19. One Step Synthesis of Benzoxazole/ Benzimidazole under Microwave and Grinding Methods

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Abstract

This present work involves comparative study of one step synthesis of one step synthesis of 2-aryl-benzoxazoles/benzimidazoles achieved by cyclocondensation reaction between o-aminophenol/ o-phenylenediamine with aromatic aldehydes under solvent free condition under different method such as microwave heating, conventional heating and grinding method. The characterisation techniques IR and 1H-NMR fully supported the structures of synthesized benzoxazoles/ benzimidazoles.

Keywords: Microwave heating, grinding method, benzoxazole /benzimidazole.

Introduction

Microwave irradiation heating method for different types of organic reactions has been well established as an environmentally friendly synthesis1 and has recently been reviewed2, as an efficient to prepare library of compounds very fast with high purity and better yields. Microwave heating method provides a number of advantages over the standard heating method3. High density microwave irradiation involves electromagnetic waves, heat the entire volume at about same rate and therefore useful for accelerating time consuming reactions4 and in conventional heating, surface of material heat first and then heat moves inward5. For mild reaction condition, grinding method is one which has been increasingly used in organic synthesis compared to conventional methods6, 7. The work reported by Toda on successful reactions by grinding method attracted the attention of chemist that many reactions could be conducted in high yield by just grinding solid-solid or solid-liquid together8. Literature revealed that in grinding method, the reaction is initiated with the transfer of small amounts of friction energy9 and reactions proceeds are exothermic. The grinding reactions would not work out to get desire product if the reaction is endothermic in nature.

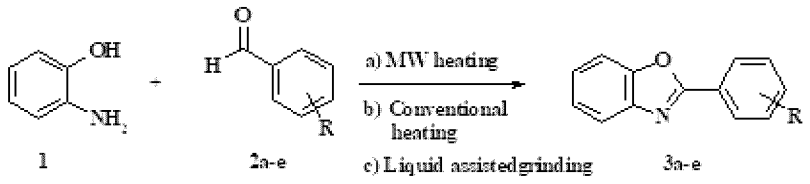
Benzoxazoles /benzimidazoles are important structural motifs exhibiting remarkable activities due to slight modification in the substitution pattern both the ring causes distinguishable difference in their pharmacological activities10-13. Benzimidazole ring having lower toxicity and high stability used as corrosion inhibitors for N80 steel-15% HCl system14.

The present work focuses on comparative study of one step synthesis of 2-aryl-benzoxazoles/benzimidazoles achieved by cyclocondensation reaction between o-aminophenol/ o-phenylenediamine with aromatic aldehydes employing microwave, conventional and hand grinding method under solvent free condition considering different form of transformation of energy to the reaction.

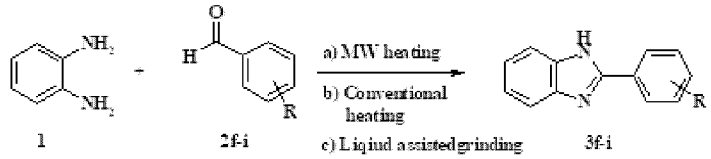
Result and Discussion

All chemicals used were of A. R. grade. Melting points of compounds were uncorrected and recorded using digital melting point apparatus (Veego-DMP). The IR spectra recorded on a Shimadzu spectrophotometer in the range 4000-400cm-1 using KBr pellets, 1H-NMR spectra obtained on a Bruker Avance II spectrophotometer in DMSO-d6. Chemical shifts obtained in ppm (δ) and measured using TMS as reference. The cyclocondensation between aryl aldehydes and o-aminophenol/ o-phenylenediamine leads to afford 2-aryl-benzoxazoles/ benzimidazoles using microwave, conventional and grinding method in good to excellent yield. The reactions were performed in domestic microwave oven at 800 W and in liquid assisted grinding. The comparison of physical constant, yield and reaction time of representative products under different form of transformation of energy to the reaction mixture taken into account with significance of this work is very small mechanochemical agitation was found to be enough for initiating such cyclocondensation reaction rather to use thermal energy or microwave energy.

Experimental



Where, 3a-e, R = H, *o*-hydroxy, *o*-nitro, *p*-methoxy, *p*-chloro, (Scheme 1)



Where, 3f-i, R = H, *o*-hydroxy, *o*-nitro, *p*-methoxy (Scheme 2)

Synthesis of 2-aryl-benzoxazoles, (3a-e) (Scheme 1)

- **Microwave Method:** A mixture of o-aminophenol (1) (0.2 mol) and various aryl aldehydes (2a-e) (0.2 mol) irradiated under microwave condition for 3-4 min. A solid

mass obtained was washed with water, dried, recrystalised in ethyl acetate and identified as a 2-aryl benzoxazoles (3a-e).

- **Conventional Method:** A cyclocondensation reaction of o-aminophenol (1) and aryl aldehydes (2a-e) in solvent free condition refluxing for 3-4 hr leads to afford solid mass, recrystalised in ethyl acetate and identified as a 2-aryl benzoxazoles (3a-e).
- **Grinding Method:** A mixture of o-aminophenol (1) and aryl aldehydes (2a-e) was ground in a mortar with pestle at room temperature for 15-20 min. A solid mass obtained was washed with water, dried, recrystalised in ethyl acetate results 2-aryl benzoxazoles (3a-e) (Scheme 1)

  Compound (3a): Anal. Calcd. For C13H9NO, Calculated: C 79.98, H 4.65, N 7.17, Found : C 78.91, H 4.62, N 6.97. IR (KBr) cm-1, 3018 (Aro-CH), 1624 (C=N), 1483 (C=C). 1H-NMR (DMSO-d6) ppm, 7.08-7.17 (s, 5H, Ar-H), 6.81-6.92 (m, 4H, Benzox-H).

Synthesis of 2-aryl-benzimidazoles, (3f-i) (Scheme 2)

2-aryl-benzimidazoles (3f-i) were achieved by using 1, 2-diaminobenzene (1) and aryl aldehydes (2f-i) by employing above methods with similar procedure (Scheme 2).

Compound (3f): Anal. Calcd. for C13H10N2, Calculated : C 80.39 , H 5.19 , N 14.42, Found : C 77.86, H 5.03, N 14.98. IR (KBr) cm-1, 3363 (-NH), 3053 (Aro-CH), 1454 (C=C). 1H-NMR (DMSO-d6) ppm, 7.71-7.83 (m, 4H, Benzmid-H), 7.31-7.65 (m, 4H, Ar-H), 8.83 (s, 1H, NH)

Synthesis data of 2-aryl-benzoxazoles (3a-e) and 2-aryl-benzimidazoles (3f-i)

Method	Microwave			Conventional			Grinding		
Compds	Yield (%)	m. p. (^{0}C)	time (min)	Yield (%)	m. p. (^{0}C)	time (min)	Yield (%)	m. p. (^{0}C)	time (min)
3a	80	172	3	64	172	180	78	171	15
3b	83	154	4	72	156	210	82	154	20
3c	96	190	4	80	192	240	92	188	15
3d	84	184	4	62	184	240	66	182	20
3e	80	122	3	64	120	180	76	122	15
3f	86	294	3	66	293	180	82	294	20
3g	88	176	4	62	172	240	85	175	20
3h	87	238	4	76	242	180	91	241	15
3i	75	224	4	72	223	240	83	224	20

Conclusion

The different form of energy used in microwave irradiation, conventional heating and grinding method which transforms substrate into product were discussed. The efficient, versatile

and inexpensive mechanochemical route for cyclocondensation reaction developed which involves comparative study of synthesis of 2-aryl-benzoxazoles/ benzimidazoles under microwave, conventional and grinding method. The mild reaction conditions and proceeds just by grinding the substrates without any solvent and hence match the green chemistry protocols. In addition to this remarkable feature of this work is very small mechanochemical agitation was found to be enough for initiating such condensation reaction rather to use thermal energy or microwave energy.

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