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Effect of Onion Filtrate Concentration (*Allium cepa* L.) and Soaking Time on the Viability and Vigor of Cabbage Seeds (*Brassica oleracea* L.)

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Abstract
Storing seeds for too long has an impact on the low quality of cabbage production. An alternative method to encourage cabbage growth is giving onion filtrate, which contains the growth hormones auxin and gibberellin. This research aims to determine the effect of the combination of onion filtrate (*Allium cepa* L.) concentration (0%, 50%, 75%, and 100%) and soaking time (0 hour, 3 hours, 6 hours, and 9 hours) on the viability and vigor of cabbage seeds (*Brassica oleracea* L.). The research design used a Randomized Block Design repeated 3 times, so that 48 research units were obtained. The obtained seed viability and vigor data, namely germination power, vigor index, growth rate, and simultaneity of growth, were analyzed for normality and homogeneity, then tested by Kruskal-Wallis and Mann-Whitney tests if significant. The results showed a significant effect on the treatment of onion filtrate concentration and soaking time on several parameters of seed viability and vigor. The concentration of onion filtrate at 75% affected the vigor index and the simultaneity of cabbage growth. The soaking time of 0 hours affected the germination power and vigor index of expired cabbage (*B. oleracea* L.) seeds.

Keywords: Expired seeds; germination; seed quality index; exogenous hormone.

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INTRODUCTION

Cabbage (*B. oleracea* L.) is an economical vegetable with high nutritional value that can meet the needs of vitamins and minerals in the human body, so it must be further increased. Based on data from the Central Statistics Agency (2021), in 2019 cabbage production in Indonesia was 1,413,060 tons, but in 2020 it fell to 1,406,985 tons. According to Rosida *et al*. (2015), cabbage seed production in Indonesia experiences agro-climatic constraints with a seed supply chain that takes a long time to reach consumers, requiring longer seed storage and affecting the low quality of cabbage seeds. In 2021-2022, the average per capita consumption experienced a growth rate of 12.26% (Central Statistics Agency, 2022). The increasing demand for cabbage consumption is an opportunity for the cabbage market, so it is necessary to increase production so that consumer needs are met. The use of seeds with a long shelf life until they expire can be attempted to support the increasing demand for cabbage production.

The use of quality seeds is important and has an impact on agricultural productivity. Basically, seeds are a genetic information system, so seed quality determines crop production (Wimalasekera, 2015). Decreased seed quality can reduce plant adaptability in the field, resulting in less than optimal production (Prabha and Chauhan, 2014). Expired seeds can be used with special treatment and care to overcome this problem because it can help accelerate the germination period (Ridha *et al*., 2017). This is because improper seed storage and too long storage until it passes its life span and experiences an expiration date can cause decreased performance or damage to the seeds (Junaidi *et al*., 2018). In long-term storage, seed viability can be maintained with low seed water content (Kolo and Tefa, 2016). In tropical climates, seed shelf life is shorter because high temperature and humidity factors can increase the respiration rate and seed damage (Sagita and Rahayu, 2022).

The ability of seeds to germinate within a certain time is included in the physiological quality index of seeds. Seed vigor testing obtains seed quality index results with higher sensitivity when compared to testing germination power, physiological quality level of seed lots, germination power,

and seed storage power (ISTA, 2014). High seed quality can be obtained by adding natural plant growth regulators (PGRs) to the seeds.

Onion (*Allium cepa* L.) are one of the ingredients that can be used because they contain natural growth regulators in the form of growth hormones auxin and gibberellin (Lubis *et al*., 2018), as well as rhizokalin, riboflavin, and vitamin B1 (thiamin) as raw materials for auxin (Gresiyanti and Rahayu, 2023). The chemical bond of allicin is formed due to the presence of allicin and thiamin (vitamin B1) to support plant tissue metabolism (Simanjuntak *et al*., 2021). The presence of this substance can help accelerate growth because it helps the process of absorbing nutrients. In addition, onions contain secondary metabolites from the flavonoid group which serves as antibacterials (Edy and Jayanti, 2022).

Based on the results of the Indonesian Center for Biodiversity and Biotechnology (ICBB) Laboratory test in 2016, auxin in the form of IAA at 10.355 ppm was found in 100 ml of onion filtrate (Kurniati *et al*., 2017). According to Ichsan *et al*. (2015), the same filtrate with concentration of 15 ml to 20 ml contains gibberellin up to 10 ppm. Wahyuningsih and Azizah (2023) who applied onion filtrate with concentrations of 0%, 25%, and 50% with a soaking period of 15 minutes, 4 hours, and 6 hours on expired pak choy mustard seeds (*B. rapa* L.) shown that the onion filtrate solution had a significant effect on the seed quality index of viability and seed vigor in the parameters of germination power, growth rate, growth simultaneity, maximum growth potential, and seed vigor index, with the highest data showing an interaction between a concentration of 50% and a soaking period of 6 hours. Thus, this study was conducted to determine the effect of the combination of red onion filtrate concentration and soaking time on the viability and vigor of expired cabbage (*B. oleracea* L.) seeds.

MATERIALS AND METHODS

This experimental research was conducted from February to March 2024 in Kemantren Village, Gedeg District, Mojokerto Regency at an altitude of ±36 meters above sea level. Randomized Block Design was used because the environment was heterogeneous with the treatment of two factors, namely the concentration of onion filtrate (0%, 50%, 75%, and 100%) and the duration of soaking cabbage seeds in onion filtrate (0 hours, 3 hours, 6 hours, and 9 hours).

This research consisted of several stages, starting with the preparation of onion filtrate. Bali Karet variety onions with a harvest age of 60 days were obtained from the Pacet Regional Market, Mojokerto. Onions were peeled and cut into small pieces, then pureed using a blender and filtered using a filter cloth. The results of the filtration were used as a preparation solution which was considered to have a concentration of 100%. The concentration of 75%, it was obtained by performing a dilution composition of 75 grams ml of onion filtrate and 25 ml of distilled water. The concentration of 50% was obtained from 50 ml of onion filtrate with the addition of 50 ml of distilled water. Then, the concentration of 0% was obtained from 100 ml of distilled water.

The second stage is soaking expired cabbage seeds in a solution of onion filtrate. Grand 22 variety cabbage seeds that have expired for 8 months were obtained from the Subur Makmur Agricultural Store, Pacet, Mojokerto. The seeds were soaked for 0 hours, 3 hours, 6 hours, and 9 hours with three repetitions at four filtrate concentrations, namely 0%, 50%, 75%, and 100%. After soaking, the seeds were sown in a petri dish with three layers of straw paper media to make it easier to take during planting (Hafsah *et al*., 2020), then at 3 days after sowing, the seeds were transferred to a prepared seedling tray measuring 2.7x2.7/hole with a planting medium in the form of a mixture of soil and manure in a ratio of 1:1 (Destiwarni *et al*., 2021), then labeled. Seed maintenance is carried out by watering in the morning using a hand sprayer and weeding regularly by removing weeds to avoid pests that interfere with plants.

Observation of seed viability and vigor parameters consisted of germination power, vigor index, growth rate, and simultaneity of growth for 7 days after sowing. Observation data were calculated based on the calculation formula for each parameter based on normal germination that has important structures, such as root candidates (radicle), leaf candidates (plumule), stem candidates (hypocotyl), and intact cotyledons (Kartasapoetra, 2003). The calculation formula for cabbage seed viability and vigor, namely germination power (%), was carried out on normal germination from day 1 to day 7 after sowing. Normal seed growth can be seen when important structures appear and grow in the plant, namely radicle, plumule, and hypocotyl. The germination power formula according to ISTA (2010), namely:

$$\text{Germination Power (\%)} = \frac{\text{Normal number of sprouts}}{\text{Number of seeds sown}} \text{ x } 100\%$$

The vigor index (%) is the accumulation of normal seed germination in the first count on the 5th day after sowing, then divided by the total number of seeds sown and multiplied by one hundred percent (ISTA, 2010).

$$\text{Vigor Index (\%)} = \frac{\sum \text{Normal sprouts first count}}{\sum \text{Number of seeds sown}} \text{ x } 100\%$$

The growth rate (%/etmal) is the sum of normal seed germination for 7 days after sowing and is divided by the observation time. This parameter indicates the ability of seeds to survive in suboptimal environmental conditions. Observations of seed growth rate are carried out every day after sowing based on the amount of growth. The formula for seed growth rate according to Kartasapoetra (2003):

$$\text{Growth Rate (\%/etmal)} = \frac{n1}{D1} + \frac{n2}{D2} + \cdots + \frac{n7}{D7}$$

Description:
n = Number of normal sprouts
D = Observation days every 24 hours (etmal)

The simultaneity of growth (%) is obtained from the calculation of normal germination in percentage. Observations are made on normal seeds that indicate seed vigor on the day between the first (5 day after sowing) and second (7 day after sowing) counts, namely at 6 day after sowing. The calculation of the simultaneity of seed growth uses the formula according to Sadjad, (1999):

$$\text{Simultaneity of Growth (\%)} = \frac{\text{Normal number of sprouts}}{\text{Number of seeds sown}} \text{ x } 100\%$$

Observation data including germination power, vigor index, seed growth rate, and seed growth simultaneity were transformed into arcsin. Data that were not normally distributed and were not homogeneous were tested by Kruskal-Wallis, then tested by Mann-Whitney if they had a significant effect to determine the effect of each treatment of onion filtrate concentration and soaking time.

RESULTS

The research of viability and vigor of expired cabbage seeds for eight months showed that the combination of onion filtrate concentration and soaking time affected several parameters, namely germination power, vigor index, growth rate, and simultaneity of cabbage seed growth. Based on statistic test, concentration of onion filtrate at concentrations of 0%, 50%, and 100% did not have any significant differences. The concentration of 75% showed a significant difference with other onion filtrate concentrations ($\alpha<0.05$), so it means that there was a significant effect of the onion filtrate concentration of 75% on the parameters of vigor index and simultaneity of seed growth.

The results of statistic test for cabbage vigor index showed that at a concentration of 0% was not significantly different from the concentrations of 50% and 100%. However, the concentration of 75% was significantly different from other concentration treatments. Then, the results statistic test on simultaneity of cabbage growth showed that the concentration of 0% was not significantly different from the concentrations of 50%, 75%, and 100%, but the concentration of 75% was significantly different from the concentration treatments of 50% and 100%. The results of the onion filtrate addition on vigor index and simulatineity of cabbage growth are presented in Table 1.

Table 1. Effect of onion filtrate concentration on the vigor index and growth simultaneity of cabbage seeds

Parameter	Concentration	Concentration*			
		0%	50%	75%	100%
Vigor Index	0%	-	0.538	0.035*	0.348
	50%	0.538	-	0.028*	0.660
	75%	0.035*	0.028*	-	0.011*
	100%	0.348	0.660	0.011*	-
Simultaneity of Growth	0%	-	0.160	0.189	0.079
	50%	0.160	-	0.024*	0.767
	75%	0.189	0.024*	-	0.007*
	100%	0.079	0.767	0.007*	-

Description: *) Values followed by an asterisk show significantly different results based on Mann-Whitney test at the 5% level.

Significant difference was found in the treatment of the duration of soaking the onion filtrate on the germination power and vigor index. The treatment of the duration of soaking the onion filtrate for 3 hours, 6 hours, and 9 hours was not significantly different, while the soaking time of 0 hours had

a significant difference with the others. The soaking time of 0 hours showed a significant difference ($\alpha<0.05$), which means that the soaking time of 0 hours had a significant effect on the parameters of germination power and vigor index.

At a soaking time of 3 hours, 6 hours, and 9 hours, there was no significant difference on germination, while a soaking time of 0 hours was significantly different from other treatments. On the other hand, cabbage vigor index showed that a soaking time of 0 hours was significantly different from the soaking time of 3 hours, 6 hours, and 9 hours. The results of soaking time effect on cabbage seeds are presented in Table 2.

Table 2. Effect of soaking time of onion filtrate on germination power and vigor index of cabbage seeds

Parameter	Soaking Time	Soaking Time*			
		0 Hours	3 Hours	6 Hours	9 Hours
Germination Power	0 Hours	-	0.004*	0.015*	0.007*
	3 Hours	0.004*	-	0.362	0.725
	6 Hours	0.015*	0.362	-	0.287
	9 Hours	0.007*	0.725	0.287	-
Vigor Index	0 Hours	-	0.003*	0.010*	0.003*
	3 Hours	0.003*	-	0.446	0.704
	6 Hours	0.010*	0.446	-	0.305
	9 Hours	0.003*	0.704	0.305	-

Description: *) Values followed by an asterisk show significantly different results based on Mann-Whitney test at the 5% level.

DISCUSSION

The concentration of 75% affected the vigor index and the concentration of 0% did not differ significantly in the parameters of seed growth simultaneity. This is in line with the seed invigoration study by Lubis *et al*. (2018), at a concentration of 25%, 50%, and 75% of onion filtrate, it was not significantly different from a concentration of 0%, but significantly different from a concentration of 100%. The administration of exogenous auxin hormone treatment will not affect seed viability and vigor if the auxin content in the seeds is sufficient. The control mechanism in plants will work when exogenous auxin is given. According to Novianti *et al*. (2015), in plants there will be a cell elongation process that is influenced by the endogenous auxin hormone synthesized by the plant and the exogenous auxin hormone derived from the administration of growth regulators. If the synthesized hormone helps metabolism sufficiently, then exogenous growth regulators will not affect growth.

Soaking seeds only in distilled water also affects the viability and vigor of cabbage seeds. This is thought to be because the entry of distilled water into the seeds can make it easier for the seeds to absorb water because the seed coat weakens, which blocks the water absorption process, thus facilitating the metabolic process. In addition, soaking seeds in distilled water functions to free seeds from pathogens that inhibit germination (Agustarini and Prameswari, 2020). The availability of sufficient water is an important factor in accelerating the germination process because the seed coat becomes permeable in the presence of osmotic pressure. When imbibition occurs, the respiration rate increases, and the enzymes and hormones in the seeds become active. Then the catabolism process occurs, namely the transformation of food reserves, so that ATP energy and nutrient components are obtained. Furthermore, the final stage of the anabolism process involves the re-formation of more complex compounds, resulting in germination because the cells enlarge and new cells will be formed. The occurrence of imbibition causes the seed coat to become soft, so that important structures, namely the radicle and plumule, can penetrate the seed coat (Panggabean, 2012). According to Silalahi (2017), water imbibition in seeds will stimulate cells and metabolic rates to degrade food reserves, thereby stimulating the hydrolysis of starch into simple sugars until the germination phase occurs.

The concentration of 75% onion filtrate was able to produce the best viability and vigor values of expired cabbage seeds compared to other concentration treatments. In line with the research of Jayadi *et al*. (2023), the treatment of 60% concentration with a soaking time of 6 hours obtained the best results in the invigoration of expired corn seeds. According to Mutryarny *et al*. (2022), the right concentration of auxin growth hormone is needed by each plant to support optimal growth. Giving the right concentration of treatment can increase the results for all parameters compared to without giving treatment because the auxin hormone content in the onion filtrate given shows different reactions in plant organs, so using the right concentration can stimulate certain organs to work. At a concentration

of 100% onion filtrate, the seed viability value decreased compared to other concentrations. Giving a low concentration of onion filtrate can work optimally on plant growth; on the other hand, growth will be inhibited if the concentration given is too high (Pradita *et al*., 2022). This is because the higher auxin hormone contained in the onion filtrate will enter the seeds simultaneously with the presence of water, thus inhibiting metabolism because toxic compounds are formed. If the concentration is too high, it will cause a decrease in seed quality due to toxins in the seeds. Conversely, if the concentration is too low, it will not give a reaction to the seeds.

Onion filtrate containing auxin and gibberellin can work together with endogenous hormones in seeds, thus helping to encourage seed germination. According to Miftakhurrohmat and Widiyanti (2016), gibberellin hormone encourages aleurone in enzyme synthesis, thus producing enzymes including α-amylase, maltase, and enzymes that play a role in both the germination phase and the end of the dormancy phase. The α-amylase enzyme will enter the endosperm and break down sugar into energy, which will be used by the embryo to develop. The effect of gibberellin hormone when given to dicotyledonous plants, such as cabbage, can help accelerate growth to reach a height of 2 meters and help the growth of plants with dwarf genetics so that they can grow normally. The effect of giving gibberellin to some plants can accelerate flowering and stop seed dormancy, and it is the same as auxin, namely that it can increase stem elongation and participate in the process of regulating plant development, such as auxin (Wiraatmaja, 2017).

In the long-soaking treatment, there was no significant effect on several parameters of viability and vigor of expired cabbage seeds. This is because high-quality seeds have sufficient food reserves, so they are able to maintain viability and vigor in a longer storage time than low-quality seeds. The seed germination process is assisted by food reserves in the seeds. The high value of seed viability indicates that the seed endosperm has sufficient food reserves to provide energy during the germination process (Nugraheni *et al*., 2019).

The treatment of soaking time of 3 hours, 6 hours, and 9 hours had no effect because the hormone content in the onion filtrate had an impact on seed germination. According to Prabawa *et al*. (2020), the amount of auxin absorbed by the seeds during the imbibition process correlates with the duration of the onion filtrate seed soaking treatment. Auxin has the ability to increase seed metabolism, thereby stimulating germination, and seeds can germinate faster. The auxin hormone helps cells in the roots and stems grow during germination, so that the synthesis of proteases and other hydrolytic enzymes increases to help development and germination (Amin *et al*., 2017). The gibberellin hormone in the onion filtrate helps the initial process of seed germination by converting carbohydrates, proteins, and fats into food reserves so that the embryo can absorb them more easily (Hafiza, 2020).

The 0-hour soaking time obtained results that significantly affected the germination power and seed vigor index when compared to other soaking time treatments. This is because soaking seeds for the right time can support seed germination; if the seeds are soaked for too long, it can damage the embryo, so that the seeds will not germinate properly and even the seeds will not grow at all. The ability to germinate seeds decreases because the seeds that should have been ready to germinate were still soaked. In line with the research of Lubis *et al*. (2018), soaking tomato seeds in onion filtrate for 12, 24, and 36 hours did not affect tomato growth. Soaking for too long causes more auxin to be absorbed by the seeds, thus inhibiting the respiration process due to loss of oxygen (anoxia).

The germination process is a respiration process that requires oxygen and will produce carbon dioxide and energy needed for growth and the formation of more complex compounds (Hartawan, 2016). Water affects the seed germination process; if it is too long, it will result in the loss of oxygen needed in the respiration process, so that the germination process will slow down. Soaking seeds for too long causes the space in the seeds to become saturated, thus inhibiting respiration and resulting in low germination parameters (Djamhuri and Hasmaliah, 2014). Therefore, the right time for soaking seeds can help accelerate metabolic reactions and affect enzyme activity, then cell division occurs until the germination process.

CONCLUSION

Based on the results of the research, it can be concluded that there is a significant effect on the treatment of onion filtrate concentration and soaking time on several parameters of seed viability and vigor. At a concentration of onion filtrate of 75%, there is a significant effect on the vigor index and the simultaneity of growth of expired cabbage seeds, while the treatment of the length of soaking time of onion filtrate for 0 hours has a significant effect on germination power and vigor index.

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CONFLICT OF INTEREST

There is no conflict of interest.

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