Original Research Paper

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SYNTHESIS AND COMPARATIVE STUDY OF CURCUMINOID ANALOGUES BY CONVENTIONAL AND NON-CONVENTIONAL METHODS.

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ABSTRACT Conventionally, Starting as an vanillin condensed with acetyl acetone by using tributyl borate, boric anhydride and butyl amine then reaction mixture was allowed to stand for overnight at room temperature, after workup it convert yellowish product. Similarly, Non-conventionally, Acetyl acetone, boric acid, anhydrous Sodium sulfate mixed in toluene then substituted aromatic aldehydes added with n-BuNH2, formed mixture irradiated to MWI, after workup, final compound was collected.
Second method is environmentally benign gives good yields of curcumin analogues under microwave condition. The reaction performed in less time of reaction, cleaner, no side product, good to excellent yield of product.

KEYWORDS : Comparative study, Curcuminoid analogue, MWI, Conventional and Non-conventional methods.

INTRODUCTION

Literature survey shown that turmeric extraction have been possible and achieved by several methods. However, Curcuminoides are poor water soluble natural product, little limitation occur for choice of solvent for extraction. In various reports non-polar solvents, ethylene dichloride, acetone and various alcohols were preferred and shown good results. Like that of water, curcumin even poorly soluble in hydrocarbon solvent. Uses of water and hydrocarbon solvents for turmeric extraction are least preferable. It has been noted, extraction with alcohols and acetone offers best yield. [1] Various studies have been done with Thin Layer Chromatography (TLC), High Performance Thin Layer Chromatography (HPTLC) and Column Chromatography to isolate Curcuminoides in pure form. Commonly silica gel used as stationary phase with various solvent systems like, ethyl acetate, benzene, chloroform, ethanol, acetic acid, methanol and hexane. [2, 3] High performance Liquid Chromatographic (HPLC) method was sensitive, accurate and precise one for quantitative detection of Curcuminoides. [4]HPLC separation mostly was done on reverse phase method, applying mixture of water, acetonitrile, ethanol and methanol. [5] As Curcuminoides contains three (Curcumin, DMC and BDMC) major and stable pigments which are different in chemical structure. It is obvious that everyone has different physico-chemical properties. One of the major pigment that is Curcumin is available commercially in more than 80% pure form (Sigma-aldrich) but DMC and BDMC are not easily available in pure form. To study various pharmacokinetic possibilities, it is important to isolate rest two pigments in pure form[6]. To separate Curcuminoides component in large amount column chromatographic technique has to be attribute with combination of appropriate mobile phase. Correct mobile phase, however, chosen by trial and error method on TLC with UV-detection method. Optimization of separation of turmeric, correct identification of R*f* (Retention Factor) values of each pigment and further purification and crystallization [6].

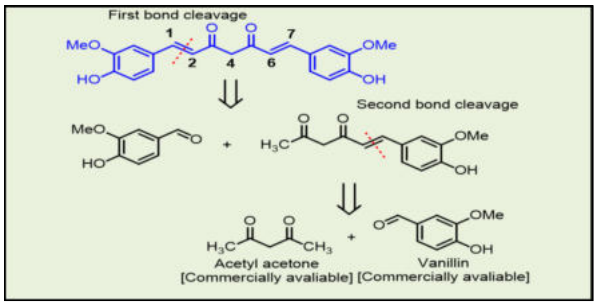


Figure 1. Retrosynthesis Of Curcumin, Vanillin And Acetyl Acetone Are Good Logical Starting Materials.

Retrosynthesis of Curcumin: Experimental Perspective

Synthesis in Laboratory is another method of obtaining Curcumin in pure form. Retro-synthetic study of curcumin (**Figure 1**) showing Vanillin (4-hydroxy-3-methoxybenzaldehyde) and acetyl acetone (Pentane-2,4-dione) are the most logical starting materials for synthesis of Curcumin. At first glance, it look feasible, Vanillin is cheap and easily available in pure form (99%) as white solid, similarly acetyl acetone as easily available colourless liquid and cheap chemical. Claisen-Schmidt condensation reaction could be the best way to construct curcumin backbone.

Condensation of aromatic aldehydes with ketone has been 'set' chemistry. Reaction catalyzed by either adding catalytic acid or base. In literature, numbers of methodologies were reported to achieve aldehydes and ketone condensation to obtained new carbon-carbon bond.

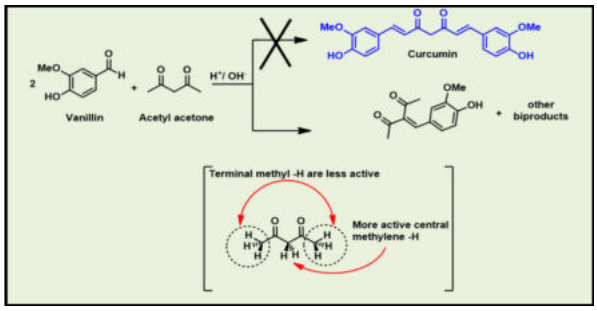


Figure 2. Condensation Of Vanillin And Acetyl Acetone With Does Not Obtained Desire Curcumin As Product.

As shown in **Figure 2** acetyl acetone consists of two sets of proton six terminal methyl proton which are supposed to undergo condensation reaction, but central methylene proton are more reactive. Terminal methyl group has only one adjacent electron withdrawing carbonyl group, whereas, central methylene proton has couple of adjacent carbonyl group, hence it is not surprising to obtain some byproducts instead of pure Curcumin.

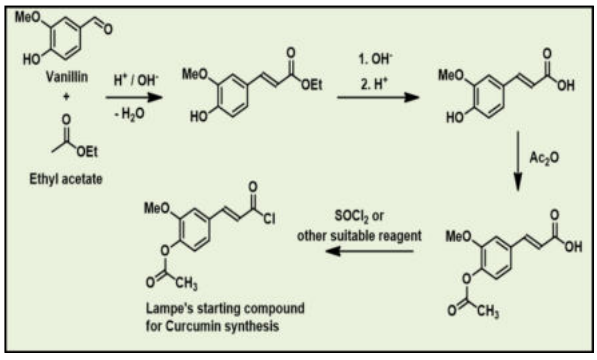


Figure 3. Illustration of general strategy for synthesis of Lampe's starting compound in the laboratory, involving highly reactive and unstable acid chloride.

To overcome this problem in the year 1910 Lampe [7] who was the first, synthesized Curcumin in laboratory. Carbomethoxyferuloyl chloride was taken with ethyl acetoacetate, further intermediate after decarboxylation again treated with second mole of carbomethylferuloyl chloride. Total synthesis was of five steps and yield of product is negligible. Lampe's method of Curcumin synthesis was suffers from many drawbacks and counting could be start from starting material carbomethoxyferuloyl chloride. Through, it was mention that actual reaction of synthesis of Curcumin consists of five steps, but Carbomethoxyferuloyl chloride is not easily available commercial chemical. Synthesis of such starting materials reduced its significant impact drastically. Common synthetic strategy for Lampe staring material is given in Figure 3.

Curcumin synthesis was remaining as challenge upto next forty years. In 1950 Pavolini[8]synthesized curcumin in just 30 minutes, by heating two parts of Vanillin and one part of acetyl acetone, boron trioxide was the catalyst used in the reaction. Pavilion's method was expeditious and choice of starting materials was smart, but yield of product was only 10%. After thirteen years later, in 1963 Pabon *et al*.,[9] repeated synthesis by Pavolini method and got only 1.5% yield. During his experimental work, observed that condensation of Vanillin and acetyl acetone was took place at 150°C in presence of boric anhydride. In addition with boric anhydride catalyst introduced tributyl borate with piperidine (as base) yield was raised upto 25%. In search of appropriate reaction condition, were used various base catalysts among which n-butyl amine was found productive, yield of reaction was 80%. Best solvent was found ethyl acetate and optimum temperature for Curcumin synthesis was 85-110°C.

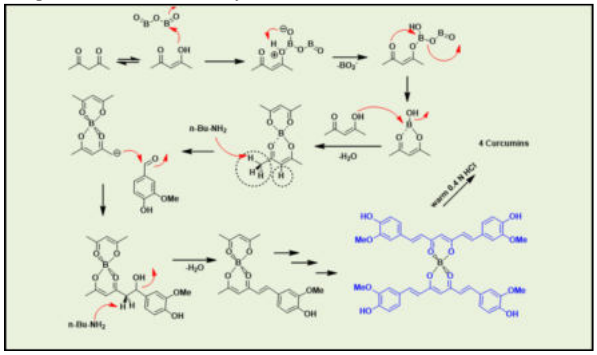


Figure 4. Acetylacetone-boric anhydride complex strategy to 'trap' acetylacetone in keto-enol form, so active central methylene proton not available to interfere with base.

Central active methylene proton was only the problem with acetyl acetone. 1,3-dicarbonyl compounds are exhibits keto-keto an keto-enol form. In the keto-enol form central methylene proton diminish and are no longer available for reaction. During the course of reaction acetyl acetone should remain in the keto-enol form, was the only requirement. Boric anhydride 'traps' two molecules of acetylacetone in keto-enol form throughout the reaction. After completion of reaction complex was break down by treatment of 60°C (warm) 0.4 *N* HCl solutions.

MATERIALS AND METHODS

General

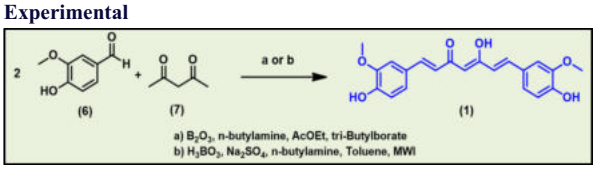
The commercial sample of curcumin was purchased from S. D. Fine Chemical Limited, Mumbai, Maharashtra. Solvents were used during experimentation was of Analytical grade purchased from Spectrochem of Loba, India and used further without distillation. Separation of Curcumin, Demethoxy Curcumin and Bisdemethoxy Curcumin from commercial sample was performed by Column Chromatography. [10-13].

Starting materials were check by Thin Layer Chromatography (TLC) for their purity purpose. Separation or formation of products was initially confirmed by TLC techniques. Mobile phase selected by trial and error method. Silica plate was used TLC Silica gel 60G, F_{254} Plates by Merck.

IR was recorded for compounds synthesized in the laboratory and for validation of isolated curcumin from Curcuminoides. Absorption spectra recorded in the range of 400-4000 $cm^{-1}$with KBr pallets, JASCO-8000 FT-IR spectrophotometer. Recorded spectra further substantiated by matching with reported values.

Compounds synthesized during laboratory experimental work analyzed by using proton NMR and Carbon NMR. Deuterated solvents mostly used as DMSO-*d6*, unless it is mention. Tetra methyl Silane (TMS) was used as internal standard. Actual scanning was done by Burker Advance DRX 300 FT-NMR.

Experimental



Scheme 1. Synthesis of Curcumin from vanillin (6) and acetyl acetone

***Conventional Method-1:*[9]**

Vanillin (**6**) (6 gm; 0.04 mol) and tributyl borate (21ml; 0.08mol) were dissolved in 25ml of moisture free ethyl acetate. To this, previously formed mixture of acetylacetone (2ml; 0.02mol) and boric anhydride (1gm; 0.014mol) was added and allowed to stir for next 10 minutes. Butyl amine (0.1 ml; 0.001mol) was added very slowly drop wise over 20 minutes. This reaction mixture was allowed to stir for next four hours at room temperature. After four hours reaction mixture was allowed to stand for overnight at room temperature. Next day 25 ml of 0.4*N* HCl was added to reaction mixture and stir for one hour at room temperature. Two layers (organic and aqueous) separated and aqueous layer was washed with ethyl acetate (20ml× 2). Organic layer combined with washing and thus obtained ethyl acetate washed with distilled water (50ml ×3). Yellow coloured organic layer were put on rota evaporator to remove approximately half of solvent. To this methanol (10 ml) was added and kept in ice bath for two hours. Thus obtained yellow crystals were filter, washed with cold methanol to obtained crude product. Column chromatographic purification offers pure product as yellow crystals. (4.41 gm; 60%)

Conventional Method-II:

Acetylacetone (2 ml; 0.02 mole) and boric anhydride were stirred at 50°C till white past formed. To this aromatic aldehydes (0.04 mole) and piperidine (10 mole %) was added in toluene. Reaction was subject to reflux for next 5-8 hours (**Table 1**). Completion of reaction was confirmed by TLC (MeOH 4% in DCM). Allowed contains to attained room temperature and 20 ml of 5% HCl solution was added and stir vigorously for next 30 minutes. Two layers were separated out and moisture was removed from organic layer prior to distill using anhydrous sodium sulfate. After removal of major amount of toluene in reduced pressure, reaction mixture allowed to cooled down and filter to afforded crude product, column chromatographic purification offers pure product as yellow colour crystals (5.2 gm; 70.74%).

Non conventional Method:

Acetyl acetone (1 mmol), boric acid (1 mmol) and anhydrous Sodium sulfate (0.5mmol) were taken in moisture free toluene as solvent and stirred for 60 min. at 50°C in water bath. Substituted aromatic aldehydes (2.2mmol) was added to reaction mixture, finally drop wise with continuous stirring n-$BuNH_2$ (0. 2 eq.) was added, reaction mixture was irradiated at 800 W for 4-5 minutes, (**Table 1**) with few second resting time after 30 sec. of successive irradiation. After completion of reaction (TLC), filter and collect yellow coloured residue, cold 1 *N* hydrochloric acid was added (20 ml) to residue and stirred for another 2 hours. Finally contain were filter, wash several times with cold water, air dried and purified by Column chromatography. (Yield 73%)

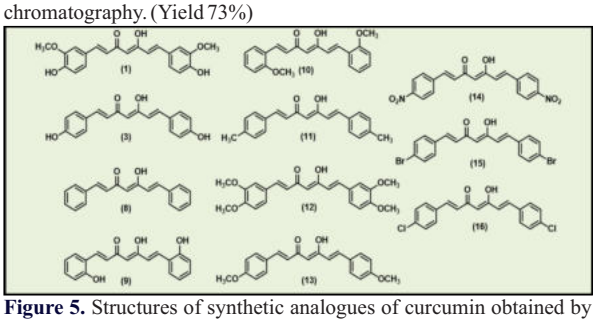


Figure 5. Structures of synthetic analogues of curcumin obtained by conventional and non-conventional method.

RESULTS AND DISCUSSION

Describe new conventional and non-conventional methods are

productive, easy workup procedure and could be good alternatives for established methodologies. [8, 9]

Claisen-schmidt reactions are common with describe alkaline alcoholic medium offers products with satisfactory yield of product. When 1,3-dicarbonyl (acetylacetone) moiety trap with boron, synthesis of curcumin proceeds via Claisen-schmidt reaction. It was observed that addition of aromatic aldehydes, acetyl acetone and boron one portion did not productive and results obtained were unsatisfactory. In such case aldehyde spot remain present on TLC after 8 hours.

For optimization of reaction condition and amount of catalyst in conventional method as well as Non-conventional method, model reaction methodology were adopted. Vanillin and acetylacetone were kept fixed reacting partner. Amount of boric anhydride was kept constant, as theoretically single boron involved in complex formation with two moles of acetylacetone. Non- hydroxyl curcumin analogues synthesis was smooth and more productive compared to –OH containing analogues. (**Table 1**) Hydroxyl group is more hydrophilic in nature, hence during water workup it could be possible lost and same physico-chemical property may be responsible, why column chromatographic purification was found much needed in case of –OH containing curcumin derivatives. It observed that significant change in yield of product when –OH present as single substituent (**Table 1**; Entry 2,3 and 4) than halogen containing moieties. (**Table 1**; Entry 9,10 and 11)

Table 1. Synthesis Of Curcumin And Analogues And Yield Of Reaction By Conventional And Non-conventional Method[b]

Sr. No.	Product numbers (Figure 2.5.1.1)	Time and Yield of product (%)[a]			
		Conventional[b]		MWI[c]	
		Time	Yield[a]	Time	Yield[a]
1.	(1)	4 hr.	70	4 min.	73
2.	(3)	6 hr.	51	5 min.	71
3.	(8)	6 hr.	50	5 min.	62
4.	(9)	6 hr.	55	5 min.	70
5.	(10)	5 hr.	67	5 min.	79
6.	(11)	6 hr.	76	5 min.	92
7.	(12)	5 hr.	72	5 min.	90
8.	(13)	4 hr.	83	4 min.	94
9.	(14)	4 hr.	80	4 min.	93
10.	(15)	4 hr.	88	4 min.	94
11.	(16)	4 hr.	79	4 min.	89

[a]Isolated yield; [b]Conventional method-II: (7) (0.02 mol) and boric anhydride (0.014 mol) pest added to toluene containing Vanillin (0.04 mol) followed by drop wise piperidine (10 mol%); [c]MWI: To the mixture of Vanillin and tributyl borate white pest of acetylacetone and boric acid was added in one portion followed by butylamine and MWI (800W).

In summary, describe conventional and non-conventional methods of synthesis of curcumin and analogues are expeditious one pot method. Both methods are productive and consisting easily available starting materials. MWI techniques further gain advantage to offers better yield with hydroxyl curcumin analogues, within less time. These are methodologies, believed, to be good replacement for present conventional methods.

Spectral Analysis Of Synthesized Compounds:

(1E,4Z,6E)-5-hydroxy-1,7-bis(4-hydroxy-3-methoxyphenyl)hepta-1,4,6-trien-3-one (1):

(2.39 g,65%), mp 178–180°C (lit.[]mp 182–183°C), IR(KBr) υ_{max} 3428, 1613, 1276, 1154, 1027, 957 cm^{-1}; ^{1}HNMR ($CDCl_3$) δ 3.94 (6H, s, 2· Ar-OCH3), 5.79 (1H,s, H-4), 6.46 (2H, d, J = 16.0 Hz, H-2,6), 6.92 (2H, d,J = 8.0 Hz, H-50,500), 7.04 (2H, d, J = 2.0 Hz, H-20,200),7.11 (2H, dd, J = 8.0, 2.0 Hz, H-60,600), 7.58 (2H, d,J = 16.0 Hz, H-1,7); EIMS m/z (%): 368 (M+, 53), 350(36), 191 (66), 190 (78), 177 (100), 158 (30), 149 (21),145 (85), 137 (81), 117 (29), 110 (63), 77 (29).

(1E,4Z,6E)-5-hydroxy-1,7-bis(4-hydroxyphenyl)hepta-1,4,6-trien-3-one (3):

Yield 55%, mp 222–224°C (lit.28 mp 223–224°C);IR (KBr) υ_{max} 3211, 1620, 1600, 1269, 1168, 1140, 955,831 cm1; 1H NMR (DMSO-d6) d 6.03 (1H, s, H-4),6.68 (2H, d, J = 16.0 Hz, H-2,6), 6.80 (4H, d,J = 8.0 Hz, H-30,50,300,500), 7.50 (2H, d, J = 16.0 Hz, H-1,7), 7.55 (4H, d, J = 8.0 Hz, H-20,60,200,600); EIMS m/z(%): 308 (M+, 20), 290 (14), 159 (36), 146 (100), 147(87), 119 (38), 106 (42), 90 (42), 65 (32).

(1E,4Z,6E)-5-hydroxy-1,7-diphenylhepta-1,4,6-trien-3-one (8):

IR (KBr): ν 3398, 2942, 1684, 1605, 1172,1025 cm–11H NMR (300 MHz, CDCl3): δ 6.54 (1H, s, H-4),6.73 (1H, d, J = 16.0 Hz, H-7), 6.82 (1H, d,J = 16.0 Hz, H-6), 7.15 (1H, d, J = 16.0 Hz, H-2),7.27 (2H, dd, J = 8.0, 2Hz, H-4′, 4′′), 7.37 (4H, dd,J = 8.0 Hz, H-3′, 5′, 3′′, 5′′), 7.51 (4H, dd, J = 8.0,2.0 Hz, H-2′, 6′, 2′′, 6′′), 7.64 (1H, d, J = 16.0 Hz,H-1) ppm13C NMR (75MHz, CDCl3): δ 101.2 (C-4),118.3 (C-6), 122.9 (C-2), 126.5 (C-4′, 4′′),128.3 (C-2′, 6′, 2′′, 6′′), 128.6 (C-3′, 5′, 3′′,5′′), 135.2 (C-1', 1"), 140.5 (C-7), 142.3 (C-1),182.4 (C-3, C-5) ppm

(1E,4Z,6E)-5-hydroxy-1,7-bis(2-hydroxyphenyl)hepta-1,4,6-trien-3-one (9):

Yield 23%, mp 160–162 C (lit.30 mp 163–164 C);IR (KBr) mmax 3391, 1615, 1255, 1142, 961, 752 cm1; 1HNMR (DMSO-d6) d 6.11 (1H, s, H-4), 6.91 (2H, d,J = 7.5 Hz, H-30,300), 6.92 (2H, d, J = 15.8 Hz, H-2,6),7.21 (4H, m, H-40,50,400,500), 7.63 (2H, d, J = 7.5 Hz, H-60,600), 7.89 (2H, d, J = 15.8 Hz, H-1,7); LC–MS m/z(%): (ESI-negative mode) 307 [(MH), 100].

(1E,4Z,6E)-5-hydroxy-1,7-bis(2-methoxyphenyl)hepta-1,4,6-trien-3-one (10):

IR (KBr): ν 3412, 1668, 1255, 1142, 961, 752 cm–11H NMR (300 MHz, CDCl3): δ 3.85 (6H, s, 2·Ar-OCH3), 6.13 (1H, s, H-4), 6.62 (1H, d, J =16 Hz,H-6), 6.79 (2H, d, J = 7.5 Hz, H-3′, 3′′), 6.83 (1H,d, J = 16 Hz, H-2), H- 6.97 (1H, d, J = 16 Hz,H-7), 7.17 (4H, m, H-4′, 5′, 4′′, 5′′), 7.53 (2H, d,J = 7.5 Hz, H-6′, 6′′), 7.74 (2H, d, J = 16 Hz, H-1)ppm13C NMR (75MHz, CDCl3): δ 55.4 (OCH3),101.2 (C-4), 115.2 (C-3′, 3′′), 118.5 (C-6), 120.8 (C-5′,5′′), 122.9 (C-2), 127.9 (C-4′, 4′′), 125.4 (C-11′′), 134.8 (C-6′, 6′′), 140.4 (C-7), 142.4 (C-1),159.3 (C-2′, 2′′), 182.4 (C-3, C-5) ppm

(1E,4Z,6E)-5-hydroxy-1,7-di-p-tolylhepta-1,4,6-trien-3-one (11):

IR (KBr): ν 3422, 2942, 1672, 1605, 1172,1025 cm^{-1}

^{1}H NMR (300 MHz, $CDCl_3$): δ 2.35 (6H, s, $ArCH_3$),6.52 (1H, s, H-4), 6.83 (1H, d, J = 16.0 Hz, H-7),6.87 (1H, d, J = 16.0 Hz, H-6), 7.06 (1H, d,J = 16.0 Hz, H-2) 7.13 (2H, dd, J = 8.0, 2Hz, H-3′,5′, 3′′, 5′′), 7.47 (4H, dd, J = 8.0 Hz, H-2′, 6′, 2′′,6′′), 7.69 (1H, d, J = 16.0 Hz, H-1) ppm 13C NMR (75MHz, $CDCl_3$): δ 21.4 (CH_3),101.1 (C-4), 118.5 (C-6), 123.2 (C-2), 128.4 (C-2′,6′, 2′′, 6′′), 128.7 (C-3′, 5′, 3′′, 5′′), 130.9 (C-4′,4′′), 132.2 (C-1′, 1′′), 140.4 (C-7), 142.2 (C-1),182.2 (C-3, C-5) ppm

(1E,4Z,6E)-1,7-bis(3,4-dimethoxyphenyl)-5-hydr oxyhepta-1,4,6-trien-3-one (12):

IR (KBr): ν 3420, 2933, 1676, 1592, 1177, 1028, 977,826 cm–11H NMR (300 MHz, CDCl3): δ 3.92, (s, 6H), 3.97 (s,6H), 6.67 (1H, s, H-4), 6.83 (d, J = 16.0 Hz, 1H, H-7),6.89 (1H, d, J =16 Hz, H-6), 6.97 (2H, d, J = 8.0 Hz,H-5′, 5′′), 7.05 (1H, d, J = 16Hz, H-2), 7.13 (2H, d,J = 2.0 Hz, H-2′, 2′′), 7.21 (2H, dd, J = 2.0, 8.0 Hz,H-6′, 6′′), 7.68 (2H, d, J = 16.0 Hz, H-1) ppm13C NMR (75MHz, CDCl3): δ 55.8 (OCH3),56.2 (OCH3), 101.5 (C-4), 111.9 (C- 2′, 2′′), 112.3 (C-5′,5′′), 118.4 (C-6), 122.4 (C-6′, 6′′), 123.2 (C-2),127.4 (C-1′, 1′′), 140.3 (C-7), 142.6 (C-1), 149.0 (C-4′,4′′), 149.7 (C-3′, 3′′), 182.8(C-3, C-5) ppm

(1E,4Z,6E)-5-hydroxy-1,7-bis(4-methoxyphenyl)hepta-1,4,6-trien-3-one (13):

Yield 54%, mp 156–158°C (mp 154–158°C);IR (KBr) mmax 2933, 1625, 1600, 1177, 1028, 977,826 cm^{-1}; ^{1}H NMR ($CDCl_3$) δ 3.84 (6H, s, 2· Ar-OCH3), 5.78 (1H, s, H-4), 6.49 (2H, d, J = 15.7 Hz, H-2,6), 6.91 (4H, d, J = 8.7 Hz, H-30,50,300,500), 7.50 (4H,d, J = 8.7 Hz, H-20,60,200,600), 7.62 (2H, d, J = 15.7 Hz,H-1,7); LC–MS m/z (%): (ESI-positive mode) 337[(M+H)+, 100].

(1E,4Z,6E)-1,7-bis(4-bromophenyl)-5-hydroxyhepta-1,4,6-trien-3-one (15):

IR (KBr): ν 3412, 2932, 1627, 1603, 962, 814 cm–11H NMR (300 MHz, CDCl3): δ 6.52 (1H, s, H-4),6.82 (1H, d, J = 16.0 Hz, H-7), 6.89 (1H, d, J=16 Hz, H-6), 7.04 (1H, d, J =16 Hz, H-2), 7.35 (2H,dd, J = 8.0, 2 Hz, H-3′, 5′, 3′′, 5′′), 7.56 (4H, dd,J = 8.0 Hz, H-2′, 6′, 2′′, 6′′), 7.75 (1H, d, J = 16.0 Hz,H-1) ppm13C NMR (75MHz, CDCl3): δ 101.1 (C-4), 118.6 (C-6),122.6 (C-4′, 4′′), 123.1 (C-2), 128.6 (C-2′, 6′, 2′′,2′′), 130.6 (C-3′, 5′, 3′′, 5′′), 131.9 (C-1′, 1′′),140.4 (C-7), 142.2 (C-1), 182.5 (C-3, C-5) ppm

(1E,4Z,6E)-1,7-bis(4-chlorophenyl)-5-hydroxyhepta-1,4,6-trien-3-one (16):

IR (KBr): ν 3422, 2932, 1685, 1603, 1172,1025 cm^{-1}; ^{1}H NMR (300

MHz, $CDCl_3$): δ 6.57 (1H,s, H-4),6.82 (1H, d, J = 16.0 Hz, H-7), 6.88 (1H, d,J = 16.0 Hz, H-6), 7.08 (1H, d, J = 16.0 Hz, H-2),7.32 (2H, dd, J = 8.0, 2Hz, H-3′, 5′, 3′′, 5′′),7.52 (4H, dd, J = 8.0 Hz, H-2′, 6′, 2′′, 6′′), 7.71 (1H,d, J = 16.0 Hz, H-1) ppm 13C NMR (75MHz, $CDCl_3$): δ 101.0 (C-4),118.9 (C-6), 123.5 (C-2), 128.6 (C-3′, 5′, 3′′,5′′), 129.2 (C-2′, 6′, 2′′, 2′′), 131.9 (C-1′,1′′), 133.6 (C-4′, 4′′), 140.6 (C-7), 142.4 (C-1),182.5 (C-3, C-5) ppm

CONCLUSION

In brief, in comparison of conventional and non-conventional method, microwave irradiation method is effective, advanced, efficient and time reducing over convention method for synthesis of synthesis of curcumin and its analogues with good to better yield.

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REFERENCES

[1] V.S.Govindarjan, **(1980)** Turmeric – chemistry, Technology, and Quality. **CRC Critical Review in FoodScience and Nutrition**, 12, 3, pp. 199-301.

[2] P. Ravindran, K. N. Babu, K. Sivaraman**(2007)In Turmeric: the genus Curcuma. Boca**pp.150-155

[3] A. P. Gupta, M. M.Gupta, S. J. Kuma**(1999)** Simultaneous determination of curcuminoids in curcuma samples using high-performance thin-layer chromatography. **Liquid Chromatogrphy: Real Time,** 22, pp.1561–1569.

[4] SompolParamapojn and WandeeGritsanapan**(2009)** Free radical scavenging activity determination and quantitative analysis of curcuminoids in Curcuma zedoariarhizome extracts by HPLC method,**Current science**, vol. 97, pp.1069-1073.

[5] G.K. Jayaprakasha, L. JaganmohanRao, K. K.Sakariah,**(2002)** Improved HPLC method for the determination of curcumin, demethoxycurcumin and bisdemethoxycurcumin. **Journal of Agriculture and Food Chemistry,** 50, 3668–72.

[6] M.Madhava Naidu, Shyamala, Srinivas**(2009)** Simple HPLC Method for Resolution of Curcuminoids with Antioxidant Potential. **Journal of food science**,vol 74,4, pp-C312-318

[7] J. Milobedzka, V. Kostanecki, V. Lampe, **(1910)**, Structure of curcumin, **Ber. Deut. Chem**. **Ges**., 43, 2163-70.

[8] T. Pavolini, F. Cumbarin and A. M. Crinzuto, **Ann. Chim. Roma** 40, 280 (1950).

[9] H. J. J. Pabon, **Rec. Trav. Chim. Pays-Bas** 1964, 83, 379.

[10] L. P. Almeida, A. P. F. Cherubino, R. J. Alves, L. Dufosse, M. B. B. d Gloria **(2005)** Separation and determination of the physico-chemical characteristicsof curcumin, demethoxycurcumin and bisdemethoxycurcumin, **Food Research International,**38, 8-9, pp. 1039-1044.

[11] J. P. Annaraj, K. M. Ponvel, P. Athappan**(2004)** Synthesis, spectra and redox behavior of copper (II) complexes of curcumin diketimines as models for blue copper proteins, **Transition Metal Chemistry,**29, 7, *pp.*722-727.

[12] K. R. Srinivasan **(1953)** A chromatographic study of the curcuminoids in Curcuma longa, **Journal of Pharmacy and Pharmacology**, 5, 1, pp.448–457.

[13] G. Liang, X. Li, L. Chan, S. Yang, X. Wu, E. Studer, E. Gurley, P. B. Hylemon, F. Ye, Y. Li, H. Zhou, **(2008)** Synthesis and anti-inflammatory activities of mono-carbonyl analogues of curcumin, **Bioorganic and Medicinal Chemistry Letters**, 18, 4, pp-1525-1529.