhibit seed germination.

The results showed that the highest vigor index was obtained with a concentration of 50 ppm (G1) around 0.83 germinating seeds/day. The higher the Gibberellin concentration given, the Arabica coffee seed vigor index tends to increase even though it has experienced a decline. The application of gibberellin concentration 50 ppm (G1) was the best concentration in increasing the induction of Arabica coffee vigor. The seed vigor index is closely related to the germination rate of seeds. The high vigor index indicates that the germination rate of seeds is also high and more resistant to adverse environmental. According to Weiss and Ori (2007) stated that one of the physiological effects of gibberellins is encouraging the activity of hydrolytic enzymes in the process of seed germination and seed vigority. During the seed germination process, the developing embryo releases the gibberellins into the aleurone layer. The gibberellin causes the transcription of several marker genes of hydrolytic enzymes including α amylase. Then the enzyme enters the endosperm and hydrolyzes starch and protein as a food source for embryo development.

Table 2. Vigor index of Arabica coffee seeds in immersion time treatment at the initial water temperature of 50°C and Gibberellins concentration

Immersion Time 50°C (minute/s)	Gibberellins Concentration (ppm)				Average
	G_0 (0)	G_1 (50)	G_2 (100)	G_3 (150)	
	.....berkecambah/hari.....				
P_0 (0)	0,59 g	0,80 bcd	0,85 abc	0,87 ab	0,78
P_1 (10)	0,74 def	0,85 abc	0,67 f	0,72 def	0,75
P_2 (20)	0,71 ef	0,77 cde	0,76 de	0,80 bcd	0,76
P_3 (30)	0,74 def	0,89 a	0,74 def	0,78 cde	0,79
Average	0,69	0,83	0,75	0,79	

Description: The number followed by the same letter showed no significant difference in the Duncan Multiple Range Test at the level of α = 5%.

Leaf Appearance Time

Based on the research results showed that the fastest leaf appearance time was obtained in immersion time at an initial temperature of 50°C for 30 minutes (P3). Ini dapat dilihat dari waktu penampilan daun pada perlakuan P3 dengan rata-rata 22,88 hari. Germination process is a complex series of morphological and biochemical changes.

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Morphologically the germination of a seed is marked by the appearance of a prospective root (radicle) or prospective leaf (plumule) that protrudes out from the seed shell. According to Najiyati and Danarti (1997) during the germination process, the cotyledons and small embryos on coffee seeds swell by sucking on the endosperm, then the small roots and hypocotyls grow. Finally, the hypocotyls appear from the soil, bending and standing upright by lifting the cotyledons which are still covered by the endosperm and epidermis. Growth at this level is often called "soldaatje" or soldier. In the growth of soldiers stage, it temporarily stopped growing for about 1 month. Then it starts to grow again, i.e. the cotyledons are enlarged hence the endosperm and epidermis are torn and then the endocarp is released. Then the cotyledons lifted as if they were still attached, then separated and grew a pair of leaf pieces called "kepel". In the treatment of gibberellin concentration, it was found that the fastest Arabica coffee leaf appearance time was obtained in 150 ppm Gibberellins concentration (G3).

This can be seen from the leaf appearance time in the G3 treatment with an average of 22.57 days, but there was no interaction between the two factors. The immersion time treatment of coffee seeds in the 150 ppm Gibberellin concentration (G3) stimulated the cell division and elongation, causing leaves to appear quickly. This can occur because GA3 or also called as the Gibberellins hormone serves to stimulate, divide and elongate cells. The Gibberellin application can activate the endogenous gibberellins hence the enzymatic reaction will be more active. This was supported by the statement of Wattimena (1993) which stated that the seeds undergoing dormancy due to low endogenous gibberellins can be removed by exogenous gibberellins application, these gibberellins will diffuse into the seeds, thereby stimulating the release of alpha-amylase into the endosperm, then overhauling food reserves and produce energy that is useful for cell activity and growth.

Table 3. Leaf Appearance Time of Arabica coffee in immersion time treatment at an initial water temperature of 50°C and Gibberellins concentration.

Immersion Time 50°C (minute/s)	Gibberellins Concentrarion (ppm)				Average
	G_0 (0)	G_1 (50)	G_2 (100)	G_3 (150)	
	.....hari.....				
P_0 (0)	27,27	26,46	24,60	22,97	25,33 a
P_1 (10)	24,47	25,12	23,24	22,10	23,73 b
P_2 (20)	23,73	23,93	22,23	22,45	23,08 b
P_3 (30)	23,25	23,94	21,55	22,78	22,88 b
Rataan	24,68 a	24,86 a	22,90 b	22,57 b	

Description: The number followed by the same letter showed no significant difference in the Duncan Multiple Range Test at the level of $\alpha = 5\%$.

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CONCLUSION

Increasing in the immersion time of the seeds at the initial water temperature of 50°C can accelerate the germination rate and accelerate the leaf appearance time. Increasing of the Gibberellin concentration accelerated the germination rates, increasing the percentage of normal sprouts, decreasing the percentage of dead seeds, increasing the vigor index, hypocotyl length, root length, accelerated the leaf appearance time and decreasing the percentage of abnormal sprouts but decreasing the percentage of growth potential. The treatment interactions can increase the viability of Arabica coffee seeds, namely germination rate for 21.74 days, the percentage of abnormal germination by 0%, the vigor index by 0.85 germinating seeds/day, and root length by 8.78 cm.

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