Coumarin Synthesis Via The Pechmann Reaction

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Abstract- *There are two techniques to create derivatives of Coumarin under various factors using phenol condensed with β-keto esters via Pechmann condensation. This work examines the synthesis of Coumarin with respect to product yield, reaction time, and reaction conditions.*

Keywords- Coumarin , Pechmann reaction, phenols , β-keto esters.

I. INTRODUCTION

Coumarin is one of the benzopyrone derivatives . It is the basic particle that can be synthesis from many more complex of the Coumarin derivatives. The compounds containing alkyl groups or hydroxy or benzyl as imitative total.[1] The Coumarin is within the important organic compounds and within the many uses of terms within the cosmetics, dyes and food addtives [2]. Coumarin derivatives have been used in the medical field as anti-coagulant blood pressure depressor muscles loosened and many others [3] as well as HIV and affecting the liver . [4]One of the Industrial methods of preparing Coumarin is Pechman reaction, where they preparing a number of Coumarin derivatives by condensation of phenol or products with compounds beta - keto ester with sulfuric acid. [5]

REACTION MECHANISM:-

The interaction between phenols and carboxylic acid or ester compounds containing the β-carbonyl functional group is how German chemist Hans von Pechmann, using laboratory procedures, synthesizes coumarins and heterogeneous chemicals. [5]

PECHMANN CONDENSATION COUMARIN SYNTHESIS:-

Synthesis of coumarins by Pechmann Condensation reaction between phenolic compounds and β-keto ester compounds .

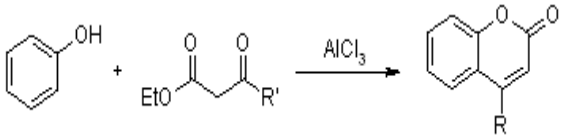


Figure 1.

MECHANISM OF THE PECHMANN REACTION:

Strong acids like methanesulfonic acid or Lewis acids like AlCl3 are used in the reaction. Both transesterification and keto-enol tautomerization are catalyzed by the acid .

Figure 2 illustrates how the product is obtained through the subsequent induced-acid elimination of H2O. [6]

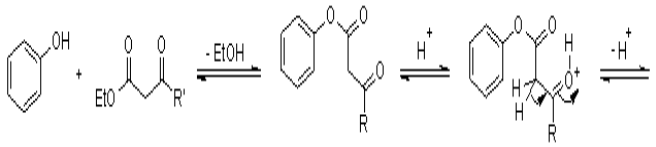


Figure 2

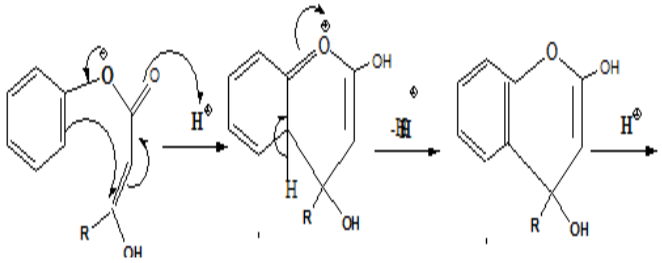


Figure 3

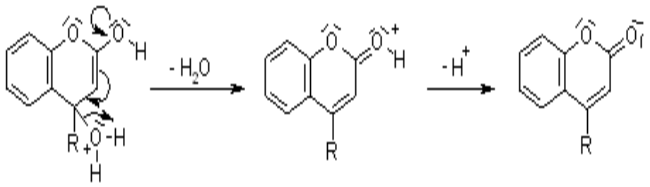


Figure 4

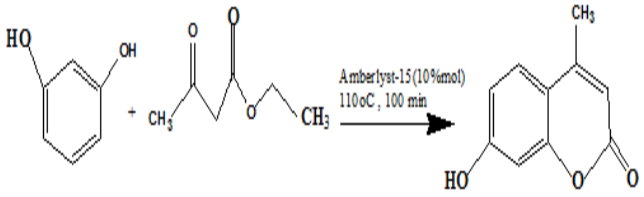
Different reaction and ways for Pechman reaction to synthesis coumarin:-

An analysis of the synthesis of Coumarin is conducted, comparing the many compounds utilized in the Pechman reaction with respect to their products and methodologies. Initially, this reaction involved a reaction between phenol compounds and β-keto esters compounds.

METHOD 1:
Conventional methods (All reaction conditions show in tabel-1)

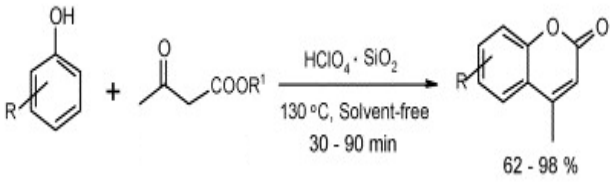
1- **The coumarins synthesis from Pechmann condensation by use Amberlyst-15** catalyst**:**

Using a catalyst of 10% amberlyst-15 and 1 mmol of resorcinol and 1.1 mmol of ethyl acetoacetate, the reaction mixture was first agitated in an oil bath at 110°C for the required amount of time.Through thin-layer chromatography, the reaction was observed. Following the completion of the reaction, the filtered mixture was cooled to room temperature in order to eliminate the heterogeneous catalyst. Next, hot methanol was added to the cooled filtrate, resulting in a solid that was filtered and then recrystallized with ethanol to yield pure product.[7]



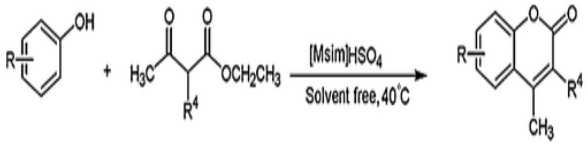
SCHEME 1.

2- **The coumarins synthesis from Pechmann condensation by use heterogeneous catalyst [8]**



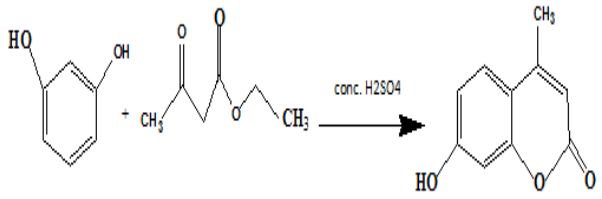
SCHEME 2.

3- The **coumarins synthesis** from **Pechmann reaction by use (ILi) onic liquid catalyzed [9]**



SCHEME 3.

4- The coumarins synthesis from Pechmann condensation by use H2SO4 acid catalyst [10]



SCHEME 4.

Table-1: Reaction conditions of the coumarins synthesis by Conventional methods of Pechman reaction

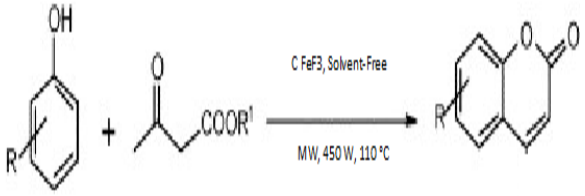
SYNTHESIS	CATALYST	TIME[s]	TEMP. [°C]	YIELD [%]
1	Amberlyst-15	600	110	95
2	$HClO_4.SiO_2$	1800-3600	130	98
3	$[Msim]HSO_4$	1320	60	96
4	$Conc.H_2SO_4$	Overnight	R.T	85

METHOD 2

The coumarins synthesis from Pechmann reaction by Assisted Microwave

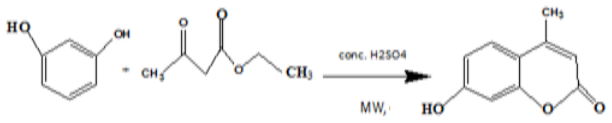
(all Reaction conditions show in tabel-2)

5- The synthesis of coumarins from Pechmann Condensation by FeF3 Catalyzed by Assisted Microwave: In an open Pyrex beaker, 1 mmol of resorsinol, 1 mmol of ethyl acetoacetate, and 0.05 g of FeF3 were crushed. The homogenized mixture was then heated by microwave irradiation for approximately 7 min [11].



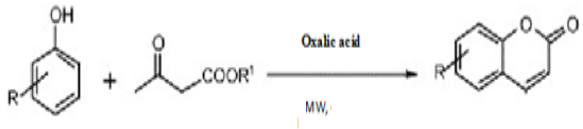
SCHEME 5.

6- The coumarins synthesis from Pechmann Condensation by use conc. H2SO4 Catalyzed by Microwave Irradiation[12].



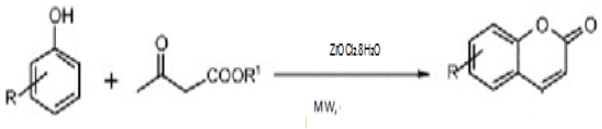
SCHEME 6

7- The coumarins synthesis from Pechmann Condensation by use Oxalic acid Catalyzed in Microwave Irradiation [13]



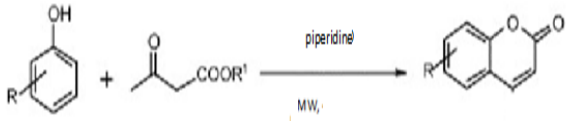
SCHEME 7

8- The coumarins synthesis from Pechmann Condensation by use ZrOCl2.8H2O Catalyzed in Microwave Irradiation [14]



SCHEME 8

9- The coumarins synthesis from Pechmann Condensation by use piperidine Catalyzed in Microwave Irradiation [15]



SCHEME 9

Table -2: Assisted Microwave Reaction conditions of the coumarins synthesis by the Pechman reaction

SYNTHESIS	CATALYST	TIME[S]	TEMP.[C°]	YIELD[%]
6	0.05g FeF3	540	MW,450W,110°C	95
7	Conc.H_2SO_4 – 1 ml	600	MW,350,75°C Or less	95
8	Oxalic acid	500	MW,700,110-140°C	68
9	$ZrOCl_2.8H_2O$	3600	MW,700W,120°C	86
10	piperidine	600	MW,700W,129°C	89

METHOD 3

11-The coumarins synthesis from Pechmann reactionWithout any Catalyst.[16]
(Reaction conditions show in tabel-3)

Conventional technique of synthesising coumarins without the need for a catalyst: Resorcinol and ethyl β-amino crotonate (EAA) enamine derivatives were heated in an equimolar amount of solution at 180°C without the use of a catalyst. The reaction was then monitored using thin-layer chromatography, and the mixture product was cooled and poured into cold water. The resulting solid was then washed with cold water, and the solid mass was finally recrystallized from aqueous alcohol to yield a pure product.

Table-3: Reaction conditions of the coumarins synthesis by the Pechman reaction Without any Catalyst

SYNTHESIS	TIME[s]	TEMP[°C]	YIELD[%]
11	1200	180	85

II. CONCLUSION

Pechmann Reaction: There are numerous ways to synthesize coumarins. Given that it just needs basic starting components, one of these kinds for the Pechmann reaction is thought to be among the most significant. Compounds containing ester and simple phenols have β-carbonyl groups.

According to every study covered in this review, using conventional and microwave irradiation techniques to synthesize coumarin derivatives via the Pechmann reaction has demonstrated more catalytic activity than using no catalyst at all.

The outcomes using all of these techniques We value their stated outstanding observations and excellent yield.

REFERENCES

[1] R. O'Kennedy and R. D. Thornes , Coumarins: Biology,Applications and Mode of Action, Wiley & Sons, Chichester, 1997.
[2] M. Zahradnik, The Production and Application of FluorescentBrightening Agents, Wiley & Sons, 1992.
[3] M. Maeda and Laser Dyes, Academic Press, New York, 1994.
[4] R. D. H. Murray, J. Mendez and S. A. Brown, The NaturalCoumarins: Occurance, Chemistry and Biochemistry, Wiley &Sons, New York, 1982.

[5] J. D. Hepworth, Ch. D. Gabbut and B. M. Heron, in: Comprehesive in Heterocyclic Chemistry, Pergamon Press, 2nd edition, 1996.
[6] Jump up^ H. v. Pechmann (1884). "Neue Bildungsweise derCumarine. Synthese des Daphnetins". Berichte der deutschenchemischen Gesellschaft. 17 (1): 929–936. doi:10.1002/cber.188401701248.
[7] Daru, János; Stirling and András (4 November 2011). "Mechanism of the Pechmann Reaction: A Theoretical Study". The Journal ofOrganic Chemistry. 76 (21): 8749–8755. doi:10.1021/jo201439u. PMID 21932799
[8] Fadia Al-Haj Hussien1, Mohammad Keshe1, KhaledAlzobar1,Joumaa Merza1 and Ayman Karam2, Synthesis and Nitration of 7-Hydroxy-4-Methyl Coumarin via Pechmann Condensation Using Eco-Friendly Medias International Letters ofChemistry, Physics and Astronomy *(2016-08-12) ISSN: 2299-3843, Vol. 69, pp 66-73
[9] MuchchintalaMaheswaraVidavalur ,SiddaiahGuri Lakishmi,VasanthaDamuYerra ,KoteswaraRaoChunduri ,VenkataRao ,A solvent-free synthesis of coumarins via Pechmann condensationusing heterogeneous catalyst, Journal of Molecular CatalysisVolume 255, Issues 1–2, 1 August 2006, Pages 49-52
[10] Nader Ghaffari Khaligh, Synthesis of coumarins via Pechmann reaction catalyzed by 3-methyl-1-sulfonic acid imidazoliumhydrogen sulfate as an efficient, halogen-free and reusableacidicionic liquid, ,Journal of Catalysis Science & Technology ,2012, **2**, 1633-1636 ,
[11] Chavan1 and Mohammad A. Baseer ,Comparative study of varioussynthetic methods of 7-hydroxy-4-methyl coumarins via Pechmannreaction Omprakash S., Pelagia Research Library Der ChemicaSinica, 2014, 5(5):67-70
[12] Vahid Vahabi †,* and Farhad Hatamjafari †, Microwave AssistedConvenient One-Pot Synthesis of Coumarin Derivatives viaPechmann Condensation Catalyzed by FeF3 under Solvent-Free Conditions and Antimicrobial Activities of the Products Molecules2014, 19, 13093-13103; doi:10.3390/molecules190913093 ISSN 1420-3049
[13] Abdulkarim M.A. Al- Kadasi and G.M. Wazeruddin, Int.J.Chem.Sci .2012, 10 (1), 324-330
[14] Paramgeet Kaur Monga , Dibak Sharma , AheetL bhasin andArtidubey,Environmentally Positive and energy proficientsynthesisof coumarin by Pechmann reaction via Microwaveirradiation , Indian journal of chemical technology VOL. -42, Jouly 2027 pp.447-451
[15] F. Matloubi Moghaddam1; , Z. Mirjafary1 and H. Saeidian1, Microwave-Assisted Synthesis of 3-Substituted Coumarins UsingZrOCl2.8H2O as an Eective Catalyst, Transactions C: Chemistryand Chemical Engineering, Vol. 16, No. 1, pp. 12-16. June 2009
[16] Thomas Kappe and Erich Zilegler, Organic Preparation andProcedures ,1969, 1 (1), 61-62