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Physicochemical differences and sensory profiling of six lai *(Durio kutejensis)* and four durian *(Durio zibethinus)* cultivars indigenous Indonesia

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Abstract

Lai has different physical characteristics compared with durian. Therefore most probable their physicochemical and sensory properties also differ. In this study, the variability of physicochemical (fat, protein, carbohydrate, ash, total sugar, moisture, soluble solid content, pH and flesh color) and sensory characteristics (sweetness, sourness, bitterness, moist, texture and stickiness) of indigenous lai and durian cultivars in Indonesia were examined. The sensory characterization of lai and durian was applied evaluated by Quantitative Descriptive Analysis method (QDA). The results showed that physicochemical characteristics and sensory characteristic of lai and durian cultivars were highly varied. PCA classified lai and durian cultivars into three different groups. The first group consisted of four durian cultivars (Ajimah, Hejo, Matahari and Sukarno), characterized by higher value of moisture, lightness (L^*) and moist sensation. The second group consisted of five lai cultivars (Batuah, Merah, Mahakam, Kutai, Gincu) were characterized by higher fat content, carbohydrate, soluble solids contents, yellowness (a^*) and redness (b^*) values, sweet tastes and stickiness. Mas lai cultivar was separated from these two previous groups. Strong correlation between physicochemical characteristics and sensory properties indicate that physicochemical can be used as an indicator to predict the sensory quality of lai and durian.

Introduction

Durian is a very popular tropical fruits and often referred as the king of tropical fruits in South East Asia. Durian has a special shape and nutrient content. It possesses strong aroma and unique taste. In Indonesia, durian is not only eaten as a fresh fruit but also used as ingredient for ice cream, pudding, juices and in various food products. Durian cultivars are very diverse in taste, smell, texture and flesh color, as well as variations in the shape and size of the fruits (Weenan *et al.*, 1996; Uji, 2007; Norjana and Aziah, 2011).

Indonesia is one of the *Durio* genetic diversity centers in the world. One of edible and famous *Durio* species in Kutai, Kalimantan, Indonesia, is lai *(D.kutejensis)* (Uji, 2005). Lai has different physical characteristics compared with durian. Lai fruit peel color is light yellowish but the shape is similar to durian. Lai has an attractive flesh color from orange to red and low aroma intensity, therefore most probable their physicochemical and sensory properties also differ. Some of lai cultivars are being developed in Kalimantan including Batuah, Kutai, Mahakam, Merah and Gincu. These species are interesting to breed for getting new improved cultivars (Hariyati *et al.*, 2013).

Sensory properties are one of the most important quality parameters in crop breeding and frequently used as the primary consideration in product development (Cevallos *et al.*, 2009). Both sensory properties and physicochemical parameters determined by its metabolites. These metabolites existence associate to primary and secondary biochemical pathways that are influenced by many factors, such as genetic and growth conditions including climate, irrigation strategy or soil type (Callahan, 2003; Kader, 2008).

New cultivars which have combination in sensory, nutritive and physical properties of lai and durian are eagerly awaited to be developed. Therefore, breeders need more information and perspective analytical tools in order to produce new fruit cultivars with better flavor (Uji, 2005; Baldwin, 2008). Studies on several physicochemical and sensory properties of Malaysian durians (Voon *et al.*, 2007; Maninang *et al.*, 2011) and their volatiles composition (Voon *et al.*, 2006; Zhang *et al.*, 2006; Rahman and Hashim, 2007) has been conducted. However, information on lai physicochemical composition and sensory attributes is very limited. This study

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aimed to provide comprehensive information on physicochemical composition and sensory attributes profiles (taste and mouth feel) of several Indonesian lai and durian cultivars. The relationship between sensory, physical and chemical composition of lai and durian cultivar were also studied. Correlation analysis would make the selection process of lai and durian breeding programs easier (Saftner *et al.*, 2008; Gadze *et al*., 2011; Eggink *et al*., 2012). The comprehensive information of physicochemical and sensory characteristics can be used as indicators of the genotype and phenotype diversity as the basis for selection to produce new fruit genotypes having a better flavor (Kader, 2008).

Materials and Methods

Plant material

Lai and durian fruit cultivars used in this research were harvested in January to February 2013. Five lai cultivars, ('Batuah', 'Merah', 'Mahakam','Kutai' and 'Gincu) were obtained from Batuah villages, districts Loa Janan, Kutai Kartanegara, East Kalimantan, Indonesia. Lai cultivar 'Mas' and four durian cultivars ('Matahari', 'Sukarno', 'Ajimah' and 'Hejo') were obtained from Mekarsari Fruit Garden Bogor, West Java, Indonesia. Lai and durian fruits were harvested at the same physiological maturity. Dropped naturally ripened, free of visual defect and not rotten fruits were collected. The fruits were stored at 30ºC and 80% RH for 2 days to optimize ripening (Ketsa and Daengkanit, 1999). Afterward lai and durian was cut opened along the rind, the pulp was separated from the seed manually and then delivered to the laboratory immediately. Sample was homogenized for about 2 min (using blender). Four hundred grams of separated blended fruit pulps of each cultivar was packed in a commercial aluminum foil, then was packaged using vacuum sealer and stored at -30±2ºC in freezer. Prior to the analysis, all fruit pulps were fully thawed.

Physicochemical analysis

Moisture content was determined by AOAC 934.01 (2005) method. Ash content was determined by AOAC 930.05 (2005) method. Protein content was measured by Micro Kjeldahl method (AOAC 978.04, 2005). Fat content was determined by AOAC 963.15 (2005). Total sugar content was determined by Luff-Schoorl method (INS, 1992).

Soluble solids content was measured according to Voon *et al*. (2007), by using hand refractometer and the results were expressed as °Brix. The pH of the pulp was determined by using a Methrom 620 pH meter. Calibration was done by using buffer pH 4.0 and 7.0 solutions. All the chemical results were obtained in duplicate.

Color measurements were performed using a Colorimeter 3 (Minolta CR-300/CR-310). Random readings, 3 measurements, were taken at 3 different locations on the flesh of each sample. The mean of these 3 readings were taken and color description for each sample was expressed as CIE values for lightness (L^*), redness (a^*) and yellowness (b^*). Lightness parameter L declared value 0 = black, 100 = white. Chromatic colors red-green color mixture was shown by the value of (a) = 0-80 red and (a-) = 0 - (-80) for the green color. Whereas, for the blue-yellow chromatic mixture color was shown by the value of (b) = 0-70 yellow and (b-) = 0 - (-70) blue.

Sensory analysis

Quantitative descriptive analysis method (QDA) was applied for detailed sensory characterization of lai and durian by 10 selected and trained panelists (7 females and 3 males, aged from 26 to 45 years). Sensory characterization was also evaluated by a panel using FGD (Focus Group Discussion) as described in Meilgaard *et al.* (1999). In QDA test, the samples were described using each 3 attributes of taste (sweetness, sourness, bitterness) and mouth feel (texture, moist and stickiness). A continuous, 15 cm unstructured scale (assuming a scale of 0 -100) was used for the evaluation (0 indicates not detected intensity - scale 100 indicates very strong intensity). Three replicated measurements were made for each sample.

Statistical analysis

Data obtained from chemical and sensory analyses were subjected to analysis of variance (ANOVA) and means were separated by Duncan's multiple range test at P=0.05 (IBM SPSS Statistics version 20). For sensory and physic chemical characteristics correlation, raw data was used to calculate Pearson correlation coefficient which was used to model the relationships. PCA was applied for lai and durian cultivars physicochemical and sensory mapping (The Unscrambler Windows Version 9.7 software package, CAMO A/S, Trondheim, Norway).

Results and Discussion

Physicochemical analysis

The results of the physicochemical analysis of lai and durian were shown in Tables 1, 2 and 3. For all cultivars, significant differences ($p< 0.05$) were observed in the physicochemical composition. Lai

Table 1. Fat, protein, carbohydrate, moisture, ash, total sugar, SSC and pH of lai *(D. kutejensis)* and durian *(D. zibethinus)*

No	Cultivar	Fat (%)	Protein (%)	Carbohydrate (%)	Water (%)	Ash (%)	Total Sugar (%)	SSC (°Brix)	pH
1	Batuah	3.14±0.06^{b}	2.83±0.04^{e}	37.65±0.21^{f}	55.15±0.35^{b}	1.27±0.04^{b}	17.45±0.07^{g}	29.10±1.27^{ef}	6.87±0.15^{ab}
2	Merah	3.80±0.09^{c}	2.93±0.15^{e}	33.90±0.57^{d}	57.35±0.50^{cd}	2.07±0.13^{d}	16.30±0.28^{f}	26.40±0.28^{d}	7.18±0.28^{c}
3	Mahakam	3.37±0.18^{bc}	1.94±0.01^{b}	34.05±0.50^{de}	58.15±0.35^{cd}	2.51±0.05^{e}	11.70±0.42^{c}	25.00±0.28^{d}	7.21±0.14^{bc}
4	Kutai	3.31±0.36^{b}	2.29±0.00^{d}	35.90±0.00^{ef}	56.80±0.42^{c}	1.74±0.08^{c}	17.45±0.07^{g}	28.00±0.57^{e}	7.20±0.06^{bc}
5	Gincu	4.69±0.41^{d}	2.37±0.01^{d}	31.65±0.64^{c}	59.95±0.92^{e}	1.37±0.09^{b}	18.95±0.07^{h}	30.00±0.00^{g}	6.77±0.02^{a}
6	Mas	4.81±0.21^{d}	2.24±0.02^{cd}	42.05±0.07^{g}	49.05±0.21^{a}	1.82±0.06^{c}	13.20±0.00^{d}	25.60±0.57^{d}	7.42±0.11^{c}
7	Ajimah	2.92±0.14^{b}	2.36±0.01^{d}	28.9±1.84^{b}	63.05±1.49^{f}	2.77±0.17^{f}	14.05±0.07^{e}	23.00±0.28^{c}	7.38±0.13^{c}
8	Hejo	1.59±0.05^{a}	1.76±0.01^{a}	15.65±0.35^{a}	79.35±0.50^{h}	1.65±0.04^{c}	3.10±0.05^{a}	12.50±0.28^{a}	7.80±0.14^{d}
9	Matahari	1.69±0.09^{a}	2.33±0.11^{d}	34.65±1.49^{de}	58.80±1.13^{de}	2.53±0.17^{e}	8.14±0.06^{b}	22.40±0.57^{c}	7.98±0.20^{de}
10	Sukarno	1.86±0.10^{a}	2.13±0.05^{c}	27.30±0.42^{b}	67.70±0.28^{g}	1.03±0.02^{a}	8.12±0.04^{b}	18.50±0.99^{b}	8.15±0.04^{f}

All data are the means ± SD of two replicates.
Means with each row followed by a different letter are significantly different at p < 0.05 (Duncan test).
Lai cultivars (1,2,3,4,5,6) and durian cultivars no (7,8,9,10).

Table 2. Flesh color (L*,a*,b*) of lai (Batuah, Merah, Mahakam, Kutai, Gincu, Mas) and durian (Ajimah, Hejo, Matahari, Sukarno) cultivars

No	Cultivar	L*	a*	b*
1	Batuah	77.19±0.16^{b}	5.76±0.06^{e}	85.05±0.54^{e}
2	Merah	77.09±0.87^{b}	3.46±0.29^{d}	88.14±1.68^{ef}
3	Mahakam	77.81± 1.31^{bc}	8.19±0.19^{f}	86.82±2.28^{ef}
4	Kutai	80.10±1.34^{c}	3.40±0.49^{d}	89.47±3.49^{f}
5	Gincu	73.68±2.42^{c}	6.78±0.26^{e}	73.15±0.09^{d}
6	Mas	85.01±0.38^{de}	-0.82±0.34^{b}	81.25±0.18^{d}
7	Ajimah	89.22±0.53^{f}	-1.52±0.15^{b}	14.25±0.35^{b}
8	Hejo	84.25±1.97^{d}	-4.09±1.66^{a}	20.66±0.04^{c}
9	Matahari	87.53±0.72^{ef}	-4.53±0.30^{a}	27.53±1.82^{c}
10	Sukarno	85.58±0.38^{de}	0.74±0.26^{c}	7.36±0.23^{a}

All data are the means of three replicates.
All data are the means ± SD of three replicates. Means with each row followed by a different letter are significantly different at p < 0.05 (Duncan test).
Lai cultivars (1,2,3,4,5,6) and durian cultivars (7,8,9,10).

cultivars had fat content varied from 3.14 to 4.81% and durian cultivars varied from 1.58 to 2.92%. The fat content of Indonesian lai *(D. kutejensis)* was higher than those of Sarawak lai (Hoe and Siong, 1999) and Sabah *D. dulcis* (Mamat *et al.*, 2013). Ajimah had the highest fat content among durian cultivars while Hejo, Matahari and Sukarno were not significantly different. Among lai and durian cultivars, Mas had the highest fat content. Previous study reported that the main fatty acid components in ripe durian were oleic acid and palmitic acid (Moser *et al.*, 1980; Haruenkit *et al*., 2010).

Analysis of variance of protein content was also found significantly different (p < 0.05). Lai cultivars protein content was within the range of 1.94-2.93%, lower than Sabah *Durio dulcis* (Mamat *et al*., 2013). Durian protein content varied between 1.76% and 2.36%. This is in accordance with that reported by Hoe and Siong (1999). Merah and Batuah had the highest protein content while Hejo had the lowest. Kutai, Gincu, Ajimah and Matahari had similar protein content.

The carbohydrate content of lai cultivars was 31.65 - 42.05%, within the range of *D. dulcis* carbohydrate content as found by Mamat *et al.* (2013). Carbohydrate content of durian was within the range of 15.65- 34.65% are in agreement that reported by Hoe and Siong (1999). Mas cultivar had the highest carbohydrate content, while Hejo had the lowest. This carbohydrate content may relate to SSC and total sugar content as well as sweet taste. An increase in SSC, total sugar content and sweet taste may also relate with starch degradation, the presence of polygalacturonase, pectinesterase, β–galactosidase and cellulase enzymes during ripening (Ketsa and Daengkanit, 1999; Khurnpoon *et al*., 2008; Maninang *et al*., 2011).

Moisture content is one of the most important physicochemical characteristics, as it will influence the flavor, texture, appearance and shelf life of fruit. Water variations between lai and durian cultivars were found to be significantly different (p<0.05). In this study lai cultivars have moisture varies between 49.05 to 59.95%, while Mas had the lowest moisture content (49.05%). Durian fruits had moisture content within the range of 58.80-79.35% which is in accordance with those reported by Charoensiri *et al.* (2009). High water content in durian cultivars make durian fruit has a short shelf life. Maninang *et al.* (2011) reported that fresh Chanee cultivar durian only lasted for 3 days in ambient condition, whereas lai has a shelf life up to 5 days according to observation result.

Average ash content of lai cultivars (1.27-2.51%) was slightly higher than *D. dulcis* as found by Mamat *et al.* (2013). Average ash content of durian ranged from 1.03-2.77% similar to those reported by Hoe and Siong (1999). Ajimah cultivar had the highest

Table 3. Pearson correlations coefficients between physicochemical and sensory of lai and durian cultivars

	Fat	Protein	Carbohy drate	Mois ture	Ash	Tot. Sugar	SSC	pH	L*	a*	b*	Sweet ness	Sour ness	Bitter ness	Texture	Moist	Sticki ness
Fat	1																
Protein	.36	1															
Carbohydrate	.62*	.53*	1														
Moisture	-.70*	-.55*	-.99**	1													
Ash	-.48	-.45	-.61*	.57*	1												
Tot.Sugar	.76**	.69*	.65*	-.70*	-.58*	1											
SSC	.76**	.65*	.81**	-.84**	-.61*	.94**	1										
pH	-.73*	-.49	-.42	.48	.34	-.84**	-.79**	1									
L*	-.54	-.35	-.23	.27	.47	-.61*	-.61*	.74*	1								
a*	.57*	.30	.38	-.41	-.53*	.69*	.70*	-.74*	-.86**	1							
b*	.76**	.41	.64*	-.68*	-.49	.71*	.77**	-.78**	-.78**	.73*	1						
Sweetness	.59	.62*	.63*	-.69*	-.18	.79**	.84**	-.73*	-.47	.51*	.61*	1					
Sourness	-.12	.04	.31	-.27	-.19	-.26	-.13	.55*	.57*	-.41	-.42	-.18	1				
Bitterness	-.01	-.36	.08	-.04	-.16	-.46	-.39	.57*	.51*	-.46	-.31	-.59*	.71*	1			
Texture	.07	-.53*	.06	-.01	-.25	-.35	-.26	.36	.34	-.19	-.25	-.49	.53*	.83**	1		
Moist	-.73*	-.14	-.75**	.74*	.57*	-.51*	-.56*	.41	.22	-.31	-.66*	-.23	-.06	-.33	-.35	1	
Stickiness	.75**	.45	.54*	-.58*	-.54*	.76**	.77**	-.81**	-.86**	.80**	.97**	.58*	-.49	-.39	-.31	-.58*	1

**. Strong correlation is significant at the 0.01 level.

*. Moderate correlation is significant at the 0.05 level.

ash content, while Sukarno had the lowest.

Total sugar, pH and SSC of lai and durian cultivars were significantly different ($p<0.05$). Total sugar content of the six lai cultivars was within the range of 11.7-18.95%, while total sugar content of durian cultivars was varied from 3.10 to 14.05%, the higest was Gincu followed by Batuah and Merah, while the lowest was Hejo. Durian ripening is characterized by increasing sugar content in fruits. The highest sugar content of durian is sucrose followed by glucose, fructose and maltose (Haryanto and Royaningsih, 2003; Voon *et al*., 2006). SSC of lai cultivars (25.60-30.00 ºBrix) was higher than those of durian cultivars (12.50-23.00 ºBrix). The durian SSC values were similar with those reported by Karichiappan *et al.* (2000). SSC variability of lai and durian indicates the variability in sugar, organic acids, soluble pectins, anthocyanins, other phenolic and ascorbic acid contents within cultivars (Kader, 2008).

There was a significant difference ($P<0.05$) of pH among seven cultivars of lai and durian (Ajimah, Hejo, Matahari, Sukarno, Mas, Batuah and Gincu). The cultivars with no significant different pH among them were Merah, Mahakam and Kutai. The pH of lai cultivars were in the range 6.77-7.42, while durian cultivars were 7.38 - 8.15. Durian pH value has similar result with the previous study reported by Voon *et al.* (2006). Neutral pH in lai and durian cultivars was probably due to the effect of the buffering capacity of the fruit tissue (Voon *et al*., 2006). Sukarno had the highest pH values, while Gincu was the lowest as compared to the other lai and durian cultivars.

Color and appearance are critical factors of food for both its esthetic value and for quality judgment. Dark product is usually less attractive for the consumers (Norjana and Aziah, 2011). The result of colorimetric measurements for all lai and durian cultivars were different ($p<0.05$) for L^*, a^* and b^* value. The results are shown in Table 2. Six lai cultivars, including Mas, Batuah, Merah, Mahakam, Kutai and Gincu had different in L^*, a^* and b^*value. Color analysis showed that L^* values of lai cultivars were in the range of 73.68-85.01 and durian cultivars were 84.25-89.22, while a^*values of lai were varied (-0.82-8.19) and durian were between -4.53 to 0.74. Mahakam has a deepest color than many other cultivars with highest value of a^*. Yellow to orange color of lai and durian is associated with the presence of β-Caroten (Charoensiri *et al*. 2009). The orange to red color in lai cultivars made lai visually more attractive than durian cultivar which has pale yellowish color. According to Norjana and Aziah (2011) panelist acceptance was positively correlated with b^* value of durian juice. Ajimah had the lightest while Gincu had a darker color than most of lai and durian cultivars. Several durian cultivars had the color value (a^*) within -4.09 to 0.74 and (b^*) within 7.36-27.53, those durian flesh has pale yellow appearance.

Lai and durian sensory properties

According to Focus Group Discussion (FGD) results, the taste of lai and durian was mainly sweet, sour and bitter. Mouth feel was determined by moist, texture and stickiness sensory attributes. All

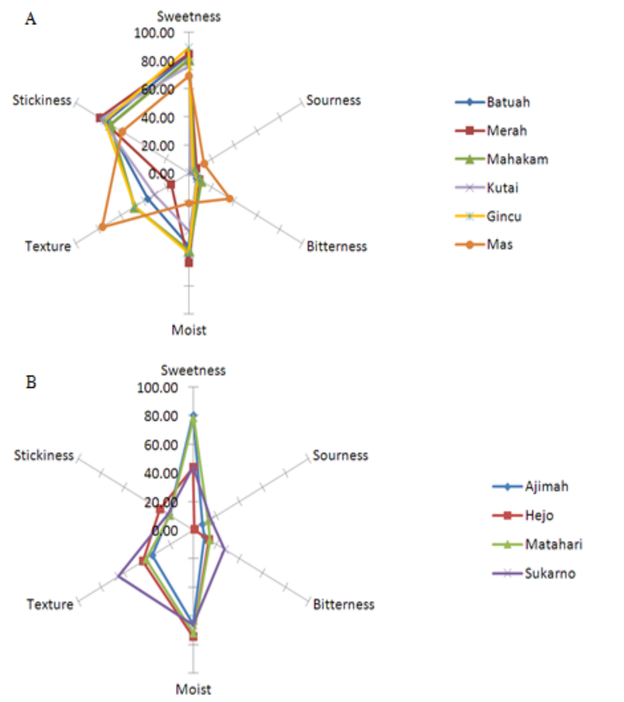

Figure 1. Quantitative descriptive analysis of taste and mouth feel attributes of lai (A) and durian (B) cultivars

tested sensory characteristic (sweetness, sourness, bitterness, moist, texture and stickiness) were different ($p<0.05$) between lai and durian cultivars, as can be seen in Figure1.

Sweetness perception is one of the most important characteristic of fruit or vegetable flavor. Lai and durian cultivars had higher sweetness perception than bitterness and sourness. Lai cultivars have the higher sweetness (69.2-89.2) as compared to durian cultivars (44.0-80.2). Gincu has the highest sweetness taste (89.2) followed by Batuah (83.8). The highest sweetness value was influenced by sugar content as shown in Table 4. Sugar content of durian was dominated by sucrose followed by glucose, fructose and maltose (Voon *et al.*, 2006). The sour taste had been identified in all lai and durian cultivars. The highest sourness was found in Sukarno cultivar. The sour taste is influenced by the presence organic acids in the fruits. Voon *et al.* (2006) found the presence of malic, citric, tartaric and succinic acids in durian. The sourness and sweetness are often present simultaneously, and sourness of acids is suppressed by sweetness from sugars (Lawless and Heymann, 2010). Sourness intensity in lai and durian were altered by the presence of sugars too (Table 4). The presence of bitter taste was also found in some cultivars. The highest bitter taste was found in Sukarno followed by Mas. The bitter taste of durian fruit was probably influenced by the presence of several amino acids that have bitter taste, such as alanine, proline, phenylalanine and isoleucine

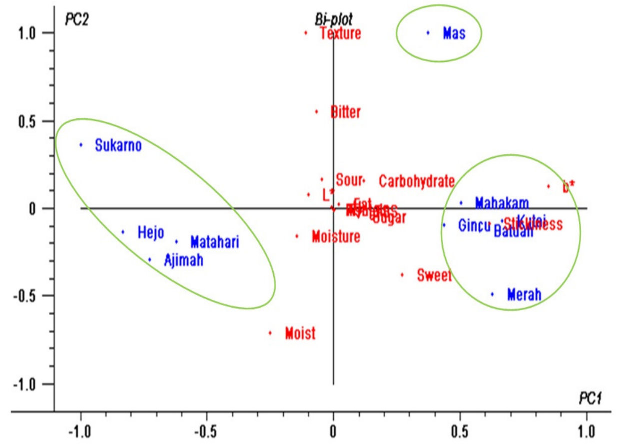

Figure 2. PCA biplot of the lai and durian cultivars (blue color) and the physicochemical and sensory attributes (red color) are shown interpretation about the relations. In total, 90% of the variation of data were represented by PC1 (73%) and PC2 (17%)

(Zanariah and Rehan, 1987).

Mouth feel is one of the consumer acceptance parameter of a fruit. Besides the three basic flavors previously mentioned, the FGD also defined texture, moisture and stickiness as mouth feel parameters in lai and durian. Merah lai had the softest flesh texture (15.7), while Mas lai had more fibrous texture (76.4). Durian cultivars had higher moist sensation than lai cultivars (65.7-74.6). Mas cultivar had the lowest moist sensation than the others. Moist sensation is influenced by the water content. Durian cultivars had higher water content than lai cultivars (Table 1). Higher water content makes the fruit flesh of durian cultivars softer and easier to move on the surface of the tongue and oral cavity than lai. Figure1 showed that the stickiness sensation score for lai was higher than durian cultivars. Several cultivars in durian especially Ajimah, Hejo, Matahari and Sukarno had stickiness score in the range of 20.2-29.2. It was lower than lai cultivars which had stickiness value in the range of 58.9-78.6. Merah had the most intense in stickiness sensation. The high stickiness sensation of lai cultivars may be resulted from the presence of higher fat content. There was a positive correlation between lipid deposits with the perception of mouth feel, in particularly with the stickiness (Kupirovic *et al.* 2012). Besides, sticky impression is also influenced by the high content of total sugar, SSC, carbohydrates and lower water content.

PCA of physicochemical and sensory characteristics

Figure 2 showed the result of PCA biplot of lai and durian physicochemical and sensory characteristics. PC1 and PC2 scores provided the better visualization accounted for 73% and 17% of the total variance, respectively. The PCA analysis showed these data was grouped into three groups. The five lai cultivars (Mahakam, Gincu, Kutai, Batuah and Merah) and four cultivars of durian (Sukarno, Hejo, Matahari, Ajimah) were well separated in PC1. While "Mas" cultivar was in PC 2 separated from both lai and durian groups. Genetic grouping based on RNA / DNA in durian and lai has been reported (Mursyidin and Qurrohman, 2012).

Mas is a member of lai cultivar family, however, the fact showed that this cultivar grouped separately than the other lai cultivars although it was still closer to the lai group as compared to the durian ones. Mas cultivar was planted in the same location as the durian cultivars. The phenomena showed that the environmental and agronomic factors may have strong influences on the cultivars characteristics however the genetic influence is remaining stronger.

The bi plot clusters allowed the classification of each lai and durian cultivar according to its physicochemical and sensory properties. Three durian cultivars Hejo, Matahari and Ajimah were characterized by the lightness (L^*) color, moisture content and moist sensation in the mouth. Sukarno cultivar had low value for yellowness and redness color, sweet taste, stickiness and fat, carbohydrates, total sugar and SSC, therefore it was a bit shifted from Hejo, Matahari and Ajimah group in PC 2. Lai cultivars including Mahakam, Kutai, Gincu, Batuah and Merah had positive scores for PC 1. Lai cultivars were characterized by yellowness and redness color, sweet taste, sticky sensation in the mouth, high fat, carbohydrates, total sugars and soluble solids content. On the other hand, Mas cultivar which had different cluster than lai and durian cultivars had little bitter taste and fibrous texture characteristic (Figure 1 (a)). This cultivar has different morphology too (leave size, height of plant, the color of flower, fruit skin color) than other lai cultivars.

Physicochemical and sensory characteristics correlation

Pearson's correlation was used to determine the relationship between physicochemical characteristics and sensory properties. Table 3 shows that the physicochemical characteristics corresponded to the sensory attributes. There was a strong positive correlation between sweet taste with total sugar content (0.79^{**}) and SSC (0.84^{**}). It implies that an increase of total sugars content and SSC correlated with high sweetness in lai and durian cultivars.

Various textural and visual quality characteristics also influenced consumer assessment of overall eating (Saftner, 2008). Moisture has strong positive correlation with moist sensation (0.75^{**}). Strongly positive correlations were observed among fat content (0.75^{**}); total sugar content (0.76^{**}) and SSC (0.77**) with stickiness sensation. On the other hand, stickiness sensation was negatively correlated with pH (-0.81^{**}). Hence, in this study showed that high fat content, total sugar content, SSC and lower pH were a good indicator of stickiness of lai and durian cultivars.

L^*value was strong negatively correlated with stickiness (-0.86^{**}), it means that high (L^*) value of durian flesh color indicated lower intensity of stickiness. The value of a^* was strong positively correlated with stickiness (0.80^{**}), therefore red color of lai and durian indicated the higher sticky impression in the mouth. Yellow color (b^*) has strong negatively correlated with pH (-0.78^{**}) and positive correlation with fat content (0.76^{**}), SSC (0.77^{**}) and stickiness (0.97^{**}). The higher b^* value of lai and durian flesh can be used as an indicator of higher fat content, total sugars content, SSC and sticky sensation, but it indicated lower pH. In this study, the results of color analysis suggested that pulp fruit color is a good indicator of lai and durian sensory quality. Gincu has the highest b^* value and a^* values, indicating Gincu has lower pH content but high fat content, total sugar content, and SSC. It also indicated that Gincu has sticky sensation.

In this study, the relationships between physicochemical and sensory characteristics of the examined lai and durian may indicate the importance of chemical and physical characteristics in estimating sensory characteristics. Meanwhile, there are some attributes that was not significantly correlated among them. These results suggested that chemical characteristics can be used to predict sensory quality, except for protein content and sourness; fat content, carbohydrate, moisture content with bitterness and; fat content, carbohydrate content, moisture content with texture.

Conclusion

The content of fat, protein, carbohydrate, ash, water, soluble solid content (SSC), as well as pH, color and sensory characteristics of six lai and four durian cultivars were significantly different ($p<0.05$) among them. Durian (Matahari, Sukarno, Ajimah, Hejo) were characterized with higher water content and moist sensation, but lower in stickiness. Five lai cultivars (Mahakam, Gincu, Kutai, Batuah and Merah) were characterized with high value of yellowness (a^*), redness (b^*), fat, carbohydrate, Soluble Solid Content (SSC), sweet taste and stickiness sensation. Mas lai was separately than the other lai cultivars, with the highest score for bitter taste and fibrous texture.

There were strong positive correlation between moisture and moist sensation (0.75^{**}); sweet taste with total sugar content and SSC; stickiness sensation with fat content, total sugar content, SSC, and (redness) a^*; yellowness (b^*) with stickiness; yellowness (b^*) with fat content, total sugars content, SSC and stickiness sensation. The relationships between physicochemical and sensory characteristics indicate that physicochemical characteristic can be used as an indicator to predict the sensory quality of lai and durian.

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