Synthesis of 3-Phenyl Coumarins by Using Microwave Chemistry as a green method

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ABSTRACT:
Green Chemistry means design chemical processes to reduce generation of waste that effect on environment. We have to design methods which follows 12 Principles of green chemistry. Coumarins occupy an important place in the realm of natural products and synthetic organic chemistry. A highly efficient green process for synthesis of 3-Phenyl Coumarins from salicylaldehydes and phenyl acetyl chlorides in presence of *N*-Methyl imidazole as green solvent & catalyst using microwave chemistry was developed and prepared various derivatives. The method is simple giving high yield of pure product and recycle all reagents.

KEYWORDS:
Salicylaldehyde, *N*-Methyl imidazole, Phenyl acetyl chloride, Sodium Hydroxide, Bromine, Chlorine, Acetic acid, Calcium Nitrate tetra hydrate, Microwave oven CATA 2R Model, Ethyl alcohol, Isopropyl alcohol and Ethyl acetate.

INTRODUCTION:
Green Chemistry is also called as sustainable chemistry, is an umbrella concepts adopt to avoid hazardous reagents and chemicals that are harmful to environment and all humans, plants and surrounding. All world knows chemistry is everywhere but in the production of various substances the generation of waste at every steps. Industries makes our life luxurious and comfortable but these industries having potential to damage our environment. Thus at every steps there is need to use non-hazardous substances, simple design process, low temperatures and pressures. The use of green concepts to decrease environmental pollution, use of biodegradable raw materials, avoid waste generation. Green Chemistry addresses not only safety but also development of technology to ensure that the chemical reaction produce less waste, use of renewable sources and maximum atom economy. Increased local and global concern for environmental pollution offers incentive to explore new green materials for safeguarding the environment. Due to pollution increase in greenhouse gases, acid rain, depletion of ozone layer and global warming. Thus adopt and use of greener methods to save our environment and planet is very most important. There are various green methods used such as use of Phase transfer catalysts, universal solvent as water, carry reaction at ambient temperature and pressure, ionic liquids, microwave oven chemistry, ultrasonic bath. Out of these methods microwave chemistry is fast, energy efficient and highly convenient to synthesis of molecules.

Coumarins are aromatic heterocyclic compounds possessing wide variety of biological activities such as antimicrobial, anti HIV, anticoagulants, antihyper proliferative, antitubercular, antihistamic, anti-inflammatory, rodenticides, optical brightening agents etc. The 3-Phenyl Coumarin derivatives are very important. Microwave chemistry is science in which microwave radiations are used to enhance chemical reaction. In microwave, high frequency electric fields are used to heat the objects. Microwave radiations heat the target compound without heating the entire body of object. That will heat the compound throughout their volume, which saves a time and energy by applying more uniform heating. In conventional heating involves the use of mantles, oil baths or hot plates, which first heat the wall of reactor and then target compound by heat of conduction. This will take more and longer time to achieve target temperature. These are the benefits of microwave heating over other tools. In sonochemistry, molecules undergo excitation with electromagnetic radiation, this effect was utilized in home microwave oven to heat foods. In literatures there are use of household microwave oven to enhance large number of reactions. In microwave oven, radiational energy is converted to heat energy to result superheating of object. The reaction which take place several hours in conventional methods is completed in few minutes. Microwave oven chemistry used to carry out many

reactions to heat efficiently, accelerate reaction rates, improve yield, purity and selectivity, which leads to achieve green processes. In the experiment use of CATA 2 R Microwave oven to carry out reactions.

EXPERIMENTAL PROCESS:

In 50 mL microwave reactor was fitted with heating, magnetic stirring, temperature and time programmer setting with reflux mode condenser arrangement. Reaction conditions were optimized for higher yields. Charge salicylaldehyde, *N*-Methyl imidazole and stirred to make a homogeneous mass. Add phenyl acetyl chloride, the exotherm was observed and temperature reaches to 40 ^{0}C. Run the reaction at 420 watt for 10 minutes. Cool reaction mass to room temperature add dilute cold hydrochloric acid under stirring, decant the aqueous layer which contains *N*-Methyl imidazolium chloride. The *N*-Methyl imidazolium Chloride is a valuable ionic liquids and can be separated with market value. Residue remained in RBF was crystallize in 80 % ethanol. Filter mass under vacuum and dried in oven. The Product was characterized by MP. IR., NMR. By using above methods, we prepared substituted 3- Phenyl coumarins and details will be given table 2. To the aqueous layer sodium hydroxide was added and organic layer was separated and dried by adding sodium sulphate. Organic layer was distilled under vacuum to get *N*-Methyl imidazole which was used in next reaction. The microwave power and watt relation given below in table 1.

Table 1:

Sr. No.	% Power	Watt
1	20	140
2	30	210
3	35	245
4	40	280
5	50	350
6	60	420
7	65	455
8	70	490
9	80	560
10	100	700

PROCESS FOR SYNTHESIS OF CHLORIDES:

1] In a 1 lit RBF, with heating, stirring, addition funnel and thermometer pocket arrangement add phenyl acetic acid (136 gms) and toluene (250 ml) at room temperature under well stirring, till phenyl acetic acid dissolves completely.

2] Add thionyl chloride (140 gms) through addition funnel at room temperature under good mixing and it is completed in 1hr.Add 1gm of DMF in the reaction mixture.

3] Maintain temperature - 40 ^{0}C for 1 Hr., 60 ^{0}C for 1 Hr., 80 ^{0}C for 1 Hr .with fast stirring.

4] Arrange distillation set up to recover solvent Toluene at atmospheric temperature.

5] Cool to 80 ^{0} C, set up Cow Head with three receivers and apply vacuum to remove mixed low boiling fraction.

6] By changing receiver position remove mixed fraction and main fraction in third receiver without break of vacuum.

7] Packed in clean, dry and air tight container under nitrogen blanketing. Store in Freeze. By using same process prepare various chlorides with substituted phenyl acetic acids.

PROCESS FOR SYNTHESIS OF SALICYLADEHYDES**:**

5- Chloro Salicylaldehyde-

In a RBF with heating, stirring and reflux mode set up. Charge salicylaldehyde and purged chlorine gas for 30 minutes using methyl chloride as a solvent. The reaction mass was heat to recover solvent and solid remains crystallize in isopropyl alcohol

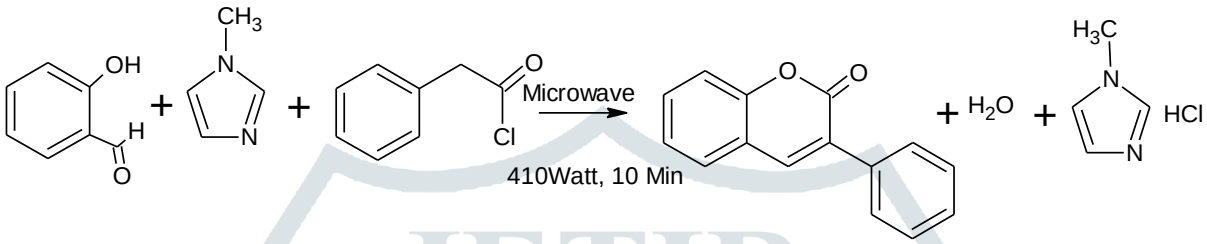
5- Bromo Salicylaldehyde-

In a RBF with heating, stirring and reflux mode set up. Charge salicylaldehyde and bromine using methyl chloride as a solvent. The reaction mass was heat to reflux for 1 hour, recover solvent and solid remains crystallize in ethyl alcohol.

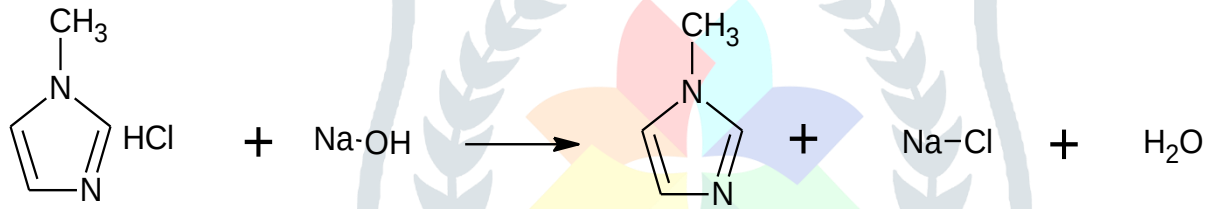
5- Nitro Salicylaldehyde-

In a RBF with heating, stirring and reflux mode set up. Charge salicylaldehyde, acetic acid and calcium nitrate tetra hydrate and reaction mass heat to reflux for 3 hours cool and pour in ice cold water and crystallize in ethyl acetate.

Reaction Scheme:



Scheme 1. Preparation of 3-Phenyl Coumarins.



Scheme 2. Recovery of ionic liquid precursor.

The aqueous layer collected after the separation of 3 - Phenyl Coumarin was treated with NaOH to deprotonate *N*-Methyl imidazolium chloride formed during the reaction. The separated *N*-Methyl Imidazole is dehydrate by treating with anhydrous Na_2SO_4 and separate by using separator. The separated *N*-Methyl imidazole vacuum distil to get pure *N*-Methyl Imidazole, having purity above 99.00 %, checked by GC. The *N*-Methyl Imidazole chloride formed during the reaction of 3- Phenyl Coumarin is a valuable by-product. The formed ionic liquid that is *N*-Methyl imidazolium chloride having better purity and market value. By using above basic reaction scheme prepared various substitute by same process only change of reagents. The product was characterized by IR, GC, and melting point.

Table 2:

Sr.No.	Substrate 1	Substrate 2	Product	TimeMints	Yield (%)	M.P. (°C)
1	Salicylaldehyde	Phenyl acetyl chloride	3-phenyl Coumarin	10	99	140
2	5-Nitro Salicylaldehyde	4-Methoxy phenyl acetyl chloride	6-Nitro-3-[4-methoxy]phenyl Coumarin	10	59	137-140
3	5-Bromo Salicylaldehyde	Phenyl acetyl chloride	6-Bromo-3-phenyl Coumarin	10	31.1	184-187
4	5-Chloro Salicylaldehyde	4-Methoxy phenyl acetyl chloride	6-Chloro-3- [4-Methoxy]phenyl Coumarin	10	40	193-194
5	Salicylaldehyde	4-Methoxy phenyl acetyl chloride	3-[4-Methoxy]phenyl Coumarin	10	59.2	145

6	5-Chloro Salicylaldehyde	4-Methoxy phenyl acetyl chloride	6-Chloro- 3- [4-Methoxy]phenyl Coumarin	10	65	199-202
7	5-Nitro Salicylaldehyde	Phenyl acetyl chloride	6-Nitro-3-phenyl Coumarin	10	68.5	121-123
8	Salicylaldehyde	4-Nitro phenyl acetyl chloride	3-(4-Nitro-Phenyl) Coumarin	10	35	188-190
9	5-Bromo Salicylaldehyde	4-Methoxy phenyl acetyl chloride	6-Bromo- 3- [4-Methoxy] phenyl Coumarin	10	60	206-208

CONCLUSION:

The method developed for the synthesis of 3- phenyl coumarin and its derivatives is simple, one pot reaction and adheres to the rules of Green Chemistry. The yield of 3- phenyl coumarin prepared by this method is 99 % which was good comparative to the previously reported methods. The product can be easily purified by crystallisation alone without the use of any costly separation techniques. The product isolated was characterized by GC, IR, MP and NMR.

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REFERENCES:

1. Yadav G. D. Design of Benign and Efficious Chemicals for Agro, Pharma, Dyestuff and Speciality Sectors through Green chemistry and Engineering. FICCI conference, Mumbai, November 2004.
2. D.Katkar & S.Sonawale, Research Journal of Chemical and Environmental Sciences Res J. Chem. Environ. Sci. Vol 4 June 2016: 64- 67.
3. Kennedy R. O.; Thurnes R. D.; Coumarins, biology, applications and mode of action, Wiley & Sons, Chichester, 1997.
4. Shubashini K S, Kandasamy L. Syn Comm Vol.34, No 17, PP. 3129-3134,2004.. Shubashini K S, Kandasamy Int. Journ. Of Org. Chemistry, 2013, 3, 42-47.
5. Sethna S. M.; Shah N. M.; Chemical Review 36 (1945), 1.
6. Donnelly B. J.; Donnelly D. M. X.; Sullivan, O; Tetrahedron, 24(6), 1968, 2617.
7. J. H. Clark, Green Chemistry, 1999, 1, 1.
8. www.epa.gov/dfe/greenchem.
9. T. J. Collins, Green Chemistry.
10. C. Starks, J. Amer. Chem. Soc.1971, 93 [1], 95199.
11. D. Katkar & S. Sonawale, International Journal of Scientific Research in Science & Technology, January-February-2018 [(4) 2: 924-927].
12. Basil- BASF Processes Based On Ionic Liquids, By Dr. Matthias Maase, Dr. Vagt, Chemfiles Vol. 5, and Article 6.