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Pengaruh Kondisi Penyimpanan dan Pencahayaan terhadap Kadar Kurkumin dalam Serbuk Kunyit

Effect of Storage Conditions and Light Exposure on Curcumin Content in Turmeric Powder

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ABSTRAK

Serbuk kunyit merupakan bahan yang umum digunakan dalam bidang pangan dan kesehatan, serta sering disimpan dalam jangka waktu lama. Kurkumin sebagai senyawa aktif utama dalam kunyit diketahui rentan terhadap degradasi akibat paparan cahaya dan lingkungan. Penelitian ini bertujuan untuk menentukan kadar kurkumin dalam serbuk kunyit serta mengevaluasi pengaruh tempat dan pencahayaan penyimpanan terhadap kestabilannya. Analisis dilakukan menggunakan spektrofotometri UV-Vis pada sampel yang disimpan dalam dua kondisi: terpapar cahaya dan terlindung dari cahaya. Hasil menunjukkan kadar awal kurkumin sebesar 3,42%, dengan penurunan sebesar 1% pada sampel yang terpapar cahaya, sedangkan kadar tetap stabil pada sampel yang terlindung cahaya. Temuan ini menunjukkan bahwa pencahayaan dan kondisi penyimpanan berpengaruh terhadap kestabilan kurkumin. Oleh karena itu, penyimpanan serbuk kunyit dalam kondisi gelap direkomendasikan untuk mempertahankan kualitas dan aktivitas senyawa aktifnya.

Keywords:

Curcumin Stability
Storage Conditions
Light Exposure
Spectrophotometric
Analysis

ABSTRACT

Turmeric powder is widely used in food and health applications and is often stored for extended periods. Curcumin, the main active compound in turmeric, is known to be unstable when exposed to light and environmental factors. This study aimed to determine the curcumin content in turmeric powder and evaluate the effect of storage conditions and light exposure on its stability. Analysis was conducted using UV-Vis spectrophotometry on samples stored under two conditions: exposed to light and protected from light. The initial curcumin content was 3.42%, which decreased by 1% in the light-exposed samples, while the content remained stable in samples protected from light. These findings indicate that storage conditions, particularly light exposure, significantly affect curcumin stability. Therefore, storing turmeric powder in dark conditions is recommended to maintain the quality and activity of its active compound.

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1. INTRODUCTION

Turmeric powder is a processed product derived from the rhizomes of Curcuma longa, widely used in the food, traditional medicine, and cosmetic industries. It is commonly obtained from dried whole rhizomes (fingers), split rhizomes (splits), or slices of dried rhizome [1]. The quality and economic value of turmeric powder are largely determined by its curcuminoid content, especially curcumin as the primary bioactive compound [2].

Curcumin possesses various pharmacological activities, including antibacterial and antioxidant properties [3]. In addition, it has been reported to enhance appetite by accelerating gastric emptying and stimulating bile secretion [4]. However, curcumin is known to be unstable and susceptible to degradation when exposed to light and heat during storage [5]. Previous studies have shown that food and beverages containing curcumin exhibit a significant decrease in color intensity when stored under light exposure [5].

Curcumin content can be determined quantitatively using UV-Vis spectrophotometry, either through a complexation reaction with boric acid under acidic conditions forming rubrocurcumin [6], or directly without complex formation [7]. For the extraction of curcumin from turmeric rhizomes, the reflux method is considered effective, particularly for compounds that are heat-stable [8].

Although numerous studies have investigated curcumin stability, most have focused on liquid formulations or derived products. Research specifically examining the effect of storage location and light exposure on curcumin levels in turmeric powder remains limited. This is critical, as turmeric powder is one of the most commonly consumed and long-stored forms of the plant.

Therefore, this study aims to evaluate the effect of storage conditions and light exposure on the curcumin content of turmeric powder. The findings are expected to provide scientific insight into maintaining the stability of active compounds in herbal products during storage.

2. METHODE

2.1. Materials and Instruments

This study employed a UV-Visible spectrophotometer, analytical balance, reflux apparatus, water bath, and black plastic wrap for light protection.

The chemical reagents used were boric acid (p.a., E-Merck), oxalic acid (p.a., E-Merck), acetic anhydride (p.a., E-Merck), ethanol 96% (p.a., E-Merck), and curcumin (p.a., E-Merck). The turmeric powder sample used in the experiment was a commercial product labeled as brand X

2.2. Procedure

Sample Storage Treatment

Turmeric powder from the same commercial brand (brand X) was divided into two treatment groups: **Light-exposed group:** stored in transparent containers under ambient light. **Light-protected group:** stored in the same conditions but wrapped in black plastic to block light exposure.

Both groups were kept at room temperature, and samples were analyzed on day 0, day 5, day 10, and day 15 to evaluate the effect of light exposure and storage duration on curcumin content.

Extraction Procedure

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At each time point, 1 gram of turmeric powder was weighed and extracted with 50 mL of 96% ethanol (p.a., E-Merck) using a reflux apparatus for 1 hour. The extract was filtered and used for further analysis.

Analytical Method A: Complexation Reaction (Colorimetric Method)

A 0.5 mL aliquot of the filtrate was transferred into a beaker glass, followed by the addition of 10 mg boric acid and 10 mg oxalic acid. The mixture was covered with black plastic and heated in a water bath for 5 minutes, then cooled to room temperature. The solution was transferred to a 5 mL volumetric flask and diluted to volume with acetic anhydride. Absorbance was measured at the maximum wavelength (λmax) using a UV-Vis spectrophotometer.

A calibration curve was prepared using curcumin standards treated with the same reagents.

Analytical Method B: Direct UV-Vis Method

Another 0.5 mL of the filtrate was transferred into a 5 mL volumetric flask and diluted to volume with 96% ethanol. Absorbance was measured directly at the maximum wavelength (λmax) and optimum operating time without any additional reagents. A separate calibration curve was prepared using curcumin standards in ethanol only.

Method Validation

Both analytical methods were validated for linearity, accuracy, precision, limit of detection (LOD), limit of quantification (LOQ), and selectivity to ensure accurate and reliable quantification of curcumin.

3. RESULTS

Wavelength Optimization and Calibration Curve

The analytical performance of both methods was first evaluated by determining the maximum wavelength (λmax), operating time, and calibration curves. The maximum wavelength for curcumin using the indirect (complexation) method was observed at 457 nm with an absorbance of 0.556, while the direct method without complexation showed a maximum wavelength at 421 nm with a slightly higher absorbance of 0.634. For the indirect method, the optimal operating time—the period in which absorbance remained stable—was observed between 1 to 30 minutes, with the first 10 minutes showing the most consistent results. This indicates the complex formed is most stable within this time range.

Calibration curves were constructed using six series of standard curcumin solutions (30–80 ppm), prepared from a 1020 ppm stock solution. Each method used its own calibration curve with corresponding treatment.

- **Indirect method:**

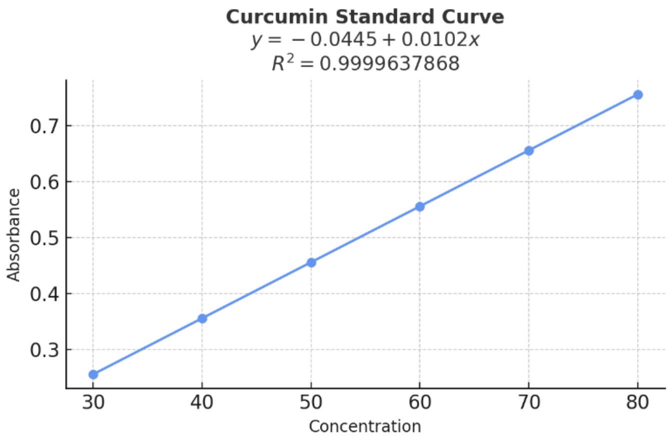

Figure 1. Calibration curve of curcumin using the indirect method

Linear regression equation:
y = –0.0446 + 0.0102x Correlation coefficient (**r**) = **0.99996** *(Equation 1)*

- **Direct method:**

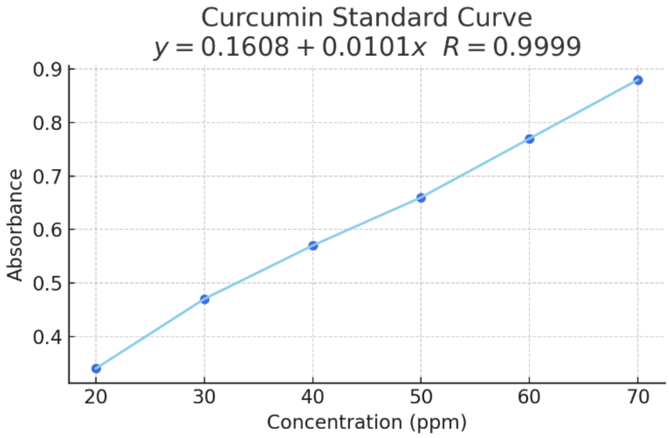

Figure 2. Calibration curve of curcumin using the direct method

Linear regression equation:
y = 0.1608 + 0.0103x Correlation coefficient (**r**) = **0.99998** *(Equation 2)*

Method Validation

The measured maximum wavelength of the sample analyzed with the indirect method was **484 nm**, which deviated from the standard curcumin peak at 457 nm. This may indicate matrix interference or differences in the complex formed in the sample matrix. In contrast, the sample analyzed using the direct method exhibited a maximum wavelength of **418 nm**, closely matching the standard at 421 nm, indicating better selectivity and compatibility of the method.

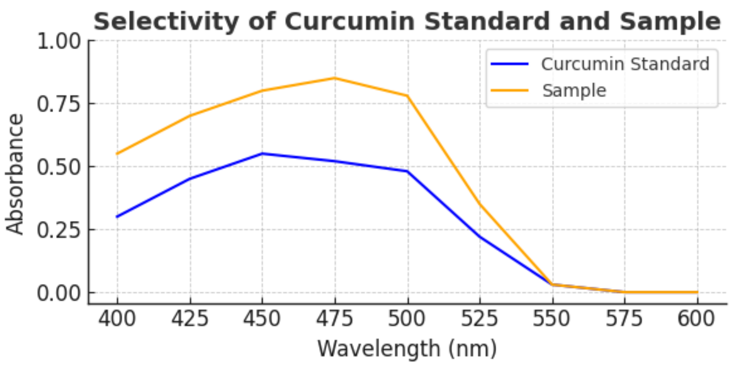

Figure 3. λmax of curcumin standard and sample (indirect method)

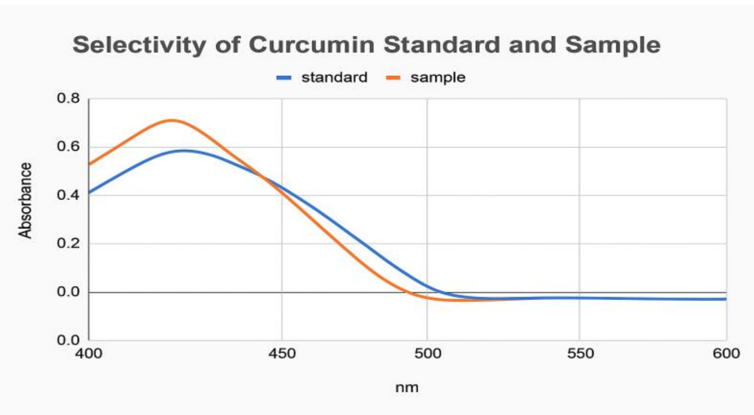

Figure 4. λmax of curcumin standard and sample (direct method)

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Determination of Curcumin Content under Storage Conditions

In the **light-exposed samples**, a **gradual decrease** in curcumin content was observed from day 0 to day 15. In contrast, the **light-protected samples** showed **no significant decrease** in curcumin levels throughout the storage period. This indicates that light exposure significantly affects curcumin stability in turmeric powder during storage.

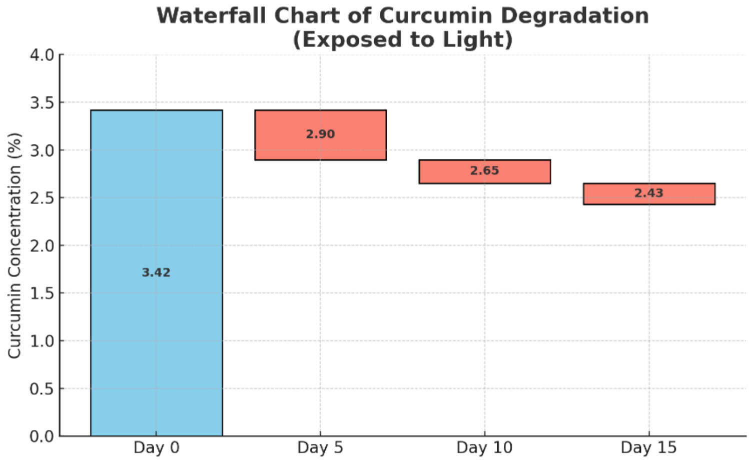

Figure 5. Curcumin content in turmeric powder under different storage conditions

This waterfall chart visualizes the progressive decrease in curcumin content (%) in a turmeric powder sample exposed to light over a 15-day storage period. The curcumin concentration was measured at four time points: day 0, day 5, day 10, and day 15.

The initial curcumin level on day 0 was set as the baseline (3.42%). A gradual decline is observed over time, with concentrations decreasing to 2.90%, 2.65%, and finally 2.43% on day 15. Each descending bar in the chart represents the magnitude of degradation occurring between time intervals, highlighting the cumulative loss of curcumin due to light exposure.

The chart clearly demonstrates that light significantly accelerates the degradation of curcumin in turmeric powder during storage. This visual presentation emphasizes the importance of protecting curcumin-containing products from light to maintain their potency and stability over time.

4. DISCUSSION

The maximum wavelength (λmax) obtained using the indirect method differed from those reported in the literature, while the result from the direct method matched the reported λmax values for curcumin [12][8]. This variation can be attributed to spectral shifts, known as hypsochromic (blue shift)—a shift to a shorter wavelength, and bathochromic (red shift)—a shift to a longer wavelength. Hypsochromic shifts often result from solvent changes or the absence of auxochrome substituents on the chromophore, while bathochromic shifts may occur due to the presence of such substituents [2][14][17].

The results of the wavelength selectivity test showed that the sample and standard curcumin had similar λmax values when analyzed using the direct method. This confirms the good selectivity of the direct method and its ability to accurately measure curcumin in the sample matrix without interference [3][8][16]. Based on this, the quantification of curcumin was continued using the direct method only.

The curcumin content of turmeric powder stored under light-exposed conditions showed a clear decrease over time, from 3.42% on day 0 to 2.48% on day 15. In contrast, the samples stored in light-protected conditions exhibited no significant decrease in curcumin content. This finding aligns with previous studies reporting that curcuminoid

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content in herbal formulations containing turmeric decreases more significantly when stored under direct sunlight compared to protected storage conditions. Similarly, curcumin-based beverages stored at room temperature with light exposure showed the most intense color fading [16][12].

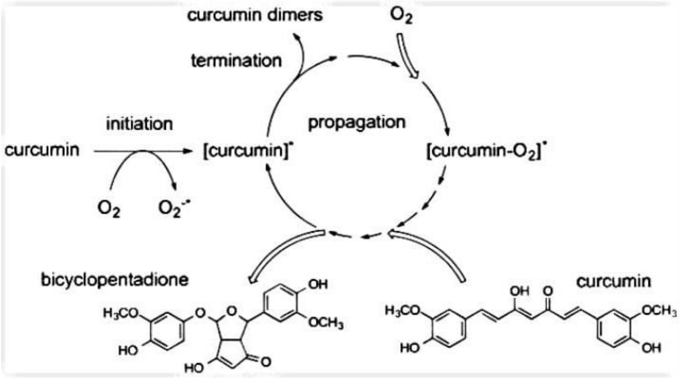

Figure 6. Structural degradation pathway of curcumin under light exposure

The observed degradation is likely due to photochemical decomposition of curcumin, leading to structural changes such as cyclization or breakdown of its conjugated double bonds, which results in color changes and reduced stability. This process is known as degradation, a decline in the integrity or concentration of the active compound. These findings support the conclusion that storage location and light exposure significantly affect the stability and content of curcumin in turmeric powder.

5. CONCLUSION

This study demonstrated that light exposure during storage significantly affects the stability of curcumin content in turmeric powder. Samples stored under light exposure showed a gradual decline in curcumin levels up to day 15, while those stored in light-protected conditions maintained stable curcumin content. The direct analytical method without complexation exhibited better selectivity and was thus selected for quantitative determination. These findings underscore the importance of proper storage conditions and appropriate analytical method selection to preserve the quality of turmeric-based natural products, particularly in the development of phytopharmaceuticals and herbal formulations.

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