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CHARACTERISTICS OF 22 CASSAVA (*Manihot esculenta* Crantz) GENOTYPES FROM RIAU PROVINCE, INDONESIA

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SUMMARY

Cassava is a woody herbaceous plant and grows well on low fertility and acidic soils and requires lower labor demand than other major food crops. It has been used by most of the people in the tropical/subtropical countries including Indonesia. We characterized 22 cassava genotypes collected from Riau Province, Indonesia, which were grown from March 2013 to June 2014 at the Biological Research Station, Faculty of Mathematics and Natural Sciences, Riau University, Indonesia. The results showed that genotypes have distinctive characters based on morphological and biochemical traits. In general, the cassava genotypes had relatively low starch content (< 20% in fresh storage roots), intermediate dry matter content (20%-30%), and cyanide compounds ranged between 100 to 200 ppm. Five genotypes were classified as bitter genotypes with high cyanide (> 300 ppm). Hijau was categorized as a sweet genotype with the lowest levels of cyanide (≤ 100 ppm). Pucuk Hitam had the highest content of starch (21.7%) and dry matter (38.9%). Seven genotypes, such as Sayur, Juray, Kuning, Hijau, Pulut Bengkalis, Pucuk Hijau, and Okulasi produced flowers and seeds. At the 48% similarity coefficient, all genotypes clustered into 3 groups. Moreover, most of the bitter ones clustered in the same group. Such genetic variability may be used through cassava breeding program.

Key words: Cyanide, dry matter, genetic variability, *Manihot esculenta*, morphological, Riau, starch content

Key findings: Twenty two cassava genotypes from Riau Province were characterized and had distinctive characters. Some of them produced flowers and seeds, had high content of starch and dry matter, and low cyanide compounds level. These traits are important for cassava breeding programs.

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INTRODUCTION

Cassava has long been used by Indonesian peoples such as in Papua and Gunung Kidul as a staple food, but eventually it has eroded by modernization and replaced by rice. Currently, food diversification is warranted to support sustainability of agriculture and food security.

The main goal of food diversification is to reduce the dependence upon rice and enhance the use of corn, sago, and tubers (potato, sweet potato, and cassava).

Cassava is a woody shrub tolerant to prolonged drought (El-Sharkawy, 1993) and performs well on low fertility acidic soils, requiring low labor demand than other major food crops (Scott *et al*., 2002; Howeler, 2006). It produces storage roots rich in dietary carbohydrate which can be cooked and consumed fresh by humans when low in cyanogenic glucosides (CG). It can also be processed (when high in CG) into various starch-based food and industrial products such as medicine, cosmetics, and biopolymers (Tonukari, 2004), animal feeds, and bioethanol (El-Sharkawy, 2003; Nassar and Ortiz, 2010; Nuwamanya *et al*., 2011; Marx and Nquma, 2013). For those utilities, contents of starch, dry matter, and CG in cassava storage roots are important selection criterion in breeding programs (Jennings and Iglesias, 2002; Mohamed *et al*., 2009). The starch and dry matter contents affect the quality of starch products and postharvest shelf-life of harvested storage root, whereas the level of CG determines the bitterness of roots and other parts of the plant, particularly high protein leaves, that are oftenly consumed as human food in Africa and South America (Lancaster and Brooks,1983).

As the contents of those biochemical characters in genotypes vary, it was suggested that a threshold of 17% starch is good for multiple purposes (Jennings and Iglesias, 2002). The starch content in Indonesian varieties, such as Adira 4 and Kaspro are medium (around 20%) in fresh roots (Prasetiaswati *et al*., 2012). The dry matter content in some varieties are high, approximately 39.5% in Adira 4, 46.3% in UJ5, and 43.1% in Malang 6 (Solihin, 2012). The level of CG in several varieties, such as Adira 2, Malang 4, and Malang 6, are high, around 100 to 200 ppm (Suhartina, 2005). When CG is above 40 mg/kg of fresh roots (Irtwange and Achimba, 2009), it causes bitterness and poisoning in absence of adequate processing.

Cassava CGs are linamarin and lotaustralin species (Siritunga and Sayre, 2003). Although CGs may have a role in plant defense against pests (Bellotti and Riis, 1994), a high content is not desirable for health hazards (Priyadharsani *et al*., 2004; Mburu *et al*., 2012). Therefore, it is warranted to study the morphological and biochemical traits of local cassava germplasm in order to enhance the development of improved cultivars via breeding programs (Nassar, 2004).

METHODS

Plant Materials

The plant material used in this study included 22 cassava genotypes (Table 1). They were collected from several areas in Riau Province of Indonesia and grown at the Biological Research station, Faculty of Mathematics and Natural Sciences, Riau University, Indonesia which was 34% sand, 36% silt, 30% clay, and pH 4.0. Seven plants for each genotype were planted vertically using ridged woody stem cuttings containing at least 3 nodes with axillary buds. Each genotype was planted in a row with 1 m spacing between plants and 1 m between rows.

Table 1. Common names of 22 cassava genotypes along with their origin.

No.	Common name	Origin (sub-district, district)	No.	Common name	Origin (sub-district, district)
1	Ubi Medan	Pasir Pangarayan, Rokan Hulu	12	Ubi Jari Tangkai Merah	Langgam, Pelalawan
2	Ubi Roti Rohul	Pasir Pangarayan, Rokan Hulu	13	Ubi Emas	Mandau, Bengkalis
3	Ubi Sayur	Pasir Pangarayan, Rokan Hulu	14	Ubi Lambau	Mandau, Bengkalis
4	Ubi Juray	Pasir Pangarayan, Rokan Hulu	15	Ubi Menggalo	Mandau, Bengkalis
5	Ubi Cita	Pasir Pangarayan, Rokan Hulu	16	Ubi Pulut Bengkalis	Mandau, Bengkalis
6	Ubi Lurus	Pujud, Rokan Hilir	17	Ubi Okulasi	Kulim, Pekanbaru
7	Ubi Keriting	Pujud, Rokan Hilir	18	Ubi Pucuk Hitam	Kuantan Tengah, Kuantan Singingi
8	Ubi Roti Pelalawan	Langgam, Pelalawan	19	Ubi Bangka	Kuantan Tengah, Kuantan Singingi
9	Ubi Hijau	Langgam, Pelalawan	20	Ubi Pulut Kuansing	Kuantan Tengah, Kuantan Singingi

No.	Common name	Origin (sub-district, district)	No.	Common name	Origin (sub-district, district)
10	Ubi Kuning	Langgam, Pelalawan	21	Ubi Roti Kuansing	Kuantan Tengah, Kuantan Singingi
11	Ubi Jari Tangkai Putih	Langgam, Pelalawan	22	Ubi Pucuk Hijau	Kuantan Tengah, Kuantan Singingi

Morphological Characters Analysis

Observations of morphological characters were carried out at 5 months after planting. Days to flower and morphology of flower were observed at the time to flower. The storage roots were harvested at 12 months after planting then observed. All data which involved stem diameter (1 m above soil surface), plant height, internode length, petiole length, size of lobe, length and width of the central leaf lobe were measured from 10 samples that were taken from 7 plants and then averaged.

Analysis of Starch and Dry Matter Contents of the Fresh Stoarge Roots

The starch and the dry matter contents of storage roots were determined on each genotype using the specific gravity method (Kawano *et al*., 1987; Teye *et al*., 2011) with slight modifications. Each freshly harvested roots were cleaned and weighed in air (Wa), then in 1100 grams of water (Wb). The weight in water (Ww) was calculated as: Ww = Wb - 1100. Root specific gravity (Sg), starch content (%), and dry matter content (%) were determined following Kawano *et al*. (1987). Specific gravity (Sg) was calculated with this formula: Sg = Wa/(Wa - Ww). The Sg value subsequently converted into starch content (Y) using the formula: Y = (112.1 x Sg) - 106.4; and dry matter content (DM) using the formula: DM = (158.3 x Sg) - 142.

Analysis of CG Content of the Fresh Tubers

Harvested storage roots were peeled and 2 grams from pulp were ground using mortar and pestel. After that, 15 ml of distilled water was added then centrifugation at 3000 rpm for 15 minutes was performed. The pellet was dissolved in 100 ml of distilled water for determining CG using silver nitrate volumetric method in duplo (Tanya *et al*., 1997) at Environmental Forensics Laboratory, Department of Chemistry, Faculty of Mathematics and Natural Science, Riau University.

Data Analysis

Data were used to calculate and to create the genetic similarity matrix using the Simple Matching coefficient. Thereafter, the genetic similarity matrix was used for cluster analysis based on UPGMA (Unweighted Pair Group Method with Arithmetic) using NTSYSpc version 2.02i software. In addition, Pearson correlation analysis and principal components analysis (PCA) were performed based on the covariance matrix using Minitab version 16 software.

RESULTS

Characteristics of Local Cassava Genotypes

Generally, cassava genotypes collected from Riau Province had the following morphological characteristics (in % of total accessions): ungrooved greenish-yellow stem (36.4%), medium stem diameter (12-25 mm) (77.3%), 3 subsequent branching levels (forking) (50.0%), and very tall plant (> 250 cm) (90.9%). The internode length was about 3-5 cm (81.8%). Foliar scar as circle half (72.7%) and prominent (68.2%). Greenish red petiole (27.3%) or purple (27.3%) and its length > 20 cm (50%). The young leaves were light green (54.5%) and the mature leaves were dark green (59.1%). The leaf lobes were ovoid (40.9%) and lanceolate (31.8%) with the tip become pointed (90.9%), $4.0 < L \leq 5.0$ cm of wide (40.9%), and $15.0 < P \leq 20.0$ cm of length (54.5%). The storage root was conical-cylindrical (90.9%) with light brown peel (50.0%) and white or cream cortex (54.5%). The cortex was thin (1-2 mm) and was easy to be peeled off. White storage root pulp (95.5%) and sweet with low CG (81.8%). There were 7 (31.8%) genotypes producing flowers and seeds: Sayur, Juray, and Kuning (10 months after planting), Hijau (9 months after planting), Pulut Bengkalis, and Pucuk Hijau (7 months after planting), and Okulasi (2 months after planting) (Table 2).

Table 2. The phenotypes frequency of 22 cassava genotypes from Riau Province of Indonesia.

No	Characters	Phenotypes	Number	Frequency (%)
1	Color of stem exterior, one meter obove ground surface	orange	1	4.5
		greenish yellow	8	36.4
		golden	3	13.6
		green	2	9.1
		silver	3	13.6
		gray	3	13.6
		dark brown	2	9.1
2	Stem diameter	medium	17	77.3
		large	5	22.7
3	Stem profile	grooved	10	45.5
		not grooved	12	54.5
4	Plant type	branching	17	77.3
		not branching	5	22.7
5	Number of branching level	one	6	27.3
		two	3	13.6
		three	11	50.0
		more than three	2	9.1
6	Plant height	tall	2	9.1
		very tall	20	90.9
7	Internode length	short	18	81.8
		intermediate	4	18.2
8	Foliar scar shape	like circle half	16	72.7
		form a circle	5	22.7
		sixangle	1	4.5
9	Petiole color	yellowish green	4	18.2
		green	2	9.1
		reddish green	3	13.6
		greenish red	6	27.3
		red	1	4.5
		purple	6	27.3
10	Petiole length	intermediate	4	18.2
		long	7	31.8
		very long	11	50.0
11	Color of bractea at the base	red	12	54.5
		green	10	45.5
12	Color of apical or young leaves	light green	12	54.5
		dark green	2	9.1
		purplish green	6	27.3
		purple	2	9.1
13	Color of the fifth or mature leaves	light green	6	27.3
		dark green	13	59.1
		purplish green	2	9.1
		variegate green-yellow	1	4.5
14	Central lobe shape	ovoid	9	40.9
		elliptic lanceolate	1	4.5
		obovate lanceolate	2	9.1
		lanceolate	7	31.8
		pandurate	1	4.5
		linear pandurate	1	4.5
		wrinkle	1	4.5
15	Number of lobes	three	2	9.1
		six	1	4.5
		seven	16	72.7

No	Characters	Phenotypes	Number	Frequency (%)
		nine	3	13.6
16	Size of lobe	wide	18	81.8
		narrow	4	18.2
17	Lobe tip shape	become pointed	20	90.9
		pointed	2	9.1
18	Tuber shape	conical cylindrical	20	90.9
		irregular	2	9.1
19	Cortex thickness	very thin	1	4.5
		thin	20	90.9
		intermediate	1	4.5
20	External color of tuber	yelow	1	4.5
		light brown	11	50.0
		dark brown	10	45.5
21	Cortex color	white or cream	12	54.5
		yellow	1	4.5
		pink	4	18.2
		purple	5	22.7
22	Tuber pulp color	white	21	95.5
		yellow	1	4.5
23	Starch content	low	21	95.5
		intermediate	1	4.5
24	Taste of cooked tuber	bitter	5	22.7
		not bitter	18	81.8
25	Cortex removement	easy	19	86.4
		difficult	3	13.6
26	Cyanide content of fresh tuber	low, ≤ 100	1	4.5
		little high, $100<CN^{-}\leq 200$	13	59.1
		high, $200<CN^{-}\leq 300$	4	18.2
		very high, $300<CN^{-}$	4	18.2
27	Leaf vein color on the basal of the upper leaf surface	pink	5	22.7
		red	8	36.4
		light green	3	13.6
		green	3	13.6
		yellowish green	1	4.5
		yellow	2	9.1
28	Leaf vein color on the basal of the beneath leaf surface	pink	6	27.3
		red	7	31.8
		light green	3	13.6
		green	2	9.1
		yellowish green	1	4.5
		yellow	3	13.6
29	Central leaf lobe width (cm)	$1,0<L\leq 2,0$	3	13.6
		$2,0<L\leq 3,0$	2	9.1
		$3,0<L\leq 4,0$	5	22.7
		$4,0<L\leq 5,0$	9	40.9
		$5,0<L\leq 6,0$	3	13.6
30	Central leaf lobe length (cm)	$P<5,0$	1	4.5
		$10,0<P\leq 15,0$	7	31.8
		$15,0<P\leq 20,0$	12	54.5
		$20,0<P$	2	9.1
31	Prominence of foliar scars	semi-prominent	7	31.8
		prominent	15	68.2
32	Dry matter content	low	3	13.6
		intermediate	17	77.3
		high	2	9.1
33	Flowering time	identified	7	31.8
		not identified	15	68.2

Lurus was the tallest (393.6 cm), whereas Pulut Kuansing was the shortest (226.0 cm). The largest stem diameter, the longest petiole, and the thickest cortex were found, respectively, in Lurus (3.8 cm), Menggalo (32.8 cm), and Hijau (2.5 mm). In contrast, the smallest stem diameter, the shortest petiole, and the thinnest cortex were found, respectively, in Bangka (1.6 cm), Juray (9.8 cm), and Cita (0.5 mm) (Table 3).

The genotypes predominatly had relatively low starch content (less than 20%), intermediate dry matter content (20% -30%), and CG ranging between 100 ppm to 200 ppm on fresh weight basis (Table 3). Bitter-tasted storage roots with very high CG (> 300 ppm) were in Lurus, Keriting, Okulasi, and Pulut Kuansing. The remaining accessions were sweet containing low CG (≤ 100 ppm) with Hijau the lowest (84.126 ppm). Pucuk Hitam had the highest starch (21.7%) and dry matter (38.9%). Sayur also had high dry matter content up to 35.9% (Table 3).

Table 3. The average of several characters in 22 cassava genotypes of Riau Province.

Common name	Plant height (cm)	Stem diameter (cm)	Petiole length (cm)	Cortex thickness (mm)	Cyanide level (ppm)	Starch content (%)	Dry matter content (%)
Medan	242.1	2.45	15.5	1.5	177.0417	8.5	20.3
Roti Rohul	269.1	2.32	24	1.5	134.3696	8.8	20.7
Sayur	258.8	2.30	15.4	1.5	102.5994	19.6	35.9
Juray	362.0	3.40	9.8	1.0	143.5452	8.5	20.5
Cita	266.7	2.20	20.8	0.5	189.6808	10.9	23.7
Lurus	393.6	3.80	29	2.0	312.8535	14.9	29.2
Roti Pelalawan	276.9	2.80	22	2.0	131.3503	9.9	22.2
Hijau	295.1	2.20	16.4	2.5	84.1263	10.1	22.5
Kuning	259.6	2.15	17.7	1.0	156.1149	10.2	22.7
Jari Tangkai Putih	271.4	2.10	13.1	1.0	131.1997	11.8	24.9
Jari Tangkai Merah	364.3	2.80	19.6	1.0	121.2838	8.8	20.7
Keriting	262.4	3.20	20.1	2.0	400.6378	9.2	21.3
Emas	294.0	2.27	27.1	2.0	158.9422	6.8	17.8
Lambau	262.0	2.03	23.8	1.5	226.9254	8.7	20.6
Menggalo	306.0	2.17	32.3	1.5	296.5565	8.3	19.9
Pulut Bengkalis	293.0	1.90	21.2	2.0	134.3251	9.3	21.4
Okulasi	334.0	2.20	17.8	2.0	338.3695	7.4	18.7
Pucuk Hitam	248.0	2.30	21.6	1.5	144.9476	21.7	38.9
Bangka	252.0	1.60	23.9	1.0	175.5494	13.3	27.1
Pulut Kuansing	226.0	2.26	20.3	1.0	300.7687	14.2	28.3
Roti Kuansing	280.0	2.00	19.6	1.5	216.3394	11.3	24.3
Pucuk Hijau	288.0	2.26	21.6	1.0	216.2319	10.8	23.5

Clustering Patterns

Generally, level of genetic diversity of germplasm from Riau Province is moderate, approximately 55%. Three groups of genotypes were clasified by cluster analysis, but they were not clustered according to their origin. Group I consisted of 16 genotypes, group II with 4 genotypes, and group III with 2 genotypes. The members of group II were the bitter-tasted Lurus, Keriting, Okulasi, and Pulut Kuansing (Figure 1).

The smallest genetic similarity coefficient (33%) was found between some genotypes. In contrast, the greatest genetic similarity coefficient approximately 79% was found between the Pucuk Hijau with Pulut Bengkalis cassavas. The results also showed that some genotypes had the same common name, namely Roti Rohul, Roti Pelalawan, and Roti Kuansing, as well as Pulut Bengkalis and Pulut Kuansing.

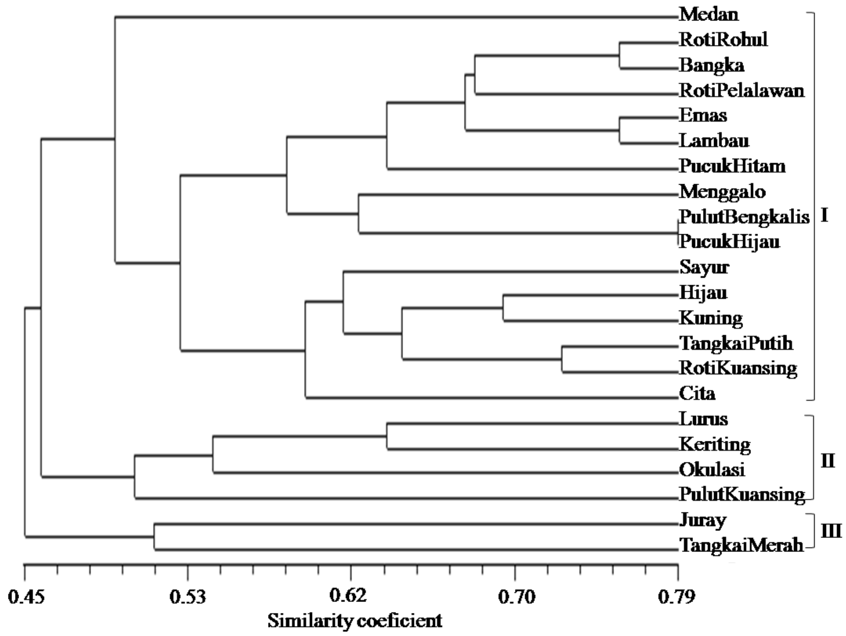

Figure 1. Dendrogram showing the genetic similarity among 22 genotypes of cassava from Riau Province of Indonesia based on morphological and biochemical traits using the simple matching coefficient with UPGMA method.

Correlation Analysis between Characters

Correlation analysis showed that 2 characters were correlated negatively, such as the type of plant with number of branching level (r = -0.877, $P < 0.000$) and sweetness of cooked storage root with CG level (r = -0.840, $P < 0.000$).

Principal Components Analysis

Principal components analysis designated 10 major components with eigen value more than one. These can explain 84.6% of the variability which included 22 characters. Six characters were on PC1, 4 on PC2, 3 on PC3 and PC4, 2 on PC5 and PC6, and 1 on PC8 and PC10 (Table 4).

PC1 included the petiole color, the basal bractea color, the apical or young leaves color, the central leaf lobe shape, leaf vein color on the basal of the upper and the lower of the leaf surface. PC2 involved plant type, taste of the cooked storage roots, CG of the fresh pulp, and the dry matter content based on specific gravity. The remaining PCs involved plant height, stem profile, number of leaf lobes, size of central lobe, shape of tip lobe, tuber shape, peel color, cortex color, pulp color, dry matter content, cortex separation, and prominence of foliar scars (Table 4).

DISCUSSION

Cassava cross-pollination systems, whether naturally or manually, requires genotypes that produce flowers and seeds. Seven genotypes from Riau Province that can produce flowers at the age of no more than 12 months after planting have been identified. These are potentially valuable as parental materials in breeding programs. The remaining 15 nonflowering genotypes may be propagated as clones for their delicious flavor of cooked roots, young leaves, and sweetness.

In case grafting is considered viable and commercially practical system, the eleven sweet genotypes such as Medan, Roti Rohul, Cita, Roti Pelalawan, Jari Tangkai Putih, Jari Tangkai Merah, Emas, Lambau, Pucuk Hitam, Bangka, dan Roti Kuansing may be used as rootstocks.

Conversely, bitter-tasted Lurus, Keriting, Menggalo, dan Pulut Kuansing may be used as scions.

One genotype that had yellow pulp, namely Medan, may be a good source for ß-carotene to enrich cassava roots for vitamin A. The result is in agreement with Mezette *et al*. (2013) that the color of pulp and root cortex was predominantly white and cream.

Morphological characterization has been used to analyze the genetic diversity of cassava germplasm (Mezette *et al*., 2013; Asare *et al*., 2011) because it is relatively cheaper, easier, and faster than other techniques like biochemical or molecular. On the other side, morphological characteristic can be correlated to the agronomic traits for preliminary evaluation. But, biochemical characterization is also important because it relates to the usefulness of cassava in human life (Tonukari, 2004; Demiate and Kotovicz, 2011; Ebah-Djedji *et al*., 2012).

The most important of biochemical characters are starch, dry matter, and CG contents in storage roots and they vary among cassava varieties. Therefore, high starch content, high dry matter content, and low CG represent major goals of the cassava breeding program (Kizito *et al*., 2007).

In cassava storage roots, the starch content is 70%-90% of dry weight (Baguma, 2004). Due to the high amount of starch content and also the adaptability of cassava to grow and produce well on marginal soils, it became a target to supply the growing demand of starch, particularly in view of the great increase of human population in tropical/subtropical regions.

Table 4. The 10 major components showing the contribution of morphological and biochemical characters to total variation of 22 cassava genotypes from Riau Province of Indonesia.

Characters	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
Stem profile	0.19	0.07	0.07	0.07	-0.19	0.12	-0.21	-0.20	-0.02	0.42
Plant type	0.05	-0.29	-0.22	0.08	-0.26	-0.09	-0.15	-0.11	0.20	0.07
Plant height	-0.07	0.05	-0.28	0.12	-0.32	0.08	0.38	0.08	-0.01	-0.04
Petiole color	0.31	-0.09	0.08	0.10	-0.19	-0.08	0.08	0.02	0.02	0.18
Color of bractea at the base	-0.29	0.09	-0.26	0.08	-0.01	0.06	-0.12	0.03	0.11	0.00
Color of apical or young leaf	0.23	0.07	0.04	-0.25	-0.26	-0.04	0.07	0.22	-0.18	-0.16
Central lobe shape	-0.25	0.03	0.15	-0.22	-0.13	0.18	0.19	-0.26	-0.02	0.01
Number of leaf lobes	-0.02	-0.17	0.33	0.00	-0.15	0.14	-0.07	-0.02	-0.02	0.09
Size of leaf lobe (cm)	-0.15	-0.14	0.29	0.11	-0.11	0.27	-0.15	0.09	-0.09	0.30
Lobe tip shape	-0.17	0.09	0.25	0.07	-0.24	-0.05	0.18	-0.30	0.11	-0.14
Tuber shape	-0.15	-0.10	0.19	-0.36	0.14	-0.06	0.04	0.26	0.11	0.14
External tuber color	0.01	-0.08	0.15	0.35	0.01	-0.07	-0.27	0.23	-0.03	-0.26
Cortex color	0.14	-0.07	0.06	-0.08	0.36	0.18	0.19	-0.26	-0.09	0.17
Tuber pulp color	-0.02	-0.04	0.14	-0.39	0.12	-0.28	-0.13	0.21	0.17	0.04
Starch content based on specific gravity (%)	0.12	-0.06	0.14	0.10	0.32	0.00	-0.11	-0.29	0.15	-0.17
Taste of cooked tuber	0.12	-0.35	-0.03	-0.10	0.01	-0.04	0.32	0.02	-0.01	0.03
Cortex removement	0.01	0.12	0.09	0.05	-0.21	-0.40	0.13	-0.29	-0.24	-0.02
Cyanide content of fresh tuber (ppm)	-0.08	0.37	0.02	0.09	0.05	0.07	-0.26	-0.10	0.13	-0.04
Leaf vein color on the basal of the upper leaf surface	-0.28	-0.15	-0.15	-0.06	-0.07	0.10	-0.15	-0.07	-0.38	-0.14
Leaf vein color on the basal of the lower leaf surface	-0.33	-0.12	-0.12	0.07	-0.01	0.08	-0.17	0.11	-0.20	-0.10
Prominence of foliar scars	0.07	-0.15	-0.09	0.09	0.02	0.44	0.25	0.08	0.38	-0.10
Dry matter content based on specific gravity (%)	0.03	-0.29	0.14	0.15	0.18	-0.14	0.00	-0.14	0.15	-0.35
Eigen value	5.94	4.22	3.52	3.13	2.80	2.16	1.87	1.57	1.36	1.34
% Variance	0.18	0.13	0.11	0.10	0.09	0.07	0.06	0.05	0.04	0.04
Cumulative Variance	0.18	0.31	0.42	0.51	0.59	0.66	0.72	0.76	0.81	0.85

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