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MORPHOLOGICAL VARIATION OF KEDONDONG (SPONDIAS DULCIS PARKINSON) IN CENTRAL PART OF SUMATRA

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Ibna Hayati, Alex Hartana, Nina Ratna Djuita & Nunik Sri Ariyanti. 2022. Variasi Morfologi Kedondong (*Spondias dulcis* Parkinson) di Sumatra bagian Tengah. *Floribunda* 6(8): 315–323 — Kedondong (*Spondias dulcis* Parkinson) dibudidayakan secara luas di daerah tropik dan dilaporkan tanaman asli dari Malesia dan Pasifik. Beberapa daerah di Indonesia dikenal sebagai daerah penghasil kedondong sejak lama. Sumatra memiliki kedondong yang berukuran besar dan rasa manis sekitar tahun 60-an yang berasal dari Sabang. Akan tetapi informasi mengenai plasma nutfah kedondong masih terbatas. Tujuan penelitian ini adalah untuk mengeksplorasi dan mengelompokkan kedondong di Sumatra bagian tengah berdasarkan ciri morfologi. Spesimen dieksplorasi dan dikoleksi dari Riau, Sumatra Barat dan Jambi. Sebanyak 50 ciri morfologi diamati dan diberi nilai untuk analisis pengelompokan menggunakan metode UPGMA. Beberapa ciri kedondong dari Sumatra bagian tengah sangat barvariasi. Kedondong mengelompok ke dalam dua kelompok yaitu kelompok buah kedondong berwarna hijau terang dan kelompok berwarna hijau gelap. Akan tetapi, ciri tersebut belum dapat digunakan sebagai dasar untuk membedakan kultivar karena kontiniutas karakter dalam kelompok kultivar terutama ukuran dan bentuk buah. Akan tetapi, berdasarkan jenis buah, kedondong manis cenderung memiliki bentuk buah lonjong.
Kata kunci: Fenetik, kedondong, morfologi, tanaman budidaya.

Ibna Hayati, Alex Hartana, Nina Ratna Djuita & Nunik Sri Ariyanti. 2022. Morphological Variation of Kedondong (*Spondias dulcis* Parkinson) in Central Part of Sumatra. *Floribunda* 6(8): 315–323 — Kedondong (*Spondias dulcis* Parkinson), is widely cultivated in the tropics and reported possibly native plant from Malesia and Pacific. Since a long time several regions in Indonesia has been known as producing area. Around 60s, Sumatra has reputable kedondong from sabang which has sweet flavour and large size. However information on the morphological variation of kedondong germplasm is still limited. The objective of this study was to describe and grouped morphological variation of kedondong germplasm in central part of Sumatra. The specimens were explored and collected from Riau, West Sumatra, and Jambi. Fifty morphological characters were observed and scored for grouping analysis using UPGMA methods. Some characteristics of kedondong from central part of Sumatra are very varied. The kedondong specimens in the cluster analysis grouped into two main groups A and B based on the color of the mature fruit, but these characteristics may not qualify to be used as standard criteria for evaluating cultivated variety because within the group there are still variations in other characters, such as size and shape of the fruits. However based on fruit type, sweet kedondong tends to has oblong type.
Keywords: Cultivated plant, kedondong, morphology, phenetic.

Kedondong (*Spondias dulcis* Parkinson) is one of the valuable members of Anacardiaceae since all of the plant parts are edible and useful, not only as fruit plant and various commercial products but also as ornamental plant and medicinal resources (Verheij & Coronel 1991; Lim 2012; Hayati *et al*. 2019). Kedondong is widely cultivated in the tropics and reported possibly native plant from Malesia and Pacific (Mitchell & Daly 2015; Sujarwo & Keim 2019). In Indonesia, kedondong was not commercially cultivated but found growing mainly as individual tree in rural areas, home gardens and small plantation managed by local people (Hayati *et al*. 2019).

Since a long time several regions in Indonesia has been known as producing area such as Ka-

rimunjawa (Central Java), Sabang (Aceh), Mandailing Natal (North Sumatra) and Indragiri Hulu (Riau). However information on the morphological variation of kedondong germplasm is still limited if we compared to other famous close relatives such as mango (Fitmawati *et al*. 2009). One attemption to characterized the kedondong germplasm in Parang Village (Karimunjawa, Central Java) has been done by Cempaka *et al*. 2019. While in Sumatra, there is no information at all. The objective of this study was to describe and grouped morphological variation of kedondong germplasm in central part of Sumatra. This research is important to collect and give information about superior seed of kedondong planted in Sumatra.

MATERIALS AND METHODS

This research was conducted in July to August 2019 in central part of Sumatra which included the provinces of Riau, West Sumatra and Jambi. These location, Kuantan Singingi and Indragiri Hulu districts (Riau), Batang Hari district (Jambi), Agam and Padang Pariaman districts (West Sumatra) were selected to be explored. We collected 50 specimens consist of 23 specimens from Riau Province (RH1-RH14; RK1-RK9), 11 specimens from West Sumatra Province (SP1-SP6; SA1-SA5), and 16 specimens (JM1-JM16) from Jambi Province.

Fifty morphological characters were observed including four characters of stem, 17 characters of leaf, 6 characters of flower and 23 characters of fruits (Table 1). Standardization for observing colour using the Munsell Colour System. The observed vegetative characters were mostly adapted and modified from mango descriptor (IPGRI 2006). However, the observed generative characters were newly develop for kedondong in this study (Shaded area in Table 1). The clustering analysis using the UPGMA method was applied in the Numerical Taxonomy and Multivariate System (NTSYSpc) version 2.11a program (Rohlf 2002).

Table 1. Morhological characters observed and used in clustering analysis

No	Characters	Character state
1	Bark colour	Blackish gray=0; gray with a tinge of light brown=1; reddish gray=2; light brown=3
2	Stem surface	Glabrous=0; coarse=1; very coarse=2
3	Tree growth habit	Erect=0; spreading=1; semi-drooping=2
4	Branch Pattern	Erect=0; horizontal=1; irregular=2
5	Number of lateral leaflet	4–7 pairs=0; 8–12 pairs=1
6	Length of leaf	≤ 30 cm=0; > 30-65 cm
7	Width of leaf	≤ 15 cm=0; > 15–26 cm
8	Length of petiole	< 8 cm=0; ≥ 8–16 cm
9	Length of rachis	≤ 15 cm=0; > 15–39 cm
10	Length of terminal petiolule	≤ 18 mm=0; > 18–28 mm
11	Length of lateral petiolule	≤ 4.5 mm=0; > 4.5–8.6 mm
12	Leaflet texture	Coriaceous=0; subcoriaceous=1; chartaceous=2
13	Leaflet margin	Denticulate-revolute=0; crenate=1
14	Leaflet adaxial surface	Dull=0; shiny=1
15	Terminal leaflet blade shape	Elliptic=0; elliptic-oblong=1; elliptic-obovate=2; elliptic ovate=3; broadly elliptical=4; lanceolate=5
16	Lateral leaflet blade shape	Elliptic-broadly elliptic=0; oblong=1; ovate-lanceolate=2
17	Distance between first and second leaflet pairs	1.9–3.85 cm=0; >3.85-5.75 cm=1
18	Length of lateral leaflet	5–8.5 cm=0; >8.5–12 cm=1
19	Width of lateral leaflet	1.5–2.75=0; >2.75–4 cm=1

Table 1. Morhological characters observed and used in clustering analysis (continue)

No	Characters	Character state
20	Length of terminal leaflet	4–7.5 cm=0; >7.5–10 cm
21	Width of terminal leaflet	1.8–3 cm=0; >3–4.2 cm
22	Inflorescence shape	Conical=0; pyramidal=1; broadly pyramidal=2
23	Bud shape	oblong=0; globose=1
24	Petal colour	Creamy white=0; greenish white=1
25	Ovary colour	Light green=0; dark green=1
26	Petal lamina margin	flat=0; involute=1
27	Disc colour	yellow=0; greenish yellow=1
28	Fruit shape	oblong=0; globose=1
29	Fruit base shape	Slightly pointed=0; blunt=1spheroid=2; slightly flat to flat=3
30	Fruit apex shape	Slightly pointed=0;blunt=1; spheroid=2
31	Fruit stalk insertion	Vertical=0; oblique=1
32	Fruit weight	≤60–95 g=0; ≥ 100–200 g=1
33	Fruit length	≥ 4.54–6.65 cm=0; ≥ 6.66–8.77 cm=1
34	Fruit diameter	≥ 3.85–5.41 cm=0; ≥ 5.42–6.98 cm=1
35	Fruit peel thickness	≤ 0.7 mm=0; > 0.7–1 mm
36	Mature fruit colour	Olive/Light green (2.5GY 5/8) =0; dark green (5.0GY 3/8)=1
37	Ripe fruit colour	yellow (5Y 9/8) =0; orange yellow (2.5Y 8/12)=1; light orange (7.5YR 8/14)=2
38	Fruit peel texture	smooth=0; rough=1
39	Pulp thickness	≤ 1.65 cm=0; > 1.65–2 cm=1
40	Mesocarp colour of mature fruit	Dark green (7.5GY 4/10)=0; light green (5.0GY 8/12)=1
41	Pulp colour of mature fruit	Pale brown with a yellowish tinge (5.0GY 9/6)=0; pale yellowish orange (10Y 9/4)=1;
42	Mesocarp colour of ripe fruit	Light orange (7.5YR 8/14)=0; yellowish orange (2.5Y 8/14)=1; pale yellow (2.5Y 9/8)=2
43	Pulp colour of ripe fruit	pale yellowish orange (7.5Y 9/4)=0; pale yellow (2.5Y 9/8)=1
44	Mature fruit taste	sour=0; sweet-sour=1; sweet=2
45	Ripe fruit taste	sour=0; sweet-sour=1
46	Endocarp weight	≥ 3 gr=0; ≥7 gr=1
47	Mature fruit pulp texture	soft=0; crunchy=1
48	Ripe fruit pulp texture	soft=0; intermediet=1; firm=2
49	Brix (^{o})	4.6–10=0; >10-14=1; >14–18=2
50	Pulp aroma	mild=0; intermediet=1; strong=2

RESULT AND DISCUSSION

Morphological Variation

Recent publication on of *Spondias* explained general fruit morphology and anatomy (Mitchell & Daly 2015; Herrera *et al*. 2018), and standard descriptor for the genus *Spondias* has not been published. Fruit morphology are important traits to differentiate infraspecific variants in *Spondias* since fruit is the most frequently used. Kedondong

has many morphological variation in generative traits, particularly the colour and taste of fruit. In the Grenada region (Caribbean Islands, America) kedondong were categorized by local community based on tree types, fruit shape, weight and taste (Daulmerie 1994). The cultivated variants of American species of *S. purpurea,* the close relative of kedondong are differentiated by color traits of fruits (Ferrer *et al.* 2017). We found out variation particularly on the characteristics of bark colour, pair number of lateral leaflets; leaflet apex, margin, and base; color of petal, ovary, mature fruit, ripe fruit, and pulp; fruit shape and taste.

Stem

Kedondong has tree habitus, tree growth habit erect or spreading with height up to 12 m, and sympodial. Kedondong has glabrous to rough, shallow fissured bark. The bark vary in colour: blackish gray, gray with a tinge of light brown, reddish gray and light brown (Fig. 1). We couldn't obtain the wet bark as specimen because of the forbidden in cutting the bark. There were several kinds of local wisdom related to kedondong tree founded in West Sumatra. One of them are selling the fruit will make the tree stop to flowering. This founded in kedondong tree planted in Ulakan region of Padang Pariaman regency.

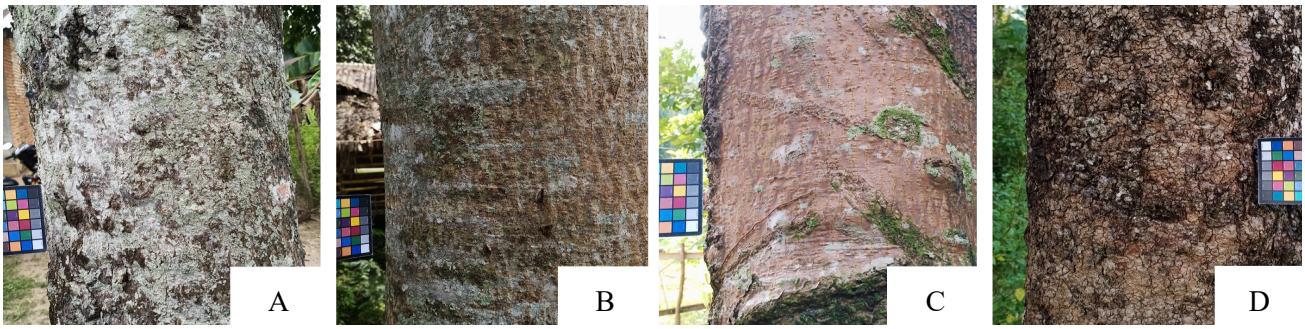

Fig. 1. Outer Bark variation of *S. dulcis* collected from central part of Sumatra: A. blackish gray. B. gray with a tinge of light brown. C. reddish gray. D. light brown

Leaves

The leaves of kedondong are scattered on the branches, which are imparipinnate with variations in leaf length ranging from 20–65 cm. Lateral leaflets always pairing, 4–8 pairs and 9–12 pairs (Fig. 2) while at the end there are usually unpaired terminal leaflets. Leaflets generally have a shape ranging from elliptical, lanceolate, ovate, oblong, obovate, and wide elliptical with an asymmetric or pointed base and a tapered apex. The arrangement of leaflets usually opposite but also found sub-opposite. The margin of leaflets are slightly rolled back (revolute) and serrulate or usually crenulate.

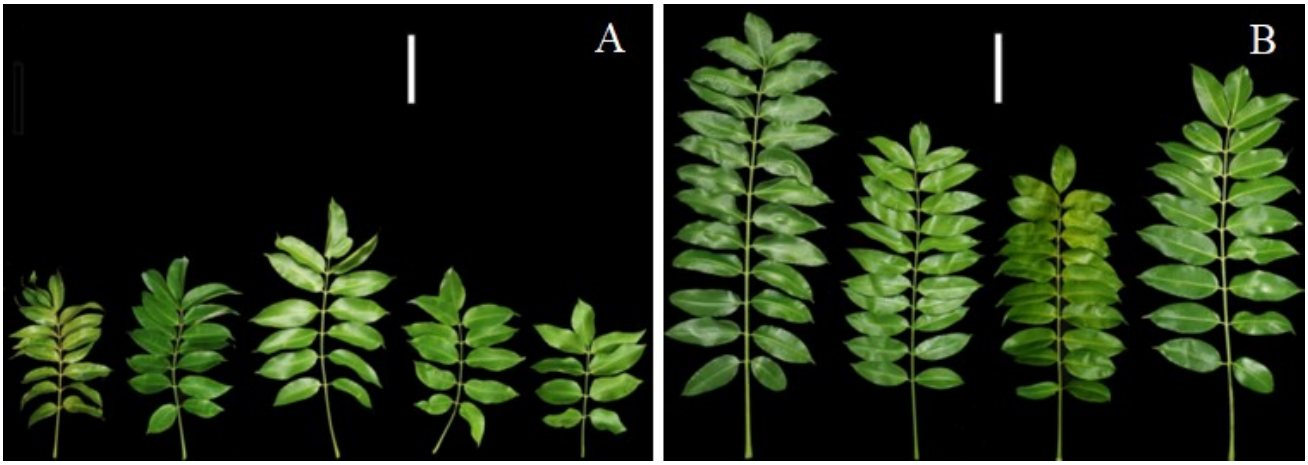

Fig. 2. Leaf variation of *S. dulcis* collected from central part of Sumatra: A. lateral leaflets 4-8 pairs. B. lateral leaflets 9-12 pairs. Scale bar: A-B = 10 cm.

Inflorescence and Flower

The inflorescences of kedondong vary from narrow pyramidal, pyramidal and broadly pyramidal. Part of kedondong flower shown in Fig. 3. The buds of kedondong flower vary in shape: oblong and globose (Fig. 4). The colour of flower disc also varies from yellow to greenish yellow. The colour of the petals is greenish white and yellowish white. The margin of the petals are varied: curling adaxially (involute) and not curling (flat). This also correlates with the thickness of petal. The thicker the petal, when anthesis, the margin to the apex of the petal will roll in an adaxial direction (involute). The character of involute petals associate the characters of fruit taste, it found nearly in all sweet fruits.

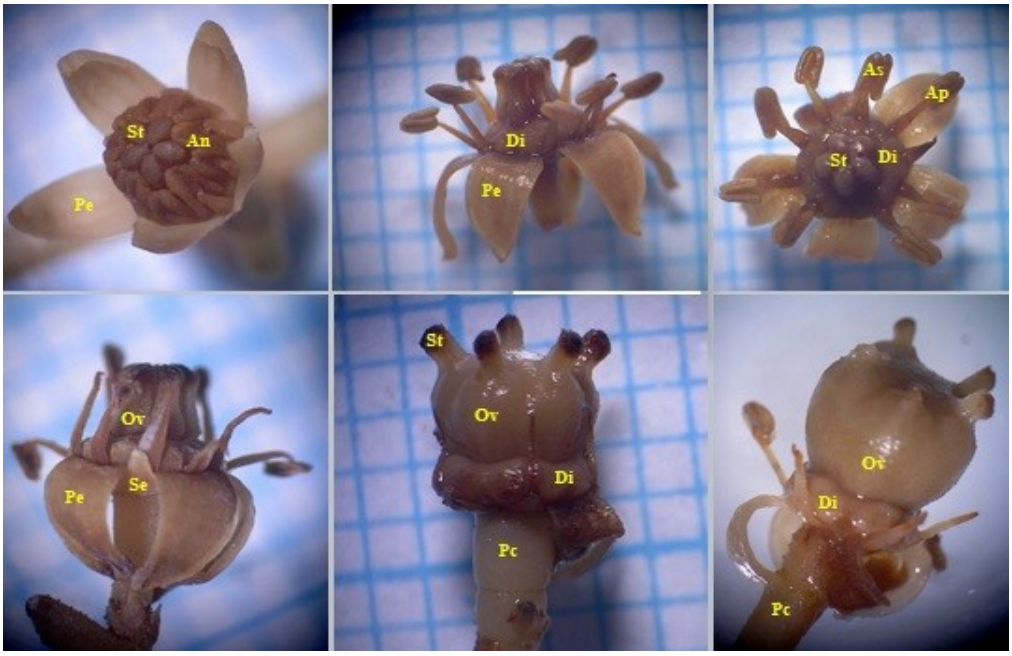

Fig. 3. Part of kedondong flower. Pc=pedicle, Se=sepal, Pe=petal, An=Anther, St=Stigma, Ap=Antepetal stamen, As=Antesepal stamen, Di=Disc, Ov=Ovary. Scale bar = 1 mm.

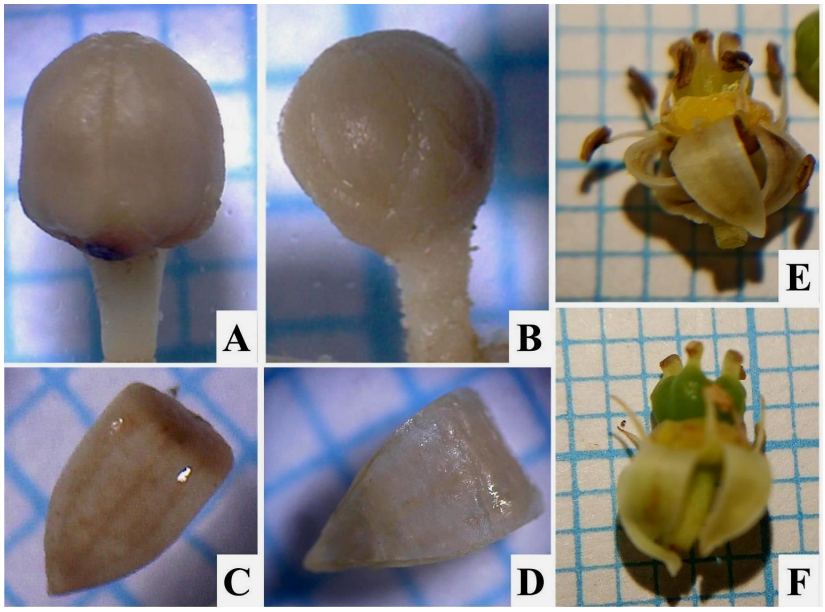

Fig. 4. Flower variation of *S. dulcis* collected from central part of Sumatra: A. bud oblong. B. bud globose. C. petal flat. D. petal involute. E. petal creamy white petal and ovary light green. F. petal greenish white and ovary dark green. Scale bar: A-F = 1 mm.

Fruit

The shape of fruit is the most various characters observed in kedondong, but it can be classify) into two category: oblong type (ellipsoid to ovoid-oblong) (Fig. 5A) and globose type (broadly ellipsoid to globose) (Fig. 5B). Within the shape categories we found variation on the base part of fruit, that is slightly pointed, blunt, spheroid, slightly flat to flat; the apical part of fruit is slightly pointed, blunt and spheroid; the stalk insertion varied from vertical to oblique.

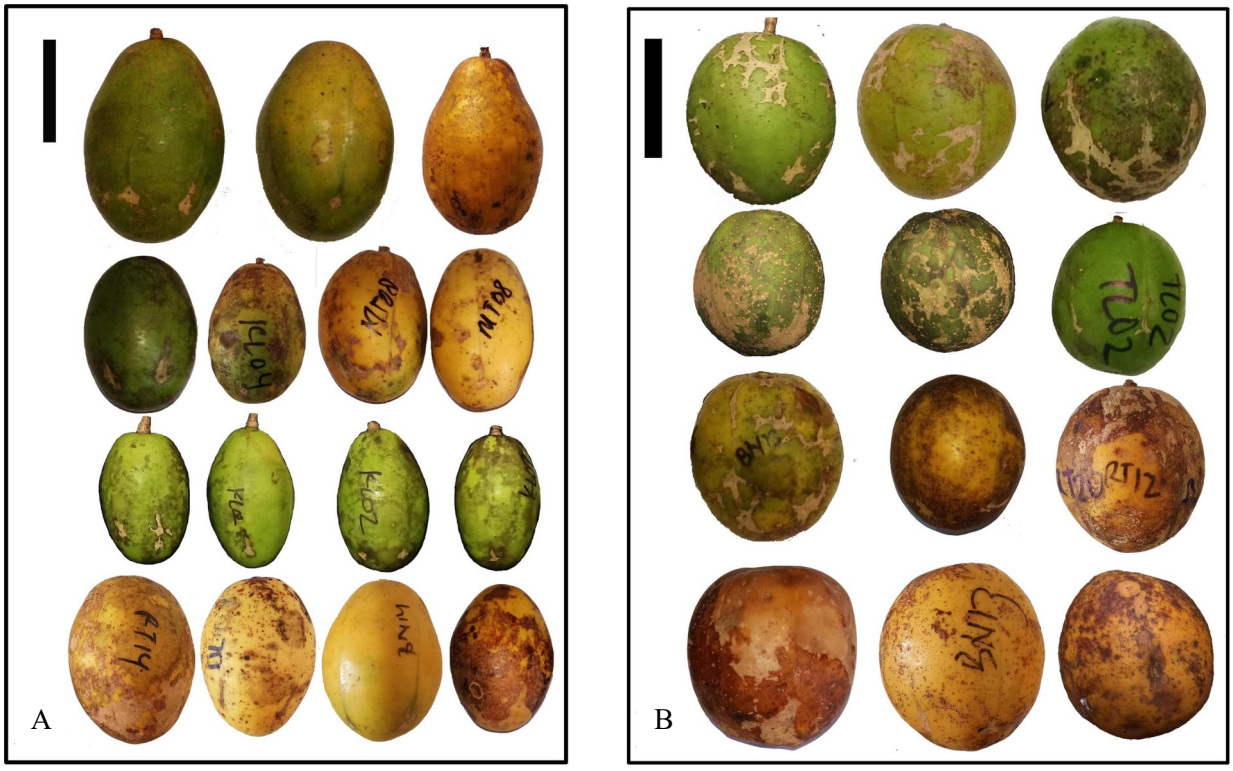

Fig. 5. Fruit shape morphology of *S. dulcis* collected from central part of Sumatra: A. oblong type. B. globose type. Scale bar: A-B = 5 cm.

Among 50 observed plant, we found plant which have superior fruit characters, that is the plant produce 100–200 g per fruits obtained from West Sumatra and Riau (SP1, SP3, RK8, RH14) and the plant produce sweet fruit especially from the West Sumatra (SP1, SP3, SP5) so that it may designated as table fruit. However, the sour fruits are also valuable since it can be processed for food diversification or other purposes.

Phenetic Analysis of Kedondong in Central Part of Sumatra

Kedondong from central part of Sumatra were grouped at morphological similarity of 0.46 and divides into two main groups A and B (Fig. 6). The samples were grouped mainly based on color of mature fruit. For kedondong case, terminology of mature fruit is different from ripe fruit. It is marked by the peel color and hardness level of fruit. All samples with light green colour of mature fruit were in group A and samples with dark green colour of mature fruit were in group B. Mature fruit has not yet physiologically ripe however the peel color could be also affected by sun exposure whether exposed to direct sunlight or shaded.

Group A consisted of 33 kedondong samples (7 collection from West Sumatra, 20 collection from Riau and 6 collection from Jambi) with morphological similarity coefficient of 0.52. Group A was the kedondong group with light green colour of mature fruit (2.5GY 5/8). In addition, group A has common characteristics such as petal colour creamy white, ovary colour light green, flower disc colour yellow, mesocarp colour of mature fruit light green (5.0GY 8/12), pulp colour of mature fruit pale yellowish orange (10Y 9/4).

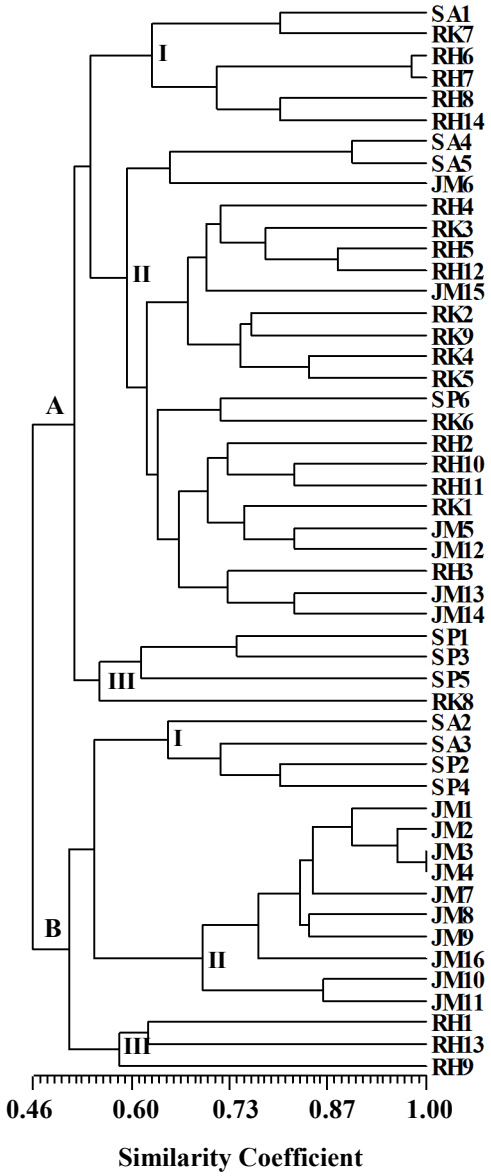

Fig. 6. Dendrogram 50 collection numbers of kedondong from central part of Sumatra using the UPGMA method based on 50 morphological characteristics. RH: sample from Indragiri Hulu Riau; RK: sample from Kuantan Singingi Riau; SA: samples from Agam, West Sumatra; SP: samples from Pariaman-Padang Pariaman West Sumatra; JM: samples from Muara Tembesi Jambi.

Group A1 consists of 5 collections from Riau (RK7, RH6, RH7, RH8, RH14) and 1 collection from West Sumatra (SA1). Group A1 shares common traits of long petioles and fruit stalks, fruit colour and mesocarp colour of ripe fruit light orange (7.5YR 8/14), fruit peel less thick with rough texture, pulp colour of ripe fruit pale yellow (2.5Y 9/8) and the pulp is thick. Two samples from Riau, namely RH6 and RH7 (Indragiri Hulu collection), have higher similarity (0.97). Both of kedondong plants have oblong type of fruit shape and sweet taste of mature fruit.

Group A2 is grouped by bud flower and fruit shape are oblong type. This group consists of 13 collections from Riau, 3 collections from West Sumatra and 6 collections from Jambi. Samples from West Sumatra, namely SA4 and SA5 (Agam collection) have higher similarity (0.90). Both are kedondong plants with an oblong fruit shape with sour taste of mature fruit.

Group A3 consists of 3 collections from West Sumatra (SP1, SP3, SP5) and 1 collection from Riau (RK8). Group A3 is united by inflorescence shape broadly pyramidal flower bud oblong, petal involute, fruit shape oblong, pulp is thick (> 1.65–2 cm), sweet taste of mature fruit, sour-sweet taste of ripe fruit, pulp texture of ripe fruit soft, pulp aroma mild, and ^{o}Brix value of 14–18. SP1, SP3, SP5 and RK8 are collections of kedondong plants with characteristics favored by the local people.

Most of the members of A3 have heavy weight and sweet taste which has the potential to be developed as source of kedondong germplasm in Sumatra. This potential characters could be affected by genetic factor and also from the soil type and content of nutrients.

Group B consisted of 17 kedondong samples with morphological similarity coefficient of 0.51. Group B consisted of 4 collection from West Sumatra, 3 collection from Riau and 10 collection from Jambi. Group B was the kedondong group with dark green colour of mature fruit (5.0GY 3/8). In addition, group B has common characteristics such as petal colour greenish white, ovary colour dark green, flower disc colour greenish yellow, mesocarp colour of mature fruit dark green (7.5GY 4/10), pulp colour of mature fruit pale brown with a yellowish tinge (5.0GY 9/6).

In group B, there are three sample groups with a similarity coefficient of 58% to 70% and it shows that samples from the same origin location are in the same group. Group B1 consisted of samples from West Sumatra, group B2 consisted of samples from Jambi, and group B3 consisted of samples from Riau.

Group B1 (SA2, SA3, SP2, SP4) has similarities including adaxial surface of leaflets glossy, flower bud globose, petal flat, fruit base shape spheroid, sour taste of ripe fruit and crunchy texture of mature fruit. Group B2 has bark colour gray with a tinge of light brown, glabrous, sub coriaceous leaflet lamina texture, crenulate, the first and second pairs of lateral leaflets more distance (1.9–3.85 cm), inflorescence shape pyramidal, flower bud oblong, petal flat, fruit shape oblong, fruit apex slightly pointed, fruit stalk insertion oblique, fruit mass less weight (60–95 g), fruit length ≥ 4.54–6.65 cm, fruit diameter ≥ 3.85–5.41 cm and fruit peel less thick (≤ 0.7 mm). Group B3 consists of three collections from Indragiri Hulu Riau, namely one collection from Kelayang (RH1) and two collections from Rengat (RH9, RH13). Group B3 was united by the characteristics of adaxial surface of leaflets dull, fruit stalk insertion vertical, colour of ripe fruit light orange (7.5YR 8/14), sweet taste of mature fruit, the weight of endocarp ≥ 3 g and the ^{o}Brix value of 14–18.

There is a correlation between the taste and fruit type of kedondong. Oblong type usually has more sweet taste than globose type. Infraspecies classification could be made by doing deeply observation and measurement related to endocarp characters of kedondong. This is as far as our (physical) observation extends.

Based on the observation of morphological variations, identification keys of kedondong were compiled below.

Key identification for Kedondong in central part of Sumatra

1. a. Petal colour creamy white, ovary colour light green, flower disc colour yellow, peel colour of mature fruit light green, mesocarp colour of mature fruit light green, pulp colour of mature fruit pale yellowish orange.....Kedondong Group A
   b. Petal colour greenish white, ovary colour dark green, flower disc colour greenish yellow, peel colour of mature fruit dark green, mesocarp colour of mature fruit dark green, pulp clour of mature fruit pale brown with yellowish tinge .....Kedondong Group B

CONCLUSION

Kedondong from central part of Sumatra have variation on the characteristics of bark colour, pair number of lateral leaflets; leaflet apex, margin, and base; color of petal, ovary, mature fruit, ripe fruit, and pulp; fruit shape and taste. The kedondong specimens in the cluster analysis grouped into two main groups A and B based on the color of the mature fruit, but these characteristics may not qualify to be used as standard criteria for evaluating cultivated variety because within the group there are still variations in other characters, such as size and shape of the fruits.

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