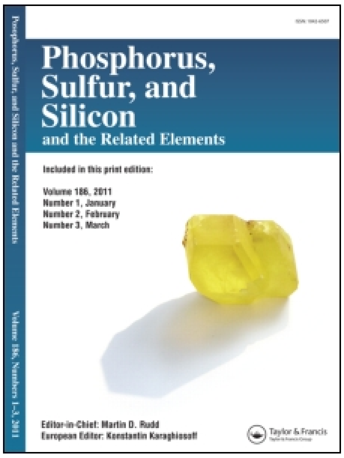


Phosphorus, Sulfur, and Silicon and the Related Elements
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

SOLID STATE SYNTHESIS OF SUBSTITUTED COUMARIN-3-CARBOXYLIC ACIDS VIA THE KNOEVENAGEL CONDENSATION UNDER MICROWAVE IRRADIATION

Majid M. Heravi[a]; Rahim Hekmatshoar[a]; Maryam Emamgholizadeh[a]
[a] Department of Chemistry, Faculty of Science, Alzahra University, Vanak, Tehran, Iran

Online publication date: 16 August 2010

To cite this Article Heravi, Majid M. , Hekmatshoar, Rahim and Emamgholizadeh, Maryam(2004) 'SOLID STATE SYNTHESIS OF SUBSTITUTED COUMARIN-3-CARBOXYLIC ACIDS VIA THE KNOEVENAGEL CONDENSATION UNDER MICROWAVE IRRADIATION', Phosphorus, Sulfur, and Silicon and the Related Elements, 179: 9, 1893 — 1896
To link to this Article: DOI: 10.1080/10426500490466814
URL: http://dx.doi.org/10.1080/10426500490466814

Phosphorus, Sulfur, and Silicon, 179:1893–1896, 2004

ISSN: 1042-6507 print / 1563-5325 online
DOI: 10.1080/10426500490466814

SOLID STATE SYNTHESIS OF SUBSTITUTED COUMARIN-3-CARBOXYLIC ACIDS VIA THE KNOEVENAGEL CONDENSATION UNDER MICROWAVE IRRADIATION

Majid M. Heravi, Rahim Hekmatshoar,
and Maryam Emamgholizadeh
Department of Chemistry, Faculty of Science,
Alzahra University, Vanak, Tehran, Iran

(Received January 22, 2004; accepted February 20, 2004)

Synthesis of substituted coumarin-3-carboxylic acids using the Knovenagel reaction of malonic acid and O-hydroxyaryl aldehydes supported onto HZSM-5 zeolite under microwave irradiation is described.

Keywords: Coumarin; Knoevenage; microwave irradiation; solid state; zeolite

INTRODUCTION

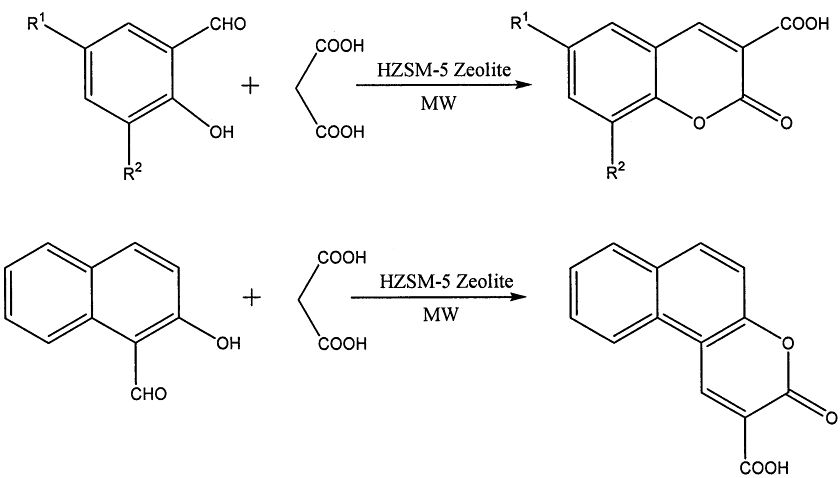
Coumarins are widespread in nature as physiologically active constituent plants.[1–3] Moreover, coumarins have a broad range of application in the pharmaceutical, perfumes, cosmetic, and food industries.[4] The synthesis of coumarins and their derivatives has attracted considerable attraction from organic and medicinal chemists for many years, as a large number of natural products contain this reterocyclic system.[5]

Coumarins have been synthesized by many different routes, including traditional Pechmann reaction[6] and Knoevenagel condensation[7] of hydroxyl aldehydes with maleic acid,[8] malonic ester or cyanoacetic ester.[10] For Knoevenagel condensation of coumarin synthesis, a series of developments and modifications have been also reported.[11] The methods have their own merits and drawbacks.

The microwave-enhanced chemical reactions in solventless system have gained popularity as they can be conducted efficiently and rapidly to afford pure products in high yield.[12] Recently there has been a shift

Address correspondence to Majid M. Heravi, Department of Chemistry, Faculty of Science, Alzahra University, Vanak, Tehran, Iran. E-mail: mmheravi@azzahra.ac.ir

in emphasis in chemistry, with the desire to develop more environmentally friendly routes to a myriad of materials. This shift is most apparent in the growth of green chemistry. Green chemistry approaches not only hold significant potential for omitting undesirable by-product, avoiding use of toxic, expensive, and flammable solvents, reduction in waste disposal, and lowering energy costs, but also for the development of new methodologies toward previously unobtainable materials using existing technologies.[13] We have recently reported on a solvent-free synthesis of coumarins,[14b] on the microwave assisted Pechmann reaction on P_2O_5/moleculare sieves application for the preparation of 4-substituted coumarins.[14a] In continuation of our interest on reactions under microwave irradiation in solvent-free conditions, in this communication we report the soli-state synthesis of substituted coumarin-3-carboxylic acids via Knoevenagel condensation under microwave irradiation. In an effort to find suitable mineral support, traditional supports such as alumina, silica gel montmorilonitrile K-10, HY-zeolite, and HZSM-5 zeolite were examined. The latter gave the best result regarding yields, rate of reaction, and ease of workup procedure. We have found that coumarin-3-carboxylic acids can be readily prepared from the reaction of 2-hydroxybenzaldehydes and hydroxynaphthaldehyde supported onto HZSM-5 zeolite to microwave irradiation. Most of the hydroxyaldehyde disappeared within the first 2 min as determined by TLC (Scheme 1). It is notable that in the absence of solid support the reactions are sluggish, and considerable amounts of starting materials are recovered unchanged even after prolonged exposure to microwave irradiation.



SCHEME 1

In conclusion we have developed a very simple and fast synthesis of coumarin-3-carboxylic acids utilizing the Knoevenagel condensation between 2-hydroxybenzaldehydes and 2-hydroxynaphthaldehyde with malonic acid supported onto HZSM-5 zeolite under microwave irradiation in solventless system. The ease of this synthesis, along with its eco-friendly nature, make it suitable a methodology in oganic synthesis.

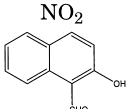
EXPERIMENTAL

Melting points were determined with an electrothermal 9100 apparatus and are uncorrected. The infrared spectra were obtained on Philips PU 9800 Fourier transform infrared (FTIR) spectrometer. ^{1}H NMR spectra were recorded Brucker 80 MHz. TLC analysis were performed on Merck 60 PF 256 silica gel plates using mixture of hexane-ethyl acetate 40:60. HZSM-5 zeolite was prepared following a previously described method.[17] Some products (entries 1–3, 5) were brown, and their physical and spectroscopic data were compared with those of authentic samples.

General Procedure

Malonic acid (1.5 mmol) was mixed thoroughly with HZSM-5 zeolite (0.15 g) using pistal and mortar. The mixture was transferred to a beaker and mixed with a selected 2-hydroxybenzaldehyde (1 mmol). The beaker was placed in a house hold microwave oven for the specified time. The progress of reaction was monitored by TLC using hexane:ethyl acetate 40:60. Dichloromethane (20 ml) was added to the crude product and filtered. Water (20 ml) was added and the organic layer was separated. The solvent was distilled and the crude product was purified if necessary by crystallization (Table I).

TABLE I Knoevenagel Synthesis of Coumarin-3-carboxylic Acids under Microwave Irradiation in Solventless System

Entry	R^1	R^2	Reaction time (min)	Mp		[a]Yield (%)
1	H	H	4	190(MeOH)	190–191[16]	87
2	OMe	H	6	192–193	194–196[16]	89
3	H	OMe	3	194(EtOAc)	194–195[16]	97
4	NO_2	H	4	185(EtOAc)		93
5			15	235–236(EtOAc)	236–237[16]	75

[a]Yields refer to isolated products.

REFERENCES

[1] a) A. Schonberg and N. Latif, *J. Am. Chem. Soc.*, **76,** 6208 (1954); b) N. R. Guz, P. Lorenz, and R. Stermitz, *Tetrahedron Lett.*, **42,** 6491 (2001).
[2] O. Kayser and H. Kulodziej, *Planta. Med.*, **63,** 508 (1997).
[3] C. J. Wang, Y. J. Hsieh, C. Y. Chu, Y. L. Lin, and T. H. Tsong, *Cancer Lett.*, **183,** 163 (2002).
[4] T. N. Van, S. Delanedelti, and N. Dekempe, *Tetrahedron Lett.*, **44,** 4199 (2003) and references cited therein.
[5] D. Subhas Bose, A. P. Rudradas, and M. Hari Babu, *Tetrahedron Lett.*, **50,** 9195 (2002) and references cited therein.
[6] H. V. Pechman and C. Dursberg, *Chem. Ges.*, **16,** 2219 (1883).
[7] G. Jones, *Inorganic Reactions* (John Wiley and Sons, New York, 1983), p. 204–599.
[8] F. Bigi, L. Chesioi, R. Maggi, and G. Sartori, *J. Org. Chem.*, **64,** 1033 (1999).
[9] E. Knoevenagel, *Chem. Ber.*, **37,** 4461 (1904).
[10] C. Wiener, C. H. Schroeder, and K. P. Link. *J. Am. Chem. Soc.*, **79,** 5301 (1957).
[11] a) V. Armstrong, O. Soto, J. A. Valderra, and R. Tapia, *Synth. Commun.*, **18,** 817 (1988); b) R. Maggi, F. Bigi, S. Caloni, A. Mazzacani, and G. Sartani, *Green Chem.*, **3,** 173 (2001); c) B. P. Bandgar, L. S. Uppolla, and V. S. S. Sadavarte, *J. Chem. Res. Syropses*, 40 (2002); d) B. T. Watson and G. E. Christianson, *Tetrahedron Lett.*, **39,** 6087 (1998); e) A. Song, X. Wang, and K. S. Lam, *Tetrahedron Lett.*, **44,** 1755 (2003).
[12] J. J. Filippi, X. Fernandez, L. Lizzani Cunelier, and A. M. Loiseau, *Tetrahedron Lett.*, **44,** 6647 (2003) and references cited therein.
[13] A. McCluskey, P. J. Robinson, T. Hill, J. L. Scatt, and J. K. Edwards, *Tetrahedron Lett.*, **43,** 3117 (2002) and references cited therein.
[14] a) A. Shokravi, H. Valizadeh, and M. M. Heravi, *Phosphorus, Sulfur and Silicon*, **177,** 2835 (2002); b) A. Shokravi, H. Shurgi, H. Valizadeh, and M. M. Heravi, *Phosphorus, Sulfur and Silicon*, **177,** 2555 (2002).
[15] a) M. M. Heravi, D. Ajami, and M. Ghassemzadeh, *Synthesis*, B93 (1999); b) M. M. Heravi, D. Ajami, M. M. Mojtahedi, and M. Ghassemzadeh, *Tetrahedron Lett.*, **40,** 561 (1999); c) M. M. Heravi, D. Ajami, K. Aghapoor, and M. Ghassemzadeh, *Chem. Commun.*, 833 (1999); d) M. M. Heravi, H. A. Oskooie, L. Sangsefidi, M. Ghassemzadeh, and K. Tabar Hydar, *Phosphorus, Sulfur and Silicon*, **177,** 2843 (2002); e) M. Tajbakhsh, M. M. Heravi, A. Hsseini, and A. Shshrezaiee, *Phosphorus, Sulfur and Silicon*, **178,** 773 (2003).
[16] F. Bigi, L. Chesini, R. Maggi, and G. Sartari, *J. Org. Chem.*, **64,** 1033 (1999).
[17] T. Sano, N. Yamashita, Y. Iwame, K. Takeda, and Y. Kawakami, *Zeolite*, **16,** 258 (1996).