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Review Article

Convenient approach for the preparation of various organic compounds using microwave technology

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Abstract

Heterocyclic compounds have been recognized as the prospective entities in the mostly rising chemical world of organic compounds having promising and almost all types pharmacologically, chemically as well as useful agrochemicals activities. These Heterocyclic organic compounds are synthesized by using different type of synthetic routes those permit different extents of diverse pharmacological activities. The information of different type of synthetic processes and the different physicochemical factors for synthesizing of various organic heterocyclic compounds and draws the remarkable attention of chemists or researcher to produce combinatorial library and carry out comprehensive efforts in the explore of new and leads molecules. This review provided outlook of the synthesis of some heterocyclic compounds using microwave technology and compared with conventional synthetic methods.

1. Introduction

As the population raises and health troubles also increases and requirement to investigate new drugs development is more desire. The designing of drugs recommends some of the utmost hopes for achievement in current and future period. The heterocyclic organic compounds are extensively disseminated in natural and synthetic medicinal chemistry and are vital for human life. There are various biologically active organic compounds are clinically active and several of which are in usual clinical practices [1]. The trial approaches towards effectiveness and focus on the search of optimized compounds have become greatly significant. Arrival of microwaves (MWs), the magnetron an unexpected appliance for forming fixed-frequency MWs, was considered by Randall and Booth [2].

A magnetron is a vacuum appliance which changes direct current (DC) electricity into MWs. It was acknowledged that MWs could heat water in a impressive manner and used as household and profit-making electrical device for cooking and heating of food materials starting to come out in the 1950s. In 1955, first MW oven was initiated but the extensive use of domestic MW ovens arises in 1970s and 1980s. The initial purpose of MW irradiation in synthesis of chemical compounds preparation was accounted in 1986 [3]. A MW is an electro-magnetic energy that cascade at the lesser frequency end of the electro-magnetic spectrum (300-300000 MHz). Microwave (MW) heating (dielectric) is well-organized procedure due to the MW couple straightly with the compounds that are exist in the reaction mixture, most important to a fast increase in temperature, quicker reactions and clean chemistry. The two elementary methods for transferring energy from MWs to the material are ionic conduction and dipole rotation. The dipole rotation is a dealing in which polar compounds try to line up themselves with the quickly altering electric field of the MW. Ionic conduction method consists in the direct super heating of the ionic compound due to ionic motion produced by the electric field [4]. When the temperature rises, the transfer of energy develops into more capable. As their ionic nature, ionic liquids absorb MW irradiation exceptionally well and convey energy rapidly by ionic conduction [5].

Organic chemistry laboratories are using huge extents of toxic chemicals and solvents to carry out reactions

revealing scientist, chemist, researcher and scholars and atmosphere to the associated hazards. The majority of the labs take up a micro scale method using small quantities of reactants to reduce the pollutions and wastes. By commencement of green chemistry, main beliefs it can provide an optimistic point about what chemists are doing for the atmosphere and introduced them to this promising area of chemicals research. The purposes of MW irradiation is to offer simple, economic, clean, ecological friendly, improved reaction rate and enhanced products formation in chemical synthesis.

Microwave (MW) irradiation method is providing fairly booming in the development of a diversity of hetero organic compounds. It is a process for the synthesis of various organic compounds. It is an essential tool in the directions of green chemistry, which is well- known as an existing guide in preparation of various organic compounds. The conventional methods of synthesis require more heating time, complicated and tiresome equipment set-up, which outcome in more cost and also cause ecological pollution. The modern transform taken place to make standard chemistry tests, eco-friendly and with growing alertness about green chemistry, developed simple methods for synthesis of various organic compound using MW oven as a heating resource [6]. Heterocyclic organic compounds have been created as the prospective entities in the principally rising chemical world of chemical compounds having capable biological activities. Various types of heterocyclic compounds can be prepared by different synthetic routes, with diverse pharmacological activities. In future the heterocyclic moieties and its derivatives have drawn a special attention of medicinal chemists to formed various scaffolds with potent biological activities and also as a lead pharmacophore of various organic compounds and useful for clinical investigations. Heterocyclic compounds have attracted great attention in medicinal field due to its diversified pharmacological effectiveness such as anti-microbial, anti-fungal, anti- tubercular, antiviral, anti-oxidant, local anaesthetic, 5-HT receptor antagonist, immunomodulatory, anti-inflammatory, analgesic, anti cancer, anti- convulsant, anti-allergy, phosphodiesterase (PDE) inhibitors and many more other activities [7- 10].

2. Synthesis of some organic compounds

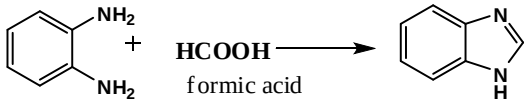
Microwave (MW) tempted organic reactions development is a easy, fast, clean, competent and profitable process for the preparation of a huge number of organic compounds. The MW irradiation methods have materialized as a device towards green chemistry, which is recognized as a modern guide in organic compounds synthetic chemistry. The utilization of MW irradiation in organic compounds preparation has become progressively more accepted within the research and educational or academic fields, since it is a latest enable technology for new drug synthesis, innovation and progress. The aim of this technology for the development of new techniques for quick and eco-friendly preparations and also initiates values of green chemistry.

Preparation of various organic compounds, which are generally used in organic chemistry practicals were conducted by using MW method [6]. The synthesis of heterocyclic organic compounds such as phenytoin, phthalimide, 2,3-diphenyl quinoxaline, benzimidazole, fluorescein and some use other organic compounds such as benzocaine, benzophenoneoxime, diethyl fumarate, and sulfacetamide by using MW oven method. These synthesis were carried out both by conventional and MW irradiation methods. The yields of final products, reaction time period and quality of final compounds were evaluated [11-15].

2.1 Synthesis of heterocyclic organic compounds using Microwave:

Benzimidazole:

Taken 5 gm of o-phenylenediamine and 3.25 ml of formic acid in a flask. A funnel was positioned above the flask to evade too much evaporation. The reaction material was irradiated with MW at 60% (540 W) strength for 1 minute 10 seconds. Water containing beaker was located in the oven then to reaction vessel to use as a heating sink. Then reaction mixture was iced at room temperature, the solution was neutralized with 10 % sodium hydroxide solution. The compound was separated, filtered off and dried. Re-crystallized the final products with distilled water.

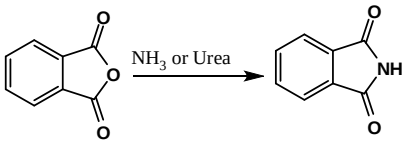


o-phenylene diamine benzimidazole

Phthalimide:

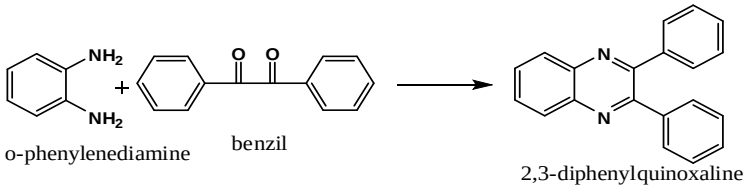
Taken 25 gm of phthalic anhydride and 30 ml of concentrated ammonia solution in a flask. A funnel was positioned above the flask to evade too much evaporation. The reaction material was irradiated with MW at 60% (540 W) strength for half minute. Water containing beaker was located in the oven after that to reaction vessel to use as a

warming sink. The reaction mixture was iced at room temperature. The compound was separated, filtered off, dried and re-crystallized with ethyl alcohol.



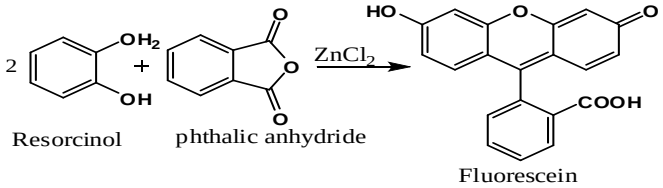
2,3-Diphenyl quinoxaline:

Taken 2.1 gm of benzil, 1.1 gm of o-phenylinediamine and 16 ml of ethyl alcohol in a flask. A funnel was positioned above the flask to evade too much evaporation. The reaction material was irradiated with MW at 60% (540 W) strength for about 1 minute. Water containing beaker was located in the oven after that to reaction vessel to use as a warming sink. The reaction mixture was iced at room temperature and compound was separated, filtered off and re-crystallized with ethyl alcohol.



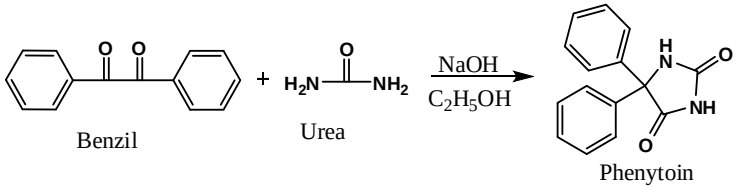
Fluorescein:

Taken 7.5 gm of phthalic anhydride and 11 gm of resorcinol in a flask. A funnel was positioned above the flask to evade too much evaporation. The reaction material was irradiated with MW at 60% (540 W) strength for 3 minute. Water containing beaker was positioned in the oven after that to reaction vessel to use as a warming sink. The reaction mixture was iced at room temperature. Acidified the compound with 50 ml of dilute hydrochloric acid and shaking for 15 minutes. The compound was separated, filtered off, dried and re-crystallized with ethyl alcohol.



Phenytoin:

Taken 2.65 gm of benzil, 15 gm of urea, 7.5 ml of 30% sodium hydroxide solution and 37.5 ml of ethyl alcohol in a flask. Mixed all reactants and a funnel was positioned above the flask to evade too much evaporation. The reaction material was irradiated with MW 60% (540 W) intensity for 150 seconds (2.5 min). A water containing beaker was positioned in the oven after that to reaction vessel to use as a warming sink. The reaction mixture was iced at room temperature. The crude compounds was obtained when the reaction material was poured into about 100 ml of distilled water and stirred carefully. The reaction solution was acidic with concentrated hydrochloric acid and precipitatied phenytoin was formed and chilled for entire precipitate. The separated compound was filtered off, dried and re-crystallized with ethyl alcohol.



2.2 Synthesis of some organic compounds using Microwave:

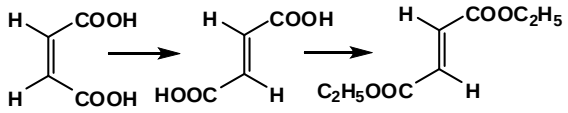
Fumaric acid:

Taken 10 gm of maleic acid in 10 ml of warm water and concentrated 20 ml hydrochloric acid in a flask. After enclosing with a funnel, the reaction material was irradiated with MW at 60% (540 W) strength for 20 seconds. Water containing beaker was located in the oven after that to reaction vessel to use as a warming sink. The compound was obtained and iced at room temperature. The crude compound was formed, filtered off, dried and then re- crystallized

with 0.1M hydrochloric acid.

Diethyl fumarate:

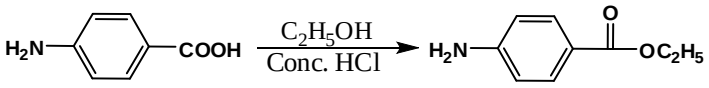
Taken 7 gm of fumaric acid, 15 ml of absolute ethyl alcohol and 22 ml of benzene in a flask, and added 2-3 drops of concentrated H2SO4 with regular stirring. After enclosing with a funnel, the reaction material was irradiated with MW at 60% (540 W) strength for 2 minute. Water containing beaker water was located in the oven subsequently to reaction vessel to use as a warming sink. The reaction material was cooled, crude product was obtained, and benzene layer was separated off. Crude product was washed with sodium carbonate solution. The reaction was evaporated to remove excess solvent from product and get diethyl fumarate



Maleic acid Fumaric acid Diethylfumarate

Benzocaine:

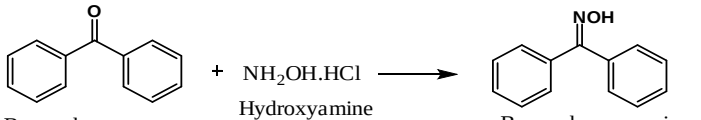
Taken 3 gm of p-amino benzoic acid, 20 ml of ethyl alcohol and 2 ml of concentrated hydrochloric acid in a flask. After enclosing with a funnel, the reaction material was irradiated with MW at 60% (540 W) strength for 60 seconds. Water containing beaker was located in the oven after that to reaction vessel to use as a warming sink. After that the reaction material was iced at room temperature and the crude compound was poured into the chilled water, and dissolved in sodium carbonate to neutralize the compound, filtered off, washed with water, dried and re-crystallized with ethyl alcohol.



p-Amino benzoic acid benzocain

Benzophenoneoxime:

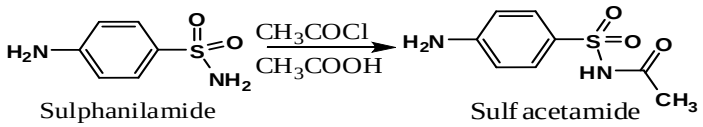
Taken 4 gm of benzophenone, 2.4 gm of hydroxylamine hydrochloride, 15 ml of ethyl alcohol and 3 ml of distilled water in a flask. After enclosing with a funnel, the reaction material was irradiated by using MW at 60% (540 W) strength for 30 second. Water containing beaker was located in the oven after that to reaction vessel to supply as a heating sink. The reaction product was iced and un-reacted benzophenone was filter off. The filtrate was acidified with 35 ml of dilute hydrochloric acid and precipitated products was filtered off, washed with cold water and re-crystallized with methyl alcohol.



Benzophenone Benzophenone oxime

Sulfacetamide: Sulfacetamide:

Taken 1 gm of sulphanilamide and 2.5 ml acetyl chloride were taken in a flask. After enclosing with funnel and the reaction material was irradiated by using MW at 60% (540 W) strength for 60 seconds. A water containing beaker was located in the oven after that to reaction vessel to use as a heating sink. After that reaction material was iced at room 6 temperature and poured into the chilled water. The products was obtained, filtered out and dissolved in sodium hydrogen carbonate solution. The reaction solution was acidified with glacial acetic acid and solid product was separated out. The filter the solid product, dried and re-crystallized with ethyl alcohol.



Sulphanilamide Sulf acetamide

A diversity of pharmacological importance of heterocyclic compounds makes its crucial pharmacophores in the medicinal chemistry. The synthesis and characterization of organic heterocyclic compounds those having extensive beneficial in the interest of the medicinal chemistry. This mini review specified the reported synthetic approach to synthesize and its most important therapeutic field as exploited. In this manner it is predictable that this review will be advantageous for the researchers and chemist working in the synthesis of organic synthesis.

By use of the microwave irradiation method for heating, these organic compounds were formed in higher amounts than the conventionally used synthetic methods. The qualities of these synthetic compounds were found to be superior and also exhibiting lesser impurities when compared to the conventional synthesized compounds. The physical, chemical and spectral characterizations of the compounds formed by MW reaction were found to be the same when compared with the conventional synthesized compounds. The synthesis could be performed in much lesser time period by using MW irradiation methods. Elevated yields were attained for the synthesis of phenytoin, phthalimide, diethyl fumarate, 2,3-diphenyl quinoxaline, benzocaine, sulfacetamide, benzimidazole, fluorescein and benzophenoneoxime by using MW irradiation techniques in less time period as compared to the conventional methods of synthesis (Table 1) and presented their Rf value (Table 2).

Table 1: Reaction time, Yield and M.P/B.P of products by conventional and microwave techniques

Compounds	Conventional method			Microwave method		
	Reaction time (Hour)	% yield	M.P/B.P* (°C)	Reaction time (in sec)	% yield	M.P/B.P* (°C)
Heterocyclic compounds						
Benzimidazole	2	85	199-171	70	91	168-170
Phthalimide	2	92	231-233	30	94	231-233
2,3-diphenyl-quinoxaline	0.5	93	146-148	30	95	143-145
Fluorescein	1	84	314-316	180	88	313-315
Phenytoin	2	86	281-283	150	90	280-282
Other organic compounds						
Fumaric acid	0.5	80	276-278	20	83	274-276
Diethyl fumarate	12	65	216-218*	120	72	218-219*
Benzocaine	2	68	89-91	60	75	89-91
Benzophenone oxime	0.5	93	146-148	30	95	143-145
Sulfacetamide	0.5	81	182-184	60	86	182-184

The innovative methods can be used for usual chemistry practical and can use well in valuable synthesis of organic compound for the development of new therapeutic agent in medicinal chemistry [6]. Since the synthesis of organic compounds by using microwave reactions were achieved effectively using very low quantity of chemicals, reduced heating time intervals primary to reduced cost of fuels or electricity and also decreased the ecological pollutions.

Table 2: R_f value of heterocyclic organic compounds synthesized by microwave method

Heterocyclic Compounds	Mobile phase	R_f value	Other organic compounds	Mobile phase	R_f value
Benzimidazole	Chloroform: Ethyl acetate (9:1)	0.55	Diethyl fumarate	Chloroform: Ethyl acetate (9:1)	0.57
Phthalimide	Chloroform: Ethyl acetate: (9:1)	0.68	Benzophenone oxime	Chloroform: carbon tetrachloride (8:2)	0.372
2,3-diphenyl-quinoxaline	Chloroform: Ethyl acetate: (9:1)	0.59	Benzocaine	Chloroform: Ethyl acetate: (9:1)	0.54
Fluorescein	Chloroform: Ethyl acetate: (9:1)	0.53	sulfacetamide	Chloroform: Ethyl acetate: (9:1)	0.58
Phenytoin	Chloroform: Ethyl acetate: (7:3)	0.67			

3. Conclusion

Microwave reactions are exceptionally attractive for the synthesis of heterocyclic organic compounds and attract chemists due to their capability to progress regio and/or chemo selectivity and for eco-friendly with smaller reaction time periods and successfully adopted the uses of micro wave (MW) technology for fast synthesis of various organic compounds. These organic compounds are established to be having immense prospective for the various types of biological activities, so the synthesis of organic compounds by means of microwave techniques are established to be advance beneficial.

References

[1] Finar, I.L, Organic Chemistry: Stereochemistry & the chemistry of natural products, 5, 2, ELBS Longman Group Ltd., London, 2009, 614-615.

[2] Harvey, F. Microwave Engineering, Academic Press, New York, 1963.Horeis, A.G.; Pichler, S.; Stadler, A.; Gössler, W.; Kappe, C.O. Fifth Inter. Electronic Conference on Synthetic Organic Chemistry (ECSOC-5). 2001, 1–30.

[3] Pelle, L.; Tierney, J.; Wathey, B.; Westman, J. *Tetrahedron*., 2001, 57.

[4] Chawla, A.; Sharma, A.; Sharma, A.K. Review: A convenient approach for the synthesis of imidazole derivatives using microwaves. *Der Pharma Chemica*, 2012, 4 (1):116-140.

[5] Joshi, S.D.; Kulkarni, M.; More, U.A. Synthesis of some medicinal/organic compounds using microwave technology. *Uni J Pharm*, 2013, 02(03): Page 139-143.

[6] Singh, H.; Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan. 2008, 2: 1-2.

[7] Matyus, P.; Czako, K. *Trend in heterocyclic chemistry*, 1993, 3, pp. 249.

[8] Sir Deker Barton, F.R.S.; David Ollis, F.R.S. Chairman and deputy chairman of the editorial board. *Comprehensive Organic Chemistry*. *The synthesis & reaction of the organic compound*. Matyus P and Czako K. *Trend in heterocyclic chemistry*, 1993; 3, pp. 249.

[9] Tisler, M.; Stanovic, B. *Advance in heterocyclic chemistry*, Katritzky Alan R., and boulton A J eds academic press, 1979; pp. 408.

[10] Anastas, P.T.; Warner, J.C. Green Chemistry: Theory and Practice, New York: Oxford University Press, 1998.

[11] Dennis, L.H.; David, L.S.; Janet, M.B. Green Chemistry, *J. Chem. Edu*., 2000; 77:1543.

[12] Joshi, S.D.; Joshi, A.; Vagdevi, H.M.; Vaidya, V.P.; Gadaginamath, G.S. Synthesis of some new quinolinylpyrazoles as potential antibacterial and antitubercular agents. *Indian J. Heterocyclic Chem.*, 2010; 19:221-224.

[13] Venugopala, K.N.; Jayashree, B.S. Microwave-induced synthesis of schiff bases of aminothiazolyl bromocoumarins as antibacterials. *Indian J. Pharm Sci.*, 2008; 70:88-91.

[14] Mann, F.G.; Saunders, B.C. Practical Organic Chemistry, 4th ed., New Delhi: Orient Longman, 1986.