Effect of Storage Time and Storage Container on the Viability and Growth of Sweet Corn Seeds (*Zea mays* saccharata Sturt)

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Abstract. Seed is a means of agricultural production that must be available in sufficient quantities and of high grade. This study aimed to determine the effect of storage time and storage container on the viability and growth of sweet corn seeds, which can increase the growth of sweet corn plants. This study used a Group Random Design (GRD) with two factors, namely the storage time factor, which consisted of 3 treatment levels and was repeated 3 times, and the storage container factor, which consisted of 3 treatment levels and was repeated 3 times, resulting in 27 experimental units. Five sampled plants were placed in each bed, resulting in 135 sampled plants. The first factor is W (Storage time), consisting of W1 (stored for 1 week), W2 (stored for 2 weeks), and W3 (stored for 3 weeks), while the second factor A (storage container) consists of A1 (storage container using plastic bottles), A2 (storage container using glass bottles) and A3 (storage container using plastic clip packaging). The results showed that storage time had a significant effect on the parameters of germination percentage and plant height; the best results were demonstrated by W1 (1 week storage time). Storage containers significantly impact the parameters of germination and plant height. However, it did not significantly affect the number of leaves, and the best result was shown by A3 (storage container using plastic clip packaging).

Keywords: Sweet corn; shelf life; vigor

1 Introduction

Sweet corn (*Zea mays* saccharata Sturt) is the most important crop after rice and wheat because it has many benefits such as a source of carbohydrates and animal feed. The demand for corn in Indonesia has increased along with population growth and market demand [1]. Corn production can be increased starting from selecting the right and quality seeds, namely those with high vigor so that they are more tolerant of growing and developing on less fertile land and environments and are resistant to storage [2]. Seed vigor can be interpreted as the ability of seeds to grow normally in suboptimal environments and to survive in extreme conditions and slow aging processes. Seed viability is the germination power of seeds, the percentage of seed germination or seed growth power. Seed viability is also the germination capacity of seeds which can be indicated through metabolic symptoms or seed growth symptoms which are a form of benchmark for potential seed viability parameters. Differences in germination rates and the ability of seeds to develop normally indicate differences in the level of seed viability produced [3].

ICEHHA 2024, December 13-14, Ruteng, Indonesia

DOI 10.4108/eai.13-12-2024.2355539

Seed quality is influenced by storage, the high and low viability and vigor of seeds as a result of whether or not the physical maturation conditions of the seeds will be easily affected by storage factors, so that appropriate methods and treatments are needed during storage, so that the quality of the seeds does not deteriorate quickly [4]. Long-term storage will result in a decrease in seed quality or decreased seed viability, this process of seed quality decline cannot be stopped because the seeds always respire. Actions that can be taken are to control the factors that affect the rate of seed deterioration, including airtight storage containers [5]. The longer the seeds are stored, the less their germination capacity will be. Seeds with high initial quality, proper packaging methods and a safe storage environment are very good for storing seeds for a longer period [6].

Tight storage containers do not allow air exchange from the environment to the storage container. Seed quality can be maintained if packed with ethylene plastic bags and aluminum foil, but if stored with plastic sacks and burlap sacks, the seeds will quickly deteriorate [7]. An ineffective storage model can cause seed needs to become less available or seed deterioration occurs so that the existing seeds are of poor quality or the seeds experience deterioration. Corn seeds used for planting are good seeds, the seeds are shiny, free from pests and diseases because quality seeds provide great results for their productivity [8].

Based on this background, it is necessary to conduct research entitled "Effect of Storage Time and Storage Container on the Viability and Growth of Sweet Corn Seeds (*Zea mays* saccharata Sturt)".

2 Method

The research was conducted at the Laboratory of the Faculty of Agriculture, Universitas Katolik Indonesia Santu Paulus Ruteng, while the field research was conducted in Poco Likang Village, Ruteng District, Manggarai Regency. The research was conducted from September to November 2023. This study used a Randomized Block Design (RAK) with 2 treatment factors, namely the first treatment was the length of seed Storage time (W) consisting of seeds stored for 1 week (W_1), seeds stored for 2 weeks (W_2), and seeds stored for 3 weeks (W_3). The second treatment was the seed storage container (A) consisting of a storage container using a plastic bottle (A_1), a storage container using a glass bottle (A_2), and a storage container using a plastic clip packaging (A_3). This study contained 9 treatment combinations and 243 seeds in each treatment with 3 repetitions so the total experimental units were 27. There were 5 sample plants so the total sample plants were 135. The observation parameters included: water content, germination power, plant height, and number of leaves. The data obtained in this study were processed using Analysis of Variance (ANOVA) at the 5% level, if there was a significant difference, it was continued with the Duncan Multiple Range Test (DMRT) at the 5% test stage using the SPSS 26 application.

3 Results and Discussion

3.1 Moisture Content

Based on the results of the analysis of variance in the moisture content of sweet corn seeds, there was an interaction between the Storage time treatment and the storage container. The average moisture content of sweet corn seeds between treatments that had a significant effect is presented in Table 1.

Table 1 Average Moisture Content

Treatment	Moisture Content (%)
W_1A_1	13.33^b
W_1A_2	14.00^c
W_1A_3	12.99^a
W_2A_1	14.71^f
W_2A_2	14.43^e
W_2A_3	14.23^d
W_3A_1	15.29^h
W_3A_2	15.00^g
W_3A_3	14.41^e

Description: Numbers followed by the same letter indicate no significant difference while numbers not followed by the same letter indicate a significant difference based on DMRT further test at 5% level.

Table 1 shows that the combination of W_1A_3 treatments (1 week storage period and storage container with plastic clip packaging) has the lowest percentage of sweet corn seed moisture content, which is 12.99%. The low percentage of seed moisture content in the combination of W_1A_3 treatments (1 week storage period and storage container with plastic clip packaging) is thought to be due to the short storage period of the seeds so that the seed moisture content is still optimal and the lowest percentage of moisture content indicates that the viability and vigor of sweet corn seeds are still optimal. [4] stated that the optimal seed moisture content ranges from 5% -14% because seeds with a moisture content below 5% can be accelerated to deteriorate due to physicochemical reactions, while seeds with a moisture content above 14% will be easily attacked by fungi. The low percentage of sweet corn seed moisture content is thought to be due to the sweet corn seed storage container using plastic clips being able to maintain the seed moisture content from external influences. [9] stated that poly ethylene or poly propylene plastic bags can play a role in modifying the packaging space during storage against external influences such as temperature and humidity so that the moisture content and seed quality can be maintained, the respiration rate is low, the food reserves in the seeds are still high and the germination coefficient is also high.

Treatment W_3A_1 (3 weeks of storage time and storage container with plastic bottles) has the highest percentage of sweet corn seed water content, namely 15.29%. The high percentage of seed moisture content in the W_3A_1 treatment (3 weeks of Storage time and storage container with plastic bottles) is thought to be due to the storage time of the seeds and the seeds are hygroscopic. [10] stated that seeds are hygroscopic and always try to achieve equilibrium conditions with their environment, seeds will absorb moisture content from air that has higher humidity so that the seed moisture content increases. [11] stated that seed moisture content during storage is a factor that affects seed vigor and viability and the longer the seeds are stored, the higher the seed moisture content can reduce the number of normal sprouts. [12] stated that seeds stored for a long period with high moisture content and inadequate placement accelerate deterioration which is indicated by decreasing germination power and can increase and trigger the development of microorganism activities such as fungi. [13] stated that high seed moisture content encourages the creation of conditions that accelerate the rate of deterioration resulting in cell membrane leakage which can reduce seed viability and vigor.

3.2 Germination

Based on the results of the analysis of variance, it shows that there is a significant effect between the treatment of storage time and storage container for sweet corn seeds on germination power. The average germination power of sweet corn that has a significant effect between treatments is presented in Table 2.

Table 2 Average Germination

Treatment	Germination (%)
	1 WAP
Storage time (W)	
W_1	97.78[b]
W_2	97.78[b]
W_3	71.11[a]
Storage Container (A)	
A_1	86.67[ab]
A_2	84.44[a]
A_3	95.56[b]
Interaction	nr

Descriptions: Numbers followed by the same letter indicate no significant difference while numbers not followed by the same letter indicate a significant difference based on DMRT further test at 5% level. nr= not real

Table 2 shows that treatment W_3 (seeds stored for 3 weeks) has the lowest percentage of germination of sweet corn seeds at the age of 1 WAP, 71.11% for germinated seeds whose collectibles penetrate the soil surface. This is thought to be due to the Storage time time of the seeds so the moisture content of the seeds increases and accelerates the rate of deterioration during storage. [12], that seeds stored for a long period, with high moisture content, and improper placement accelerate deterioration characterized by decreased germination. [22] showed that the Storage time in sorghum seeds affects the deterioration and vigor of seeds which can increase the percentage of damaged seeds in storage containers. The W_1 (1 week storage period) and W_2 (2 weeks storage period) treatments had the highest percentage of germination of sweet corn seeds at the age of 1 WAP, which was 97.78%. This is thought to be caused by the short Storage time of sweet corn seeds so the viability of the seeds is still high. [12], that the germination of seeds is influenced by the length of the seed storage period, namely the longer the seeds are stored, the lower the viability of the seeds due to respiration during storage. [23] that during the storage process, the seeds respire which will cause the viability and vigor of the seeds to decrease over time.

Table 2 shows that the storage container treatment has a significant effect on the germination of sweet corn. The A_2 treatment (storage container with glass bottle) had the lowest percentage of sweet corn germination at the age of 1 WAP, which was 84.44%. The low percentage of germination in this treatment is thought to be caused by the seeds respiring to produce heat and water vapor during storage and continuing to be in the packaging so that the seed moisture content increases and the seed storage environment becomes humid. [17], state that the increase in seed moisture content in glass bottles during storage can be caused by seeds carrying out metabolic activities, namely respiration which produces carbon dioxide gas and water vapor and continues to be in the package. [15] states that storing seeds in a tightly closed glass bottle causes water vapor and heat from seed respiration to not be able to escape and stick to the inner wall of the glass bottle. According to [20], too high water content causes the food reserves in the seeds to run out quickly and accelerates the rate of seed deterioration.

Treatment A_3 (storage container with plastic clip packaging) had the highest percentage of sweet corn germination at the age of 1 WAP, which was 95.56%. The high percentage of germination is thought to be due to the plastic clips being able to keep the sweet corn seeds from external influences so that the quality of sweet corn can be maintained during storage. [9] stated that polyethylene or polypropylene plastic bags can modify the packaging space during storage against external influences such as temperature and humidity so that the moisture content and temperature of the seeds can be maintained, the respiration rate is low, the food reserves in the seeds are still high, and the germination coefficient is also high. [19]; stated that plastic storage containers have the best effect on mung bean seed germination. The results of research from [13] showed that sorghum seeds stored using polypropylene plastic packaging material had the best germination percentage value of 93.33% and were significantly different from other packaging material treatments. Research by [9], showed that the germination of soybean seeds after 4 months of storage using polypropylene plastic packaging and polyethylene plastic packaging was still high at 92.30% and 94.38% and met the quality standards of soybean seeds.

3.3 Plant Height

Based on the results of the analysis of variance, it shows that there is a significant effect on the treatment of storage time and storage container for sweet corn seeds on plant height. The average height of sweet corn plants at the ages of 1 WAP, 2 WAP, 3 WAP and 4 WAP is presented in Table 3.

Table 3 Average Plant Height

Treatment	Plant Height (cm)			
	1 WAP	2 WAP	3 WAP	4 WAP
Storage time (W)				
W_1	3.69^{b}	16.06^{b}	29.33^{b}	43.42^{c}
W_2	3.72^{b}	15.15^{b}	26.82^{b}	39.27^{b}
W_3	1.96^{a}	10.22^{a}	21.82^{a}	33.64^{a}
Storage container (A)				
A_1	3.05^{ab}	12.72^{a}	24.62^{a}	37.60^{a}
A_2	2.81^{a}	13.20^{a}	24.82^{a}	37.16^{a}
A_3	3.52^{b}	15.51^{b}	28.53^{b}	41.58^{b}
Interaction	nr	nr	nr	nr

Descriptions: Numbers followed by the same letter indicate no significant difference while numbers not followed by the same letter indicate a significant difference based on DMRT further test at 5% level. nr= not real.

Treatment W_1 (1 week Storage time) had the highest average sweet corn plant height parameter at the age of 4 weeks after planting, which was 43.42 cm. The high average of the height parameter of sweet corn plants is thought to be due to the short Storage time of the seeds so that the viability of the seeds and the vigor of the sweet corn seeds are still high and have the potential for sweet corn plants to grow and develop well. [26] that high-quality seeds can be characterized by high viability and vigor, are capable of normal production in sub-optimum conditions and above-normal conditions, and have the ability to grow quickly and synchronously. The speed of growth indicates the vigor of the seed's growing power because fast-growing seeds are better able to deal with sub-optimal field conditions.

Table 3 shows that the A_2 treatment (storage container with glass bottles) has the lowest average of sweet corn plant height parameters at the age of 4 weeks after planting, which is 37.16 cm. This is thought to be due to the A_2 treatment with storage containers using glass bottles increasing the moisture content of sweet corn seeds to increase the rate of seed deterioration during storage and the low percentage of germination of sweet corn seeds at the age of 1 WAP using glass bottle storage containers can inhibit growth and development. [17] stated that the increase in seed moisture content in glass bottles during storage can be caused by the seeds carrying out metabolic activities, namely respiration which produces carbon dioxide gas and water vapor and continues to be in the packaging. [15] stated that storing seeds in a tightly closed glass bottle causes water vapor and heat from seed respiration to not be able to escape and stick to the inner wall of the glass bottle. According to [18], stated that too high water content causes the food reserves in the seeds to run out quickly and accelerate the rate of seed deterioration.

Treatment A_3 (storage container with plastic clip packaging) has the highest average of sweet corn plant height parameters, namely 41.58 cm at the age of 4 weeks after planting. This is thought to be due to the A_3 treatment with a plastic clip container that can maintain the quality of sweet corn seeds during storage so that the process of growth and development of sweet corn plants remains optimal. [24] stated that the quality of seeds can be maintained when packed with ethylene plastic bags and aluminum foil, but when stored in plastic bags and gunny sacks, the seeds quickly deteriorate.

3.4 Number of Leaves

Based on the results of the analysis of variance on the number of sweet corn leaves, it shows a significant effect on the storage period treatment, while the storage container treatment shows no significant effect. The average number of leaves at the ages of 2 WAP, 3 WAP and 4 WAP is presented in Table 4.

Table 4 Average Number of Leaves

Treatment	Numbers of Leaves (leaf)		
	2 WAP	3 WAP	4 WAP
Storage time (W)			
W_1	2.98^{a}	4.62^{b}	5.58^{b}
W_2	3.38^{a}	4.40^{b}	5.67^{b}
W_3	2.62^{b}	3.89^{a}	4.96^{a}

Descriptions: Numbers followed by the same letter indicate no significant difference while numbers not followed by the same letter indicate a significant difference based on DMRT further test at 5% level.

Table 4 shows that treatment W_3 (3 weeks Storage time) gave the lowest average of the number of leaves of sweet corn at the age of 4 weeks, which was 4.96 strands. This is thought to be due to the length of time sweet corn seed storage can spur the rate of seed deterioration so that the growth and development of plants becomes not optimal and the low percentage of sweet corn germination in treatment W_3 (3 weeks shelf life) causes the growth and development process to be inhibited. [18] stated that stored seeds will experience natural physiological decline or aging, causing loss of viability. Research by [25] showed that the length of the storage period had a significant effect on the number of leaves of vanilla seedlings, namely the longer the seeds were stored, the more the number of leaves decreased. [27] that the ability of plants to carry out photosynthesis is supported by physiological conditions and vigor that make plants able to adapt well, and the number of leaves affects the photosynthate produced. [21] stated that the number of leaves produced by sweet corn plants can be used as an indicator of the growth of these plants, it can be said that the more leaves, the greater the opportunity for sweet corn plants to carry out the photosynthesis process and the number of leaves produced will affect the amount of forage produced and the higher the plant, the more the number of leaves will also be. [25] stated that the length of the storage period had a significant effect on the number of leaves of vanilla seedlings, the number of leaves decreased with the longer the storage period.

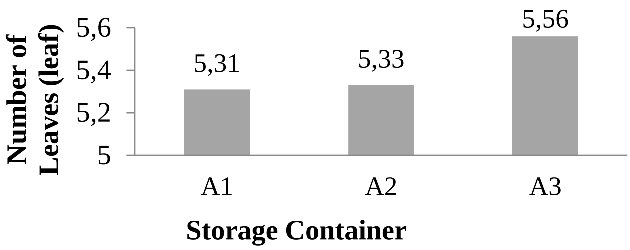

Figure 1. Average Number of Leaves

Figure 1 shows that the storage container treatment did not have a significant effect on the number of leaves of sweet corn plants at the age of 4 weeks after planting, but the A_1 treatment (storage container with plastic bottles) gave the lowest average of the number of leaves parameter, which was 5.31 strands. The low average number of leaves in the A_1 treatment (plastic bottle storage container) is thought to be due to the storage of seeds using plastic bottle containers that can spur the rate of deterioration of sweet corn seeds during storage and the low percentage of sweet corn germination in the W_3 treatment (3 weeks shelf life) causing the growth and development process to be inhibited. [21], stated that germination will affect the difference in plant height and the number of leaves of sweet corn, the greater the germination of plants, the higher the potential of plants to grow and develop properly. [20] stated that too high water content results in food reserves in the seed being quickly depleted and accelerates the rate of seed deterioration. [17] stated that the increase in seed moisture content in storage containers using plastic bottles was due to imperfect bottle cap adhesion.

Treatment A_3 (storage container with plastic clip packaging) gave the highest average of the number of sweet corn leaves at the age of 4 weeks after planting, which was 5.56 strands. This is thought to be due to the A_3 treatment with plastic clip packaging being able to maintain the quality of sweet corn seeds during storage. [16] states that plastic bag storage containers can protect seeds from the influence of changes in environmental conditions, namely the humidity of the surrounding air.

The Storage time and storage containers have no interaction with the number of sweet corn leaves, but the treatment of storage length and appropriate storage containers will have a good effect on the number of sweet corn leaves. [14] showing that there is no interaction between the treatment of Storage time and the type of container on the number of leaves of red ginger plants.

4 Conclusions

A one-week storage time significantly affects the parameters of germination, and plant height of sweet corn plants. The storage container using plastic clip packaging (A3) significantly differed in the parameters of germination, and plant height of sweet corn plants, and the storage container of sweet corn seeds showed the best results. The interaction between storage time and storage container gave a significant difference in the percentage of moisture content of sweet corn seeds but did not have a significant effect on the parameters of germination, plant height, and number of leaves. The combination of a 1-week storage period and plastic clip container (W1A3) gave the best results on the percentage of water content of sweet corn seeds.

References

[1] Mumpuni, A. N, Kholifah, A. N, Syahfitri, A. A, Febrian, F. W, Aulia, I. D. and Ramadhani, K.: Organisme penganggu penyerang bibit tanaman jagung (*Zea mays* L.) dan penanganannya. *Prosiding Seminar Nasional Biologi*. pp. 1208-1216. Banten, Universitas Islam Negeri Syarif Hidayatullah, Jakarta (2021)

[2] Sutresna, I. W, Dwiani, N. W. and Wangiyana, W.: Aplikasi teknologi benih sebagai upaya meningkatkan produksi jagung (*Zea mays* L.) di Desa Jembatan Kembar Kabupaten Lombok Barat. Prosiding PEPADU Seminar Nasional Pengabdian kepada Masyarakat: 80-83. Mataram, 2-3 December 2020: LPPM Universitas Mataram (2020)

[3] Gumelar, A. I., Tefa, A. and Kenjam, R.: Uji vigor dan viabilitas benih jagung (*Zea mays* L.) lokal putih pada beberapa metode penyimpanan tradisional di Kabupaten Timor Tengah Utara. Paspalum: Jurnal Ilmiah Pertanian. Vol. 10, No. 2, pp. 186-193 (2022)

[4] Kartasapoetra, and Ance G.: Teknologi benih pengolahan benih dan tuntunan praktikum. PT Rineka Cipta, ID (2003)

[5] Suparto, H., Saputra, R. A. and Saragih, N.: Pengaruh wadah penyimpnan jenis kedap terhadap mutu benih padi. Jurnal Ilmiah AGROTECH Gontor. Vol. 7, No. 2, pp. 109-135 (2021)

[6] Gama, F. F., Astiningsih, A. A. M. and Raka, I. G. N.: Mutu benih jagung (*Zea mays* L.) yang disimpan dengan drum dan silo pada masa simpan 0, 1 dan 2 tahun. Jurnal Agroteknologi Tropika. Vol. 6, No. 4, pp. 389-396 (2017)

[7] Sari, W. and Faisal, M. F.: Pengaruh media penyimpanan benih terhadap viabilitas dan vigor benih padi pandan wangi. Agroscience. Vol. 7, No. 2, pp. 300-310 (2017)

[8] Subagio, H. and Aqil, M.: Pemetaan pengembangan varietas unggul jagung di lahan kering iklim kering. In Seminar Nasional Serealia. Vol. 7, No. 3, pp. 11-19 (2013)

[9] Purwanti, D. M.: Efektifitas kemasan dan suhu ruang simpan terhadap daya simpan benih kedelai (*Glycine max* [L.] Merril). Planta Tropika Journal of Agro Science. Vol. 3, No. 1, pp. 1-7 (2015)

[10] Dewi, T. K. Pengaruh suhu dan lama penyimpanan terhadap mutu benih jagung manis (*Zea mays sachaarata* Sturt) di PT. Sang Hyang Seri (Persero) Sukamandi. Jurnal Agrorektan. Vol. 2, No. 2, pp. 117-123 (2015)

[11] Kolo, E. and Teffa, A.: Pengaruh kondisi simpan terhadap viabilitas dan vigor benih tomat (*Lycopersicum esculentum* M.). Savana Candana. Vol. 1, No. 3, pp. 112-115 (2016)

[12] Nuriani, A., Sumadi, M., Kadapi, A., Wahyudin, D. and Anindya, N.: Evaluasi ketahanan simpan enambelas genotip benih jagung hibrida unpad pada periode simpan empat bulan. Jurnal Kultivasi. Vol. 17, No. 1, pp. 568-575 (2018)
[13] Kotten, D. D. C. and Pudihartati, E.: Pengruh kondisi ruang simpan dan bahan pengemas terhadap daya simpan benih jagung pulut varietas uri. *Jurnal Ilmu Pertanian*. Vol. 17, No. 2, pp. 364-378 (2023).
[14] Agus, M. A. and Rogomulyo, R.: Pengaruh lama simpan dan macam wadah penyimpanan terhadap pertumbuhan dan hasil panen muda jahe merah (*Zingiber Officinale* Var. Rubrum. Rosc.). Vegelika. Vol. 10, No. 2, pp. 133-139 (2021)
[15] Agustin. E. K.: Pengaruh metode penyimpanan terhadap perkecambahan biji *Garcina dulcis* (Roxb.) Kurz. Penelitian Hayati, Vol. 7, No. 1, pp. 99-101 (2011)
[16] Dinarto, W.: Pengaruh kadar air dan wadah simpan terhadap viabilitas benih kacang hijau dan populasi hama kumbang bubuk kacang hijau *Callosbruchus chinensis* L. Jurnal Agrisains, Vol. 1, No. 1, pp. 68-78 (2010)
[17] Febriyanti, F. and Memen, S.: Viabilitas benih koro (*Canavalia ensoformis* (L) DC.) yang disimpan pada beberapa jenis kemasan dan periode simpan. Buletin agrohorti, Vol. 3, No.1, pp. 119-126 (2015)
[18] Hayati, N. and Setiono.: Pengaruh lama penyimpanan terhadap viabilitas benih kedelai varietas (*Glycine max* (L) Merrill) Varietas Anjasmoro. Jurnal Sains Agro, Vol. 6, No. 2, pp. 66-76 (2021)
[19] Listyana, H. N., Widyastuti, R., and Widyantoro.: Pengaruh wadah, suhu dan waktu simpan terhadap perkecambahan benih meniran (*Phyllanthus nirvuri* L.). Jurnal Tumbuhan Obat Indonesia, Vol. 12, No. 2, pp. 75-82 (2019)
[20] Maheswari, M. A., I Nyoman. G. A., and Ida. A. P. D.: Pengaruh ekstraksi benih dengan HCl dan jenis wadah penyimpanan terhadap daya simpan benih tomat (*Lycopersicum esculentum* Mill.). Journal on Agriculture Science, Vol. 14, No.1, pp. 23-31 (2024)
[21] Oktaviani, W., Lizah, K., and Nyimas, P. I.: Pengaruh berbagai varietas jagung manis (*Zea mays saccharata* Sturt) terhadap tinggi tanaman, jumlah daun dan kandungan lignin tanaman jagung. *Jurnal* Nutrisi Ternak Tropis dan Ilmu Pakan, Vol. 2, No. 2, pp. 60-70 (2020).
[22] Pramono, E, Kamal, M., Setiawan, K., and Tantia, M.A.: Pengaruh lama simpan dan suhu ruang penyimpanan pada kemunduran dan vigor benih sorgum (*Sorghum bicolor* [L.] Moench.) varietas Samurai-1. J. Agrotek Tropika. Vol. 7, No. 2, pp. 383-389, (2019)
[23] Rahmawati and Syamsudin.: Mutu Benih Jagung Lamuru pada Umur Simpan Berbeda dengan Beberapa Metode Pengujian. Agros, Vol. 16, No.1, pp. 53-60 (2014).
[24] Sari, W. and Faisal, M. F.: Pengaruh media penyimpanan benih terhadap viabilitas dan vigor benih padi pandan wangi. Agroscience, Vol. 7, No. 2, pp. 300-310 (2017)
[25] Udia, B. A. A. A., Rusmin, D., Fatmawaty, A. A., Hermita, N., and Syukur, C.: Mutu fisik dan fisiologis benih setek berakar vanili pada berbagai jenis media dan lama periode simpan. Jurnal Kultivasi, Vol. 20, No.2, pp. 111-119 (2021)
[26] Ridha, R., Syahril, M., and Boy, R. J.: Viabilitas dan vigor benih kedelai (*Glycine max* (L.) Merrill) akibat perendaman dalam ekstrak telur keong mas. *Agrosamudra Jurnal Penelitian*, Vol. 4, No. 1, pp. 84-90 (2017).
[27] Agusta, F. B., Fatimah, T., and Rahmawati.: Pertumbuhan bibit kakao (*Theobroma Cacao* L.) klon ICCRI 03 dan MCC 01 pada beberapa lama penyimpanan benih. Proceedings Transformasi Penelitian Digital dalam Mendukung Ketahanan Pangan dan Masa Depan yang Berkelanjutan, pp. 85-93. Politeknik Negeri Jember, 19 Oktober 2022: *Agropross National Conference Proceedings of Agriculture* (2022)