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Morphological Characteristics and Similarity Analysis of Cassava (*Manihot esculenta* Crantz) in Wonosobo, Temanggung, and Magelang Regencies

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Abstract. *The diversity of cassava in Wonosobo, Temanggung and Magelang districts must be investigated. The objective of the study was to analyze the diversity of cassava based on morphological characteristics. The cassava of each accession was planted in Bandongan, Magelang Regency. Morphological characters observed after six months of planting included apical leaf color, apical leaf hair, leaf lobe shape, petiole color, leaf color, number of leaf lobes, leaf length, leaf width, petiole length, vein color, petiole orientation, color epidermis of stem, color of outer appearance of stem, distance between nodes, stem growth, color of mature branch tip, branching type, tuber, tuber shape, outer tuber skin color, tuber flesh color, and tuber inner skin color. Analysis of the morphological characteristics of cassava is presented in the form of a dendrogram using the MVSP (Multi Variate Statistical Package) version 3.22. The results of the study obtained 39 accessions of cassava which showed different morphological characteristics. The lowest morphological similarity (0.735) was found in Group I only consisted of 2 acquisitions that did not have tubers, namely Red Vegetables and Green Vegetables and Group II (Groups III and IV) have a similarity of 0.92. The highest similarity was in groups IIIa and IIIb and Groups IVa and IVb have a similarity coefficient value of 0.95. The morphological diversity of 39 accessions is a source of cassava germplasm: 37 accessions are harvested for tubers and 2 accessions areharvested explicitly for leaves as vegetables. This research was useful for the development of cassava-based food industry bioproducts.*

Keywords: *accession, cassava, dendrogram, morphological characters, similarity coefficient*

Citation
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INTRODUCTION

Cassava ranks third as the source of calories after rice and corn in tropical countries. Cassava is a food, feed and raw material for the textile, paper and glue industries (Sudarmonowati et al., 2018), as a raw material for mocaf (Analianasari et al., 2020), nutraceutical in the form of polyphenols in cassava leaves as a source of antioxidants (Laya & Koubala, 2020). Cassava plants originate from South America are cultivated in the tropics through domestication selection by the domestication selection by community cultivation(Monteros-Altamirano et al., 2021). Based on harvested area and cassava production, Central

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Java ranks second after Lampung Province in 2015. Based on productivity, Central Java ranks seventh (Sudarmonowati et al., 2018). Currently, cassava in Central Java is from the genotypes Buto Ijo, Gatot Kaca, Kaporo, Ketan, Randu, Sentul, Markonah, Marita, Budin Kuning, Budin Ketan, Budin Mentega, and Daplan (Sudarmonowati et al., 2018).

The morphological characteristics of cassava are a reference for comparison to distinguish one variety from another (Nurdjanah et al., 2020). Cassava is generally divided into two groups, namely sweet types for consumption and bitter types for industrial raw materials (Monteros-Altamirano et al., 2021). Rapid characterization of cassava plants requires morphological characterization. Variations in morphological characters in general include variations in shoot color, petiole color, leaf shape, leaf color, number of leaf lobes, leaf vein color, distribution of anthocyanins in the petiole, stem color, tuber outer skin color, tuber cortex layer color, and tuber color (Hartati, 2015).

Variations in cassava genetic resources are obtained through collection activities, enrichment of exploratory species collections in various regions, identification, characterization, and evaluation of the superior characteristics of each type of cassava for plant breeding activities (Sudarmonowati et al., 2018). Morphological characterization of cassava is used to obtain phenotypic descriptions of plants, variations, important agronomic characteristics, genetic distance, morphological character relationships, adaptation relationships, identification and evaluation of the identity of cassava found in an area (La & Sirappa, 2009). Descriptions should be easily observed, have a high degree of discrepancy, and have low environmental influence. For example, the EMBRAPA-Brasil Corporation has 75 morphological descriptions of cassava and 47 traditional varieties, 159 accessions conserved in the field in Côte d'Ivoire, Africa, and in Mexico 40 accessions were characterized from a germplasm bank (Monteros-Altamirano et al., 2021).

The biodiversity of cassava is the basic foundation, the key to sustainable agriculture and food security. The superior characteristics of each type of cassava are very helpful in improving these types of cassava. Local cassava resources in Magelang Regency are spread across 21 districts with a planting area and cassava harvest area of 1,198 hectares based on data from the Central Statistics Agency of Magelang Regency in 2020. The biodiversity collection of cassava from Magelang, Temanggung and Wonosobo districts is planted at the Bandongan Teaching Farm at Tidar University in Magelang. This collection is useful for maintaining cassava biodiversity from the three districts in supporting cassava breeding activities in the future considering that Magelang is a Gethuk city. Processed cassava-based food products that are also often found in Magelang include Slondok, Criping Gethuk, and Criping. These products require different cassava criteria. The availability of sustainable cassava needs to be supported by a study of the diversity of cassava germplasm. The objective of the study was to analyze the diversity of cassava based on morphological characteristics and analysis of similarities of 39 cassava accessions (*Manihot esculenta*) collected from Wonosobo, Temanggung and Magelang Regencies.

MATERIALS AND METHODS

The research was conducted from August 2021 to May 2022. The cassava plant samples came from Wonosobo, Temanggung and Magelang Regencies (Figure 1). The tools used included knives, hoes, tape measure,

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plastic, camera, stationery, and white cloth for the photo documentation of the identified plant parts. Materials include cassava stems (*Manihot esculenta*) originating from the districts of Wonosobo, Temanggung and Magelang as cuttings for planting, manure and NPK fertilizer. All accessions were planted in the Bandongan Teaching Farm, Tidar University, located in Sidorejo Village, Bandongan District, Magelang Regency. Latosol soil type, with the altitude is 416.3 meters above sea level.

Figure 2 Map of Sampling Locations ((a) Wonosobo Regency, (b) Temanggung Regency, (c) Magelang Regency).

The sampling technique according to (Firdaus et al., 2016) was as follows: 1). Observations were made through observations in the field for data acquisition, 2). Documentation of observations to support the data was carried out according to (Fukuda et al., 2010). Cassava stem cuttings were planted vertically. The spacing used was 90 cm and each planting hole was filled with 1 (one) cassava stem cutting. The layout of planting was done randomly. Measurement of morphological character parameters was carried out when cassava was 6 months old by taking the whole plant. This characterization was carried out by taking several samples and observing and identifying cassava based on references (Fukuda et al., 2010). Morphological data were presented descriptively, which were then analyzed for similarities between cassava varieties using the MVSP (Multi Variate Statistical Package) version 3.22 program to obtain the degree of kinship among cassava accessions and depicted in the form of a dendrogram.

RESULTS AND DISCUSSION

Morphological characterization can be used as a tool to validate the identity of a genotype (Skovmand, 2000). Based on exploration results in Wonosobo, Temanggung and Magelang Regencies, 39 cassava accessions were obtained with different morphological characteristics in each accession. Wonosobo, Temanggung, and Magelang districts received 9, 12, and 10 accessions respectively. As a comparison, the number of cassava accessions carried out in 4 sub-districts in West Sumatra was 15 cassava accessions and grouped into 5

groups. Each cassava accession has very diverse morphological characteristics of leaves, stems and tubers at different ages (Firdaus et al., 2016). Cassava characters include stem color, stem shape, petiole color, leaf shape, leaf color, tuber shape and tuber color (Caniago et al., 2014).

The results of the morphological characterization of cassava from Magelang, Temanggung and Wonosobo Regencies show morphological diversity in leaf apical color, leaf apical hairs, leaf lobe shape, leaf petiole color, leaf length, leaf width, petiole length, leaf vein color, stem epidermis color, external appearance of the stem, distance between internodes, tubers, root parenchyma color, and external appearance color from tubers. Visual observation of dark green leaf color, horizontal petiole orientation, straight stem growth, and white tuber flesh color had almost the same morphological characteristics in 37 accessions, except for two accessions that did not have tubers.

According to research (Dahamarudin, 2009), the characterization of cassava includes leaf length and width (cm), ratio of leaf length or width, ratio of lobe length or petiole length, number of leaf lobes, petiole color, shoot color, leaf color, leaf surface shape, scion color, and rootstock color. Characterization of cassava in North Sumatra according to (Fauzi et al., 2015) obtained 6 varieties (Malaysia, Roti, Lampung, Adira 1, Kalimantan, Pulut, and Valencia).

The results of this research found differences in the form of purple apical leaves, lobe shapes (elliptical, scalpel-shaped, egg-shaped, and linear), and petiole colors (green, yellowish green, red, greenish red, and purple). This was compared with (Karuniawan et al., 2018), that apical leaf color (light green, dark green, and purplish green) without purple, leaf lobe shape (lanceolate, lanceolate oval, lanceolate oval, elliptical lanceolate, straight or linear, and linear pyramidal), and color petiole (reddish green, red, and greenish red). In this study, the number of leaf lobes was found to be 3, 5, 7, and 9 lobes. Leaf length ranges from 13 cm – 24 cm, leaf width ranges from 1.5 cm – 5.5 cm, and leaf stalk length ranges from 12 cm – 32 cm. The color of cassava leaf bones found was green and reddish green (> ½ lobe).

The color characteristics of the leaves are dark green and light green. The color characteristics of the leaf veins are green and reddish green. The petiole orientation characters are tilted up, slanted down, and horizontal. The color characteristics of the epidermis of the stem are cream, light brown, and dark brown. The outer appearance of the stem is light brown, dark brown, silver, gray, gold, and cream. The distance between books is short, medium, and long. The character of the stem is different from research (Sari, 2016), the color of young stems, namely light green, yellowish red, dark green, and reddish green. The colors of the old stems were grayish green, dark red, brownish red, brown, whitish green, reddish brown, brownish green, and yellowish brown.

Based on morphological observations on tuber characters, there were two accessions that did not have tubers, namely accessions T9 (Red Vegetables) in Figure 2 and T10 (Green Vegetables) in Figure 3. This was because the leaves of two accessions (Table 1) are used by the local community as vegetables. Based on the results of interviews with farmers, if the leaves on cassava plants are frequently harvested, the cassava plants will not form tubers. Accessions T9 and T10 as vegetable ingredients, according to (Poonsri et al., 2019), cassava leaves have the potential as a source of antioxidants, protein and fiber in noodle products. Cassava leaves contain

crude protein, beta carotene, lipids, carbohydrates, flavonoid compounds (clovin, myricetin-3-O-rutinoside, robinin, hyperoside, nicotiflorin, narcissin) (Haiteng et al., 2019), Ca, Mg, K, Na, Mn, Fe, Cu, Zn (Oresegun et al., 2016), and vitamin C (Bruna et al., 2020). The nutritional content of cassava leaves is not only influenced by the cultivation environment but also by the genotype.

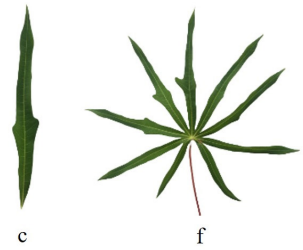

Figure 2 Differences in morphological characters of red cassava variety accessions from Wonoboyo, Temanggung Regency (accession code T9). The photos are research documents. Note: C, F, M, and N notations in Table 1 show different morphological characters from the T10 accession

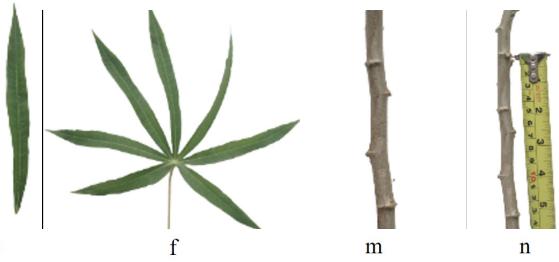

Figure 3. Differences in morphological characters of green cassava variety accessions from Wonoboyo, Temanggung Regency (accession code T10). The photos are research documents. Note: C, F, M, and N notations in Table 1 show different morphological characters from the T9 accession.

Table 1 Map of sampling locations ((a) Wonosobo Regency, (b) Temanggung Regency, (c) Magelang Regency).

Notation	Morphological Character(MC)	Red Vegetable (T9)	Green Vegetable (T10)
A	Apical leaf color	Greenish purple	Greenish purple
B	Apical leaf hairs	None	None
C	Leaf lobe shape	Pyramidal linear	Linear
D	Petiole color	Greenish red	Greenish red
E	Leaf color	Dark green	Dark green
F	Number of leaf lobes	Nine lobes	Seven lobes
G	Leaf length	24 cm	20 cm
H	Leaf width	4 cm	2 cm
I	Petiole length	27 cm	20 cm
J	Leaf color	Green	Green
K	Petiole orientation	Horizontal	Horizontal
L	Stem epidermis color	Light brown	Light brown
M	Bar exterior color	Yellowish green	Light brown
N	Distance between books	Short	Medium
O	Stem growth	Straight	Straight
p	Tubers	Not found	Not found

The morphological characteristics of tubers found were tubers having cylindrical, conical, cylindrical, and irregular tuber shapes. The outer appearance of the tubers is dark brown and light brown. The color of the inner skin of the tubers is white, pink, and purple. According to (Lestari, 2014), the color of the tuber skin is present in two parts, namely the outer skin and the inner skin. There were 4 tuber outer skin colors found, namely brown, reddish brown, brownish gray, and yellowish gray. The color of the inner skin of the tubers found 5 characters namely pink, yellowish-white, yellow, and light yellow.

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Morphological diversity can be observed based on quantitative and qualitative characteristics. Quantitative characters are characters resulting from measurements with certain measuring instruments. Quantitative characters that can be used to analyze the diversity of cassava are the number of leaf lobes, lobe size, stipule length, stipule size, tuber number, plant height, tuber weight, and harvest index. The qualitative characters used for the analysis of cassava diversity were leaf, stem, and tuber color, petiole color, leaf veins, stem cortex, stem epidermis, stem branch tips, plant shape, and root shape (Zuraida, 2010). The results of morphological analysis based on diversity and variability can indicate that there is a relationship between the accessions of a plant (Table 2).

Table 2. Qualitative characters of cassava plants in 39 accessions from Wonosobo, Temanggung and Magelang Regencies

Accession Code	Apical Leaf Color (ALC)	Apical Leaf Hairs (ALH)	Shape of Leaf Lobes (SLL)	Color of Petiole (CP)	Color of Veins (CV)	Color of Stem Epidermis (CSE)	Color of Outer Stem (COAS)	Distance Between Nodes (DBN)	Shape of Tuber (ST)	Color of Outer tuber Skin (COTS)	Color of Inner Tuber Skin (CITS)
M1	DG	Yes	L	YG	G	C	Silver	L	CC	DB	White
M2	LG	No	L	P	G	DB	Grey	S	C	DB	White
M3	P	No	L	RG	RG	LB	DB	L	CC	DB	White
M4	GP	No	LO	YG	G	LB	LB	L	CC	LB	White
M5	P	No	L	P	G	DB	Grey	L	IR	DB	Purple
M6	DG	Yes	L	YG	G	C	Silver	L	TR	LB	Pink
M7	LG	Yes	L	P	RG	C	Silver	M	C	DB	Pink
M8	GP	No	EL	P	RG	DB	LB	M	IR	DB	White
M9	GP	No	LO	YG	G	C	Golden	M	CC	DB	Pink
M10	GP	No	LO	YG	G	C	Golden	M	CC	DB	White
M11	P	No	Li	YG	G	C	Silver	M	CC	DB	White
M12	P	No	L	G	G	DB	DB	L	CC	DB	White
M13	P	No	EL	P	G	DB	DB	L	CC	DB	Pink
M14	GP	No	L	GR	G	C	Silver	L	CC	DB	White
M15	GP	No	L	P	RG	LB	Silver	L	CC	DB	Purple
M16	P	No	EL	P	G	LB	DB	L	CC	DB	Pink
M17	GP	No	L	P	RG	DB	DB	M	CC	DB	White
M18	P	No	L	GR	G	DB	DB	M	CC	DB	White
M19	GP	No	L	YG	G	C	DB	M	CC	DB	Pink
T1	DG	No	L	G	G	DB	DB	M	CC	DB	Purple
T2	GP	No	L	YG	G	LB	DB	M	CC	DB	Pink
T3	P	No	LObv	P	G	DB	DB	M	CC	DB	Pink
T4	GP	No	L	Red	RG	DB	Golden	M	CC	DB	White
T5	P	No	L	YG	RG	DB	DB	L	CC	DB	Pink
T6	P	No	L	RG	G	LB	DB	S	CC	LB	Pink
T7	GP	No	EL	RG	RG	LB	Silver	M	CC	DB	White
T8-	GP	No	L	RG	G	LB	Golden	M	CC-	CC-	-
T9	GP	No	LiP	GR	G	LB	YG	S	-	-	-
T10	GP	N	Li	GR	G	LB	LB	M	-	-	White
T11	GP	No	Li	GR	G	LB	LB	M	CC	DB	Pink
T12	GP	No	L	P	RG	LB	DB	M	CC	DB	Purple
W1	DG	Yes	L	GR	RG	C	DB	L	IR	DB	White
W2	P	No	EL	YG	G	LB	DB	L	CC	DB	Purple
W3	DG	Yes	L	P	RG	LB	DB	L	CC	DB	White
W4	GP	No	L	YG	G	DB	DB	L	CC	DB	White
W5	P	No	Li	GR	G	LB	Golden	M	CC	DB	White
W6	P	No	L	YG	G	DB	DB	M	CC	LB	White
W7	LG	Yes	L	P	RG	C	LB	M	CC	CC	Pink
W8	GP	No	Li	G	G	C	LB	M	CC	CC	Pink

Description: Apical leaf color (ALC)DG = dark green LG = light green GP = greenish purple P = purple Apical leaf hairs (ALH)N = none Leaf lobe shape L = lanceolate LO = lancet- oblongata EL = elliptical lancet OvL = Obovate Lancet Li = liniar LiP = linear pyramidal	Leaf color (LC)YG = yellowish green GR = greenish red RG = reddish green P = purple Color of Stem Epidermis (CSE) C = creamy DB = dark brown LB = light brown	Color of veins (CV):G = green RG = reddish green (> ½ lobe) Distance Between Nodes (DBN): L = long M = medium S = short Color of Outer tuber Skin (COTS) |LB = ligth brown DB = dark brown	Shape of tuber: IR = irregular CC = cylindrical cone C = cylindrical The orientation of the petioles is all horizontal. Stem growth all straight. The number of leaf lobes of all samples was 7 except T9; All samples had tubers except T9 and T10. The color of the tuber flesh is all white except T9 and T10.

The morphological differences of the 39 accessions were due to two possibilities, namely different varieties in each accession and the influence of the growing environment. According to (Fauzi et al., 2015), environmental factors such as temperature, altitude, light intensity, humidity, and others can also affect the growth and character of plants such as changes in the morphology of the anatomy of the stems, leaves, reproductive characters, and changes in the texture and content of cassava. The similarity analysis of 39 cassava accessions based on morphological characters used the Unweight Pair Group Method with Arithmatic Mean (UPGMA) in Figure 4. The similarity coefficient value in the dendrogram formed shows that the higher the similarity coefficient value, the closer the relationship between plant accessions. The lower the similarity coefficient value, the more distant the relationship between plant accessions (Hasanuddin & Fitriana, 2014). The far or close kinship between cassava accessions is grouped into clusters formed with each similarity coefficient value.

Clustering analysis was used to group observation data. The data contains an overview of observations and the relationship of each accession. The purpose of cluster analysis is to group accessions that have similarities to each other and are different from other groups (Charles & Mongi, 2015). The results of the cassava cluster analysis based on morphological characters showed that 39 cassava accessions were divided into two groups consisting of 2 cassava accessions, namely T9 (Red Vegetables) and T10 (Green Vegetables) and 37 other accessions with a similarity coefficient of 0.735. This shows that the T9 accession is distantly related to 37 other accessions. The fundamental difference produced by group I which consisted of T9 and T10 was that they did not have tubers while in group II, all accessions had tubers (Tables 2 and 3). The group of 37 cassava accessions was divided into 2 groups with a similarity coefficient value of 0.92, consisting of group III, namely IIIa and IIIb which had a similarity coefficient value of 0.95 (Figure 4). Group IV is divided into two subgroups, namely IVa and IVb with a similarity coefficient value of 0.95. Group IVa consists of M3 (Gajah) and group IVb consists of M2 (Pakis 2) and M1 (Pakis 1). Group IVa has different morphological characteristics from the other accessions, namely having red-green petioles. The difference between group IVb and the other groups was the outer skin color of the gray stems (Tables 2 and 3).

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Table 3. Cluster dendrogram of 39 cassava accessions based on agromorphological characters

Cluster	Sub Cluster		Accessions	Variety	Regional Origin	Regency
II	III	IIIa	W7	Klanteng 1	Mojotengah	Wonosobo
			W3	Palengka 2	Kalikajar	Wonosobo
			W1	Palengka 1	Kalikajar	Wonosobo
			T1	Gandum 1	Wonoboyo	Temanggung
			M7	-	Borobudur	Magelang
			M6	Mentega	Bandongan	Magelang
		IIIb	W8	Kemangi	Mojotengah	Wonosobo
			W6	Mentega	Mojotengah	Wonosobo
			W5	Lintring	Mojotengah	Wonosobo
			W4	Klanteng 1	Kalikajar	Wonosobo
			W2	Marekan	Kalikajar	Wonosobo
			T12	Lokal 2	Wonoboyo	Temanggung
			T11	-	Wonoboyo	Temanggung
			T8	Gandum 2	Candiroto	Temanggung
			T7	Mentega	Kedu	Temanggung
			T6	-	Wonoboyo 1	Temanggung
			T5	Trengganis	Wonoboyo	Temanggung
			T4	2	Ngadirejo	Temanggung
			T3	Lokal 1	Ngadirejo	Temanggung
			T2	Marini	Candiroto	Temanggung
			M19	Trengganis	Tegalrejo 4	Magelang
			M18	-	Tegalrejo 3	Magelang
			M17	-	Tegalrejo 2	Magelang
			M16	-	Tegalrejo	Magelang
			M15	Kempis	Tegalrejo 1	Magelang
			M14	-	Pakis	Magelang
			M13	Kapasan	Ngablak	Magelang
			M12	Jarakan 2	Ngablak	Magelang
			M11	Kenanti	Ngablak	Magelang
			M10	Jarakan 1	Secang	Magelang
			M9	-	Kajoran	Magelang
			M8	-	Srumbung	Magelang
			M5	Gatotkaca	Bandongan	Magelang
			M4	Ketan	Bandongan	Magelang
	IV	IVa	M3	-	Bandongan	Magelang
		IVb	M2	Gajah	Pakis 2	Magelang
			M1	-	Pakis 1	Magelang
I			T9	-	Wonoboyo	Temanggung
			T10	Green vegetables Red vegetables	Wonoboyo	Temanggun

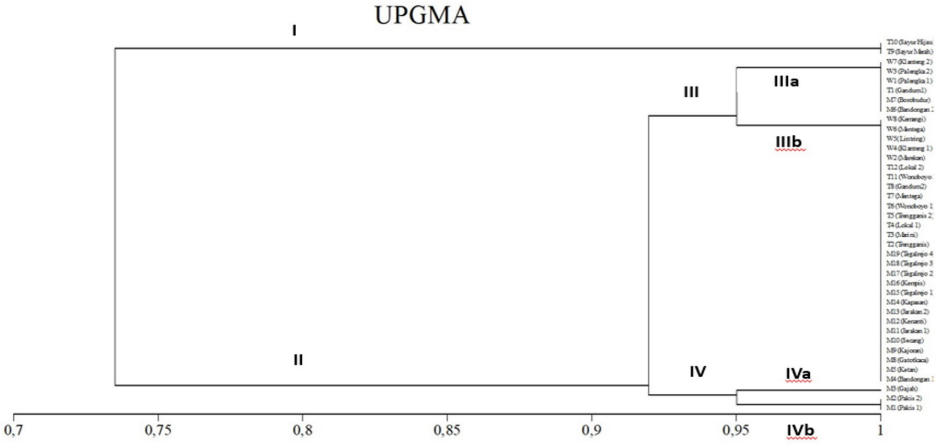

Figure 4. Cassava Clustering Dendogram for Wonosobo, Magelang, and Temanggung Regencies

Figure 4. Quantitative characters of 39 cassava accessions from Wonosobo, Temanggung and Magelang Regencies

Characters	Accessions	Accession Number	Average	P value
Number of lobes	WonosoboTemanggung	812	6.255.50	0.069
	Magelang	19	5.16	
	Total	39	5.63	
Leaf length (cm)	Wonosobo	8	17.50	0.122
	Temanggung	12	16.06	
	Magelang	19	16.08	
	Total	39	16.54	
Leaf width (cm)	Wonosobo	8	4.01	0.974
	Temanggung	12	3.95	
	Magelang	19	3.81	
	Total	39	3.92	
Petiole length (cm)	Wonosobo	8	22.44	0.622
	Temanggung	12	18.63	
	Magelang	19	18.63	
	Total	39	19.90	
Plant height (cm)	Wonosobo	8	261.54	0.807
	Temanggung	12	267.58	
	Magelang	19	245.75	
	Total	39	258.29	

Similarities between cassava accessions based on morphological characters in this study should be increased from the number of observed characters of only 20 characters to 50 morphological characters so that the results of kinship studies are more accurate (Fukuda et al., 2010). The high level of similarity is also caused by less extensive variations in altitude, planting patterns, and planting land criteria. According to (Wijayanto et al., 2013), there are several factors that can influence the similarities and differences in plant morphological characters, namely the physiological condition of individual plants, especially the plant's ability to absorb nutrients and the presence of pests and diseases.

The results of the analysis of similarity to the 39 cassava accessions (Figure 4) showed that there were 2 groups with a similarity value of 0.735 or 73.5% which indicated that the two groups had the lowest coefficient of similarity. Accessions T9 (Red Vegetables) and T10 (Green Vegetables) are distantly related to other accessions, therefore accessions T9 and T10 have a high genetic distance from other accessions. According to (Efendi, 2015), the greater the genetic similarity coefficient, the greater the chance of kinship relationships occurring. (Warhamni, 2013) stated that the greater the number of dissimilarities, the lower the level of similarity between individuals.

Groups II and III are known to have many similarities. These accessions are known to come from different areas but have many similarities, so it can be said that each accession has a close relationship. This contradicts the opinion of (Sulistiyo et al., 2014) which stated that close relationships exist in genotypes of different origins and populations from the same habitat do not necessarily have closer relationships.

Different morphological characters can be caused by environmental factors such as altitude, cropping pattern, criteria for planting land, or plant age. According to (Wijayanto et al., 2013) there are several factors that can influence differences in plant morphological characters, namely the physiological condition of individual plants in the form of the plant's ability to absorb plant nutrients and the presence of pests and diseases.

The results of quantitative character

analysis of the number of lobes, leaf length, leaf width, petiole length, and plant height showed that there were no differences between accessions, because the P value <1 (Table 4). In the quantitative character study, there was no variation between accessions because measurements were only made six months after planting, while the quantitative character of the tubers had not been carried out. With more complete quantitative data on tuber characters, it is hoped that there will be variations between genotypes. According to (Nduwumuremyi et al., 2017), large variations in quantitative characteristics can be used as evaluation material between genotypes. Environmental and genetic influences are thought to cause variation. The influence of the two interactions is important for the properties of cassava.

CONCLUSION

Exploration results of cassava from Wonosobo, Temanggung, and Magelang regencies resulted in 39 accessions with different morphological characteristics. Based on the dendrogram, 2 groups were produced with a coefficient of similarity between groups I and II of 0.735 and the furthest level of similarity, while the closest degree of kinship was 0.92 which was obtained by groups IIIa with IIIb and IVa with IVb. The highest similarity is in groups IIIa and IIIb and groups IVa and IVb have a similarity coefficient value 0.95. The morphological diversity of 39 accessions is a source of cassava germplasm: 37 accessions are harvested for tubers and 2 accessions are harvested explicitly for leaves as vegetables.

AUTHOR CONTRIBUTION

S. designed the research and supervised all processes, L.H. collected data, T.S.W. analyzed the data and wrote the manuscript. E.D. helped write the script.

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CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

REFERENCES

Analianasari, A., Hidayat, B. & Trisnanto, T. B. (2020). Functional Characteristics and Added Value siger Rice Based on Cassava as A Local Food Source. *IOP Conference Series: Earth and Environmental Science*, 411(1). DOI: 10.1088/1755-1315/411/1/012055.

Bruna, R. da S. S., Silva, E. F. R., Cavalcante, Minho, L. A. C., Cardoso, Brandão, G., Santos, A. M. P. dos S., Santos, W. P. C. dos, Lopes Silva, M. V. & Lopes dos Santos, W. N. (2020). Evaluation of The Nutritional Composition in Effect of Processing Cassava Leaves (*Manihot esculenta*) Using Multivariate Analysis Techniques. *Microchemical Journal*, 152, 104271. DOI: 10.1016/j.microc.2019.104271.

Caniago, M., Roslim, D. I. & Herman. (2014). Deskripsi Karakter Morfologi Ubi Kayu (*Manihot esculenta* Crantz) Juray dari Kabupaten Rokan Hulu. *Murtiana*, 1(2), 613–619.

Charles, E. & Mongi. (2015). Penggunaan Analisis Two Step Clustering untuk

Data Campuran Two Step Clustering Analysis for Combination Data. *JdC*, 4(1).

Dahamarudin, L. & M. N. (2009). Eksplorasi dan Konservasi Ex-situ Plasma Nutfah Ubi Kayu Sebagai Upaya Mewujudkan Ketahanan Pangan di Maluku. *Jurnal Agrotropika*, 14(2), 73–80.

Efendi, E. (2015). Efektifitas Sistem Akuaponik Dalam Mereduksi Konsentrasi. *Journal Rekayasa dan Teknologi Budidaya Perairan*, 3,, 2–5.

Fauzi, M., Kardhinata, E. H. & Putri, L. A. P. (2015). Identifikasi dan Inventarisasi Genotip Tanaman Ubi kayu (*Manihot esculenta* Crantz) di Kabupaten Serdang Bedagai Sumatera Utara. *Jurnal Online Agroekoteknologi*, 3(3), 1082–1088.

Firdaus, N. R., Hayati, P. D., & Yusniwati. (2016). Karakterisasi Fenotipik Ubi Kayu (*Manihot esculenta* Crantz) Lokal Sumatera Barat. *Jurnal Agroteknologi*, 10(01), 104–116.

Fukuda, W. M. G., Guevara, C. L., Kawuki, R. & Ferguson, M. E. (2010). Selected Morphological and Agronomic Descriptors for the Characterization of Cassava. International Institute of Tropical Agriculture (IITA). Retrived from https://cassavabase.org/static_content/Fukuda_et_al_2010.pdf.

Haiteng, T., Cui, B., Hongxia, Z., Din, B. A. El. & Feijie, L. (2019). Identification and Characterization of Flavonoids Compounds in Cassava Leaves (*Manihot esculenta* Crantz) by HPLC/FTI-CR-MS. *International Journal of Food Properties*, 22(1), 1134–1145. DOI: 10.1080/10942912.2019.1626879.

Hartati, Aryaningrum, P. D., Hartati, W> N. S. & Sudarmonowati, E. (2015). Karakterisasi Morfologi dan Uji Organoleptik 11 Genotip Ubi Kayu Terseleksi untuk Pangan. *Prosiding Seminar Hasil Penelitian Unggulan Bidang Pangan Nabati. Bioresourses untuk Pembangunan Ekonomi Hijau*, 391–405.

Hasanuddin & Fitriana. (2014). Hubungan Kekerabatan Fenetik 12 Spesies Anggota Familia Asteraceae. *Jurnal EduBio Tropika*, 2(2), 187–250.

Karuniawan, A., Wicaksono, H. N., Ustari, D., Setiawati, T. & Supriatun, T. (2018). Identifikasi Keragaman Genetik Plasma Nutfah Ubi Kayu Liar (*Manihot Glaziovii* Muell) Berdasarkan Karakter Morfo-Agronomi. *Kultivasi,* 16(3), 435–443. DOI: 10.24198/kultivasi.v16i3.14038.

La, D. & Sirappa, M. P. (2009). Eksplorasi Dan Konservasi Ex-Situ Plasma Nutfah Ubikayu Sebagai Upaya Mewujudkan Ketahanan Pangan di Maluku (Exploration and Conservation Ex-Situ Cassava Germ Plasma as Efforts to Actualization in Food Security in Moluccas. *Jurnal Budidaya Pertanian*, 5(1), 61–67.

Laya, A. & Koubala, B. B. (2020). Polyphenols in Cassava Leaves (Manihot esculenta Crantz) and Their Stability in Antioxidant Potential After In Vitro Gastrointestinal Digestion. *Heliyon*, 6(3).

Lestari, T. (2014). Pelestarian Plasma Nutfah Ubi Kayu Lokal Bangka sebagai Diversifikasi Pangan Lokal. *Enviargo, Jurnal Pertanian Dan Lingkungan*, 7(2), 1–48.

Monteros-Altamirano, Á., Tapia, C., Paredes, N., Alulema, V., Tacán, M., Alberto, R., & Marten, S. (2021). Morphological And Ecogeographic Study of The Diversity of Cassava (*Manihot esculenta* Crantz) in Ecuador. Agronomy, 11(9), 1–27. DOI: 10.3390/agronomy11091844.

Nduwumuremyi, A., Melis, R., Shanahan, P. & Theodore, A. (2017). Interaction of Genotype And Environment Effects on Important Traits of Cassava (*Mani-*

hot esculenta Crantz). *Crop Journal*, 5(5), 373–386. DOI: 10.1016/j.cj.2017.02.004.

Nurdjanah, S., Susilawati, S., Hasanudin, U. & Anitasari, A. (2020). Karakteristik Morfologi dan Kimiawi Beberapa Varietas Ubi Kayu Manis Asal Kecamatan Palas, Kabupaten Lampung Selatan Berdasarkan Umur Panen Yang Berbeda. *Jurnal Agroteknologi*, 14(02), 126. DOI: 10.19184/j-agt.v14i02.17383.

Oresegun, A., Fagbenro, O. A., Ilona, P. & Bernard, E. (2016). Nutritional and Anti-Nutritional Composition of Cassava Leaf Protein Concentrate From Six Cassava Varieties For Use in Aqua Feed. *Cogent Food and Agriculture*, 2(1). DOI: 10.1080/23311932.2016.1147323.

Poonsri, T., Jafarzadeh, S., Ariffin, F. & Zainul Abidin, S. (2019). Improving Nutrition, Physicochemical and Antioxidant Properties of Rice Noodles with Fiber and Protein-rich Fractions Derived from Cassava Leaves. *Journal of Food and Nutrition Research*, 7(4), 325–332. DOI: 10.12691/jfnr-7-4-10.

Sari, K. N. (2016). Analisis Kekerabatan Varietas Tanaman Ketela Pohon (Manihot utilisima) Berdasarkan Karakter Morfologi di Wilayah Kabupaten Nganjuk. *Skripsi*. Universitas Nusantara PGRI Kediri.

Sudarmonowati, E., Hartati, N. S., Fathoni, A., & Hartati. (2018). *Perakitan Klon Unggul dan Pemanfaatan Bioresources Ubi Kayu Untuk Mendukung Ketahanan Pangan*. Jakarta: LIPI Press.

Skovmand, J. H. D. I. H. (2000). Characterization of Mexican Wheat Landraces Using Agronomically Useful Attributes. Genet. Res. *Crop Evol*., 47, 591–602.

Sulistiyo, R. H., Soetopo, L., & Damanhuri. (2014). Eksplorasi dan Identifikasi Karakter Morfologi Porang (*Amorphophallus muelleri* B .) di Jawa Timur Eksploration and Identification Morphological Character of Elephant Yam (*Amorphophallus muelleri* B .) in East Java. *Jurnal Produksi Tanaman*, 3(5), 353–361.

Warhamni, D. B. M. (2013). Keragaman Morfologi Ubi Jalar (*Ipomoea batatas* (L.) Lam.) Asal Kabupaten Muna. *J. Agroteknos,* 3, 121–126.

Wijayanto, T., Dirvamena, B. & La, E. (2013). Hubungan Kekerabatan Aksesi Pisang Kepok (*Musa paradisiaca* Formatypica) di Kabupaten Muna. *Agroteknos*, 3(3), 163–169.

Zuraida, N. (2010). Karakterisasi Beberapa Sifat Kualitatif dan Kuantitatif Plasma Nutfah Ubi Kayu (*Manihot esculenta* Crantz). *Bulletin Plasma Nutfah*, 16(1), 49–56.