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Innovative Application of Onion Extract to Improve the Quality of Tomato Fruit

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Abstract

Tomatoes are one of the daily necessities for people. In general, consumers favor tomatoes with few seeds. Therefore, there must be efforts made to improve the quality of tomatoes, one of which is to reduce the number of seeds, even if it is possible to make tomatoes without seeds (seedlessness). By applying *Gibberellic acid* (GA) during the growth phase of tomato plants, it is possible to enhance tomato quality through technology. The application of GA to certain plants can reduce the number of tomato seeds and increase their sweetness. It is necessary to discover a way to use GA-containing natural ingredients to prepare for the high cost of synthetic GA. Onions are one of the natural ingredients that contain GA. Thus, this study aimed to examine the effect of applying onion extract as a source of GA to obtain the optimum concentration of onion extract that can improve the quality of tomato fruit. The experimental design utilized Randomized-Group Design with five different treatments: no spraying, spraying with 25%, 50%, 75%, and 100% onion extract. According to the findings, the application of onion extract improved the quality of tomato fruit. This condition is reflected by a decrease in the number and weight of seeds per fruit and an increase in the fruit's vitamin C content. Therefore, it is essential to conduct this research to produce inexpensive, high-quality tomatoes to sustain the economy and increase farmers' income.

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INTRODUCTION

As a tourist destination, Bali has a high demand for fruits and vegetables to meet the demands of hotels and restaurants, industry, and the local community. One of the required vegetables is tomato (Batt and Parining 2000; Surya 2007). Farmers typically cultivate tomatoes as an intercropping crop with rice (Tchedry 2020; Wirata 2022). The conventional tomato cultivation system results in inefficient production and quality, declining prices, and partner rejection of the produced tomatoes (Artha et al., 2022). In addition, tomatoes grown by farmers typically have a substantial amount of seeds, which significantly complicates the process of processing tomatoes into a product (Adnyesuari et al., 2015).

The demand for organic (healthy) vegetables is increasing due to adopting a healthier lifestyle among urban or tourist communities in Bali (Ariati, 2017). Moreover, as a tourist destination, Bali is visited by many foreign tourists accustomed to eating vegetables in salad form. According to Surya's (2006) research, the quantity of tomato-specific vegetables required by hotels, restaurants, and restaurants in five regencies in Bali in 2001 was 50,217 tons, while the total production was 43,785 tons, indicating a demand reduction of 6,432 tons. The data indicates that the rising demand for vegetable commodities (tomatoes) offers an ideal opportunity for cultivation (Ariati, 2017). This situation shows that Bali is a tourist destination that has the potential to absorb vegetables, especially tomatoes.

Increased production and quality of tomato fruit can be achieved by applying growth regulators/ZPTs related to Gibberellin/GA. Application of ZPT, especially 10 ppm of GA3 on tomatoes grown in Uttarakhand, showed an increase in fruit set formation up to 71.4% compared to the control (Tiwari & Singh, 2014). The application of ZPT GA can also increase tomato germination in unfavorable conditions (Martins et al., 2018)(Martins et al. 2018; Pramanik et al. 2018; Shohat et al. 2021; Ogugua et al. 2022). Increased productivity of tomatoes given the ZPT GA3 was also reported in tomatoes grown in Bangladesh (Rahman et al., 2015), India (Kumar et al. 2018; Jakhar et al. 2018), and Nepal (Jha et al., 2022). ZPTs such as cytokines, brassinosteroids, and gibberellins can also be used to induce parthenocarpy, producing few or no seeds (Raja and Rani 2021; Sharif et al. 2022).

One thing that needs to be done to improve the quality of tomato fruit is to cut down on the number of seeds, even if it is possible to grow tomatoes without seeds (seedlessness). According to Gultom and Silitonga (2018), the technology that can be used to improve the quality of tomato fruit is applying GA in the growth phase of tomato plants because, as shown in several studies, the application of GA to

several types of plants can reduce the number of seeds and increase the sweetness of tomato fruit. The use of GA to increase the quality and yield of tomatoes is promising, but the high price of synthesized GA, which reaches 2 million rupiahs per gram, poses a problem that needs to be solved.

The novelty of this research is the use of GA derived from natural sources, such as onion extract, as an alternative solution to the problem. Onion extract was utilized to circumvent the costly nature of synthetic GA. The significance of this research is to produce high-quality tomatoes at a low price to sustain the economy and increase farmers' income. This study was intended to (1) determine the effect of applying onion extract as a source of GA to enhance the quality of tomato fruit and (2) obtain the optimal concentration of onion extract for enhancing tomato fruit quality.

RESEARCH METHODS

The research was conducted in Kerobokan Kelod Village, North Kuta, Badung, Bali. Meanwhile, fruit quality analysis was carried out at the Ecophysiology Laboratory, Faculty of Agriculture, Udayana University, in 2022.

The study utilized a Randomized-Group Design with one factor, onion extract, as a source of GA, consisting of five treatments repeated five times for twenty-five experimental units. This study's treatments consisted of the following:

E0 = without spraying
E1 = sprayed 25% onion extract
E2 = sprayed 50% onion extract
E3 = sprayed 75% onion extract
E4 = sprayed 100% onion extract

The observation variables consisted of: (1) weight per fruit; (2) fruit diameter; (3) weight of seeds per fruit; (4) number of seeds per fruit; and (5) vitamin C content in tomato fruit.

Tomato seeds were sown as the first step in the seed preparations for the study. After the formation of four leaves (21 days after sowing), the seedlings were ready for transplanting. The preparation of the planting medium consists of soil, compost, and husk in a ratio of 1:2:1, then mixing and placing in 25 polybags with a diameter of 40 cm. Next, uniformly grown tomato seedlings were used for planting. The first application of NPK fertilizer occurred 14 days after transplanting, the second application 24 days after transplanting, and the third application 35 days after transplanting.

The preparation of onion extract as a natural GA source adopts the method used by Silva et al. (2013), namely the fermentation of solid natural ingredients (pulp or slurry) fermented with EM4. To make onion extract, cut 200 grams of onions into small pieces, then crush them in a blender to form slurry. The resulting onion pulp is then placed in a clean container, mixed with 1 liter of water, 200 grams of sugar, and 50 milliliters of EM4, covered with plastic and tied with rubber to ensure the fermentation process runs smoothly. The fermented material is placed in the shade for 15 days. Fermentation aims to decompose gibberellin compounds present in onion extract. Following the completion of the fermentation process, the material is filtered to extract the water and placed in the resulting liquid, which is then called "onion extract" as a natural source of GA.

The spraying of onion extract was done three times. The first spraying was done with a hand sprayer on each bunch before the first flower bloomed. The second and third sprays were three days apart from the previous spray. Spraying was done on three flower bunches per plant in one experimental unit. The sprayed flower clusters were shielded with plastic mica or paper during spraying to prevent the treatment from influencing unwanted plants. The GA3 application was done in the morning. The sprayed flower clusters were labeled and dated to facilitate future spraying.

Harvesting is done ± 65 days after planting. The characteristics of ripe tomato fruit include the color of the fruit changing from green to yellowish, then to red. The harvest is put in a labeled plastic container before being transported to the laboratory for observation.

RESULTS AND DISCUSSION

The Effect of Application of Onion Extract as a GA Source to Improve Tomato Fruit Quality

The results showed that the application of onion extract as a natural source of GA had no significant effect on the observation variables of fruit weight per fruit, fruit diameter, seed weight per fruit, number of seeds per fruit, and vitamin C content in tomato fruit. Table 1 shows the effect of onion extract application on fruit weight and diameter.

Table 1. The Effect of Onion Extract Concentration Treatment on Fruit Weight (g) and Fruit Diameter (cm)

Concentration Treatment	Fruit Weigh (g)	Fruit Diameter (cm)
E0 = control	33.69 a	3.73 a
E1 = 25% concentration	30.00 a	3.59 a
E2 = 50% concentration	30.02 a	3.59 a
E3 = 75% concentration	30.07 a	3.68 a
E4 = 100% concentration	30.02 a	3.68 a
BNT 5%	**Ns**	**ns**

Notes: Numbers followed by the same letter in the same column indicate no significant difference based on the 5% BNT test.

The application of onion extract as a source of natural GA to tomato plants resulted in the largest fruit weight of 33.69 g in E0 (control), which was not substantially different from all other treatments. E0 (control) also had the largest fruit diameter, which was not significantly different from the other treatments. Chen et al. (2016) reported that GA could affect tomato plant germination, seed formation, and fruit weight. (Niu *et al.*, 2023) reported similar results in which the administration of exogenous GA3 induced parthenocarpy and reduced fruit size in tomato plants. According to research (Zain *et al.*, 2015), the production of parthenocarpy eggplant fruit (in which no seeds are formed) reduces fruit weight and dimensions. (Serrani *et al.*, 2007) reported that due to the absence of seeds in the fruit, metabolic activities and hormone synthesis are reduced, albeit to a lesser extent, resulting in a reduction in the translocation of photosynthates and other metabolites to the fruit and thereby reducing fruit size. In this study, the same thing occurred: using onion extract as a natural GA source on tomato plants decreased fruit weight and diameter.

It was discovered that spraying onion extract on tomato plants during the pre-bloom floral phase reduced the number and weight of seeds per fruit on tomato plants. Table 2 shows how the onion extract affected the number of seeds per fruit and how much each seed weighed.

Table 2. The Effect of Onion Extract Concentration on the Number and Weight of Seeds per Fruit

Concentration Treatment	Number of Seeds per Fruit (seeds)	Weight of Seeds (g)
E0 = control	64.33 a	0.23 a
E1 = 25% concentration	62.00 a	0.19 a
E2 = 50% concentration	61.70 a	0.18 a
E3 = 75% concentration	61.27 a	0.18 a
E4 = 100% concentration	53.12 a	0.17 a
BNT 5%	**Ns**	**ns**

Notes: Numbers followed by the same letter in the same column indicate no significant difference based on the 5% BNT test.

The onion extract was effective in reducing the number of seeds and the weight of seeds per fruit. The application of onion extract at a concentration of 100% (E4) yielded the fewest seeds, 53.12, followed by E3 (75% concentration), E2 (50% concentration), E1 (25% concentration), and E0 (control). There was a decrease in the number of seeds by 21.10% with the application of onion extract at 100% concentration when compared to the control.

The variable of seed weight per fruit showed that the application of onion extract decreased seed weight per fruit. The application of onion extract at a concentration of 100% (E4) resulted in the lowest seed weight of 0.17 g, followed by E3 (75% concentration), E2 (50% concentration), E1 (25% concentration), and E0 (control), respectively. There was a 35.29% decrease in seed weight with the application of onion extract at 100% concentration compared to the control. Applying onion extract as a natural source of GA reduced the number of seeds but could not produce parthenocarpy or seedless tomato fruit. Setiawan *et al.* (2016) also reported similar findings, in which the application of GA on seven tomato genotypes could not remove all seeds. Fruit formation begins with pollination.

GA, which functions to inhibit the fertilization process, can prevent the formation of seeds in tomato fruit (Binenbaum *et al.*, 2018). The presence of GA prevents the formation of embryos (zygotes) because the pollen tube cannot reach the microphyll, preventing the egg cell from meeting with the sperm cell. Embryo formation that does not occur causes the development of ovules to stop so that no seeds are formed. Parthenocarpy occurs when fruit formation is not preceded by fertilization; in parthenocarpic fruits, fertilization is replaced by GA (Salisbury &

Ross, 1995). In this study, the number of tomato seeds could be reduced, but there were still seeds formed because there were still fertilized ovules.

Optimum Onion Extract Concentration that Can Improve Tomato Fruit Quality

Giving onion extract as a natural source of GA can boost the vitamin C content of tomato fruit. The effect of onion extract concentration treatment on vitamin C content can be seen in Table 3.

Table 3. The Effect of Onion Extract Concentration Treatment on Vitamin C Content

Concentration Treatment	Vitamin C (mg/100g)
K0 = control	48.58 a
E1 = 25% concentration	48.63 a
E2 = 50% concentration	51.60 a
E3 = 75% concentration	52.39 a
E4 = 100% concentration	56.38 a
BNT 5%	**ns**

Notes: Numbers followed by the same letter in the same column indicate no significant difference based on the 5% BNT test.

The application of onion extract to tomato plants can increase the vitamin C content of the fruit, as shown in Table 3. The higher the onion extract concentration, the higher the vitamin C content. Applying onion extract with a concentration of 100% (E4) yielded the highest vitamin C content, 56.38 mg/100g, an increase of 16.06% compared to the control, which yielded 48.58 mg/100g. According to Tilahun *et al.* (2017), the antioxidant content of tomatoes can be affected by cultivars, the surrounding environment, and the treatment given to the tomatoes. Handarin and Haryati (2013) conducted research on tomato plants and discovered that the application of GA3 concentrations up to 750 ppm significantly increased vitamin C levels in fruit compared to applications using GA3 at lesser concentrations up to 300 ppm. The study's findings (Handrian *et al.*, 2013) align with this research's results, as the higher the concentration of onion extract as a source of natural GA applied, the higher the vitamin C content in tomato fruit. However Setiawan *et al.* (2016), discovered that the application of GA decreased the vitamin C content of parthenocarpic tomatoes.

CONCLUSIONS

The application of onion extract can enhance the quality of tomato fruit, including the number and weight of seeds per fruit as well as the fruit's vitamin C content. Given the high cost of synthetic Gibberellic acid (GA), this effort benefits farmers' efforts to reduce production costs. By incorporating onion extract into tomato cultivation, farmers can improve the quality of tomato fruit, thereby increasing their income.

RECOMMENDATIONS

Based on the study's results and conclusions, it could be suggested that more research be done by increasing the frequency with which onion extract is applied during the plant's growth phase. This effort would make the effect more noticeable and improve the quality of the tomato fruit even more.

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