

MICROWAVE ASSISTED ORGANIC SYNTHESIS OF SOME TRADITIONAL AND NAMED REACTIONS: A PRACTICAL APPROACH OF GREEN CHEMISTRY

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Received: 11 Jun 2013, Revised and Accepted: 03 Jul 2013

ABSTRACT

The microwave-assisted organic reactions are proved to be eco-friendly with higher yields. Thus, one-amongst-the accepted fields in the green chemistry. Short reaction time, wide range of reactions, minimum exposure of hazardous chemicals and maximum utilization of energy; these features enables microwave assisted synthesis an effective and handy tool for industry as well as academic research.

Objectives: The main objectives of present study were to review utility of microwave assisted green chemistry synthesis of known and some named reactions viz. Borsche–Drechsel cyclization, benzillic acid rearrangement, Biginelle reaction, pinacol-pinacolone rearrangement, Claisen-Smith condensation reaction and Nientowski quinazoline synthesis, and to establish these reactions by microwave assisted synthesis.

Methods: These named traditional reactions were performed using microwave assisted synthesis on Samsung domestic microwave, 1.2 GHz, at specific power levels and time period, as well as by conventional method of synthesis; the reactions were worked up extensively to obtain a pure form of product which was isolated using usual literature work-up procedures. The products were further recrystallized with suitable solvents. The reactions were monitored with TLC intermittently for microwave assisted synthesis and hourly for conventional method of synthesis.

Results: The work emphasizes on modifications in traditional and named reactions due to microwave assisted green chemical synthesis and its practical utilization. The products were characterized by IR and ¹H-NMR for both methods of synthesis. The products obtained from traditional and named reactions using microwave assisted synthesis complied with spectroscopic assignments as with those obtained from the conventional method of synthesis suggesting the novelty of these modifications by microwave assisted synthesis. Also the time taken by microwave assisted synthesis was shorter with higher yields.

Conclusion: in this paper we have established the methods for synthesis of named reactions viz Borsche–Drechsel cyclization, benzillic acid rearrangement, Biginelle reaction, pinacol-pinacolone rearrangement, Claisen-Smith condensation reaction and Nientowski quinazoline synthesis by microwave assisted synthesis with short time of synthesis and practical green chemistry approach.

Keywords: Microwave assisted chemical synthesis, Borsche–Drechsel cyclization, Phenytoin, Quinazolinone, Biginelli reaction.

INTRODUCTION

Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous materials. One of the principles of green chemistry involves use of microwave to carry out the reaction [1]. Microwave assisted organic reactions are of great interest because of its advantages. Main objectives of this research study were to modify the basic reactions like Borsche–Drechsel cyclization [2], Benzillic acid rearrangement [3], Biginelle reaction [4], Claisen-Smith condensation [5] of Pyrazoline Cyclization [6], Nimentowski reaction [7] etc. using microwave synthesis, following the green chemistry approach. Further, to synthesize and characterize these synthesized products and their comparison with the products obtained from the conventional reactions using IR and ¹H-NMR.

MATERIAL AND METHODS

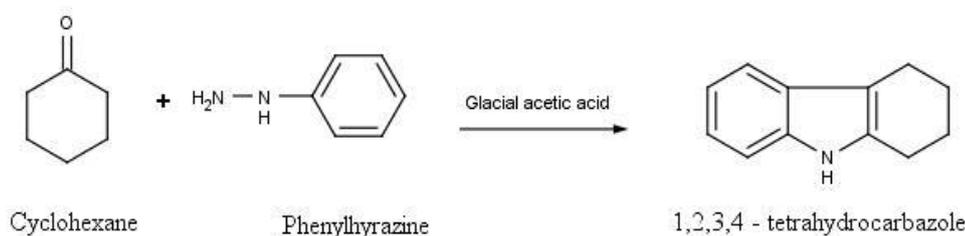
All reagent used were of synthetic grade. Melting points were recorded by open capillary method and are uncorrected. Experiments were performed using Samsung domestic microwave oven with maximum output power of 1.2 GHz, and 160, 240, 320 and 840 watt power levels. Comparatively the reactions were

performed using conventional methods of synthesis using reflux condenser. The reactions were monitored with Silica Gel GF₂₅₄ pre-coated aluminum TLC sheets intermittently for the MWI assisted synthesis and at specific hours for conventional synthesis. The time for the conventional and microwave assisted synthesis were noted. IR was recorded on the Shimadzu IR Affinity-1 spectrophotometer, ¹H-NMRs were recorded on Varian mercury 300 MHz spectrometer.

Synthesis of Tetrahydrocarbazole (Borsche–Drechsel cyclization)[2]

A. MWI assisted reaction: In 250 ml RBF, mixture of equimolar quantities of cyclohexanone and redistilled phenyl hydrazine was placed with few drops of glacial acetic acid, then subjected to microwave at 2 level(320 w) for 10 min. then the reaction mixture was cooled to 5°C. The above mixture was filtered at pump and the filtered solid was washed with cold water. M.pt: 115-116°C. Recrystallized from methanol. IR (KBr, cm⁻¹): 3268 (CH st), 1480 (CH ben), 3325 (NH str.), ¹H-NMR (δ,ppm) : 7.99 (NH amine)

B. Conventional Synthesis: Approximately 2 hours of reflux followed by procedure remaining same from cooling at 5°C.

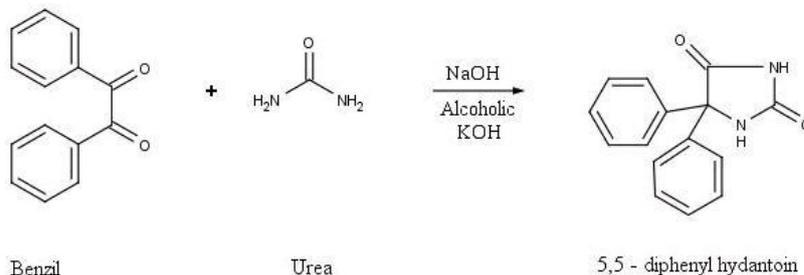


Scheme-I

Synthesis of Phenytoin (Benzilic acid rearrangement)[3]

The reaction is depicted in Scheme-II

A. Microwave assisted reaction: In a 250 ml RBF, a mixture 2.0 gms of benzil and 1.13 gms of urea were taken in ethanol, to it was 30 % NaOH solution was added and the reaction was subjected to microwave at 160 watts for 30 min, Intermittently TLCs were recorded. Reaction mixture

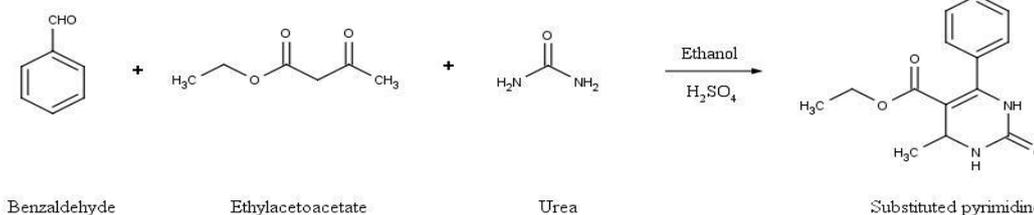


Scheme-II

Synthesis of tetrahydro pyrimidine (Bignelli Condensation)[4]

The reaction is depicted in Scheme-III

A. Microwave assisted reaction: In a 250ml RBF, an equimolar mixture of aromatic aldehyde, ethylacetoacetate and urea were taken. To this few drops of concentrated Hydrochloric acid is added as catalyst. The reaction was subjected to microwave at 180 watts and monitored on TLC intermittently for 30

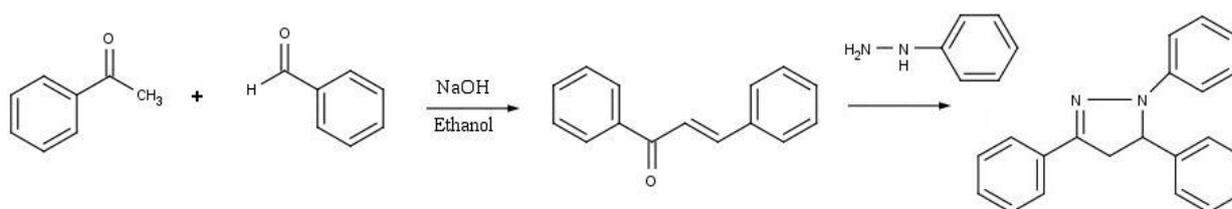


Scheme-III

Synthesis of Pyrazoline by Claisen-smith reaction [6]

The reaction is depicted in Scheme-IV

A. Microwave assisted reaction: Step-2: Synthesis of pyrazoline: Collected chalcone was dissolved in 25 ml of ethanol. 1.8 gm of phenyl hydrazine was added drop wise into mixture. Above subjected to MWI at 320 watts for 30 min. Then above mixture was



Scheme-IV

Synthesis of 3H-Quinazolin-4-one by Nimentowski reaction [7]

The reaction is depicted in Scheme-V

A. Microwave assisted reaction: In 100 ml of two necked RBF, 5gm (0.033 mole) of methyl anthranilate & 15 ml of formamide were mixed. And subjected to MWI at 350W 40 min & reaction mixture was allowed to cool at room temperature & then poured on ice water, the solid separate out was filtered & dried. The crude product

was rendered acidic with conc. HCl. The product obtained was separated by filtration at the pump washed with alcohol. M.pt: 296-98°C. IR (KBr, cm^{-1}): 3250 (CH str.), 1680 (C=O), 1480 (CH ben), 3325 (NH str.), $^1\text{H-NMR}$ (δ ,ppm): 7.19 (CH aromatic), 7.34 (CH aromatic), 7.58 (CH aromatic), 7.67 (CH aromatic), 8.35 (NH amine)

B. Conventional synthesis: Approximately 3hrs of reflux is required to obtain the product using the equimolar quantities.

seconds.[5] After 30 seconds, the product was washed with ethyl acetate and alcohol to obtain pure compound. Further recrystallized from ethanol. M.pt:202-205°C. IR (KBr, cm^{-1}): 3250 (CH str.), 1680 (C=O), 3325 (NH str.), 1480 (CH ben), $^1\text{H-NMR}$ (δ ,ppm): 7.34 (CH aromatic 1H), 7.38 (CH aromatic 1H), 6.82 (CH_3 3H), 8.35 (NH amine)

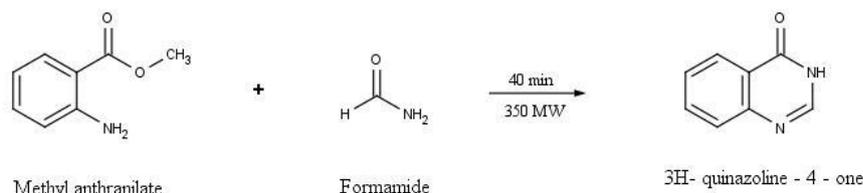
B. Conventional synthesis: Approximately 6 hrs of reflux is required to obtain product by using equimolar quantities.

cooled to room temperature which results in precipitation of pyrazoline. Crude product was recrystallized from ethanol & then characterized. IR (KBr, cm^{-1}): 3250 (CH str.), 1480 (CH ben), 3325 (NH str.), $^1\text{H-NMR}$ (δ ,ppm): 7.88 (CH aromatic), 7.56 (CH aromatic), 8.07 (CH aromatic)

B. Conventional synthesis: Approximately 6 hours of reflux is required to obtain final product using equimolar quantities.

on crystallization from methanol- dimethyl formamid mixture yielded requisite 3H- Quinazolinone-4-one.IR (KBr, cm^{-1}): 3250 (CH str.), 1480 (CH benzene), 3325 (NH str.), 1680 (C=O), $^1\text{H-NMR}$ (δ ,ppm): 7.27 (CH pyrimidine), 7.5 (CH aromatic), 7.83 (CH aromatic), 8.33 (NH amine)

B. Conventional Synthesis: It takes approximately 8 hrs to obtain final product using above described quantities of the reagents.



Scheme-V

Table 1: Comparison of the Time taken by Microwave Irradiation and time taken by Conventional Synthesis

Name of compound	% yield From MWI	Time taken by Conventional Synthesis in hours	Time taken by MWI in minutes
1,2,3,4-tetracarbazole	95.6	2	10
Phenytoin	79.16	3	30
Tetra hydro pyrimidine	85.71	6	≤ 1
Pyrazoline	83.66	6	30
3H-quinazolin-4-one	91.02	8	40

RESULT AND DISCUSSION

Table 1 shows comparison of the time taken by microwave assisted synthesis and also by MWI, the compounds were obtained in good yields also the compounds were compared for spectral characterization.

IR spectra: These complied with functional group assignments for the microwave assisted synthesis products and conventional synthesis products.

¹H-NMR: The obtained from the microwave assisted synthesis complied with those obtained from the conventional method of synthesis.

CONCLUSION

Microwave assisted synthesis is faster, better and safer green chemistry approach for the traditional and applied named reactions. The time take for the synthesis is drastically reduced by the microwave assisted synthesis. Several named reactions were carried out using microwave assisted synthesis, which complied in spectral

assignments as that of those with products obtained from the conventional methods.

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