ANTIOXIDANT ACTIVITY OF GREENLY SYNTHESIZED PHOTOCHROMIC FULGIDES

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ABSTRACT

One pot synthesis of acid esters by Stobbe condensation of alkylidene / arylidene succinates and aldehydes or ketones, their subsequent hydrolysis to diacids have reported. The Stobbe condensation of various aromatic aldehydes or ketones with dimethyl succinate gives different types of diacids which on further cyclisation with Hexamethylenetetramine gives Fulgides[3a,(E)-3-benzylidene-4-(diphenylmethylene)dihydrofuran-2,5-dione],[3b, (3Z,4E)-3-(hexan-3-ylidene)-4-(1-phenylethylidene)dihydrofuran-2,5-dione], through green approach. The improved yields of Fulgenic acid have observed by the green approach as compared with other classical methods employed so far. The antioxidant activity of anhydride compounds have done by using 2,2 Diphenyl-1- Picryl Hydrazyl(DPPH).

Keywords: Green synthesis, Stobbe condensation, Photochromic Fulgides, aryl aldehydes & ketones and their products

1. Introduction:

The earlier classical method involved use of hazardous solvents like benzene, ether etc for the formation of Fulgenic acid and their anhydride forms[1, 2]. Also classical method consumed more time for the formation of required products.

The present work describes ecofriendly one pot synthesis method for Stobbe condensation in which solvent free condition improves the yield. As compared to classical condensation methods reported previously, in which extensive use of solvents and hazardous chemicals have involved; green method requires fewer amounts of dry solid reagents, for the formation of acid esters. Moreover, heat energy consumption by the reaction is also averted.

Stobbe condensation under solvent free condition using solid potassium tertiary butoxide has done with dimethyl succinate and aromatic, aliphatic[3] aldehyde and ketone which lead to the formation of the acid- esters, which on saponification yielded the corresponding diacids. This green approach not only increases the product's yield, but also maintains & raises its photochromic strength. Fulgenic acids (cyclised forms) are the promising materials[4] in optical memory devices, optical switches and sensors, specially dyes and inks. These are representative class of photochromic organic[5-7]molecules which exhibits several interesting properties for diverse applications in fields such as data storage or high resolution spectroscopy.

The anhydride products have prepared by cyclisation of diacids by using silica and perchloric acid. The antioxidant is a molecule that inhibits oxidation of biomolecule. Oxidation is a chemical reaction that can produce free radicals leading to chain reaction that may damage cells and initiates diseased condition. The term antioxidant mainly used for two different groups of substances, industrial chemicals which have added to products to prevent oxidation and natural chemicals found in food and body tissues which are said to have beneficial health effects. Antioxidants are classified into two broad divisions, depending on whether they are soluble in water (hydrophilic) or in lipids (lipophilic).In general, water soluble antioxidants react with oxidants in the cells cytosol and the blood plasma, while lipid soluble antioxidants protect cell membrane from lipid peroxidation[8]. In present study, we also determined the solubility property of Fulgenic acid esters. The different antioxidants

are present at a wide range of concentration in body fluids and tissues.

2.Materials and Methods (Experimental):

2.1 Reagents

Diethyl succinate, Benzophenone, Benzaldehyde, anhydrous methanol, ethylene dichloride, conc. H_2SO_4, 8% alcoholic KOH, Acetophenone, Hex-3-one have used as raw materials. Petroleum ether, n-Hexane have used for double solvent recrystalisation of the obtained product. All the above solvents have purified by the reported procedures[9].

2.2 Instrumentation:-

The Infrared spectra have obtained on a Bruker Avance 520 Fourier transform Infrared spectrometer using KBr pellets from SAIF Punjab University Chandigarh, India. High resolution ^{1}H-NMR spectra have recorded on a Bruker Avance II 400 MHz spectrometer in D_2O with TMS as an internal standard. Melting points have measured on a digital Electrothermal 9100 Melting Point Apparatus have reported without correction. UV and Visible spectra have measured for a 10^{-4} M in Toluene solution. The pH-metric titrations have conducted in aq. Ethanol (50:50, v/v) on an automatic recording ECIL pH-meter (Model pH 821) having a glass-calomel electrode assembly[10]. Molecular weights of the acidic products have determined by titrimetric method[11] as their equivalent weights. The general procedure for Stobbe condensation and saponification of Stobbe condensation products have similar to those described earlier[12-13]. These general procedures for Stobbe condensation has modified by using green method.

2.3 General experimental procedure (Material synthesis)

A mixture of dimethyl succinate (9.0 g, 0.09 mole) and aldehydes or ketones have added dropwise to a suspension of Hexamethylenetetramine(12.6 g,0.09 mole).The reaction mixture ground in mortar and pestle for 10 minutes and allowed to stand for another 20 minutes. Then 3N HCl has added in small amounts. Alcohol has distilled off under reduced pressure and reaction mixture has extracted with ether at room temperature. Acidic substances have separated by using 10% Na_2CO_3. On further acidification, finally it gives acid ester which has again recrystallized with n-Hexane /Benzene petroleum ether. Further on esterification, with anhydrous CH_3OH, ethylene dichloride and conc.H_2SO_4 at room temperature it gives diester .Once again the diester has mixed with aldehydes or ketones and Hexamethylenetetramine, the same procedure repeated and recrystallization has done with petroleum ether which gives 2nd acid ester.

Finally the obtained 2nd acid ester has saponified with alcoholic KOH at room temperature for 1 hour and followed by acidification and recrystallization which would give a solid crystalline natured diacids (2a, 2b,).Further these diacids undergo cyclisation in presence of silica and perchloric acid (1:1) to give anhydrides (3a, 3b).

3. Results and Discussions:

In this research article, Fulgides have prepared via Stobbe condensation using hexamethylenetetramine through green context. Further these diacids undergo cyclisation in presence of silica and perchloric acid (1:1) to give anhydrides. Stobbe condensation generally involves the use of metal alkoxide as a catalyst in refluxing alcohol, particularly, butanol[14]. On the other hand, instead of butanol, in this research paper Hexamethylenetetramine, has taken for the reaction. The advantages are short reaction time, good yield, less by-products.

The Fulgides (3a, 3b) synthesized using current method is of high purity compared with classical synthesis. The synthesized Fulgides have specific melting and boiling point, NMR peak values. In previous synthetic methods, tremendous heat has used, which leads impure diacids with less percentage yield[15].

The anhydride **(E)-3-benzylidene-4-(diphenylmethylene) dihydrofuran-2,5-dione**(3a) exhibited a molecular formula $C_{24}H_{16}O_3$ showed highest antioxidant activity, due to presence of three phenyl groups. **(Figure1)**.

The anhydride**, (3Z,4E)-3-(hexan-3-ylidene)-4-(1-phenylethylidene)dihydrofuran-2,5-dione** (3b) having molecular formula $C_{18}H_{20}O_3$also showed second highest antioxidant activity. Due to presence of ethyl and propyl groups, its activity gets lower down.**(Figure1)**.

3.1 Reaction Schemes of Experimental Work

The Fulgenic acids (diacids) **2a, 2b** have

prepared by using following schemes:
The synthesis of different substituted Fulgenic acids have possible by stepwise Stobbe condensation (twice) with different aldehydes and ketones through green approach which are given as below.

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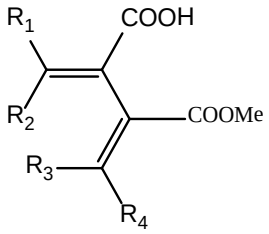
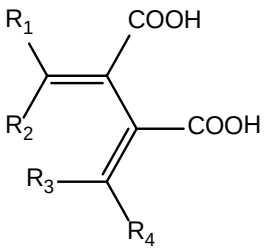
Scheme1



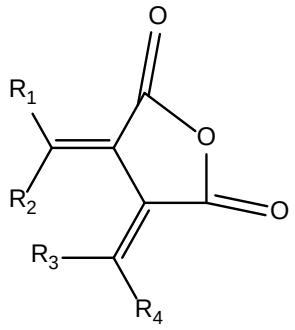
(1)

a)R_1,R_2 = Ph, Ph ; R_3,R_4 = Ph, H
b)R_1,R_2 = Ph,Me ; R_3,R_4= Et,Pr



(2)

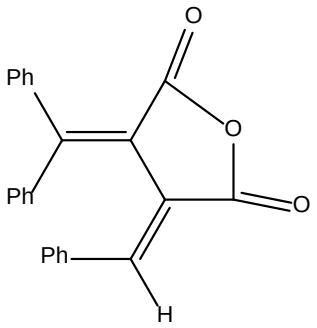
a)R_1,R_2 = Ph, Ph ; R_3,R_4 = Ph, H
b)R_1,R_2 = Ph,Me ; R_3,R_4= Et,Pr



(3)

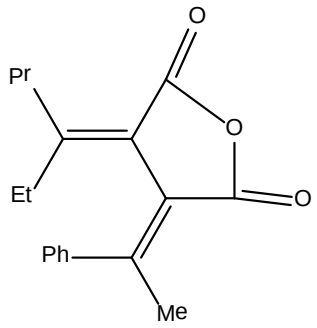
a)R_1,R_2 = Ph, Ph ; R_3,R_4 = Ph, H
b)R_1,R_2 = Ph,Me ; R_3,R_4= Et,Pr

Scheme 2



(3a)

(*E*)-3-benzylidene-4-(diphenylmethylene)dihydrofuran-2,5-dione
Chemical Formula: $C_{24}H_{16}O_3$
Exact Mass: 352.11
Molecular Weight: 352.38
m/z: 352.11 (100.0%), 353.11 (26.1%), 354.12 (3.3%)
Elemental Analysis: C, 81.80; H, 4.58; O, 13.62



(3b)

(3*Z*,4*E*)-3-(hexan-3-ylidene)-4-(1-phenylethylidene)dihydrofuran-2,5-dione
Chemical Formula: $C_{18}H_{20}O_3$
Exact Mass: 284.14
Molecular Weight: 284.35
m/z: 284.14 (100.0%), 285.14 (19.5%), 286.15 (2.5%)
Elemental Analysis: C, 76.03; H, 7.09; O, 16.88

Structures of Fulgides

4. Conclusion:

The greener chemical reaction strategy managed to synthesize Fulgenic acid (2a, 2b) by simple and efficient means with improved yield. The solvent free Stobbe condensation of aromatic aldehydes and aliphatic, aromatic ketones with dimethyl succinate at room temperature occurred smoothly to give substituted acid esters which on further saponification give diacid. These diacids undergo cyclisation in presence of silica and perchloric acid (1:1) to give anhydrides. Organic photochromic compounds such as Fulgenic acids are potential candidates for application in erasable optical information media. This methodology brought down not only the reaction time but also the uses of hazardous organic solvents possible [16]. The prepared anhydrides (3a, 3b) can also be used in the preparation of photosensitive glasses, photosensitive toys and other instruments, Optical data recording like Compact Disc,

preparation of photosensitive inks for security purpose, and variable density filters.

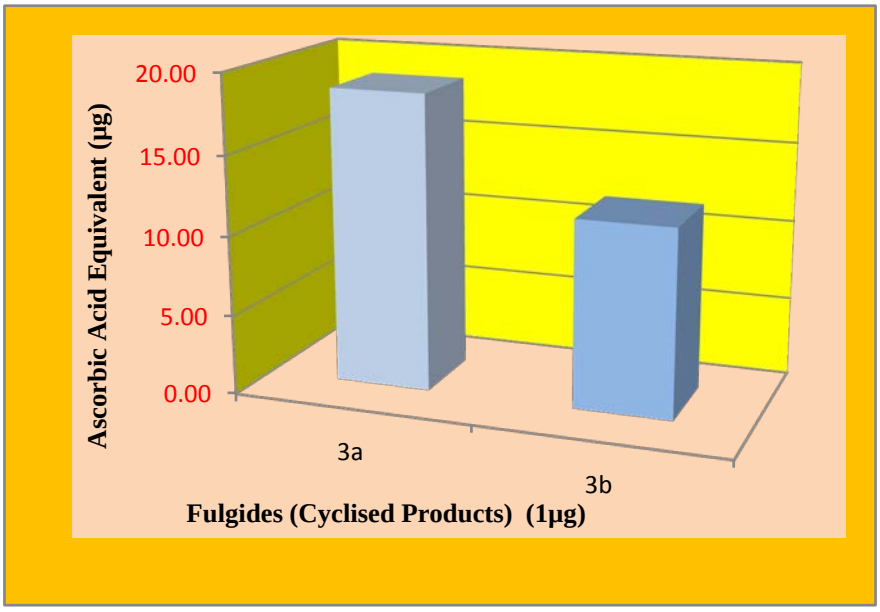
Table 1- Synthesis of Anhydrides (3a-3b) in the presence of $HClO_4$-SiO_2 by reaction of various aldehydes and ketones at room temperature

Entry	R				Products	Yields (%)	Melting Point (°C)	MolecularTi Weight
R1	R2	R3	R4		Classical	Green		(gm)
1Ph , Ph, Ph ,H				(3a)	70.11	92.35336	352.11 120	
2Ph, Me, Et, Pr				(3b)	69.51	94.66364	284.14125	

Table 2- Antioxidant activity of Fulgides (anhydrides) in terms of ascorbic acid equivalent

Compounds Identity	Ascorbic Acid Equivalent (µg)
3a	18.65
3b	14.63

Figure no. 1 Antioxidant activity of Fulgides in terms of ascorbic acid equivalent



Acknowledgements:
The authors are grateful to SAIF Chandigarh, for IR and NMR spectra, NEERI Nagpur for Antioxidant activity, Principal, Hislop College, Nagpur, India for providing research facility.

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