

Effect of hormones gibberelin (GA_3) to produce parthenocarp fruit on tomato tree (*Solanum Betaceum*, Cav)

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Abstract. Tomato tree (*Solanum betaceum*, Cav) has a high economic value. Consumed as fresh and processed fruit such as juice and syrup. Tomato tree has small seeds, a lot of seed and hard seed coat, so it requires a special handling on processing. Gibberalin hormone can increase fruit size and play a role in the formation of a little of seeds (*seedless*). This study aims to determine the effect of Gibberelin (GA_3) on producing of parthenocarp fruit. Conducted in April - August 2017 at experimental garden of Vegetable Research Institute at Tongkoh Berastagi Sumatera Utara, Indonesia. Gibberellin applied with five concentration, they are: 0 ppm as a control (G_0), 10 ppm (G_1), 20 ppm (G_2), 30 ppm (G_3), and 40 ppm (G_4) application by sprayed directly on the flower bud for six times and lapse of 3 days. The parameters observed were the percentage of fruit formation, the thickness of the flesh, the weight of the fruit, the weight of the fruit flesh, the weight of the seed, the number of potential seeds, the pithy seed, and the degenerated seeds. The results showed that the application of Gibberelin had significant effect on the decrease of number of potential seeds, seeds and increased degenerated seeds, but no significant on the percentage of fruit formation, the thickness of the flesh, the weight of the fruit, the weight of the flesh and the weight of the seed. The average number of potential seeds, seeds, and degenerated seeds was significantly different at each dose. The lowest number of seeds was found at concentrations of 40 ppm (G_4).

1. Introduction

Tomato tree (*Solanum betaceum*, Cav) is a fruit plant, a kind of bush plant has a short stem and half woody. Leaves are heart-shaped and green in color. The flowers are small, have bunches, stamens and pistils and petals are rose pink to violet. The fruit is oval, the skin is smooth and shiny (Figure 1a).

Has a fruit length of about 5- 6 cm and a diameter of ± 5 cm. The texture of the flesh is rather soft and smells nice. Tomato tree fruit flavor such as tomato and texture like plum with lots of vitamin A, C, anthocyanin, carotenoid, and fiber. The outer layer of the flesh contains a lot of water, a little rough and a little sweet taste. The seeds are hard, light brown to black. The shape of the seed is rather dull, round and small, and larger than the tomato seeds [1]. Figures 1b and 1d.



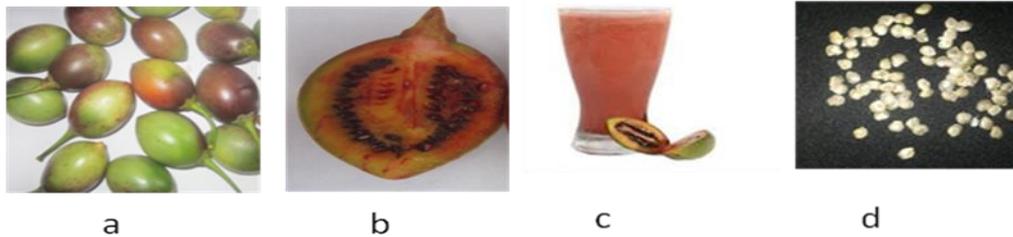


Figure 1. a Tomato tree fruit; b.tomato tree fruit with seed; c.tomato tree juice ; d. seeds

In 100 g of tomato tree contains 82.7-87.8 g water; protein 1.5 g; fat 0.06-1.28 g; 10.3 g carbohydrates; fiber 1.4-4.29 g; ash 0.66-0.94 mg; carotene 0.371-0.653 mg; vitamin A 540 I.U. and vitamin C 23.3 - 44.9 mg [2] In general, people consume in the form of juices and seeds should be separated (figure 1 c). In this seed processing industry becomes an obstacle, because it will cost higher to separate it.

Parthenocarpy fruit is a fruit with little seed (seedless) or seedless (fully seedless). Parthenocarpy fruit is formed without going through the pollination process and / or fertilization. Partenocarps can occur naturally or artificially, but the formation of natural partenocarps is rare in nature. Artificial partenocarps can be stimulated through the application of growth regulators, such as auxin, gibberellins, and cytokinins[3]. Partenocarpi will also increase fruit production through increased fruit formation. Artificial partenocarps can be induced through the application of growth regulating substances (fitohormon) in flower buds [4]. GA3 can play a role in the development of seedless grape [5] watermelon without seed [6] fruit tomato partenokarpi [7]. Gibberellic acid (GA), especially GA3, also plays a role in the flowering process and can affect the thin thickness of the watermelon skin [8]. Flowers treated with gibberellin (GA3) before the flowers bloom have respiration and enzyme activity in the pollen decreases [9]. In addition, gibberellin (GA3) also gives deformation of coiled pollen tube tubes from a straight initial form in the pistil even though the pistils are pollinated by highly variable pollen[10]. GA applications have been performed on many plants especially in the Solanaceae family and Cucurbitaceae, with improved yield and quality to suit the desired. Based on the success of other plants, the research on the formation of parthenocarpy fruit in the tomato tree.

2. Experimental Method

A. Material

The research material is a productive and flowering tomato tree plant of 12 trees, gibberellic acid (GA3), aquades, and 70% alcohol. The tools used are sliding, paper labels, knives, scissors, hand sprayer, analytical scales, measuring cups, beaker, dropper drops, tweezers, microscopes, cameras, and square boxes.

B. Methode

A productive and flowering tree is selected from several plants. The determination of interest is done by selecting the flower that is still bud and labeling done in accordance with the experiment design is Completely Randomized Design with 6 replications.

The experiments were performed with five treatments at 0 ppm concentration as control (G0), 10 ppm (G1), 20 ppm (G2), 30 ppm (G3) and 40 ppm (G4). Each experimental unit used 5 flowers that were repeated six times, so the total interest used in the research was 150 flowers which were in 12 tomato tree plants

Preparation of GA3 solution by weighing GA3 as much as 10 mg (concentration 10 ppm), 20 mg (concentration 20 ppm), 30 mg (concentration 30 ppm), 40 mg (concentration 40 ppm). Each of GA3 was dissolved by adding 70% to 70ml of a 1000ml flask, then added aquadest until the final volume of 1000 ml [11].

The GA3 solution was sprayed in each repeat group with different concentrations according to the treatment. All flowers are labeled according to treatment (figure 2). Application of GA3 solution is done six times. The first application is given before the flowers bloom on each flower using a hand sprayer 3 times each spray. The second, third, fourth, fifth and sixth apps are three days from the previous app.



Figure 2. Application of GA3 on tomato tree flower a. Concentration 10 ppm. b.20 ppm; c.30 ppm; d. 40 ppm

Observations were performed on young fruit five weeks after the last application. The goal is to know the treatment has no effect on the number of seeds so that the research can continue until the fruit is mature.

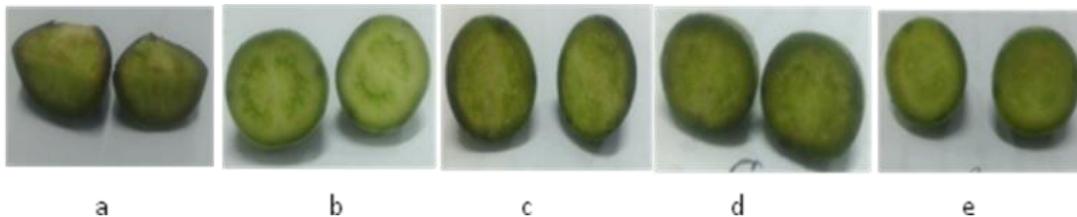


Figure 3. Tomato tree immature fruit a. 0 ppm;b. 10 ppm c. 20 ppm d. 30 ppm ;e. 40 ppm

Harvesting when the fruit is 16 weeks old and has shown signs are ripe (the color changes from green to purple yellow)

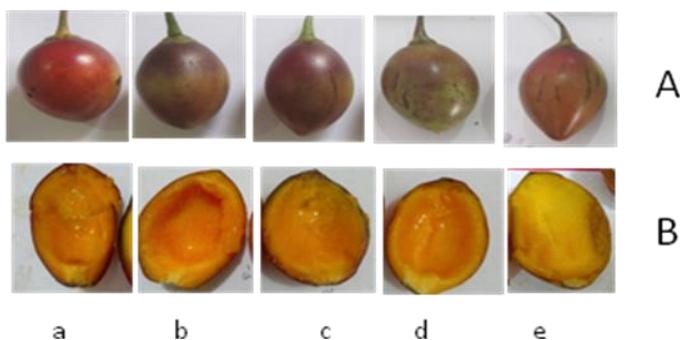


Figure 4. Tomato tree mature fruit under treated with GA3 (A): The fruit is cut across (B)
a. 0 ppm (control) b. 10 ppm;c. 20 ppm ;d. 30 ppm; e. 40 ppm

The thickness of the flesh is measured using a sliding range. Weights of fruit, fruit flesh, and seeds weighed with analytic balance scales. The number of potential, seeds and degenerated seeds is counted after the seeds are removed from the fruit.

The total number of seeds, seeds and seeds degenerated per fruit is calculated by splitting the fruit tomato tree transversely, then the seeds contained in the fruit are removed and sorted by seeds of pine and seeds degenerated, then calculated manually. Seed counting was performed on five tomato trees from each treatment. The total potential seed is the total number of seeds that can be shaped by the fruits including pine seeds and degenerated seeds. Pure seeds are normal-sized seeds of conception. Degenerated seeds are unfertilized and undeveloped and small seeds. To distinguish seeds of pungent and degenerated seeds, all the seeds are soaked in water. Pithy seeds sink, while degenerated seeds float on the surface of the water.

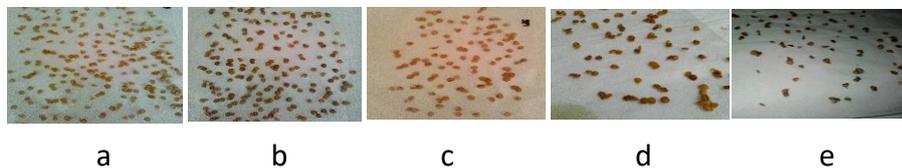


Figure 5. Tomato tree Seeds

(a) Control, (b) Concentration of 10 ppm, (c) 20 ppm, (d) 30 ppm, (e) 40 ppm

Data Analysis

Data obtained, coded, and entry to computer files by using Microsoft Excel application. A one-way ANOVA test was performed to see the significance of treatment at the 0.05 levels and to determine which treatment was different, followed by a Tukey test.

3. Results and Discussion

GA3 application on the formation of fruit partenokarpi tomato tree significantly affect the parameters of the number of potential seeds, the number of seeds and the number of seeds degenerated. but did not give a significant effect on the parameters of the fruits (%), the thickness of the flesh (cm), the fruit weight (gr) the weight of the fruit flesh (gr) and the seed weight (g). Although the GA3 hormone did not show a significant effect on the percentage parameters of fruit formation, the thickness of the fruit, the fruit weight, the weight of the fruit flesh and the weight of the seeds were shown in table 1.

Tabel 1. Fruit set, Thick flesh Fruit , Fruit weight , weight flesh fruit

Concentration of GA3	Parameter			
	Fruit set (%)	Thick flesh Fruit (cm)	Fruit weight (gr)	Weight flesh fruit (gr)
(G0)Control	9,40	0,53	43,93	41,29
(G1)10 ppm	9,12	0,49	37,25	34,91
(G2)20 ppm	6,60	0,51	41,81	39,18
(G3)30 ppm	9,01	0,47	35,59	33,63
(G4)40 ppm	8,33	0,45	34,60	33,31

GA3 application does not give a significant influence on the percentage of fruit formation.

The control has the highest average percentage of fruit formation of 9.40%. The results of this study are in accordance with Andyesuari [11] which states that there is no significant effect of GA3 on the fruit set on tomato plants of varieties Gamato 3 and Kaliurang 206.

From the results of observation of the thickness of the fruit flesh obtained from the observation of each treatment, the control treatment has the thickest thickness of the meat flesh that is equal to 0.53 cm

Parameter of the number of potential seeds, pithy seeds, and degenerated GA3 application gives a significant effect. However, GA3 does not give significant effect to seed weight.

Further test with Tukey test showed that the average number of total seeds, number of seeds and number of degenerated seeds at 40 ppm (G4) was very different with mean at doses of 0 ppm (G0), 10 ppm (G1) and 20 ppm (G2) but not at 30 ppm(G3).

The result of research by spraying GA3 on Tomato tree flower did not give significant effect to the thickness of the flesh. This is not in accordance with Setiawan's research [7] which states that GA3 applications result in significant decrease in fruit thickness.

The results show that on fruit weight found that the control has the highest average fruit weight of 43.93 grams. The insignificant effect was thought to be due to an unfavorable concentration of GA3 to produce heavier fruit weights. Seed weight obtained from each treatment, control has the highest average seed weight of 2.64 g

Tabel 2. Weight of seed, Number of potential seed, Number of potential seed, Number of Degenerated seed

Concentration of GA3	Parameters			
	Weight of seed (gr)	Number of potential seed	Number of seed	Number of Degenerated seed
(G0)Control	2,64	228,60 ^a	228,20 ^a	0,60 ^a
(G1)10 ppm	2,34	226,40 ^b	225,40 ^b	1,80 ^a
(G2)20 ppm	2,20	169,40 ^c	165,60 ^c	4,20 ^b
(G3)30 ppm	1,96	138,00 ^d	122,60 ^c	9,80 ^c
(G4)40 ppm	1,34	97,80 ^{de}	89,40 ^{ce}	8,40 ^{ce}

Means with different superscript letters in columns indicate a significant difference using Tukey's test ($p < 0.05$) for different samples.

Number of Potential, Bernas, and Degenerated Seeds

GA3 application gives a significant influence on the number of potential seeds, seeds are pithy and degenerated seeds. Higher concentrations decrease the number of potential seeds, seeds are pithy and increase the degenerated seeds

The number of potential seeds of each treatment showed that the control had the highest average total number of seeds of 228.60. Number of seeds in each treatment, 10 ppm has the highest potential seeds of 231,40.

Degenerated seeds from each treatment showed that the 30 ppm concentration had the highest degenerated seeds of 9.80 seeds.

The decrease in the number of seeds caused by the application of the concentration of GA3 further stimulates the increase in giberelin and auxin content so that ovul can not give signal the pollen tube to fertilize while the giberelin and auxin in the ovaries are sufficient at the threshold to grow into fruit. This causes fewer fertilized ovules in line with the study [12].

GA3 resulted in decreased expression of VvGA20ox3 and VvGA3ox3 genes. Where the expression of this gene has an influence on the growth of flower organs, anther development, and the presence of GA deficiency and overdose affect fertility. GA20ox causes inhibited growth of the anther marked with a failed tapetum degradation [13]. Exogenous gibberellin (GA3) applications can induce an increase in gibberellin and auxin content. The interaction between GA and auxin can initiate fruit formation. The auxin gene serves as a signal for the formation of partenocarps.

Parthenocarpy fruit induction also can not be separated from the role of GA3 that acts as a pollenicide. Where gibberellins in high concentrations can inhibit the formation of pollen [14]. The formation of pollen can be inhibited because the rate of respiration and the activity of enzyme in the pollen decreases. Inhibition of pollen tube formation also occurs in vinegars dipped in GA3 solution before blooming This proves that sperm cells are affected by gibberellins prior to conception [10]. The two components for the auxin signaling line Auxin Response Factor 7 (ARF7) and Aux / IAA [15] act as the initiation repressor for the formation of partenocarps. Among all IAA gene groups, IAA9 acts as a negative regulator prevent the initiation of partenocarps fruit on tomatoes. While ARF7 acts as a negative regulator for fruit set initiation. The presence of SIIAA9 and SIARF7 silencing results in the development of partenocarps and inhibition of pole tube growth [15]. In the procerca mutant tomato, GA affects the auxin signaling component through SIIAA9 and SIARF7 deactivation (negative regulator) [16].

4. Conclusion

Application of gibberellin (GA3) with different concentrations in Tomato tree gives significant effect on the decrease of potential seed number and number of pithy seeds and increase the number of degenerated seeds

The concentration of gibberellin (GA3) 30 ppm and 40 ppm was not yet optimal in Tomato tree partenocarpi formation but was able to produce fruits with fewer seeds than the control.

5. References

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