http://www.e-journals.net

ISSN: 0973-4945; CODEN ECJHAO
E-Journal of Chemistry
2011, **8(4),** 1614-1619

Comparative Study of Microwave Induced and Conventional Synthesis of Acetylated Sugar Isothiocyanates and Related Thiocarbamides

ATUL V. YADGIRE, GAJANAN V. KORPE and SHIRISH P. DESHMUKH*

P. G. Department of Chemistry
Shri Shivaji College, Akola-444 001 (M.S.), India
atulyadgire@gmail.com

Received 16 December 2010; Accepted 28 February 2011

Abstract: The synthesis of several acetylated sugar isothiocyanates have been carried out under microwave irradiation in excellent yields of products by using related bromides and lead thiocyanate in sodium dried xylene. Several acetylated sugar thiocarbamides have been synthesized by the interaction of respective acetylated sugar isothiocyanates with appropriate aryl amines under microwave irradiation.

Keywords: MORE, Conventional synthesis, Sugar isothiocyanates, Thiocarbamides

Introduction

Owing to present environmental awareness, attempts are being made towards the evolution of environmentally benign processes using microwave induced organic reaction enhancement (MORE). The chief features of microwave assisted reactions are the enhanced selectivity, much improved reaction rates, milder reaction conditions and formation of cleaner products. Microwave irradiation method replaces the classical one because it proves to be a clean, cheap and convenient method[1]. Microwave assisted synthesis affords higher yields and minor wastes. Conventional method required longer heating time, tedious procedure and the excessive use of solvents while microwave assisted reactions are often performed neat, simplifying the work-up process and minimizing the need for organic solvents. Hence, microwave method has emerged as a tool towards green chemistry. Few researchers synthesized aryl thiocarbamides[2] under microwave irradiation. At the present time, microwave assisted carbohydrate chemistry is experiencing considerable growth and has potential to greatly improve the image of carbohydrate chemistry.

Sugar isothiocyanates are the versatile reagent in the field of carbohydrate chemistry. Due to synthetic flexibility of the isothiocyanate function[3], glycosyl isothiocyanates are attracting much attention among the *N*-glycosides. Sugar isothiocyanates have been used for the synthesis of carbohydrate derivatives particularly having thiourea structure, of synthetic, biological and pharmaceutical interest[4-6]. Antiviral, antibacterial and antitumor agents have been prepared by reaction of glycosyl isothiocyanates with biologically active amines[7,8].

Conventionally, in our laboratory, a number of researchers[9-11] reported the synthesis of acetylated sugar isothiocyanates and related thiocarbamides. We herein report the synthesis of acetylated sugar (glucose, galactose, lactose and maltose) isothiocyanates and related thiocarbamides under microwave irradiation. In the course of our study on carbohydrate chemistry, we found that microwave irradiation could promote the acetylated sugar isothiocyanates and related thiocarbamides in moderate yields.

Experimental

All reactions were carried out in a commercially available Godrej GMC 25E 09 MRGX microwave oven having a maximum power output of 900W operating at 2450 MHz. Melting points were recorded on a MAC digital melting point apparatus and are uncorrected. Thin layer chromatography was conducted on E. Merck TLC Silica gel 60 aluminium sheet.

Results and Discussion

Under microwave irradiation, acetylations of sugars (glucose, galactose, lactose and maltose) have been carried out by using appropriate amount of acetic anhydride and anhydrous sodium acetate as a catalyst. Bromination of acetylated sugars has been carried out conventionally using bromine in acetic acid and red phosphorus. Acetylated sugar isothiocyanates have been synthesized from related bromides using lead thiocyanate in sodium dried xylene under microwave irradiation. To afford products, the solvent was distilled off and sticky residue obtained was triturated with petroleum ether (60-80 ^{o}C). The products were purified by chloroform-ether. The products were found to be desulfurized when boiled with alkaline plumbite solution.

Synthesis of tetra-O-acetyl-β-D-glucosyl isothiocyanate and tetra-O-acetyl-β-D-galactosyl isothiocyanate under microwave irradiation

To a solution of tetra-*O*-acetyl-*α*-*D*-glucosyl bromide **(Ia)** (0.024 M, 10.0 g) dissolved in sodium dried xylene (25 mL) was added lead thiocyanate (6.0 g). The reaction mixture was then kept under microwave irradiation for about 25 min. at constant power P-70, the temperature of reaction mixture remain constant at 130-140 ^{o}C. The resultant solution was then cooled and separated lead bromide was removed by filtration. The solvent was distilled off and sticky mass obtained as residue was triturated with petroleum ether (60-80 ^{o}C). A pale yellow solid (8.5 g) was obtained. The product **(IIa)** was purified by chloroform–ether. m.p. 112 ^{o}C. (Scheme 1).

In the similar manner, tetra-*O*-acetyl-*β*-*D*-galactosyl isothiocyanate **(IIb)** (6.2 g), m.p. 92 ^{o}C have been synthesized from tetra-*O*-acetyl-*α*-*D*-galactosyl bromide **(Ib)** (0.024 M, 10.0 g) dissolved in sodium dried xylene (25 mL) in presence of lead thiocyanate (6.0 g). (Scheme 1). The results were showed in Table 1.

Synthesis of hepta-O-acetyl-β-D-lactosyl isothiocyanate and hepta-O-acetyl-β-D-maltosyl isothiocyanate under microwave irradiation

To a solution of hepta-*O*-acetyl-*α*-*D*-lactosyl bromide **(IV)** (0.014 M, 10.0 g) dissolved in sodium dried xylene (25 mL) was added lead thiocyanate (6.0 g) in a 50 mL beaker. The reaction mixture was then kept under microwave irradiation for about 40 min. at constant power P-70, the temperature of reaction mixture remain constant at 130-140 ^{o}C. The resultant

solution was then cooled and separated lead bromide was removed by filtration. The solvent was distilled off and sticky mass obtained as residue was triturated with petroleum ether (60-80 ^{o}C). A pale yellow solid (7.2 g) was obtained. The product **(V)** was purified by chloroform–ether. m.p. 164 ^{o}C. (Scheme 2).

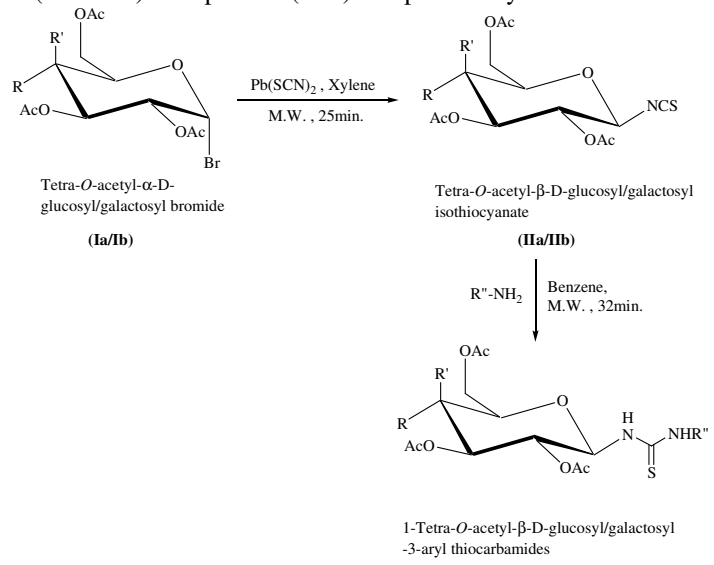
In the similar manner, hepta-*O*-acetyl-*β*-*D*-maltosyl isothiocyanate **(VIII)** (6.5 g), m.p. 118 ^{o}C have been synthesized from hepta-*O*-acetyl-*α*-*D*-maltosyl bromide **(VII)** (0.014 M, 10.0 g) dissolved in sodium dried xylene (25 mL) in presence of lead thiocyanate (6.0 g). (Scheme 3). The results were showed in Table 1.

Table 1. Physical data of acetylated sugar isothiocyanates and comparative study of conventional *vs*. microwave method

S.No.	Sugar isothiocyanates	m.p., ^{o}C	Conventional method		m.p., ^{o}C	Microwave method	
			Time, h	% Yield		Time, min	% Yield
1	**IIa**	111-114	3	73.83	112	25	89.66
2	**IIb**	92-94	3	58.01	92	25	65.40
3	**V**	163-165	3	63.88	164	40	74.30
4	**VIII**	118-120	3	59.88	118	40	67.07

Synthesis of 1-tetra-O-acetyl-β-D-glucosyl-3-aryl thiocarbamides and 1-tetra-O-acetyl-β-D-galactosyl-3-aryl thiocarbamides under microwave irradiation

To benzene solution (15 mL) of tetra-*O*-acetyl-*β*-*D*-glucosyl isothiocyanate **(IIa)** (0.02 M, 7.7 g) was added appropriate amount of various aryl amines in a 50 mL beaker. The reaction mixture was then kept under microwave irradiation for about 28 min. at constant power P-70. Afterwards, solvent was distilled off and sticky mass obtained as residue was triturated with petroleum ether (60-80 ^{o}C). The product (**IIIa**) was purified by chloroform–ether. (Scheme 1).



Where, i) tetra -*O*-Acetyl-*β*-*D*-glucosyl isothicoyanate; if R=OAc and R' = H; ii) tetra -*O*-acetyl-*β*-*D*-glucosyl isothicoyanate; if R=H and R' = OAc and iii) R" = a) phenyl, b) *o*-tolyl, c) *m*-tolyl, d) *p*-tolyl, e) *o*-Cl-phenyl, f) *m*-Cl-phenyl, g) *p*-Cl-phenyl

Scheme 1

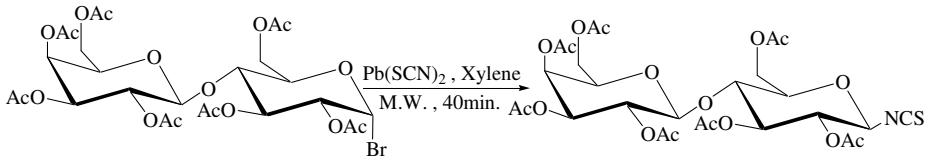
In the similar manner, 1-tetra-*O*-acetyl-*β*-*D*-galactosyl-3-aryl thiocarbamides **(IIIb)** have been synthesized from tetra-*O*-acetyl-*β*-*D*-galactosyl isothiocyanate **(IIb)** (0.005 M, 2.0 g) dissolved in benzene solution with appropriate amount of various aryl amines. (Scheme 1). The results were showed in Table 2.

Table 2. Physical data of acetylated sugar thiocarbamides and comparative study of conventional *vs*. microwave method

S.No.	Compounds		m.p., °C	Conventional method		m.p., °C	Microwave method	
	Sugar isothiocyanates	Sugar thiocarbamides		Time, h	% Yield		Time, min	% Yield
1	**IIa**	IIIaa	162	3	68.42	162	28	74.21
		IIIab	170	3	86.58	170	28	88.36
		IIIac	138	3	81.52	138	28	86.36
		IIIad	132	3	83.08	132	28	84.18
		IIIae	160	3	70.45	160	28	76.50
		IIIaf	172	3	78.27	172	28	80.57
		IIIag	145	3	58.70	145	28	60.78
2	**IIb**	IIIba	128	3	65.58	128	28	70.85
		IIIbb	172	3	54.90	172	28	60.78
		IIIbc	160	3	66.66	160	28	72.54
		IIIbd	110	3	68.23	110	28	74.11
		IIIbe	176	3	71.69	176	28	77.73
		IIIbf	124	3	62.26	124	28	70.18
		IIIbg	140	3	69.81	140	28	76.22
3	**V**	VIa	138	3	82.91	138	32	87.93
		VIb	148	3	79.01	148	32	83.20
		VIc	109	3	76.54	109	32	81.23
		VId	124	3	86.41	124	32	91.35
		VIe	149	3	62.65	149	32	69.87
		VIf	153	3	48.19	153	32	55.42
		VIg	139	3	86.74	139	32	91.56
4	**VIII**	IXa	110	3	75.78	110	32	78.87
		IXb	202	3	63.56	202	32	65.36
		IXc	230	3	65.79	230	32	67.93
		IXd	134	3	58.00	134	32	61.23
		IXe	222	3	62.18	222	32	64.25
		IXf	112	3	58.00	112	32	60.63
		IXg	161	3	62.88	161	32	65.78

Synthesis of 1-hepta-O-acetyl-β-D-lactosyl-3-aryl thiocarbamides and 1-hepta-O-acetyl-β-D-maltosyl-3-aryl thiocarbamides under microwave irradiation

To benzene solution (15 mL) of hepta-*O*-acetyl-*β*-*D*-lactosyl isothiocyanate **(V)** (0.005 M, 3.5 g) was added appropriate amount of various aryl amines in a 50 mL beaker. The reaction mixture was then kept under microwave irradiation for about 32 min. at constant power P-70. Afterwards, solvent was distilled off and sticky mass obtained as residue was triturated with petroleum ether (60-80 °C). The product (**VIa-g**) was purified by chloroform–ether. (Scheme 2).

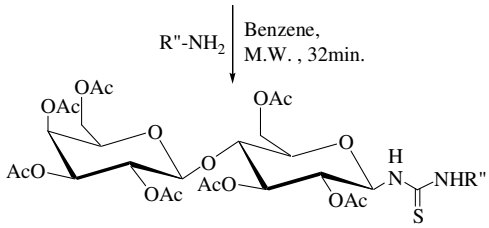


Hepta-*O*-acetyl-α-D-lactosyl bromide

(IV)

Hepta-*O*-acetyl-β-D-lactosyl isothiocyanate

(V)



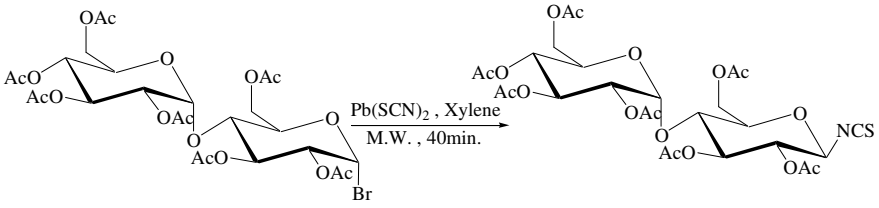
1-Hepta-*O*-acetyl-β-D-lactosyl-3-aryl thiocarbamides

(VIa-g)

Where, R" = a) phenyl, b) *o*-tolyl, c) *m*-tolyl, d) *p*-tolyl, e) *o*-Cl-phenyl, f) *m*-Cl-phenyl, g) *p*-Cl-phenyl.

Scheme 2

In the similar manner, 1-hepta-*O*-acetyl-*β*-*D*-maltosyl-3-aryl thiocarbamides **(IXa-g)** have been synthesized from hepta-*O*-acetyl-*β*-*D*-maltosyl isothiocyanate **(VIII)** (0.005 M, 3.5 g) dissolved in benzene solution with appropriate amount of various aryl amines. (Scheme 3). The results were showed in Table 2.

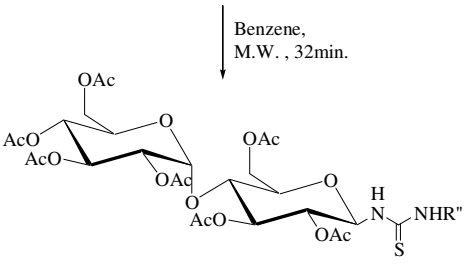


Hepta-*O*-acetyl-α-D-maltosyl bromide

(VII)

Hepta-*O*-acetyl-β-D-maltosyl isothiocyanate

(VIII)



1-Hepta-*O*-acetyl-β-D-maltosyl-3-aryl thiocarbamides

(IXa-g)

Where, R" = a) phenyl, b) *o*-tolyl, c) *m*-tolyl, d) *p*-tolyl, e) *o*-Cl-phenyl, f) *m*-Cl-phenyl, g) *p*-Cl-phenyl.

Scheme 3

Acknowledgment

The authors are thankful to UGC, New Delhi for providing financial support for the major research project. [Project File No. 38-208/2009(SR)]. The authors acknowledge the help of SAIF, C.D.R.I., Lucknow. They are also thankful to Principal, Dr. S.G. Bhadange for providing necessary facilities.

References

1. Corsaro A, Chiacchio U, Pistara V and Romeo G, *Curr Org Chem.*, 2004, **8(6)**, 511-538.
2. Ubarahande S S, Thakare V G and Berad B N, *J Indian Chem Soc.*, 2010, **87,** 1137-1141.
3. Mukerjee A K and Ashare R, *Chem Rev.*, 1991, **91(1)**, 1-24.
4. Garcia Fernandez J M and Mellet C O, *Adv Carbohydr Chem Biochem.*, 2000, **55**, 35-135.
5. Gasch C, Pradera M A, Salameh B A B, Molina J L and Fuentes J, *Tetrahedron Asymmetry*, 2001, **12**, 1267-1277.
6. Fernandez-Bolanos J G, Zafra E, Lopez O, Robina I and Fuentes J, *Tetrahedron: Asymmetry*, 1999, **10(15)**, 3011-3023.
7. Todoulou O G, Papadaki-Valiraki A E, Filippatos E C, Ikeda S and De Clercq E, *Eur J Med Chem.*, 1994, **29**, 127-131.
8. Povarov L S, Potapova N P, Bakina E V, Preobrazhenskaya M N and Rozynov B V, *Bioorg Khim.*, 1992, **18**, 1117-1126.
9. Deshmukh S P, *Oriental J Chem*., 2000, **16(1),** 143-146.
10. Mahalle P R, Korpe G V and Deshmukh S P, *J Indian Chem Soc.*, 2008, **85**, 953-958.
11. Tale P V and Deshmukh S P, *Heteroatom Chem.*, 2006, **17(4)**, 306-309.