Identification of the Morphophysiological Characteristics of Cassava (Manihot esculenta Crantz) Based on Altitude

A Setiawan, Rosmayati and N Rahmawati*

Faculty of Agriculture, Universitas Sumatera Utara, Padang Bulan, Medan 20155, Indonesia

E-mail: *nini@usu.ac.id

Abstract. The study of the morph physiological characteristics of cassava is considered important for understanding the actual condition of local food resources. This research was conducted at Serdang Bedagai Regency from April - May 2018. Area of sampling decided was for each district was chose 1 Sub district, each Sub district was taken 3 villages and 3 farmers for each village. The objective of this study was to determine the type, kinship and physiological relationship of the distribution of cassava plasma (Manihot esculenta Crantz) based on altitude. The genotype types of cassava that have been found include White Klanting (S1), Red Klanting (S2), Jakarta (S3), Malaysia (S4), Gundoruwo (S5), Gundoruwo Hitam (S6), Thailand (S7), Yellow Potatoes (S8), and Adira (S9). The lowest euclidean values was showed on S1 and S6 with 10.084. In the dendogram there was two main parts, namely part 1 and 2 kinship with 25% dissimilarity scale. The highest water content was showed on Jakarta genotype with 66.22%, the highest glucose level was showed on Red Klanting genotype with 24.43%, the highest starch content was showed on Red Klanting genotype with 21.99% and the highest total chlorophyll was showed on Yellow Potatoes genotype with 88.25940 mg/g.

1. Introduction
Cassava (Manihot esculenta Crantz) is an annual food crop in the tropical regions and the most important crops in the Euphorbiaceae family. It is mainly grown in Africa, the Caribbean and Asia [1]. Due to the high concentration of carbohydrates and being easy to grow, cassava is considered as a multifunctional plant, such as food, feed and raw materials in various industries. Thus, this tuber crop is not only for poor man's food but also a valuable crop for millions of people living in rural areas of Southeast Asia [2].

The central area that has potential for cassava cultivation is in Serdang Bedagai district. Based on data, cassava is generally cultivated in 33 districts/cities in North Sumatra, although the number of plants and production are varies. This reflects that the number of types of cassava (Manihot esculenta Crantz). that planted in the area of North Sumatra is the hugest and needs to be identified [3]. Based on data from the Central Statistics Agency 2017 that the production of cassava in Serdang Regency in 2016 was 545,881.3 tons with productivity of 435.41 (kw / ha) [4]. Although there is sufficient data about harvested area, production, and productivity, however until now it is not recognized yet the exactly types of cassava planted by the farmers at North Sumatra province, so it is necessary to conduct research in the form of an inventory of cassava types [5].
Efforts to make an inventory requires identification. Identification is an activity of characterization of all the properties possessed by sources of plant genetic diversity. Identification is done to find and recognize taxonomic characteristics of diverse individuals and put them in a taxon [6]. Identification based on morphological and physiological characters is very useful to find out various types and diversity of cassava genotype. The morphological characterization can reveal morphological variability and duplicates within current germplasm. It can also cluster access to classes and establish corresponding between current and existing germplasms [7]. The objective of the research was to determine the type, kinship and physiological relationship of the distribution of cassava plasma (*Manihot esculenta* Crantz) based on altitude.

2. Materials and Methods

This research was conducted in Serdang Bedagai Regency the province of Sumatera Utara, from April - May 2018. Each District was taken by 1 Subdistrict, each Subdistrict was taken 3 villages and each village selected 3 farmers. Geographically, Serdang Bedagai Regency is located at 20° 57' North Latitude, 30° 16' South Latitude, 98° 33' - 99° 27' East Longitude with a height ranging from 0 - 500 meters above sea level. Sampling of farmers was done through nonprobability sampling design, which sampling coincidence (accidental sampling) [8]. Based on information found from the first farmer, the second farmer was identified. The implementation of research surveys by determining the location of cassava production centers in North Sumatra obtained from the Central Statistics Agency (BPS). Sampling was taken from plants located in the middle of the plot of plants that grow well. Direct interviews with farmers also done to obtain general information about cassava cultivation. Data collection was done by observing the sample based on the manual description of cassava Selected Morphological and Agronomic Descriptors for the Characterization of Cassava [9]. Morphological characters were observed through the form of qualitative and quantitative characters. The physiological characters observed included: glucose level, water content, starch content, chlorophyll a, chlorophyll b, total chlorophyll. Observations on physiological characteristics of water content, starch content, glucose levels were carried out in the food technology laboratory and observation of leaf chlorophyll was carried out in Tissue Culture Laboratory Faculty of Agriculture, Universitas Sumatera Utara.

3. Results and Discussion

The research location was determined based on the highest harvested area and production from the Central Statistics Agency (BPS) in North Sumatra, namely in Serdang Bedagai Regency. Based on the information obtained, then surveyed in various sub-districts and villages. The following data shows the research locations that cassava (*Manihot esculenta* Crantz) has been found and their types:

Table 1. Research location and type of cassava in Serdang Bedagai Regency

The result showed that about 9 (nine) types of cassava were found in Serdang Bedagai Regency. The types of cassava that have been found include White Klanting (S1), Red Klanting (S2), Jakarta (S3), Malaysia (S4), Gundoruwo (S5), Gundoruwo Hitam (S6), Thailand (S7), Yellow Potatoes (S8), and Adira (S9), which has different morphological characters. Cassava species that grow at the highest altitude were white cassava (S1) and red klanting (S2) in Bintang Bayu Sub district, Panambean Village at the coordinates N 3° 19'3.9576"; E 98° 57'50.4972" with altitude 117 m above sea level. The type of cassava that grow at the lowest altitude was Adira (S9) cassava in Dolok Masihul, Kampong Padang Village on the coordinates of N 3° 20'46.7844"; E 99° 0'44.8524" with an altitude of 70 meter above sea level. This difference occurs due to the coordinates and altitude of the place affecting the metabolic process of cassava plants, where the light intensity, temperature, and humidity obtained varies to achieve an optimal metabolic process, thus impacting the growth of cassava morphology. The existence of geographical differences such as differences in altitude above sea level (asl) caused differences in weather and climate at the place, especially temperature, humidity and rainfall. Low place difference is indicated by high ambient temperature, air pressure and oxygen...
while high places are characterized by ambient temperature, low air pressure but increased rainfall [10].

Table 1. Based on morphological characters of cassava in Serdang Bedagai Regency, the value of kinship relationship can be seen in the following Table:

| Code | Types of cassava     | districts    | Village                | Coordinate point       | Place Height (mdpl) |
|------|----------------------|--------------|------------------------|------------------------|---------------------|
| S1   | Klanting Putih       | Bintang Bayu | Penambean              | N 3°19'3.9576" E 98°57'50.4972" | 117                 |
| S2   | Klanting Merah       | Bintang Bayu | Penambean              | N 3°19'3.9576" E 98°57'50.4972" | 117                 |
| S3   | Jakarta              | Dolok Masihul| Kampung Tengah PerluasanPergulaan | N 3°24'7.2396" E 99°1'47.8812" | 42                  |
| S4   | Malaysia             | Sei Rampah   | Pergulaan              | N 3°25'21.7092" E 99°2'34.96"  | 38                  |
| S5   | Gundoruwo            | Sei Rampah   | Pergulaan              | N 3°25'52.7844" E 99°2'42.9792" | 21                  |
| S6   | Gundoruwo Hitam      | Sei Rampah   | Belidaan               | N 3°27'45.7488" E 99°5'30.6564" | 11                  |
| S7   | Thailand             | Sei Rampah   | Belidaan               | N 3°27'47.3616" E 99°5'29.4036" | 6                   |
| S8   | Kuning               | Sei Rampah   | Belidaan               | N 3°27'45.7488" E 99°5'30.6564" | 11                  |
| S9   | Adira                | Dolok Masihul| Kampung Padang         | N 3°20'46.7844" E 99°0'44.8524" | 70                  |

The smaller the euclidean value between variables one with the other variables, the relationship between the two variables is closer or greater the level of similarity and vice versa. The lowest euclidean values are found in S1 and S6 which is 10,084. The highest euclidean values are found in S2 and S5 which are 68,222 (Table 2). Based on the results of cassava survey in Serdang Bedagai Regency, cassava types can be grouped into 2 groups, 3 groups and 4 groups which can be seen from the Table 3.

Based on the dendogram that was formed (Figure 1) there are two main parts, namely part 1 and 2 kinship on a 25% dissimilarity scale. part of group 1, namely S1, S6, S9, S2, S8, S3, S4, S7 with a characteristic lower average tuber weight. Part of group 2 is S5 with a higher average characteristic of tuber weight.
Table 2. Relationship between cassava based on Dissimilarity Matrix

| No | Kinship Relations | Euclidean value |
|----|-------------------|-----------------|
| 1  | S1                | S6              | 10.084          |
| 2  | S6                | S9              | 28.040          |
| 3  | S2                | S6              | 29.758          |
| 4  | S3                | S9              | 29.911          |
| 5  | S1                | S2              | 30.476          |
| 6  | S1                | S9              | 31.122          |
| 7  | S4                | S9              | 31.653          |
| 8  | S3                | S4              | 31.657          |
| 9  | S8                | S9              | 32.554          |
| 10 | S6                | S8              | 34.643          |
| 11 | S1                | S3              | 36.516          |
| 12 | S4                | S7              | 39.120          |
| 13 | S4                | S5              | 39.352          |
| 14 | S1                | S7              | 39.520          |
| 15 | S1                | S8              | 40.727          |
| 16 | S2                | S4              | 40.771          |
| 17 | S2                | S9              | 41.315          |
| 18 | S6                | S7              | 42.877          |
| 19 | S1                | S4              | 44.377          |
| 20 | S7                | S8              | 45.362          |
| 21 | S2                | S8              | 47.226          |
| 22 | S1                | S5              | 47.241          |
| 23 | S4                | S6              | 48.175          |
| 24 | S2                | S7              | 48.928          |
| 25 | S2                | S3              | 49.365          |
| 26 | S3                | S6              | 49.423          |
| 27 | S5                | S9              | 50.040          |
| 28 | S5                | S6              | 52.767          |
| 29 | S3                | S7              | 54.598          |
| 30 | S4                | S8              | 55.241          |
| 31 | S3                | S5              | 56.085          |
| 32 | S7                | S9              | 62.122          |
| 33 | S3                | S8              | 63.327          |
| 34 | S5                | S8              | 64.737          |
| 35 | S5                | S7              | 66.669          |
| 36 | S2                | S5              | 68.222          |
**Table 3.** Grouping of Cassava Plants in Serdang Bedagai Regency

| Types of cassava     | 4 Groups | 3 Groups | 2 Groups |
|----------------------|----------|----------|----------|
| Klanting Putih       | 1        | 1        | 1        |
| Klanting Merah       | 1        | 1        | 1        |
| Jakarta              | 2        | 1        | 1        |
| Malaysia             | 2        | 1        | 1        |
| Gundorowo            | 3        | 2        | 2        |
| Gundorowo Hitam      | 1        | 1        | 1        |
| Thailand             | 4        | 3        | 1        |
| Ubi Kuning           | 1        | 1        | 1        |
| Adira                | 1        | 1        | 1        |

From the Table above, a grouping dendogram is obtained based on the similarity of characteristics found between several types of cassava in Serdang Bedagai Regency which can be seen in the following:

**Figure 1.** Dendogram for Grouping of Woody Types in Serdang Bedagai Regency
3.1 Physiological Character

Table 4. Results of Physiological Analysis of Cassava Types in Serdang Bedagai Regency

| Types of cassava     | Water content (%) | Glucose (%) | Starch levels (%) | Chlorophyll a (mg/g) | Chlorophyll b (mg/g) | Total Chlorophyll (mg/g) |
|----------------------|-------------------|-------------|-------------------|----------------------|----------------------|-------------------------|
| Klanting Putih       | 65.99386          | 10.29860    | 9.26870           | 29.35492             | 47.98060             | 77.22180                |
| Klanting Merah       | 65.76730          | 24.43130    | 21.98820          | 29.91078             | 39.73800             | 69.54910                |
| Jakarta              | 66.22218          | 11.71760    | 10.54580          | 33.56100             | 48.06600             | 81.50900                |
| Malaysia             | 57.85428          | 11.25810    | 10.13230          | 32.57742             | 34.89060             | 67.37430                |
| Gondoruwo            | 64.08945          | 13.83140    | 12.44830          | 26.23014             | 56.22420             | 82.32910                |
| Gondoruwo Hitam      | 59.29780          | 9.98800     | 8.82000           | 31.00890             | 33.20640             | 64.12610                |
| Thailand             | 57.74345          | 12.46610    | 11.21950          | 25.75782             | 58.33980             | 83.96910                |
| Ubi Kuning           | 58.12671          | 11.31470    | 10.18320          | 26.42340             | 61.97160             | 88.25940                |
| Siantar/Adira        | 64.22324          | 4.78940     | 4.31050           | 31.38684             | 27.48120             | 58.78860                |

In Table 4 the highest water content was found in the Jakarta genotype which was 66.22218%, the highest glucose level was found in the red klanting genotype which was 24.43130%, the highest starch content was found in the red klanting genotype which was 21.98820% and the highest total chlorophyll was found in yellow yam genotype, 88.25940mg / g.

Cassava does not have a clear mature period because the yams continue to grow. As a result, harvest periods can vary so that cassava is produced which has different physical and chemical properties. Physical and chemical properties of starch such as granule shape and size, amylose content and non starch component content are strongly influenced by genetic factors, growing conditions and plant age [11].

the highest altitude is found in the red klanting genotype, which is 117 meters above sea level. a high place is marked by increased rainfall [10]. The higher the place, the higher glucose and starch levels. The greater the rainfall, there will be an increase in the availability of water in the soil so that the need for water for the metabolic processes of the plant will be fulfilled. If the need for water has been fulfilled, the rate of photosynthesis as a process of carbohydrate synthesis will increase. The amount of rainy day is related to the availability of water. The greater the value of rainy days, the more water is available in the soil, this is because the availability of water greatly affects various metabolic processes that occur in plants, and the process of the process is beneficial for plant growth [12].

Water shortages can inhibit photosynthetic rates, mainly due to their influence on the turgidity of stomatal guard [13].

The height of the place (elevation) included in physiographic factors, greatly affects the climate, especially rainfall and air temperature. the height of the place affects the air temperature and light intensity. The temperature and light intensity will be smaller as the place grows [14]. Reduced temperature and light intensity can inhibit growth because photosynthesis is disrupted. Areas that have high elevations in the amount of CO2 concentration are relatively smaller when compared to the lower regions [15]. This causes the photosynthesis rate to slow down, carbohydrates for growth to decrease, and the height of the plant will decrease.

4. Conclusions

The result of this research showed that the cassava plants that have been found and identified in Serdang regency were consist of 9 genotypes. 2 types of cassava were found with a 25% dissimilarity scale, which was an average type of low tuber weight of 8 genotypes and an average type of tuber height weight of 1 genotype. The lowest euclidean values was showed on S1 and S6 with 10.084. The
highest water content was showed on Jakarta genotype with 66.22218%, the highest glucose level was showed on red klanting genotype which was with 21.98820% and the highest total chlorophyll was showed on Yellow Potatoes genotype with 88.25940 mg/g.

References
[1] Ceballos H, Iglesias C A, Pérez J C, Dixon A G O 2004 Cassava breeding: opportunities and challenges Plant molecular biology 56 4 pp 503-16
[2] Howeler R 2014 Sustainable soil and Crop management of Cassava in Asia A reference manual (Vietnam: CIAT Publication) ISBN 978-958-694-125-9
[3] Azwar A 2004 Aspek Kesehatan dan Gizi dalam Ketahanan Pangan [Health and Nutrition Aspects in Food Security] Prosiding Widyakarya Nasional Pangan dan Gizi VII [Proc. of Widyakarya National Food and Nutrition VIII] (Jakarta: Indonesian Institute of Sciences)
[4] Central Bureau of Statistics 2017 Production, Productivity, and Harvesting of Woody Area by Province (Jakarta: Central Bureau of Statistics)
[5] Kardhinata E H 2010 Inventory and Identification of Types of Cassava Consumption (Manihot Esculenta, Crantz) in the Lowlands in Deli Serdang Regency, Serdang Bedagai and Langkat. (Special Report I)
[6] Ferita I, Tawarati Z, Syarif 2015 Identification and characterization of enau plants (Arenga pinnata) in Gayo Lues Regency pro and kontra Biodiv Indon 32 1 pp 31-7
[7] N’Zuë B, Pamela O M, Michel K A, Brice D K E, Pierre Z G, Sidoine E B and Alexandre D A. 2014 Morphological characterization of cassava (Manihot esculenta crantz) accessions collected in the centre-west, south-west and west of Côte d'Ivoire Greener Journal of Agricultural Science 4 6 pp 220-31
[8] Eunike A 2013 Statistil industry 1 [Industrial Statistics 1] Retrieved from www.aunike.lecture.ub.ac.id
[9] Fukuda W M G, Guevara C L, Kawuki R and Ferguson M E 2010 Selected morphological and agronomic descriptors for the characterization of cassava (Ibadan, Nigeria: International institute of tropical agriculture)
[10] Sangadjia S 2001 Pengaruh iklim tropis di dua ketinggian tempat yang berbeda terhadap potensi hasil tanaman soba (Fagopyrum Esculentum Moench) [The Influence of Tropical Climate in Two Altitudes of Different Places on the Potential Results of Soba Crops [Fagopyrum esculentum Moench]] [Thesis] (Bogor, Indonesia: Institut Pertanian Bogor)
[11] Rubatzky V E and Yamaguchi 1988 Production and Nutrition (Bandung, Indonesia: Institut Teknologi Bandung)
[12] Nurnasari E and Djamali 2010 Height conditions for places to production and quality of temanggung tobacco Crop Bulletin, Fiber & Oil Industry 2 2 pp 45–59
[13] Lakitan B 1993 Basics of Plant Physiology (Jakarta, Indonesia: Raja Grafindo Persada)
[14] Sulistyono 199. The influence of the height of the place on Pinus merkusii Jungh et de Vriese in KPH Probolinggo Perum Perhutani Unit II Jawa Timur [Thesis] (Bogor, Indonesia: Institut Pertanian Bogor)
[15] Muhdi 2004 Pengaruh Elevasi Terhadap Pertumbuhan dan Kualitas Kayu [Effect Of Elevation on Growth and the Quality of Wood] (Medan, Indonesia: Universitas Sumatera Utara)