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SYNTHESIS AND EVALUATION OF ASPIRIN ASSISTED BY MICROWAVE OVEN

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ABSTRACT

Microwave synthetic methods were devised for three lab reactions. The synthesis of Aspirin. These reactions are all done in either general chemistry or organic chemistry. Under conventional heating methods, the aspirin synthesis requires heating at 55 °C for 30 minutes. The proposed microwave methods provide shorter reaction times (7 min. at 175 watts) while maintaining similar, if not better, yields. The aspirin and phenytoin syntheses were shortened to 7 minutes, and the Claisen condensation was shortened to 4.5 minutes. The microwave method produced a 85.88% yield for aspirin, while conventional yield was 72.08%.

KEY WORDS

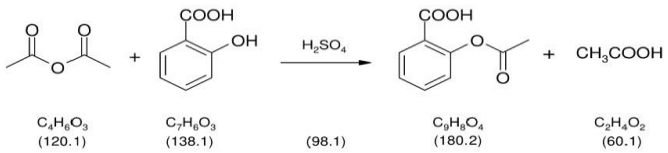
Aspirin, Microwave oven, Phenytoin, Organic Chemistry

INTRODUCTION

In organic chemistry, many syntheses take hours under normal heating conditions. Microwave chemistry allows such reactions to proceed at a fraction of the time, and boasts better yields. A microwave emits oscillating magnetic fields, causing polar molecules to rotate along with the magnetic field. This movement of molecules causes more interactions between molecules.

Microwave reactions have been shown to be much faster, making these reactions useful. One such use is applying microwave chemistry in the undergraduate organic lab. Using a microwave in the organic chemistry lab can help students learn about optimization, while reducing wasted time in the lab. Students can run multiple reactions in the time it usually takes to run one reaction.

Aspirin can be used as a painkiller, but it is also given to people who are at a higher risk of heart attack. Aspirin lowers the risk of forming blood clots in arteries, decreasing the risk of heart attack. As well as being a blood thinner, aspirin is an analgesic that is used to reduce swelling. The synthesis of aspirin is an organic reaction known as an acetylation. The reaction proceeds when the alcohol group of salicylic acid attacks one of the carbonyl groups of acetic anhydrides. Now day's technique is considered as an important approach toward green chemistry, because this technique is more environmentally friendly. This technology is still under-used in the laboratory and has the potential to have large impact on the fields of screening, combinatorial chemistry, medicinal chemistry and drug development. Conventional method of organic synthesis usually needs longer heating time, tedious apparatus setup, which result in higher cost of process and the excessive use of solvents/ reagents lead to environmental pollution. This growth of green chemistry holds significant potential for a reduction of the by product, a reduction in waste production and a lowering of the energy costs. Due to its ability to couple directly with the reaction molecule and by-passing thermal conductivity leading to a rapid rise in the temperature, microwave irradiation has been used to improve many organic syntheses.



Reaction-Principle-

Microwave assisted syntheses of Aspirin for the organic chemistry lab. Inorganic chemistry, many syntheses take hour under normal heating condition. Microwave chemistry allowed such reaction to proceed at a fraction of the time and boast better yield. A microwave emits oscillating magnetic field, molecule cause more interaction between molecules.

Microwave reactions have been shown to be much faster. Making these reactions useful. One such use is applying microwave chemistry in the undergraduate organic lab. Using a microwave in the organic lab can help student learn about optimization.[1,3,7]

MATERIAL AND METHODS

Principle of microwave oven

Microwave oven is one of the most widely used household appliances. Most of home and most of conveniences have microwave oven. The reason for its popularity is that it cooks food in an amazingly short amount of time. 7

Operating principle

Microwaves are radio waves. In the case of microwave oven, the commonly use radio frequency is roughly 2500 megahertz. Radio wave in this frequency has an interesting property they are absorbed they are converted directly into atomic motion and motion is converted into heat. Microwave in this frequency range have another interesting property they are not absorbed by most plastic, glass or ceramic and metal cause spark in a microwave oven. The reason behind that metal reflects microwave is that no electronic waves resident in inside of conductor because conductor conductivity is infinity as we studied in our course. The property in this paragraph is possible because the frequency 2500 megahertz is resonance frequency of water.

Molecule of all food are consisting of a dipole and have positive charge in one side and have negative charge in another side. If we put electromagnetic field in this, all molecules are arranged + ^{ve} charge is to – ^{ve} pole and – ^{ve} charge is to positive pole. In this process molecule heat is produced by fraction. The frequency of microwave oven is 2500 megahertz as we saw before. Then microwave of this freq. changes the direction of electromagnetic field 2,500,000,000 times in 1 sec. consequently the heat efficiency of a microwave oven is greatly high. [2]

Synthesis of Aspirin [Conventional]

Procedure: -

1. Prepare an admixture of 10 ml of each acetic anhydride & glacial acetic acid in 100 ml clean and dry beaker.
2. Now add this mixture carefully to 6 gm salicylic acid previously weighed &placed in 100 ml round bottom flask & fit the same with a reflux condenser.
3. Boil the reaction mixture on an electric heating mantle for duration of 35-45 min.
4. Pour the hot resulting mixture directly into 100 ml of cold water containing in 500 ml beaker in one lot and stir the content vigorously with resp. to a glass rod when the shining tiny crystals of aspirin separate out.
5. Filter off crude aspirin in Buchner funnel fitted with an air-suction device &wash the residue with sufficient cold water, drain well and finally remove the excess water by pressing it between the air to allow it dry completely.

Calculation

Theoretical yield

Molecular weight of Salicylic acid (reactant) = Molecular weight of Aspirin (product)=

$C_7\ H_6\ O_3 = 12 \times 7 + 1 \times 6 + 16 \times 3 = 138$, $C_9\ H_8\ O_4 = 12 \times 9 + 1 \times 8 + 16 \times 4 = 180$

Theoretical yield = 32.60g, Practical yield = 23.5g, Percentage (%) yield= 72.08%

SYNTHESIS OF ASPIRIN [MICROWAVE OVEN]

Procedure

Two reaction consist of a two-neck flask with magnetic stir bar, temperature, sensor and intensive cooler. A mixture of salicylic acid and acetic anhydride is filled in the reaction flask and three drop of conc. Sulphuric Acid are added the apparatus is installed by means of a glass tube in the microwave system. Standard refluxing apparatus for microwave system. The reaction mixture

is heated under stirring for 90 sec. with 900 W to 140 C, during the following cooling down the clear yellowish solidified to a compact white crystalline mass. 7,3

Calculation: -

Salicylic acid-25 g (181.15 mmol)

Acetic anhydride-21.73 g (203.71 mmol)

Conc. H_2SO_4 - 0.5 ml

Ethanol - 60 ml

Theoretical yield= 32.60 g, Practical yield= 28 g, Percentage (%) yield = 85.88%

RESULT S

EVALUATION OF ASPIRIN [CONVENTIONAL & MICROWAVE]

Physicochemical characterization

Colour	White		
Appearance	Crystalline- powder		
Odour	Odourless		
State	Solid		
Flame test	Positive – Aspirin is aromatic in nature		
Solubility	Sample + Water (heat) - Soluble	Sample + Ether	- Insoluble
	Conventional	**Microwave**	
Melting Point	134°C -136°C	136°C - 138°C	
pH determination	3.4	3.2	
Sulphated Ash Value	0.2%	0.2%	
Loss on drying	0.9%	0.5 %	
Partition coefficient	(Log p) or k = 2.00	(Log p) or k = 2.05	
Pka	Pka = 04 (pH = pka)	Pka = 3.2 (pH = pka)	

Identification tests

Sr.no	Test	Observation	Inference
1.	Boil about 0.5g add 10ml of NaOH solution for 3mn, cool and add 10ml of sulfuric acid solution. a white crystalline ppt is produced, filter dissolve ppt about 2ml water & ferric chloride test solution.	Dark violet color is observed.	Test is positive
2.	In test A add 3ml ethanol (95%) add 3ml sulphuric acid and heat.	Odour of ethyl acetate is observed.	Test is positive

Limit tests

Sr. no	Limit Test	Inference
1.	Chloride Test	positive
2.	Sulphate Test	positive
3.	Arsenic Test	positive
4.	Heavy metal Test	positive

Assay of Aspirin

Observation for assay

Sr.no	Titration for	Burette reading		End point
		Initial	Final	
1.	Sample: 1.5g aspirin +15ml ethanol +50ml 0.5N NaOH boil for 10 min. Titrate with 0.5N HCL with phenol red indicator.	0.0ml	19.2 ml (Conventional) 17.0 ml (microwave)	Color change from pink to orange.
2.	Blank:15ml ethanol +50ml 0.5N NaOH boil for 10 min. Titrate with 0.5N HCL with phenol red indicator	0.0ml	33.7 ml (Conventional) 33.0 ml (microwave)	Color change from orange to pink.

Factor: - Each ml of 0.5 N NaOH ≅ 0.04504g of $C_9H_8O_4$

Percentage purity = 89.56%

Percentage purity = 98.82%

Standardization of 0.5 N HCL

Normality of HCL = 0.49N

Assay of Salicylic acid

Content	Burette reading		End point
	Initial	final	
0.300g Salicylic acid +50ml ethanol+20ml of water +1-2 drops of phenol red indicator, titrate with 0.1N NaOH solution.	0.00 ml	1.6 ml	Color change from orange to faint pink.

Percentage purity = 73.65 %

Characterization

Element detection

Sr,no	Test	Observation	Inference
1	Test for Nitrogen	Blue color ppt.	positive
2	Test for Halogen	ppt. observed	positive
3	Test for Sulphur	Violet colored observed	positive

U V Spectroscopy of Aspirin

Microwave		Conventional	
Wavelength (nm)	Absorbance (A1%1CM)	Wavelength (nm)	Absorbance (A 1%1CM)
530 tests	0.856	530 tests	0.810
530 std	0.937	530 std	0.937

Microwave = $\frac{0.856}{0.937}X100$ = 91.35%

Conventional = $\frac{0.810}{0.937}X100$ = 86.44%

Rationale

Particulars	Conventional	Microwave
Time	30-45 min	7- 10 min
% Yield	72.05%	85.88%
Eco friendly	No	Yes

DISCUSSION

Under the conventional condition, salicylic acid and acetic anhydride are heated at 55 °C for 30 min. Aspirin is recrystallized from ethanol, and the final product analyzed by melting point and GC. However, analysis of GC data shows that recrystallizing with ethanol resulted in the trans-esterification. The microwave procedure involved reacting salicylic acid and acetic anhydride for 7 min. at 175 watts in the microwave, shorting the reaction time 7 min. to prevent the trans-esterification, water was used to recrystallized the resulting the aspirin. Using conventional heating aspirin was isolated with a yield of 75.08 % while the shorter microwave method resulted in a comparable 85.88 % yield.

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