



Fruit Morphology Characteristics of *Durio lowianus* Scort. Ex King In Kuala Lipis, Pahang

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Abstract

Durian (*Durio* sp.) is one of the main agricultural commodities in Southeast Asia. Besides the well-known *Durio zibethinus*, there are eight others edible *Durio* species, including *Durio lowianus*. This study aimed to observe and record the morphological characteristics of *D. lowianus* fruit in Kuala Lipis, Pahang, for species identification. Fruit-based morphological identification can assist farmers in recognising and differentiating durian species and support breeding programs aimed at producing high-quality durian. Observations of *D. lowianus* fruits were conducted according to the guidelines of the Malaysian Department of Agriculture, involving forty-three parameters categorised into external and internal structures. The main parameters observed were size, shape, colour, and aril characteristics. The results showed that fruit weight ranged from 1.14 kg to 1.22 kg, with oval and round shapes and a bright yellow-green colour. The aril was light greenish yellow with a thickness of 0.2 cm to 0.23 cm. This research depicted that external and internal morphological data of durian fruits are valuable in recognising *D. lowianus* species.

Keywords: Fruit, *Durio lowianus*, Kuala Lipis, durian

Introduction

Durian (*Durio* sp.) has become one of the main sources of agricultural commodity for many Southeast Asian countries including Malaysia. *Durio zibethinus* L. or its local name, durian, is commonly known as the 'King of Fruit' in countries of Southeast Asia such as Malaysia, Indonesia and Thailand (Teh et al., 2017); (Husin et al., 2018). In Malaysia, *Durio* is classified as an underutilised fruit, although *D. zibethinus* (Durian) is a well-known commodity with a high potential as an agricultural resource (Khoo et al., 2016). A study done by MARDI revealed that Kuala Lipis, Pahang had the highest underutilised fruit species richness in Peninsular Malaysia (Nordin et al., 2015).

Durio sp. or durian is a Southeast Asian tropical plant that belongs to the Malvaceae family and Helicteroideae subfamily (Teh et

al., 2017). In Southeast Asia, it is named as durian after the Malay word 'duri' which means spine due to its spiny characteristics (Sudarmono et al., 2023). Durian is universally known as 'King of Fruits' for its hefty, spine-covered fruit, sweet custard-like aril flesh and remarkable sulphury odour (Husin et al., 2018). The texture and aroma are two primary characteristics that determine the market demand for durian fruits through customer's perspective (Husin et al., 2018). Currently, 25 species of *Durio* have been recognised in Malaysia, with 13 species found in Sabah, 16 species in Sarawak and 13 species in Peninsular Malaysia. (Thorogood et al., 2022). While 16 are classified as endemic species, 9 are edible, namely *D. zibethinus*, *D. kutejensis*, *D. dulcis*, *D. excelsus*, *D. testudinarium*, *D. oxleyanus*, *D. grandiflorus*, *D. graveolens* and *D. lowianus* (Mursyidin et al., 2022).

D. lowianus (Durian daun) have previously been found in Peninsular Malaysia and Sumatera, Indonesia (O'Gara et al., 2004). Vegetation analysis carried out in the interior of Siberut Island, Mentawai Island District, West Sumatra, Indonesia identified *D.*

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lowianus as one of the most significant trees that plays an important role in providing essential food resources to the local community (Indra et al., 2024). Other than as food resources, the timber of *D. lowianus* is also used for construction purposes and thus lead to overharvesting and exacerbating the species loss (Syamsuardi et al., 2022). Due to this, *D. lowianus* was found to be vulnerable (VU) based on the IUCN Red List of Threatened Species (Malaysia Biodiversity Information System, 2021).

D. lowianus inhabits rainforests at altitudes of up to 150 m, with a medium-sized tree that can reach heights of 50 m, with a trunk diameter of up to 90 cm and characterised by steep, short buttresses (Lemmens et al., 1995). This species is closely related to *D. dulcis* but varies in fruit colouration. *D. lowianus* possesses a dark yellow, consumable pulp and smaller fruit compared to *D. zibethinus* (Wyatt-Smith, 1953); (Soegeng-Reksodihardjo, 1962). A recent *in-silico* analysis done using internal transcribed spacer (ITS) region to study the genetic diversity and relationship of *Durio* sp. revealed that *D. zibethinus* is closely related to *D. lowianus* and very far from *Durio griffithii* (Mursyidin et al., 2023). *D. zibethinus* and *D. lowianus* have similar morphological characteristics such as calyx, the arrangement of filament and anther architecture (Nyffeler & Baum, 2000). Other than that, research assessing the resilience of *Durio* sp. to stem canker induced by *Phytophthora palmivora* demonstrated that a specific *D. lowianus* accession from Jerangau, Terengganu exhibited resistance, with lesions less than 5 mm after 20 days of inoculation (Nik Masdek, 2009). This finding suggests that *D. lowianus* exhibits tolerance to patch canker and may serve as rootstock for commercially available clones (Nik Masdek, 2009).

In Pahang, *D. lowianus* can be found in Kuala Lipis. The region features a diverse array of flora, encompassing native hardwood species, medicinal plants, fruit trees, and rare endemic species that enhance the ecological balance of the area. Despite the cultivation and

commercialization of *D. lowianus* in various locations such as Kuala Lipis Pahang, detailed morphological studies on this species remain exceedingly limited. Most research efforts have focused on the more commercially successful *D. zibethinus*, leaving a gap in the scientific understanding of the lesser-known species within the *Durio* genus. *D. lowianus*, with its unique traits and ecological significance, has been largely overlooked in terms of comprehensive morphological characterisation, which is critical for precise species identification and potential agricultural development. Thus, this study aims to observe and record morphological characteristics of *D. lowianus* fruit in Kuala Lipis, Pahang.

Materials and Methods

The fruit morphology of *Durio lowianus* samples was determined based on fresh samples collected from Kuala Lipis, Pahang, Malaysia. Six replicates were taken and observed. The observations involved external characteristics such as fruit surface, rind, spine architecture, pedicel characteristics, apex and base characteristics and internal characteristics which were fruit size, segment characteristics, aril characteristics, seeds characteristics and number of seeds per fruit. Fruit parameters such as length, width and circumference were measured using a ruler and measuring tape. A weighing balance was used to determine the weight of the sample. The density of matured spines was determined by calculating the spines under a quadrant of 25cm² randomly placed at the upper, middle, and lower parts of the fruit. The colour of all fruit parts was determined based on Royal Horticultural Society (RHS) Colour Chart (2019). Subsequently, the fruit morphological structures of the collected samples were analysed and identified by comparing them with DOA's National Guideline for the "Conduct of Tests for Distinctness, Uniformity and Stability on Durian" (DOA, 2018) and descriptive terminology described by Simpson (2010).

Results and Discussion

Table 1.0 External and internal characteristics of *D. lowianus* from Kuala Lipis, Pahang

No.	Fruit parts	Parameters	Characteristics
1.	External surface	Fruit shape	1. Oval 2. Circular
		Fruit symmetry	Symmetry
		Fruit colour	Strong yellow-green (N144 C)
		Depth of groove	Absent or weak
		Line dividing sections at ridges	1. Weak 2. Medium
2.	Spines' architecture	Small spines along the line dividing sections	Absent
		Spine type	Conical
		Spine length	0.4 cm - 1.7 cm
		Spine width	0.3 cm – 0.8 cm
		Density of matured spines in 25 cm ²	24 – 26
3.	Rind's architecture	Spine colour	Strong yellow green (N144C)
		Spines' ends colour	Brownish orange (164A)
		Rind weight	159.7 g - 177.7 g
		Rind length	14.8 cm - 15.9 cm
		Rind width	1.8 cm
4.	Pedicel's architecture	Total of rind	5
		Pedicel length	2.0 - 2.1 cm
		Pedicel diameter	11.2 mm - 11.7 mm
		Pedicel colour	Moderate reddish brown (166 B)
		Presence of spines around the base of the pedicel	Present
No.	Fruit parts	Parameters	Characteristics
5.	Apex characteristics	Apex shape	Cordate
		Presence of spines on apex	Present
		Spines curvature at apex ends	Strongly curved
		Area of spines at the stylar ends	Small
6.	Base characteristics	Base shape	Rounded
		Presence of spines at base	Present
		Spines curvature at base ends	1. Straight 2. Strongly curved
7.	Fruit size	Fruit length	15.3 cm - 16.5 cm
		Fruit width	14.5 cm – 14.7 cm
		Fruit diameter	50.6 cm - 51.2 cm
		Fruit weight	1.14 kg – 1.22 kg
		Percentage to overall fruit weight	Aril only weight to overall fruit weight: 12.24%
			Rind only weight to overall fruit weight: 77.03%
			Aril + seed weight to overall fruit weight: 25.98%
8.	Aril's characteristics	Seed only weight to overall fruit weight: 14.61%	
		Thickness of aril	0.20 cm – 0.23 cm
		Colour of aril	Light greenish yellow (6D)

9.	Segment's characteristics	Segment length	14.82 cm - 15.82 cm
		Segment width	7.05 cm - 7.32 cm
		Pericarp thickness	1.77 cm - 1.83 cm
		Colour of segments	White (NN155)
10.	Seed's characteristics	Number of seeds per fruit	6-8
		Weight (seed only)	160.33 g - 177.67 g
		Shape	Ellipsoid, oblong, obovoid
		Colour	Moderate orange (N167 C)
		Seed length	4.77 cm – 4.99 cm
		Seed width	2.29 cm – 2.50 cm
		Seed diameter	8.26 mm – 9.18 mm
		Percentage of viable seed	95.8% - 100%

External Structure

Fruit surface

The fruit shape of *D. lowianus* were either oval or circular (Figure 1). Fruit shape variation helps in *D. lowianus* identification as it differentiates it from other *Durio* species such as *D. grandifloras* which was reported to be ellipsoid (Kostermans, 1958). The fruit shape is similar to existing registered *D. zibethinus* varieties (Musang King and Beserah) as reported in Department of Agriculture (DOA) (2018). It is also similar to *D. graveolens* and *D. kutejensis* as reported by DOA Sarawak.

The diversity of fruit colours plays a crucial role in attracting animals that eat the fruits and facilitating seed dispersal (Wang et al., 2015). The colour of *D. lowianus* fruits is strong yellow green (Figure 1). The fruit colour is similar to the colour of *D. zibethinus* fruits that was found to be yellow-green to brown colour (Shamin-Shazwan et al., 2022a) but different from *D. graveolens* that has orange yellow to orange fruit colour (Kurdianata et al., 2020). The fruit skin colour is also almost similar to the newly discovered arilless *Durio* sp., *D. gerikensis* which have green to golden yellowish fruit skin (Ghazalli et al., 2022).

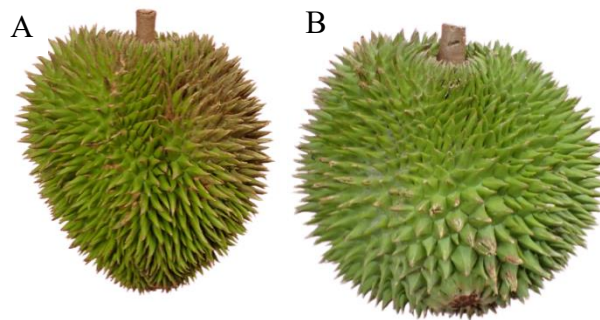


Figure 1: Fruit of *D. lowianus* (A) oval shape, (B) circular shape

Generally, there were three types of fruit bases: acute, rounded and cordate and three types of fruit apices: pointed, rounded and retuse (DOA, 2018). *D. lowianus* had rounded to cordate base with the spines at the base ends ranging from straight to slightly

curved. It also had rounded fruit apex with the spines at the apex ends were strongly curved. Additionally, *D. lowianus* were also symmetrical and had weak groove depth (Figure 2). The weak depth of groove feature is similar to Durian Beserah (D145).

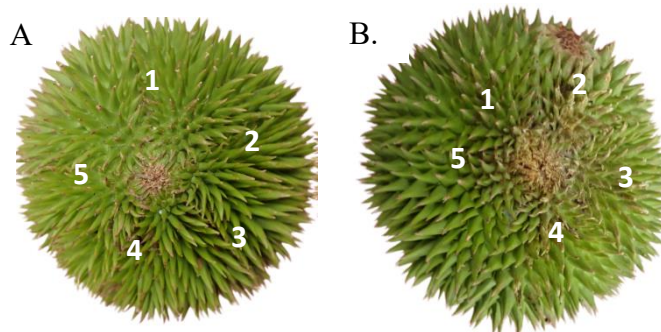


Figure 2: Presence of ridges in *Durio lowianus* A) Medium B) Weak

According to DOA (2018), durian producers and the enthusiasts can easily identify Musang King (D197) due to the notable presence of ridges at the dividing section line. This shows that the ridges presence is one of the significant durian fruit's morphology features that can be used for species or cultivar characterisation and classification. The features are also mentioned in a study done by Shamin-Shazwan et al. (2022a) where they found that the ridges along the dividing sections of *D. zibethinus* fruits were ranging from weak to strong. In contrast, this study depicted that *D. lowianus* had a weak to medium ridge presence along the line of dividing sections. This result shows that *D. lowianus* have different feature than *D. zibethinus* and therefore these characteristics can be used to differentiate between these two species.

Rind characteristics

In the study of *Cucumis melo*, Keren-Keiserman et al. (2004) mentioned that in addition to serving as a barrier against mechanical damage throughout the pre- and postharvest stages, rind features are among the significant indicators of fruit maturity and quality. Therefore, it is crucial to investigate this morphological feature in *Durio*, as rind characteristics can serve as valuable indicators for assessing the fruit's ripening stage. This data can provide insights into optimal harvest times and post-harvest handling to ensure fruit quality. This study shows the rind length and rind width for matured *D. lowianus* ranged from 14.8 cm to 15.9 cm and 1.8 cm, respectively.

Generally, *Durio* rinds are categorized as wastes that will be disposed to the environment and it has become concerning as the quantity of durian rind waste is growing yearly (Nguyen et al., 2024). Recent studies have taken the initiative to discover the potential usage of durian rind in producing value-added products such as biodegradable

packaging with high tensile strength and stiffness (Tan et al., 2023), low-cost adsorbents that will be useful to remove water pollutants (Nguyen et al., 2024) and natural fibre for textile industry (Lubis et al., 2018). In Malaysia, durian varieties generally comprised approximately one-third of edible fresh aril, with the remaining weight consisted of inedible parts which include 67% - 70% rinds and 20% - 25% seeds (Shamin-Shazwan et al., 2022b). This statement is in line with our findings in which the average rind weight of *D. lowianus* was 909.67 g and the average percentage of rind to total fruit weight was 77.03%. The high percentage of rind weight to total fruit weight shows that rind of *D. lowianus* may offer a significant number of raw materials for further study into durian value-added products for durian and for usage in industry.

Spine's architecture

The distinctive characteristic of *D. lowianus* that set it apart from other *D. zibethinus* is its curved conical spines. The curvature of the spines makes it easier for the farmers to differentiate between *D. lowianus* and *D. zibethinus*. The conical spine shape of *D. lowianus* is the same as *D. graveolens* studied in Kalimantan, Indonesia (Kurniadinata et al., 2020) but different with *D. zibethinus* which have broadly pyramidal spine. Based on Sundari and Roini (2018) spine length can be categorised into three groups: short (less than 1.00 cm), intermediate (between 1.10 cm to 1.50 cm) and long (above 1.51 cm). In this study, *D. lowianus* had long spines ranging from 0.4 cm to 1.7 cm, spines width ranging from 0.3 cm to 0.8 cm and covered with brown-coloured ends. Similar findings from a study conducted on Pulau Laut, South Kalimantan, Indonesia, indicated that *D. dulcis*, *D. oxleyanus*, and *D. zibethinus* have long spines, in contrast to *D. kutejensis*, which has small spines (Sudarmono et al., 2023).

In this study, spines density is categorised into three density categories; sparse

(less than 19 spines), medium (20-24 spines) and dense (more than 25 spines) within 25cm² quadrant. This study revealed that the spines

density of *D. lowianus* were dense at the fruit apex and base and medium at the middle of the fruit (Figure 3).

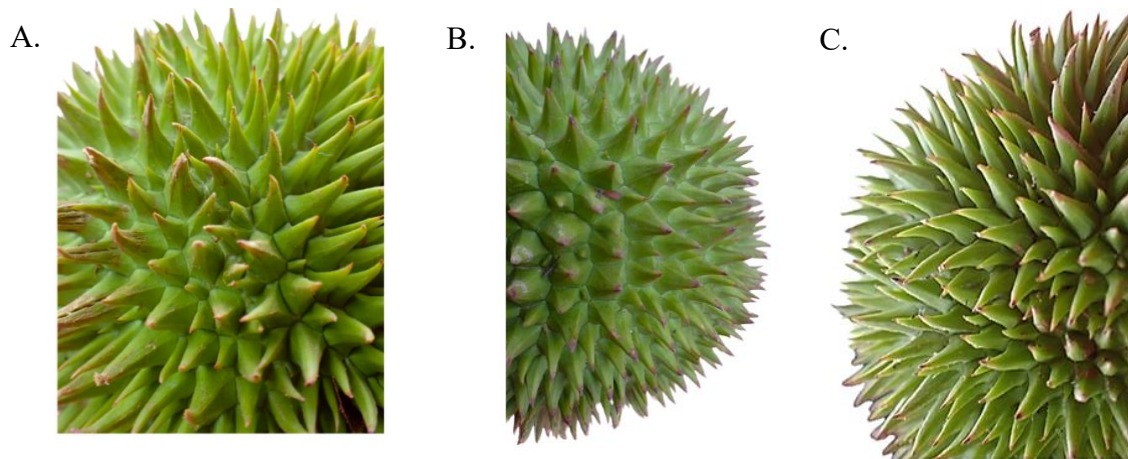


Figure 3: Curved conical Spines of *Durio lowianus* A) Dense spine density at fruit apex B) Medium spine density at middle of the fruit C) Dense spine density at fruit base

Pedicle characteristics

The pedicel of *D. lowianus* was in moderate reddish-brown colour with short and thin pedicel ranging from 2.0 -2.1 cm, while diameter was around 11.2 mm to 11.7 mm.

Strongly curved spines were observed around the base of the pedicel of *D. lowianus* (Figure 4). This characteristic is similar to Durian Beserah (D145) and Durian Hajah Hasmah (D168) (DOA, 2018).

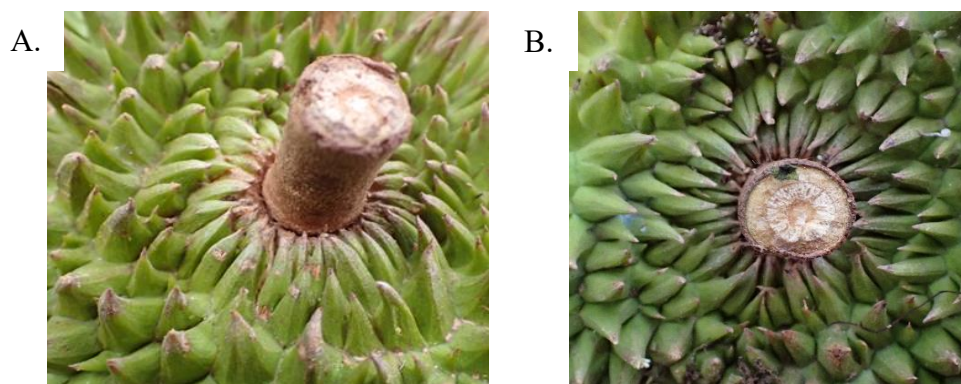


Figure 4: Presence of strongly curved spines around the base of both *D. lowianus* pedicel in (A) and (B)

Internal Structure

Fruit size

Generally, fruit size is an economically important factor that facilitates in determining fruit quality and fruit maturity.

The appropriate size of fruits will add an additional value to the products as it is one of the concerning factors by the durian fruit consumers. As *D. lowianus* is found in the wild and not cultivated, it is important to determine the fruit quality of *D. lowianus*

through fruit size. The findings revealed that the fruit length of *D. lowianus* ranging from 15.3 cm to 16.5 cm, the width ranging from 14.5 cm to 14.7 cm and the circumference ranging from 50.6 cm to 51.2 cm. This shows that the average fruit size of *D. lowianus* are considered small to medium.

Among the morphological traits, fruit weight plays a significant role in determining market demand, particularly for registered cultivars like D168 Hajjah Hasmah (1.5 kg) and D175 Udang Merah, which exhibits a wider weight range of 1.5–3.0 kg (DOA, 2018). This characteristic also has become an important element in determining other the quality of other fruit productions. The fruit weight can be categorised into four categories: small (less than 1.5 kg), medium (1.6 kg – 2.5 kg), large (2.6 kg – 3.5 kg) and extra-large (>3.6 kg) (Sundari and Roini, 2018). The fruits of *D. lowianus* are categorised as small fruit as its overall fruit weight ranging from 1.14 kg to 1.22 kg.

Aril characteristics

Aril colour is a widely utilized trait in evaluating the quality of durian species. *D. lowianus* had light greenish yellow aril colour (Figure 5). This colour is distinct as compared to *D. graveolens* which aril colour varies from pale yellow to deep yellow, orange and crimson red (Lim, 2012; Sujang et al., 2023). The result is also a bit different from *D. zibethinus* which have aril colour

ranging from pale yellow to dark yellow and yellowish orange (Idris et al., 2018). In a recent study, *D. kutejensis* was reported to have a more appealing appearance than the edible *D. dulcis* and *D. oxleyanus*, attributed to its yellow to orange-gold coloration rather than the pale-yellow color observed in the other species (Sudarmono et al., 2023). This shows that the aril colour of *D. lowianus* studied in this research is different from *D. kutejensis* which have a brighter yellow to orange colour.

The average percentage of aril and seed to total fruit weight was 25.98%. Meanwhile, the average percentage of aril only to total fruit weight was 12.24%. The percentage of aril in *D. lowianus* is lower compared to the percentage of aril in *D. zibethinus* which is 12% to 26% as reported by Shamin-Shazwan et al. (2022a). This is due to *D. lowianus* having smaller and thinner aril compared to *D. zibethinus*.

Aril thickness can also be classified into three qualities: Grade A (premium quality: more than 1.0 cm), Grade B (average quality: 0.5 cm – 0.99 cm) and Grade C (low grade: below 0.49 cm) (Shamin-Shazwan et al., 2022a). This study revealed that the aril thickness of *D. lowianus* is between 0.20 cm to 0.23 cm (Figure 5). This result shows that *D. lowianus* have thinner aril as compared to *D. zibethinus* which ranges from 0.23 cm to 1.17 cm as reported by Shamin-Shazwan et al. (2022a).

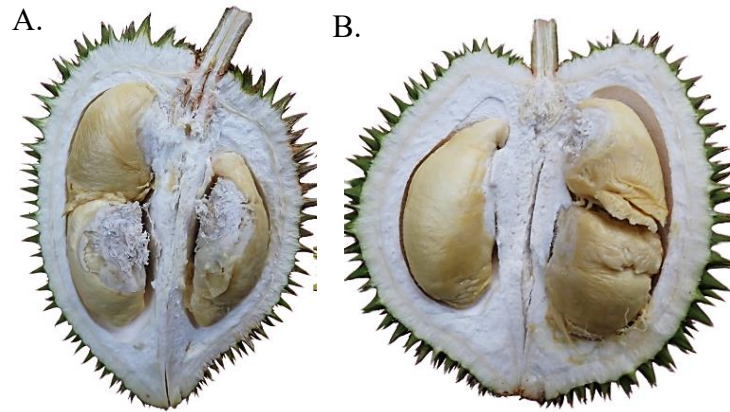


Figure 5: The colour of *D. lowianus* aril is light greenish yellow with 0.20 – 0.23 cm aril thickness for both (A) and (B)

Segment characteristics

In a morphological analysis by Sawitri et al. (2019), segment traits were used as supplementary parameters to assess phylogenetic variation in durian, with results indicating that *Durio* typically has four to seven segments. (Shamin-Shazwan et al., 2022a). This study reveals that *D. lowianus* produces fruit with five segments. The length of segments for *D. lowianus* ranging from 14.82 cm to 15.82 cm, the segment width ranging from 7.05 cm to 7.32 cm. Meanwhile, the pericarp thickness ranged from 7.05 cm to 7.32 cm and white in colour.

Seed characteristics

The average seed weight was 160.33 g to 177.67 g. The seed shapes were ellipsoid, oblong or obovoid. The ellipsoid seed shape is similar to seed of *D. graveolens* (Kurniadinata et al., 2020) and *Durio kutejensis* (Seng et al., 2020). The seed colour was moderate orange and this colour is different from *D. graveolens* and *D.*

kutejensis which have glossy brown colour seed (Seng et al., 2020). The fruits had high percentage of viable seed, ranging from 95.8% to 100%. The results indicate that *D. lowianus* produces high-quality viable seeds, which possess significant potential for use as rootstock in the propagation of durian (Figure 6)



Figure 6: Seeds of *Durio lowianus*

CONCLUSION

This study found that external and internal morphological data are valuable in recognising and categorising *D. lowianus*. The external morphological factors such as shape, fruit colour, apex and base shape and spine characteristics may be utilised in initial identification of *D. lowianus*'s fruit. The internal structure may be useful to assess the potential and quality of fruit. In addition, two crucial parameters, the percentage of fresh aril weight over total weight and aril thickness must be taken into account in determining fruit quality. *D. lowianus* of Kuala Lipis accessions have the potential to be commercialised for its unique taste and high percentage of viable seed. However, further research is required with larger sample size per accession in order to gain consistency of data.

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