

# Extraction of Curcumin Pigment from Indonesian Local Turmeric with Its Infrared Spectra and Thermal Decomposition Properties

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**Abstract.** Curcumin is one of the pigments which is used as a spice in Asian cuisine, traditional cosmetic, and medicine. Therefore, process for getting curcumin has been widely studied. Here, the purpose of this study was to demonstrate the simple method for extracting curcumin from Indonesian local turmeric and investigate the infrared spectra and thermal decomposition properties. In the experimental procedure, the washed turmeric was dissolved into an ethanol solution, and then put into a rotary evaporator to enrich curcumin concentration. The result showed that the present method is effective to isolate curcumin compound from Indonesian local turmeric. Since the process is very simple, this method can be used for home industrial application. Further, understanding the thermal decomposition properties of curcumin give information, specifically relating to the selection of treatment when curcumin must face the thermal-related process.

## 1. Introduction

Curcumin is one of the organic materials with a natural orange-yellow color. Curcumin is commonly used as natural coloring agent in Asian cuisine, traditional cosmetics, and medicine Curcumin can be obtained from turmeric [1] and has a melting point of 174 °C.[2] Curcumin is stable in acidic pH and heat, but it can decompose at alkaline pH and sensitive to light. [3]

For the first time, curcumin was isolated by Vogel in 1842. Then, in 1910, its structured manner was described by Lampe and Milobedeska [4]. Until Now, research about curcumin has been widely spread and curcumin has been used for many applications[5,6]. Curcumin has been studied because of its antibacterial, antifungal, and antiviral activity [7]. Curcumin also has been investigated as a diabetic



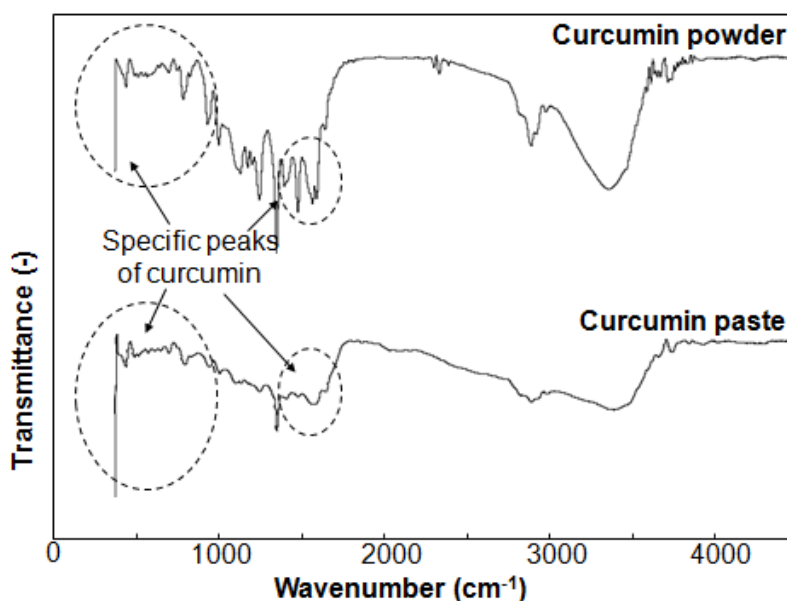
prevention agent [8]. Over the decade, extraction of curcumin from turmeric was reported and more advanced methods are still being reported.

Here, the purpose of this study was to demonstrate the simple method for extracting curcumin from Indonesian local turmeric and investigate the infrared spectra and thermal decomposition properties. In the experimental procedure, the washed turmeric was dissolved into an ethanol solution, and then put into a rotary evaporator to enrich curcumin concentration. The result showed that the present method is effective to isolate curcumin compound from Indonesian local turmeric. Since the process is very simple, this method can be used for home industrial application. Further, understanding the thermal decomposition properties of curcumin will give information, specifically relating to the selection of treatment when curcumin must face the thermal-related process.

## 2. Experimental Method

Curcumin was extracted from turmeric collected from Bandung using our previous method[9]. There are several steps to obtain curcumin from turmeric. First, turmeric was washed and sliced into small pieces (sizes of about 1 mm). The sliced turmeric was then dried at 50°C to remove water. After that, the dried turmeric were grinded to become turmeric powder. Next, turmeric powder was dissolved in ethanol (95%) and heated at 50°C in water bath for 1 hour. The solution then filtered and filtrate was put in rotary evaporator (at 90°C) to remove excess ethanol in the filtrate. Finally, curcumin gel was obtained. To investigate the chemical properties of our product, we used a Thermal Gravimetry Analysis (TGA; Shimadzu Corp., Japan) and a Fourier Transform Infra Red (FTIR; Prestige 21, Shimadzu Corp., Japan).

## 3. Results and Discussion



**Figure 1.** FTIR spectra of dried turmeric and curcumin paste. Figure was adopted from reference [9]

**Figure 1** shows the FTIR spectra of dried turmeric and curcumin paste. In the dried turmeric sample, there is a sharp peak in 3425,58  $\text{cm}^{-1}$ , indicating the sample has strong O-H stretching. However, this peak decreased in curcumin paste sample. In addition, there are also several peaks in spectra found in dried turmeric that reduce in curcumin spectra such as in 1327 and 1276  $\text{cm}^{-1}$ . Interestingly, FTIR results showed that both samples had specific spectra of curcumin (shown in the dashed area), such as 1438 (olefinic C-H bending vibration), 1510 (C=C vibrations), as well as 1597 and 1674,21  $\text{cm}^{-1}$  (C-O stretch). Detailed information about the peak detected in the FTIR analysis is shown in **Table 1**.

Based on above results, we can conclude that

- (1) The dried turmeric has similar structure with the curcumin product. This confirm that the curcumin component existed in the dried turmeric.
- (2) Peaks at 1327 and 1276  $\text{cm}^{-1}$  were detected in the dried turmeric sample only. These peaks are not characteristic peaks for curcumin, in which this confirmed the existence of other compounds in turmeric. Then, the extraction process made these compounds to be reduced/removed.
- (3) Peaks at 3425,58  $\text{cm}^{-1}$  (indicated OH) were detected in both sample. However, this peak decreased greatly after the extraction process. The dried curcumin can take much water because this sample contained some components that can interact with water, for example starch and reduced sugar [10]. Since these component is typically reduced after the extraction process, the curcumin paste is relatively water insoluble.

**Table 1.** Functional group of curcumin in FTIR

Functional Group	Wavenumber (obtained from experiment) ( $\text{cm}^{-1}$ )	Wavenumber (from references) ( $\text{cm}^{-1}$ )	References
Phenolic O–H stretching	3425,58	3510	[11]
C=C vibrations	1510,26	1627	[12]
C-O stretch	1674,21	1656	[13]
olefinic C–H bending vibration	1438,90	1427	[14] [11]
aromatic C–O stretching vibrations	1276,88	1285	[15]
C–O–C stretching vibrations	1033,86	840 1027	[11]
C-H methyl ring	2924,09	2845	[11]
aromatic ring	3028,241	3016	[16]

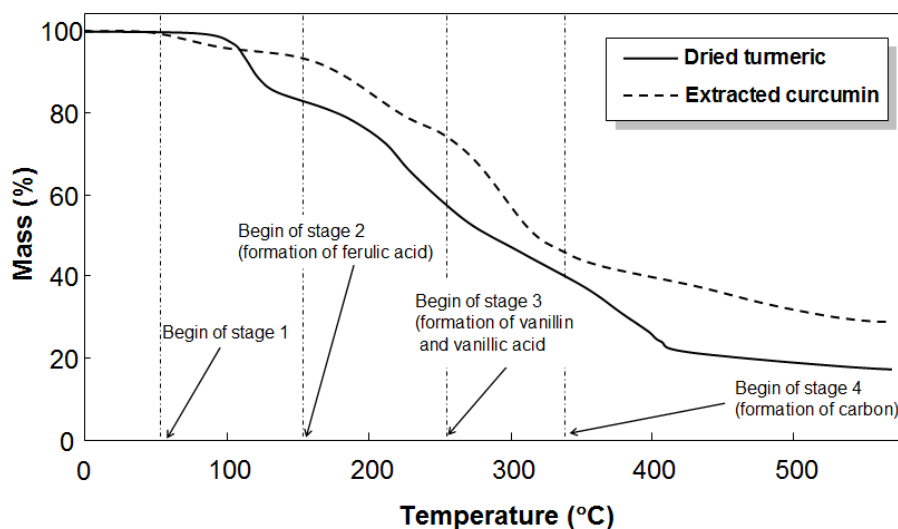
**Figure 2** shows the TGA curves of dried turmeric and extracted curcumin. As shown in this figure, the mass loss starts at about 60°C, ends at about 500°C. The observed mass loss in the TG curve is 20 and 30% for dried turmeric and extracted curcumin, respectively. The final mass was obtained as a black powder, indicating that samples were completely decomposed into carbon. Different thermal characteristics are because of different compositions contained in the sample. Dried curcumin did not contain only curcumin compound but also other components, such as sugar and sucrose. [10] Indeed, these components make the formation of carbon in the final product lower than that in the extracted curcumin.

Based on the above result, the thermal decomposition of curcumin below 600 °C occurs in four stages (See **Figure 3**). The decomposition of curcumin involved several processes that produce trans-6-(4,-hydroxy-3,-methoxyphenyl)-2,4-dioxo-5-hexenal; ferulic acid; vanillin and vanillic acid, and carbon. [17, 18,19] Detailed stages occurred during the thermal decomposition are in the following:

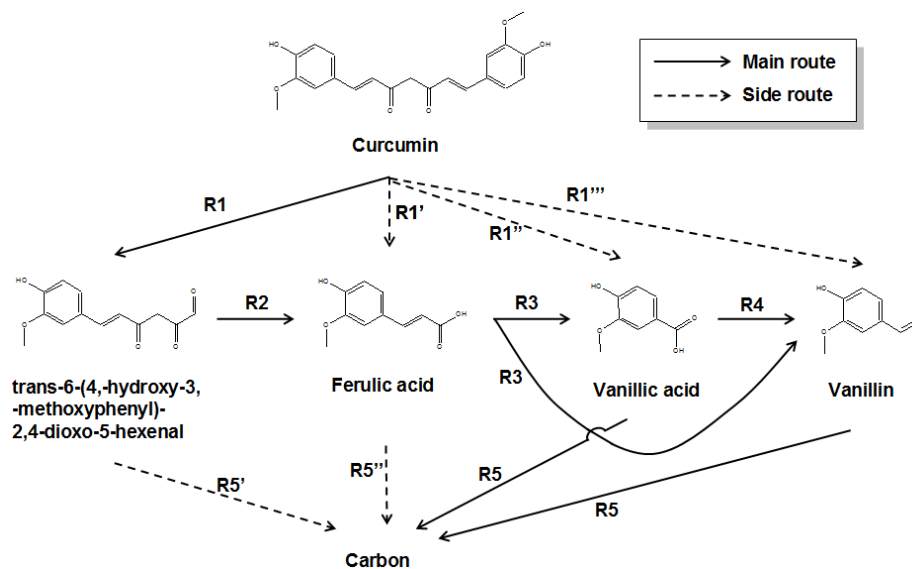
- (1) The stage I (route R1), in which the mass loss is 5% that starts at about 60 °C and ends at about 100 °C, is the decomposition of curcumin into trans-6-(4,-hydroxy-3,-methoxyphenyl)-2,4-dioxo-5-hexenal;
- (2) The stage II (route R2), in which the mass loss is 15% that begins at about 170 °C and ends at about 220 °C, is the decomposition of 6-(4,-hydroxy-3,-methoxyphenyl)-2,4-dioxo-5-hexenal become ferulic acid;
- (3) The stage III (route R3 and R4), in which mass loss is 35% that begins at about 260 °C and ends at about 320 °C, is the decomposition of ferulic acid become vanillin and vanillic acid;

- (4) The stage IV (route R5), in which the mass decreases gradually and is relatively stable after 50 °C, is the decomposition of vanillin and vanillic acid become few other smaller compounds such as carbon.

Although the reaction can be predicted as shown in **Figure 3**, other reactions are possible. Therefore, in this figure, we classified the reaction route into two types, one is the main route (shown as solid line) and the other is side route (dashed line). In short, side routes (as dashed lines) are the chemical reaction routes that happen as an additional possible route.



**Figure 2.** Thermal decomposition properties of curcumin and dried turmeric



**Figure 3.** Thermal decomposition of curcumin (reaction mechanism route)

#### 4. Conclusion

The simple method for extracting curcumin from Indonesian local turmeric has been demonstrated. We also presented the infrared spectra and thermal decomposition properties of the isolated curcumin. Since the process is very simple, this method can be used for home industrial application. Further, understanding the thermal decomposition properties of curcumin give information, specifically relating to the selection of treatment when curcumin must face the thermal-related process.

#### Acknowledgement

Authors thank to RISTEK DIKTI (Grant: Penelitian Unggulan Perguruan Tinggi Negeri). Authors also acknowledged Desri Sofiani, Novie Permatasari, and Transmissa Noviska Suachya.

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