Effect of delayed cob drying on maize (*Zea mays* L.) seed vigor

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**Abstract.** Maize seed vigor was affected by its processing stage. The process must be continue from one stage to another. Delayed one stage in seed processing will affect its vigor. The research aims to study effect of delayed cob drying to maize seed vigor. The research was carried out in Bajeng Experimental Farm and seed laboratory of Indonesian Cereal Research Institute, from February 2018 until April 2019. Bisma and Provit A1 of OPV was used and after harvest, the unhusk cob were store in the processing warehouse and treated by, 0 (immediately drying), 8, 12, 16, 20, 24 days delayed drying. After drying, seeds were store in the room temperature (26-32°C) for one year with observation period every two months. The treatments were arranged using completely randomized design with three factors; varieties, duration of delayed cob drying, and duration of seeds store. Observation were recorded data of seed moisture content, germination, germination rate dry weight, root and shoot length, root and shoot dry weight, electrical conductivity of seed soaking water. The results showed that delayed cob drying significantly affect its seed moisture content, germination percentage, germination rate, root length, shoot length, electrical conductivity of seed soaking water. Delayed cob drying until 24 days were significantly decrease its seed moisture content by 17.5% on Bisma and decreased 17.6% on Provit A1. Delayed cob drying until 12 days could maintain high vigor seeds in term of conductivity leakage value which lower than 25 µS cm⁻¹ g⁻¹.

1. Introduction

High quality seed is essential to the farmer for production of high yielding plants, rapid, uniform and under a wide range of field conditions [1]. High quality seeds are able to withstand unfavourable growing conditions, ensure good seedling stand establishment and optimum plant population [1, 2]. Performance of high quality seeds is firstly stimulated by faster germination under a wide range of field conditions with maximal yields as compared to low quality seeds [1]. Poor seed quality gives rise to problems of failing to establish vigorous maize seedlings. Whereas, high quality seeds are able to produce seedlings of high vigour across a wide range of environments [3]. Vigour in seeds amplifies the physiological traits of seeds that govern their ability to promptly germinate in the soil. This seed quality attribute also enables the endurance of different negative environmental factors by the seeds [4]. During storage, seed quality can remain at the initial level or decline to a level that may make the seed unacceptable for planting purpose what is related to many determinants: environments conditions during seed production, pests, diseases, seed oil content, seed moisture content, mechanical damages of seed in processing, storage longevity, package, pesticides, air temperature and relative air humidity in storage, biochemical injury of seed tissue and similarly [5, 6, 7, 8, 9, 10]. Storage longevity may varies from six months (usually for maize, soybean and sunflower), up to 20 months or longer if the
seeds are to be carried over. Longevity of seed in storage is influenced by the stored seed quality as well as stored conditions. Irrespective of initial seed quality, unfavourable storage conditions, particularly air temperature and air relative humidity, contribute to accelerating seed deterioration in storage. Priority problems that farmers face during seed production in many lowland rainfed, especially in central and eastern part of Indonesia were identified as follows: postharvest processes and its facilities, pest and disease infestation, low-soil fertility, insufficient and excess water for plant production. Among the post-harvest processes, artificial drying is the most relevant when dealing with maize seed harvest from ears with high moisture content. Despite its advantages, artificial drying has been causing damage to seeds, with significant reductions in their physiological quality [11]. Removal of water from the seeds may cause chemical, physical and physiological changes, which makes the drying process a critical step in the production of seeds. Therefore, the initial drying of maize seeds harvested with high moisture contents is recommended to be initially performed at a lower temperature, 35 °C, since it appears to simulate the processes which normally occur to the plant, allowing the mechanisms of tolerance to desiccation to become active or to be imposed on seeds [12].

During the natural drying of seeds in the field, they lose water gradually, allowing the development of mechanisms of tolerance, preparing them to withstand the consequences of dehydration [13]. Climate condition at harvest influence maize field drying. In addition, maize seed is usually harvested in the ear to minimize mechanical damage that allows product removal at high moisture contents. Therefore, ear maize seed drying will be extremely slow and seed will reach about 25 – 30% based on the equilibrium moisture content. In Indonesia, maize harvest time in rainy season, made difficulties for some farmers especially for the farmers which not have mechanical drier. Some farmers put the the harvest cob into the plastic sack, but some others farmers, lay the the maize cobs onto the floors in ware house for several days or weeks until solar radiation is enough for drying process. Maize cob drying is needed to reduce respiration by removal of excess moisture in storage. Fluctuations in temperature, humidity and postpone storage result in considerable nutrient losses [14]. Storage is another important factor to consider. As hygroscopic material, outer part of maize seed allows moisture to enter and exit the kernels depending on surrounding conditions. Seed moisture content comes into equilibrium with the relative humidity of surrounding air and temperature.

Relative humidity of surrounding air and temperature are the main contributors to in-field drying after formation of black layer at the tip of the kernel. After harvest the maize cob should directly drying to exit the water from the kernel. Some farmers don not have enough drying floor to dry the whole maize cob at the same time. So, they postpone maize cob storage at the warehouses in plastic sack with uncontrol temperature and air humidity. In the storage, wetter portions of the grain would equilibrium with drier portions of the grain. At this situation, respiration process will continue, with water and heat as by products. Stored the seeds increases in moisture percentage and temperature unless dried artificially or aerated (air movement without heat). Storage the maize cobs may cause loss in seed quality thus leading to degenerative changes [15]. The decrease of seed quality could minimize when the seeds are stored in adequate conditions. The research aims to study effect of prolonge cob storage time in ware house to physiological quality of maize seed.

2. Materials and Methods
The research was conducted in Bajeng Experimental Farm, Gowa, South Sulawesi, processing warehouse and Seed Laboratory of Indonesian Cereal Research Institute, from February 2018 until May 2019. Two open pollinated variety, Bisma and Provit A1 were used and sowed in Bajeng Experimental Farm, Gowa. Maize ear harvesting and husking was performed manually and cobs were then put into perforated plastic sack and store in the processing warehouse and treated with delayed cob drying treatments. The treatments were replicated thrice and arranged using randomized completely design with three factors, as follows: A. Varieties; Bisma and Provit A1. B. Delayed drying treatments; 0 (immediately drying), 8, 12, 16, 20, 24 days delayed drying. C. Storage period; 0 (initial observation), 2, 4, 6, 8, 10, 12 months. Statistical analysis was according to [11, 8]. Before cobs were drying, determination of seed moisture content were carried out by using grain moisture

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tester PM 400. Cobs were naturally drying until reached 14-15% moisture content. After drying, cobs were hand-shelled, and drying again until seed moisture content reached 10-11%. After all processing stage had completely finished, seed quality determination were carried out in ICERI seed laboratory. Seeds in each lot, 2 kg were put into airtight plastic sack and store in the room temperature for 12 months. Temperature and relative humidity of storage room were recorded every day during seed storage. Observation on seed viability and vigor were conducted every two months. All determinations for seed quality analysis were carried out according to International Rules for Seed Testing [16].

**Moisture content:** 100 seed samples were ground and oven-dried at 130°C for two hours. Calculations were based on the wet basis. **Germination:** 100 seeds from each treatment and each replications were germinated in rolled germination towels moistened with water in an incubator at 25°C. The first count was made 5 days later. Normal seedlings were evaluated after 7 days. Germination percentage was expressed by the percentage of seed germinating normally after 7 days [14]. **Germination rate:** Data obtained from substrate of seed germination test. Every observation time, total percentage of normal shoot is divided by etmal (24 hours). Cumulative etmal value is obtained when seeds are planted until the time of observation. The formula used as follows:

\[
KT = \frac{(Xi-Xi-1)}{Ti}
\]

- \(KT\) = germination rate (%/etmal)
- \(Xi\) = the percentage of normal seed etmal i
- \(Ti\) = time of observation (etmal)

**Shoot length:** About 10 normal seedlings were taken at random from each replicate at the end of standard germination test to evaluate shoot length (cm). **Root length:** The same 10 normal seedlings of shoot length evaluation test used to evaluate root length (cm). **Electrical conductivity:** Three replications of 50 seeds of each treatment were weighed and moisture content recorded. The seeds of each replication were placed in 200ml beaker and 50ml of deionized water was added. Seeds were stirred gently to ensure that all seeds were completely immersed and evenly distributed. The beakers were placed at temperature of 20°C for 24 hours. The electrical conductivity of the leachates of each replication was measured by using a conductivity meter (sension5) and conductivity per gram of seed weight was calculated [16]:

\[
\text{Conductivity (μScm}^{-1}\text{g}^{-1}) = \frac{\text{conductivity reading - blank reading}}{\text{weight (g) of replicate}}
\]

3. **Results and Discussion**
In the warehouse, sufficient airflow through cob mass in perforated plastic sack was essential to avoid seed damage caused by storage temperature. The results showed that average moisture content of cob at harvest were about 30.2% (Bisma variety) and 30.1% (Provit A1 variety), and after store cobs in the processing warehouse, moisture content were decreased 17.5% on Bisma variety and 17.6% on Provit A1 variety (Table 1). Decrease moisture content might caused by transfer of moisture from the seed surface to the air around the seed and then second the movement of moisture from inside the seed to the seed surface. This is accomplished by temperature raised and low relative humidity of air and passing it through the seed mass. The heat from the air is transferred to the seed increasing the vapor pressure in the seed. Due to the differences vapor pressure between the air and seed, moisture is forced out of the seed and carried away by the air. If the temperature of the air is very high, the moisture transfer process may be too violent resulting in damage to the seed. Temperature ware house storage during cob storage were between 26-32°C and relative humidity between 55- 60%.
Table 1. Seed moisture content of cob after store in processing ware house (%)

| Variety | Delayed drying (days) | 0 (direct drying) | 4 | 8 | 12 | 16 | 20 |
|---------|----------------------|-------------------|---|---|----|----|----|
| Bisma   |                      | 30.2              | 28.6 | 25.1 | 24.1 | 23.8 | 24.9 |
| Provit A1 |                    | 30.1              | 29.1 | 28.2 | 27.1 | 26.3 | 24.8 |

average daily temperature of processing ware house 26-32°C and average relative humidity 55-60 % during cob storage

The results showed seed moisture content had no significant increased both in Bisma and Provit A1 variety. Moisture content increased in Bisma variety 10.6% and Provit A1 variety 9.76% (Table 2).

Table 2. Average seed moisture content in room temperature storage

| Variety | Delayed Drying (days) | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
|---------|-----------------------|---|---|---|---|---|----|----|
| Bisma   | 10,17 x               | 10,27 wvx          | 10,70 pq | 10,80 nop | 10,77 op | 11,17 kp | 11,37 i |
| Provit A1 | 10,17 x              | 10,37 uv           | 10,60 rs | 10,77 no | 10,87 m | 11,03 m | 11,27 jk |
| Bisma   | 10,20 x               | 10,23 wx           | 10,57 st | 10,70 pq | 10,87 no | 11,17 kl | 11,70 ef |
| Provit A1 | 10,20 x              | 10,37 uv           | 10,50 t | 10,67 qr | 10,90 n | 11,03 m | 11,50 no |
| Bisma   | 10,27 x               | 10,40 u            | 10,87 no | 11,47 h | 11,57 g | 11,87 c | 11,87 c |
| Provit A1 | 10,17 x              | 10,37 uv           | 10,90 n | 11,17 kl | 11,37 i | 11,67 f | 11,77 ed |
| Bisma   | 10,17 x               | 10,27 wvx          | 10,80 nop | 11,03 m | 11,17 kl | 11,37 i | 11,67 f |
| Provit A1 | 10,17 x              | 10,27 wvx           | 10,57 st | 10,87 no | 11,131 | 11,27 jk | 11,70 ef |
| Bisma   | 10,17 x               | 10,27 wvx          | 10,77 op | 10,90 n | 11,37 i | 11,50 gh | 11,67 f |
| Provit A1 | 10,20 x              | 10,53 st           | 10,80 nop | 11,17 kl | 11,47 h | 11,83 ed | 12,03 b |
| Bisma   | 10,30 vw              | 10,76 op           | 11,17 kl | 11,37 i | 11,70 ef | 11,87 c | 12,03 b |
| Provit A1 | 10,30 vw             | 10,77 op           | 11,03 m | 11,17 kl | 11,30 ij | 11,57 g | 11,87 c |
| Bisma   | 10,37 uv              | 10,87 no           | 10,90 n | 11,57 g | 11,77 ed | 11,87 c | 12,27 a |
| Provit A1 | 10,37 uv             | 10,87 no           | 10,90 n | 11,17 kl | 11,70 ef | 11,77 ed | 12,03 b |

Note: The numbers followed by the same letters in the same column and row are different but not real based on Duncan’s test at 1%

Germination percentage was decline 7% on Bisma variety and 10% on Provit A1 variety after delayed cob drying 24 days. In the storage, after 12 months storage, without delayed cob drying, germination decline significantly by 9.4% on Bisma variety and 12.3% on Provit A1 variety (Table 3). It is difficult to assess the effective storage period because the storability of the seed is a function of initial seed quality and the storage conditions [7, 10, 17]. Intensity of quality decreasing of stored seed is different among plant species and within plant species (genotypic variability), implying considerable influence of genetic (heritable) component on phenotific expression of traits which determine seed quality [9, 18, 19, 20]. In this research, two aspects were significantly affect the decline of germination percentage, duration of storage and duration of delayed cob drying, as shown in Table 3.
Table 3. Germination percentage of Bisma and Provit A1 variety in every two months period.
ICERI, 2018-2019

| Variety | Delayed Drying (days) | Storage period (month) |
|---------|-----------------------|------------------------|
|         | 0                     | 2                      | 4 | 6 | 8 | 10 | 12 |
| Bisma   | 0                     | 99.67 ab               | 100 a | 98.67 cd | 98.00 de | 95.67 hij | 92 lm | 90.33 no |
|         | 4                     | 99.67 ab               | 97 fg | 93.67 k | 92.33 lm | 89.33 op | 88.33 qr |
|         | 8                     | 99.67 ab               | 95.00 j | 90.67 n | 90.33 no | 90 no | 86.67 stu |
|         | 12                    | 99.67 ab               | 93.67 k | 89.67 pq | 87.67 rs | 86.67 stu | 85.67 vwx |
| Provit A1 | 0                     | 96.33 gh               | 89.67 nop | 89.67 nop | 87.67 rs | 83.67 z | 82.00 bc | 80.33 ef |
|         | 4                     | 96.67 k                | 85.00 xy | 82.67 ab | 81.67 cd | 79.67 fg | 79.00 g |
|         | 8                     | 96.67 k                | 88.67 pq | 87.33 s | 84.67 y | 83.00 za | 79.00 g |
|         | 12                    | 96.67 k                | 86.67 stu | 86.33 tuv | 85.00 xy | 82.67 ab | 72.67 i |
| Bisma   | 0                     | 90.00 no               | 86.00 uvw | 83.67 z | 81.67 cd | 80.67 e | 80.33 ef | 72.33 i |
|         | 4                     | 90.00 no               | 86.00 uvw | 83.67 z | 81.67 cd | 80.67 e | 80.33 ef | 72.33 i |
|         | 8                     | 90.00 no               | 86.00 uvw | 83.67 z | 81.67 cd | 80.67 e | 80.33 ef | 72.33 i |
|         | 12                    | 90.00 no               | 86.00 uvw | 83.67 z | 81.67 cd | 80.67 e | 80.33 ef | 72.33 i |

Note: The numbers followed by the same column and row are different but not real based on Duncan’s test at 1%

In the storage room, germination rate on each seed lots decline by duration of seed storage. From the seed lots without delayed treatment, germination rate of Bisma variety decline 7.1% and Provit A1 variety decline 9% after 12 months storage. The results showed that with delayed drying treatments 24 days, germination rate decrease 6% on Bisma variety, while on Provit A1 variety the decrease was 15%. Observation on 12 months storage, showed that cobs with delayed drying treatments 24 days, showed decrease germination rate 15% on Bisma variety and 17% on Provit A1 variety compare to treatments with immediately drying (without postponed drying) as shown in Table 4.

Table 4. Germination rate of Bisma and Provit A1 variety in every two months period.
ICERI, 2018-2019

| Variety | Delayed Drying (days) | Storage period (month) |
|---------|-----------------------|------------------------|
|         | 0                     | 2                      | 4 | 6 | 8 | 10 | 12 |
| Bisma   | 0                     | 31.55 a               | 30.70 c | 29.80 fg | 29.70 gh | 29.60 hi | 29.40 jk | 29.30 kl |
|         | 4                     | 31.55 a               | 31.30 b | 30.30 d | 29.80 fg | 29.70 gh | 29.0 no | 28.70 qr |
|         | 8                     | 31.30 b               | 29.80 fg | 29.50 ij | 29.30 kl | 29.20 lm | 29.10 mn | 28.90 op |
|         | 12                    | 31.30 b               | 29.70 gh | 29.60 hi | 29.20 lm | 29.10 mn | 28.90 op | 28.50 st |
| Provit A1 | 0                     | 30.30 d               | 29.90 f | 29.40 jk | 29.30 kl | 28.70 qr | 28.60 rs | 28.80 pq |
|         | 4                     | 30.30 d               | 29.90 f | 29.40 jk | 29.30 kl | 28.70 qr | 28.60 rs | 28.45 t |
|         | 8                     | 29.90 f               | 29.80 fg | 29.50 ij | 29.10 mn | 28.90 op | 28.80 pq | 28.70 qr |
|         | 12                    | 29.90 f               | 29.80 fg | 29.50 ij | 29.10 mn | 28.90 op | 28.80 pq | 28.70 qr |
| Bisma   | 0                     | 30.20 de              | 29.70 gh | 29.50 ij | 28.80 pq | 28.60 rs | 28.50 st | 28.40 tu |
|         | 4                     | 30.20 de              | 29.70 gh | 29.50 ij | 28.80 pq | 28.60 rs | 28.50 st | 28.40 tu |
|         | 8                     | 28.20 vw              | 28.10 wx | 27.70 y | 27.10 a | 26.70 c | 26.50 d | 24.90 g |
|         | 12                    | 28.20 vw              | 28.10 wx | 27.70 y | 27.10 a | 26.70 c | 26.50 d | 24.90 g |
| Provit A1 | 0                     | 30.10 e               | 29.50 ij | 29.40 jk | 28.30 uv | 27.30 z | 26.90 b | 26.30 e |
|         | 4                     | 27.30 z               | 27.10 a | 26.90 b | 26.70 c | 25.30 f | 24.90 g | 24.30 i |
|         | 8                     | 29.60 hi              | 28.70 qr | 28.50 st | 28.0 x | 27.20 za | 25.60 d | 24.90 g |
|         | 12                    | 26.90 b               | 26.80 bc | 26.50 d | 26.30 e | 25.20 f | 24.60 h | 23.90 j |

Note: The numbers followed by the same column and row are different but not real based on Duncan’s test at 1%

Evaluation of seedlings showed that shoot and root length had significant difference on delayed cob drying treatments. In storage, decrease seed vigor were obtained by the decrease of shoot and root
length. At 12 months storage in seed lot without delayed drying treatment, shoot length decrease 14% (Bisma) and 19% (Provit A1) from initial observation. Delayed cob drying treatment significantly decrease shoot length, from 12 days, 16 days, 20 days, and 24 days as follows 2.05%, 2.67%, 12.61%, 13.85% on Bisma variety and decrease 4.97%, 6.04%, 14.3% and 18.63% on Provit A1 variety. Similar to shoot length, root length decline with the passage of time. At 12 months storage in seed lot without delayed drying treatment, root length decrease 22.40% on Bisma and 24.27% on Provit A1 variety from root length at initial observation. Delayed drying treatment significantly decrease root length by 7.47% on Bisma variety and 18.67% on Provit A1 variety. Delayed drying treatment significantly decrease root length by 7.47% on Bisma variety and 18.67% on Provit A1 compare to cob with immediately drying (without postpone cob drying as shown in Table 5. [21] found that high temperature during cob storage could affected shoot and root length values.

**Table 5.** Shoot and root length of Bisma and Provit A1 variety in every two months period.

ICERI. 2018-2019

| Shoot Length (cm) | Delayed Drying (days) | Storage period (month) | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
|-------------------|-----------------------|------------------------|---|---|---|---|---|----|----|
| Bisma 0           | 16.10 a               | 15.40 e                | 14.87 g           | 14.47 h           | 14.20 ij          | 13.87 mno         | 12.20 bc          |
| Provit A1         | 16.07 a               | 15.27 ef               | 14.37 hi          | 14.17 jk          | 13.87 mno         | 12.80 tuv          | 12.46 yza          |
| Bisma 4           | 15.97 ab              | 15.40 e                | 14.77 g           | 14.70 g           | 14.07 jkld        | 13.77 op          | 12.40 za           |
| Provit A1         | 15.97 ab              | 15.27 ef               | 14.17 jk          | 14.0 klm          | 13.10 rs          | 12.57 xyz          | 12.37 ab*          |
| Bisma 8           | 15.87 bc              | 15.27 ef               | 14.70 g           | 14.47 h           | 14.0 klm          | 13.60 p           | 12.17 cd*          |
| Provit A1         | 15.37 e               | 15.10 f                | 14.0 klm          | 13.87 mno         | 13.97 st          | 12.60 wxy          | 12.30 abc*         |
| Bisma 12          | 15.77 cd              | 15.17 f                | 14.40 h           | 14.20 ij          | 13.77 op          | 13.17 r           | 11.97 ef*          |
| Provit A1         | 15.27 ef              | 14.87 g               | 13.97 lmn         | 13.70 op          | 13.37 q           | 12.67 vwxy         | 11.97 ef*          |
| Bisma 16          | 15.67 d               | 13.37 q               | 13.07 rs          | 12.80 tuv          | 12.60 wxy         | 12.17 cd          | 11.37 h*           |
| Provit A1         | 15.10 f               | 12.93 stu              | 13.0 rs           | 12.37 ab          | 12.00 de          | 11.80 fg           | 10.40 p*           |
| Bisma 20          | 14.07 jkl             | 12.77 uvw              | 12.37 ab          | 11.67 g           | 11.27 hi          | 11.10 ijk          | 10.77 n*           |
| Provit A1         | 13.80 no              | 12.70 vwxy             | 11.97 ef          | 11.17 ij          | 11.00 jkld        | 10.80 mn           | 9.97 r*            |
| Bisma 24          | 13.87 mno             | 12.80 tuvw             | 12.20 bc*         | 11.37 h*          | 11.00 jkld        | 10.87 lmn          | 10.17 q*           |
| Provit A1         | 13.10 rs              | 12.20 bcw              | 11.20 h1          | 10.97 klm*        | 10.57 o*          | 10.20 q*           | 9.57 s*            |

Note: The numbers followed by the same letters in the same column and row are different but not real based on Duncan’s test at 1%
Electrolyte and ions quantification in seed immersed water were counted by electric conductivity [22]. [23] results showed that strong effects of seed size, seed age, hybrid and their interactions on the majority of maize seed and seedling vigour parameters. The initial seed vigour contributes to the intensity of possible seed imbibition damage in the conditions of electrical conductivity test. Electrical conductivity measured leakage during the early stages of seed inhibitions due to damage to the cell membrane. Greater pericarp damage may occurred from high temperature in the ware house storage (average daily temperature 28-32°C) which subsequently increased deterioration during storage. Conductivity value of leachate were higher on the seed lot with delayed drying treatments and seed lot in the storage. This may be increased the amount of seed leachate in the water and, therefore electrical conductivity of seed leakage increase significantly from 18.98 to 21.88 µS cm⁻¹ g⁻¹ on Bisma variety and 18.42 to 22.08 µS cm⁻¹ g⁻¹ on Provit A1 variety after 12 months storage respectively (Table 7). Delayed cob drying until 24 days significantly increase electrolyte leakage, from 18.98 to 29.20 µS cm⁻¹ g⁻¹ on Bisma variety and from 18.42 to 29.73 µS cm⁻¹ g⁻¹, which may be caused by high temperature and there was substantial reduction of starch grain in the embryonic axis. In line with [16], the results showed that delayed cob drying treatment until 12 days still maintain high seed vigor due to its electrical conductivity value lower than 25 µS cm⁻¹ g⁻¹ even the seeds were store for 12 months. Moreover, [4] proposed that if the electrical conductivity value higher than 43 µS cm⁻¹ g⁻¹, the seeds should not be recommended to sowed. It was suggested that starch hydrolysis in the embrionic axis caused sugar leakage that leading to germination loss. At the first stage of imbibition, soaked maize seed released ions, amino acid, and many others electrolytes. Deteriorated seed with it’s weakened membrane structure or slow in repairing their cell membrane after rehydration process tend to release more ions and electrolyte into seed immerse water.

Table 6. Electrolyte leakage of Bisma and Provit A1 variety with delayed cob drying treatments in every two month period of storage. ICERI. 2018-2019

| Variety | Delayed Drying (days) | Electrolyte leakage (µS cm⁻¹ g⁻¹) |
|---------|-----------------------|----------------------------------|
|         | 0                    | 2  | 4  | 6  | 8  | 10 | 12 |
| Bisma   | 0                    | 18.98 uv | 19.38 s-v | 19.40 s-v | 20.07 p-v | 20.50 p-v | 21.41 n-u | 21.88 m-t |
| Provit A1 | 0                    | 18.42 v-v | 19.88 t-v | 19.98 q-v | 20.98 o-v | 21.12 o-v | 21.89 m-t | 22.08 k-t |
| Bisma   | 4                    | 19.34 u-v | 20.55 p-v | 21.23 p-u | 21.83 m-t | 22.04 k-t | 22.13 k-t | 22.24 j-s |
| Provit A1 | 0                    | 19.90 r-v | 20.28 p-v | 21.45 n-u | 21.99 t-t | 22.27 j-q | 22.19 j-t | 22.45 i-r |
| Bisma   | 8                    | 20.20 p-v | 20.77 o-v | 21.56 m-u | 21.97 t-t | 22.25 j-s | 22.42 i-r | 22.55 h-q |
| Provit A1 | 0                    | 20.13 p-v | 20.98-o | 21.59 m-u | 22.08 k-t | 22.29 j-q | 22.86 h-q | 22.89 f-n |
| Bisma   | 12                   | 21.14 o-v | 21.86 m-t | 21.98 l-t | 22.12 k-t | 22.36 i-r | 22.53 h-q | 22.89 f-n |
| Provit A1 | 0                    | 21.24 p-u | 21.90 m-t | 22.12 k-t | 22.56 h-q | 22.54 h-q | 22.88 h-q | 22.95 f-n |
| Bisma   | 16                   | 24.26 d-n | 24.77 d-l | 24.98 d-j | 25.12 d-i | 25.26 d-h | 25.64 d-f | 25.97 d-e |
| Provit A1 | 0                    | 24.38 d-m | 24.88 d-k | 25.12 d-i | 25.34 d-g | 25.10 d-i | 25.78 d-e | 26.99 c-d |
| Bisma   | 20                   | 28.63 b-c | 28.97 a-c | 28.99 a-bc | 25.79 d-e | 29.12 d-e | 29.90 a-bc | 30.00 a-bc |
| Provit A1 | 0                    | 28.99 abc | 28.99 abc | 29.12 abc | 29.93 abc | 29.67 abc | 30.07 a-bc | 31.23 abc |
| Bisma   | 24                   | 29.20 abc | 29.40 abc | 29.60 abc | 29.80 abc | 29.93 abc | 23.46 e-n | 30.20 abc |
| Provit A1 | 0                    | 29.73 ab | 29.83 ab | 29.73 ab | 29.90 ab | 30.13 ab | 30.13 ab | 31.63 a |

Note: The numbers followed by the same letters in the same column and row are different but not real based on Duncan’s test at 1%.

Postpone of cob drying treatments support for deterioration or seed aging processed. In these process, free radical oxidation, enzymatic dehydrogenase, aldehyde oxidation from proteins and Maillard reaction were found [24]. Free radical will fractured cell membrane and cause decreased it’s viscosities and permeabilities [14, 25]. Increasing solution in seed immersed water were indicated that seed membrane cell had already fractured. From this research, of all parameter observed, showed that delayed cob drying could maintain high vigor seed on both variety tested if delayed duration only 12 days based on its conductivity value which lower than 25 µS cm⁻¹ g⁻¹ due to [4]. Delayed cob drying
until 24 days were significantly decline its vigor in term of germination percentage, germination rate, shoot and root length and shoot and root dry weight, and conductivity value.

4. Conclusion
Delayed cob drying until 12 days still maintain high seed vigor on both maize varieties tested based on electrical conductivity value. Bisma variety tend to retain its germination percentage and germination rate higher than Provit A1 variety with delayed drying and storage treatments. Delayed cob drying until 24 days significantly decline its vigor on both varieties tested in term of germination percentage, germination rate, shoot and root length and conductivity electric value.

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