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Quality of kapok honey in some areas of *Apis mellifera* honey cultivation in Central Java and East Java Province

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Abstract. Java Island is a center for developing *Apis mellifera* bee cultivation due to the availability of honey bee feed plants. The most reliable plant species producing honey is kapok plant (*Ceiba petandra*), because the flowering period is around 2.5 months. This study aims to determine the quality of *A.mellifera* kapok honey from Central and East Java. Sampling was carried out by purposive sampling method in Pati District and Jepara District (Central Java Province) and Pasuruan District (East Java Province), which were the centers of honey production. To find out the quality of kapok honey, laboratory analysis of 9 honey samples from honey producers was done. The results showed that the acidity, hydroxymethylfurfural (HMF), reducing sugar and sucrose levels of all honey samples met SNI 8664-2018 standards, except honey water content which exceeded the SNI limit (maximum 22%). Kapok honey is acidic with a pH value of 4.0 to 4.5, white to light amber with an intensity value of 20 to 73 mm Pfund. The results of the phytochemical analysis that showed that the kapok honey in Pati District contained saponin active compounds, whereas honey from Jepara and Pasuruan District contained saponins and flavonoids which had the potential to be anti-bacterial and antioxidant.

1. Introduction

Honey is one of the leading non-timber forest product (NTFP) commodities as stipulated in Permenhut Number P.21 / Menhut-II / 2009 [1]. Honey is a natural product produced by honey bees (*Apis sp.*) from nectar secreted by flowers or other parts of plants after going through a physicochemical process [2]. According to the Indonesian National Standard (SNI) honey is a natural liquid that generally has a sweet taste produced by honey bees (*Apis sp.*) from plant flower extracts (floral nectar) or other parts of plants (extra floral).

Indonesia is one of the honey producing countries with an average production of around 5,000 tons per year [3] and around 25% of the total honey production in Indonesia comes from *Apis mellifera* bee cultivation [4]. The cultivation of *A.mellifera* is widely developed in Java and occupies an important position in beekeeping activities in Indonesia [4]. *Apis mellifera* bees are imported bees imported from Australia, and can adapt to the environment in Indonesia. In 2006 there were around 33,000 *A.mellifera* bee colonies [5]. The development of *A.mellifera* honey bee cultivation in Java, due to the sufficient availability of honey bee food sources as a source of nectar and pollen and the availability of affordable road infrastructure to various corners where honeybee feed is available [6].

The most reliable type of honey bee breeder *A.mellifera* on Java Island is kapok (*Ceiba petandra*), because the flowering period is quite long from May to July. Kapok plants as a source of nectar and pollen for honey bees. This type of plant is widely found in Central Java and East Java Provinces. Some areas producing honey bee or as a center for honeybee production, e.g. in Pati District and



Jepara District (Central Java Province); in Banyuwangi, Pasuruan, and Probolinggo Districts (East Java Province).

Varied landscapes in each region make each region produce honey in accordance with the characteristics of plants that dominate it. The physicochemical characteristics of honey and its composition in each region are different, this is because it is influenced by the type of soil, climate and type of vegetation found in the area [7]. Important honey quality indicators for consumers include the color, taste and aroma of honey [8]. The color, taste and aroma of honey are influenced by the type of plant source of nectar for honey bees. The composition, taste, aroma and physical appearance of honey varied [9]. Factors that influence differences in honey characteristics include geographical location, plant vegetation, climate, temperature and humidity, topography, bee food sources and processing and storage processes. The physicochemical characteristics of honey in many studies can be a reference in identifying honey quality. In Indonesia the quality of honey or honey quality is determined based on the Indonesian National Standard (SNI) Number 8664-2018 [10]. The quality of honey is greatly influenced by environmental conditions and plant origin as a source of honey bee nectar [11]. Based on the description above, it is necessary to do research on the quality of honey from various regions of honey production centers. The purpose of this study was to determine the quality of *A.mellifera* bee kapok honey from various honey production centers in Central Java and East Java Provinces.

2. Methods

A total of 9 kapok honey samples obtained from various locations in three districts were taken directly from *A.mellifera* kapok honey beekeepers so that the falsification of honey could be avoided. Honey sampling was carried out in three districts namely Pati District and Jepara District, Central Java Province and Pasuruan District, East Java Province. In each district, 3 samples of manual honey were taken (Table 1). Honey sampling was carried out in June to August 2015 during the honey harvest season with its main food source as kapok flowers. Kapok honey is a monoflora honey type, because it is dominated by one type of plant as a source of kapok honey food. The kapok plant (*Ceiba petandra*) is a source of nectar and pollen for honey bees.

Table 1. Location of honey type honey bee *Apis mellifera* sampling

No	Sample code	Harvesting location			Sampling
		Village	Sub District	District	
1	R 1	Guo	Telogowungu	Pati	June 2015
2	R 7	Mejobo	Cluak	Pati	June 2015
3	R 12	Gajihan	Gunung Wungkal	Pati	July 2015
4	R 10	Perning	Keling	Jepara	July 2015
5	R 11	Batugede	Mayong	Jepara	July 2015
6	R 16	Pendem	Kembangsari	Jepara	August 2015
7	R 18	Pancur	Lumbang	Pasuruan	August 2015
8	R 19	Ngembal	Tutur	Pasuruan	August 2015
9	R 20	Rawi	Rawi	Pasuruan	August 2015

The chemicals used in this study consisted of distilled water, oxalic acid, penolpthalin, sulfuric acid, FeCl₃, NaOH, borax, sulfuric acid, ethanol, methanol and oxalic acid. The equipment used includes analytical scales, refractometers, spectrophotometers, honey color analyzers, hygrometers, and thermometers.

This research approach uses a quantitative approach with the support of a qualitative approach. The research method used was a survey, observation and interview with *A.mellifera* honey beekeepers. Purposive sampling locations are selected based on the area which is the center of honey production.

To find out the physical-chemical characteristics of kapok honey zwere carried out an analysis at the Forest Research Center laboratory and the Biopharmaca Laboratory. The parameters tested to determine the physical-chemical properties of honey consist of water content, pH value, honey color,

acidity, sugar content, and hidroxymethylfurfural (HMF). The results of the analysis were compared with the Indonesian National Standard (SNI) 8664-2018 on honey [10]. Phytochemical analysis is carried out to determine whether there are classes of active compounds in honey. The testing procedure refers to Harbone [12]. The identification carried out was an alkaloid, tannin, flavonoid, saponin, steroid, and triterpenoid test.

Physical characteristics analysis consisted of honey color analysis using a honey color analyzer type HI 96785. Honey chemical characteristic analysis consisted of water content according to AOAC [13] with the refractometer method, pH analysis using a pH meter, analysis of sugar types (glucose, fructose and sucrose) using a HPLC tool and analyzing reducing sugars using a spectrophotometer. Phytochemical analysis of honey qualitatively was done using color visualization methods. The results of data analysis are presented descriptively.

3. Results and discussions

3.1. Honey Color

The results of color analysis using a honey color analyzer show that honey from the three locations have a variety of colors, including white to light amber with a color intensity value of 20–73 mm Pfund (Table 2). This shows that the color of honey is strongly influenced by the biophysical conditions of the honey bee food source area as a producer of nectar and its mineral content. In general, the brighter the color of honey contains fewer minerals than the dark honey [14]. Color has an important role in the assessment of honey based on consumer preferences [15]. Honey color does not determine the quality of honey because honey color depends on the type of flower nectar consumed by bees [16]. The honey color from Ngembal Village, Pasuruan District is darker than the other honey and has the highest intensity value. Eleazu *et al.* [17] suggested that darker colored honey contains high phenolic compared to light colored honey.

Table 2. Properties of kapok honey

No	Sample code	Honey colour intensity (mm Pfund)	Colour criteria	Water content (%)	pH	Acidity (ml N NaOH/kg)	HMF (mg/kg)	Reducing sugar (%)
1	R 1	41	Extra light amber	28.0	4.0	10.03	0.1914	65.49
2	R 7	20	White	23.5	4.5	5.78	0.0743	67.29
3	R 12	43	Extra light amber	31.0	4.0	8.30	0.1487	77.73
4	R 10	38	Extra light amber	24.5	4.5	7.49	0.0598	71.37
5	R 11	36	Extra light amber	33.0	4.0	7.32	0.0446	70.03
6	R 16	39	Extra light amber	27.5	4.1	7.56	0.1476	82.14
7	R 18	51	Light amber	33.5	4.0	7.86	0.0441	65.39
8	R 19	73	Light amber	32.0	4.0	10.71	0.0591	64.89
9	R 20	33	White	26.5	4.0	7.65	0.4341	68.64

3.2. Water Content

The water content in honey determines the quality of honey. Good quality honey containing water content around 17–21%. Higher water content in honey reflects lower honey quality [14]. All honey samples studied has various water contents and exceed SNI 8664-2018 standards (maximum 22%).

Novitawati *et al.* [18] suggested that honey water content is influenced by nectar sources and weather conditions. Kahraman *et al.* [19] suggested that the factors affecting honey water content include the harvest season. The level of honey maturity in the combination of geographical and environmental factors including the surrounding air humidity. Honey with high water content (more than 25% water content) is easily fermented [20]. To be able to meet SNI standards, it is necessary to conduct proper post-harvest handling to lower honey water content [14].

3.3. PH Value

The pH value indicates the degree of acidity to express the acidity or basicity of a substance. The acidity of honey is determined by the dissociation of hydrogen ions in aqueous solution. The results of the analysis show that the honey obtained from various locations has a low pH of 4.0–4.5. A low pH value can affect the stability of honey against microorganisms and the taste and aroma of honey [14]. Chua *et al.* [21] suggested that low honey pH can prevent the growth of various kinds of bacteria. Bacteria can grow at neutral or alkaline pH, while molds are able to grow in an acidic environment [22].

3.4. Acidity Level

Acidity is an important criterion for determining the quality of honey. The acidity level of all honey from the obtained honey from the three districts is very versatile but still meets SNI 2018 standards (maximum 50 ml N NaOH/kg). This indicates that the honey has not undergone fermentation. Acid affects the stability of honey against microorganisms and the taste and aroma of honey [23]. If the acidity level is greater than 50 ml N NaOH/kg, it indicates that the honey has undergone fermentation. The cause of fermentation is yeast or yeast of the genus *Zygosaccharomyces* which are resistant to high sugar concentrations.

3.5. Hydroxymethylfurfural Analysis

Testing the hydroxy methyl furfural (HMF) levels in honey is very important in determining the authenticity and freshness of honey [24]. The content of HMF is an indicator of honey damage caused by overheating. The higher the heating temperature and storage time, the higher the HMF levels formed and the higher HMF levels will reduce the quality of honey [25]. The results of the analysis that all honey samples have hydroxy methyl furfural (HMF) levels meet SNI 8664-2018 (maximum 50 mg/kg). This shows that manual honey from various locations is pure honey that is still fresh and there is no treatment for heating and storage. Koesprimadisari *et al.* [24] suggested that high levels of HMF in honey would reduce the quality of honey. HMF levels will increase due to storage temperature.

3.6. Sugar Level Analysis

Sugar content in honey is one of the honey quality criteria. Savitri *et al.* [26] states that water content, total sugar content and acidity level are honey quality criteria. Glucose and fructose are monosaccharide carbohydrates which are dominant in honey which is around 70–80% [8]. According to SNI [10] the two monosaccharides are termed reducing sugars [27]. The results of the analysis showed that most of the reducing sugar content of honey studied fulfilled the 2018 SNI standard, which was a minimum of 65%. A total of one sample from nine honey samples were examined under SNI standards. This showed that most of the honey from the three regencies were good in quality. The content of reducing sugar honey in each harvesting area varies. Silvia *et al.* [28] stated that the composition of honey sugar is influenced by the type of flower used by bees, as well as the region and climate conditions.

In most types of honey, fructose is a major component in honey that causes honey to have a sweeter taste than sugar [29]. The results of the analysis show that the randu honey has a higher fructose content than the glucose content. This is in line with the statement of White [30] that which states that almost all types of honey have greater fructose content than glucose.

The level of sucrose in honey is very important because it is one of the tests of the authenticity of honey. High levels of sucrose in honey are possible forging of honey or adding sugar solution to

honey. Therefore the Indonesian National Standard (SNI) 8664-2018 [10] limits the sucrose content in honey to a maximum of 5% w/w. The results of the analysis showed that the sucrose content of all honey samples from the three districts met the SNI 8664-2018 standard. This shows that the honey is real honey and there is no addition of other sugars into honey. Sumantri *et al.* [31] suggested that the level of sucrose in honey is very important because it is a standard in determining the authenticity of honey.

Table 3. Honey phytochemical analysis results

No	Sample code	Alkaloids			Steroids	Flavonoids	Tannin	Saponin	Triterpenoid
		Wagner	Mayer	Dragendorf					
1	R 1	-	-	-	-	-	-	++	-
2	R 7	-	-	-	-	-	-	++	-
3	R 12	-	-	-	-	-	-	++	-
4	R 10	-	-	-	-	-	-	++	-
5	R 11	-	-	-	-	+	-	++	-
6	R 16	-	-	-	-	+	-	+++	-
7	R 18	-	-	-	-	+	-	+++	-
8	R 19	-	-	-	-	++	-	+++	-
9	R 20	-	-	-	-	+	-	+++	-

3.7. Phytochemical Analysis of Honey

Phytochemical analysis of honey is carried out to identify active compounds that are suspected of being potential as antibacterial and antioxidant. Rita [32] stated that to find out the secondary metabolite compounds qualitatively based on the color intensity produced through phytochemical tests. The results of phytochemical analysis that all honey samples obtained from various positive regions contain active compounds of saponin group with the formation of foam that is stable with the results of saponin from positive to strong positive. Prasetyo *et al.* [33] states that saponins have the ability to be antibacterial. This shows that all the honey samples studied have the potential to be antibacterial.

The antibacterial potential of the manual honey in each region in three districts varies. There are differences in antibacterial potential at each honey harvesting location from Jepara District. while honey from Pati and Pasuruan Districts have the same potential at each harvesting location. This is because there are differences in biophysical conditions, the source of honey bee feed as a source of nectar and pollen found in each region where honey is harvested. Kapok honey from Pasuruan District has the potential as an antibacterial higher than the honey from Jepara District and Pati District. This is indicated by the positive saponin yield compared to honey from other regions with moderate positive saponin yield. This is in line with the statement of Purwata [34] that honey has different chemical composition. so that there is a difference in the activity of honey as an antibacterial.

Addition to containing saponin compounds, kapok honey contains flavonoids. Mahardika [35] suggested that flavonoids can function as antioxidants. All honey samples from Pasuruan District contain active compounds of the flavonoid group, and as many as two honey samples from Jepara District contain flavonoids, while all honey samples from Pati District do not contain flavonoids. This shows that honey from Jepara and Pasuruan Districts has potential as an antioxidant. Enzymatic compounds such as glucoseoxidase and non-enzymatic compounds such as flavonoids found in honey so that honey has antioxidant properties [36]. The results of flavonoid analysis of honey from the districts of Jepara and Pasuruan varied marked by the results of positive to weak positive flavonoids. This shows that the antioxidant potential of honey varies at each honey harvest location. Honey from Ngembal Village, Pasuruan District has a higher flavonoid content than other locations. This is indicated by the results of moderate positive flavonoids, so that the honey from Ngembal Village has the highest antioxidant potential and is the highest compared to other honey harvesting locations.

All honey samples from Pati District, Jepara District and Pasuruan District do not contain active alkaloid compounds which are not formed by sedimentation with Dragendorff. Mayer and Wagner reagents, do not contain triterpenoids with no browning color formation. and do not contain steroids with no greenish blue formation. and does not contain tannin in the absence of dark blue color.

4. Conclusion

Kapok honey obtained from various honey harvesting locations in Pati, Jepara, and Pasuruan Districts has a variety of colors including white to light amber. All honey samples have acidity and hydroxy methyl furfural (HMF) levels and sucrose levels that meet the Indonesian National Standard (SNI) 8664-2018, with a water content above the SNI standard. Kapok honey has a low pH value and is acidic. The majority of kapok honey has reducing sugar content that meets SNI standards with a higher fructose content than glucose content.

There are differences in active compounds at each honey harvesting location. All honey samples contain active compounds of saponins that have the potential to be antibacterial. Kapok honey from Pasuruan District and Jepara District contain active compounds of flavonoid which have potential as antioxidants. However, all samples of the study honey did not contain active compounds such as alkaloids, steroids, tannins, triterpenoids, and quinons.

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