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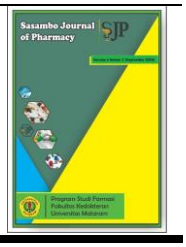

Sugar content evaluation in commercially available lidah kucing pastries: uv-vis spectrophotometric analysis of traditional indonesian confections in pontianak tenggara district

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Abstract: Glucose content in confectionery products requires careful monitoring due to its association with serious health conditions including obesity, diabetes, and cardiovascular disease. This study examined glucose levels in three lidah kucing cookie samples from Pontianak Tenggara district retailers to assess nutritional variability in these traditional Indonesian confections. The research employed a dual analytical approach combining qualitative and quantitative methods. Initial screening utilized Fehling and Benedict reagent tests to confirm glucose presence, followed by precise quantitative analysis using the Nelson-Somogyi method with UV-visible spectrophotometry. The quantitative protocol involved standard solution preparation, calibration curve development, optimal wavelength determination, and triplicate sample measurements to ensure analytical reliability. Qualitative testing confirmed glucose presence in all three samples through positive Fehling and Benedict reactions. Quantitative analysis revealed significant concentration variations among products. Sample A contained 0.227 percent glucose, Sample B demonstrated substantially higher levels at 0.993 percent, while Sample C showed minimal glucose content at 0.004 percent. These results indicate considerable variability in glucose concentrations across commercially available lidah kucing products within the study area. The investigation successfully established glucose presence in all examined samples while documenting substantial differences in glucose concentrations among similar commercial products. These findings highlight the importance of analytical monitoring in traditional confectionery items and demonstrate significant nutritional variation among comparable products in local markets. The results provide essential baseline data for consumer awareness and potential regulatory considerations regarding glucose content in traditional Indonesian baked goods, supporting informed dietary choices and public health initiatives.

Keywords: Glucose; lidah kucing cakes; spectrophotometry UV-Visible.

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Introduction

Traditional cookies represent a distinctive category of baked goods characterized by their low moisture content, which enables extended storage periods without compromising quality. These popular treats are typically crafted from foundational ingredients including wheat flour, rice flour, glutinous rice flour, or sago, with the manufacturing process involving careful oven-baking techniques that produce

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a characteristically firm yet crispy texture. Among the various traditional cookie varieties, cat tongue cookies stand out for their elongated, thin shape that resembles a cat's tongue, earning them their distinctive name. These delicate treats have garnered widespread appeal across diverse demographic groups, from children to adults, establishing themselves as cherished snacks particularly during religious observances such as Ramadan and major celebrations including Eid al-Fitr, Christmas, and Chinese New Year (Putri et al., 2022).

Building upon this popularity, traditional cookies occupy a significant position within Indonesia's snack food market, with Pontianak serving as a notable regional hub for consumption and production. Annual consumption patterns demonstrate consistent growth trajectories, reflecting broader economic development and evolving lifestyle preferences among Indonesian consumers. The marketplace consequently offers an extensive array of cookie brands featuring diverse flavor profiles and aesthetic presentations, providing consumers with numerous options to suit varying preferences. However, this expanding variety necessitates careful attention to quality considerations, particularly regarding ingredient composition and the potential health implications for consumers (Lee et al., 2022; Putri et al., 2022).

The growing market diversity brings glucose content to the forefront as a critical factor requiring systematic examination in traditional cookie production. As a simple carbohydrate classified within the monosaccharide group, glucose forms through starch hydrolysis processes and serves dual functions as both an energy source and a potential health concern. While glucose provides necessary energy for bodily functions, excessive consumption can lead to fat storage conversion, subsequently increasing obesity risks. Furthermore, elevated glucose intake correlates with heightened risks for diabetes, cardiovascular disease, and other metabolic disorders, prompting regulatory attention from health authorities. The Indonesian Ministry of Health has established clear guidelines through Regulation No. 30 of 2013, setting daily sugar consumption limits at 50 grams, equivalent to four tablespoons (Akyüz et al., 2021).

Given these health considerations and regulatory frameworks, the Nelson-Somogyi method utilizing UV-Vis spectrophotometry presents an optimal analytical approach for glucose content determination in food products. This methodology offers several advantages including high accuracy levels, optimal sensitivity parameters, and efficient measurement timeframes, making it particularly suitable for food safety analysis. While previous research has examined various food safety aspects, including borax content analysis and consumer decision-making factors in bakery products, specific glucose content studies focusing on cat tongue cookies in the Pontianak Tenggara District remain unexplored. This research gap therefore presents a significant opportunity to contribute valuable data regarding glucose levels in locally produced cat tongue cookie brands, utilizing UV-Vis spectrophotometry methods to ensure precise analytical results that can inform both consumer choices and public health policy (Chan et al., 2023; Manik & Herlinawati, 2021; Sahu et al., 2024).

Materials and Methods

Reagents and Instruments

This investigation employed sophisticated analytical instrumentation, including high-precision micropipettes (Finnpipette®), analytical balances (Radwag®), ultrasonic equipment (Maskot®), and UV-Vis spectrophotometry systems (Shimadzu®). The experimental materials consisted of artisanal cookies manufactured by small and medium enterprises operating in Southeast Pontianak, supplemented by pharmaceutical-grade glucose standards and a comprehensive suite of analytical reagents. These reagents included Fehling A and B solutions, Benedict's reagent, alkaline copper reagent formulated through the combination of Nelson A and Nelson B components, arsenomolybdate reagent, and purified distilled water. All chemical reagents utilized throughout this research maintained analytical grade specifications and were sourced exclusively from Merck, Germany, ensuring consistent quality and reliability of experimental results.

Sample Preparation

A precise 10-gram sample of the cookies underwent mechanical pulverization using a mortar and pestle until achieving a fine, uniform powder consistency. The resulting powder was subsequently dissolved in 100 mL of distilled water under continuous stirring to ensure complete homogenization. Following thorough mixing, the solution was allowed to equilibrate until achieving complete uniformity. The homogenized mixture was then subjected to filtration through standard filter paper to eliminate insoluble particulates and obtain a clear, homogeneous solution. This filtered extract served as the primary analytical sample for subsequent quantitative analysis of the lidah kucing cookies (Rahmayani et al., n.d.).

Qualitative Analysis

Two complementary qualitative assays were conducted to determine the presence of reducing sugars within the cookie samples: the Fehling test and the Benedict test. Both analytical procedures serve as reliable indicators for detecting reducing sugar content

through characteristic colorimetric reactions (Mawlong et al., 2017).

The Fehling test protocol involved transferring 2.0 mL of the prepared sample solution into a clean reaction tube. The sample was then treated with 1.0 mL of Fehling A reagent, followed by the addition of 1.0 mL of Fehling B reagent. The resulting mixture was subjected to controlled heating for precisely five minutes while monitoring for observable chemical changes and color development.

The Benedict test procedure required 1.0 mL of the sample solution, which was combined with an equal volume of Benedict's reagent in a reaction vessel. This mixture underwent thermal treatment for five minutes under controlled conditions, during which any colorimetric changes were systematically recorded and evaluated (Mawlong et al., 2017).

Quantitative Analysis

Preparation of the stock solution

A standard stock solution was prepared by dissolving glucose to achieve a concentration of 100 ppm in distilled water. The resulting solution underwent ultrasonic homogenization using a sonicator for precisely five minutes to ensure uniform distribution of the glucose molecules and achieve complete molecular-level mixing. This sonication process eliminates any potential concentration gradients and guarantees consistent analytical performance. Following homogenization, the 100 ppm glucose stock solution was systematically diluted using volumetric techniques to produce a working standard solution with a final concentration of 40 ppm (Mawlong et al., 2017).

Operating time determination

The determination of optimal operating time commenced with the precise combination of 1.0 mL of 40 ppm glucose standard solution and alkaline copper reagent (comprising Nelson A and Nelson B reagents in a 25:1 ratio) within a 10 mL volumetric flask. The mixture underwent thorough homogenization followed by controlled thermal treatment at elevated temperature for ten minutes to ensure complete reaction kinetics and optimal complex formation (Mawlong et al., 2017).

Upon completion of the heating phase, the solution was allowed to equilibrate to ambient temperature under controlled conditions. Subsequently, 1.0 mL of arsenomolybdate reagent was introduced to the cooled mixture, and the final volume was adjusted to the graduation mark using distilled water to achieve precise dilution (Sahu et al., 2024).

The operating time optimization protocol involved systematic absorbance measurements at the predetermined maximum wavelength. Spectrophotometric readings were recorded at five-minute intervals over a sixty-minute monitoring period to establish the kinetic profile of the colorimetric reaction (Chan et al., 2023).

Maximum wavelenght determination

The determination of maximum wavelength was conducted through a systematic spectrophotometric analysis protocol. The procedure commenced by combining 1.0 mL of 40 ppm glucose standard solution with 1.0 mL of alkaline copper reagent in a reaction vessel. The mixture was thoroughly agitated to ensure complete molecular interaction, followed by controlled heating for ten minutes to facilitate optimal reaction conditions and complete complex formation.

Following the thermal treatment phase, the solution was allowed to cool to ambient temperature under controlled conditions to prevent thermal interference with subsequent measurements. The cooled reaction mixture was then quantitatively transferred to a 10 mL volumetric flask. At this stage, 1.0 mL of arsenomolybdate reagent was incorporated to promote the formation of the desired chromophoric complex essential for spectrophotometric detection.

The spectrophotometric analysis was performed across a wavelength range of 640-840 nm using a calibrated UV-Vis spectrophotometer. All measurements were conducted after the predetermined operating time had elapsed to ensure reaction completion and signal stability (Sahu et al., 2024).

Callibration curve construction

The construction of the standard calibration curve was executed through a systematic five-point calibration series using the 100 ppm glucose stock solution. Precise volumes of 1.0, 2.0, 3.0, 4.0, and 5.0 mL were transferred using calibrated micropipettes into separate 10 mL volumetric flasks to establish the concentration gradient required for linear regression analysis (Mabood et al., 2016).

Each calibration standard received 1.0 mL of alkaline copper reagent, followed by thorough mixing to ensure complete homogenization and uniform distribution of reactants. The prepared solutions underwent controlled thermal treatment for ten minutes using a calibrated hotplate equipped with a water bath system. Complete immersion of the reaction vessels in the heated water bath ensured uniform temperature distribution and optimal reaction kinetics across all calibration points (Nunes et al., 2024).

Following the thermal treatment phase, all solutions were allowed to equilibrate to ambient temperature to facilitate safe handling and prevent thermal artifacts in subsequent measurements. Each cooled solution was then treated with 1.0 mL of arsenomolybdate reagent, resulting in the characteristic

blue-green chromophoric complex formation. The final volume of each calibration standard was adjusted to the 10 mL graduation mark using distilled water, yielding a complete calibration series with concentrations of 1, 2, 3, 4, and 5 ppm respectively.

Spectrophotometric measurements were conducted at the predetermined maximum wavelength for each calibration standard. The resulting absorbance values were plotted against their corresponding concentrations to generate a linear calibration curve, which serves as the quantitative foundation for determining glucose concentrations in unknown samples through interpolation analysis (Mawlong et al., 2017).

Validation of analytical methods

Analytical method validation was conducted through comprehensive evaluation of linearity parameters and determination of detection and quantification limits. The linearity assessment employed a systematic five-point calibration approach utilizing glucose standard solutions prepared at discrete concentration levels of 1, 2, 3, 4, and 5 ppm respectively.

Each calibration standard underwent spectrophotometric analysis at the predetermined maximum wavelength to establish the relationship between analyte concentration and instrumental response. The linearity evaluation was assessed through statistical analysis of the calibration data, with method acceptability determined by achieving a coefficient of determination (R^2) exceeding 0.995, which demonstrates excellent correlation between concentration and absorbance measurements (Rahmayani et al., 2024.).

Quantification of sample's glucose content

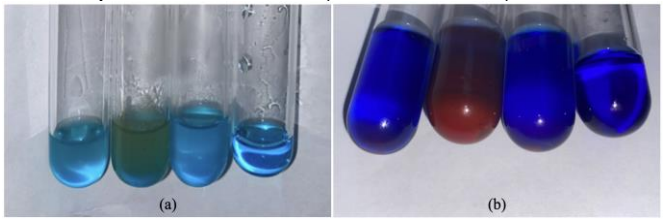
For glucose determination, the sample solution was initially diluted by transferring 1.0 mL of sample into a 50 mL volumetric flask and diluting to the graduation mark with distilled water to achieve a 1:50 dilution ratio suitable for analysis. Subsequently, 1.0 mL of the diluted sample was transferred to a 10 mL volumetric flask and combined with 1.0 mL of alkaline copper solution, after which the mixture was thoroughly mixed to ensure complete homogeneity. The reaction mixture was then heated in a controlled water bath where the flask was completely submerged in hot water for exactly 10 minutes to facilitate complete reaction between glucose and the alkaline copper reagent. Following the heating process, the flask was removed from the heat source and allowed to cool to room temperature to ensure safe handling and measurement accuracy. Once cooled, 1.0 mL of arsenomolybdate solution was added to develop the characteristic blue color complex, and the solution was mixed thoroughly to ensure uniform reagent distribution. The colored solution was then diluted to the 10 mL graduation mark using distilled water and mixed completely to achieve uniform color distribution throughout the volume. Finally, the absorbance was measured using a UV-Vis spectrophotometer at the predetermined maximum wavelength specific to the glucose-copper-arsenomolybdate complex, with measurements performed in triplicate to ensure statistical reliability and accurate quantitative analysis of the glucose content (Manik & Herlinawati, 2021).

Result and Discussion

Qualitative Analysis

This investigation implemented a comprehensive dual-phase analytical strategy that combined qualitative screening techniques with precise quantitative determination methods to establish a thorough profile of glucose content in lidah kucing cookie samples. The methodological framework was specifically designed to ensure both preliminary identification through chemical screening and accurate quantification through instrumental analysis, thereby providing robust analytical data suitable for food quality assessment, regulatory compliance, and research applications in carbohydrate analysis.

The qualitative analysis results demonstrated remarkably consistent positive reactions across all three lidah kucing cookie samples subjected to testing protocols, as illustrated in **Figure 1**. Both Benedict's and Fehling's tests produced the expected characteristic color changes that definitively indicated the presence of reducing sugars, with the observed intensity of color development providing valuable preliminary semi-quantitative information regarding relative glucose concentration levels between samples. The systematic acid-base treatment results confirmed the chemical stability of the detected glucose content under various pH conditions and provided definitive verification that the identified reducing sugars were indeed glucose compounds rather than other potentially interfering reducing substances that might naturally occur within the complex cookie matrix (Sun et al., 2022).



(a) (b)

Figure 1. Qualitative test results using (a) Benedict and (b) Fehling

The Fehling test serves as a qualitative analytical method for detecting reducing sugars in biological samples through a well-established redox mechanism. This test utilizes Fehling reagent, which consists of two separate components that must be combined during testing: Fehling A contains copper(II) sulfate ($CuSO_4$), while Fehling B comprises a mixture of sodium hydroxide (NaOH) and sodium-potassium tartrate. The fundamental principle underlying this test involves the reduction of copper(II) ions by aldehyde groups present in reducing sugars, resulting in the formation of a characteristic red precipitate of copper(I) oxide (Cu_2O).

The reaction mechanism proceeds through a systematic redox process wherein aldehyde groups in reducing sugars such as glucose function as reducing agents. These functional groups reduce copper(II) ions (Cu^{2+}) from the copper sulfate solution to copper(I) ions (Cu^{+}), which subsequently precipitate as copper(I) oxide with a distinctive red-brick coloration. When the Fehling reagent is combined with samples containing reducing sugars and subjected to heating, the solution undergoes a predictable sequence of color changes that serve as visual indicators of the reaction progress. The initial blue color of the mixed reagent gradually transitions through green and yellow phases before ultimately developing the characteristic reddish hue, with the intensity of color change and precipitate formation directly correlating to the concentration of reducing sugars present in the sample (Nunes et al., 2024).

Experimental procedures involved combining 2 mL of each test sample with 1 mL each of Fehling A and Fehling B reagents. The resulting blue mixture was heated for five minutes to facilitate the redox reaction. Analysis results demonstrated positive outcomes for reducing sugar presence across all three samples (A, B, and C), evidenced by the formation of red-brick precipitates in each case. However, significant variations in precipitate intensity were observed, reflecting different reducing sugar concentrations among the samples. Sample A exhibited moderate precipitate formation with an intensity rating of (++), indicating substantial reducing sugar content. Sample B displayed the highest intensity level (+++), with sufficient precipitate formation to impart a red coloration to the entire solution, suggesting elevated reducing sugar concentrations. In contrast, Sample C showed minimal precipitate formation with a low intensity rating (+), indicating relatively lower reducing sugar levels. This quantitative relationship between precipitate formation and sugar concentration validates the test's utility as both a qualitative detector and semi-quantitative estimator of reducing sugar content, with comprehensive visual documentation of these results presented in **Figure 1b**.

Quatitative Analysis

The quantitative determination of glucose content in cat's tongue cookies employed the Nelson-Somogyi method, which represents a superior analytical approach compared to the anthrone-sulfate method, particularly when analyzing samples containing mixed sugar types. This method operates through the oxidation of glucose using Nelson reagent, subsequently generating a distinctive blue-green molybdenum complex upon addition of arsenomolybdate reagent. The fundamental mechanism involves the reduction of copper(II) ions (Cu^{2+}) to copper(I) ions (Cu^{+}) by reducing sugars, with the resulting Cu^{+} ions reacting with arsenomolybdate to form the characteristic colored complex that enables spectrophotometric quantification.

Prior to establishing the calibration curve and conducting sample analysis, critical analytical parameters required optimization, including operating time and maximum wavelength determination. The maximum wavelength (λmax) represents the wavelength producing the highest absorbance due to electronic excitation, which is essential for achieving optimal sensitivity and precision in analytical measurements. Absorbance measurements were conducted across the wavelength range of 640-840 nm, yielding maximum wavelength values of 431.80 nm, 742.2 nm, and 743.0 nm for the three replicates respectively.

Operating time determination aimed to establish the duration required for the solution to achieve constant absorbance. Following the standard heating and cooling procedure, absorbance measurements were conducted at 740 nm wavelength at one-minute intervals over a sixty-minute period to monitor stability. Results, described in Table 1, indicated that the optimal operating time ranged between 35 and 50 minutes, ensuring consistent and reliable measurements.

Table 1. Operating time determination

Time (mins)	Absorbance
25	0.8431
30	0.8577
35	0.8717
49	0.8796
45	0.8873
50	0.8847

The establishment of a calibration curve served to visualize the linear correlation between solution concentration and absorbance values, enabling accurate quantification of reducing sugar content in samples. Absorbance measurements were performed in triplicate at the predetermined maximum wavelength, yielding values of 0.2316, 0.3840, 0.5407, 0.6008, and 0.5967. The resulting linear regression equation was y = 0.0947x +

0.1867 with a correlation coefficient (r) of 0.9358, approaching the ideal value of 0.9770.

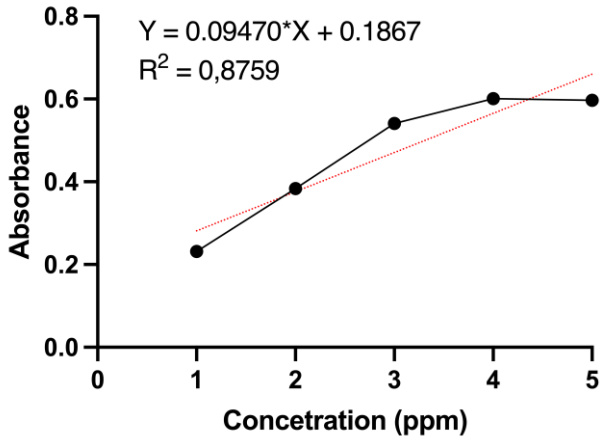


Figure 2. Linier regression curve of standard glucose

Method validation parameters included the determination of limit of detection (LOD) and limit of quantification (LOQ) values. The calculated LOD of 11.1132 ppm represents the minimum concentration at which the analyte can be reliably detected with adequate precision, while the LOQ of 37.0441 ppm indicates the lowest concentration providing sufficiently accurate results for quantitative analysis.

Spectrophotometric measurements were conducted using UV-Vis spectrophotometry at the predetermined maximum wavelength, with each sample analyzed in triplicate to enhance accuracy and minimize measurement error. The obtained absorbance values were 0.6156 for Sample A, 1.1275 for Sample B, and 0.2620 for Sample C. Application of the linear regression equation from the calibration curve yielded average glucose concentrations of 0.227% for Sample A, 0.993% for Sample B, and 0.004% for Sample C, demonstrating significant variation in reducing sugar content among the analyzed samples.

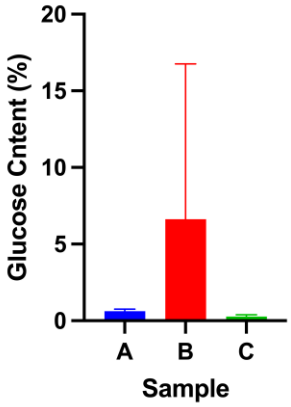


Figure 3. Sugar content of several Commercially Available Lidah Kucing Pastries in Pontianak Tenggara

Conclusion

Based on the comprehensive analytical results obtained from this investigation, the study successfully identified three distinct varieties of cat's tongue cookies produced by small and medium enterprises (SMEs) operating within the Southeast Pontianak district. Qualitative testing confirmed the presence of glucose content across all three sample types, establishing a consistent foundation for further quantitative analysis. The quantitative assessment revealed significant variations in glucose concentrations among the analyzed samples. Sample A demonstrated a glucose content of 0.227%, equivalent to approximately 22.7 mg per 10-gram serving. Sample B exhibited the highest glucose concentration at 0.993%, corresponding to approximately 99.3 mg per 10-gram portion. In contrast, Sample C contained minimal glucose levels at 0.004%, representing approximately 0.4 mg per 10-gram sample. These findings indicate substantial differences in formulation and processing methods among the various SME producers, with glucose content varying by more than two orders of magnitude across the sample set. The results provide valuable baseline data for quality assessment and standardization efforts within the local confectionery industry.

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