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Short Communication: Digital identification approach to characterize *Hevea brasiliensis* leaves

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Abstract. *Pratomo B, Lisnawita, Nisa TC, Basyuni M. 2021. Short Communication: Digital identification approach to characterize* Hevea brasiliensis *leaves. Biodiversitas 22: 1006-1013.* The purity of clones is a key factor to obtain uniform growth of *Hevea brasiliensis* Muell Arg in the field. Crop uniformity has an impact on production patterns that can be predicted in latex content. Basically, H. brasiliensis tree leaves show similarities to each other such as the color, texture, or shape of the leaves. Identification of clones that have been very common by the morphology of *H. brasiliensis* leaves. This study links the results of previous research on digital methods used. A total of 27 clones were sampled in this study which came from the garden collection of entres, which can be used as a source of elders for assisted pollination or source of planting materials for the needs of production-scale seeds in the field. Here, we used a database of 540 leaves from 27 clones and 10 quantitative characters to address these issues The analysis data used a randomized complete block design (RCBD) factorial. The result showed the identification method digitally on characterizing of leaves by using Software Adobe Photoshop, depicting that the characteristics contained in *H. brasiliensis* leaves are very proper to be used as the first character in identifying an *H. brasiliensis* clone. The present work provided a piece of important information on the characterization of *H. brasiliensis* leaves to enhance the selection of parent clones.

Keywords: Characterize, clones, *Hevea brasiliensis*, identity, leaves

INTRODUCTION

The number of plant species or flora in Indonesia is abundant and their richness is unquestioned. Almost every region in Indonesia has one or more typical plants that may not exist in other countries. In increasing the potential diversity of tropical plant resources, good biodiversity management and utilization are required. Based on such diversity, the classification of plants becomes a challenge (Hidayat et al. 2018). In manual identification, special plant characteristics are determined as those that help in identifying the intended plant species. Conventional plant species identification methods (Kaur and Kaur 2019) seem impractical to ordinary people and are a challenge for professional taxonomy as well. Manual identification is often time-consuming and inefficient.

Since the traditional identification methods are strenuous, there arises a need to automate the process of species identification. Scientific and technological challenges in identifying species (Kolivand et al. 2018) or even subs below them such as varieties or clones of plants, against a wide variety of plants and countless taxonomic characteristics. The conditions of equatorial tropical forests have a high diversity of plants (Bruno et al. 2008), making traditional and very special taxonomic techniques difficult, slow, as most later manuals. Thus, researchers have tried to develop a system of identification and classification of plant species that can be used as a purpose of species recognition to some extent (Ghasab et al. 2015; Goyal and Kumar 2018).

In this digital era, smartphones and digital cameras are widely found and available to everyone. Digital images (Cerutti et al. 2013) have become an indispensable element of several fields, including facial recognition, plant recognition, and health informatics, computer vision (Valliammal and Geethalakshmi 2012). In addition, the development of technology (Bakhshipour and Jafari 2018) in the field of image processing and toolboxes available to implement it has aimed to automate the process of species identification. The most common way to recognize between one plant and another is to identify the leaves of each plant. Leaf-based classification is the most effective alternative and way to implement because the leaves will be there all the time, while fruits and flowers may only exist at any given time.

Nowadays the classification of plants is being carried out by computational models of leaf recognition systems. Most plant species have unique leaves that differ from each other based on characteristics such as shape, color, texture, and margin (Thibaut et al. 2011; Casanova et al. 2012). Databases for *Hevea brasiliensis* Muell Arg. tree species need to be set up to preserve the type of clones and as a source of elders for breeding programs. Introduction of plants through leaf shapes using image processing as initial processing inputted leaf images (Kaur and Kaur 2019) converted into binary images will then be further processed to find features (Wirdiani and Sudana 2016). Many methods can be used to calculate the extraction of features as well as the introduction of plants by identifying the shape (Agus et al. 2015, Pallavi and Devi 2014), segment (Lee and Hong 2013), color (Trishen et al. 2015), and leaf texture (Bhardwaj et al. 2013; Kadir et al. 2012).

Suhendry and Pasaribu (2009) studied the identification of *H. brasiliensis* clones through quantitative characteristics of *H. brasiliensis* leaves from several clones on some growth stadia. The purity of a clone plays a role in the uniformity of growth in the field on *H. brasiliensis* plantations. If the crop condition from various clones, it will produce a variety of *H. brasiliensis* planting growth. This present study aimed to evaluate the digital method to identify the characterization of the *H. brasiliensis* leaves a sample of the clones.

MATERIALS AND METHODS

Plant materials

The plant materials used as samples in this study came from the garden collection of PT Socfin Indonesia, Tanah Besih, Tebing Syahbandar, Serdang Bedagai Regency, North Sumatra Province, Indonesia. These sampling sites were located at 3°19.579' north latitudes and 99°12.971' east longitudes. The sample consisted of 27 clones of entres namely IRR 5, PB 217, PB 340, IRCA 18, IRCA 19, IRCA 41, IRCA 101, IRCA 130, IRCA 230, IRCA 317, IRVA 331, IRCA 427, IRCA 804, GT 1, IRR 220, IRR 221, IRR 429, IRR 440, PB 260, PC 10, PM 10, PR 300, RRIC 100, RRIM 901, RRIM 908, RRIM 921 and RRIM 2020. Each clone is taken as long as 20 strands of the middle leaf, from the trifoliate of *H. brasiliensis* leaves, considering the previous method described by (Suhendry and Pasaribu 2009; Pasaribu and Suhendry 2018) based on the variations between strands were not real, the size of the dominant middle leaf was larger than other leaf strands. Leaves that do not grow normally in shape and size, and disproportionately the breadth between each leaf in one stalk, are not used as a sample. The present study referred to the previous research that is distinguished using samples from a larger number of clones and repeated to validate obtained data for better and reliable results (Pasaribu and Suhendry 2018).

Measurement techniques

Each of the Sample leaves of 20 strands was randomly taken from 27 clones are planted on entres plantation. The abnormal leaves that have a disproportionate size and shape of strands were not selected as a sample. The middle leaf is separated from the stalk, given an identity number then the leaf is transferred into digital format through a scanner. With the help of Adobe Photoshop Software series 6, the leaves are cropped and measured the parameters of the marker. The scanned leaves are then manually extracted according to the same identity recorded on the computer.

In this research, the same activity was measured at several parameters. The three main quantitative characters used as parameters in this study are the size of the length, maximum leaf width, and angle on some parts of the leaves. Of the three main quantitative characters developed various sizes in Table 1.

Data analysis

Data analysis to determine the influence of clones (K), quantitative characters (C), and interactions between K x C was conducted through a diversity analysis of RandomIzed Design Factorial Group (RCBD), where the number of leaves became a crosser. the following linear models are used in the analysis:

$$Y_{ijk} = \mu + D_k + K_i + C_j + K_iC_j + E$$

Note: Yijk was a response caused in the research unit that includes a combination of factors of the number of clones as much as I level and quantitative character as much as j level with a repeat in the form of the number of leaves as much ask level. D = leaf strand (repeat), K = number of clones, C = quantitative character, KC = interaction factor of clones and characters, and E = error.

Table 1. Various quantitative characters

Quantitative characters	Explanation
Leaf length (P)	It is measured by centimeter-scale from the lower end of the leaf (base) to the upper end of the leaf (musty)
Center point (TP)	It is half the length of the leaf
Leaf folding point (TL)	Location of the leaf folding point is the bone length of the leaf from the point of the fold at the maximum leaf width towards the musty
Width of the leaf (L)	It is measured by a centimeter-scale at the maximum leaf width
Widht of the left leaf strand of the vein (HKr)	It is measured at the maximum leaf width position from the left edge boundary of the leaf to the bone of the middle leaf
The angle of the natural base (B)	It is measured by using a bow at the bottom of the leaf following the border of the leaf edge with the center point of the bow at the base of the stalk of the leaf strands
The angle of the natural apex (A)	It is measured in the same way as the center of the bow at the tip of the leaf
The angle of the vein (V)	The angle of the vein against the leaf bone is the large angle between the veins against the leaf bone measured in one of the veins that are around the folding point of the leaf
The angle of the kite base (BL)	It is an angle formed from the base of the stalk of the leaf strands to the outer side of the leaf at the maximum leaf width
The angle of the kite apex (AL)	It is an angle formed from the tip of the leaf strands to the outer side of the leaf at the maximum leaf width

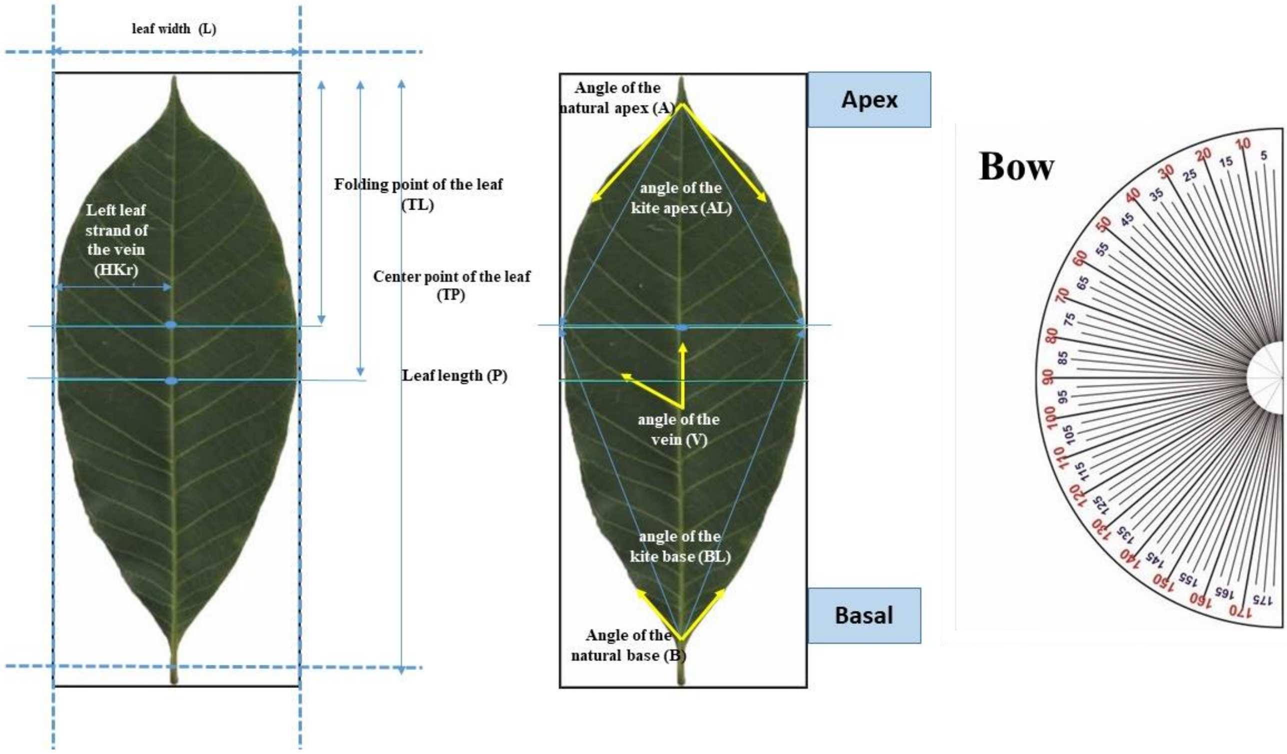

Figure 1. Points of measurement quantitative character of *Hevea brasiliensis* leaves

RESULTS AND DISCUSSION

Results

Table 1 shows the results of the analysis of variance from some factor, clones (K), quantitative character (C). The R-Square value of 0.90 emphasized that the experimental model used the closer the number one will be the better. The coefficient variation of data analysis results is also in a good range with a value of 23.78. Then based on probability results stated that both factor K and C and interaction both have a very real effect (<.0001). This explains that 10 quantitative characters of *H. brasiliensis* leaves can be used for the identification of tested *H. brasiliensis* clones. Analysis data in Table 1 is processed from 27 clones with 10 quantitative characters and repeated 3x, then there are 5400 data processed. Complete data on the average of quantitative characters of 27 clones were depicted in Table 2-5. The method of measurement displayed in Figure1 is illustrated with 10 different quantitative characters of the *H. brasiliensis* leaf.

Tabel 7 derived from the multiplication of length mean and width mean of leaves, as the main quantitative characters. Since the multiplication is not a rectangle, the term"approximate" is used. Table 6 described that RRIM 908 is the largest leaves (371.160) as mean and from all clones from table 2 until table 5, as not identified clones type. Another type of slow starter represented by PB217 (312.732) and PB 340 (346.045) is the largest from quick starter clones.

Tabel 2. Analysis of variance (ANOVA) procedure

Source	dF	SS	MS	FV	Pr > F
block	19	1162.495	61.184	0.890	0.5971
K	26	20806.493	800.250	11.630	<.0001
C	9	3062627.156	340291.906	4945.100	<.0001
K*C	234	102845.018	439.509	6.390	<.0001
Error	5111	351707.877	68.814		
Corrected Total	5399	3539149.039			
R-Square	0.90				
Coefficient Variation	23.78				

Note: dF: the degree of freedom, SS: the sum of squares, MS: mean square, FV: F value, Pr: probability

Tabel 3. Means of the quantitative character of *Hevea brasiliensis* leaves

Quantitative character	Clones of *H. brasiliensis* plant from the entres collection plantation						
	SS						QS
	GT1	IRCA 41	PB 217	PR 300	RRIC 100	RRIM 921	IRCA 18
Leaf length (P)	23.195	22.570	28.950	28.360	22.444	21.558	29.637
Leaf width (L)	7.487	9.100	10.803	9.195	8.264	8.288	10.431
Left leaf strand of the vein (HKr)	3.741	4.562	5.404	4.807	4.335	4.414	5.236
Folding point of the leaf (TL)	9.482	9.641	14.016	11.598	10.057	9.294	13.164
Center point of the leaf (TP)	11.601	11.273	14.457	14.229	11.334	11.004	14.831
The angle of the natural base (B)	57.136	68.870	82.150	50.562	74.208	56.060	68.472
The angle of the natural apex (A)	61.455	80.930	63.580	63.324	74.396	79.502	69.347
The angle of the vein (V)	55.114	57.875	56.863	54.710	55.917	55.372	65.353
The angle of the kite base (BL)	33.364	42.398	44.348	33.167	38.771	39.690	38.969
The angle of the kite apex (AL)	44.886	53.993	45.350	46.043	46.731	49.222	44.494

Note: SS is Slow Starter Clones, QS is Quick Starter Clones

Tabel 4. Means of the quantitative character of *Hevea brasiliensis* leaves from Quick Starter (QS) Clones type

Quantitative character	Clones of *H. brasiliensis* plant from the entres collection plantation						
	IRCA 19	IRCA 101	IRCA 130	IRCA 230	IRCA 317	IRR 5	IRR 220
Leaf length (P)	30.306	28.545	25.038	22.640	22.996	29.959	23.790
Leaf width (L)	9.502	10.815	9.814	8.531	8.633	10.076	8.086
Left leaf strand of the vein (HKr)	4.752	5.403	4.907	4.297	4.317	5.038	4.029
Folding point of the leaf (TL)	14.043	11.858	10.718	10.263	10.249	13.216	10.976
Center point of the leaf (TP)	15.152	14.270	12.519	11.322	11.476	14.982	12.029
The angle of the natural base (B)	68.977	75.091	62.409	65.450	65.064	62.992	54.691
The angle of the natural apex (A)	58.159	80.466	82.161	72.688	73.598	59.984	66.122
The angle of the vein (V)	65.000	64.341	63.864	58.375	60.345	63.994	55.218
The angle of the kite base (BL)	34.175	39.761	42.795	60.500	40.421	37.101	37.819
The angle of the kite apex (AL)	38.734	50.091	48.722	46.650	49.851	43.485	42.763

Tabel 5. Means of the quantitative character of *Hevea brasiliensis* leaves from Quick Starter (QS) and unidentified clones

Quantitative character	Clones of *H. brasiliensis* plant from the entres collection plantation						
	QS			Unidentified clones type			
	IRR 221	PB 260	PB 340	RRIM 901	IRCA 331	IRCA 427	IRCA 804
Leaf length (P)	23.231	29.116	30.517	22.521	24.874	22.563	25.782
Leaf width (L)	8.933	10.989	11.339	8.820	8.244	8.882	8.839
Left leaf strand of the vein (HKr)	4.467	5.489	5.845	4.583	4.122	4.465	4.271
Folding point of the leaf (TL)	11.354	13.753	13.941	9.652	11.125	10.566	12.568
Center point of the leaf (TP)	11.616	14.551	15.367	11.318	12.421	11.290	13.063
The angle of the natural base (B)	81.149	74.555	73.061	57.360	68.292	86.935	77.240
The angle of the natural apex (A)	66.591	74.313	55.137	74.365	63.583	83.054	58.477
The angle of the vein (V)	59.623	57.942	56.842	55.188	57.988	68.791	62.094
The angle of the kite base (BL)	44.718	44.576	41.066	40.411	35.052	44.783	42.470
The angle of the kite apex (AL)	45.726	45.408	44.495	51.238	43.233	48.120	41.757

Tabel 6. Means of the quantitative character of *Hevea brasiliensis* leaves from unidentified clones

Quantitative character	Clones of *H. brasiliensis* plant from the entres collection plantation					
	IRR 429	IRR 440	PC 10	PM 10	RRIM 908	RRIM 2020
Leaf length (P)	23.895	19.222	32.100	30.134	29.579	22.538
Leaf width (L)	8.682	7.406	11.029	11.600	12.548	8.603
Left leaf strand of the vein (HKr)	4.340	3.703	5.703	5.987	6.487	4.481
Folding point of the leaf (TL)	11.128	8.448	14.536	14.036	13.399	9.835
Center point of the leaf (TP)	11.947	9.560	16.154	15.088	15.019	11.556
The angle of the natural base (B)	71.469	63.834	66.542	72.767	69.420	57.446
The angle of the natural apex (A)	71.669	79.384	57.339	58.124	76.730	72.894
The angle of the vein (V)	62.040	58.350	54.750	56.321	55.550	56.570
The angle of the kite base (BL)	40.987	40.882	35.994	43.267	44.716	38.712
The angle of the kite apex (AL)	45.325	51.156	41.728	46.274	52.474	49.376

Tabel 7. Large approximate of *Hevea brasiliensis* leaves

Quantitative character	PB 217	IRCA 18	IRR 5	PB 260	PB 340	PC 10	PM 10	RRIM 908
Leaf length (P)	28.950	29.637	29.959	29.116	30.517	32.100	30.134	29.579
Leaf width (L)	10.803	10.431	10.076	10.989	11.339	11.029	11.600	12.548
Large (cm2)	312.732	309.133	301.865	319.973	346.045	354.045	349.538	371.160

Figure 2. *Hevea brasiliensis* leaves sample. Eight leaves from Table 7 to be represented to some of the clones, PB 217, IRCA 18, IRR 5, PB 260, PB 340, PC 10, RRIM 908, and PM 10

Discussion

Clones identification is a necessary component of most studies of biological diversity, and computational approaches are beginning to automate it. The influence of the interaction of clones with quantitative characters measured emphasizes that this is very capable of being a character of *H. brasiliensis* clones, this was proven by Table 2 the annova procedure from the probability value of K as clones, C as a quantitative character, and both interaction (<0.0001). Similar research was also conducted to identify weeds by introducing a plant species based on the shape and arrangement of its leaf bones by moment invariant method (characteristic of weed leaf shape and image) and lacunarity (texture feature of weed image) (Herman and Harjoko 2015).

The importance of the role of leaf detection and classification (Thyagharajan and Raji 2018) for agriculture, forestry, rural medicine, and other commercial applications. Diagnosis of plant leaf disease for automatic identification is highly demanded on precision agriculture (Ahmad et al. 2018; Bakhshipour et al. 2017); Environment and Forestry need solutions for automatic tree species identification (Bakhshipour et al. 2017) rural medicine (Ahmad et al. 2018) involves the recognition of plant species to decide the suitability of consumption. Other research *H. brasiliensis* tree leaves are naturally in palmate leaf class, as trifoliate leaves where there are 3 leaves on each petiole that join in their base. Thus reflecting the position information of the leaves whether the leaves overlap or separate. Therefore, this unique feature can be used to distinguish certain leaves from clones of others to identify tree types. This research was conducted by Tekkesinoglu et al. (2014) on the problem of identifying overlapping leaves against a complex background. The approach taken to identify *H. brasiliensis* leaf boundaries based on morphological operations and edge detection methods shows promising results.

Generally for plants, the leaves play a very important role as the center of metabolism in breaking down nutrients from the soil which are transported by the xylem vessels at the roots to the leaves and processed into photosynthate to be circulated to all parts of the plant by phloem vessels as energy for growth. Likewise for *H. brasiliensis* plants, the production of latex which is the main goal of *H. brasiliensis* cultivation in plantations, determined by leaves. In this research, a number of clones used as sample sources refer to previous work (Pratomo et al. 2020) of detecting polyisoprenoid in *H. brasiliensis* clones, which have defined the types of clones based on the types of quick starter and slow starter clones (Herlinawati and Kuswanhadi 2013; Martiansyah et al. 2018; Obouayeba et al. 2010; Woelan et al. 2012). And some pictures of leaves showed in Figure 2. The importance of identifying clones is carried out since the beginning of the selection of parent clones for the artificial crossing to be known with certainty the male elders and their female elders (Pasaribu and Suhendry 2018).

H. brasiliensis leaves also described the stress response of plant drought and tolerance complex biological process. The results showed that the relative water content (RWC) in the leaves continues to decrease with the severity of drought stress. Wilted leaves are observed for 7 days without water (dww). *H. brasiliensis* tree clone GT1 leaf sample (original clone breed in Indonesia). These results (Wang and Li-feng 2014) suggest that drought stress adaptation in *H. brasiliensis* trees is regulated by energy biosynthesis, antioxidative enzymes, and osmoregulation. With regard to the influence of weather and climate, the results of research (Liyanage et al. 2018) in China showed that two clones of RRIM 600 and GT1 (who are also familiar in Indonesia) were defoliated during the last week of December and refoliated in the last week of January. This helps *H. brasiliensis* growers to schedule appropriate disease control measures, as well as design hybridization programs aimed at the production of clones resistant to foliar disease. Recently, it has been reported that the tolerance level of the GT1 seedlings to drought with the addition of PEG 6000 by showing an increase of taproot length (Pasaribu et al. 2021).

Visually, although only from the length and width of the leaves, it can be seen that the differences in each clone were observed and their characters were measured. And for the details, measurements were taken digitally. Figure 2 is related to Table 6 describing different large approximate of *H. brasiliensis* leaves. The results of Suhendry and Pasaribu (2009) showed that *H. brasiliensis* leaves have specific quantitative characteristics among clones so that the characteristics contained in the leaves can be used as a description in identifying an *H. brasiliensis* clone. Variations in leaf size and length, leaf area, the ratio of leaf length and width, the proportion of character length and width of leaves, corners of leaves, and proportions of leaf angles and conversion values differ very manifestly delivered by clones thus emphasizing the character in identifying *H. brasiliensis* clones.

In digital techniques, before the leaves were measured first done the separation of the background through cropping techniques. The cropping technique was performed visually by using the magic tool in the Adobe Photoshop Software program. Pasaribu and Suhendry (2018) have reported the influence of operator accuracy level did not cause different phenomena between clones. This is evidence from the fact the interaction of methods with clones. The interaction of identification techniques with clones indicated that the technique of measuring *H. brasiliensis* leaf characteristics were not influenced by clones, meaning that any clone can be measured by digital identification techniques as carried out in this study.

In conclusion, the identification method digitally on the characterization of *H. brasiliensis* leaves showing that the characteristics contained in *H. brasiliensis* leaves were very suitable and used as the first character in identifying an *H. brasiliensis* clone.

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