Invigoration of expired chilli plant (*Capsicum frutescens* L.) seeds with various concentrations and soaking duration of bean sprout extract

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Abstract. Expired seed has a very low vigour and viability which can inhibit the sprout growth due to difficulty in imbibition. Bean sprout extract contains more auxin, cytokinin and gibberellic acid that are important to increase growth potential of expired seed. Therefore, it is a must to pay attention to the concentration and soaking duration of bean sprout extract when soaking the seeds. The research was conducted in March to April 2020 at Sei Rengas I Subdistrict, Medan Kota, North Sumatera, using randomized complete block design with two treatment factors. The result showed that the concentration of bean sprout extract significantly affected the parameters of the membrane leakage rate which the best treatment is soaking in aquadest. The soaking duration significantly affected the parameters of the membrane leakage rate and growth speed which the best soaking duration is 12 hours. The interaction of two treatments significantly affected the parameters of the membrane leakage rate which the best combination is soaking in aquadest for 12 hours.

1. Introduction

Chilli plant (*Capsicum frutescens* L.) is the annual plant of horticulture, which has an important economic value in Indonesia. Market demand for chilli products is increasing along with the increasing demand of the community which triggers the productivity of the chilli plant. This can be seen from the statistical data on yields per hectare in 2017 which reaches 6.88 tonnes/ha [1] while in 2018, it reaches 7.72 tonnes/ha [2]. The data shows the increasing but has not reached the potential productivity of chilli plant per hectare.

Superior seed with the characteristic of high germination and good vigor and viability is needed as the effort to increase the productivity of chilli plant. However, the certificated seed can also experience the quality degradation as the result of improper storage and expiration of the seed’s life span (expired) [3]. Expired seed itself is the seed, which has passed over the recommended time of plating that has been determined by seed producer [4]. The seed which has been deteriorated will be difficult to germinate due to loss vigor and viability. However, it can be solved by giving the treatment to increase the quality of seed.

Expired chilli plant has been deteriorated in seed quality that many farmers keep those expired seed for their own consumption. Besides that, there are a lot of expired seeds which has been distributed to farmers. Moreover, the incident of selling expired seeds has often occurs and it harms many farmers and it is known that sing poor seed quality in plant cultivation will give the limitation of growth and yield [5].
Seed invigoration is the treatment which is given to seed before planting in order to fix its germination and growth. Seed invigoration can be done by a lot of ways such as soaking the seed in water, priming in various solution and practicing matriconditioning [6].

Bean sprout contains more free amino acids, monosaccharides organic acids, vitamin and phytochemical than the seed itself [7]. It is caused by protein synthesis during germination apart from the lack of dry matter due to sugar releasing during soaking and germination [8]. The former research shows that potato which is given plant growth regulator twice shows the best data in growth and yield compared to the other plant growth regulator or control [9]. Besides that, bean sprout treatment of 200 g/L with the soaking duration of 15 minutes and 200 g/L with the soaking duration of 30 minutes show the best result of plant growth rate of shallot seed (Allium ascalonicum L.) [10]. Eggplant soaking in the concentration of 30% of bean sprout for 12 hours is able to increase hypocotyls length while soaking in the concentration of 20% of bean sprout in 12 hours is able to increase the root length [11].

Based on the statements above, there is a need to do further research about the invigoration treatment to expired chilli plant seed (Capsicum frutescens L.) with various concentration and soaking duration of bean sprout.

2. Materials and methods
The experiment was conducted in March-April 2020 in the Sei Rengas Subdistrict, Medan. This research used a randomized complete block design with two factors, the first factor was the concentration of bean sprout extract (soaking in aquadest, 10%, 20%, 30% and 40%) and the second factor was the soaking duration (6 hours, 12 hours and 18 hours). This research started from babybag and growing media preparation, bean sprout extract preparation, giving treatment, nursery, taking care of the chilli plant sprout and observed parameters which includes membrane leakage rate, vigor index, germination, and maximum growth potential.

The chilli plant seed was soaked in aquadest for 15 minutes to see whether the seed is pithy or not. The pithy seed is indicated by the sinking of seed. Then, seed was soaked in the bean sprout extract for 6 hours, 12 hours and 18 hours according to the treatment. Each treatment consists of 10 seed with 2 replications.

The data were analysed statistically using F-test and continued by the Duncan Multiple Range Test (DMRT) at $\alpha$ 5%.

3. Results and discussion
Table 1 shows that the seed with the treatment of soaking in aquadest for 12 hours has the lowest electrical conductivity (EC is done as the physical test to see the membrane leakage rate) which is significantly different from the other treatment. It indicates that the seed with the treatment of soaking in aquadest for 12 hours ($K_0L_2$) had the best vigor and viability. The membrane damage causes a lot of compounds such as sugar, amino acids, phosphate and the other anorganic compounds escape so that the metabolism process and synthesis of new compounds are distracted. This high membrane leakage also can inhibit the imbibitions because the dysfunction of mitochondria so there will be decreased mitochondrial phospholipid synthesis [12]. Besides that, it is also caused by the water content in the seed as the result of soaking which can affect the electrical conductivity [13].

Based on Table 2 shows that the highest germination of chilli plant is the seed of $K_3L_1$ which is 45.0% but it is not significantly different from other treatments. It can be happened because of soaking the seed in osmotic solution which can inhibit the imbibitions and there are 3 phases of imbibitions and deteriorated seeds cannot complete the first one due to membrane damage that can affect the metabolism in the next phase. The accumulation of membrane damage causes the failure of seed to germinate or it can germinate abnormally [14].
While concentration does not show any significant graphic which the best duration to soak the expired seed is for 11.08 hours. Soaking above 12 hours can decrease the growth speed immediately to trigger its growth metabolism which has role in protein synthesis through RNA transcription. Adding auxin to research has found that highest amount of auxin in bean sprout extract which is 0.247%/etmal.

Based on Figure 1 that shows the exponential graphic which the best duration to soak the expired seed is for 11.08 hours. Soaking above 12 hours can decrease the growth speed immediately to 0.247%/etmal.

The results of the F-test indicate that the soaking duration treatment shows the significantly different. $L_2$ shows the highest value of growth speed which is 0.505%/etmal and $L_3$ is the lowest one which is 0.247%/etmal. While concentration does not show any significant difference. The former research has found that highest amount of auxin in bean sprout extract [15,16] can affect the RNA metabolism which has role in protein synthesis through RNA transcription. Adding auxin to plant can trigger its growth [17] but adding too much will reduce it [18].

Based on Figure 1 that shows the exponential graphic which the best duration to soak the expired seed is for 11.08 hours. Soaking above 12 hours can decrease the growth speed immediately to 0.247%/etmal.

### Table 1. Average of electrical conductivity test (EC) of chilli plant at various bean sprout extract concentration and soaking duration

| Soaking Duration (hours) | Concentration (%) | Average | μS.cm⁻¹ |
|--------------------------|-------------------|---------|---------|
|                          | $K_0$: 0          | $K_1$: 10 | $K_2$: 20 | $K_3$: 30 | $K_4$: 40 |       |
| L₁: 6                    | 1.90 c            | 1.35 ef  | 1.25 fg  | 1.80 cd  | 1.25 fg  | 1.51  |
| L₂: 12                   | 0.05 i            | 1.30 fg  | 1.90 c  | 1.95 c   | 2.50 b   | 1.54  |
| L₃: 18                   | 0.70 h            | 1.65 cde | 1.05 g  | 3.40 a   | 1.50 def | 1.66  |
| Average                  | 0.88              | 1.43     | 1.40    | 2.38     | 1.75     |

Note: Numbers followed by the same letters indicated no significant difference in Duncan's Multiple Range Test at $\alpha = 5\%$.

### Table 2. Average of chilli plant germination at various bean sprout extract concentration and soaking duration

| Soaking Duration (hours) | Concentration (%) | Average |
|--------------------------|-------------------|---------|
|                          | $K_0$: 0          | $K_1$: 10 | $K_2$: 20 | $K_3$: 30 | $K_4$: 40 |       |
| L₁: 6                    | 40.0              | 15.0     | 10.0     | 45.0     | 50.0     | 32.0  |
| L₂: 12                   | 35.0              | 35.0     | 30.0     | 30.0     | 15.0     | 29.0  |
| L₃: 18                   | 15.0              | 40.0     | 20.0     | 15.0     | 40.0     | 26.0  |
| Average                  | 30.0              | 30.0     | 20.0     | 30.0     | 35.0     | 29.0  |

### Table 3. Average of growth speed of chilli plant at various bean sprout extract concentration and soaking duration

| Soaking Duration (hours) | Concentration (%) | Average |
|--------------------------|-------------------|---------|
|                          | $K_0$: 0          | $K_1$: 10 | $K_2$: 20 | $K_3$: 30 | $K_4$: 40 |       |
| L₁: 6                    | 0.369             | 0.152    | 0.587    | 0.238    | 0.494    | 0.368 ab |
| L₂: 12                   | 0.576             | 0.533    | 0.489    | 0.378    | 0.551    | 0.505 a  |
| L₃: 18                   | 0.373             | 0.179    | 0.036    | 0.341    | 0.306    | 0.247 b  |
| Average                  | 0.439             | 0.288    | 0.371    | 0.319    | 0.450    |

Note: Numbers at the same column followed by the same letters indicated no significant difference in Duncan's Multiple Range Test at $\alpha = 5\%$. 

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Figure 1. The correlation of soaking duration towards speed growth of chilli plant.

The results of the F-test indicate that \( K_4 \) has the highest maximum growth potential at concentration of bean sprout extract treatment while \( L_1 \) is the highest maximum growth potential at soaking duration treatment. There is no significantly different at the interaction of treatment due to the dominant character of a treatment so that both treatment cannot run synergistically [19]. \( L_2 \) and \( L_3 \) had the lowest value of maximum growth potential could be caused by too long duration of soaking which can lead the seed to death because of anoxia (an absence of oxygen) so the respiration cannot happen normally [20].

Table 4. Average of Maximum Growth Potential of chilli plant at various bean sprout extract concentration and soaking duration.

| Soaking Duration (hours) | Concentration (%) | Average |
|--------------------------|-------------------|---------|
|                          | \( K_0: 0 \)      | \( K_1: 10 \) | \( K_2: 20 \) | \( K_3: 30 \) | \( K_4: 40 \) |       |
| L1: 6                    | 40.00             | 15.00   | 25.00   | 50.00   | 50.00   | 36.00   |
| L2: 12                   | 40.00             | 35.00   | 30.00   | 35.00   | 15.00   | 31.00   |
| L3: 18                   | 25.00             | 45.00   | 20.00   | 20.00   | 45.00   | 31.00   |
| Average                  | 35.00             | 31.67   | 25.00   | 35.00   | 36.67   | 32.67   |

4. Conclusions
The result of this research shows that the seed soaking in aquadest for 12 hours has the best result at membrane leakage rate and significantly different from the highest value of membrane leakage rate. For growth speed parameter, there is significantly different only at soaking duration treatment while maximum growth potential does not show any significantly different. The seed which is soaked in bean sprout extract cannot grow well because of its high concentration while it should be 12 hours because soaking in longer duration can cause anoxia. The improper concentration and soaking duration can lead to dysfunction of mitochondria, inhibit imbibitions, respiration, RNA metabolism due to the escaping of many compounds in seed.

References
[1] Badan Pusat Statistik [Central Bureau of Statistics] 2018 Statistik Tanaman Sayuran dan Buah-Buahan Semusim Indonesia 2017 [The Statistic of Annual Vegetable and Fruit Plant of Indonesia 2017] (Jakarta: BPS)
[2] Badan Pusat Statistik [Central Bureau of Statistics] 2019 Statistik Tanaman Sayuran dan Buah-Buahan Semusim Indonesia 2018 [The Statistic of Annual Vegetable and Fruit Plant of Indonesia 2018] (Jakarta: BPS)

[3] Ernawati, Rahardjo P and Suroso B 2017 Respon benih cabai merah (Capsicum annuum L.) kadaluarsa pada lama perendaman air kelapa muda terhadap viabilitas, vigor dan pertumbuhan bibit [Response of seed red chilli (Capsicum annuum L.) expired on the long soaking of coconut water against viability, vigor and seedling growth] Agritrop 15 1 pp 71-83

[4] Kartasapoeitra A G 2003 Teknologi Benih [Seed Technology] (Jakarta: PT. Rineka Cipta).

[5] Marlih A, Nasution M and Azmi S 2010 Pengaruh masa kadaluarsa dan penggunaan berbagai ekstrak bahan organik terhadap viabilitas dan vigor beih semangka (Citrus vulgaris Schard.) [Effect of expired time and use of various organic matter extract on viability and vigor water melon seed] J. Agrista 14 2 pp 44-50

[6] Arief R and Koes F 2010 I Vigorasi Benih [Seed Invigoration] (Maros: Balai Penelitian Tanaman Serealia [Research Institute for Cereal Plants])

[7] Wang H, Guo X, Li Q, Lu Y, Huang W, Zhang F, Chen L, Liu R H and Yan S 2020 Kerangka transkriptomik dan metaboli terpadu untuk metabolisme karbon dan regulasi hormon tanaman di vigna radiata selama pasca pertumbuhan perkecambahan benih [Integrated transcriptomic and metabolic framework for carbon metabolism and plant hormones regulation in vigna radiate during post-germination seedling growth] Sci Rep 10 p 3745

[8] Winarno F G 1981 Dari Nilai Gizi Tauge sampai Noda Bitot, Kumpulan Pikiran dan Gagasan Tertulis [From Nutritional Value of Bean Sprouts to Bitot Strains, Written Collection of Thoughts and Ideas] (Bogor: Pusbangtepa IPB)

[9] Mahanani A 2003 Pengaruh Macam Sumber ZPT Alami dan Frekuensi Pemberiannya Terhadap Pertumbuhan dan Hasil Kentang Solanum tuberosum L. Varietas Granola [The Effect of Given Natural Hormone Sources and the Frequency to the Growth and Yield of Granola Cultivar of Potato Solanum tuberosum L.] (Malang: Universitas Muhammadiyah Malang)

[10] Adelia A, Sarjiah and Utama N A 2013 Pengaruh Konsentrasi dan Lama Perendaman Ekstrak Rebung dan Tauge Terhadap Pertumbuhan Tunas dan Hasil Bawang Merah (Allium ascalonicum L.) [The Effect of Concentration and Soaking Length of Bamboo Shoot Growt Accelerate & Increasing Yield of Shallot (Allium ascalonicum L.)] (Yogyakarta: Universitas Muhammadiyah Yogyakarta)

[11] Nurmiati and Gazali Z 2019 Pengaruh Konsentrasi dan lama perendaman ekstrak tauge (Vigna radiata L.) terhadap perkembahan terung (Solanum melongena L.) [Effect of concentration and prolonged submersion extract bean sprouts (Vigna radiata L.) on germination of eggplant (Solanum melongena L.).] J. Pendidikan Biologi dan Sains 4 1 pp 41-6

[12] Umar S 2012 Pengaruh Pemberian bahan organik terhadap daya simpan benih kedelai (Glycine max (L) Merr.) [Effect of organic matter application on storage period of soybean (Glycine max (L) Merr.) seed] Berita Biologi 11 3 pp 401-10

[13] Sivritepe H O, Senturk B and Teoman S 2015 Uji daya hantar listrik pada benih jagung [Electrical conductivity tests in maize seeds] Medcrave 2 7

[14] Ruliyansyah A 2011 Peningkatan Performansi benih kakangan dengan perlakuan invigorasi [The increasing performance of nut seeds with invigoration treatment] J. Perkebunan & Lahan Tropika 1 pp 13-8

[15] D’Agostino I B and Kieber J J 1993 Mekanisasi molekuler aksi sitokinin [Molecular mechanisms of cytokinin action] Current Opinion in Plant Biology 2 pp 359-64

[16] Sanjaya W, Indratmi D and Suffianto 2019 Pemberian berbagai ekstrak tumbuhan terhadap respon pertumbuhan batang buah naga merah (Hylocereus polyrhizus) [Applications various extracts of plant on stem growth response of red dragon fruit (Hylocereus polyrhizus)] J. Tropical Cro Science and Technonoloy 1 1 pp 33-43

[17] Pamungkas S S T and Nopiyan R R 2020 Pengaruh zat pengatur tumbuh alami dari ekstrak tauge terhadap pertumbuhan bibit budchip tebu (Saccharum officinarum L.) varietas Bululawang (BL)
[The effect of bean sprouts extract as a natural plant hormone to growth in nurseries using Bululawang varieties cane budchip] *Mediagro* 16 1 pp 68-80

[18] Sianipar M W, Rustikawati, Harini R R Y, Herison C and Mukhtasar 2019 Pengaruh berbagai macam dan konsentrasi senyawa organik kompleks terhadap pertumbuhan nana secara in vitro [Effect of several types and concentration of complex organic compounds on growth of pineapple in vitro] *Akta Agrosia* 22 1 pp 22-8

[19] Lubis R R, Kurniawan T and Zuyasna 2018 Invigorasi benih tomat kadaluarsa dengan ekstrak bawang merah pada berbagai konsentrasi dan lama perendaman [Invigoration of expired tomato seed with onion extract at various concentrations and soaking durations] *J. Ilmiah Mahasiswa Pertanian* 3 4 pp 175-84

[20] Ajar S 2015 Pengaruh Konsentrasi Air Kelapa dan Lama Perendaman Terhadap Perkecambahan Benih Padi (*Oryza sativa L.*) Kadaluarsa [Effect of Coconut Water Concentrations and Soaking Durations to Germination of Rice Seeds] (Meulaboh Aceh Barat: Universitas Teuku Umar).