Genotype characterization of sugar palm (*Arenga pinnata* (Wurmb.) Merr.) on seed and germination stage

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Abstract. Characterization of local sugar palm accessions is not currently available. This characterization information will be useful in the development of high yielding varieties of sugar palm in Indonesia. The aims of this research were to study the morphology characters of sugar palm ranging from fruits, seeds until germination. The experiment used descriptive method to observe the morphological characteristics of seed germination. Each accession and variety used 20 of sugar palm seeds germinated in the polybag and repeated 5 times. Observations were carried out up to 90 days after sowing (DAS). The results showed that the accession of Pematang Siantar, Bengkulu Lebong, Bengkulu Curup, Banten, Cianjur, and variety of Kutai Timur has range of fruit weight 37.2-66.2 g, range of seed weight 3.7-6.3 g, range of seed length 23.3-31.8 mm, range of seed diameter 17.6-20.7 mm, range of seed fresh weight 16.0-29.3 g, range of seed dry weight 13.4-21.8 g, range of potential growth 66-100%, range of germination percentage 44-98%, range of seed water content 22-36%, range of hypocotyl length 9.6-14.0 cm (90 DAS), range of radicle length 17.6-27.2 cm (90 DAS), and range of plumule length 8.3-19.2 cm (90 DAS).

Keywords: germination, seed characterization, sugar palm accessions

1. Introduction
Sugar palms (*Arenga pinnata* (Wurmb) Merr.) is origin in Indo-Malaya archipelago, and their center of origin is in Indonesia. This palms can be found in all tropical regions of South and Southeast Asia, from 75 °EL in India and Sri Lanka to 145 °EL in Guam and Papua New Guinea, and stretching from 25 °NL in Myanmar to 10 °SL in East Nusa Tenggara, Indonesia [4]. Sugar palms spread from Sumatra to Papua in Indonesia. The most abundant distribution of sugar palms is in Java (19 757 ha), Sulawesi (16 951 ha), Sumatra (15 802 ha), and Kalimantan (1 816 ha) [3]. Utilization of various sugar palm plants by surrounding communities in the central area. The spread of sugar palms in Java is more prevalent in West Java, especially Banten, Bogor, Cianjur, and Garut. The people of West Java use sugar palms as a source of making brown sugar, a traditional drink called *lahang*, sago flour, and *kolong-kaling*. In East Kalimantan, the community uses sugar palms as a source of making brown sugar. In addition, palm fiber is also the main product of this palms. In North Sumatra, sugar palms besides being used to make brown sugar, the sap produced from male flowers is also used...
by the surrounding community as traditional drinks (*tuak*). The people of North Sulawesi also use sugar palms as a source of traditional drinks (*sagoer*) as the main product [4].

The usefulness of sugar palms that are so numerous and varied between regions provide an opportunity for the development of sugar palms on a large scale. The plants from each different location are local palm accessions that have not been described morphologically. Characterization of sugar palm plants starting from seeds, germination, nurseries, and mature plants will provide information from each local sugar palm accession in Indonesia. This description will be useful in knowing the superior properties that can be used for assembling superior varieties. The current problem is that there is no information about the characterization or description of local palm accessions in Indonesia, so there is a need to do research on the characterization of the accession of local sugar palm in Indonesia. The purpose of the research was to study the morphological characters of some local superior sugar palm from fruit, seeds to germination.

2. **Methodology**

2.1. **Time and location**

The research was conducted in the laboratory of the Department of Agronomy and H orticulture, Faculty of Agriculture, Bogor Agricultural University in June 2013 to June 2014.

2.2. **Materials and tools**

The materials used were five accessions and one local sugar palm variety namely Pematang Siantar, Bengkulu Curup, Bengkulu Lebong, Banten, Cianjur, and Kutai Timur. Husk charcoal was used as media. Ruler, analytical scales, digital calipers, knives, ovens, saucers, and nursery tubs were used as tools.

2.3. **Experiments methods**

The experiment used a descriptive method by observing the morphological characteristics of seed germination. Each accession and variety of sugar palm used 20 seeds germinated in polybags and repeated 5 times so that there were 100 seeds used. Seeds are observed for up to 90 days after seeding (DAS) until the emergence of the apokol, plumula and radicle. Observation of the apokol, radicle, and plumula length was measured using 10 seeds from each accession and variety, and sowing separately.

The research began with seed preparation, deoperculation, and media for seedling. Sugar palm fruit soaked in water for 5 days. The purpose of fruit immersion was to make it easier to release the fruit skin and remove calcium oxalate which is attached to the seed. The rest of the fruit flesh was cleaned by rubbing the seeds using sawdust and after the fruit peel is released then the seeds are chosen to be treated. Sugar palm seeds were selected with the same size, not deformed and have a shiny seed skin structure [2].

Then the sugar palm seeds were given dormancy breaking treatment so that the seeds quickly germinate. According to [6], the best treatment for breaking dormancy and seedling’s media for germination of sugar palm seeds was by means of deoperculation and sowing using husk charcoal media. Deoperculation is the scarification method right at the position of the embryo. After the deoperculation treatment, the seeds were immediately put into moisturized sawdust media to prevent the seeds from being damaged because of the dries embryo. After all the seeds were scrubbed then immersed into 1% chlorine solution for 30 minutes to reduce contamination by fungi [2]. Next, the seeds were planted in germination media.

The second stage was maintenance. Seeds that have been sown, watered every day to maintain moisture. Watering was done by spraying the top of the planting medium with a sprayer until the planting media is wet. Watering was also intended so that water is always available and absorbed by the seeds so that the process of dormancy breaking occurred.

The third stage was observing the morphological characteristics of sugar palm germination. Observations were made at 90 days after seeding for maximum growth and germination potential
variables. Observation of the apokol, radicle, and plumula length were carried out at 30, 60, and 90 DAS.

2.4. Observation parameters
Observations were made on the variables as follows:
- Potential Growth (PG). Observations were made on seeds that grew normally or abnormally at the last observation (90 days) then were presented. The formula for calculating PG is:
  \[ PG = \frac{\text{the number of sprouts at the end of the observation}}{\text{the number of seeds germinated}} \times 100\% \]
- Germination Percentage (GP). Seed GP percentage was calculated based on the number of normal germination (NG) at 90 days after seedling (DAS) [6]. Normal sprouts are sprouts that have radicles and plums. The formula used is:
  \[ GP = \frac{\text{the number of normal germination}}{\text{the number of seeds planted}} \times 100\% \]
- Seed moisture content. Five pieces of seeds were cut and then dried in the oven with a temperature of 105 °C for 17 hours.
  \[ \text{seed moisture content} = \frac{(M2 - M3)}{(M2 - M1)} \times 100\% \]
  description:
  M1 = empty cup weight (g)
  M2 = weight of the cup and seed before drying (g)
  M3 = weight of the cup and seed after drying (g)
- Seed wet and dry weight. Five seeds were weighed to get the wet weight and the seeds were put in the oven for 48 hours at 80 °C and weighed to get dry weight.
- The length and diameter of the seed. Measurement of seed length and diameter was measured before the seed is germinated using a digital caliper.
- Apokol length. The length of the apokol was measured at 30, 60, and 90 DAS using 10 sprouts of each accession and the variety used.
- Plumula length. Plumula was observed at 30, 60, 90 DAS, plumula observation was only carried out on sprouts that had appeared.
- Radicula length. Radicles are observed at 30, 60, 90 DAS, observations are made on the radicles that have appeared.
- Microscopic observation of apokol.

3. Results and discussions

3.1. General conditions of experiment
Sugar palm seed germination began with the process of water imbibition followed by the growth of apokol in the part of the seed that has been scrubbed. The position of the embryo on the seed was located on the left or right side of the seed back with the characteristics of a rounded curve on the back of the seed (Figure 1a).
Figure 1. The morphological characteristics of the sugar palm seeds before and after germination. (a) The position of the embryo on the sugar palm seeds is on the left or right side of the back of the seed, (b) Ring-like tissue that grows on the scrubbed part, (c) Apokol which is an elongated tissue like a tube.

Water imbibition on the sugar palm seeds did not cause the seeds to swell because the endosperm of the sugar palm seeds was very hard. The process seeds germination began with the appearance of white ring-like tissue on the part of the seed that has been scrubbed (Figure 1b). This ring-like tissue appeared after 1-2 weeks after seeding (WAS). This tissue will develop and form an elongated tube called the apokol (Figure 1c). The apokol served as a pathway for the movement of the embryo from inside the seed and moved to the bottom of the apakol for the germination process. Sugar palm germination belongs to the type of epigeal because of the sugar palm seeds raised to the ground [2].

Figure 2. Development of apokol ranging from elongation to germination. (a) An enlarged apokol at the bottom, (b) Prospective roots that grow at the bottom of the apokol, (c) Plumula growing from a ruptured apokol.

The development of the apokol began when the formation of ring-like tissue. After the ring-like tissue enlarges, then in the middle of tissue will grow to extend to the bottom of the growing media. [2] reported that the development of sprouts to form a ring-like tissue occurred after 10 days after seedlings (DAS). The apokol will continue to extend to a certain size. After the elongation process was completed, the lower part of the apokol will enlarge (Figure 2a). It was suspected that the lower part of the apokol was enlarged because the embryo has developed and will be ready to germinate. The germination process began with the emergence of a root candidate from the lower part of the apokol. The difference between the root candidate and the lower part of the apokol was clearly seen by decreasing root growth at the enlarged end of the apokol (Figure 2b). After the root candidate grows, the apokol will rupture in the middle and it grew the plumula (Figure 2c). Sugar palm seed germination has occurred to 90 DAS on average of the 5 accessions and 1 variety used in this experiment.

3.2. Fruit and seed weight
Sugar palm fruit shape is rounded and forming three curves on its side which characterize there are 3 seeds inside the fruit. Young sugar palm fruit is green and turns yellow after ripe. The process of
Maturation of sugar palm fruit occurs quite a long time. According to [4], sugar palm fruit will ripen physiologically 3 years after pollination. Each sugar palm fruit contains 2-3 seeds with the characteristics of a fully filled arch. If one of the curves is imperfect or not fully filled, there are only 2 seeds in the fruit. The cross-section of the sugar palm fruit showed that the arrangement of the seeds forms a triangle with the back of the seed on the outside (Figure 3). In the part of the seed that has been split, there is a small white part on the back of the seed. The white part is the embryo that will later grow to form apokol.

![Figure 3. Cross-section of 4 accessions and 1 variety of sugar palm fruit in Indonesia](image)

The fruit flesh is very hard when young or green but old fruit has a softer flesh and the seeds are easily separated from the flesh. The flesh contains calcium oxalate [7]. Calcium oxalate will cause pain and itching if exposed to the skin. According to [2], the way to reduce the calcium oxalate content before separating seeds from fruit flesh is by soaking the fruit for 5 days. Soaking made it easier to remove the flesh attached to the seeds but did not reduce itching if exposed to the skin in this experiment.

The fruit weights of 5 accessions and 1 variety of Indonesian sugar palm were varied (Table 1). The average fruit weight indicated that the Bengkulu Lebong fruit has a heavier weight compared to other fruit weights of 66.2 ± 6.6 g. The average weight of fruit accessions Pematang Siantar, Bengkulu Curup, and Cianjur were in the range of 49.2-53.6 g, while the lowest fruit weight was Kutai Timur of 37.2 ± 2.4 g.

| Accessions and a Variety | Fruit Weight (g fruit⁻¹) | Seed Weight (g seed⁻¹) |
|--------------------------|--------------------------|-----------------------|
| Pematang Siantar          | 53.6 ± 4.3               | 4.6 ± 0.6             |
| Bengkulu Curup           | 52.1 ± 2.2               | 4.7 ± 0.4             |
| Bengkulu Lebong          | 66.2 ± 6.6               | 6.3 ± 0.6             |
| Banten                   | -                        | 3.7 ± 0.6             |
| Cianjur                  | 49.2 ± 3.8               | 5.4 ± 0.4             |
| Kutai Timur              | 37.2 ± 2.4               | 3.8 ± 0.4             |

The seed weights of 5 accessions and 1 variety of sugar palm also varied (Table 1). The fruit that has the highest fruit weight also has the highest seed weight. Bengkulu Lebong has the highest seed weight of 6.3 ± 0.6 g compared to other seeds. Cianjur seed weight in the range of 5.4 ± 0.4 g. Pematang Siantar and Bengkulu Curup seed weight were in the range of 4.6-4.7 g, while the weights of Banten and Kutai Timur were in the range of 3.7-3.8 g.

3.3. Seed length and diameter

The seed length of sugar palm from 5 accessions and 1 variety was in the range of 23.3-31.8 mm (Table 2). The longest sugar palm seed was Bengkulu Lebong accession with a length of 31.8 ± 0.9 mm and the shortest seed was Banten accession with a length of 23.3 ± 1.7 mm. [1] stated that the length of sugar palm seeds ranges from 25-35 mm. The results of this experiment indicated that there was 1 accession that has a seed length below 25 mm. This difference occurred allegedly due to differences in the growing
environment of each accession and may also be caused by differences in fruit bunches taken from each accession.

### Table 2. The average of seed length and diameter of various accessions and a variety of local sugar palm in Indonesia

| Accessions and a variety | Seed length (mm) | Seed diameter (mm) |
|-------------------------|------------------|--------------------|
| Pematang Siantar        | 29.4 ± 3.0       | 18.3 ± 0.7         |
| Bengkulu Curup          | 27.5 ± 0.8       | 19.5 ± 0.6         |
| Bengkulu Lebong         | 31.8 ± 0.9       | 20.7 ± 0.8         |
| Banten                  | 23.3 ± 1.7       | 18.1 ± 1.1         |
| Cianjur                 | 28.5 ± 0.8       | 20.1 ± 0.5         |
| Kutai Timur             | 26.8 ± 0.7       | 17.6 ± 0.8         |

Sugar palm seed diameter was in the range of 17.6-20.7 mm (Table 2). The highest seed diameter was Bengkulu Lebong accession of 20.7 ± 0.8 mm and the smallest seed diameter was Kutai Timur of 17.6 ± 0.8 mm. [1] reported that the diameter of the sugar palm seeds was in the range of 20-25 mm, and it showed that larger than in this experiment. However, the seed diameter of Bengkulu Lebong and Cianjur was in the range of 20-25 mm.

### 3.4. Wet and dry seed weight

Wet seed weight of sugar palm was in the range of 16.0-29.3 g (Table 3). The highest wet seed weight was Bengkulu Lebong accession of 29.3 g and the lowest wet seed weight was Banten accession of 16.0 g. Moreover, the dry seed weight of sugar palm was in the range of 13.4-21.8 g (Table 3). The highest dry seed weight was also found in Bengkulu Lebong accession of 21.8 g but the lowest dry seed weight was in the Kutai Timur of 13.4 g.

### Table 3. The average wet and dry seed weight of various accessions and a variety of local sugar palm in Indonesia

| Accessions and a variety | Wet weight (g) | Dry weight (g) |
|-------------------------|---------------|---------------|
| Pematang Siantar        | 22.9          | 16.3          |
| Bengkulu Curup          | 22.2          | 16.9          |
| Bengkulu Lebong         | 29.3          | 21.8          |
| Banten                  | 16.0          | 11.9          |
| Cianjur                 | 23.8          | 15.2          |
| Kutai Timur             | 17.2          | 13.4          |

The wet and dry seed weight was affected by the position of the flower bunch and the presence of male flowers that are tapped or not tapped. According to [2] that in trees where male flower bunches are not tapped, the lower position of the female flower bunches, the higher wet, and dry seed weight. Conversely on trees whose male flowers are tapped, the lower position of the female flower bunches, the lower wet and dry seed weight. In the tapped tree, there will be an assimilation competition between male and female flower bunches. Assimilate will be used by male flowers to produce sap so that it is translocated into female flower bunches fewer which will result in smaller fruit sizes. In male flower bunches that are not tapped, there was no assimilation competition, so the assimilation is translocated into female flower bunches for fruit growth. In this experiment, the fruit collection did not pay attention to the position of the female flower and the presence or absence of tapped male flowers. Variations in the size of the sugar palm seeds might be caused by these factors.
3.5. Potential growth, germination percentage, and seed water content

Normal seeds have enough food reserves to provide energy when germinating. This is indicated by the variable of potential growth (PG). Potential growth is the ability of seeds to germinate even though there are those that do not germinate normally. Sugar palm PG in this experiment varied (Table 4). The PG average of sugar palm seeds was above 87% but only Bengkulu Lebong accession has only 66%. The low PG of accession Bengkulu Lebong because the fruit obtained was still yellowish-green and did not yet fully ripened. The germination (GP) of 5 accessions and 1 sugar palm variety showed a variety of numbers (Table 4). DB is the ability of seeds to germinate normally with the appearance of radicles and plums. The average DB of sugar palm seeds was very high, that was above 75% except for Bengkulu Lebong accession which was only 44%. The low PG in Bengkulu Lebong accession also caused a low DB and there were some seeds that did not germinate normally at the end of 90 DAS observations. The high of PG and DB in Pematang Siantar accession, Bengkulu Curup, Banten, Cianjur, and Kutai Timur varieties showed that the correct dormancy break technique is done by deopecululation. Setyaningrum (2006) reported that scarification on the backs of palm seeds resulted in a very low PG <20%. This was presumably due to improper scarification treatment in the embryonic position. [6] reported that deopecululation treatment on palm seeds produced PG and GP 86 and 85% respectively using husk charcoal media.

Table 4. The average of potential growth (%), germination percentage (%), and seed water content (%) of various accessions and a variety of local sugar palm in Indonesia

| Accessions and a variety | Potential growth | Germination percentage | Seed water content |
|-------------------------|-----------------|------------------------|--------------------|
| Pematang Siantar        | 87              | 75                     | 31                 |
| Bengkulu Curup          | 90              | 90                     | 24                 |
| Bengkulu Lebong         | 66              | 44                     | 27                 |
| Banten                  | 96              | 82                     | 27                 |
| Cianjur                 | 100             | 98                     | 36                 |
| Kutai Timur             | 92              | 89                     | 22                 |

Sugar palm seeds are classified into the recalcitrant seed group. One characteristic of recalcitrant seeds is that they have high water content [8]. Seed water content varies in the range of 22-36% (Table 4). High water content and high germination rate, except Bengkulu Lebong accession, were one of the recalcitrant seed characteristics [2]. This study supports the results of the study of [5] which stated that the decreased water content of the sugar palm seeds will also reduce the germination power.

3.6. Apokol length

Sugar palm seed germination started with the emergence of an elongated apokol and was followed by the movement of the embryo towards the lower part of the apokol. The growth of apokol of each accession and variety was different. The growth of apokol at 30 DAS for Cianjur, Banten, Pematang Siantar, Bengkulu Curup, Kutai Timur, and Bengkulu Lebong were 9.8, 9.2, 7.9, 7.3, 7.1, 7.1 and 5.1 cm respectively (Table 5). Faster growth of apokol at 30 DAS was not followed by higher apokol length increases at 60 DAS. Sugar palm seeds that had the highest apokol length at 30 DAS had a lower increment length at 60 DAS. Sugar palm seeds which have a longer apokol length at 30 DAS have the fastest apokol growth and allegedly to have a faster germination process. This can be seen from the greater part of the apokol on Cianjur's accession. One characteristic of the seeds that will germinate is the enlargement of the lower apokol and after that the appearance of the radicles.

The increased rate of apokol length has decreased from 60 to 90 DAS and it was in the range of 0-0.3 cm. A decrease in the length of the apokol occurred because the apokol has germinated at 60 DAS. Apokol that has germinated did not have any further elongation. This happened because the growth was
more concentrated on the development of embryos that have germinated. The apokol did not increase in length because at the bottom of apokol grew radicles so the elongation was continued by root growth.

Table 5. The average apokol length of various accessions and a variety of local sugar palm in Indonesia

| Accessions and a variety | Apokol length (cm) | Apokol length (cm) | Apokol length (cm) |
|--------------------------|--------------------|--------------------|--------------------|
|                          | 30 DAS             | 60 DAS             | 90 DAS             |
| Pematang Siantar         | 7.9 ± 0.7          | 9.4 ± 0.8          | 9.6 ± 0.8          |
| Bengkulu Curup           | 7.3 ± 0.9          | 10.8 ± 1.1         | 10.8 ± 1.1         |
| Bengkulu Lebong          | 5.1 ± 0.5          | 13.7 ± 2.7         | 14.0 ± 2.7         |
| Banten                   | 9.2 ± 0.8          | 11.6 ± 0.9         | 11.6 ± 1.0         |
| Cianjur                  | 9.8 ± 0.8          | 10.0 ± 0.8         | 10.1 ± 0.8         |
| Kutai Timur              | 7.1 ± 0.5          | 12.1 ± 1.9         | 12.2 ± 1.9         |

3.7. Radicula and plumula length

All sugar palm roots have emerged at 60 DAS. The longest root at 60 DAS was Cianjur accession followed by Kutai Timur, Pematang Siantar, Banten, Bengkulu Curup and Bengkulu Lebong at 18.4, 12.7, 10.8, 10.1, 9.5, and 8.3 cm respectively (Table 6). Root length increased from 60 to 90 DAS ranged from 8.4-10.7 cm. The highest root length increase was Bengkulu Curup and the lowest root length increase was Pematang Siantar accession. Accessions of Pematang Siantar, Bengkulu Curup, Bengkulu Lebong, and Kutai Timur were characterized by more secondary roots growing on primary roots (Figure 4). Accessions of Banten and Cianjur have fewer secondary roots than others.

Plumula appeared after the roots develop properly. At 60 DAS observations, plumula from 4 accessions and 1 variety were not yet seen but in Cianjur accessions the plumula had grown. At the end of observations (90 DAS), it can be seen that the longest plumula was found in Pematang Siantar accession by 19.2 cm (Table 6), while the shortest plumula in Bengkulu Lebong accession and Kutai Timur variety at 8.3 cm. Although the plumula in Cianjur accession appeared first in 60 DAS, it did not guarantee that the growth of Cianjur accession plumula was faster. It can be seen that the plumula length of the Cianjur accession was 14.1 cm and it was still lower than the Pematang Siantar accession at 90 DAS.

Figure 4. Normal sprouts from each sugar palm accession and a variety in Indonesia at 90 DAS. (A) Pematang Siantar accessions, (B) Bengkulu Curup Accessions, (C) Bengkulu Lebong Accessions, (D) Banten Accessions, (E) Cianjur Accessions, and (F) Kutai Timur Variety.
Table 6. The average radicles and plumule length of various accessions and a variety of local sugar palm in Indonesia

| Accessions and a variety | Radicles length (cm) | Plumule length (cm) |
|-------------------------|----------------------|---------------------|
|                         | 60 DAS | 90 DAS | 90 DAS |
| Pematang Siantar        | 10.8 ± 3.6 | 19.2 ± 6.3 | 19.2 ± 6.3 |
| Bengkulu Curup          | 9.5 ± 1.5 | 20.2 ± 3.1 | 8.5 ± 0.8 |
| Bengkulu Lebong         | 8.3 ± 3.3 | 17.6 ± 6.1 | 8.3 ± 1.0 |
| Banten                  | 10.1 ± 1.9 | 19.3 ± 4.3 | 9.4 ± 2.0 |
| Cianjur                 | 18.4 ± 2.4 | 27.2 ± 4.1 | 14.1 ± 2.4 |
| Kutai Timur             | 12.7 ± 1.5 | 18.1 ± 4.6 | 8.3 ± 1.5 |

3.8. Apokol characteristics

The interesting thing in sugar palm seed germination was the emergence of a long tube as the movement of the embryo from inside the seed called apokol. Apokol allegedly as a form of adaptation of plants to survive in their natural growing environment. With the existence of apokol, sugar palm seeds that are not planted too deep, the apokol will enter into the soil so that the embryo can germinate and develop. Apokol is a tissue that extends and there is a cavity in the middle (Figure 5).

![Figure 5. Cross-section of the apokol under a microscope](image)

Observation under the microscope showed that there was a tissue that resembles a small tube extending and attaching to the lower part of the apokol (Figure 6A; 6B). Inside the tube, there will be embryos that will germinate to form new plants (Figure 6C). Sugar palm embryos were thought to move through the apokol starting from the initial phase of formation and elongation of the apokol because the tube-like tissue was attached to the lower part of the apokol. During the elongation phase of the apokol and when the tip of the apokol has not yet been swollen, embryo formation has not been seen (Figure 6D). In the phase of apokol which has swollen on the tip, it is seen that the embryo has formed (Figure 6E; 6F).

In this case, the apokol was the pathway of embryo movement from the seed during apokol elongation. The movement of the embryo begins at the very beginning of the formation of an apokol through a tube-like tissue. During the elongation process, the embryo will be formed and ready to germinate when the lower part of the apokol enlarges.
Figure 6. Longitudinal cross-section of the apokol at the bottom. (A) The lower apokol was cut transversely, there was a small tube extending and attaching to the lower part of the apokol and this was the place of the embryo, (B) The small tube where the embryo was, (C) The position of the embryo in a small tube, (D) Longitudinal cross-section of the apokol which has not enlarged at the bottom and the embryo has not formed, (E) and (F) embryos that were in a small tube at the bottom of the apokol.

4. Conclusion

The characterization of 5 accessions and 1 variety of sugar palm has different morphological characteristics. The accessions of Pematang Siantar, Bengkulu Lebong, Bengkulu Curup, Banten, Cianjur, and the Kutai Timur variety had a fruit weight range of 37.2-66.2 g, seed weight 3.7-6.3 g, seed length 23.3-31.8 mm, seed diameter 17.6-29.3 g, dry seed weight 13.4-21.8 g, potential growth 66-100%, germination percentage 44-98%, seed moisture content 22-36%, apokol length 9.6-14.0 cm (90 DAS), radicle length 17.6-27.2 cm (90 DAS), and plumula length 8.3-19.2 cm (90 DAS). Sugar palm seed germination begins with the formation of apokol which is useful as an embryonic pathway before germination.

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