Organic & Biomolecular Chemistry

Accepted Manuscript

This article can be cited before page numbers have been issued, to do this please use: V. H. Tran, M. T. La and H. Kim, *Org. Biomol. Chem.*, 2019, DOI: 10.1039/C9OB01093A.

ROYAL SOCIETY OF CHEMISTRY

rsc.li/obc

View Article Online
DOI: 10.1039/C9OB01093A

ARTICLE

Practical Preparation of Diphenylmethyl Ethers from 2-Diphenylmethoxypyridine using Catalytic Iron (Ⅲ) Chloride

Received 00th January 20xx,
Accepted 00th January 20xx

DOI: 10.1039/x0xx00000x

Van Hieu Tran,[a,b] Minh Thanh La[a,b] and Hee-Kwon Kim*[a,b]

A novel facile synthetic method for producing diphenylmethyl (DPM) ethers from 2-diphenylmethoxypyridine was developed. A variety of DPM ethers was successfully achieved with high yield via treatment of alcohols with 2-diphenylmethoxypyridine in the presence of catalytic $FeCl_3$. The procedure is a practical and efficient synthetic procedure to protect various alcohols, and it can be applied to prepare bioactive compounds.

Introduction

Protection and deprotection methods are widely used in many organic syntheses. Various protecting groups have been employed for multistep synthesis of natural products or bioactive compounds, and useful protecting groups have been developed. Diphenylmethyl (DPM) groups are commonly used to protect hydroxyl groups. These products are known as benzhydryl ethers and were first used for protection of thiols.[1] DPM groups have been widely used because deprotection of the DPM group can be readily achieved under mild conditions. For example, a hydrogenation procedure has been used for removal of DPM groups from protected ethers.[2] Acidic reaction conditions such as aqueous HCl in THF, trifluoroacetic acid in CH_2Cl_2, $TiCl_4$, or electrolytic reduction are also useful for deprotection of DPM groups.[3-7] In addition to protection of hydroxyl groups in multistep synthesis, DPM ethers have been employed as effective bulky motifs for several chiral-selective reactions and for preparation of biologically active compounds such as H3 receptor antagonist and therapeutic agents for cocaine dependence.[8-12]

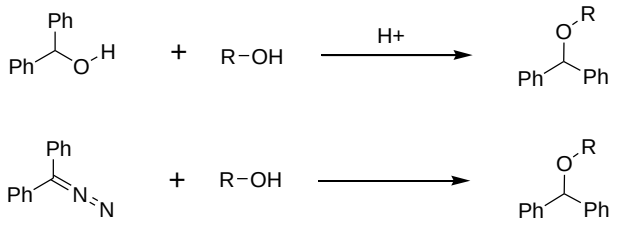
Several methods have been developed to form DPM ethers due to their importance in organic synthesis. It was reported that transformations of alcohol to the corresponding DPM ether were achieved by treatment of alcohol with benzhydrol under acidic conditions (scheme 1).[13-14] However, such reactions have employed harsh conditions such as use of strong acids or large amounts of acid, which may affect several sensitive functional groups. Reactions using tri-diphenylmethyl phosphate, diphenylmethyl diphenyl phosphate, and diphenyldiazo methane to produce DPM ethers were also developed.[15-17] However, the synthetic procedure for alkyl phosphates was expensive. In addition, diazo compounds are unstable, and careful treatment is required due to their toxicity.

Other non–diazo-mediated methods have been developed for DPM etherification. In particular, Chisholm's group introduced *O*-diphenylmethyl trichloroacetimidate for preparation of DPM ethers.[18] However, the reaction of trichloroacetimidate with alcohols for DPM ether preparation requires high temperatures (such as the high reflux temperature of toluene, 110 ℃) and long reaction times (e.g., 24 h). In addition, this reaction may produce side products by rearrangement of the DPM-protected amine, leading to efficiency concerns.

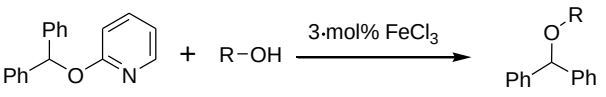
In addition, several metal-based catalysts have been used to synthesize ethers from benzydrol, namely $NbCl_5$ (niobium(V) chloride), and $PdCl_2$ (palladium chloride).[19-20] However, these catalysts are expensive, and the use of benzydrol could lead to self-etherification to produce the byproduct bis(diphenylmethyl) ether. Thus, it is desirable to find new efficient reaction procedure using more suitable catalysts that are effective and inexpensive.

2-*O*-Substituted pyridines have recently been employed for synthesis of ethers.[21] Dudley and colleagues reported that 2-benzyloxy-1-methylpyridinium salt, a reaction intermediate, could be a useful benzyl transfer agent for preparation of benzyl ethers.[21] However, formation of ethers using the synthetic method took one day and required two reaction steps. In addition, reaction conditions to produce benzyl ethers required high temperatures. Even though the 2-benzyloxy-1-methylpyridine-mediated reaction showed a weakness for etherification, we assumed that this approach could be applied to other reactions, including synthesis of DPM ethers.

Previous work



This work



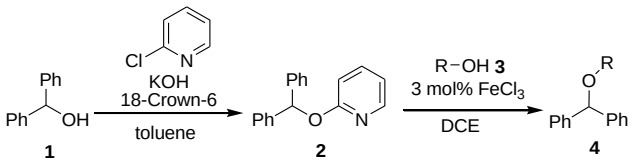
Scheme 1 Synthesis of diphenylmethyl ethers

[a] *Address here Department of Nuclear Medicine, Molecular Imaging & Therapeutic Medicine Research Center, Chonbuk National University Medical School and Hospital, Jeonju, 54907, Republic of Korea*
[b] *Research Institute of Clinical Medicine of Chonbuk National University-Biomedical Research Institute of Chonbuk National University Hospital, Jeonju, 54907, Republic of Korea*

Electronic Supplementary Information (ESI) available: [details of any supplementary information available should be included here]. See DOI: 10.1039/x0xx00000x

We hypothesized that highly efficient reactions to form DPM ethers could be discovered with reaction of 2-diphenyloxy-1-methylpyridine and alcohols in the presence of a novel catalyst. To the best of our knowledge, there is no synthetic method to convert 2-diphenylmethoxypyridine to DPM ethers via application of metal-based catalysts. Herein, we describe a novel practical synthetic method using catalytic metal-based reagents to prepare DPM ethers from 2-diphenylmethoxypyridine.

Results and discussion



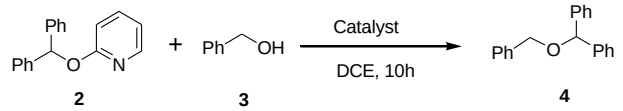
1 2 4

Scheme 2 Novel synthetic strategy of diphenylmethyl ethers

2-Diphenylmethoxypyridine (compound **2**), a starting material, was easily synthesized via reaction of diphenylmethyl alcohol with 2-chloropyridine, potassium, and 18-crown-6 according to our previous method, as shown in Scheme 2.[22]

We assumed that a catalytic reagent such as a Lewis acid would be good choice in DPM etherification. In the initial study, benzyl alcohol was employed as a substrate for the reaction with 2-diphenylmethoxypyridine. Etherification reactions of benzyl alcohol were performed in the presence of 1.5 equiv. of 2-diphenylmethoxypyridine, 1.0 equiv. of benzyl alcohol, and 0.03 equiv. of various reagents at 70 ℃ for 10 h, and the conversion yields from alcohols to the corresponding ethers were evaluated.

Table 1 Screening of catalyst for DPM etherification[a]



2 3 4

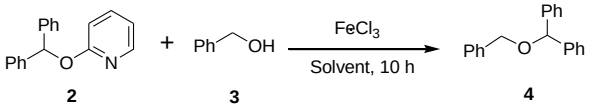
Entry	Catalyst	Temp.	Yield[b] (%)
1	K_2CO_3	70 ℃	NR[c]
2	DBU	70 ℃	NR[c]
3	$BF_3{\cdot}OEt_2$	70 ℃	NR[c]
4	$ZnCl_2$	70 ℃	NR[c]
5	$BiCl_3$	70 ℃	NR[c]
6	$CuCl_2$	70 ℃	3
7	$MnCl_2$	70 ℃	2
8	$ZrCl_4$	70 ℃	5
9	$AlCl_3$	70 ℃	52
10	$SnCl_4$	70 ℃	53
11	$FeCl_3$	70 ℃	94
12	None	70 ℃	NR[c]

[a] Reaction conditions: compound 2 (1.5 mmol), alcohol (1.0 mmol), catalyst (0.03 mmol), DCE (2 mL), 70 °C, 10 h
[b] Isolated yield after purification via flash column chromatography
[c] No reaction

Our initial screening study suggests that the reaction result was significantly affected by catalyst type, as shown in Table 1. Our result indicated that the use of bases including K_2CO_3 and DBU or Lewis acids such as $BF_3{\cdot}OEt_2$, $ZnCl_2$, and $BiCl_3$ could not yield the desired product (Table 1). Reactions using $CuCl_2$, $MnCl_2$, and $ZrCl_4$ produced the desired DPM esters with very low yields (less than 10%). Addition of $SnCl_4$ and $AlCl_3$ to the reaction resulted in increased yields of the target product. However, the results were still unsatisfactory. Finally, the reaction experiment with $FeCl_3$ was examined to prepare DPM ether, and the transformation yield of benzyl alcohol to the DPM ether was significantly increased to 94%, suggesting that $FeCl_3$ is the most effective known catalyst for DPM etherification.

Next, solvents were screened for DPM etherification. The screening study suggested that DCE was an effective reaction solvent (Table 2) for the reaction using 3 mol% of $FeCl_3$, providing a corresponding DPM ether with 94% yield. We also tried to decrease the catalyst loading to develop a green chemical protocol. Thus, various amounts of $FeCl_3$ catalyst were used in the reaction to form DPM ethers. As shown in Table 2, the amount of catalyst loading could be reduced to 1 mol% to afford a DPM ether product with satisfactory reaction yield.

Table 2 Screening of solvent for in situ etherification[a]



2 3 4

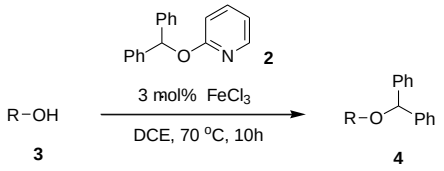
Entry	Catalyst (equiv.)	Solvent	Yield[b] (%)
1	$FeCl_3$ (0.03)	THF	43
2	$FeCl_3$ (0.03)	MeCN	45
3	$FeCl_3$ (0.03)	Dioxane	50
4	$FeCl_3$ (0.03)	Toluene	71
5	$FeCl_3$ (0.03)	DCE	94
6	$FeCl_3$ (0.2)	DCE	95
7	$FeCl_3$ (0.1)	DCE	95
8	$FeCl_3$ (0.05)	DCE	94
9	$FeCl_3$ (0.01)	DCE	74
10[c]	$FeCl_3$ (0.01)	DCE	87
11[d]	$FeCl_3$ (0.005)	DCE	63

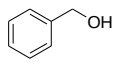
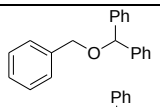
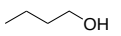
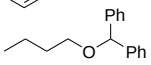
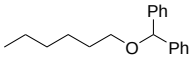
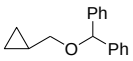
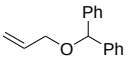
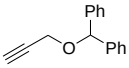
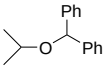
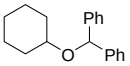
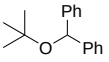
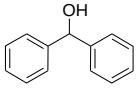
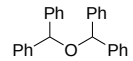
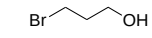
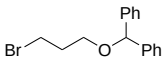
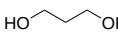
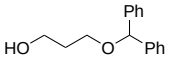
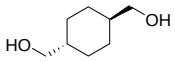
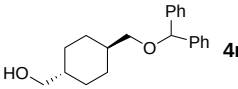
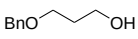
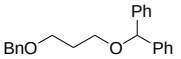
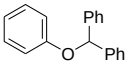
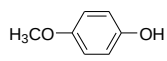
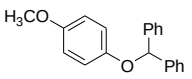
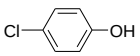
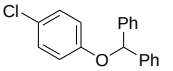
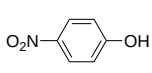
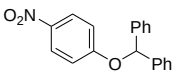
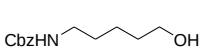
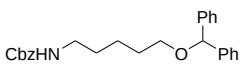
[a] Reaction conditions: compound **2** (1.5 mmol), alcohol (1.0 mmol), solvent (2 mL), 70°C, 10 h
[b] Isolated yield after purification via flash column chromatography
[c] Reaction conducted for 24 h
[d] Reaction conducted for 40 h

Using this result, the scope of this reaction for the synthesis of DPM ethers was evaluated using different types of alcohols (Table 3). Aliphatic primary alcohols were readily converted into the corresponding DPM ethers in high yields (Table 3, entries 2-4). Unsaturated alcohols such as allyl alcohol and propargyl alcohol were also reacted with 2-diphenylmethoxypyridine in the presence of

View Article Online
DOI: 10.1039/C9OB01093A

Table 3 Scope of DPM etherification using various alcohols[a]



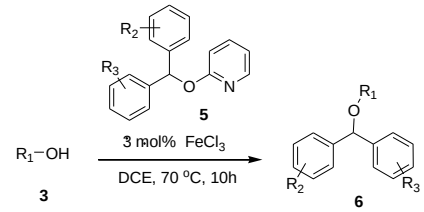
Entry	Alcohol		Product		Yield[b] (%)
1		**3a**		**4a**	94
2		**3b**		**4b**	94
3		**3c**		**4c**	93
4		**3d**		**4d**	89
5		**3e**		**4e**	93
6		**3f**		**4f**	92
7		**3g**		**4g**	86
8		**3h**		**4h**	87
9		**3i**		**4i**	84
10		**3j**		**4j**	90
11		**3k**		**4k**	92
12		**3l**		**4l**	85
13		**3m**		**4m**	78
14		**3n**		**4n**	93
15		**3o**		**4o**	90
16		**3p**		**4p**	91
17		**3q**		**4q**	95
18		**3r**		**4r**	85
19		**3s**		**4s**	91

[a] Reaction conditions: alcohol (1.0 mmol), compound 2 (1.5 mmol), $FeCl_3$ (0.03 mmol), DCE (2 mL), 70℃ for 10 h
[b] Isolated yield after purification via flash column chromatography

catalytic $FeCl_3$, and the desired DPM esters were obtained in 93% and 92% yields respectively (Table 3, entries 5–6).

Next, secondary and tertiary alcohols were investigated to investigate steric effects on reaction yields (Table 3, entries 7–10). Reactions of isopropanol, a secondary alcohol, provided the target in 86% yield. When *tert*-butyl alcohol, which has a greater steric effect, was treated with 2-diphenylmethoxypyridine under the same conditions, the synthetic yield of the DPM ether was 84%. Cyclohexanol was also used as an alicyclic substrate to examine the scope of this reaction protocol; the target DPM ether was prepared with 87% yield. Besides, benzhydrol containing two aromatic rings readily reacted with with 2-diphenylmethoxypyridine. Bromopropanol, diols, and 3-(benzyloxy)propan-1-ol were also tested to show more functional group tolerance, and the reactions successfully yield the corresponding DPM ethers (Table 3, entries 11–14). Development of efficient procedures to convert phenol to its DPM ether is valuable because achieving good synthetic results using existing procedures for this reaction can be difficult.[20] Thus, phenol was investigated for this reaction, and was etherified using 2-diphenylmethoxypyridine with 90% yield. Additionally, reactions of phenols with electron-donating and electron-withdrawing groups gave the target DPM ethers in high yields ranging from 85% to 95% (Table 3, entries 15–18). This result suggested that usage of catalytic amounts of $FeCl_3$ could produce the desired DPM ethers from a variety of aromatic alcohols with satisfactory yield. *N*-Cbz–protected amino alcohol was also examined to assess functional group tolerance; the target DPM ether 4n was readily obtained in 91% yield (Table 3, entry 19).

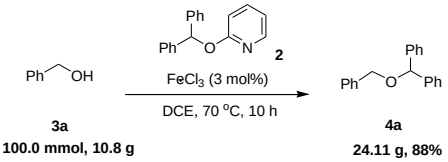
Table 4 Scope of DPM etherification using various diphenyl methanols[a]



[a] Reaction conditions: alcohol (1.0 mmol), compound **2** (1.5 mmol), $FeCl_3$ (0.03 mmol), DCE (2 mL), 70 ℃ for 10 h

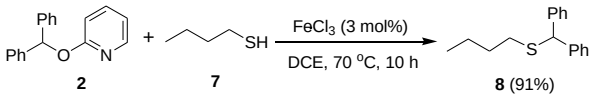
Different structures of diphenyl methyl ether scaffold were also found in commercially available drugs or bioactive compounds, including dopamine reuptake inhibitor and dopamine transporter inhibitors.[12, 23] Thus, to demonstrate the utility of $FeCl_3$-catalyzed DPM etherification, this procedure was applied to conversion of diverse substituted 2-diphenylmethoxypyridines bearing mono-/di-substitions to substituted diphenylmethyl ethers, as shown in Table 4. First, mono-substituted 2-diphenylmethoxypyridine was used to prepare a series of diphenylmethyl ethers. Alcohols such as butyl alcohol and allyl alcohol readily reacted with mono-substituted 2-diphenylmethoxypyridine-bearing, electron-donating groups (methyl-) and electron-withdrawing groups (nitro-, and chloro-) under the optimal reaction conditions, yielding the desired diphenylmethyl ether products in high yields (Table 4, 6a-6c, and 6g-6i). In addition, di-substituted 2-diphenylmethoxypyridine was employed for treatment of alcohols, and bis(4-methylphenyl)methyl ethers and bis(4-halophenyl)methyl ethers were successfully obtained in high yields. These results indicate that the novel synthetic method using $FeCl_3$ can be used to prepare various biologically active compounds.

Next, scale-up DPM etherification was conducted (Scheme 3). In the gram-scale reaction of benzyl alcohol, DPM ether was successfully obtained from the same reaction conditions: reaction of benzyl alcohol (**3a**) (100.0 mmol, 10.8 g) with 2-diphenylmethoxypyridine (**2**) afforded the target ether product (**4a**) in 88% yield via optimized reaction conditions. Thus, this reaction method is effective and scalable.

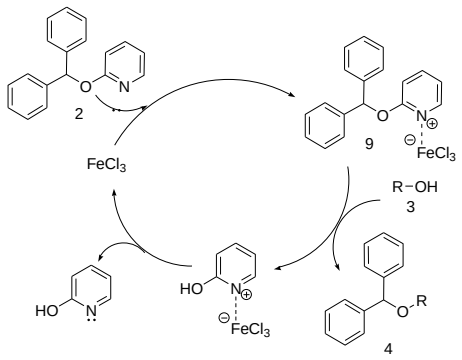


Scheme 3 Gram-scale reaction of benzyl alcohol (**3a**) with 2-diphenylmethoxypyridine (**2**).

Besides, 1-butanethiol, another nucleophile, was employed for this reaction, and it was found that the conversion yield was 91% under the same reaction condition (Scheme 4).



Scheme 4 Reaction of 1-butanethiol (**7**) with 2-diphenylmethoxypyridine (**2**).

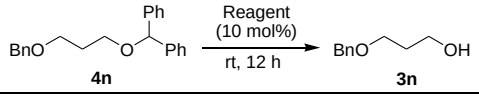


Scheme 5 Proposed etherification mechanism using 2-diphenylmethoxypyridine with $FeCl_3$.

A proposed reaction mechanism for this DPM esterification is shown in Scheme 5. 2-Diphenylmethoxypyridine **2** is activated by coordination of $FeCl_3$ with nitrogen atom to generate a $FeCl_3$-2-diphenylmethoxypyridine complex intermediate, which undergoes intermolecular nucleophilic attack by alcohol to give the DPM ether product. Then, $FeCl_3$ was given back to the reaction and continuously catalyze DPM ether reaction.

Besides, deprotection reaction of DPM ether was performed (Table 5). Several reagents (10 mol%) was tested for DPM deprotection of compound **4n** at room temperature for 12 h. When compound **4n** was treated with $FeCl_3$ and $MnCl_2$, target product was not prepared. However, reaction of compound **4n** with $AlCl_3$ and $ZrCl_4$ yielded the corresponding product with 44% and 78% yields, respectively. The result indicated that employment of $FeCl_3$ did not influence on the deprotection of DPM ether, suggesting that it was useful to prepare DPM ether, and $ZrCl_4$ is an effective catalytic reagent to remove DPM group from DPM ethers.

Table 5 DPM deprotection study with catalysts



Reagents	$FeCl_3$	$MnCl_2$	$AlCl_3$	$ZrCl_3$
(10 mol%)	No reaction	No reaction	44%	78%

Conclusions

In conclusion, a novel and efficient synthetic method for DPM etherification of various alcohols was developed. A novel synthetic protocol of DPM ethers is valuable to protect alcohols and to prepare bioactive compounds because many drugs contain diphenylmethyl ether moieties. Here, we described the $FeCl_3$-catalyzed reaction of alcohols with 2-diphenylmethoxypyridine to yield DPM ethers in high yield. The novel method is practical and highly efficient in producing DPM ethers, and it is a promising approach for preparation of bioactive compounds such as drugs.

Experimental

General methods

Reactions were performed in a well-dried flask under argon atmosphere unless noted otherwise. Solvents used as reaction media were dried over pre-dried molecular sieves (4 Å) in a microwave oven. Solvents for extraction and chromatography were reagent grade and used as received. Column chromatography was performed with silica gel 60 (70−230 mesh) using a mixture of DCM/hexane as eluent. ^1H and ^{13}C NMR spectra were, respectively, recorded on a 400 MHz (^1H NMR), 100 MHz (^{13}C NMR) spectrometer in deuterated chloroform ($CDCl_3$) with tetramethylsilane(TMS) as an internal reference. Data are reported as (ap = apparent, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad; coupling constant(s) in Hz, integration). High-resolution mass spectroscopy was performed using a magnetic sector analyzer. All of the new compounds were identified by ^1H and ^{13}C NMR, and high resolution mass spectroscopy. The identity of the known compounds was established by the comparison of their ^1H and ^{13}C NMR peaks with the authentic values.

Procedure for the preparation of 2-

diphenylmethoxypyridinium (2)
Benzydrol (3.0 g, 16.2 mmol), followed by 2-chloropyridine (1.9 mL, 19.5 mmol), and toluene (40 ml) were added sequentially to the round bottom flask. Potassium hydroxide (3.66g, 65.13 mmol) was ground in a mortar in pestle and then added to the reaction flask, followed by 18-crown-6 (0.21 g, 0.81 mmol). The reaction mixture was heated at 110 °C) for 2h. After cooling to room temperature, the reaction mixture was diluted with ethyl acetate (2 x 50 mL), washed with water (80 mL), followed by brine (80 mL). The organic layer was dried thoroughly over anhydrous sodium sulfate, and concentrated in vacuo. Column chromatography of the residue (1:2 dichloromethane/ hexane) yielded the product **2** as a white solid (3.65 g, 93%). m.p. 59 - 61°C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.14 – 8.12 (dd, J = 5.0 Hz, J = 1.5 Hz, 1H), 7.58 (ddd, J = 8.0 Hz, J = 7.0, Hz, J = 1.5 Hz, 1H), 7.46 (d, J = 6.5 Hz, 4H), 7.33 (t, J = 7.0 Hz, 4H), 7.29 (s, 1H), 7.25 – 7.23 (m, 2H), 6.88 (d, J = 7.0 Hz, 1H), 6.82 (ddd, J = 6.5 Hz, J = 5.5, Hz, J = 1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.9, 146.9, 141.6, 138.7, 128.4, 127.5, 127.3, 117.0, 111.6, 77,5; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{18}H_{16}NO$ = 262.1232, found 262.1237.

General procedure of the synthesis of diphenylmethoxyl ethers (4a-4s) & (6a-6l)
To a solution of benzyl alcohol (0.108 g. 1.00 mmol) and 2-diphenylmethoxypyridine (0.39 g, 1.50 mmol) in DCE (2 mL) $FeCl_3$ (0.0048 g. 0.03 mmol) was added. The mixture was stirred at 70 °C for 10h. The reaction mixture was extracted with ethyl acetate (2 x 10 mL), and then washed with water (10 mL), followed by brine (10 mL). The organic layer was dried over anhydrous sodium sulfate and concentrated under reduced pressure. The resulting residue was then purified by flash column chromatography on silica gel with hexane-CH_2Cl_2 as eluent to afford the desired product **4a** as a colorless liquid (0.260 g, 94%).
(Benzyloxymethylene)dibenzene (4a). Colorless liquid (0.260 g, 94%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.31 (m, 15H), 5.51 (s, 1H), 4.62 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.67, 138.43, 128.45 (4C), 128.41 (2C), 127.75 (2C), 127.57, 127.51 (2C), 127.17 (4C), 82.51, 70.53; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{20}H_{19}O$ = 275.1436, found 275.1438.
Butoxymethylene)dibenzene (4b). Colorless oil (0.225 g, 94%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.26 (m, 10H), 5.35 (s, 1H), 3.48 (t, J = 6.8 Hz, 2H), 1.69 – 1.62 (m, 2H), 1.49 – 1.42 (m, 2H), 0.93 (t, J = 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.66 (2C), 128.31 (4C), 127.29 (2C), 126.96 (4C), 83.57, 68.95, 32.01, 19.48, 13.96; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{21}O$ = 241.1592, found 241.1594.
(Heptyloxymethylene)dibenzene (4c). Colorless liquid (0.262 g, 93%);^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.33 (m, 8H), 7.31 – 7.25 (m, 2H), 5.36 (s, 1H), 3.48 (t, J = 6.4 Hz, 2H), 1.71 – 1.65 (m, 2H), 1.43 – 1.37 (m, 2H), 1.32 – 1.28 (m, 6H), 0.91 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.67 (2C), 128.38 (4C), 128.32 (2C), 127.29 (4C), 83.59, 69.27, 31.86, 29.92, 29.18, 26.25, 22.66, 14.12; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{20}H_{27}O$ = 283.2062, found 283.2065.
((Cyclopropylmethoxy)methylene)dibenzene (4d). Yellowish liquid (0.211 g, 89%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 - 7.27 (m, 10H), 5.47 (s, 1H), 5.46 (s, 1H), 3.37 (d, J = 6.8 Hz, 2H), 1.20 - 1.16 (m, 1H), 0.58 - 0.56 (m, 2H), 0.25 - 0.22 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.47 (2C), 128.37 (4C), 127.36 (2C), 127.05 (4C), 83.12, 73.66, 10.78, 3.13 (2C); HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{19}O$ = 239.1436, found 239.1437.
(Allyloxymethylene)dibenzene (4e). Colorless liquid (0.208 g, 93% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.34 (m, 8H), 7.31 – 7.28 (m, 2H), 6.07 – 5.97 (m, 1H), 5.47 (s, 1H), 5.38 – 5.33 (m, 1H), 5.26 – 5.22 (m, 1H), 4.07 – 4.05 (d, J = 5.6 Hz, J = 1.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.22 (2C), 134.79, 128.40 (4C), 127.44 (2C), 127.02 (4C), 116.91, 82.63, 69.07; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{17}O$ = 225.1279, found 225.1280.
((Prop-2-ynyloxy)methylene)dibenzene (4f). Colorless liquid (0.204 g, 92 %); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 - 7.31 (m, 10H), 7.52 (s, 1H), 4.20 (d, J = 2.4 Hz, 2H), 2.49 (t, J = 2.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.17 (2C), 128.46 (4C), 127.71 (2C), 127.30 (4C), 81.67, 79.76, 74.61, 55.81; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{15}O$ = 223.1123, found 223.1125.
(isopropoxymethylene)dibenzene (4g). Colorless liquid (0.194 g, 86%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.33 (m, 8H), 7.29 – 7.25 (m, 2H), 5.53 (s, 1H), 3.74 – 3.68 (m, 1H), 1,27 (d, J = 6.4 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.00 (2C), 128.32 (4C), 127.26 (2C), 127.11 (4C), 80,47, 69.11, 22.28 (2C); HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{19}O$ = 227.1436, found 227.1438.
(Cyclohexyloxymethylene)dibenzene (4h). Colorless liquid (0.208 g, 87%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.27 (m, 10H), 5.59 (s, 1H), 3.43 – 3.38 (m, 1H), 1,98 – 1.95 (m, 2H), 1.80 - 1.78 (m, 2H), 1.54 – 1.45 (m ,3H), 1.30 -1.20 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.17 (2C), 128.29 (4C), 127.20 (2C), 127.15 (4C), 79,97, 75.05, 32.41 (2C), 25.89, 24.15 (2C); HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{19}H_{23}O$ = 267.1749, found 267.1751.
(*tert*-butoxymethylene)dibenzene (4i). Colorless liquid (0.218 g, 84%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.31 (m, 8H), 7.28 – 7.23 (m, 2H), 5.63 (s, 1H), 1.27 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.13 (2C), 128.14 (4C), 126.94 (2C), 126.76 (4C), 75.75, 75.00, 28.79 (3C); HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{21}O$ = 241.1592, found 241.1593.
Oxybis(methanetriyl)tetrabenzene (4j). White solid (0.315g, 90%). m.p. 108 -110.0°C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.38 (m, 8H), 7.36 – 7.33 (m, 8H), 7.30 – 7.25 (m, 4H), 5.43 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.22 (4C), 128.41 (8C), 127.45 (4C), 127.28 (8C), 80.00 (2C); HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{26}H_{23}O$ = 351.1749, found 351.1751.
((3-bromopropoxy)methylene)dibenzene (4k). Colorless oil (0.28 g, 92%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.33 (m, 8H), 7.31 – 7.26 (m, 2H), 5.39 (s, 1H), 3.61 (t, J = 5.6 Hz, 4H), 2.23 – 2.17 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.15 (2C), 128.41 (4C), 127.50 (2C), 126.94 (4C), 83.88, 68.49, 33.10, 30.82; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{18}BrO$ = 305.0541, found 305.0545.
3-(benzhydryloxy)propan-1-ol (4l). Colorless oil (0.21g, 85%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.29 (m, 8H), 7.25 – 7.22 (m, 2H), 5.35 (s, 1H), 3.79 (t, J = 5.6 Hz, 2H), 3.64 (t, J = 6.0 Hz, 2H), 2.10 (s, 1H), 1.92 – 1.86 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.02 (2C), 128.48 (4C), 127.56 (2C), 126.85 (4C), 84.19, 68.16, 61.96, 32.32; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{19}O_2$ = 243.1385, found 243.1389.
(4-(benzhydryloxymethyl)cyclohexyl)methanol (4m). Colorless oil (0.24g, 78%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.32 (m, 8H), 7.30 – 7.24 (m, 2H), 5.34 (s, 1H), 3.49 (d, J = 6.0 Hz, 2H), 3.31 (d, J = 6.4 Hz, 2H), 1.95 – 1.92 (m, 2H), 1.86 – 1.83 (m, 2H), 1.69 – 1.64 (m, 1H), 1.49 – 1.44 (m, 1H), 1.40 (s, 1H), 1.08 – 0.95 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.66 (2C), 128.32 (4C), 127.31 (2C), 126.94 (4C), 83.67, 74.79, 68.72, 40.65, 38.45, 29.47 (2C), 28.97 (2C); HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{21}H_{27}O_2$ = 311.2011, found 311.2014.
((3-(benzyloxy)propoxy)methylene)dibenzene (4n). Yellowish oil (0.31g, 93%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 - 7.38 (m, 15H), 5.39 (s, 1H), 4.54 (s, 2H), 3.68 (t, J = 6.4 Hz, 2H), 3.63 (t, J = 6.4 Hz, 2H), 2.05 - 1.99 (m, 2H); ^{13}C NMR

(100 MHz, $CDCl_3$) δ 142.50 (2C), 138.56, 128.37 (6C), 127.68, 127.53, 127.34 (2C), 126.99 (4C), 83.73, 73.27, 67.48, 66.06, 30.34; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{23}H_{25}O_2$ = 333.1855, found 333.1852.

(Phenoxymethylene)dibenzene (4o). White solid (0.234 g, 90%); m.p. 53-54 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.48 - 7.39 (m, 4H), 7.38 - 7.36 (m, 4H), 7.32 - 7.25 (m, 4H), 7.01- 6.99 (m, 3H), 6.26 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.13, 141.31 (2C), 129.37 (2C), 128.61 (4C), 127.74 (2C), 126.92 (4C), 121.00, 116.13 (2C), 81.70; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{19}H_{17}O$ = 261.1279, found 261.1280.

1-(benzhydryloxy)-4-methoxybenzene (4p). White solid (0.263 g, 91%); m.p. 58-60°C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.44 (m, 4H), 7.39 – 7.35 (m, 4H), 7.32 – 7.30 (m, 2H), 6.93 – 6.90 (m, 2H), 6.80 - 6.78 (m, 2H) 6.14 (s, 1H), 3.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.99, 152.26, 141.51 (2C), 128.56 (4C), 127.69 (2C), 126.94 (4C), 117.28 (2C), 114.51 (2C), 82.64, 55.64; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{20}H_{19}O_2$ = 291.1385, found 291.1387.

1-(benzhydryloxy)-4-chlorobenzene(4q). White solid (0.279 g, 95%); m.p. 62-64°C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.45 - 7.43 (m, 4H), 7.40 – 7.36 (m, 4H), 7.33 – 7.28 (m, 2H), 7.20 (dd, J = 8.8 Hz, J = 2.4 Hz, 2H), 6.92 (dd, J = 8.8 Hz, J = 2.2 Hz, 2H), 6.20 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.65, 140.83 (2C), 129.27 (2C), 128.69 (4C), 127.91 (2C), 126.86 (4C), 125.91, 117.45 (2C); HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{19}H_{16}ClO$ = 295,0890, found 295.0893.

1-(benzhydryloxy)-4-nitrobenzene (4r). White solid (0.259 g, 85%); m.p. 68-70°C; ^1H NMR (400 MHz, $CDCl_3$) δ 8.17 – 8.15 (dd, J =7.2 Hz, J = 2.4 Hz, 2H), 7.43 – 7.39 (m, 10H), 7.05 – 7.03 (dd, J =7.2 Hz, J = 2.4 Hz, 2H), 6.34 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.96, 141.61, 139.83 (2C), 128.88 (4C), 128.30 (2C), 126.77 (4C), 125.82 (2C), 115.95 (2C), 82.49; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{19}H_{16}NO_3$ = 306.1130, found 306.1132.

Benzyl 5-(benzhydryloxy)pentylcarbamate (4s). Yellowish liquid (0.366 g, 91%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.26 (m, 15H), 5.35 (s, 1H), 5.12 (s, 2H), 4.78 (s, 1H), 3.48 (t, J = 6.4 Hz, 2H), 3.24 – 3.19 (m, 2H), 1.71 – 1.66 (m, 2H), 1.55 – 1.43 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.36, 142.51 (2C), 136.66 (2C), 128.52 (2C), 128.37(4C), 128.13, 128.09, 127.88, 127.37 (2C), 126.94 (4C), 83.67, 68.85, 66.60, 41.04, 29.77, 29.52, 23.58; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{26}H_{30}NO_3$ = 404.2224, found 404.2225.

1-(butoxy(phenyl)methyl)-4-methylbenzene (6a). Colorless liquid (0.241 g, 95%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.34 (m, 4H), 7.28 – 7.26 (m, 3H), 7.17 – 7.15 (m, 2H), 5.35 (s, 1H), 3.48 (t, J = 6.4 Hz, 2H), 2.35 (s, 3H), 1.67-1.65 (m, 2H), 1.52 -1.45 (m, 2H), 0.95 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.89, 139.70, 136.94, 129.04 (2C), 128.31(2C), 83.42, 68.89, 66.60, 32.04, 21.15, 19.52, 14.01; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{18}H_{23}O$ = 255.1749, found 255.1752.

1-(butoxy(phenyl)methyl)-4-chlorobenzene (6b). Colorless liquid (0.258 g, 94%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.27 (m, 9H), 5.33 (s, 1H), 3.49 – 3.44 (m, 2H), 1.67 - 1.64 (m, 2H), 1.47 -1.42 (m, 2H), 0.94 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.89, 139.70, 136.94, 129.04 (2C), 128.31(2C), 83.42, 68.89, 66.60, 32.04, 21.15, 19.52, 14.01; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{20}ClO$ = 275.1203, found 275.1204.

1-(butoxy(phenyl)methyl)-4-nitrobenzene (6c). Yellowish liquid (0.256 g, 90%); ^1H NMR (400 MHz, $CDCl_3$) δ 8.18 – 8.15 (m, 2H), 7.54 – 7.52 (m, 2H), 7.34 – 7.28 (m, 5H), 5.40 (s, 1H), 3.50 – 3.41 (m, 2H), 1.66 - 1.61 (m, 2H), 1.46 -1.40 (m, 2H), 0.96 – 0.86 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.21, 147.08, 141.14, 128.72 (2C), 128.05, 127.41 (2C), 127.03 (2C), 123.62 (2C), 82.72, 69.16, 31.90, 19.45, 13.94; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{20}NO_3$ = 286.1443, found 286.1447.

4,4'-(butoxymethylene)bis(methylbenzene) (6d). Colorless liquid (0.243 g, 91%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.25 (d, J = 8.4 Hz, 4H), 7.14 (d, J = 8.0 Hz, 4H), 5.29 (s, 1H), 3.45 (t, J = 6.4 Hz, 2H), 2.33 (s, 6H), 1.66 – 1.62 (m, 2H), 1.50 – 1.41 (m, 2H), 0.92 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.92 (2C), 136.79 (2C), 128.99 (4C), 126.85 (4C), 83.26, 68.83, 32.05, 21.13 (2C), 19.51, 14.01; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{19}H_{25}O$ = 269.1905, found 269.1908.

4,4'-(butoxymethylene)bis(fluorobenzene) (6e). Colorless liquid (0.264 g, 96%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.32 - 7.29 (m, 4H), 7.05 – 7.01 (m, 4H), 5.32 (s, 1H), 3.45 (t, J = 6.4 Hz, 2H), 1.66 – 1.61 (m, 2H), 1.46 – 1.41 (m, 2H), 0.94 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.32, 160.88, 138.24, 138.22, 128.55, 128.47, 115.35, 115.14, 82.19, 68.92, 31.93, 19.47, 13.94; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{19}F_2O$ = 277.1404, found 277.1405.

4,4'-(butoxymethylene)bis(chlorobenzene) (6f). Colorless liquid (0.293 g, 95%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.33 - 7.26 (m, 8H), 5.28 (s, 1H), 3.44 (t, J = 6.4 Hz, 2H), 1.66 – 1.21 (m, 2H), 1.46 – 1.41 (m, 2H), 0.94 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.75 (2C), 133.28 (2C), 128.60 (4C), 128.22 (4C), 82.18, 69.03, 31.90, 19.46, 13.94; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{19}Cl_2O$ = 309.0813, found 309.0812.

1-(allyloxy(phenyl)methyl)-4-methylbenzene (6g). Colorless liquid (0.216 g, 91%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.40 - 7.34 (m, 4H), 7.28 - 7.27 (m, 3H), 7.17 - 7.15 (m, 2H), 6.06 - 5.96 (m, 1H), 5.44 (s, 1H), 5.37 - 5.32 (dq, J = 16.8 Hz, J = 1.6 Hz, 1H), 5.25 - 5.21 (dq, J = 10.8 Hz, J = 1.2 Hz, 1H), 4.05 - 4.03 (dt, J = 5.2 Hz, J = 1.6 Hz, 2H), 2.36 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.44, 139.23, 137.11, 134.87, 129.11, 128.37, 127.33, 127.00, 126.92, 116.84, 82.46, 69.63, 21.16; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{19}O$ = 239.1436, found 239.1438.

1-(allyloxy(phenyl)methyl)-4-chlorobenzene (6h). Colorless liquid (0.232 g, 90 %); ^1H NMR (400 MHz, $CDCl_3$) δ 7.37 - 7.28 (m, 9H), 6.03 - 5.96 (m, 1H), 5.43 (s, 1H), 5.36 - 5.31 (dq, J = 17.2 Hz, J = 1.6 Hz, 1H), 5.25 - 5.21 (dq, J = 10.4 Hz, J = 1.2 Hz, 1H), 4.05 - 4.03 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.69, 140.83, 134.55, 133.15, 128.55, 128.53, 128.33, 127.70, 126.97, 117.13, 81.88, 69.71; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{16}ClO$ = 259.0890, found 259.0892.

1-(allyloxy(phenyl)methyl)-4-nitrobenzene (6i). Yellowish liquid (0.244 g, 91%); ^1H NMR (400 MHz, $CDCl_3$) δ 8.19 - 8.16 (m, 2H), 7.57 - 7.54 (m, 2H), 7.38 - 7.28 (m, 5H), 6.01 - 5.92 (m, 1H), 5.50 (s, 1H), 5.34 - 5.29 (dq, J = 17.2 Hz, J = 1.6 Hz, 1H), 5.26 - 5.22 (dq, J = 10.4 Hz, J = 1.2 Hz, 1H), 4.08 - 3.97 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.77, 147.15, 140.65, 134.17, 128.80, 128.22, 127.45, 127.15, 123.66, 117.49, 81.67, 69.83; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{16}NO_3$ = 270.1130, found 270.1135.

4,4'-(allyloxymethylene)bis(methylbenzene) (6j). Colorless liquid (0.226 g, 90%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.27 (d, J = 8.0 Hz, 4H), 7.17 (d, J = 8.0 Hz, 4H), 6.05 – 5.96 (m, 2H), 5.41 (s, 1H), 5.36 – 5.31 (dq, J = 17.2 Hz, J = 1.6 Hz, 1H), 5.24 – 5.21 (dq, J = 10.4 Hz, J = 2.0 Hz, 1H), 4.04 – 4.02 (dt, J = 5.2 Hz, J = 1.2 Hz, 2H), 2.35 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.47 (2C), 136.96 (2C), 134.96, 129.05(4C), 126.92(4C), 116.73, 82.32, 69.57, 21.14 (2C); HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{18}H_{21}O$ = 253.1592, found 253.1593.

4,4'-(allyloxymethylene)bis(fluorobenzene) (6k). Colorless liquid (0.249 g, 96%); ^1H NMR (400 MHz, $CDCl_3$) δ 7.32 -

7.26 (m, 4H), 7.04 - 6.99 (m, 4H), 5.99 - 5.91 (m, 1H), 5.39 (s, 1H), 5.32 - 5.27 (dq, J = 17.2 Hz, J = 1.2 Hz, 1H), 5.23 - 5.19 (dq, J = 10.4 Hz, J = 1.6 Hz, 1H), 3.99 - 3.97 (dt, J = 5.6 Hz, J = 1.6 Hz, 2H); ^{13}C NMR (100 MHz, CDCl3) δ 163.39, 160.95, 137.80 (2C), 137.77 (2C), 134.46, 128.64 (2C), 128.56 (2C), 117.34, 115.44, 115.22, 81.18, 69.66; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{15}F_2O$ = 261.1091, found 261.1095.

4,4'-(allyloxymethylene)bis(chlorobenzene) (6l). Colorless liquid (0.278 g, 95%); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 - 7.28 (m, 8H), 6.00 - 5.92 (m, 1H), 5.39 (s, 1H), 5.35 - 5.29 (dq, J = 18.4 Hz, J = 2.0 Hz, 1H), 5.26 - 5.22 (dq, J = 10.4 Hz, J = 1.6 Hz, 1H), 4.02 - 4.00 (dt, J = 5.2 Hz, J = 1.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.31 (2C), 134.32 (2C), 133.44, 128.68 (4C), 128.30 (4C), 117.34, 81.15, 69.73; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{16}H_{15}Cl_2O$ = 293.0500, found 293.0501.

Benzhydryl(butyl)sulfane (8). Colorless oil (0.23g, 91%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 - 7.41 (m, 4H), 7.33 - 7.28 (m, 4H), 7.25 - 7.20 (m, 2H), 5.15 (s, 1H), 2.39 (t, J = 7.2 Hz, 2H), 1.58 - 1.51 (m, 2H), 1.41 - 1.32 (m, 2H), 0.86 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.62 (2C), 128.50 (4C), 128.29 (4C), 127.07 (2C), 54.16, 32.02, 31.14, 22.01, 13.68; HRMS (ESI) m/z $(M+H)^+$ calcd for $C_{17}H_{21}S$ = 257.1364, found 257.1365.

Conflicts of interest

There are no conflicts to declare

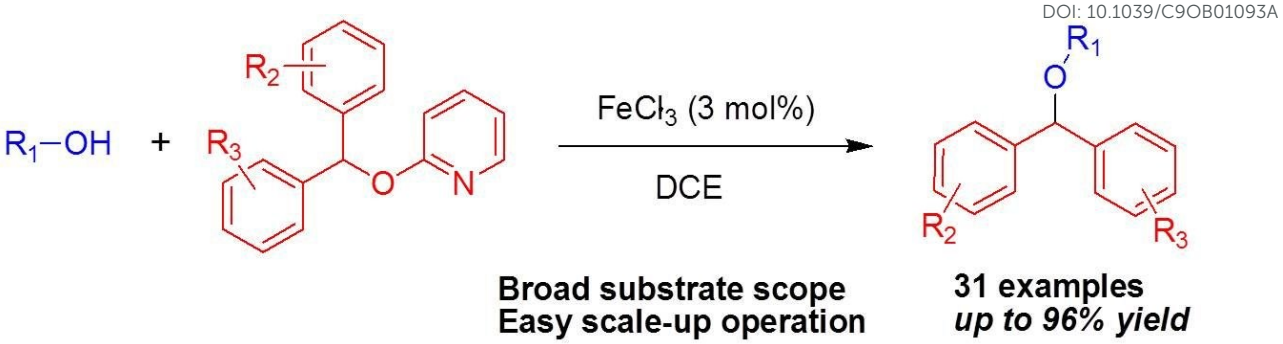
Acknowledgements

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2018R1D1A1B07047572). Tran Van Hieu was supported by the BK21 Plus program in the Chonbuk National University Medical School.

Notes and references

1. L. Zervas, I. Photaki, *J. Am. Chem. Soc*. 1962, **84**, 3887-3897.
2. 2 G. A. Olah, G. K. S. Prakash, S. C. Narang, *Synthesis*, 1978, 825
3. C. Froussios, M. Kolovos. *Synthesis*. 1987, 1106-1108.
4. M. B. Andrus, J. Liu, Z. Ye, J. F. Cannon. *Org. Lett*. 2005, **7**, 3861-3864.
5. R. Martín, C. Murruzzu, M. A. Pericàs, A. Riera. *J. Org. Chem*. 2005, **70**, 2325-2358.
6. V. G. Mairanovsky. *Angew. Chem. Int. Ed. Engl.* 1976, **15**, 281-292.
7. R. Paredes, R. L. Pérez. *Tetrahedron. Lett.* 1998, **39**, 2037-2038.
8. A. Jolit, P. M. Walleser, G. P. A. Yap, M. A. Tius. *Angew. Chem. Int. Ed.* 2014, **53**, 6180-6183.
9. S. Zhang, S. Izenwasser, D. Wade, L. Xu, M. L. Trudell. *Bioorganic. Med. Chem*. 2006, **14**, 7943-7952.
10. A. Hüls, K. Purand, H. Stark, X. Ligneau, J. M. Arrang, J. C. Schwartz. *Bioorganic. Med. Chem. Lett*. 1996, **6**, 2013-2018.
11. A. K. Dutta, X. S. Fei, P. M. Beardsley, J. L. Newman, M. E. A. Reith. *J. Med. Chem*. 2001, **44**, 937-948.
12. D. B. Lewis, D. Matecka, Y. Zhang, L. W. Hsin, C. M. Dersch, D. Stafford. *J. Med. Chem*. 1999, **42**, 5029-5042.
13. S. R. D. George, T. D. H. Frith, D. S. Thomas, J. B. Harper. *Org. Biomol. Chem*. 2015, **13**, 9035-9041.
14. M. T. Thornton, L. C. Henderson, *Org. Prep. Proced. Int.* 2013, **45**, 395-420.
15. L. Lapatsanis. *Tetrahedron. Lett*. 1978, **19**, 3943-3944.
16. D. Best, S. F. Jenkinson, S. D. Rule, R. Higham, T. B. Mercer, R. J. Newell. *Tetrahedron. Lett.* 2008, **49**, 2196-2199.
17. M. Kolovos, C. Froussios. *Tetrahedron. Lett.* 1984, **25**, 3909-3912.
18. K. T. Howard, B. C. Duffy, M. R. Linaburg, J. D. Chisholm. *Org. Biomol. Chem*. 2016, **14**, 1623-1628.
19. J. S. Yadav, D. C. Bhunia, K. K. Vamshi, P. Srihari. *Tetrahedron. Lett*. 2007, **48**, 8306-8310.
20. Y. Bikard Y, J. M. Weibel, C. Sirlin, L. Dupuis, J. P. Loeffler, P. Pale. *Tetrahedron. Lett*. 2007, **48**, 8895-8899.
21. K. W. C. Poon, G. B. Dudley. *J. Org. Chem*. 2006, **71**, 3923-3927.
22. M. T. La, H.-K. Kim. *Tetrahedron. Lett*. 2018, **59**, 1855-1859.
23. S. H. Ingwersen, S. Snel, T. G. K. Mant, D. Edwards. *J. Pharm. Sci*. 1993, **82**, 1164-1166.

View Article Online
DOI: 10.1039/C9OB01093A



Highly efficient synthesis of diphenylmethyl Ethers from alcohols and 2-diphenylmethoxypyridine in the presence of iron chloride has been developed.