

Leaf Trichome Morphology of *Durio kutejensis* Landraces from Kalimantan

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Abstract

The leaf trichome morphology of 19 *Durio kutejensis* (lai) landraces was studied. The observation of cross- and paradermal sections of *D. kutejensis* leaves showed that all landraces have glabrous leaves on the adaxial surface, while their abaxial surfaces are covered by six trichome types, one glandular (one- or two-celled stalks with a spheroid multicellular glandular head) and five non-glandular (complex peltate, simple peltate, cushioned stellate, flat stellate, and four-armed stellate trichome with a central cushion). All landraces were rarely covered by glandular trichomes. The non-glandular trichomes are varied in type, density, number of layers, diameter, and shape and margin color of the complex peltate among landraces. One landrace comprises three non-glandular trichome types, while the other landraces consist of four or five non-glandular trichome types. The shapes and margin color of complex peltate trichomes of *D. kutejensis* are the specific characteristics which distinguish this species from the other *Durio* species, however these characteristics cannot be used to differentiate one *D. kutejensis* landraces from the other. Therefore, other characteristics need to be explored in order to distinguish one *D. kutejensis* landraces from the other.

Abstrak

Morfologi Trikoma Daun Kultivar-Kultivar Setempat *Durio kutejensis* dari Kalimantan. Morfologi trikoma daun dari 19 kultivar setempat *D. kutejensis* (lai) telah dipelajari. Pengamatan terhadap irisan melintang maupun paradermal daun *D. kutejensis* menunjukkan bahwa semua kultivar setempat mempunyai daun yang gundul pada permukaan adaksial, sedangkan pada permukaan abaksialnya dilapisi oleh enam tipe trikoma, satu tipe trikoma berkelenjar (trikoma bertangkai satu hingga dua sel dengan satu kepala membulat multisel) dan lima tipe trikoma tidak berkelenjar (sisik memerisai kompleks, sisik memerisai sederhana, trikoma membintang pentol, trikoma membintang datar dan trikoma dendritik). Semua kultivar setempat *D. kutejensis* diselubungi oleh trikoma berkelenjar yang jarang sedangkan trikoma tidak berkelenjar memiliki variasi pada tipe, kerapatan, jumlah lapisan, diameter, bentuk dan warna tepi sisik memerisai kompleks di antara kultivar-kultivar setempat. Satu kultivar setempat terdiri dari tiga tipe trikoma tidak berkelenjar, sedangkan kultivar-kultivar setempat lainnya terdiri atas empat atau lima tipe trikoma tidak berkelenjar. Bentuk dan warna tepi sisik memerisai kompleks pada *D. kutejensis* adalah ciri khusus yang dapat digunakan untuk membedakan jenis ini dari jenis *Durio* lainnya, tetapi karakter ini tidak dapat digunakan untuk membedakan satu kultivar *D. kutejensis* setempat dengan lainnya. Dengan demikian, sifat-sifat lain perlu diteliti untuk dapat membedakan satu kultivar *D. kutejensis* setempat dengan lainnya.

Keywords: Abaxial leaf surface, glandular trichome, lai, non-glandular trichome

Introduction

Durio kutejensis (Hassk.) Becc. is a member of the family *Malvaceae*. This species was first described by Beccari in Malesia in 1889. This species is a perennial tree which can be as high as 24-30 m tall and 40-60 cm in stem diameter. Stipules are present but drop early. Leaves with elliptic to oblong, chartaceous, or coriaceous blades are alternately

arranged. It has a green leaf blade that is glabrous or very glossy on the adaxial surface, but its leaves are covered with a few layers of trichomes on the abaxial surface [1-4].

D. kutejensis is considered as a cultivated plant that has an economic value as an edible fruit tree [4-6]. This species has five local names: Lai, Pampakin, Pampaken,

Ruas, and Pekawai [1,3,4,6]. Borneo, as the native area of *D. kutejensis*, provides a wide variety of morphological characteristics. Local people in North Kalimantan, East Kalimantan, and South Kalimantan classify this species into different landraces based on their fruit characteristics [5]; however, due to the seasonal fruiting times, the fruit is not always available throughout the year.

Trichomes in plants are the appendages of epidermal cells that are diverse in form, structure, and function [7-9]. They have a few functions, such as protecting the plant from herbivores, heat, and sunlight, and also for controlling leaf temperature and water loss [10]. A previous study of the leaf trichome morphology on *Durio* has already performed in Malaysia. It showed the trichome feature among *Durio* species and varieties [11], however, there was no report for leaf trichomes among *D. kutejensis* landraces. The main purpose of this study is to observe the variation of morphological characteristics of leaf trichome types on the leaf surfaces of *D. kutejensis* landraces.

Materials and Methods

Plant material was collected from December 2011 to September 2013, taken from areas which cover South Kalimantan, East Kalimantan, North Kalimantan, Central Kalimantan, and West Kalimantan (Figure 1; Table 1).

Fresh and dried leaves from 19 *D. kutejensis* landraces were observed (Table 1), based on the method applied on

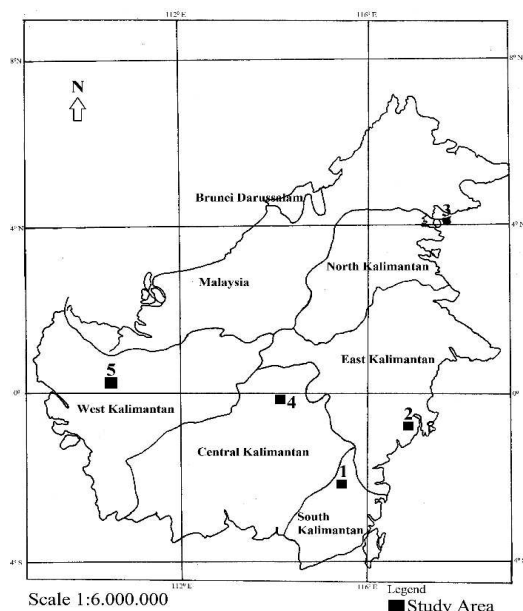


Figure 1: Sampling locations of *Durio kutejensis* landrace: 1) Tabalong regency, South Kalimantan; 2) Kutai Kartanegara regency, East Kalimantan; 3) Nunukan regency, North Kalimantan; 4) Murung Raya regency, Central Kalimantan; and 5) Sanggau regency, West Kalimantan

the previous leaf trichome observation [11,12]. From each landrace, a small leaf piece of 1 cm² was cut from the middle of the leaf (abaxial and adaxial surfaces), then was made cross- and paradermal sections. The abaxial and adaxial surfaces then were scraped and the peelings were pasted onto a glass slide [11,12]. Five slices of leaf were mounted onto a glass slide. All slides were directly observed under a fluorescence microscope and documented using a photomicroscope. The number of trichomes was calculated; there were as many as 25 observations for each *D. kutejensis* landrace using 100x and 400x magnifications.

Micromorphological data of abaxial and adaxial leaf surfaces were collected for each slide. Six micromorphological characteristics were observed, including trichome type (complex peltate shape and color, simple peltate, stellate-cushioned stellate, flat stellate, and four-armed stellate trichome with a central cushion), density, diameter, number of layers, and shape and margin color of complex peltate. The frequency of each trichome type was classified into three categories per 176.63 mm²; i.e., dense (+++) when the number of trichomes was ≥ 40 , intermediate (++) when the number of trichomes was between 21 and 40, and rare (+) when the number of trichomes was ≤ 20 .

Results and Discussion

D. kutejensis leaves have different colors between the adaxial and abaxial surfaces. The color of the adaxial leaf surface is usually green, while abaxial leaves are golden to reddish brown. Adaxial leaf surfaces of all *D. kutejensis* landraces are glabrous, while abaxial leaf surfaces are significantly covered with six trichome types, one glandular and five non-glandular. The glandular trichome type is a one- to two-celled stalk with a spheroid multicellular glandular head (Figure 2a). It covers all *D. kutejensis* leaves with rare density (Table 2). Five non-glandular trichome types comprise the complex peltate, simple peltate, cushioned stellate, flat stellate, and four-armed stellate trichome with a central cushion (Figures 2b-f). Three landraces have all five trichome types, 15 landraces comprise four trichome types, and one landrace has three trichome types (Table 2).

The complex peltate trichomes has an undulating margin, two to five lobes, long fimbriates, one to two fissures (Figure 2b), and a golden basic color. All landraces were covered with densely complex peltate trichomes on the abaxial leaf surface. A few variations were found in the shape and margin color of complex peltate trichome among *D. kutejensis* landraces. All landraces have two until five lobes.

The margin color of the trichomes has three variations, reddish brown, brown, and dark brown. Reddish brown margins were found on 14 landraces, while brown

margins were found on Gincu and Belimbing landraces. Batuah, Durian, and Kesumba landraces have dark brown margins (Table 2).

Some landraces comprises two layers of complex peltate trichomes, but Wild, Batuah, Merah, Gincu, and Pampaken have four layers. The most varied diameters were found in Kuning (347.78-828.51 µm) (Table 3).

The simple peltate trichome has strongly lobed, long fimbriates with no splits (Figure 2c). The densely

simple peltate trichome covers the abaxial leaf of all *D. kutejensis* landraces (Table 2). The trichome type forms five layers on 10 landraces, and nine landraces comprise three to four layers. The most varied diameters of simple peltate trichomes were found on Besar (174.45-500.35 µm) (Table 3).

The cushioned stellate trichome forms more than five rays with a central cushion (Figure 2d). Generally, this type has an intermediate to dense density, but Belimbing and Pampaken have a rare density (Table 2).

Table 1. Leaf Sample List of the Examined *D. kutejensis* Landraces

Landraces Names	Sample Origin	Voucher Location	Collection Number
Lai-1	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 23 (28/1/2012)
Wild	East Kutai, East Kalimantan	Herbarium Bogoriense	Kostermans 4800 (5/5/1951)
Batuah	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 24 (28/1/2012)
Mahakam	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 20 (27/1/2012)
Rudi	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 10 (26/1/2012)
Semangka	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 11 (26/1/2012)
Nangka	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 12, Pri 13 (26/1/2012)
Merah	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pei 14 (26/1/2012)
Kuning	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 15, Pri 16 (26/1/2012)
Besar	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 17, Pri 18, Pri 19 (26/1/2012)
Durian	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 145 (23/2/2013)
Gincu	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 20, 21 (27/1/2012)
Kutai	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 23 (27/1/2012)
Sahang	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 139 (23/2/2013)
Bintang	Sotok village, Sanggau, West Kalimantan	Herbarium Bogoriense	Farisy 1 (30/3/2014)
Bara	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 141 (23/2/2013)
Belimbing	Batuah village, Kutai Kartanegara, East Kalimantan	Herbarium Bogoriense	Pri 142 (23/2/2013)
Kesumba	Sungai Pimping village, Tabalong, South Kalimantan	Herbarium Bogoriense	Pri 153 (26/1/2012)
Pampaken	Sungai Pimping village, Tabalong, South Kalimantan	Herbarium Bogoriense	Pri 114, Pri 115 (16/9/2012) Pri 109 (16/9/2012)

Table 2. Density of Trichome Type, Shape, and Margin Color of Complex Peltate Trichomes

Landraces Name	Adaxial Surface	Trichome Type of Abaxial Leaves						Shape of Complex Peltate Trichome	Margin Color of Complex Peltate Trichome
		I	II	III	IV	V	VI		
Lai-1	-	+	+++	+++	+++	+	-	2-5 lobed, split 1x, long-fimbriated	reddish-brown
Wild	-	+	+++	+++	+++	+++	-	2-5 lobed, split 1-2x, long-fimbriated	reddish-brown
Batuah	-	+	+++	+++	+++	+	-	2-5 lobed, split 1x, long-fimbriated	dark brown
Mahakam	-	+	+++	+++	+++	+++	+	2-5 lobed, split 1x, long-fimbriated	reddish-brown
Rudi	-	+	+++	+++	+++	+	-	3-5 lobed, split 1x, long fimbriated	reddish-brown
Semangka	-	+	+++	+++	+++	++	-	2-5 lobed, split 1x, long-fimbriated	reddish-brown
Nangka	-	+	+++	+++	+++	++	-	2-5 lobed, split 1-2x, long-fimbriated	reddish-brown
Merah	-	+	+++	+++	++	+	-	2-5 lobed, split 1x, long-fimbriated	reddish-brown
Kuning	-	+	+++	+++	+++	++	+	2-5 lobed, split 1-2x, long-fimbriated	reddish-brown
Besar	-	+	+++	+++	+++	+	-	3-5 lobed, split 1x, long fimbriated	reddish-brown
Gincu	-	+	+++	+++	+++	+++	-	2-5 lobed, split 1-2x, long-fimbriated	brown
Kutai	-	+	+++	+++	++	+	-	3-5 lobed, split 1x, long fimbriated	reddish-brown
Sahang	-	+	+++	+++	+++	++	++	2-5 lobed, split 1x, long-fimbriated	reddish-brown
Durian	-	+	+++	+++	+++	++	-	3-5 lobed, split 1-2x, long-fimbriated	dark brown
Bintang	-	+	+++	+++	+++	+++	-	2-5 lobed, split 1-2x, long-fimbriated	reddish-brown
Bara	-	+	+++	+++	+++	++	-	3-5 lobed, split 1x, long fimbriated	reddish-brown
Belimbing	-	+	+++	+++	+	-	-	3-5 lobed, split 1-2x, long-fimbriated	brown
Kesumba	-	+	+++	+++	+++	+	-	2-5 lobed, split 1x, long-fimbriated	dark brown
Pampaken	-	+	+++	+++	+	++	-	3-5 lobed, split 1-2x, long-fimbriated	reddish-brown

Notes: -, absent; +, rare; ++, intermediate; +++, dense; I, one- or two-celled stalks with a spheroid multicellular glandular head; II, complex peltate; III, simple peltate; IV, cushioned stellate; V, flat stellate; VI, four-armed stellate trichome with a central cushion.

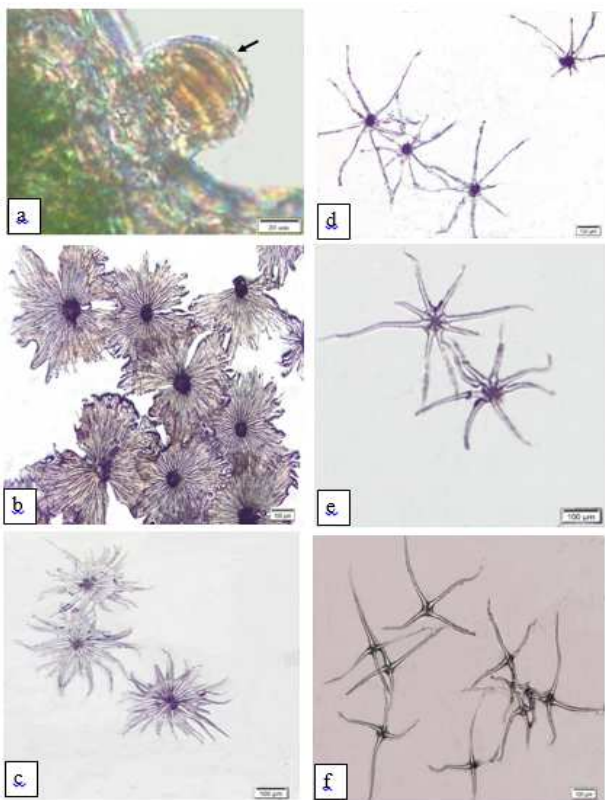


Figure 2. Indumentum Types on Abaxial Surfaces of *D. kutejensis* Leaf Landraces. a) A one- or two-celled Stalks with a Spheroid Multicellular Glandular Head, b) Complex Peltate Trichome, c) Simple Peltate Trichome, d) Cushioned Stellate Trichome, e) Flat Stellate Trichome, and f) Four-armed Stellate Trichome with a Central Cushion

The number of layers of cushioned stellate trichomes on Belimbing is consisted of two layers, while the other landraces has three to five layers. The smallest diameter of this type was found on the Belimbing landrace (97.27-146.44 μm), and the largest diameter was on Wild landraces (560.88-870.21 μm) (Table 3).

The flat stellate trichomes have five rays without a central cushion (Figure 2d). Most landraces have rare to dense density of flat stellate trichomes (Table 2). Lai-1 has the thinnest layers (two layers) of the flat stellate trichomes, while six landraces have the thickest layers (five layers). For flat stellate trichomes, the most varied diameters were found on the Wild landrace (742.90-1101.40 μm) (Table 3).

The four-armed stellate trichome with a central cushion has four rays with a central cushion (Figure 2f). This type was found in three landraces with various (rare to intermediate) density (Table 2). The number of four-armed stellate trichomes with a central cushion layer are varied (one to four layers), and the Sahang landrace has one layer and the most varied diameters of four-armed stellate trichomes with a central cushion (132.21-395.64 μm) (Table 3).

In this research, some additional notes were recorded, including the density of glandular trichomes and non-glandular trichomes, as well as in complex peltate trichome shape, the margin color of complex peltate trichomes, and the diameter of complex peltate trichome characteristics. Some new specific characteristics were also recorded, comprises the simple peltate trichome

Table 3: Layer Numbers and Diameters of Non-Glandular Leaf Trichomes

Landraces Name	Layer Number					Diameter of Trichome Type (μm)				
	I	II	III	IV	V	I	II	III	IV	V
Lai-1	3	4	3	2	-	283.0-555.7	191.8-497.6	229.0-494.0	252.9-364.8	-
Wild	4	4	3	3	-	895.92-1309.58	769.51-998.86	560.88-870.21	742.90-1101.40	-
Batuah	4	5	5	4	-	348.40-505.47	313.24-351.35	264.86-329.45	281.17-377.08	-
Mahakam	3	4	4	4	3	237.12-684.78	404.20-508.86	215.78-616.96	224.33-512.44	137.49-333.66
Rudi	3	3	5	4	-	650.83-762.13	557.41-719.98	416.19-576.32	387.03-518.52	-
Semangka	2	5	5	5	-	681.83-701.18	395.92-400.92	314.17-617.52	321.43-450.81	-
Nangka	2	5	4	5	-	473.08-768.87	342.30-486.30	377.49-641.95	350.89-566.32	-
Merah	4	5	4	3	-	331.77-692.38	243.13-522.64	204.35-566.32	182.89-514.17	-
Kuning	2	3	5	5	4	347.78-828.51	299.73-480.39	207.83-251.40	222.79-265.93	257.05-302.19
Besar	2	3	3	4	-	348.09-760.89	174.45-500.35	220.85-529.19	299.55-463.58	-
Gincu	4	5	3	4	-	409.16-703.95	327.49-527.29	337.49-547.19	340.11-478.29	-
Kutai	2	3	5	5	-	316.46-716.35	394.74-579.09	254.46-495.57	247.87-502.01	-
Sahang	3	5	4	4	1	415.82-444.99	263.65-382.66	452.32-811.03	447.21-790.66	132.21-395.64
Durian	3	4	5	5	-	371.27-597.85	372.86-417.07	339.29-535.17	312.07-497.57	-
Bintang	3	5	5	5	-	474.39-902.58	476.03-574.01	181.43-548.61	196.01-471.77	-
Bara	2	5	4	4	-	522.19-953.51	413.27-453.83	448.21-598.74	432.91-515.02	-
Belimbing	2	5	2	-	-	298.77-597.86	260.03-419.29	97.27-146.44	-	-
Kesumba	2	4	5	4	-	277.42-700.21	368.66-534.17	198.74-647.77	259.90-511.44	-
Pampaken	4	5	3	3	-	348.34-675.95	259.67-445.21	172.49-545.23	220.44-555.25	-

Notes: -, absent; I, complex peltate; II, simple peltate; III, cushioned stellate; IV, Flat stellate; V, four-armed stellate trichome with a central cushion

diameters, cushioned stellate trichomes, flat stellate trichomes, four-armed stellate trichomes with central cushions, layer numbers of five non-glandular trichome types, and margin colors of complex peltate trichomes.

The non-glandular trichome arrangement of *D. kutejensis* landraces is similar to previous descriptions for *D. kutejensis* [3] and *Neesia* [4]. In *Malvaceae*, dense trichomes on abaxial leaf surfaces were also found in many species, i.e., *D. carinatus*, *D. crassipes*, *D. dulcis*, *D. excelsus*, *D. grandiflora* var. *grandiflorus*, *D. grandiflorus* var. *tomentosus*, *D. griffithii* var. *griffithii*, *D. griffithii* var. *acutifolius*, *D. johoricus*, *D. kinabaluensis*, *D. lanceolatus*, *D. lowianus*, *D. macrolepis*, *D. macrophyllus*, *D. malaccensis*, *D. pinangianus*, *D. testudinarum*, *D. testudinarum* var. *crassifolius*, *D. perakensis*, *D. wyatt-smithii* [11], *Kostermansia malayana* [14], *Neesia altissima*, *N. malayana* [12], *Coelostegia griffithii*, and *C. chartacea* [13].

The density of glandular trichomes in this study was a rare density however the previous study [11] mentioned that the density of glandular trichomes was an intermediate one. The complex peltate trichome comprises two to five lobes with a golden basic color, and the margin color is varied from reddish brown, brown, and dark brown. Meanwhile, the previous study mentioned that the complex peltate trichome has four to five lobes that were dark brown and golden in color. The layer number of the complex peltate trichome was not reported in the previous study. The range of complex peltate trichome diameters was wider, 237.12-1309.58 μm (Table 3), than that of the previous study (473-647 μm). Unfortunately, this trichome type could not be used to distinguish one *D. kutejensis* landraces from the other.

Leaf trichomes of *D. kutejensis* landraces have a glandular trichome and five non-glandular trichomes (six trichome types), similar to the previous study [11], but it is differed in the density of each trichome type. The trichome types of *D. kutejensis* landraces were also found on *D. affinis*, *D. crassipes*, *D. dulcis*, *D. excelsus*, *D. grandiflorus* var. *grandiflorus*, *D. grandiflorus* var.

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testudinarum var. *crassifolius*, *D. wyatt-smithii*, and *D. zibethinus*. The diameter of complex peltate trichome of *D. kutejensis* (237.12-1309.58 μm) were not more varied than others (63-1184 μm).

The cushioned stellate trichome is varied from rare to dense density. A previous study has reported that *D. kutejensis* only has a dense density of the cushioned stellate trichome [11]. The layer number and the diameter of cushioned stellate trichomes are the new characteristics which were discovered in this study. They could be used to differentiate among Belimbing with other landraces.

The study is also revealed the variation of the flat stellate trichome density, which was not reported in the previous study [11]. The layer number and diameter of the flat stellate trichome were the only characteristics that could be used to distinguish the Belimbing landrace from others.

The four-armed stellate trichome with a central cushion is also varied in its density, layer number, and diameter, which was the additional information for *D. kutejensis*. The layer number of four-armed stellate trichomes with a central cushion can be used to distinguish Sahang from other landraces.

Belimbing was a very specific landrace. It was easily differentiated from other landraces based on several trichome characteristics, including the smallest trichome type (four types), diameter (97.27-146.44 μm), and two layers of cushioned stellate trichomes. The rare to dense stellate trichomes in this study are differed from those reported by Salma [11], who stated that *D. kutejensis* only has a dense stellate trichomes. However, the stellate trichomes were able to be distinguished between *Neesia altissima*, *N. glabra*, *N. malayana*, *N. pilatiflora*, and *N. synandra* [12].

The leaves datas from several locations were randomly collected and examined, but the trichome characters were similar in many aspects, i.e., type, density, shape and margin color of complex peltate trichomes, number of layers, and diameter among landraces. These characteristics could not be used to differentiate one *D. kutejensis* landraces from the other because the differentiation of density, number of layers, and diameter of leaf trichomes among *D. kutejensis* landraces were the adaptive features to reduce the leaves temperature or to prevent damage when water is not available in their habitat [9].

Conclusions

Six trichome types were found on 19 landraces of *D. kutejensis*, comprise one glandular trichome (one- or two-celled stalks with a spheroid multicellular glandular

head) and five non-glandular trichomes (complex peltate, simple peltate, cushioned stellate, flat stellate, and four-armed stellate trichomes with a central cushion) on the abaxial leaf surface. Trichome characteristics of *D. kutejensis* were more varied than the other *Durio* species in the shapes and margin color of complex peltate trichomes, but these characteristics cannot be used to distinguish one *D. kutejensis* landraces from the other.

Acknowledgments

We would like to thank the Director of Herbarium Bogoriense for voucher specimens from Central Kalimantan; the Chairman of the Food Laboratory, Islamic State University, for Fluorescent microscopic imaging; and Dr. Rugayah and Dr. Himmah Rustiami from the Research Center for Biology, Indonesian Institute of Sciences for suggestions.

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