Honey quality from the bee Apis cerana, honey potency produced by coconut and sugar palm saps

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Honey quality from the bee *Apis cerana*, honey potency produced by coconut and sugar palm saps

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Abstract. One of the big problems when keeping of honeybees is the limited of sustainable feed, especially in the rain season. The objectives of this study were to evaluate the honey quality from the bee *A. cerana* based on the chemical composition, honey potency produced by the coconut and sugar palm saps. This study using thirty colonies of the bee *A. cerana* were divided into six treatments consists of sugar palm sap without sugar palm pollen; coconut sap without sugar palm pollen; coconut sap of 50% + sugar palm sap of 50% without sugar palm pollen; sugar palm sap was added by sugar palm pollen; coconut sap was added by sugar palm pollen; coconut sap of 50% + sugar palm sap of 50% was added by sugar palm pollen. The chemical composition of honey from the *A. cerana* were moisture (20.76 to 21.80%), reducing sugar (62.78 to 68.37%), sucrose (1.44 to 3.42%), diastase enzyme activity (5.17 to 9.04 DN), hydroxymethylfurfural (2.24 to 5.81 mg/kg), and acidity (26.00 to 36.35 ml NaOH/kg). Honey potency produced by the coconut and sugar palm saps in 100 hectares area produces honey was 1,542.857 tons/year and 1,150 tons/year, respectively. It can be concluded that honey quality is produced by sugar palm and coconut saps, and potential as the bee feed.

Key words: *Arenga pinnata*, beekeeping, *Cocos nucifera* L., extrafloral nectar, multifloral nectar

Running title: Honey quality of *Apis cerana* produced by sugar palm and coconut saps

INTRODUCTION

Honeybee of *A. cerana* is one of the bees from the *Apis* genus which is include the local bee which is spread in some regions in Indonesia are Kalimantan, Sumatera, Java, Bali, Lombok, Sumbawa, Sulawesi, Papua, and Seram (Radloff et al. 2011; Hepburn and Radloff 2011). In Indonesia, beekeeping of the bee *A. cerana* has been practiced by the beekeepers using a traditional hives (for example using a coconut log hive) and semi modern hive (box hive without nest frame) to produce honey. Furthermore, several regions have been practices the beekeeping of the bee *A. cerana* has been reported by Schouten et al. (2019) are Riau, North Sumatera, Lampung, Banten, Java, Yogyakarta region, Bali, and Lombok. However, the beekeeping of *A. cerana* is mostly using traditional hives although using a box hives because is not completed by the honey frame like a beekeeping of *A. mellifera*. The bee *A. cerana* can produce honey, bee bread, royal jelly, and propolis, however their production is lower compared to the bee *A. mellifera*.

One of the problems faced by the beekeepers in Indonesia is the limited of feed sustainability as the raw material to produce honey, bee bread, and royal jelly. The limitation feed is the very serious problem have been faced by the beekeepers because they have not area which is used to planted several plants which are used the feed source to produce the honeybees products. Honeybees feeds is divided into two types namely nectar and pollen, where nectar is obtained by the foragers from the plant flowers (nectar floral) and nectar extrafloral which is obtained by the foragers from stalk and leaf of plants (Agussalim et al. 2018, 2017). Pollen is obtained by the foragers from plant flowers which is collected by using all body part and then deposited in the corbicula (Agussalim et al. 2018, 2017; Erwan et al. 2021a). When collecting nectar and pollen from the plant flowers, the foragers is role as the pollinator agent by transporting pollen from the anther to pistil so that the pollination process occurs. This process is continuously done by the foragers until their honey stomach is full by a nectar and their corbicula has been deposited by the pollen. This pollination which is impacts on the increasing the plants productivity (Pohorecka et al., 2014; Supeno et al., 2021).

One of the strategies to produce the sustainability honey from the bee *A. cerana* by using a sap from the plants such as sugar palm and coconut. Several studies have been conducted by using a sugar palm and coconut saps as the *A. cerana* feed. Erwan et al. (2021b) reported that the feed combination of coconut sap and sugar palm pollen as the *A. cerana* feed can enhancing the production of honey cells and bee bread cells. However, the use each of sap from coconut and sugar palm can increasing the honey and bee bread cells compared to control group without sap as the feed (multifloral nectar). Furthermore, Erwan et al. (2022) was also reported that the use of sugar palm and coconut saps which each added by sugar

palm pollen can improving the bee *A. cerana* productivity such as increase the honey production, brood cells number, and colony weight. In addition, in other study showed that the use of extrafloral nectar namely sugar palm (*Arenga pinnata*) and coconut (*Cocos nucifera* L.) saps as the *A. mellifera* bee feed which is resulting the honey chemical composition (reducing sugar, sucrose, acidity, moisture, and diastase enzyme activity) which are acceptable by Indonesian national standard and international standard has been regulated by Codex Alimentarius (Erwan et al. 2020). However, the studied about the chemical composition of honey from the bee *A. cerana* which are produced from the sugar palm sap, coconut sap and their honey potency production from both sap sugar palm and coconut have not been studied. Therefore, the objectives of this study were to evaluate the honey quality based on the chemical composition from the bee *A. cerana*, honey potency produced by the coconut and sugar palm saps.

MATERIALS AND METHODS

Study area

This research has been conducted in the North Duman Village (8º32'10"S 116º09'32"E), Lingsar Sub-district, West Lombok (West Nusa Tenggara Province, Indonesia). In this research, we used thirty of *A. cerana* colonies were divided into six treatments and each five colonies per treatment as the replication. The saps were used in our study were obtained from coconut (*Cocos nucifera* L.) and sugar palm (*Arenga pinnata*). The treatments in our study were sugar palm sap without added by sugar palm pollen (SP0); coconut sap without added by sugar palm pollen (CP0); coconut sap of 50% + sugar palm sap of 50% without added by sugar palm pollen (SCP0); sugar palm sap was added by sugar palm pollen (SP1); coconut sap was added by sugar palm pollen (CP1); coconut sap of 50% + sugar palm sap of 50% was added by sugar palm pollen (SCP1).

The technique was used to given sugar palm and coconut saps and sugar palm pollen was according to previously method has been reported by Erwan et al. (2022, 2021b) briefly as follows: fresh coconut and sugar palm saps were given to the bee *A. cerana* by using a plastic plate and split bamboo were completed by 4 to 5 twigs for foragers perch. The plastic plate and split bamboo were placed one meter of the box hives, while the sugar palm pollen was hung besides and above of the box hives. The distance of 600 meters to place colony to avoid the foragers to collect pollen and sap from the other treatments.

Proceduress

Honey quality

Honey from the *A. cerana* was harvested after beekeeping for three months by using a coconut and sugar palm saps. Honey from the five hives in one treatment group was composited into one honey sample and then used to analysis of their chemical composition. Honey quality from the *A. cerana* were evaluated based on the chemical composition consists of moisture, reducing sugar, sucrose, diastase enzyme activity, hydroxymethylfurfural (HMF), and acidity. The moisture content was analyzed by using a proximate analysis based on the method from Association of Official Agricultural Chemists (AOAC) (AOAC 2005). Reducing sugar was analyzed by using a Layne-Enyon method and sucrose content was analyzed by a Luff Schoorl method were described by AOAC (2005). Diastase enzyme activity, hydroxymethylfurfural (HMF), and free acidity were analyzed based on the harmonised methods of the international honey commission (Machado et al. 2022).

Honey production from sugar palm and coconut saps

Sugar palm and coconut saps each ten liters were used to measuring the honey production from the bee *A. cerana* for three months of beekeeping. The sugar palm and coconut saps were placed in the plastic plate in front of the box hives at the distance of one meter. In addition, the honey production without using of sugar palm and coconut saps were measured for one year of the beekeeping which is used to calculate the contribution of sugar palm and coconut saps in honey production.

Production of saps from coconut and sugar palm

The production of sap from coconut was measured for a year, while the sugar palm sap based on the previously studied was used to calculate the production per hectare area and was also obtained from the deep interview with the farmers. The production of coconut and sugar palm saps per hectare which was calculated from the sap production per hectare multiplied by the tress number in one hectare area. After three months of beekeeping, honey from both treatments sugar palm and coconut saps were harvested to measure the honey production from the use of ten litters sap and then honey production was measured by cylinder glass

Data analysis

The data of honey quality, production potency of honey from sugar palm and coconut saps, honey production, and production of saps were analyzed by using a descriptive analysis (Steel et al. 1997).

RESULTS AND DISCUSSION

Moisture content of honey

Honey is composed by water as the second largest of honey constituent and its ranging from 15 to 21 g/100 g, depending on the plant types as the nectar source which is affected by the botanical orig Furthermore, honey moisture is also affected by honey maturity level, processing postharvest, and storage condition (Da Silva t al. 2016). The honey moisture is affecting the ysical properties such as crystallization, viscosity, flavor, color, taste, solubility, specific gravity, and cons vation (Da Silva et al. 2016; Escuredo et al. 2013). In addition, honey moisture is also affected by the temperature and humidity or depending on the s son (rain and dry seasons) and honey moisture can increase during the post st processing such as storage condition because honey is hygroscopic that can absorbs the moisture in the air (Da Silva et al. 2016; Karabagias et al. 2014).

The recent study showed that the honey moisture from the bee *A. cerana* which was produced by sugar palm and coconut saps and their combination was ranging from 20.76 to 21.80% (Table 1). This honey moisture content is accepted by Indonesian national standard (SNI) where the moisture for beekeeping honey including the bee *A. cerana* and *A. mellifera* is not exceed 22% (National Standardization Agency of Indo sia 2018) and higher compared to international standard which is regulated by Codex Alimentarius is not exceed 20% (Thrasyvoulou et al. 2018). The variation of honey moisture of the bee *A. cerana* in our study may be caused by the different moisture content of both saps from sugar palm and coconut, however in our study has not measured. The higher moisture content is requiring the long time to ripening of honey and process decreasing of honey moisture have been started by the bees when they are taken a nectar from plant flowers or saps as the raw material to produce honey. Furthermore, small portion of moisture content has been evaporated in the honey sack before transferred to the other bee which is working in the hive. This transfer is rapid depending on the temperature, colony strength, and nectar availability (Da Silva et al. 2016).

Table 1. The moisture, reducing sugar, and sucrose contents of honey from the bee *A. cerana*

Treatments	Moisture (%)	Reducing sugar (%)	Sucrose (%)
SP0	21.60	65.24	2.86
CP0	20.76	68.37	1.96
SCP0	21.40	64.55	2.51
SP1	21.80	62.78	3.42
CP1	21.58	65.37	1.72
SCP1	20.98	67.33	1.44

Abbreviations: sugar palm sap without added by sugar palm pollen (SP0); coconut sap without added by sugar palm pollen (CP0); coconut sap of 50% + sugar palm sap of 50% without added by sugar palm pollen (SCP0); sugar palm sap was added by sugar palm pollen (SP1); coconut sap was added by sugar palm pollen (CP1); coconut sap of 50% + sugar palm sap of 50% was added by sugar palm pollen (SCP1).

Honey production process is started from the foragers collecting a nectar from the plant flowers or extrafloral nectar and then stored in honey stomach. After that, the foragers will be transferring a nectar has been collected to the other bees whom working to processing a nectar into honey in their mouth, then put in honey stomach and then is transferred to other bees for several times until honey is ripening. A considerable of water amount will be evaporated in this process and this continues with the help of wing fans that can regulate the air humidity for about 15 to 20 minutes (Balasubramanyam 2021; Zhang al. 2021). The honey moisture content in our study was differed to reported by Wang et al. (2021) that honey moisture from the bee *A. cerana* which is collected from 42 different honeycombs from China is ranging from 17.03 to 18.44%, 18.65% for *A. cerana cerana* from Hainan province, China (Wu et al. 2020), and 16.99% for *A. cerana* from Borneo (Malaysian honey) (Moniruzzaman et al. 2013). Furthermore, Erwan et al. (2020) was also reported that the honey moisture was produced by the *A. mellifera* bee by using a sugar palm and coconut saps is ranging from 19.34 to 20.94%. The different honey moisture content has been reported are affected by the different geographical origins which is impact on the different plant types can be growth each region, different environmental condition (temperature and humidity), and also different bee species which is impact on the different ability to evaporate water in the honey.

Reducing sugar and sucrose contents of honey

Sugars in honey are composed by monosaccharides for about 75%, disaccharides are 10 to 15%, and other sugars in small amounts. Honey sugars re responsible as the energy source, hygroscopic, viscosity, and granulation. Several sugars in honey have en reported such as glucose, fructose, sucrose, trehalose, rhamnose, isomaltose, gerobiose, maltotriose, maltotetraose, melezitose, melibiose, maltulose, nigerose, raffinose, palatinose, erlose and others (Da Silva et al. 2016).

The recent study showed that the honey s ducing sugar from the bee *A. cerana* were beekeeping by using a sugar palm and coconut saps and their combination as the nectar source to produce honey is ranging from 62.78 to 68.37 % (Table 1). This honey reducing sugar is acceptable by the SNI for treatments SP0, CP0, CP1, and SCP1, but not acceptable for treatments SCP0, SP1 (Table 1), where the minimum reducing sugar is 65% (National Standardization Agency of Indonesia 2018). This sugar is produced by the mechanism of vertase enzyme activity that change the sap sucrose into simple sugars. It is known that this enzyme is responsible for the conversion of sucrose into glucose and fructose. These

sugars are included in reducing sugar group and as the main component present in honey. In honey maturity process, the sucrose is break down by the invertase enzyme into simple sugars simultaneously and water will be evaporated so that it will be increasing the reducing sugar content. In addition, enzymes secreted by the worker bees are also can break down the carbohydrate into simple sugars. Furthermore, other enzyme present in honey is diastase enzyme that role to break down starch into simple sugars (Da Silva et al. 2016). The honey reducing sugar in our study (Table 1) was differed to reported by Erwan et al. (2020) that honey reducing sugar from the bee *A. mellifera* which was produced by extrafloral nectar (sugar palm and coconut saps) is ranging from 60.15 to 73.69%. The different reducing sugar may be affected by the different bee species which is impact on the different their ability to evaporate water present in honey especially when they are convert the complex sugars into simple sugars and different season when done the study which are related to temperature and humidity environmental.

The honey sucrose content from the bee *A. cerana* in our study is ranging from 1.44 to 3.42% (Table 1) and acceptable by SNI is not exceed 5% for the beekeeping honey including *A. cerana* and *A. mellifera* (National Standardization Agency of Indonesia 2018) and also accepted by the International standard has been regulated by Codex Alimentarius is not exceed 5% for blossom and honeydew honeys (Thrasyvoulou et al. 2018). Naturally, sucrose present in honey in our study is originated from sugar palm and coconut saps. The low of honey sucrose content in our study is caused the honey which is harvested in mature condition that characterized by honey cells have been covered by the wax. Furthermore, the invertase enzyme which is produced by the worker bees is actively break down of sucrose from saps into simple sugars. There are two types of invertase enzymes which are produced by the worker bees, namely glucoinvertase which is converts sucrose into glucose and fructoinvertase which is converts sucrose into fructose. These enzymes are mostly derived from the bee's secretion and only small portion from the nectar, while the honeydew from the insect's secretion is mostly contain invertase enzyme (Da Silva et al. 2016). The honey sucrose content in our study (Table 1) was differed to reported by Erwan et al. (2020) that honey sucrose content from the bee *A. mellifera* was produced by extrafloral nectar (sugar palm and coconut saps) is ranging from 4.21 to 4.40%%.

The honey sucrose content is a very important parameter to evaluate the maturity of honey to identifying manipulation, where the high levels may be indicated adulterations by adding the several sweeteners such cane sugar or refined beet sugar. In addition, also indicating the early of harvest, where sucrose is not completed transformed into fructose and glucose, the bees feeding artificial in prolonged time by using a sucrose syrup (Da Silva et al. 2016; Puscas et al. 2013; Escuredo et al. 2013; Tornuk et al. 2013). Honey is sugar solution that is supersaturated and unstable so it's easy to crystallize. The honey crystallization is affected by concentration of glucose, fructose, and water. Fructose is the dominant sugar present in honey from *A. mellifera* was produced by several plants as the nectar source which is used by workers to produce honey such as eucalyptus, acacia, bramble, lime, chestnut, sunflower, and from honeydew, except in rape honey was produced by *Brassica napus*. Rape honey is higher in glucose and lower in fructose which is impact on the rapidly crystallization (Escuredo et al. 2014). The sugars content present in honey is dependent on the geographical origins which is impact on the different plant types can growth in each region and impact on the different sugars content from the nectar which is produced by the nectary gland of plant flowers (Agus et al. 2021; Agussalim et al. 2019; Da Silva et al. 2016; Escuredo et al. 2014; Tornuk et al. 2013). Furthermore, sugars content in honey is influenced by climate (season, temperature, and humidity), processing (heating process), and storage time (Da Silva et al. 2016; Escuredo et al. 2014; Tornuk et al. 2013).

Diastase enzyme activity and hydroxymethylfurfural of honey

The recent study showed that the diastase enzyme activity from the bee *A. cerana* honey was produced by the sugar palm and coconut saps was ranging from 5.17 to 9.04 DN (Table 2). This enzyme activity is acceptable by SNI with the minimum of 3 DN for the beekeeping honey including the bee *A. cerana* and *A. mellifera* (National Standardization Agency of Indonesia 2018) and also acceptable by international standard has been regulated by Codex Alimentarius with the minimum 3 DN (Thrasyvoulou et al. 2018). One of the honey characteristics is contain enzymes which is originate from the bees, pollen, and nectar from plant flowers, but the mostly enzymes are added by the bees when they are convert nectar into honey (Da Silva et al. 2016; Thrasyvoulou et al. 2018). The honey diastase enzyme activity in our study (Table 2) was differed to reported by Erwan et al. (2020) that the diastase enzyme activity of honey from the bee *A. mellifera* was produced by extrafloral nectar (sugar palm and coconut saps) is ranging from 16.48 to 17.12 Schade unit.

Diastases is divided into α- and β-amylases which are the natural enzymes present in honey. The α-amylase is separate the starch chain randomly in the central to produce dextrin, while the β-amylase to separate the maltose in the end chain. Diastase enzyme content in honey is influenced by nectar source (floral and extrafloral nectars) to produce honey and honey geographical origins which are impact on the different chemical composition of the nectar can be produced by the plants which is impact on the honey chemical composition especially diastase enzyme activity. In addition, the bee species is also influencing the activity diastase because it's related to the distance and the flowers plant numbers can be visited by the foragers when they are collecting nectar and pollen were using to produce honey and bee bread (Da Silva et al. 2016).

Generally, diastase enzyme is role to break down the complex sugars into simple sugars. This enzyme is role to digest of starch into maltose (disaccharide) and maltotriose (trisaccharide) which are sensitive to heat or thermolabile. Thus, this condition can be used to evaluate of overheating and preservation degree of honey (Da Silva et al. 2016). Furthermore, the diastase activity is also used to evaluate honey age which is related to storage time and the temperature because the

diastase activity may be reducing when heating above 60°C and longtime storage (Da Silva et al. 2016; Yücel and Sultanoğlu 2013). The honey diastase activity from the bee *A. cerana* in our study (Table 2) was differed to reported by Wu et al. (2020) for multifloral honey produced by the *A. cerana cerana* from Hainan province (China) was 6.70 Göthe. Furthermore, also was differed to reported by Wang et al. (2021) that the diastase activity of *A. cerana* honey from Qinling Mountains (China) is ranging from 22.05 to 35.67 Göthe. The different diastase activity of honey from *A. cerana* were reported by previously researchers are influenced by the different plant types as the nectar source to produce honey, different sugars content, and different geographical origin.

Furthermore, the HMF of *A. cerana* honey was produced by the sugar palm and coconut saps in our study was ranging from 2.24 to 5.81 mg/kg (Table 2). This HMF indicate that honey from our study in fresh condition and acceptable by SNI for the beekeeping honey including from *A. cerana* and *A. mellifera* is not exceed 40 mg/kg (National Standardization Agency of Indonesia 2018) and also acceptable by the international standard has been regulated by Codex Alimentarius is not exceed 40 mg/kg for blossom and honeydew honeys (Thrasyvoulou et al. 2018). The fresh honey after harvested is generally contain the low of HMF is ranging from 0 to 4.12 mg/kg honey. Hydroxymethylfurfural is resulted from the degradation of honey monosaccharide especially fructose and glucose under acid condition and accelerated by the heating. This reaction is producing levulinic and formic acids (Da Silva et al. 2016).

Table 2. The diastase enzyme activity, hydroxymethylfurfural, and acidity of honey from the bee *A. cerana*

Treatments	Diastase enzyme activity (DN)	Hydroxymethylfurfural (mg/kg)	Acidity (ml NaOH/kg)
SP0	7.57	5.78	36.33
CP0	5.17	5.04	26.00
SCP0	9.04	4.75	28.60
SP1	6.86	4.77	29.68
CP1	8.51	5.81	28.26
SCP1	6.85	2.24	30.61

Abbreviations: sugar palm sap without added by sugar palm pollen (SP0); coconut sap without added by sugar palm pollen (CP0); coconut sap of 50% + sugar palm sap of 50% without added by sugar palm pollen (SCP0); sugar palm sap was added by sugar palm pollen (SP1); coconut sap was added by sugar palm pollen (CP1); coconut sap of 50% + sugar palm sap of 50% was added by sugar palm pollen (SCP1).

Hydroxymethyfurfural is formed after honey removed from the comb or when the wax covers was opened and the advanced processing like heating process. The increasing of the HMF content is occur in honey with the high acidity and accelerated by the heating process. However, the HMF content also influenced by several factors such as sugars content, organic acids presence, moisture content, water activity, and the plant types as the nectar source (floral source). In addition, HMF is also can be formed at the low temperatures, acidic condition, and sugars dehydration reactions. Therefore, the higher of HMF content is impact on the honey color is darker (Da Silva et al. 2016; Tornuk et al. 2013). The HMF of honey from the *A. cerana* in our study (Table 2) was differed to previously reported by Wu et al. (2020) for multifloral honey of *A. cerana cerana* from China is 3.80 mg/kg and 1.69 mg/kg for *A. cerana* honey from Qinling Mountains, China is 1.69 mg/kg. The different HMF content of honey from *A. cerana* were reported by previously researchers are influenced by the different plant types as the nectar source to produce honey, different sugars content, and different geographical origin.

Acidity of honey

Free acidity is one of an important parameter to evaluate the honey deterioration which is characterized by the organic acids present in equilibrium with internal esters, lactone and several inorganic ions such as sulfates, chlorides, and phosphates (Da Silva et al. 2016). The recent study showed that the honey acidity from *A. cerana* was produced by the sugar palm and coconut saps was ranging from 26.00 to 36.33 ml NaOH/kg (Table 2). The acidity of *A. cerana* honey in our study is acceptable by SNI is not exceed 50 ml NaOH/kg for the beekeeping honey including *A. cerana* and *A. mellifera*. Furthermore, is also acceptable of the international standard has been regulated by the Codex Alimentarius is not exceed 50 meq/kg for blossom and honeydew honeys (Thrasyvoulou et al. 2018).

The sour taste of honey originated from the several of organic and inorganic acids, where the dominant of organic acid present in honey is gluconic acid. This organic acid is produced by the enzyme activity of glucose-oxidase which is added by the bees when they are convert a nectar into honey, so can protecting a nectar until honey maturity. This protecting mechanism is occurred by the inhibit of microorganisms activity present in honey (Da Silva et al. 2016). This inhibit mechanism includes the combination several factors such as low moisture and presence hydrogen peroxide which is produced by the enzyme glucose-oxidase can inhibit the metabolism activity in the microbe cell through the destruction of cell wall resulting in change in cytoplasmic membrane permeability (Nainu et al. 2021; Pasias et al. 2018).

The acidity total content in honey is small quantity, but the present in honey is very important because can influencing the honey stability on the microorganisms, taste or flavor, and aroma of honey. The high acidity is indicating the fermentation process had been occurred when some reducing sugar is break down into acetic acid. Honey acidity content is related to the yeast number where them is break down some reducing sugar into ethanol and if it's reaction with oxygen is formed the acetic acid which is increasing the honey acidity. The values higher of acidity may be indicating the

fermentation process of sugars into organic acids. The honey acidity is affected by several factors such as different content of organic acids, different geographical origin and the seasonal when honey harvested (Da Silva et al. 2016; Tornuk et al. 2013). The honey acidity from the bee *A. cerana* in our study (Table 2) was differed to previously studied by Wu et al. (2020) for *A. cerana cerana* honey is 0.80 mol/kg and Guerzou et al. (2021) is ranging 11 to 47 meq/kg for Algerian honey. Furthermore, is differed to reported by Erwan et al. (2020) that honey acidity from the bee *A. mellifera* were produced by extrafloral nectar (sugar palm and coconut saps) is ranging from 22.00 to 43.00 ml NaOH/kg. The different acidity has been reported previously with our studied is affected by the different plant types as the nectar source to produce honey, honey pH, geographical origin, and organic acids compound, however in our study has not measured the organic acid compound and honey pH.

Honey production potency from the sugar palm and coconut saps

Coconut and sugar palm plants have a good prospect to be developed because almost part of the plants can be utilized which can contributing for communities' income. Generally, the main production from the coconut (*Cocos nucifera* L.) was harvested is coconut fruit to advanced process into coconut oil and copra. Theses commodities have a high price, but if just to producing coconut oil and copra are high risk for the farmers because they are just preparing in the raw material. Therefore, the utilizing of the sap can be produced by the coconut and sugar palm were also potency feed for the bees was used as the nectar source to produce honey. Sugar palm and coconut saps are the feed potential which is studied by Erwan et al. (2021b) that the coconut and sugar palm saps can increasing the number of honey cell and bee bread cell of the bee *A. cerana*. Furthermore, is also reported that sugar palm and coconut are improving the productivity of the bee *A. cerana* such as increase the brood cells number, colony weight, and the honey production (Erwan et al. 2022). In addition, the saps from coconut and sugar palm are usually used by the farmers to produce sugar by using a traditional process.

The coconut plants can produce of 12 stalks in a year and in one of stalk can produce sap of 90 liters, thus, in one coconut plant can produce of 1,080 liters of sap. Furthermore, if the farmers have one hectare of the land which are planted by 100 coconut plants (distance 10 m × 10 m), so can be produced for about 108,000 liters of coconut sap. To produce 1 kg of honey is required coconut sap for about 7 liters and in a year is required 84 liters to produce 12 kg of honey. Thus, honey potency in a year from 100 hectares of the land can be calculated as follows: 10,800,000 liters of sap divided by 84 liters of sap and multiplied by 12 kg of honey and obtained 1,542,857,14 kg/year (1,542.857 tons/year) or equivalent with 128.571 tons/month in 100 hectares of the land. Based on the sap production showing that the coconut plants have a big potency to produce honey. This potency was also supported by the harvest area of coconut in West Lombok (Nusa Tenggara Province, Indonesia) was 10,629.36 hectares (Department of Agricultural and Plantations 2021).

Sugar palm plant can be tapped to collect sap for about 5 to 6 months in one stalk, but generally can be tapping not exceed of 4 months. Wahyuni et al. (2021) reported that the production of sugar palm sap per plant is ranging from 8 to 22 liters/plant or 300 to 400 liters/season (3 to 4 months) or 800 to 1,500 liters/plant/year (average is 1,150 liters/plant/year). Furthermore, if in one hectare of plantation we have 100 sugar palm plants with the distance for planted is 10 m × 10 m, so can be obtained of sap for 115,000 liters.

Based on the field investigation showed that to produce 1 kg of honey from the sugar palm sap is required for about 10 liters and in a year is required for about 120 liters to produce 12 kg of honey. Thus, the honey potency from the sugar palm sap in a year from the 100 hectares of the sugar palm field is 11,500,000 liters which was divided by 120 liters and multiplied by 12 kg, so is obtained 1,150,000 kg of honey per year (1,150 tons of honey) or equivalent with 95.833 tons/month in 100 hectares area. This potency indicate that the sugar palm sap has a big potency to produce honey which is supported by the report data from the Department of Agricultural and Plantations (2021) that the sap production, sap productivity, and harvest area for sugar palm plants in West Lombok (West Nusa Tenggara Province, Indonesia) are 57.46 tones, 304.80 quintals/hectare, and 188.52, respectively, in the year of 2021. It can be concluded that Honey is produced by the bee *A. cerana* from sugar palm and coconut saps as the feed have the quality which is acceptable by Indonesian national standard and international standard has been regulated by the Codex Alimentarius. Honey potency production from the coconut sap in 100 hectares area can produce honey of 1,542.857 tons/year or equivalent with 128.571 tons/month, while in sugar palm can produce honey of 1,150 tons/year or equivalent with 95.833 tons/month.

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