

Chemical compositions and volatile compounds of Sabah indigenous durian (*Durio dulcis* Becc.)

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Abstract

The objective of this present work is to determine the chemical compositions and volatile compounds of Sabah indigenous durian (*Durio dulcis* Becc.). The results obtained showed that durian had 56.1% moisture, 3.5% protein, 2.8% fat, 1.4% ash, 36.26% carbohydrate, 6.6% dietary fiber and 7.0 µg of vitamin A. The mineral analysis results indicated that *Durio dulcis* is a good source of potassium, magnesium and phosphorus. Protein analysis found a total of sixteen major amino acids present in durian namely aspartame, serine, glutamin acid, glycine, histidine, arginine, threonine, alanine, proline, tyrosine, valine, methionine, lysine, isoleusine, leusine and phenylalaine. A total of thirty-three individual fatty acids components were analysed. Among those, palmitic acid was a predominant saturated fatty acid while oleic acid was the most abundant unsaturated fatty acid. The composition of fatty acids showed that total of monounsaturated fatty acids, polyunsaturated fatty acids and saturated fatty acids were 56.7%, 6.7% and 36.6% respectively. A total of thirty-one volatile compounds were identified, among which alcohols, esters, sulphur-containing compounds and ketones were found to be the major constituents.

1. Introduction

While research efforts are concentrated in developing the better known local tropical fruits, very little work has been done on indigenous fruits which are found only in certain localised areas of Malaysia. Many of those fruits are unknown outside the areas where they are found. In Sabah, many interesting but lesser fruits have been reported (Noorfarahzilah *et al.*, 2017; Jahurul, Ping, Sharifudin *et al.*, 2019; Noorfarahzilah *et al.*, 2020). Among these fruits, there are some species that possess the potential to be added to the list of promising tropical fruits in the country (Jahurul *et al.*, 2018; Jahurul, Leykey, Rovina *et al.*, 2019; Norazlina *et al.*, 2020). *Durio dulcis*, locally known as 'durian merah', the fruits are small, green to orange in colour while the aril is red or orange and without the typical strong aroma under durian classes.

Durian (*Durio zibethinus*), a member of the Bombaceae family, is one of the most well-known tropical fruits in Southeast Asia, while *Durio graveolens* and *Durio dulcis* are the famous durians for people in Borneo Island and both of these durians are widely consumed by people in Sabah, Sarawak as well as

Brunei. However, despite the popularity of *Durio zibethinus* the over variety of durians could not be found in other places in Southeast Asia except in Borneo. These varieties of durian are important to local people and can only be found in a market as 'Tamu'. Traditionally, local people consumed it raw or preserved with salt before eaten. Although the tree of these durians is grown wild, the high demand for these varieties of durian is due to them believing that it has its medicinal effects and make this durian quite expensive compared to other types of durian.

The scientific findings of indigenous durian from Sabah are scarce. Most of the literature reported on the research conducted for *Durio zibethinus* (Lee-Hoon and Rajeev, 2015; Aziz and Jalil, 2019). Nasaruddin *et al.*, (2013) reported the proximate and fatty acid compositions of yellow durian (*Durio graveolens*) obtained from Sabah, Malaysia. Due to limited information that has been reported with regards to *Durio dulcis* Becc., this study was conducted in order to determine the chemical and fatty acid composition of Sabah indigenous durian.

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2. Materials and methods

2.1 Preparation of processed durian

Durian fruits (*Durio dulcis* Becc) were obtained from a farm in Sipitang, Sabah, Malaysia (Figure 1). Ripened durian fruits that dropped naturally were collected and transported within 2 hrs on the same morning (at 30±2°C). Fruits were selected for uniformity of size and freedom of visual defects and were dehusked (the rind was cut open), by cutting along the suture on the back of the locules. Upon cutting, 4–6 separated fruit arils (350–420 g) were packed together. Care was taken not to break the epidermis of the pulp when removing it from the husk. The pulps were placed on polystyrene trays and wrapped in a commercially available low-density polyethylene (LDPE) cling film.



Figure 1. *Durio dulcis* morphology

2.2 Chemical composition and volatile compound analysis

The chemical composition and volatile compound analysis were carried out by an accredited commercial laboratory (Unipeq Sdn Bhd).

2.2.1 Proximate composition and mineral analysis

AOAC protocol (1995) was used to determine protein (981.10), fat (991.36), dietary fibre (991.43), moisture (950.46), ash (923.03) and vitamin A (960.45). Carbohydrate was determined by the difference method (Mamat *et al.*, 2018). For mineral quantification, the elements of Ca, K, Na and Mg were measured by atomic absorption spectrophotometry (AAS) using a Varian Spectra atomic absorption spectrophotometer, model A-400. Phosphorus was measured by Inductively coupled plasma mass spectrometry (ICP-MS).

2.2.2 Fatty acid composition measurements

To determine the fatty acid compositions, fat content was analysed using gas chromatography equipped with flame-ionisation detection (GC-FID) with fatty acids methyl ester standard. Gas chromatography analysis was conducted using an Agilent 6890 GC with a flame ionisation detector (FID) (Agilent Technologies, USA) and a 30 m × 0.32 mm × 0.25 µm film thickness Restek Fawewax column. Typical run conditions were – injector temperature 250°C, detector 275°C, hydrogen carrier gas at 2.5 mL/min, a split ratio of 100:1, the make-up flow of

45 mL/min. The initial oven temperature was 190°C held for 1 min, then ramped at 5 °C/min to reach the final temperature of 235°C and held for 2 mins.

2.2.3 Amino acid determination

The determination of amino acids was conducted by using HPLC-AccQ-Tag method.

2.2.4 Volatile organic compound determination

The composition of the volatile fraction of durian sample was investigated using a headspace sampling technique and gas chromatography coupled to mass spectrometry analysis (GC-MS).

3. Results and discussion

This study found that durian *Durio dulcis* consist of 56.1% moisture, 3.5% protein, 2.8% fat, 1.4% ash, 36.26% carbohydrate and 6.6% of dietary fibre (Table 1). The results show that this durian could provide a significant amount of protein and fat in our diet. The amount of protein, fat, ash and carbohydrate obtained were higher as compared to *Durio zibethinus* (Lim and Kamaruzzaman, 1990; Belgis *et al.*, 2016) and *Durio kutejensis* (Hoe and Siong, 1999). The differences between the results obtained might be due to cultivar, location of growth, climate, environmental conditions and soil type (Bishnoi and Khetarpaul, 1993). The environment of different locations plays an essential role in the determination of the nutritional composition of durian. The dietary fibre content of *Durio dulcis* was relatively higher (as compared to other fruits) where it's contributing 6.6 g/100 g of the durian. Studies show that dietary fibre has demonstrated benefits for health maintenance and disease prevention where fibre is help for easy digestion, prevents constipation and bloating as while as contributing to colon health. Fibre may also play a role in regulating cholesterol levels and so helps to reduce the risk of heart disease (Marlett *et al.*, 2002). This study also found that *Durio dulcis* contains a

Table 1. Chemical and mineral compositions of *Durio dulcis*

Parameter	Amount
Protein, g/100 g	3.5
Fat, g/100 g	2.8
Carbohydrate, g/100 g	36.2
Ash, g/100 g	1.4
Moisture, g/100 g	56.1
Dietary fiber, g/100 g	6.6
Energy, kcal/100 g	184 (773 kJ)
Calcium, mg/100 g	181.2
Potassium, mg/100 g	4358.6
Magnesium, mg/100 g	413.1
Sodium, mg/100 g	67.3
Phosphorus, mg/100 g	326.9

significant amount of vitamin A (7.0 mg/100 g). Vitamin A is an important macronutrient because it plays essential roles in vision, growth, and development; the development and maintenance of healthy skin, hair, and mucous membranes; immune functions; and reproduction.

Mineral analysis results found that *Durio dulcis* is a good source of potassium and magnesium where the amount of these elements was 4358.60 and 413.10 mg/100 g, respectively. Dietary potassium intake is reported to have antihypertensive effects, prevents strokes, and improves cardiovascular outcomes (Penton et al., 2015). Magnesium plays a vital function in several essential cellular processes such as intermediary metabolism, DNA replication and repair, transporting potassium and calcium ions, cell proliferation together with signalling transduction (Blaszczyk and Duda-Chodak, 2013). Moreover, this variety of durian also provided phosphorus, calcium and sodium (329.9, 181.2 and 67.3 mg/100 g, respectively). The trend of the results obtained in this investigation is in agreement with the findings reported by Charoenkiatkul et al. (2016). In general, the composition of minerals in durians are influenced predominantly by the soil in which the plants are cultivated.

Amino acids are essential precursors for the production of hormones and low-molecular weight nitrogenous components, with each having extensive biological importance (Wu, 2009). Table 2 lists the amount (grams per 100 g) of sixteen amino acids determined in this present study. The acid amino profile revealed that the primary amino acids in the aril of durian were valine (0.459 g/100 g), alanine (0.447 g/100 g), glutamic acid (0.348 g/100 g), proline (0.333 g/100 g), leucine (0.249 g/100 g) and lysine (0.224 g/100 g). All of the essential amino acids were detected in the durian sample except tryptophan. These essential amino acids accounted for approximately 41% of the total amino acid composition of the durian sample. Wu (2009) defined essential amino acid as either those amino acids whose carbon skeletons cannot be synthesised or those that are inadequately synthesised de novo by the body relative to needs and which must be obtained from the diet to achieve sufficient requirements. These amino acids play a substantial role in numerous processes, including energy metabolism, enhancing the immune function, tissue development, as well as nutrient absorption (Wu, 2010). The quality of proteins depends mainly on their amino acid concentration, especially their composition of essential amino acids. Other amino acids also present but with little amount. The presence of several amino acids such as alanine, proline, phenylalanine and isoleucine could contribute to the

bitter taste of durian (Belgis et al., 2016). Amino acids are contributed to fruit flavours, by acting as precursors of volatile compounds involved in fruit aromas (Tieman et al., 2006). Several volatile compounds are produced by the action of enzyme systems on amino acids when the tissue of the vegetable is damaged (Christensen et al., 2007).

Table 2. Amino acid profiles of *Durio dulcis*

Amino Acid	Amount (% w/w)
Essential	
Histidine	0.017
Threonine	0.117
Valine	0.459
Methionine	0.073
Lysine	0.224
Isoleucine	0.112
Leucine	0.249
Phenylalanine	0.119
Non-essential	
Serine	0.155
Glycine	0.133
Aspartic acid	0.311
Arginine	0.153
Glutamic acid	0.348
Alanine	0.447
Proline	0.333
Tyrosine	0.107

Fatty acids are important as a source of energy source and membrane constituents. They have biological activities that act to regulate cell and tissue metabolism, function, and responsiveness to hormonal and other signals (Calder, 2015). Fatty acid composition analysis of durian found a total of thirty-three individual fatty acid components in extracted fat. Among those, palmitic acid (C16:0) was a predominant saturated fatty acid (31.0%) while oleic acid (C18:1) was the most abundant monounsaturated fatty acid (52.6%). Palmitic acid is the major fatty acid occurring naturally in animals and vegetables as well as is the main component of human milk fats. Other fatty acids were also identified as α -linolenic (C18:3n3), cis-linolenic (C18:2n6c), trans-linolelaidic (C18:2n6t), palmitoleic (C16:1), pentadecanoic (C15:0) and myristic acids (C14:0), where their amount was less than 2% respectively. The composition of fatty acids showed that a total of monounsaturated fatty acids, polyunsaturated fatty acids and saturated fatty acids were 55.61%, 7.28% and 37.06% respectively (Table 3). The relationship between saturated and polyunsaturated fatty acid content is expressed as P/S index. This value is an important parameter for the determination of the nutritional value of particular oil. Oils and fats with a higher value of P/S index than 1 are considered to have nutritional value (Kostik et al., 2013). The value of P/S index for the durian sample was 1.25. A study by Phutdhawong et al.,

Table 3. Classification of saturated fatty acids, unsaturated fatty acids, and omega in methyl ester of *Durio dulcis*

Structure	Fatty acid methyl ester	% of fat extracted	Classification*
C8:0	Caprylic	0.04	SFA
C10:0	Capric	0.1	SFA
C11:0	Undecanoic	0.38	SFA
C12:0	Lauric	0.58	SFA
C13:0	Tridecanoic	0.15	SFA
C14:0	Myristic	0.88	SFA
C14:1	Myristoleic	0.28	MUFA
C15:0	Pentadaecanoic	0.32	SFA
C15:1	Cis-10- Pentadaecanoic	0.26	MUFA
C16:0	Palmitic	31.02	SFA
C16:1	Palmitoleic	1.68	MUFA
C17:0	Heptadecanoic	0.06	SFA
C17:1	Cis-10- Heptadecanoic	0.18	MUFA
C18:0	Stearic	1.27	SFA
C18:1n9c	Oleic	52.55	Omega 9
C18:2n6t	Linolelaidic (Trans)	1.38	Omega 6
C18:2n6c	Linoleic (Cis)	2.55	Omega 6
C18:3n6	γ -Linoleic	0.06	Omega 6
C18:3n3	α -Linoleic	0.39	Omega 3
C20:0	Arachidic	1.65	SFA
C20:1n9	Cis-11-Eicosenic	0.07	Omega 9
C20:2	Cis-11,14-Eicosadienoic	0.07	Omega 6
C20:3n6	Cis-8,11,14- Eicosatrienoic	0.9	Omega 6
C20:3n3	Cis-11,14,17-Eicosatrienoic	0.17	Omega 3
C20:4n6	Arachidonic	0.1	Omega 6
C20:5n3	Cis-5,8,11,14,17-ecosapentaenoic	0.12	Omega 3
C21:0	Henicosanoic	0.41	SFA
C22:1n9	Erucic	0.59	Omega 9
C22:2	Cis-13,16-Docosadienoic	1.31	Omega 6
C22:6n3	Cis-4,7,10,13,16,19-Docosahexaenoic	0.13	Omega 3
C23:0	Tricosanoic	0.16	SFA
C24:0	Lignoceric	0.04	SFA
C24:1n9	Nervonic	0.1	Omega 3

*SFA – Saturated fatty acid, MUFA – Monounsaturated fatty acid

(2015) on Thai durian aril found a high amount of stearic acid (C18:0). In contrast, *Durio dulcis* contains a high amount of oleic acid and palmitic acid, and low amount of stearic acid. Replacement of dietary saturated fat by oleic acid and/or polyunsaturated fatty acids (PUFA) has been elucidated to decrease the cardiovascular risk by lowering blood lipids, mainly cholesterol (Lopez-Huertas, 2010). A significant amount of essential fatty acids was also detected in the *Durio dulcis*. According to Kaur *et al.* (2014), the term essential fatty acids (EFA) refers to those polyunsaturated fatty acids (PUFA) that must be provided by foods because these cannot be manufactured in the body yet are necessary for health. There are two categories of EFA, omega-3 (ω -3) and omega-6 (ω -6). Omega-3 fatty acids have a final carbon-carbon double bond in the ω -3 position, i.e. the third bond from the methyl end of the fatty acid whereas ω -6 fatty acids have it in the ω -6 position, i.e. the sixth bond from the methyl end of the fatty acid. The total percentage of essential fatty acids in durian is 5.84%. Among the main EFAs detected were cis-9,12-

octadecadienoic acid (18:2 (n-6)), cis-13,16-docosadienoic acid (22:2 (n-6)) and cis-8,11,14-eicosatrienoic (20:3 (n-6)). The roles of EFA in human health is described comprehensively by Glick and Fischer (2013).

The organic volatile compound analysis found that *Durio dulcis* variety is rich in volatiles alcohols, esters, sulphur compounds and ketones (Table 4) that contribute to unique flavour and taste of durian. There are thirty-one volatile compounds determined in this present work. The main volatile component of alcohol was 2-methyl-1-propanol, 3-methyl-1-butanol, and 2,4-dimethyl-3-pentanol. Another alcohol compound detected was 2-methyl-1-butanol and 2,6-dimethyl-4-heptanol. Esters are the second most predominant volatile compound in durian after alcohol. The major ester compounds in the sample were detected as propanoic acid, 2-methyl-, 2-methylbutyl ester, propanoic acid, 2-methyl-, 3-methylbutyl ester and propanoic acid, 2-methyl, methyl ester. Besides alcohol and ester, sulfur is another primary

Table 4. The volatile compound of durian measured by GC-MS headspace

Peak No	Retention	Area (%)	Name of compound	CAS No.	Functional
1	1.461	2.2	Ethanethiol	75-08-1	SCC
2	2.056	24.7	2-methyl-1-propanol	78-83-1	Alcohol
3	2.296	0.6	3-methyl-butanal	590-86-3	Aldehyde
4	2.536	6.57	Methyl thiourea	598-52-7	SCC
5	2.679	0.37	2-methyl-, methyl ester propanoic acid	547-63-7	Ester
6	3.269	0.41	Methyl (methyl-4-deoxy-2-0-methyl. beta. 1-threo-hex-4-enolpyranosid) uronate	52425-23-0	Ester
7	3.463	13.09	3-methyl-1-butanol,	123-51-3	Alcohol
8	3.538	2.22	2-methyl-1-butanol,	137-32-1	Alcohol
9	3.921	2.6	2-methyl-, ethyl ester propanoic acid	97-62-1	Ester
10	4.184	0.13	Isobutyl acetate	110-19-0	Ester
11	4.247	0.97	1-chloro-1-butanethiol, 3-methyl-pentane	541-31-1	SCC
12	4.653	0.11	4-Propoxy-2-butanone	89975-71-3	Ketone
13	5.529	0.16	3-methyl-ethyl ester butanoic acid	108-64-5	Ester
14	5.609	8.86	2,4-dimethyl-3-pentanol	600-36-2	Alcohol
15	5.895	0.09	3-methyl-, acetate-1-butanol	123-92-2	Ester
16	6.444	19.16	2-methyl-, butyl ester propanoic acid	97-87-0	Ester
17	6.553	0.26	Diethyl disulfide	110-81-6	SCC
18	6.862	0.36	Hexyl isobutyl carbonate	959067-98-2	Ketone
19	6.931	0.58	2,6-dimethyl-4-heptanol,	108-82-7	Alcohol
20	7.022	0.15	2-methyl-, 2,2-dimethyl-1-(2-hydroxy-1-methylethyl) propyl ester propanoic acid	74367-33-2	Ester
21	7.589	0.06	Ethyl ester hexanoic acid	123-66-0	Ester
22	7.64	0.16	Butyl 2-methylbutanoate	15706-73-7	Ester
23	7.675	0.26	Isobutyl isovalerate	589-59-3	Ester
24	7.755	3.56	2-methyl-, 3-methylbutyl ester propanoic acid	3/1/2050	Ester
25	7.801	0.14	2-methyl-, 2-methylbutyl ester propanoic acid	2445-69-4	Ester
26	8.453	0.07	Ethyl 1-methylpropyl disulfide,	54166-53-9	SCC
27	8.842	0.06	Pentyl ester pentanoic acid,	2173-56-0	Ester
28	9.328	0.15	2-methylpropyl ester hexanoic acid	105-79-3	Ester
29	9.809	0.12	Ethyl ester octanoic acid,	106-32-1	Ester
30	11.257	0.2	n-Caprylic acid isobutyl ester	3/6/5461	Ester
31	12.962	0.08	n-Capric acid isobutyl ester	673-38-2	Ester

*SCC - Sulphur containing compound

compound in durian. A total of five sulphur compounds identified as methyl thiourea, ethanethiol, 3-methylbutane-1-thiol, diethyl disulfide and ethyl 1-methylpropyl disulfide. Sulphur-containing components were generally contributing for the distinct onion and rubber odour in durian fruit. Two ketones (4-propoxy-2-butanone and hexyl isobutyl carbonate) and one aldehyde (3-methyl butanal) compounds were also identified. The total volatile compounds identified for *Durio dulcis* was lower than reported by earlier published findings. Chin *et al.* (2007) investigated volatile compounds from Malaysian durians (*Durio zibethinus*). A total of 39 volatile compounds were identified including 22 esters, 9 sulphur-containing alkanes, 3 thioacetals, 2 thioesters, 2 thiolanes and 1 alcohol. Jaswir *et al.* (2005) reported a total of 38 durian volatile compounds comprising mostly esters and acids in durian aril (variety D24).

4. Conclusion

In conclusion, these findings showed that indigenous durian could provide a significant amount of nutrients for human. *Durio dulcis* provides about 62% of unsaturated fatty acid as well as 184 kcal/100 g energy. Protein analysis showed that both essential and non-essential amino acids were presented. Information presented can be used by nutritionists and food technologists to improve the nutrition of local people and develop food products that would be beneficial to human health.

Conflict of interest

The authors declare no conflicts of interest.

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