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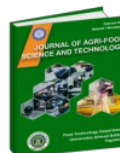
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## Physicochemical Properties of *Klutuk banana* Leaves (*Musa balbisiana* Colla) *Susu* and *Wulung* Cultivars with its Potential as Antioxidant

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8

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### ARTICLE INFO

### ABSTRACT

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1

Banana leaf is mostly used as food packaging materials. The most often used leaf of banana trees is from *Klutuk banana*. Its leaf is the broadest and most durable among other banana leaf cultivars. However, the research of potential use of *Klutuk banana* leaf has not much done. In this research, the physical and chemical properties of *Klutuk banana* leaves will be observed from the very top to the bottom of the tree. Physical properties explored from *Klutuk banana* leaves are tensile strength, elongation, thickness, and color of the leaf. The leaf then will be extracted using methanol so that its antioxidant properties can be known. The leaf from the third petiole of *Klutuk banana susu* and *wulung* cultivars, has the best physical properties, i.e., mechanical, color, and antioxidant activity properties, and is best to use as food packaging material. The most significant activity of antioxidant is found from the first shoot of *Klutuk banana susu* and *wulung* leaf cultivars.

### 1. INTRODUCTION

*Klutuk banana* leaf is one of the banana leaves that mostly used because it has durable physical property and is not easy to tear among other cultivars. Besides, it has a distinctive scent when used as food packaging, which makes the packaged food scented better. Banana leaf is found to have antioxidant and antimicrobial activities. Gallic acid which is one of the antioxidants, is found in banana leaf extract based on the study done by Sahaa et al. (2013).<sup>13</sup> According to Handayani and Mastuti (2014), the leaf extract of *Pisang Ambon* contains *Phenol, 2,4-bis(1,1-dimethyl ethyl)-*, which is categorized in phenolic compounds. This compound, along with *E-15 heptadecenal*, has the same antibacterial activities to the fraction of acetate in God leaves (*Gynura segetum*) based on a research done by Seow et al. (2012).<sup>1</sup>

The exploration of *Klutuk banana* leaf, which is used as traditional food packaging material, can be seen as one of the local cultures. However, the physical and chemical properties of *Klutuk banana* leaf are still unknown. The objective of the research is then to

analyze these properties on *Klutuk banana* leaves of *susu* and *wulung* cultivars, from the first to the last shoots of the tree. The potential of antioxidant activity will also be explored to determine which shoot or petiole has the maximum potential of antioxidants.

7

## 2. MATERIALS AND METHODS

### 2.1. Tools and Materials

Materials used in the research are *Klutuk banana* leaves of *susu* and *wulung* cultivars from the first to the fifth shoot of trees in Kebun Plasma Nutfah Pisang Yogyakarta; 2,2-diphenyl-1-picrylhydrazyl (DPPH); methanol PA; and petroleum ether. Tools used in the research are Spectrophotometer UV-VIS (Spectronic 200), Chromameter (Konika Minolta CR-400), Universal Testing Machine (Zwick ZO.5; USA), cabinet dryer, and oven.

### 2.2. Research Methods

#### 2.2.1. Mechanical Properties of *Klutuk banana* Leaf

Mechanical analysis done in the research includes tensile strength, and elongation by using Universal Testing Machine (Zwick ZO.5; USA). Each analysis was done in three repetitions.

#### 2.2.2. Thickness of *Klutuk banana* Leaf

Thickness analysis of *Klutuk banana* leaf used digital micrometer with a precise of 0.0001 mm. The measurement is done randomly at 5 different points on the leaf with three times repetitions.

#### 2.2.3. Color of *Klutuk banana* Leaf

Color analysis of *Klutuk banana* leaf used chromameter (Konika Minolta CR-400). The color measured on the screen as L score for lightness, a score for appearance, and b score as blueness measurements. The measurements are done in three times repetitions.

#### 2.2.4. Fat Content of *Klutuk banana* Leaf

Fat content analysis is done by using method of AOAC (2006). The measurements are done in three times repetitions.

#### 2.2.5. Extraction of *Klutuk banana* Leaf

The extraction of *Klutuk banana* leaf is done by using a method described in Madikizela et al. (2014) with some modification. *Klutuk banana* leaves of *Susu* dan *wulung* cultivar from the first to fifth shoots were washed by tap water and cut in uniform-sized pieces. Those pieces were then dried in a cabinet dryer for 12 hours. The dried leaves then will be mashed up by using a blender and sifted with a 60-mesh strainer. The extraction is done based on the maceration method. The powder of dried leaves is macerated by using 80% ethanol for 48 hours, then filtered by using a filter paper. The solvent evaporated by using an oven.

#### 2.2.6. Antioxidant Activity of *Klutuk banana* Leaf

Antioxidant activity of *Klutuk banana* leaf will be analyzed with 2,2-diphenyl-1-picrylhydrazyl (DPPH) by using a method in Williams et al. (1995).

### 3. RESULT AND DISCUSSIONS

#### 3.1. Mechanical Properties of of *Klutuk banana* Leaf

Mechanical properties of *Klutuk banana* leaf of *susu* dan *wulung* cultivar observed in the research are tensile strength and elongation of the leaf. The observation is done with eyes' positions parallel to the fiber of leaf. Based on Table 1, the older the age of the leaves, then the stronger the tensile strength and flexibility. The old leaves are indicated by the lower position of the petiole of *Klutuk banana* leaf. The higher the value of tensile strength indicates the more sturdy the leaf is. Meanwhile, less value of elongation indicates the more flexible the leaf is.

Beside affected by the age of the leaf, the tensile strength of *Klutuk banana* leaf is also affected by its cultivar. *Klutuk banana* leaves of *wulung* cultivar have higher tensile strength than leaves of *susu* cultivar. *Klutuk banana* of *wulung* cultivar leaves are stronger and more sturdy than leaves of *susu* cultivar.

Table 1. Mechanical properties of *Klutuk banana* leaves of *Susu* and *wulung* cultivars.

n-th leaf	<i>Klutuk banana</i> leaves of <i>susu</i> cultivar		<i>Klutuk banana</i> leaves of <i>wulung</i> cultivar	
	Tensile Strength (N/mm <sup>2</sup> )	Elongation (%)	Tensile Strength (N/mm <sup>2</sup> )	Elongation (%)
1	4.6873	4.3749	6.9264	4.3874
2	6.0691	4.1584	8.3489	4.3589
3	6.4542	3.8571	9.4103	3.9877
4	7.9621	3.5026	10.8681	3.9560
5	9.7903	2.9121	12.2249	3.6311

The high amount of water content and the sturdy texture of the leaf are in line with the increase of tensile strength on *Klutuk banana* leaves of *susu* and *wulung* cultivars. The thickness difference of leaves may happen due to the difference in their water content. The higher the water content of a leaf, then the leaf is more rigid due to its cell walls, which pushed by water (Badar, 2006).

#### 3.2. Thickness of *Klutuk banana* Leaf

The thickness of leaves is one of the physical properties, which is essential to be analyzed due to its function as food packaging. The measurement of *Klutuk banana* leaf thickness is done while the leaves are still fresh. Based on Table 2, *Klutuk banana* leaves from the first to the fifth shoots have no significant difference in thickness.

Table 2. The thickness of *Klutuk banana* leaves of *Susu* and *wulung* cultivars.

n-th Leaf	Thickness (mm)	
	Leaves of <i>susu</i> cultivar	Leaves of <i>wulung</i> cultivar
1	0.346	0.322
2	0.265	0.343
3	0.342	0.325
4	0.305	0.349
5	0.324	0.389

Treshow (1970) mentioned that the low intensity of light makes plants have a bigger and thinner size of leaves, bigger stomata, more spaces between cells, and thinner epiderm cells. It happens as one of the adaptations made by leaves from various plants. Leaves will have anatomical and morphological changes like increasing the number of b-chlorophylls, the area of the leaf, number of cuticles, wax layers, leaf feathers (trichomes), and level of anthocyanin pigment while decreasing the leaf thickness (Karyati et al., 2017).

### 3.3. Color of Klutuk banana Leaf

Color measurement of *Klutuk banana* leaves of *susu* and *wulung* cultivars are done on the outer side of the leaf. The result of color measurement is shown in Table 3 with three measurement parameters, i.e., lightness (L), appearance (a), and b-ness (b). The positive value of L means light, while the negative one means dark. The positive value of a indicates the red color, while the negative indicates green color. The positive value of b indicates the yellow color, while the negative indicates the blue color.

Based on Table 3, the value of L on *Klutuk banana* leaves of *susu* and *wulung* cultivars from the first to fifth shoots have an insignificant difference. However, *susu* cultivar has a lighter color than leaves of *wulung* cultivar from its bigger value of L. The value of a on leaves of *Susu* cultivar is less than *wulung* cultivar, so the *Klutuk banana* leaves of *susu* cultivar has brighter green in color. Moreover, the older the age of the leaf indicates brighter green in color from the result of measurement of a value. Meanwhile, the positive value of b indicates the yellow color of the leaf. The bigger the value of b means that the leaf has brighter yellow in color. *Klutuk banana* leaves of *wulung* cultivar have a lesser value of b than leaves of *Susu* cultivar. This indicates that *wulung* cultivar has leaves with a darker yellow color.

Table 3. Color of *Klutuk banana* leaves of *susu* and *wulung* cultivars.

n-th Leaf	Leaves of <i>susu</i> cultivar			Leaves of <i>wulung</i> cultivar		
	L	A	b	L	a	b
1	44.31 <sup>a</sup>	-17.79 <sup>a</sup>	30.90 <sup>a</sup>	38.82 <sup>a</sup>	-14.51 <sup>a</sup>	22.07 <sup>a</sup>
2	42.74 <sup>a</sup>	-16.18 <sup>ab</sup>	26.77 <sup>a</sup>	38.19 <sup>a</sup>	-11.90 <sup>ab</sup>	17.34 <sup>a</sup>
3	42.48 <sup>a</sup>	-15.67 <sup>ab</sup>	24.37 <sup>a</sup>	37.75 <sup>a</sup>	-11.30 <sup>ab</sup>	17.21 <sup>a</sup>
4	43.30 <sup>a</sup>	-15.92 <sup>b</sup>	25.40 <sup>a</sup>	37.08 <sup>a</sup>	-10.09 <sup>b</sup>	14.79 <sup>a</sup>
5	45.44 <sup>a</sup>	-16.58 <sup>b</sup>	28.25 <sup>a</sup>	38.58 <sup>a</sup>	-9.63 <sup>b</sup>	16.33 <sup>a</sup>

The letter symbol shows the significant difference of *Klutuk banana* leaves of *susu* and *wulung* cultivars ( $p < 0.05$ ) on the same column.

Based on Table 3, different cultivars will affect the overall color of the leaf. Gogahu et al. (2016) stated that the total concentration of chlorophyll on 3-month-old crotons from different cultivars have an insignificant difference. Meanwhile, when the crotons reached the age of 8 months, the concentration of chlorophyll showed a significant difference between cultivars. The total concentration of chlorophyll caused the different colors of the leaf in general.

The color difference in leaves is not only influenced by the total chlorophyll pigment, but all types of pigment will affect the color appearance of the leaf. Some types of these pigments are carotene, anthocyanin, xanthophyll, and etc. (Ogunwenmo et al., 2007). The color difference of *Klutuk banana* leaves of *susu* and *wulung* cultivars is not only influenced by the type of the leaf but also the pigment concentration of each cultivar



leaves. Besides, the age of *Klutuk banana* leaf also roles in the leaf color difference of both different cultivars.

### 3.4. Fat Content of *Klutuk banana* Leaf

The measurement of fat content from leaves use the Soxhlet method. The measured data are shown in Table 4. It shows that the older the age of the leaf, its fat content will be increased on both cultivars. However, the results are statistically insignificant in the difference between the first to fifth shoots.

Table 4. The fat content of *Klutuk banana* leaves of *susu* and *wulung* cultivars

n-th Leaf	Fat content(%)	
	Leaves of <i>susu</i> cultivar	Leaves of <i>wulung</i> cultivar
1	8.73 <sup>a</sup>	8.59 <sup>a</sup>
2	8.91 <sup>a</sup>	8.89 <sup>a</sup>
3	8.99 <sup>a</sup>	9.58 <sup>a</sup>
4	9.24 <sup>a</sup>	9.49 <sup>a</sup>
5	9.61 <sup>a</sup>	10.05 <sup>a</sup>

The letter symbol shows the significant difference of *Klutuk banana* leaves of *susu* and *wulung* cultivars ( $p < 0.05$ ) on the same column.

There is a shining layer that covers the surface of the leaf on banana leaves. It is called by wax layer or cuticle. The surface of the plant is covered by polyester lipid layer consisted of cutin, which contains fatty acid compounds such as palmitic acid and stearate (Aharoni et al., 2004). Fitriani (2017) obtained the result of fat content in *Klutuk banana* leaves as 18.88% on her experiment. This indicates that the cultivar and the origin of the leaf affects its content of fat.

### 3.5. Antioxidant Activity of *Klutuk banana* Leaf

Antioxidant activity of *Klutuk banana* leaves extract of *susu* and *wulung* cultivars was analyzed by using spectrophotometer Uv-Vis on the wave length of 515 nm. The concentration of the extract analyzed is 1000 ppm. The antioxidant level is represented in Table 5. Based on the measurement, the antioxidant activity of *Klutuk banana* leaf is influenced by the cultivar and the age of the leaf. The biggest antioxidant activity is found on the first shoot, while the lowest is found on the fifth shoot. Hence, the older the age of the leaf is, then its antioxidant activity will be lower.

Table 5. Antioxidant activity of *Klutuk banana* leaves of *susu* and *wulung* cultivars on 1000 ppm concentration

n-th Leaf	RSA(%)	
	Leaves of <i>susu</i> cultivar	Leaves of <i>wulung</i> cultivar
1	40.55 <sup>c</sup>	44.14 <sup>c</sup>
2	22.70 <sup>a</sup>	35.75 <sup>a</sup>
3	38.26 <sup>b</sup>	38.48 <sup>b</sup>
4	45.96 <sup>b</sup>	28.79 <sup>b</sup>
5	30.17 <sup>a</sup>	29.14 <sup>a</sup>

The letter symbol shows the significant difference of *Klutuk banana* leaves of *Susu* and *wulung* cultivars ( $p < 0.05$ ) on the same column.

Wojdyto *et al.* (2007) mentioned that a drying process that takes more than 7 hours would denature the antioxidant compound in a material. Based on Sagrin *et al.* (2013) research, the drying temperature will significantly affect its antioxidant level, the total content of phenolics, water activity, color, and rehydration of a banana leaf. The suitable temperature for drying is 50°C. The drying process is done for 12 hours on the temperature of 50°C. This duration of drying is chosen because if it takes less than 12 hours, then the leaves are not completely dried, and it will be hard to be smashed into powder. Fitriani (2016), in her research, mentioned that the antioxidant activity of *Klutuk banana* leaves extract is 4.74%RSA on the concentration of 0.01g/100ml. The antioxidant activity of *Klutuk banana* leaves also depends on its origin, which means the tree used in the research.

The capability of free radical scavenging is profoundly influenced by the hydroxyl group (OH) on the phenolic compounds (Nakiboglu *et al.*, 2007). More hydroxyl group (OH) substituted in a molecule, then its free radical scavenging activity will be higher because the number of donated hydrogen atoms is also increased (Yu Lin *et al.*, 2009).

#### 4. CONCLUSIONS

From the research that has been done, it can be concluded that the best *Klutuk banana leaf* of *susu* and *wulung* cultivars as a food packaging material is in the third leaf stalk (petiole) based on its mechanical properties, color, and antioxidant activity. The highest antioxidant activity is found in the first leaf bud (shoot) of *Klutuk banana* leaves of *susu* and *wulung* cultivars.

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