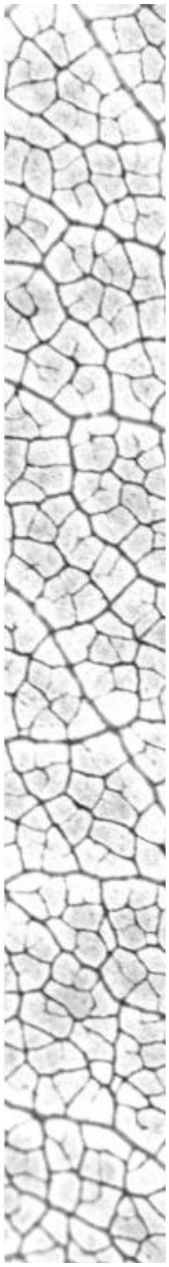

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Identification of dominan maternal and paternal line characters influence to new find sahang durian plant morphological characters as nature cross-pollination result

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Abstract
There are two types of durian that are commonly consumed and grow in Kalimantan. Two of the best-known edible durians in East Kalimantan are Durian (*Durio zibenthinus*) and Lai (*Durio kutejensis*). However, as a plant with a cross pollination mechanism, there are many character results of natural crosses between the two in nature. Sahang durian trees were found grow in Kutai Kertanegara, East Kalimantan, Indonesia. There is a question whether this variety is a new species of durio plant or this is the result of a nature cross-pollination between *D. zibenthinus* and *D. kutejensis*. The aim of this research is to know and identify morphological character of sahang durian from East Kalimantan, Indonesia. This research was carried out by exploration information by interviews with the durian tree owner farmers, then characterization of durian plant used International Plant Genetic Resources Institute (IPGRI) morphological characteristics. This study successfully identified the character of sahang durian as descendants of both durian species with combination character from its parents (D. zibenthinus and D. kutejensis). Sahang durian has some superior characters like medium-sized fruit, orange color aril, odorless like *D. kutejensis*, but has a green color fruit skin, sweet taste, soft and creamy aril like *D. zibenthinus*. Sahang durian character is more dominantly influenced by *D.kutejensis* character, its indicate maternal line has dominant influence compare to paternal parent. Therefore, it can be stated that the Sahang durian is a plant derived from the natural cross between *D.zibenthinus* and *D.kutejensis*.

Keywords: tropical rain forest, local fruit, cross-pollination, germplasm, preservation

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INTRODUCTION

There is a demand for Indonesia's tropical fruits in the world (Indonesian Ministry of Agriculture 2011). Indonesia export many kinds of fruits due to global high demand i.e. pineapples, mangosteen, banana, mango, orange and durian. Durian fruits from Indonesia has export to International markets such as Hong Kong, China, Malaysia, Vietnam, the Middle East and others. Many peoples in the world like durian fruits. Durian aril contain hundreds of volatile compounds such as esters (ethyl propanoate, methyl-2-methylbutanoate, propyl propanoate), sulphur compounds (diethyl disulphide, diethyl trisulphide and ethanethiol), thioacetals (1-(methylthio)-propane), thioesters (1-(methylthio)-ethane), thiolanes (3,5-dimethyl-1,2,4-trithiolane isomers), and alcohol (ethanol) (Belqis et.al 2017, Chin et al 2007, Ho and Bhat 2015, Nur and Abbe 2019), and all the compounds make the taste of durian fruits very special and unique compare to other fruits.

In Indonesia there are 10 provinces being centre of durian fruits production, namely East Java, Central Java, West Java, South Sulawesi, West Sumatra, and North Sumatra. Based on data from BPS (The Central Bureau of Statistics) Indonesia in 2016, the highest harvested area is in East Java Province, while the highest productivity is in North Sumatra. But Kalimantan is the largest island in Indonesia with a high level of biodiversity in the world. East Kalimantan province, is a place of mega biodiversity with humid tropical forest climate conditions (Samir et al 2015, Ercisli and Sagbas 2017). Humid tropical climate is a climate with humidity above 90%, high rainfall (annual rainfall was >2,500 mm with more than 150 rain days. year^{-1}), annual temperature above 18^{o}C, and the difference between

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the rainy season and the dry season is not very clear (Poepenoe 1974).

Kalimantan Island is the centres of diversity of durian plants (Bioversity International 2007, Brown 1997). Around 27 species of Durio worldwide, 18 of them are grow in Kalimantan, 11 are in Malaya, and 7 are in Sumatra (Millow et al. 2014). The high number of Durio species that grow in Kalimantan illustrates that this area is the most important distribution centre for *Durio sp.* plants. East Kalimantan rich in the diversity of sources of Durio germplasm (Siregar 2006). There are quite a lot of durian cultivars which has differ character from one another just like in taste, aroma (odor), and color of the fruits and flesh, size and shape of flowers and fruits, leaves size, etc. One of an exotic *Durio sp.* has been found in east Kalimantan was *D. graviolens* (Kurniadinata et al. 2020).

Generally, durian trees in Kalimantan grow wild in primary or mixed forests and only a small portion has been planted by in orchard. *D. zibenthinus* (knowed as common durian) can be found around Indonesia, include on the islands of Kalimantan, Java, Sumatra, Sulawesi and Maluku. This species can grow on various types of soil. It's widely cultivated by people in Kalimantan, including in East Kalimantan (Subhadrabandhu 1993), but commonly it has not used optimal cultivation technology.

Lai plant (*Durio kutejensis*) is another species of durian plant which is an endemic plant in East Kalimantan. Lai has different morphological characters from durian plants. Kurniadinata et.al. (2019) found six Durio sp. plants from nature cross pollination of *D. zibethinus* and *D. kutejensis* in Loa Kulu villages, East Kalimantan, Indonesia, where each kind species founded has different character. In common *D. kutejensis* tree is almost similar as *Durio zibenthinus*, but the leaves of *D. kutejensis* are wider and longer than durian, with old green color at top and at bottom are brighter with shiny golden-brown color. The skin of the *D. kutejensis* fruit is yellowish to greenish yellow, the spines are tighter, smaller and less sharp (tend to be soft). The flesh (aril) of the *D. kutejensis* fruit also drier than the *D. zibenthinus*, with yellow to orange color with without strong aroma (odourless).

The great diversity of species and sources of germplasm *Durio sp.* is very important for breeders (Ryugo 1988, Poerwanto 2003, Chakravarty et al. 2016). From plant breeding activities, it is expected that superior seeds will be obtained both in quality and fruit production (Mursidin and Daryono 2016). Indonesia, especially in East Kalimantan province, this rich diversity of durian species and germplasm has not been used optimally. Therefore, plant breeding in durian relatives (*Durio sp.*) in Indonesia needs to get the superior cultivars (Indonesian Ministry of Agriculture 2011). This can be done by collecting data and information about *Durio sp.* in Indonesia especially in centre of diversity (Belqis et al. 2017), and next step is to choose the types or sources of germplasm that have more value (Subhadrabandhu 1993, Yuniarti 2011). With the availability of diversity in germplasm types or sources, the desired superior cultivars / seeds will be assembled.

The problem about durian plant in centre of diversity is there is much kind of durian types founded grow in East Kalimantan, but there is less character information about it. When one durian plant founded, there is a question whether this variety is a new species of durian plant? To be able determine the type of plants, we must know the characteristics of the plant, especially for morphological character (Marschner H (1995), Bernier et al. 2000, Sundari 2015, Sundari and Nuraini 2018).

Sahang durian trees were found grow in Kutai Kertanegara, East Kalimantan, Indonesia. There is a question whether this variety is a new species of durio plant or this is the result of a nature cross-pollination between *D. zibenthinus* and *D. kutejensis?* The aim of this research is to know and identify morphological character of sahang durian from East Kalimantan, Indonesia. Sahang durian plant is one of the potential *Durian* plants funded in East Kalimantan Province. Therefore, it is important to do morphological identification research and documentation of potential superior commodities of Sahang durian as a potential fruit's commodities from East Kalimantan, Indonesia.

Objectives

This study aims to find, identify and initial morphological character of Sahang durian plant in Kutai Kertanegara, East Kalimantan, Indonesia, as potentially superior local fruit plants

MATERIAL AND METHOD

This research was conducted from January 2019 to June 2019 in fruits orchard, Batuah Village, Kutai Kertanegara, East Kalimantan Province, Indonesia (0°43'57.6"S 117°04'25.4"E) where Sahang durian grow, and was known by people around, as new species of durian plant. This Research are using descriptive method of exploration. Observations were carried out on 5 trees of *D.zibenthinus*, 5 trees of *D. kutejensis* and (only) 2 trees of Sahang durian founded as sample. All durian trees used as sample plant has been produce more than 3 times. All character unit were identified using tress, leaves, flowers, fruits, and trunks from each sample tress. Explore information by did interviews with durian tree owner (farmers) to get information about those tresses, and then did characterization identification used International Plant Genetic Resources Institute (IPGRI) morphological characteristics. The fruits, leaves, and flowers were collects and observed in Agronomy Laboratory, The Faculty of Agriculture, Mulawarman University, Samarinda, East Kalimantan Province, Indonesia.

Fig. 1. Sahang durian tree

Fig. 2. Sahang durian fruits (1), *D. zibenthinus* fruit (2) and *D. kutejensis* fruit (3)

RESULT AND DISCUSSION

Sahang durian has unique character, it blends of *D. zibenthinus* and *D. kutejensis* character. More specific at morphological characteristics of trees, leaves, flowers, fruits and seeds. Sahang durian trees have a semi-circular shape with a tree height of approximately 10-15 meters just like *D. zibenthinus* tree, but the stems are rough and grow straight, gray color stems and stem diameter around 50cm (**Fig. 1**) similar with *D. kutejensis* tree character.

Moreover, Sahang fruit also has aril color siminar with *D. kutejensis*, with yellow to orange color (**Fig. 2**) and similar leaves shave (**Fig. 3**).

Sahang durian fruit color is greenish yellow with bright intensity. Fruit length 13-16 cm with a diameter of 13-15 cm. The fruit consists of 5 segments, with aryl thickness in a medium scale. Orange colored aryl with a sweet taste and soft texture (**Fig. 2**).

Sahang durian leaf length (without petiole) looks similar to *D. zibenthinus* leaf, where Sahang durian leaf is around 200-230 mm and *D. zibenthinus* is around 150-180 mm. While the leaves of *D. kutejensis* have a larger size and length with a size of 280-420mm. However, it has a similar oblong shape with *D. kutejensis* leaf. The color of the upper and lower leaves of Sahang durian has the same color with upper and lower leaf color of *D. kutejensis*, i.e. dark green and silvery brown, so it is different with the upper and lower leaf color of *D. zibenthinus*, i.e. light green and coppery brown (**Fig. 3**).

Fig. 3. Difference in leaf size and leaf color between leaves of *D. zibenthinus* (A), *D. zibenthinus* x *D. kutejensis* var. Sahang (B) and *D. kutenjensis* (C). 1) Leaf uppers surface; 2) Leaf lower surfaces

Based on the results of the study, complete morphological characters of the durian Sahang lai plants are listed in **Table 1**.

Based on this research, sahang durian plant known has many combination characters from *D. zibenthinus* and *D. kutejensis*. The Sahang durian fruit has 130-160

Table 1. The Different of Morphological Characteristics of Lai-Durian var Sahang, Kutai Kertanegara region, Indonesia compare to the *D. zibenthinus* and *D. kutenjensis*

Characters Unit	unit	Durio sp.		
		Sahang (*D. zibenthinus* x *D. kutenjensis*)	***D. zibenthinus***	***D. kutenjensis***
Trunk Surface		Rought	Smooth	Rought
Trunk Growth Habit		Straight	Straight	Straight
Crown Shape		Semi-circular	Irregular	Semi-circular
Tree Growth Habit		Spreading	Spreading	Spreading
Branching Density		Dense	Sparse to dense	Spare to dense
Bark Color		Grey	grey	grey
Leaf Upper Color		Dark Green	Light Green	Dark Green
Leaf Lower Color		Silvery Brown	Coppery Brown	Silvery Brown
Leaf Density		Dense	Medium to dense	Medium to dense
Arrangement Of Leaves		Alternate	Alternate	Alternate
Leaf Attitude		Drooping at 45^0	Semi-erect	Drooping at 45^0
Petiole Length	mm	20-25	24-28	20-25
Petiole Width	mm	5-6	5-6	5-6
Leaf Length without Petiole	mm	200-230	150-180	280-420
Leaf Blade Length		Long	Intermediate to Long	Very Long
Leaf Width	mm	80-90	50-60	80-100
Leaf Blade Width		Wide	intermediate	Wide to very wide
Leaf Blade Shape		Oblong	oblong	Oblong to linear-oblong
Leaf Apec Shape		Acuminate	Caudate	Long Acuminate to Caudate
Leaf Base Shape		Round	Round to Abtuse	Acute to Cuneate
Leaf Blade Margin		Entire	Entire	Entire
Leaf Texture		Papery	Papery	Papery
Leaf Upper Surface Glossiness		Glossy	Glossy	Glossy
Leaf Lower Surface Glossiness		Not Glossy	Not Glossy	Not Glossy

Note: Descriptors Bioversity International (formerly International Plant Genetic Resources Institute (IPGRI), 2007; The same color in column indicate the similar or close-similar character

Table 1 (continued). The Different of Morphological Characteristics of Lai-Durian var Sahang, Kutai Kertanegara region, Indonesia compare to the *D. zibenthinus* and *D. kutenjensis*

Characters Unit	unit	Durio sp.		
		Sahang (*D. zibenthinus* x *D. kutenjensis*)	***D. zibenthinus***	***D. kutenjensis***
Leaf Midrib Appearance		Slightly Prominent	Slightly Prominent	Slightly Prominent
Waxiness on Adaxial Leaf Surface		Shiny	Shiny	Shiny
Position of inflorescence		On Branches	On Branches	On Branches
Flowering Regularity		Regular	Regular	Regular
Flower Clustering Habit		Combination of 1, 2, 3 or more flowers per cluster	Combination of 1, 2, 3 or more flowers per cluster	Combination of 1, 2, 3 or more flowers per cluster
Density of Flowers		Dense	Dense	Sparse
Flower Bud Shape		Globose	Globose	Oblong
Flower Bud Apex Shape		Rounded	Rounded	Rounded
Apical Bud Color		Greenish	Greenish	Greenish
Calyx Shape		Campanulate	Campanulate	Campanulate
Calyx Tooth Apex Shape		Triangular	Round	Triangular
Number of Sepal		5	5	5
Sepal Color		Yellow green	yellow	Yellow
Flower Size		Large	large	Large
Pedicel Length	mm	25-50	35-45	30-50
Number of Petals		5	5	5
Petal Color		Pink	White to Yellow	Red
Petal Color Intensity		Light	Light	Dark
Petal Margin Color		Pink	White to Yellow	Red
Petal Shape		Spathulate to Broad-Spathulate	Spathulate	Spathulate to Broad-Spathulate
Inner Surface Hairiness of Petal		Glabrous	Glabrous	Glabrous
Outer Surface Hairiness of Petal		Glabrous	Glabrous	Glabrous
Type of Stamen		Free	Phalanx	Free
Stamen Exsertion Relative to Stigma		Short	Short	Short
Anther Number		45-50	55-65	45-60
Anther Shape		Reniform	Reniform	Reniform
Anther Dehiscence		Longitudinal	Longitudinal	Longitudinal
Style Length	mm	50-60	50-60	70-100
Style Shape		Curved	Curved	Curved
Hairiness on Style		basal	basal	Basal
Stigma Shape		Turbinate	Turbinate to Capitate, not lobed	Capitate, 5-lobed
Stigma Color		Orange	Yellow	Yellow to orange
Stigma Color Intensity		Dark	Light	Light
Upper Surface of Stigma		Smooth	Grooved	Smooth
Fruit Ripening		Non-synchronous	Non-synchronous	Non-synchronous
Fruit Dehiscence		NO	NO	NO
Fruit Bearing Habit		Annual (regular)	Annual (regular)	Annual (regular)
Fruit Clustering Habit		Combination of 1, 2, 3, 4 up to 6 fruits per cluster	One fruit per cluster	One fruit per cluster
Fruits Shape		Oblate	Oval	Globose
Shape of Fruit Apex		Convex	Pointede to Convex	Convex
Shape of Fruit Base		Depressed	Convex to truncate	Depressed or Concave
Blossom End		small	Small to large	small
Fruit Stalk Length		short	Short to medium	Short to medium
Fruit Stalk Attachment		strong	Week	Strong
Fruit Stalk Color		Brown	Brown	Brown
Fruit Spininess		Spiny	Spiny	Spiny
Fruit Spine Shape		Conical	Conival, concave, Pointed-concave, pyramidal	Hooked, Concave,Pointed-concave
Surface of Spine		Glabrous	Glabrous	Glabrous
Fruit Spine Density		intermediate	Intermediate to dense	intermediate
Fruit Spine Length		short	intermediate	Short
Fruit Length	mm	130-160	150-300	130-270
Fruit Diameter	mm	120-150	130-270	120-250

Note: Descriptors Bioversity International (formerly International Plant Genetic Resources Institute (IPGRI), 2007; The same color in column indicate the similar or close-similar character

Table 1 (continued). The Different of Morphological Characteristics of Lai-Durian var Sahang, Kutai Kertanegara region, Indonesia compare to the *D. zibenthinus* and *D. kutenjensis*

Characters Unit	unit	Durio sp.		
		Sahang (*D. zibenthinus* x *D. kutenjensis)*	***D. zibenthinus***	***D. kutenjensis***
Fruit Rind Thickness		thin	Thin to medium	Thin to medium
Number of Fruit Segments/Locules		5	5	5
Fruit Skin/Rind Color		Greenish Yellow	Green to Yellow	Yellowish to Orange
Fruit Skin/Rind Color Intensity		light	light	Light to Dark
Shelf Life	days	2-4	2-4	5-10
Aril Thickness		medium	Medium to thick	medium to thick
Aril Texture		soft	soft	Soft to intemediate
Aril Juiciness		Non-juicy	Non-juicy to juicy	Non-juicy
Presence of Fiber		Absent	Absent to high	Low to medium
Flesh Creaminess		Fair	Fair to strong	Poor
Flesh Taste		Sweet	Slightly Sweet, sweet, bitter sweet, bland, sweet with bitter after taste	Slightly Sweet, to sweet
Flesh Aroma		Mild	Mild to strong	Mild
Flesh Color		Orange	Creamy white, lemon yellow,Yellowish orange	Yellowish orange to orange
Flesh Color Intensity		light	light	light
Number of Rows of Pulp Units per Locule		Single row	Single row	Single row
Number of Carpels Per Fruit		5	5	5
Persistence of Calyx		No	No	No
Persistence of Stamen		No	No	No
Easiness of Splitting		Easy	Easy to intermediate	Easy
Flesh Stickiness		Slightly sticky	Slightly sticky to strong sticky	Slightly sticky to intemediate
Seed Length	mm	30-50	20-50	30-50
Seed Width	mm	25-30	20-30	20-30
Seed Shape		oblong	Ellipsoid to oblong	Ellipsoid to oblong
Seed Coat Color		Brown	Yellow Brown to Brown	Brown
Seed Coat Color Intensity		Dark	Light to Dark	light
fruit weight	Kg	0.8-1.2	1.5-2.5	1.0-1.7
Number of Fruits per tree	fruits	200-300	30-80	200-300
Yield	$Kg.tree^{-1}$	200-420	100-130	260-480

mm long with a diameter of 120-150 mm and weighs 0.8-1.2 kg, while *D. zibenthinus* has a length of 150-300 mm with a diameter of 130-270 mm and a weight of 1.5-2.5 kg, and *D. kutejensis* has a length of 130-270 mm with a diameter of 120-250 mm and a weight of 1.0-1.7 kg. Some character, especially for the fruits were unique and can being developed as potential character, i.e. mild aroma, smaller fruit size, good flesh color, sweet taste and soft aril. Some people like the *D. zibenthinus* taste but dislike with the strong aroma, and vice versa with *D. kutejensis* fruits, the aroma is less compared to *D. zibenthinus,* but the taste is not as good as *D. zibenthinus*. All of the combination of these character can find in Sahang durian fruit. It has sweet taste, thick and soft flesh, mild flesh aroma, fair flesh creaminess, dry texture and non-juicy flesh. Another advantage of Sahang durian is it has smaller fruit size compared to *D. zibenthinus* and *D. kutenjensis*, it makes one fruit is suitable to consume by one person.

Most of Sahang durian morphological character influent by D. kutejensis charachter. *Durio sp.* known has cross-pollination mechanism. Based on Indriyani et.al (2012), maternal and paternal line give different effect for the durian fruits character. Maternal effect was significant on the characters of fruit set, fruit weight, fruit circumference, fruit length, fruit rind thickness, flesh thickness, edible portion, spine length, the number of locules without the pulp, seed weight per fruit, seed number per fruit, and percentage of deflated seed. while paternal line effect occurs on fruit set, fruit length, rind thickness, seed number per fruit, seed weight per fruit, and percentage of deflated seed. It indicates the D. kutejensis were the maternal parent for sahang durian.

Sahang durian at the first time, thought to be a different kind of durio species, and has differ from *D. zibenthinus* and *D. kutejensis*. This research showed that sahang durian is cross-pollination result from *D.zibenthinus* and *D. kutejensis*. Where *D. zibenthinus* as the paternal parent and *D. kutejensis* as maternal parent. To prove this theory, we can see from the flowers color/ petal color. Durian sahang has pink flowers color. It indicates that sahang durian flowers color is the blend color from *D. zibenthinus* with white flower color and *D. kutejensis* with red flower color (**Fig. 4**). The combination

Fig. 4. Sahang durian leaf (1), *D. zibenthinus* flower (2) and *D. kutejensis* flower (3)

of the color of flower come from its parents as genetic character (Hillman 1962).

This study successfully identified the character of Sahang durian as descendants of both durian species with combination character from its parents (*D. zibenthinus* and *D. kutejensis*). Most of Sahang durian morphological character influent by D. kutejensis character as maternal parent (**Table 1**). Sahang durian has similar character with *D. kutejensis* in trunk surface, crown shape, leaf upper color, leaf lower collor, leaf attitude, leaf width, leaf blade width, calyx tooth apex shape, type of stamen, anther number, upper surface of stigma, shape of fruit apex, fruit stalk attachment, shape of fruit base, blossom end, fruit spine density, fruit spine length, flesh aroma, easiness of splitting, seed coat color, and number of fruits per tree. On the other hand, Sahang durian has some blend superior characters like medium-sized fruit, orange color aril, mild aroma like *D. kutejensis*, and has a green color fruit skin, sweet taste, soft and creamy aril like *D. zibenthinus.* All of the unique characters above make sahang durian being an exotic fruit plant, because has combine character between the two most famous durian plants in Indonesia. Therefore, it can be stated that the Sahang durian is a plant derived from the natural cross between *D.zibenthinus* and *D.kutejensis*, and it can be a source of durian fruits genetic diversity from Kalimantan, Indonesia in the future.

CONCLUSIONS

Sahang durian fruit show combination character originated from its parents (*D. zibenthinus* and *D. kutejensis*) such as sweet, thick and soft flesh, mild flesh aroma, fair flesh creaminess, dry texture, non-juicy flesh, and has pink flower color (petal color) which is the blend color from *D.zibenthinus* and *D. kutejensis* flowers color. Another advantage of Sahang durian is it has smaller fruit size compared to *D. zibenthinus* and *D. kutenjensis*. Most people like the fruit with suitable fruits size to consume by one person. Sahang durian character is more dominantly influenced by *D.kutejensis* character, its indicate maternal line has dominant influence compare to paternal parent.

Furthermore, it is necessary to start propagate this plant to maintain the presence of plants that are only found two trees in Batuah Village, Kutai Kertanegara, East Kalimantan Province, Indonesia. This Study will be an important information about sahang durian plant character as the result of natural cross-pollination from *D. zibenthinus* and *D. kutenjensis* and being a base information to protect this varieties as potentially superior local varieties from East Kalimantan, Indonesia.

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