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ZINC OXIDE CATALYZED, ENVIRONMENTALLY BENIGN PROTOCOL FOR THE SYNTHESIS OF SUBSTITUTED CARBOXYLIC ACID

Majid Shaikh[a], Mujahed Shaikh[a] , Devendra Wagare[b], Sayyad Sultan Kasim*[a]

*[*a] Maulana Azad College, Aurangabad 431001 Maharashtra, India*
[b]Department of chemistry, Vivekanand college, Aurangabad (M.S.), India
Email Id (Corresponding author):1) sayyadsultankasim@gmail.com
2) majid.orchid@rediffmail.com

Abstract:
Carboxylic acid act as a versatile precursor to synthesized biologically valuable molecule like amide, acid chloride and many more. Hence, we have developed convenient method to synthesized substituted carboxylic acid. The previous synthetic method found limitations regarding the use of hazardous solvent, tedious work-up, slow and moderate product yields. To over come, these lacunas herein we have developed a facial and highly efficient synthetic protocol for the synthesis of carboxylic acids from the reaction of substituted aldehydes and hydrogen peroxide (70%) with zinc oxide (10% mol) as a catalyst and in onion extract. Reported method is better substitute for the existing previous methods because it has many advantages such as easy work-up, reduces the reaction time in just 1-2 hours with excellent yield and most important the Zinc oxide easily removed with filtration.

Keywords: Environmentally, zinc oxide, hydrogen peroxide, carboxylic acids, catalyst, onion extract.

Introduction:

In malevolence of the escalating awareness of the necessity for 'green chemistry', many researchers still use environmentally hateful reagents or pointlessly complicated circumstances for the oxidation of aldehyde (I-V). To synthesized biologically active compounds, carboxylic acid acts as key precursor moreover, carboxylic acid shows promising medical importance (VI-VIII). Perhaps, there are many methods are reported to prepare carboxylic acids from the oxidation of aldehydes but most of them does not meet the principle of green chemistry. Various oxidising agents are poisonous to mankind as well as environment such as KMnO4, K2Cr2O7, H2CrO4, PCC, Dess martin, RuO4 etc.

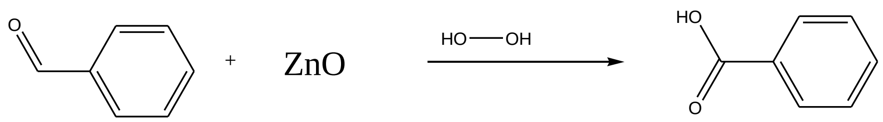
Zinc oxide is a white powder and odourless and also shown that zinc oxide particles disturb bacterial cell membrane integrity (IX-XIII). Decrease cell surface hydro-phobicity and normalize the transcription of oxidative stress conflict genes in bacteria (XIV-XVII). They enhance intracellular bacterial killing by inducing ROS production (XVIII-XXI). Hydrogen peroxide is a mild antiseptic used on the skin to prevent infection of minor cuts, scrapes, and burns (XXII-XXIV) It is used for the treatment of many diseases as a blood purifier, diuretic, antirheumatic and antidote in snakebite (Chopra et al., 1956; Alam et al., 1996). Despite the traditional use of the plant in folk medicine, only a few articles have reported the chemical constituents of the H solubility, acidity, binding by plasma proteins, lethal toxicity, slices of renal cortex, and disposal by the dog kidney (XXV-XXIX). The reactions in green solvents are very important and some of the paper (XXX-XXXVIII) uses PEG-400, Glycerol, and PEG-SO_3 as solvents but the use onion extract is better choice.

In the present study, we have oxidized aldehyde by using 10% zinc oxide as a catalyst with hydrogen peroxide (70%) to carboxylic acid in onion extract under reflux condition.

Onion Extraction:

The Pressure choker with large glass bowl, SS Steamer and small glass bowl was taken. The 100 ml of water was taken into Pressure choker, placed glass bowl. Then the steamer was placed in the glass bowl, Added onion pieces, and covered the onion with large glass bowl. All this moiety was heated up to 30 min and release pressure naturally. The extract obtained was filtrate and it was used as a solvent (XXXIX-XL).

Scheme : Synthesis of Carboxylic Acid



Experimental

Melting point taken in microcontroller based melting point apparatus CL-726 and it was uncorrected. H^1 NMR recorded by Brucker 400 MHz spectrophotometer, IR Spectra was recorded on PerkinElmer; The reaction was monitor by thin layer chromatography.

General procedure for the synthesis of carboxylic acid [6a]:-

To the aldehyde (1 mmol), 70% hydrogen peroxide (3 mmol) was added. This was followed by the addition of zinc oxide (10 mol %) in 5 ml onion extract was refluxed at 90-95^{o}C. The reaction was monitored by thin layer chromatography. The reaction mixture made alkaline with (10%) potassium hydroxide solution in water. Solid obtained was removed by filtration and this filtrate was acidified with (10 %) hydrochloric acid to attained PH 2. The solid obtained was filtered. The solid was dried and recrystallized with proper solvents.

Result and discussion

We have designed a facial, highly efficient and environmentally benign method for the synthesis of carboxylic acid. As we are always work with green solvent [XXV-XXXII] therefore once more we have used green solvent. Initially, we have optimized reaction condition for synthesis of 3a in various solvents. We have observed that the reaction was competently ended in all of solvents listed in table-1 but counter with small yield with more reaction time. We also carried out reaction in PEG-400 and different ratio of PEG-400 with water but we obtained comparatively low yield. Finally, we carried out this reaction in onion extract. We observed better result with onion extract (Table 1, serial no. 7). For that reason, onion extract was the choice of solvent for all further reaction under work.

Table 1 Optimization of the solvent for the synthesis of carboxylic acid (3a):-

Serial No.	Different types of Solvents	Ratio of solvents	Volume in ml	Time in hours	Yield %of product
1	Toluene	-	10	3	61-63
2	Dichloromethane	-	10	3	63-66

3	Ethanol	-	10	3	79-82
4	PEG-400	-	10	3	85-87
5	PEG-400	9:1	10	2.5	88-90
6	PEG-400	8:2	10	2.5	88-90
7	Onion Extract	-	10	2.0	93-95

Aldehyde (1mmol), 70% Hydrogen Peroxide (3mmol), ZnO_2, refluxed at 90-95 °C in onion extract.

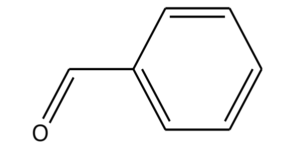
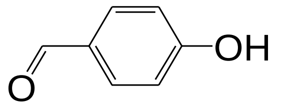
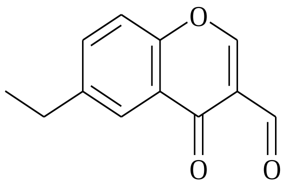
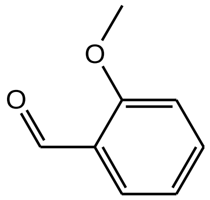
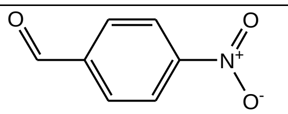
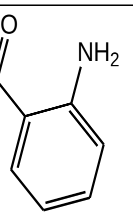
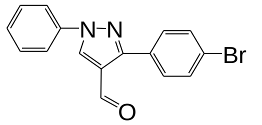
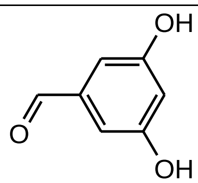
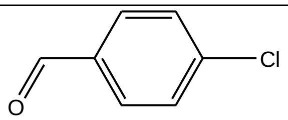
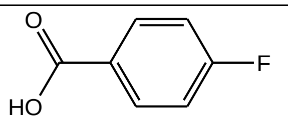
The effect of catalyst addition has strong influence on results i.e. percentage conversion of aldehyde to desired carboxylic acid. The outcome of catalyst addition was shown in table 2. The addition different concentration of catalyst was increases the yield and the highest observed at 10 mol % (Table 2, serial no. 3). While further increase in the concentration i.e. 20 mol % of catalyst was not increase yield of compound.

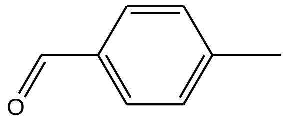
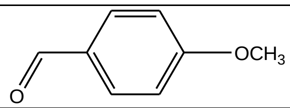
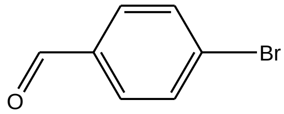
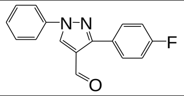
Table 2 Optimization of the solvent for the synthesis of carboxylic acid (3a):-

Serial No.	Concentration of catalyst	Time in hours	Yield %of product
1	2 mol %	3	61-63
2	5 mol %	3	83-85
3	10 mol %	2.0	93-95
4	15 mol %	2.0	93-95
5	20 mol %	2.0	93-95

Here we propose and developed procedure for the synthesis of carboxylic acids by reacting carbaldehyde with 70% hydrogen-peroxide and ZnO (10% mol) in environmentally benign media i.e. in onion extract refluxed at 90-95 °C. The evolution of response was monitored by thin layer chromatography (TLC). The excellent yield for compound 3a was promoted to examine the scope of reaction with different types of aldehyde under optimized circumstances.**(Scheme 1, Table 3)**. The main improvement of this method is that easily available material, cost effective reaction procedure, faster reaction time, environmentally benign reaction media and excellent yield with purity. Zinc oxide is heterogeneous catalyst and hence easily removed in first filtration from reaction mixture.

Table 3 Evaluation of Compounds [3a-l]:-

Compounds	R=	Yield%	Melting Point (ºC)
3a		**90**	**121-123**
3b		**92**	**213-215**
3c		**91**	**131-133**
3d		**91**	**100-102**
3e		**90**	**236-238**
3f		**91**	**186-188**
3g		**92**	**142-144**
3h		**92**	**168-170**
3i		**93**	**275-277**
3j		**93**	**183-185**

3k		**92**	**178-180**
3l		**93**	**183-185**
3m		**93**	**251-253**
3n		**94**	**159-161**

Spectra analysis of some important compounds

4-hydroxybenzoic acid (3b)
H^1 NMR (MHz): 11.82 ppm (s, 1H), 9.98 ppm (S, 1H), 6.85-7.99 ppm (m, 4H).
IR spectra: 3071, 1719.

4-methoxybenzoic acid (3l)
H^1 NMR (MHz): 11.91 ppm (s, 1H), 6.81-8.10 ppm (m, 4H), 4.51 ppm (s, 3H).

4-bromobenzoic acid (3m)
H^1 NMR (MHz): 11.79 ppm (s, 1H), 6.78-8.01 ppm (m, 4H).

4-chlorobenzoic acid (3i)
H^1 NMR (MHz): 11.88 ppm (s, 1H), 6.81-7.86 ppm (m, 4H).

6-ethyl-4-oxo-4H-chromene-3-carboxylic acid (3c)
^1H NMR (MHz): 12.99 ppm (s,1H), 8.79 ppm (s, 1H), 8.08 ppm (s, 1H), 7.75 ppm (dd, 1H), 7.48 ppm (d, 1H), 2.68 ppm (q, 2H), 1.19 (t, 3H).
IR spectra: 3062, 2955, 2919, 2870, 1722, 1624, 1466, 1428, 1299.

Conclusion

We have design the method for oxidation of aldehyde to carboxylic acid by using zinc oxide powder which is used as the catalyst for the oxidation. Here zinc oxide and hydrogen peroxide used for oxidation where zinc oxide was easily remove from first filtration as it is heterogeneous catalyst.

The main advantages of this method are non-volatile organic solvents, to avoid high temperature and toxic solvent. Obtain excellent yield in minimum reaction time and easily available material and also the no additional instrument.

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