

# Synthesis and characterization of 1,3-bis-(4'-dimethylamino benzylidene)acetone by cross aldol condensation reaction using microwave assisted organic synthesis (MAOS) method

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**Abstract.** A serie of curcumin analogue has been synthesized under microwave irradiation using ratio of sodium hydroxide as catalyst. Curcumin analogue as potential anticancer, antiinflammation, and antiparasitic compounds. Synthesis of curcumin(1,3-bis-(4'-dimethyl aminobenzylidene)acetone) was carried out based on the cross aldol condensation reaction using Microwave Assisted Organic Synthesis (MAOS) method. The materials that used were acetone (0.005 mole) and 4-dimethylaminobenzaldehyde (0.0100 mole). Sodium Hydroxide was used as catalyst and ethanol as solvent. Sodium hydroxide that used was 0.0025 mole; 0.0050 mole; 0.0075 mole; 0.0100 mole and 0.0125 mole. The products were analyzed and characterized by TLC, TLC scanner, FT-IR, and <sup>1</sup>H-NMR Spectrometer. In this research, 1,3-bis-(4'-dimethylamino benzylidene)acetone was successfully synthesized in the form of a brick-red solid. The synthesis under microwave irradiation was done in 40 seconds. The highest product was obtained 98.676% by 0.0100 mole NaOH as a catalyst.

## 1. Introduction

Curcumin is an organic molecular with orange-yellow in color which found in the rhizome *Curcuma longa L* [1]. Curcumin is a key active component in the traditional herb *Curcuma Longa* and has been used for centuries throughout Asia as a food additive, cosmetic, and as traditional herbal medicine. As a spice, it provides curry with its distinctive color and flavor [2]. Over the past decade, several studies have substantiated the potential prophylactic or therapeutic value of curcumin and have unequivocally supported reports of its potential biological benefits, including anticancer [2], anti-inflammation [1], and antiparasitic [3].

The organic molecular synthesis method is needed because most organic molecules have high complexity. Synthesis of organic compounds is a technique used to obtain a compound that has similarities with compounds derived from nature, but using chemicals. Until now, many organic compounds have been synthesized on a laboratory scale or in the chemical industry scale. Many organic compounds have been successfully synthesized from the combination of small molecules into larger molecules through various chemical reactions.

The cross-aldol condensation reaction is one of the methods used in combining small molecules into larger molecules. The cross aldol condensation reaction starts with the attack of the nucleophilic enolate ion of a carbonyl compound against the carbonyl group of other carbonyl compounds [4]. Sri in 2009 explained that cross aldol condensation using acetone and benzaldehyde with a mole ratio of

1:1 only happened in one reaction step that produced benzalacetone. While the synthesis used acetone and benzaldehyde with a mole ratio 1:2 occurred two reaction steps which produced dibenzalacetone. The formation of dibenzalacetone occurred because the benzalacetone from the first step of the reaction still has  $H_{\alpha}$  which can form enolate ions [5].

In a synthesis process, variations of catalyst usually affect the product. Octovianto has been synthesized the compound 2,6-bis-(4'-methoxybenzylidene)cyclohexanone using materials of cyclohexanone and 4-methoxybenzaldehyde (1:2). The mole ratio of the NaOH catalyst that used was 0.0025 mole; 0.005 mole; 0.01 mole; 0.02 mole; and 0.04 mole. The highest product was obtained 86.97 % by using 0.04 mole NaOH [6]. Sardjiman in 2007 has been synthesized 4-dimethylamino benzalacetone by cross-aldol condensation reaction with one reaction step using ratio of NaOH catalyst, stirring time and stirring speed. Concentration of NaOH that used were 7.5%; 10.0%; 12.5% and yielded yields of 75%, 80%, 70%, respectively. The stirring speed carried out was 500 rpm, 700 rpm, 900 rpm, and yielded yields of 78.6%, 80.9%, 77.9 %, respectively. while the reaction time carried out was 60 minutes, 90 minutes, and 120 minutes, Yielded a yield of 74.6%, 85%, and 86% [7]. From some of these studies, it was evident that the ratio of NaOH catalyst affected the yield of the product that was produced.

Nowadays synthesis methods have been developed, ranging from simple (conventional) to those using modern equipment (modern). One modern method that is developing and widely using is Microwave Assisted Organic Synthesis (MAOS) method. Microwave energy that is in direct contact with the solvent through the vessel wall allows the substrate to not receive heat directly and allows faster reaction times [8]. Pambudi in 2013 has been reported that the MAOS method provides better time effectiveness than conventional and sonochemical methods in the synthesis of 2-hydroxychalcone with a NaOH catalyst. This indicated that the time spent in the synthesis using conventional methods, MAOS, and sonochemical was 3 hours, 30-50 seconds, and 30 minutes yielded yields of 10.37%, 40.35%, and 31.2% [9].

Based on this description, the synthesis of 1,3-bis-(4'-dimethylaminobenzylidene)acetone was carried out with the ratio of NaOH catalyst as much as 0.0025 mole; 0.0050 mole; 0.0075 mole; 0.0100 mole; 0.0125 mole using 4-dimethylaminobenzaldehyde and acetone as materials (2:1) with Microwave Assisted Organic Synthesis (MAOS) method.

## **2. Research Method**

### *2.1. Materials*

The reagents and solvents that used were obtained from Merck with pro analysis grade without further purification, i.e., 4-dimethylaminobenzaldehyde, benzaldehyde, acetone, ethanol, Sodium Hydroxide, chloroform, *n*-hexane, Thin-layer chromatography was performed using aluminum plates (20×20 cm) coated with silica gel 60 F254 (Merck),

### *2.2. Instrumentations*

The tools that used include standard laboratory glass, stirrer, electric scales (Libror EB 330 Shimadzu), filtered Buchner, microwave (SIGMATIC SMO-25SSG), FT-IR spectrometer (Shimadzu Prestige-21), and  $^1\text{H-NMR}$  spectrometer (500 MHz) (JEOL JNMECA, internal standard TMS).

### *2.3. Synthesis 1,3-bis-(4'-dimethylaminobenzylidene)acetone*

0.4 grams of NaOH (0.0100 mole) dissolved with 2 mL of ethanol and put into the vessel. 0.29 grams of acetone (0.0050 mole) was added and stirred until mixed. Furthermore, 4-dimethylamino benzaldehyde was added as much as 1.49 grams (0.0100 mole) while continuing to stir. Then vessel was closed aluminium foil and put in the microwave for 40 seconds. The product formed was cooled, dried and weighed. Purity test used TLC. Elucidation of the structure was done by FT-IR and  $^1\text{H-NMR}$  spectrometers. The procedure was repeated with a mole variation of NaOH catalyst 0.0025 mole; 0.0050 mole; 0.0075 mole and 0.0125 mole.

### 3. Result and Discussion

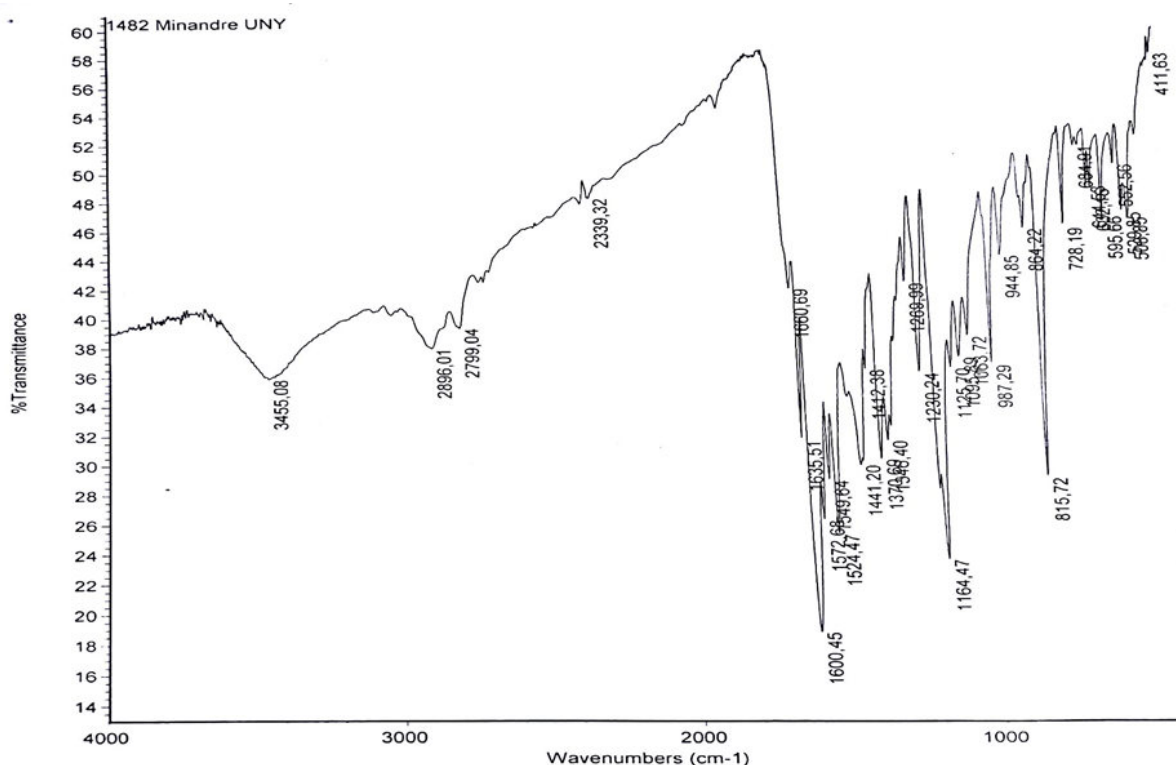
#### 3.1. Synthesis 1,3-bis-(4'-dimethylaminobenzylidene)acetone

Synthesis of 1,3-bis-(4'-dimethylaminobenzylidene)acetone was carried out with the ratio of NaOH catalysts 0.0025 mole; 0.0050 mole; 0.0075 mole; 0.0100 mole and 0.0125. Table 1 shows an increase in the yield of NaOH mole ratio and a decrease in the use of 0.0125 mole NaOH. The decrease is due to the increasing number of enolate ions that are formed so that self-condensation of acetone is possible or a Cannizzaro reaction can occur on 4-dimethylaminobenzaldehyde molecules that do not have  $H\alpha$ . The highest yield was obtained by using 0.0100 mole NaOH

**Table 1.** The yields of the product from variation of moles NaOH

NaOH (mole)	Aceton (mole)	4-dimethylamino benzaldehyde (mole)	Purity (%)	Yield (%)
0.0025	0.005	0.010	46.49	59.931
0.0050	0.005	0.010	41.70	60.321
0.0075	0.005	0.010	42.58	60.523
0.0100	0.005	0.010	67.92	98.676
0.0125	0.005	0.010	59.45	81.136

The resulting synthesis product was a brick red solid and seen under UV light 254 nm greenish-yellow in color. Structure elucidation of the synthesized 1,3-bis-(4'-dimethylaminobenzylidene)acetone was carried out with FT-IR and  $^1H$ -NMR spectrometers.



**Figure 1.** Infrared spectrum of synthesized compound

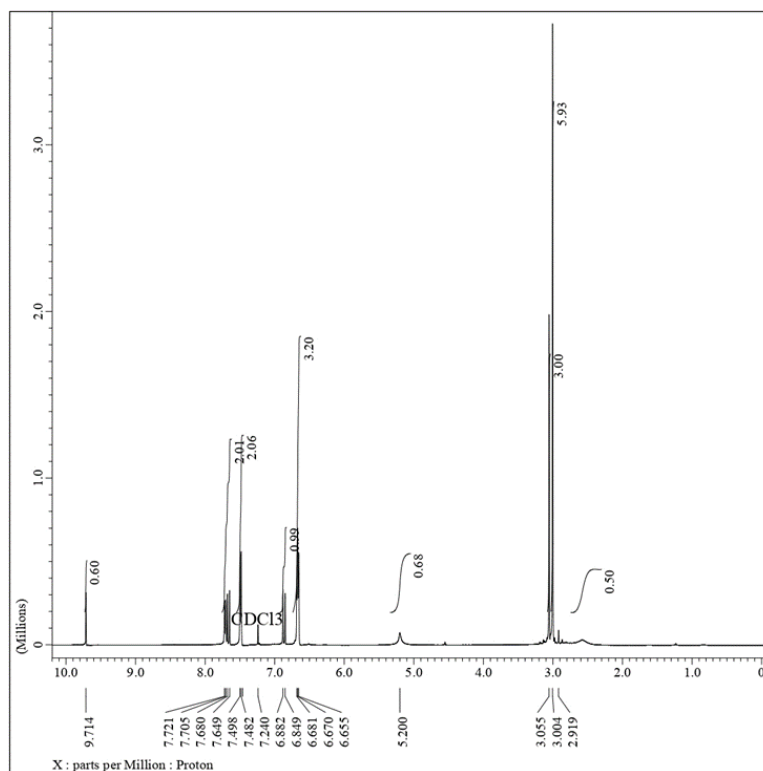
The infrared spectrum in Figure 1 is the spectrum of the synthesis product using a 0.0100 mole NaOH catalyst that has the highest in purity. Widespread absorption occurred in areas above 3000  $cm^{-1}$

<sup>1</sup>. Pavia in 2009 said that the widened absorption occurred due to the presence of water vapor contaminants on KBr pellets thus giving rise to hydroxy absorption [10]. Absorption at wavelengths with an intensity of 1360-1310  $\text{cm}^{-1}$  indicated a bond between C-N tertiary [7]. When seen in the spectrum, there was absorption at the wave number 1370.68  $\text{cm}^{-1}$ . The presence of tertiary amines is also strengthened by the absence of absorption in the area of 3500-3100  $\text{cm}^{-1}$  where tertiary amines have no N-H bonds [11]. The strong intensity in the absorption area of 1600.45  $\text{cm}^{-1}$  is typical for C=O carbonyl absorption.

**Table 2.** Functional groups in the infrared spectrum of synthesized compound

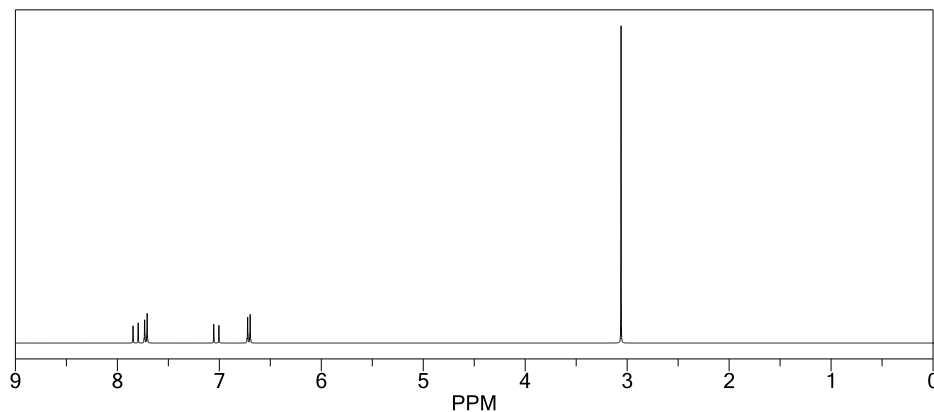
Wave number ( $\text{cm}^{-1}$ )	Functional group
2896.01	C-H aliphatic
1635.51	C=C alkene
1600.45	C=O carbonyl
1572.68 dan 1549.64	Aromatic group
1370.68	C-N tertiary
815.72	benzene substituted para

Absorption with moderate-weak intensity and side by side in an area 1600  $\text{cm}^{-1}$  indicated the presence of aromatic groups, absorption of 1572.68 and 1549.64  $\text{cm}^{-1}$ . The absorption for alkene C=C double bonds appeared in 1635.51  $\text{cm}^{-1}$ . Specific absorption was also found in the area 2896.01  $\text{cm}^{-1}$  which indicated the presence of aliphatic C-H bonds. Sastrohadmidjojo in 1992 said that substituted benzene in the para position occurred in the absorption area 850-800  $\text{cm}^{-1}$  [12] and in the spectra there was absorption which located in the area 815.72  $\text{cm}^{-1}$  which also strengthens the compound of synthesis having substituted benzene in the para position.

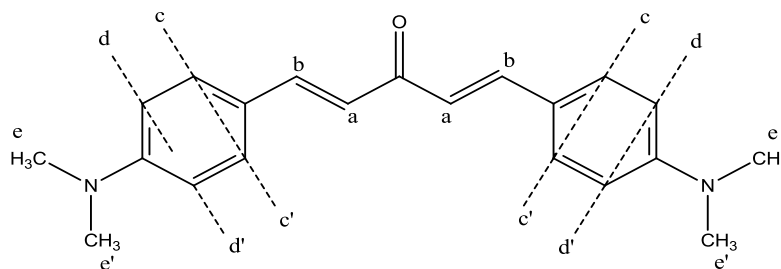


**Figure 2.**  $^1\text{H-NMR}$  spectrum of synthesized compound

The analysis was also carried out using  $^1\text{H-NMR}$  which can be seen in Figure 2. The spectrum of the results of this analysis is similar to the estimated spectrum using chemdraw software in Figure 3 and the estimated proton position of the target compound can be seen in Figure 4.



**Figure 3.** Estimated spectrum of  $^1\text{H-NMR}$  of synthesized compound using chemdraw software



**Figure 4.** Estimated proton position of product

**Table 3.** The types of protons and the magnitude of the chemical shift of synthesized compound

Code	Chemdraw $\delta$ (ppm)	product $\delta$ (ppm)	Multiplicity	Estimated Proton
a	7.03	6.882	<i>S</i>	C-H alkene
b	7.82	7.680	<i>S</i>	
c, c'	7.72	7.498	<i>D</i>	C-H aromatic
d, d'	6.71	6.670	<i>D</i>	
e, e'	3.06	3.004	<i>S</i>	N-CH <sub>3</sub>

Based on the  $^1\text{H-NMR}$  spectra, the yield of the compound is known that specific absorbance appears in regions of chemical shift ( $\delta$ ). The peak appeared in the area  $\delta$  3,004 ppm, singlet, with the number of H atoms as much as 6 atoms. This showed the presence of a methyl group ( $-\text{CH}_3$ ) but binds to the N atom so that the shift becomes greater than the area of methyl absorption it should be. The singlet multiplicity of this group is caused by not having neighboring protons. Next came the absorption area ( $\delta$ ) 3,055 ppm with singlet multiplicity. This absorption was thought to be a methyl group ( $-\text{CH}_3$ ) from a 4-dimethylaminobenzalacetone side compound with a proton number of 3 atoms.

In the area of  $\delta$  6,670 ppm, doublet absorption with 2 H atoms indicated the presence of aromatic C-H bonds. The compound substituted benzene para structure has two pairs of ortho coupling protons in the aromatic area which will give two signals with a multiplicity of doublets between 6-7.5 ppm [8]. In the spectra also appeared the doublet absorption area next to the chemical shift ( $\delta$ ) 7.498 ppm. Furthermore, peaks in the absorption area of 6.882 ppm and 7.680 ppm showed the presence of C-H alkene bonds. The difference between the two chemical shifts of the alkene because of the environment of the proton. absorption in the area of 7,721 ppm appeared 2 protons with doublet

multiplicity and absorption in the higher area, 9,714 ppm appeared 1 proton with singlet multiplicity. Both of these absorptions were thought to be the absorption of proton base material which is still mixed with the synthesis results. The basic material used was 4-dimethylaminobenzaldehyde having an aldehyde group and also an aromatic group. The absorption of proton aldehyde groups appears typically at high chemical shifts.

From the results of FT-IR and <sup>1</sup>H-NMR spectrometers, it can be concluded that the synthesized compound is 1,3-bis-(4'-dimethylaminobenzylidene)acetone.

#### 4. Conclusion

Based on the results of this study, it can be concluded that the compound 1,3-bis-(4'-dimethylamino benzylidene)acetone was successfully synthesized using precursor acetone and 4-dimethylamino benzaldehyde using Microwave Assisted Organic Synthesis (MAOS) method. The synthesis under microwave irradiation was done in 40 seconds and the highest yield was obtained 98.676% by using a 0.0100 mole NaOH as a catalyst

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