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The Quality of Comb and Packaged Honey in the Bojongmurni Beekeeping Area, Bogor District, West Java Indonesia

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ABSTRACT

Comb honey is honey that remains in the hive and has not undergone extraction, while packaged honey is commercial honey available in the market. This study aimed to analyze the quality of comb honey and packaged honey from the Bojongmurni Beekeeping Area, Bogor District, West Java Indonesia. Each type of honey was analysed directly without any pretreatment, with with 20 replicates for each physical test and three replicates for each chemical test. Physical tests (solubility, turbidity foam, hexagonal pattern, and heating tests) were analyzed descriptively based on effectiveness values (%), whereas chemical tests (moisture content, water insoluble solids, hydroxymethylfurfural (HMF), and diastase enzyme activity) were analyzed descriptively using mean and standard deviation. The physical tests showed high effectiveness (100%) in solubility, heating, and hexagonal tests, while turbidity–foam test values varied: 90±0.22% (fresh honey), 80±0.41% (packaged honey), and 85±0.36% (comb honey). Chemical analyses revealed that HMF (0 mg/kg) and diastase activity (5.18–5.52 DN) met SNI 8664:2024 standards. However, moisture content in packaged (23.8±0.29%) and comb honey (22.2±0.25%), as well as water insoluble solids (0.51%–0.64%), slightly exceeded the SNI limits. Overall, both comb and packaged honey from Bojongmurni Beekeeping Area were confirmed to be pure honey.

Keywords: chemical test, comb honey, honey quality, packaged honey, physical test

ABSTRAK

Madu sarang adalah madu yang masih di dalam sarang lebah dan belum mengalami proses pemerasan atau ekstraksi. Madu kemasan merupakan madu komersil yang beredar dipasaran. Penelitian ini bertujuan untuk menganalisis kualitas madu sarang dan madu kemasan di Kawasan Peternakan Lebah Bojongmurni. Setiap jenis madu dianalisis secara langsung tanpa perlakuan pendahuluan, dengan 20 ulangan setiap uji fisik dan tiga ulangan setiap uji kimia. Uji fisik (uji larut, keruh-buih, segienam, pemanasan) dianalisis secara deskriptif berdasarkan nilai efektifitas (%), sedangkan uji kimia (kadar air, kadar padatan tak larut air, hidroksimethilfurfural (HMF), jumlah enzim diastase) dianalisis secara deskriptif berdasarkan nilai rerata dan simpangan baku. Hasil uji fisik, semua sampel madu memiliki efektivitas tinggi (100%) pada uji larut, uji pemanasan, dan uji segi enam. Hasil uji keruh dan buih beragam dengan nilai 90±0,22% pada madu segar, 80± 0,41% pada madu kemasan, dan 85±0,36% pada madu sarang. Hasil uji kimia nilai HMF dan DN memenuhi SNI 8664:2024. Nilai HMF pada semua jenis madu adalah 0 mg/kg, dan nilai enzim diastase madu segar 5,18 DN, madu sarang 5,51 DN, dan madu kemasan 5,52 DN. Nilai kadar air madu kemasan dan sarang sedikit lebih tinggi dari SNI, berturut-turut 23,8±0,29% untuk kadar air madu kemasan dan 22,2±0,25% untuk kadar air madu sarang. Begitu juga dengan kandungan padatan tak larut air pada madu kemasan dan madu sarang sedikit di atas standar SNI, berturut–turut yaitu 0,51±0,01%, 0,64±0,01%. Dari hasil uji fisik dan kimia secara umum menunjukkan bahwa madu yang berasal dari Kawasan Peternakan Lebah Bojongmurni Kabupaten Bogor merupakan madu murni.

Kata kunci: kualitas madu, madu kemasan, madu sarang, uji fisik, uji kimia

INTRODUCTION

Honey is a naturally sweet liquid derived from flower nectar collected by honeybees. According to the Indonesian National Standard (SNI) 8664:2024, honey is classified by bee type: forest honey (*Apis dorsata*), cultivated honey (*Apis mellifera* and *Apis cerana*), and stingless bee honey (*Trigona sp*.). Honey contains active compounds and antioxidants beneficial to health, making it widely used in food, beverages, and medicine (Baltic *et al*. 2023). Honey remaining in the hive, unpressed or unextracted, is referred to as comb honey (Syahroni 2017). Comb honey represents the purest form of honey, while the wax in the comb has significant nutritional value. Its combination of nutritional content, health benefits, and palatable taste contributes to its consumption and commercialization (Oliveira Neto *et al*. 2021). Packaged honey, sourced from either wild or cultivated bees, is sold commercially.

Honey is popular among the public, particularly for medicinal purposes. This demand has led to a wide range of honey quality in the market. Market circulation allows counterfeit honey, which is difficult for consumers to distinguish from genuine honey. Counterfeit honey is often mixed with additives such as sugar, fruit juice, or flavorings to mimic pure honey (Prabowo *et al*. 2019). Although the quality and purity of honey are regulated by SNI 8664:2024, it is challenging for laypersons to verify authenticity, especially in packaged products. Simple physical tests such as solubility, turbidity, foam, and hexagon tests can serve as preliminary authenticity checks. Physical tests are easy to perform but are susceptible to interference from external variables, which may affect results (Fatma *et al*. 2017). Therefore, physical testing is primarily a preliminary screening method, while more accurate analyses, such as chemical testing, should follow. Chemical testing validates honey purity after initial physical testing (Prabowo *et al*. 2019). Chemical analysis offers precise determination of honey quality and quantity in accordance with SNI standards. Key chemical parameters include hydroxymethylfurfural (HMF) content and diastase enzyme activity. Compared to physical testing, chemical analysis provides more consistent and reliable results.

The Bojongmurni area is one of the major beekeeping regions in Bogor and also serves as a supplier of honey to other regions. However, to date, no comprehensive scientific study has been reported on the quality characteristics of honey produced in the Bojongmurni area, creating an important research gap. Therefore, evaluating the quality of honey from this region is essential as part of quality assurance efforts based on physical and chemical tests that have not previously been conducted. Accordingly, this study aims to examine the relationship between physical and chemical honey testing. The specific objective is to assess the purity of comb and packaged honey from the Bojongmurni area using both physical and chemical methods.

MATERIALS AND METHODS

Materials

The samples used were comb honey and packaged honey aged one month post harvest, as well as fresh honey aged three days after harvest. Sample images are shown in Figure 1. The honey samples were produced by *Apis cerana* bees and sourced from the Sadar Tani Muda Forest Farmers Group in the Bojongmurni Beekeeping Area, Bogor Regency. The materials used for analysis were iodine stock solution, iodine solution, acetate buffer solution, sodium chloride solution, starch solution, Carrez solution, and sodium bisulfite. The equipment used included a refractometer, spectrophotometer, photometer, photoelectric device, water bath, test tubes, 400 mL beakers, and filter paper.

Methods

This study was conducted in three stages: sample preparation, physical testing of honey purity, and chemical analysis of honey. The physical tests performed included solubility, turbidity-foam, heating, and hexagon. Chemical tests for honey purity included measurements of moisture content, water insoluble solids, hydroxymethylfurfural (HMF) content, and diastase enzyme activity. Data for physical testing were collected using the one-zero sampling method. In this method, the observer records a value of 1 if the activity occurs and 0 if it does not (Bailey and Burch 2017).

Sample Preparation. Each type of honey comb, packaged, and fresh was stored in 200 mL bottles and labeled, with three replicates for each sample.

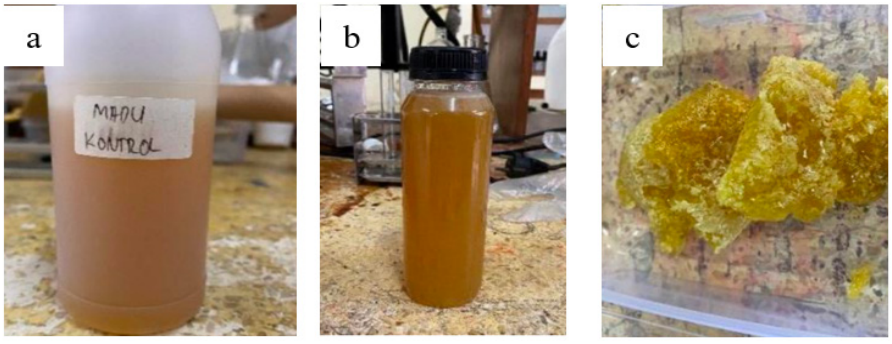

Figure 1. Sample of honey from the Bojong Murni Beekeeping Area, Bogor Regency. a= fresh honey, b= packaged honey, and c= comb honey

Solubility Test (Mulsi and Yovi 2015). A 10 cm diameter glass was filled with 200 mL of warm water (50 °C) and placed on a white cardboard to observe honey movement. One tablespoon of honey was gently poured from 10 cm above the water at a 30° angle. Immediate mixing with water was scored as 0 (impure honey), while delayed or no mixing was scored as 1 (pure honey).

Turbidity - Foam Test (Mulsi and Yovi 2015). A 10 cm diameter glass was filled with 200 mL of warm water (50 °C). One tablespoon of honey was added and stirred with a teaspoon for approximately 100 strokes over 30 seconds until fully mixed. Pure honey produces turbidity due to water-soluble polyphenols and pigments. If small bubbles appear, disappear quickly, and the solution remains clear, it is scored 0 (impure honey). If small bubbles persist and the solution becomes turbid, it is scored 1 (pure honey).

Heating Test (Nuraini *et al.* 2021). Five milliliters of honey were poured onto a tablespoon and heated over a 1 cm candle wick at a 2 cm distance from the flame for 2 min. If the honey did not overflow from the spoon after 2 min, it was scored 0 (impure honey). If bubbles formed and the honey overflowed before 2 min, it was scored 1 (pure honey).

Hexagon Test (Nuraini *et al.* 2021). Ten milliliters of honey were poured onto a 15 cm diameter white ceramic plate, and 100 mL of water was added along the plate edge until the honey was submerged. The plate was gently moved in a figure-eight pattern three times. If the hexagonal patterns were unclear, irregular, or disappeared within 10 seconds, the sample was scored 0 (impure honey). If the hexagonal patterns were clear, regular, and lasted at least 10 seconds, it was scored 1 (pure honey).

Moisture Content Test (SNI 8664:2018). The moisture content of honey was measured using a manual refractometer. A few drops of honey were placed on the refractometer prism, which had been cleaned and dried. The sample was applied until the prism was fully covered without air bubbles, then the prism cover was closed. The reading was observed through the eyepiece, and the value was determined at the boundary between the blue and white field, denoted as "a." The honey moisture content was then calculated based on this measurement:

$$\text{Moisture content (\%)} = 100 - a \quad (1)$$

Water Insoluble Solids Test (SNI 2891:1992; Albu *et al.* 2025). The total water insoluble solids in honey were determined according to SNI 01-2891-1992. Five grams of honey were weighed and dissolved in 100 mL of hot water. The solution was then filtered through pre weighed filter paper and rinsed with hot water. The filter paper containing the insoluble solids was dried in an oven at 100-105 °C for 2 hours, cooled in a desiccator, and weighed until a constant weight was obtained.

Hydroxymethylfurfural (HMF) Test (SNI 8664:2018). Five grams of honey (accurate to 1 mg) were weighed into a small glass beaker, transferred to a 50 mL volumetric flask, and rinsed with water up to a total volume of 25 mL. Then, 0.50 mL of Carrez I solution (15 g potassium ferrocyanide $K_4Fe(CN)_6 \cdot 3H_2O$ in water, diluted to 100 mL) was added, mixed, followed by 0.50 mL of Carrez II solution (30 g zinc acetate $Zn(CH_3COO)_2 \cdot 2H_2O$ in water, diluted to 100 mL), and mixed again. The solution was then diluted with water to the mark and a drop of alcohol was added to remove surface foam. The solution was filtered, discarding the first 10 mL of filtrate. Five milliliters of the filtrate were pipetted into a 18 × 150 mm test tube for the sample, and 5 mL of water and 5 mL of 0.20% sodium bisulfite solution were pipetted into separate tubes as a reference. The solutions were mixed thoroughly (Vortex mixer), and absorbance of the sample was measured against the reference in a 1 cm cuvette at 284 nm and 336 nm. If the absorbance exceeded 0.6, the sample and reference solutions were diluted accordingly. The absorbance values were multiplied by the dilution factor before calculating HMF content according to the formula:

$$\text{HMF (mg/100 g honey)} = ((A284 - A336) : BC\ (g)) \times 14{,}97 \times BC\ (g) \quad (2)$$

Note: A284 is absorbance at 284 nm; A336 is absorbance at 336 nm; value of 14.97 is correction factor; and BC is sample weight (g).

Diastase Enzyme Number Test (SNI 8664:2018). Five grams of honey were weighed into a 20 mL beaker, then 10–15 mL of water and 2.5 mL of acetate buffer solution were added. The mixture was stirred in a cooled environment until the honey completely dissolved. The solution was transferred to a 25 mL volumetric flask containing 1.5 mL of NaCl solution and diluted to the mark with water (the solution must be buffered before adding NaCl). Ten milliliters of this sample solution were pipetted into a 50 mL test tube, and 5 mL of starch solution was added along the inner wall of the tube. The tube was placed in a water bath at 40 ± 0.2 °C for 15 min. The mixture was stirred, and a stopwatch was started. At 5 min intervals, 1 mL of the sample mixture was pipetted and added to 10 mL of iodine solution, mixed, and diluted to the original volume. The absorbance was measured at 660 nm. The reaction time was recorded from the moment starch was mixed with honey until the sample was added to iodine. Sampling continued at regular intervals until the absorbance (A) was less than 0.235. Absorbance values were plotted against time on graph paper, and a straight line was drawn through several points. The time required to reach an absorbance of 0.235 was determined from the graph. Diastase enzyme activity (DN) was calculated as:

$$DN = 300/t \quad (3)$$

Note: DN is diastase enzyme activity; t is time required to reach an absorbance value of A = 0.235 (min)

Experimental Design and Data Analysis

The experimental design of this study involved three types of honey (fresh, packaged, and comb honey), with 20 replicates for each physical test and three replicates for each chemical test. As the research was exploratory in nature and no treatments were applied to the samples, data analysis was

performed descriptively. Descriptive statistical techniques included effectiveness percentage, mean, and standard deviation. Effectiveness Value (Budiarsa *et al*. 2025) was used to determine the proportion of honey samples that passed each test. Test effectiveness was calculated using the formula:

$$\text{Effectiveness Value (\%)} = \frac{\alpha}{s} \times 100\% \quad (4)$$

Note: α is number of successful outcomes (1) in each test; s is number of repetitions for each test (20).

RESULT AND DISCUSSION

Physical Tests of Honey Purity

Physical tests were used as the initial assessment of honey quality. The results of the physical purity tests are presented in Table 1.

Honey Solubility Level. The solubility test was highly effective in evaluating the purity of all honey samples. The solubility test in a glass of water showed an effectiveness percentage of 100%. This was observed from all honey samples that did not dissolve immediately when poured into the glass of water, as shown in Figure 2. This result is consistent with the findings of Prabowo *et al.* (2019), who reported solubility test effectiveness ranging between 80%–100%. The solubility of honey is influenced by its rheological properties. Pure honey has low solubility due to its thick consistency and high viscosity, as well as the presence of additional components such as beeswax, proteins, vitamins, and minerals, which are absent in fake or adulterated honey (Prabowo *et al.* 2019).

Viscosity is a measure of a fluid's resistance to flow or its resistance to pouring (Maheswar 2018). Honey with higher viscosity flows more slowly and is more difficult to pour (Bambang *et al*. 2019). The viscosity of honey is also affected by its water content. In this study, the water content of fresh honey, packaged honey, and comb honey were 22.33%, 23.83%, and 22.20%, respectively (Table 2). The 100% effectiveness of the solubility test for all three honey types was attributed to honey's natural components that influence its solubility behavior. Pure honey will not dissolve immediately when mixed with water, whereas adulterated honey mixes readily with water (Ichsan *et al.* 2022).

Turbidity-Foam Level. The turbidity test was carried out to observe the cloudiness of water caused by pigments in honey, followed by the foam test, which makes the foam turbidity test quite effective in assessing honey authenticity. The effectiveness of the foam turbidity test showed an average effectiveness of 85%. Fresh, packaged, and comb honey showed effectiveness values of 90 ± 0.22%, 80 ± 0.41%, and 85 ± 0.36%, respectively (Table 1). The turbidity in honey is caused by the pigment substances it contains. The pigments in honey consist of water-soluble and fat-soluble fractions. The polyphenol content in honey also affects the turbidity in the turbidity test (Prabowo *et al.* 2019).

The foam formed in the honey water mixture is an emulsion of air in the solution. Foam in honey mixed with water is caused by proteins, which act as foaming agents. These foaming substances bind gas bubbles, creating stability. Viscosity and surface tension also contribute to the characteristic foam formation in honey. Proteins are the dominant foaming agents in foods (Murray 2020), therefore during the foam test, stirring reduces honey's surface tension due to its protein content, which in turn promotes foam formation.

Hexagonal Level. The effectiveness of the hexagonal test on fresh, packaged, and comb honey showed an

Table 1. Effectiveness Value of Physical Purity Tests of Honey from The Bojong Murni Beekeeping Area, Bogor Regency

Examination	Honey Type			Means (%)
	Fresh Honey (%)	Packaged Honey (%)	Comb Honey (%)	
Solubility Test	100 ± 0.00	100 ± 0.00	100 ± 0.00	100 ± 0.00
Turbidity-Foam Test	90 ± 0.22	80 ± 0.41	85 ± 0.37	85 ± 4.08
Hexagonal Test	100 ± 0.00	100 ± 0.00	100 ± 0.00	100 ± 0.00
Heating Test	100 ± 0.00	100 ± 0.00	100 ± 0.00	100 ± 0.00

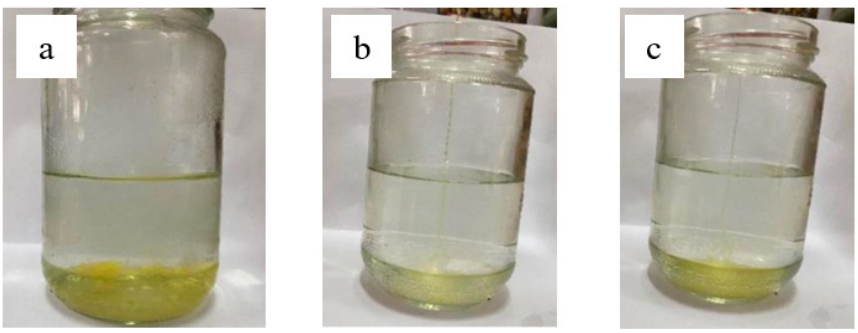

Figure 2. Solubility test honey from the Bojong Murni Beekeeping Area, Bogor Regency. a= fresh honey, b= packaged honey, and c= comb honey

Table 2. Results of Chemical Purity Tests of Honey from The Bojong Murni Beekeeping Area, Bogor Regency

Variables	Honey Type			SNI 8664:2024
	Fresh Honey	Packaged Honey	Comb Honey	
Moisture Content (%)	22.3 ± 0.29	23.8 ± 0.29	22.2 ± 0.26	Max 22
Water Insoluble Solids (%)	0.21 ± 0.01	0.51 ± 0.01	0.64 ± 0.01	Max 0.5
Hydroxymethylfurfural (HMF) (mg/kg)	0	0	0	Max 50
Diastase Number (DN)	5.18 ± 0.02	5.52 ± 0.01	5.51 ± 0.01	Min 3

average value of 100%. The hexagonal test results indicated that all honey samples formed hexagonal patterns when the plate containing water and honey was gently shaken, and the patterns persisted for 10 seconds. Honey purity can be observed through the hexagonal test, as in pure honey the hexagonal shapes formed in water appear clearly. This phenomenon occurs because the specific gravity of honey is much higher than that of water, approximately 1.42. The presence of beeswax in honey also contributes to the formation of hexagonal patterns in this test (Sihombing 2005). The hexagonal test can also be applied to detect additional substances in honey, such as CMC, gelatin, and sago. Budiarsa *et al.* (2025) stated that heating tests and hexagonal tests are effective for detecting the addition of CMC, gelatin, and sago in honey.

Heating Test. The effectiveness of the heating test on fresh, packaged, and comb honey showed an average value of 100%. The heating test results indicated that all honey samples passed the purity test. During heating, foamy bubbles formed on the honey, which then overflowed from the spoon. Heating honey causes the formation of bubbles due to the presence of sugars and proteins in pure honey. When heated, the water content in honey decreases, proteins are denatured, and surface tension is reduced, leading to foam formation and overflow from the spoon (Prabowo *et al.* 2019). In pure honey, heating produces foam that overflows or spills from the spoon, while in adulterated honey no overflow occurs (Ichsan *et al.* 2022).

Chemical Tests of Honey Purity

Chemical analyses were carried out on all honey samples to support the results of the physical purity tests in the Bojong Murni area. The chemical tests included water content, insoluble solids, HMF content, and diastase enzyme activity (Table 2). According to the National Standardization Agency of Indonesia (2024), the quality standards for cultivated honey specify a maximum water content of 22%, maximum HMF level of 50 mg/kg, insoluble solids below 0.5% w/w, and a minimum diastase enzyme activity of 3 DN.

Moisture Content of Honey. Based on the analysis, fresh honey had a water content of 22,3 ± 0.29%, which is close to the value set by the SNI 8664:2024. Packaged honey showed a higher water content (23.8 ± 0.29%), likely due to storage conditions, as its hygroscopic nature allows honey to readily absorb moisture from the surrounding air when the relative humidity exceeds 60% (Crain and Visscher 2009). Comb honey had a water content of 22.2 ± 0.26%, slightly lower than fresh honey and lower than packaged honey. Water content plays a critical role in honey storage and quality (Albu *et al.* 2025; Fatma *et al.* 2017). Differences in water content are influenced by climatic conditions and honey ripeness. Seasonal variations had a significant effect on moisture content, total soluble solids, and acidity, with a tendency for the rainy season with high rainfall to increase moisture content, water activity (aw), and acidity (Lavinas *et al*. 2025). Honey's tendency to absorb environmental humidity (Suhaela *et al.* 2016) and the water content of nectar sources also affect its levels. Over time, honey within the comb becomes thicker as water evaporates.

Water Insoluble Solids. The insoluble solids content of fresh honey met the requirements of SNI 8664:2024, while packaged honey and comb honey exceeded the standard. Packaged honey contained 0.51 ± 0.01% insoluble solids, and comb honey 0.64 ± 0.01%. This higher level is presumed to originate from pollen and resins present in honey, which may come from *Calliandra* nectar as a bee forage source. The presence of pollen is also influenced by the extraction method used prior to testing. Honey obtained by pressing the combs retains a higher amount of pollen and other solid components compared with honey extracted by centrifugation (Hu *et al.* 2023). Insoluble solids are substances that do not dissolve in water or honey. The good manufacturing practices during production and processing are effective in maintaining low levels of insoluble matter in honey (Gela *et al.* 2021). Lower insoluble solid levels are often the result of filtration before processing. Other factors that can affect insoluble solids include impurities or contaminants in the honey sample or in the water used during testing (Prabowo *et al.* 2019).

Hydroxymethylfurfural (HMF) Value. The HMF analysis results (Table 2) showed that fresh, packaged, and comb honey all had very low values, namely 0. This indicates that the samples had not undergone heating or long-term storage. Evahelda *et al.* (2017) noted that HMF content in honey serves as an indicator of freshness, heating, and storage duration. HMF levels increase with longer storage due to the decomposition of glucose, fructose, and other hexose monosaccharides in acidic conditions, which is accelerated by heat. The formation of 5-hydroxymethylfurfural (HMF) in honey is influenced by improper processing, unsuitable storage, and adulteration (Ojha *et al*. 2025).

Diastase Enzyme Value. All three honey samples met the requirements of SNI 8664:2024, as each contained more than 3 DN of diastase enzyme activity. Packaged and comb honey showed similar values of 5.52 ± 0.01 and 5.51 ± 0.01 DN, while fresh honey had a slightly lower value of 5.18 ± 0.02 DN. The presence of diastase enzyme in

all samples indicates that the diastase test can be used to assess honey purity and detect whether processing has occurred. Diastase plays an important role in evaluating honey quality and serves as an indicator of honey purity, as the enzyme originates from bees (Cahyani *et al*. 2021). Thus, diastase activity is a key indicator of honey quality. A low diastase number suggests that the honey may have been exposed to temperatures above 40 °C, and may also indicate adulteration with sugar syrup or prolonged storage under unfavorable conditions (Zak and Wilczynska 2023).

CONCLUSION

The results of physical testing, corroborated by chemical analyses, indicate that both packaged and comb honey from the Bojongmurni meet the criteria for pure honey. The physical tests showed high effectiveness, with 100% results in the solubility, heating, and hexagonal tests. In the chemical analyses, both HMF values and diastase enzyme activity of all honey types met the standards of SNI 8664:2024.

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