

Enhanced Yield of 7- Hydroxy – 4-Methyl Coumarin (Hymecromone) Assisted by Irradiations

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Abstract

Two independent irradiation techniques (as unconventional heating) were used to enhance the yield of 7- hydroxy – 4- methyl coumarin(Hymecromone) : microwave and ir lamp irradiations, together with conventional method. Highest yield (95%) was obtained with shorter reaction time(4 minutes) using catalytic amount of sulfuric acid and magnesium sulfate (as conductive support) by the microwave irradiation , while the ir lamp irradiations gave low yield(50%)with long reaction time (8hours).

Introduction:

Coumarin nucleus was the bases of several biological activities, such as antibacterial , anticarcinogenic , antispasmodic diuretic and anticoagulant [1-2].

These compounds were prepared by modification of Pechman-Daisberag condensation using concentrated sulfuric acid as catalyst and benzene as solvent under conventional heating [3].

In the electromagnetic radiation spectrum, microwaves (0.3 GHz–300 GHz) lie between radiowave (Rf)and infrared (IR) frequencies with relatively large wavelength. Microwaves, a nonionizing radiation incapable of breaking bonds are a form of energy and not heat and are manifested as heat through their interaction with the medium or materials wherein they can be reflected (metals), transmitted (good insulators that will not heat) or absorbed (decreasing the available microwave energy and rapidly heating the sample) [4-5]. These techniques became an increasingly popular in academic and industrial research laboratories, due to certain advantages such as particular shorter reaction times and rapid optimization of chemical reactions [6-7]. The using of infrared light produced by a medicinal infrared lamp (250W), to yield the corresponding products under solvent-free conditions were investigated in literatures as methods with solvent-free approach with short time reactions[8] . Infrared light activation as a non-conventional energy source has become an important method that can be used to carry out a wide range of reactions with short reaction times and high yields. Indeed, infrared light heating rapidly increases temperature in absence of the solvent and leads to a uniform energy transfer to the reactants of the chemical reaction.

As part of continuous program directed toward the studies with irradiation techniques [9],it was became of interest to investigate preparative routs to enhance the yield of 7- hydroxy – 4-methy coumarin(Hymecromone)using two different irradiation techniques, microwave, and IR lamp and compared them with conventional method.

Experimental:

Synthesis of 7- Hydroxy – 4-methyl coumarin(Hymecromone):

7- Hydroxy – 4-methyl coumarin(Hymecromone) was prepared by the following methods using a solution of (1.1gm,0.01mole) resorcinol and (1.3gm,0.01mole) ethylacetoacetate EAA .

Method(a) (Conventional method)[10]:

The solution was added dropwise with stirring to 10ml of conc. sulfuric acid so that the temperature of the mixture did not rise above 10°C, the reaction mixture was kept at ambient temperature for 18 hours, then poured with vigorous stirring into mixture of ice and water .The precipitate was filtered off and washed with water. Drying under reduced pressure was carried out to afford the crude solid Hymecromone ,which recrystallized from aqueous ethanol to give the target compound of mp 190-91C, lit .

(the same as litreture[11]),U.V. ,(MeOH) λ_{max} (nm) ,300.and IR (KBr) ν cm^{-1} C=O (1690) and C-O (1065),

Yield % of the product was listed in Table (1).

Method (b) (Microwave Irradation) [12]:

The solution was mixed with a spatula for a few minutes with 1ml of concentrated sulfuric acid and placed in an open conical flask in domestic microwave oven (containing crucible of 2mg magnesium sulfate) and irradiated for 5 minutes (the reaction was TLC monitored to indicate the disappearance of the starting material) and worked up as in method (a).Yield % of the product was listed in Table (1).

Method (C) (ir Lamp heating) [13]:

Using a procedure similar to that in method (a)with irradiation using a medicinal infrared lamp (250 Watts)for 8hours(the temperature did not exceed 75°C) and worked up as in method (a). Yield % of the product was listed in Table (1).

Table (1): Yields % of the three different methods of preparation of 7- Hydroxy – 4-methyl coumarin(Hymecromone)

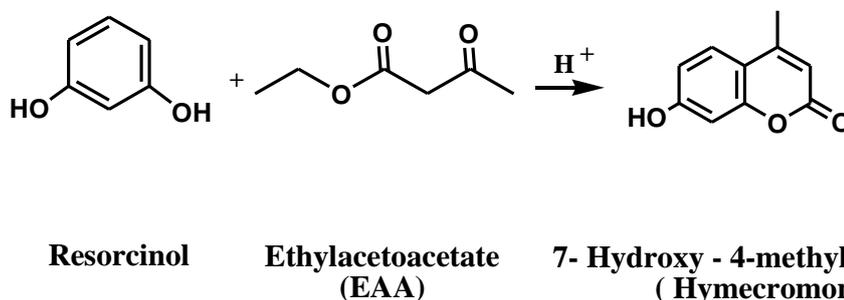
Method	Yields %
(a)(Conventional method)	85
(b) (Microwave Irradation)	95
(c) (ir Lamp heating)	50

Results and Discussion:

A special attention has been given as a part of efforts to develop an inexpensive , safe, short time and high yield practical synthesis of 7-hydroxy -4-methyl coumarin (Hymecromone). A modification of Pechman-Duisberg condensation by independent radiation methods (b-c)

Scheme(1) in which two independent irradiation techniques (as unconventional heating) were used : microwave and ir lamp irradiations , together with conventional method.

The results at these methods were reported , the remarkable observations, high yield can be obtained with short reaction time (%95,4minutes) and simply handling was in method (b).



Scheme (1)

Heterogeneous reactions facilitated by supported reagents on inorganic compounds (the use of magnesium sulfate) have received attention in recent years[14]. The application of microwave irradiation in conjunction with the use of catalysts or mineral-supported reagents, enabled organic reactions to occur expeditiously at ambient pressure [15-18], thus providing unique chemical processes with special attributes such as enhanced reaction rates, higher yields, and the associated ease of manipulation.

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Conclusion:

For the Synthesis of 7- Hydroxy – 4-methyl coumarin(Hymecromone), the microwave irradiation offered several advantages such as it can be performed in a short time(4 minutes), with high yields (95%) and with lowering the use of catalyst and without using any solvents, while the ir lamp irradiations gave low yield(50%)with long reaction time (8hours).

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زيادة انتاجية ٧- هيدروكسي - ٤-مثيل كيومارين (الهايميكرومون) بمساعدة التشعيع

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الملخص

استخدمت طريقتان من تقنيات التشعيع (بالتسخين غير التقليدي) للمساعدة في زيادة إنتاجية ٧- هيدروكسي - ٤-مثيل كيومارين (الهايميكرومون) : وهي التشعيع بالميكروويف ومصباح الأشعة تحت الحمراء سويا مع الطريقة التقليدية . أعلى منتج تم الحصول عليه (٩٥%) وبوقت تفاعل (٤ دقائق) باستخدام كميات مساعدة من حامض الكبريتيك وباستخدام سلفات المغنيسيوم (كدعامة للتوصيل) وذلك بالتشعيع بالميكروويف.بينما اعطى استخدام مصباح الأشعة تحت الحمراء منتج واطى(٥٠%) مع وقت تفاعل طويل(٨ ساعات).