EFFICIENT CONVERSION OF ALKYL HALIDES TO ALDEHYDES USING PYRAZINYLSULFINYL GROUP

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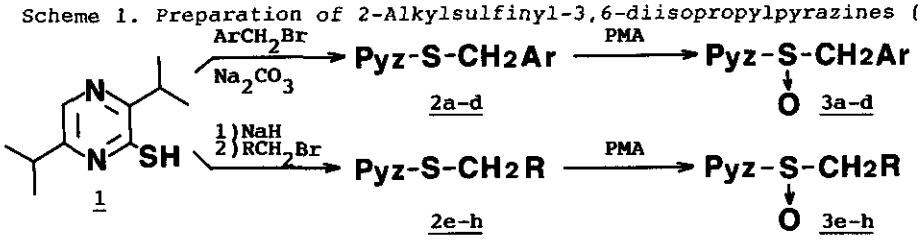
Abstract —— Reactions of pyrazinyl sulfoxides with trifluoroacetic anhydride and the subsequent treatment with aqueous K_2CO_3 or NBS gave aldehydes rapidly in excellent yields.

Reactions of sulfoxides with acid anhydride generally proceed by the Pummerer rearrangement. Kaji et al. have reported that α-trifluoroacetoxyalkyl phenyl sulfides, prepared from alkyl phenyl sulfoxides and trifluoroacetic anhydride (TFAA) by this rearrangement, underwent hydrolysis with $NaHCO_3$, $CuCl_2$ or $HgCl_2$ to give aldehydes.[1] But this method requires the aid of 2,6-lutidine for the rearrangement. In our previous paper, it was reported that the ß-elimination using pyrazinylsulfinyl group proceeded more quickly than the one using phenylsulfinyl group.[2] Pyrazinyl sulfoxides were prepared from pyrazinethiols which do not have the bad odor characteristic of mercaptans. An attempt was then made to improve the method of Kaji et al. using the pyrazinylsulfinyl group. An examination was first made to determine if various alkyl halides would couple with 3,6-diisopropyl-2-pyrazinethiol (1)[3]. Benzyl bromides coupled with the thiol due to the reported method to synthesize 3,6-diisopropyl-2-(cyanomethylthio)pyrazine[2] to give the corresponding sulfides, but alkyl halides which do not possess electron-withdrawing groups at the α-position did not exhibit this coupling ability under the same conditions. Thus, coupling reactions between the thiol and alkyl halides except benzyl bromides were carried out using NaH as a base in 1,2-dimethoxyethane (DME), as shown in Scheme 1.

Scheme 1. Preparation of 2-Alkylsulfinyl-3,6-diisopropylpyrazines (3a-h)



Ar = Ph, o-MePh, m-MePh, p-MePh PMA = Permaleic Acid

R = $PhCH_2$, n-$C_{17}H_{35}$, n-$C_{15}H_{31}$, n-$C_{13}H_{27}$

Conversion of these sulfides (2a-h) to the corresponding sulfoxides (3a-h) was accomplished according to the method reported in our previous paper[2]. Periodate and m-chloroperbenzoic acid (MCPBA) were also examined as oxidation reagents, but both of them were inferior to PMA. Periodate could not oxidize any pyrazinyl sulfides and MCPBA gave the corresponding sulfones in high yields as well as the desired sulfoxides.

3,6-Diisopropyl-2-(2-phenylethylsulfinyl)pyrazine (3a) was allowed to react with TFAA without 2,6-lutidine at room temperature and the starting material disappeared within 10 min. The reaction mixture was poured into ice water and stirred for 1 min, followed by the addition of K_2CO_3 and 40% CH_3CN aq., additional stirring for 10 min and extraction with Et_2O. The extract was washed with 1N NaOH and then with saturated NaCl aq., and worked up in the usual manner to give phenylacetaldehyde in quantitative yield. All results of the reactions of various alkyl halides with TFAA are shown in Table 1.

The hydrolysis of the hemithioacetals, prepared by Pummerer rearrangement, using $NaHCO_3$ was also examined. However, the hemithioacetals remained without hydrolysis. The reaction of hexadecylsulfinylbenzene[1] and TFAA without 2,6-lutidine was also carried out but hardly proceeded within 10 min. This result shows the rate of Pummerer rearrangement of alkylsulfinylpyrazines was faster than one of the corresponding alkylsulfinylbenzenes.

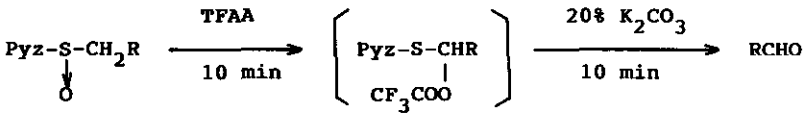
This procedure starting from benzyl bromides gave the corresponding benzaldehydes in lower yields and α,α-bis-(3,6-diisopropyl-2-pyrazinylthio)-toluenes as a by-product. These dithioacetals underwent conversion to the corresponding benzaldehydes by Corey's method[4] with excellent yields. The reaction mixture was stirred with 3 eq. of NBS for 20 min in 80% CH_3CN at room temperature to give the desired aldehydes in excellent yields as shown in Table 2.

By the same procedure, an attempt was made to prepare acetophenone from 1-chloro-1-phenylethane[5] without success, though it was possible to obtain 1-trifluoroacetoxy-1-phenylethane.

The present reactions for obtaining aldehydes from the corresponding alkyl halides may possibly proceed by virtue of the greater elimination ability of pyrazinylthio group and have the following favorable features:

1. They proceeded faster than when using the phenylsulfinyl group.
2. The working up is quite easy.
3. Pyrazinethiols do not have the bad odor characteristic of mercaptans.

Table 1. Preparation of Aliphatic Aldehydes from 2-Alkylsulfinyl-3,6-diisopropylpyrazines (3e-h)

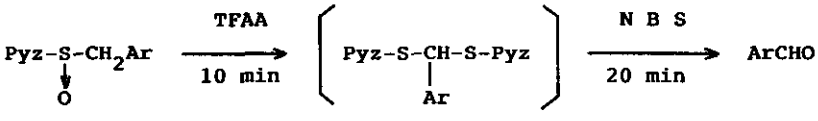


Sulfoxides	R	Yields of Aldehydes	Mp (°C) of Oximes [lit.[6](°C)]
3e	$PhCH_2$-	quant.	95 - 96 [98.5]
3f	n-$C_{17}H_{35}$-	quant.	82 - 84 [89]
3g	n-$C_{15}H_{31}$-	quant.	83 - 85 [88]
3h	n-$C_{13}H_{27}$-	90 %	79 - 80 [82 - 83]

Pyz = 3,6-Diisopropyl-2-pyrazinylsulfinyl

TFAA = Trifluoroacetic Anhydride

Table 2. Preparation of Aromatic Aldehydes from 2-Benzylsulfinyl-3,6-diisopropylpyrazines (3a-d)



Sulfoxides	Ar	Yields of Benzaldehydes	Mp (°C) of 2,4-D [lit.[6](°C)]
3a	Ph-	quant.	229 - 232 [237]
3b	o-MePh-	quant.	184 - 187 [193 - 194]
3c	m-MePh-	94 %	204 - 206 [211.5 - 212.5]
3d	p-MePh-	quant.	232 - 234 [232.5 - 234.5]

Pyz = 3,6-Diisopropyl-2-pyrazinylsulfinyl

TFAA = Trifluoroacetic Anhydride

2,4-D = 2,4-Dinitrophenylhydrazones

EXPERIMENTAL

None of the melting or boiling points were corrected. ^{1}H-Nmr spectra of **2a-d** were given by Varian EM-360 (60 MHz) using TMS as the internal standard. The spectra of the other compounds were given by Brucker AM-400 (400 MHz) and their chemical shifts were corrected by referring to the one of $C\underline{H}Cl_3$ (δ 7.26 ppm). The following instruments were used to obtain the other spectral data. Ir spectra: Japan Spectroscopic Co. A-100; Ms: Hitachi M-80 spectrometer.

General Procedure for Preparation of 2-Benzylthio-3,6-diisopropylpyrazines (2a-d)

The reaction of 2-benzylthio-3,6-diisopropylpyrazines (**2a-d**) was carried out according to the previous method[2].

2-Benzylthio-3,6-diisopropylpyrazine (2a)

Colorless viscous oil; bp 105-112°C/0.04 torr; yield: 75%; ms: m/z 286 (M^+); ^{1}H-nmr ($CDCl_3$): δ 1.18 (d, J = 7 Hz, 6H, $CH(C\underline{H}_3)_2$), 1.23 (d, J = 7 Hz, 6H, $CH(C\underline{H}_3)_2$), 2.70-3.37 (m, 2H, 2 X $C\underline{H}(CH_3)_2$), 4.33 (s, 2H, $SC\underline{H}_2Ph$), 7.46-6.93 (m, 5H, benzene H), 7.94 (s, 1H, pyrazine H) ppm; Anal. Calcd. for $C_{17}H_{22}N_2S$: C, 71.28; H, 7.74; N, 9.78. Found: C, 71.43; H, 7.83; N, 9.92.

2-(2-Methylbenzylthio)-3,6-diisopropylpyrazine (2b)

Colorless viscous oil; yield: 87%; ms: m/z 300 (M^+); ^{1}H-nmr ($CDCl_3$): δ 1.20 (d, J = 8 Hz, 6H, $CH(C\underline{H}_3)_2$), 1.28 (d, J = 6 Hz, 6H, $CH(C\underline{H}_3)_2$), 2.36 (s, 3H, o-CH_3), 2.70-3.43 (m, 2H, 2 X $C\underline{H}(CH_3)_2$), 4.36 (s, 2H, $SC\underline{H}_2Ph$), 6.83-7.43 (m, 4H, benzene H), 7.93 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{18}H_{24}N_2S$: 300.1658. Found: 300.1642.

2-(3-Methylbenzylthio)-3,6-diisopropylpyrazine (2c)

Colorless viscous oil; yield: 99%; ms: m/z 300 (M^+); ^{1}H-nmr ($CDCl_3$): δ 1.24 (d, J = 6 Hz, 6H, $CH(C\underline{H}_3)_2$), 1.30 (d, J = 6 Hz, 6H, $CH(C\underline{H}_3)_2$), 2.30 (s, 3H, m-CH_3), 2.67-3.53 (m, 2H, 2 X $C\underline{H}(CH_3)_2$), 4.36 (s, 2H, $SC\underline{H}_2Ph$), 6.80-7.40 (m, 4H, benzene H), 8.00 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{18}H_{24}N_2S$: 300.1658. Found: 300.1635.

2-(4-Methylbenzylthio)-3,6-diisopropylpyrazine (2d)

Colorless viscous oil; yield: 99%; ms: m/z 300 (M^+); ^{1}H-nmr ($CDCl_3$): δ 1.18 (d, J = 6 Hz, 6H, $CH(C\underline{H}_3)_2$), 1.25 (d, J = 6 Hz, 6H, $CH(C\underline{H}_3)_2$), 2.30 (s, 3H, p-CH_3), 2.53-3.40 (m, 2H, 2 X $C\underline{H}(CH_3)_2$), 4.20 (s, 2H, $SC\underline{H}_2Ph$), 6.85

(d, J = 8 Hz, 2H, benzene H), 7.10 (d, J = 8 Hz, 2H, benzene H), 7.80 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{18}H_{24}N_2S$: 300.1658. Found: 300.1642.

General Procedure for Preparation of 2-Alkylthio-3,6-diisopropylpyrazines (2e-h)

To a solution of 3,6-diisopropyl-2-pyrazinethiol (1) previously dissolved in 1,2-dimethoxyethane (DME), 1.5 eq. of NaH was added. After stirring for 15 min, 1.0 eq. of alkyl halides was added to the solution. The mixture was refluxed for 5 h and the solvent was removed by distillation under reduced pressure. The residue was extracted with Et_2O and worked up by the usual manner to give 2-alkylthio-3,6-diisopropylpyrazines (**2e-h**) as a colorless viscous oil. All products were purified by column chromatography on silica gel, but could not be distilled because of their higher boiling points.

2-(2-Phenylethylthio)-3,6-diisopropylpyrazine (2e)

Colorless viscous oil; yield: 95%; ms: m/z 300 (M^+); ^{1}H-nmr ($CDCl_3$): δ 1.28 (d, J = 7 Hz, 6H, $CH(C\underline{H}_3)_2$), 1.35 (d, J = 7 Hz, 6H, $CH(C\underline{H}_3)_2$), 3.00-3.11 (m, 3H, $C\underline{H}(CH_3)_2$, $SCH_2C\underline{H}_2Ph$), 3.43 (dd, J = 7 and 10 Hz, 2H, $SC\underline{H}_2CH_2Ph$), 7.22-7.35 (m, 5H, benzene H), 8.08 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{18}H_{24}N_2S$: 300.1658. Found: 300.1649.

2-Octadecylthio-3,6-diisopropylpyrazine (2f)

Colorless solid; mp 32-33°C; yield 68%; ms: m/z 448 (M^+); ^{1}H-nmr ($CDCl_3$): δ 0.88 (t, J = 7 Hz, 3H, $S(CH_2)_{17}C\underline{H}_3$), 1.22-1.74 (m, 44H, 2 X $CH(C\underline{H}_3)_2$, $SCH_2(C\underline{H}_2)_{16}CH_3$), 2.95-3.05 (m, 1H, $C\underline{H}(CH_2)_3$), 3.16 (t, J = 7 Hz, 2H, $SC\underline{H}_2(CH_2)_{16}CH_3$), 3.19-3.29 (m, 1H, $C\underline{H}(CH_3)_2$), 8.02 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{28}H_{52}N_2S$: 448.3848. Found: 448.3866.

2-Hexadecylthio-3,6-diisopropylpyrazine (2g)

Colorless viscous oil; yield 98%; ms: m/z 420 (M^+); ^{1}H-nmr ($CDCl_3$): δ 0.88 (t, J = 7 Hz, 3H, $S(CH_2)_{15}C\underline{H}_3$), 1.25-1.74 (m, 40H, 2 X $CH(C\underline{H}_3)_2$, $SCH_2(C\underline{H}_2)_{14}CH_3$), 2.95-3.05 (m, 1H, $C\underline{H}(CH_3)_2$), 3.16 (t, J = 7 Hz, 2H, $SC\underline{H}_2(CH_2)_{14}CH_3$), 3.19-3.29 (m, 1H, $C\underline{H}(CH_3)_2$), 8.02 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{26}H_{48}N_2S$: 420.3535. Found: 420.3526.

2-Tetradecylthio-3,6-diisopropylpyrazine (2h)

Colorless viscous oil; yield: 99%; ms: m/z 392 (M^+); ^{1}H-nmr ($CDCl_3$): δ 0.88 (t, J = 7 Hz, 3H, $S(CH_2)_{13}\underline{CH_3}$), 1.05-1.74 (m, 36H, 2 X $CH(\underline{CH_3})_2$, $SCH_2(\underline{CH_2})_{12}$-$CH_3$), 2.95-3.05 (m, 1H, $\underline{CH}(CH_3)_2$), 3.16 (t, J = 7 Hz, 2H, $SC\underline{H_2}(CH_2)_{12}CH_3$), 3.18-3.29 (m, 1H, $\underline{CH}(CH_3)_2$), 8.02 (s, 1H, pyrazine H) ppm; High resolution mass: Calcd. for $C_{24}H_{44}N_2S$: 392.3223. Found: 392.3235.

General Procedure for Preparation of 2-Alkylsulfinyl-3,6-diisopropylpyrazines (3a-h)

The reaction of 2-alkylsulfinyl-3,6-diisopropylpyrazines (3a-h) was carried out according to the previous report[2].

2-Benzylsulfinyl-3,6-diisopropylpyrazine (3a)

Colorless solid; bp 148°C/0.08 torr; yield: 94%; ms: m/z 302 (M^+); ir (KBr): 1040 (ν_{SO}) cm^{-1}; ^{1}H-nmr ($CDCl_3$): δ 0.78 (d, J = 7 Hz, 3H, $CH(C\underline{Ha_3})CHb_3$), 1.17 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb_3}$), 1.42 (d, J = 7 Hz, 3H, $CH(C\underline{Ha_3})CHb_3$), 1.43 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb_3}$), 3.21-3.31 (m, 1H, $\underline{CH}(CH_3)_2$), 3.28-3.38 (m, 1H, $\underline{CH}(CH_3)_2$), 4.42 (d, J = 12 Hz, 1H, $SC\underline{Ha}Ph$), 4.56 (d, J = 12 Hz, 1H, $SC\underline{Hb}Ph$), 6.97-6.99 (m, 2H, benzene H), 7.19-7.25 (m, 3H, benzene H), 8.52 (s, 1H, pyrazine H) ppm; Anal. Calcd. for $C_{17}H_{22}N_2OS$: C, 67.51; H, 7.33; N, 9.26. Found: C, 67.48; H, 7.44; N, 9.38.

2-(2-Methylbenzylsulfinyl)-3,6-diisopropylpyrazine (3b)

Colorless viscous oil; yield: 99%; ms: m/z 316 (M^+); ir (neat): 1060 (ν_{SO}) cm^{-1}; ^{1}H-nmr ($CDCl_3$): δ 0.71 (d, J = 7 Hz, 3H, $CH(C\underline{Ha_3})CHb_3$), 1.19 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb_3}$), 1.43 (d, J = 7 Hz, 3H, $CH(C\underline{Ha_3})CHb_3$), 1.44 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb_3}$), 2.37 (s, 3H, o-$CH_3$), 3.19-3.27 (m, 1H, $\underline{CH}(CH_3)_2$), 3.24-3.32 (m, 1H, $\underline{CH}(CH_3)_2$), 4.47 (d, J = 12 Hz, 1H, $SC\underline{Ha}Ph$), 4.58 (d, J = 12 Hz, 1H, $SC\underline{Hb}Ph$), 6.66 (d, J = 7 Hz, 1H, benzene H), 6.95 (dt, J = 2 and 8 Hz, 1H, benzene H), 7.11-7.15 (m, 2H, benzene H), 8.54 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{18}H_{24}N_2OS$: 316.1607. Found: 316.1604.

2-(3-Methylbenzylsulfinyl)-3,6-diisopropylpyrazine (3c)

Colorless viscous oil; yield: 99%; ms: m/z 316 (M^+); ir (neat): 1050 (ν_{SO}) cm^{-1}; ^{1}H-nmr ($CDCl_3$): δ 0.80 (d, J = 7 Hz, 3H, $CH(C\underline{Ha_3})CHb_3$), 1.18 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb_3}$), 1.42 (d, J = 7 Hz, 3H, $CH(C\underline{Ha_3})CHb_3$), 1.44 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb_3}$), 2.21 (s, 3H, m-$CH_3$), 3.21-3.32 (m, 1H,

$C\underline{H}(CH_3)_2$), 3.29-3.40 (m, 1H, $C\underline{H}(CH_3)_2$), 4.38 (d, J = 12 Hz, 1H, $SC\underline{Ha}Ph$), 4.50 (d, J = 12 Hz, 1H, $SC\underline{Hb}Ph$), 6.78-6.79 (m, 2H, benzene H), 7.01-7.10 (m, 2H, benzene H), 8.51 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{18}H_{24}N_2OS$: 316.1607. Found: 316.1627.

2-(4-Methylbenzylsulfinyl)-3,6-diisopropylpyrazine (3d)

Colorless viscous oil; yield: 77%; ms: m/z 316 (M^+); ir (neat): 1050 (ν_{SO}) cm^{-1}; ^{1}H-nmr ($CDCl_3$): 0.79 (d, J = 7 Hz, 3H, $CH(C\underline{Ha}_3)CHb_3$), 1.16 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb}_3$), 1.41 (d, J = 7 Hz, 3H, $CH(C\underline{Ha}_3)CHb_3$), 1.42 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb}_3$), 2.23 (s, 3H, p-$CH_3$), 3.20-3.30 (m, 1H, $C\underline{H}(CH_3)_2$), 3.24-3.36 (m, 1H, $C\underline{H}(CH_3)_2$), 4.37 (d, J = 12 Hz, 1H, $SC\underline{Ha}Ph$), 4.51 (d, J = 12 Hz, 1H, $SC\underline{Hb}Ph$), 6.85 (d, J = 8 Hz, 2H, benzene H), 7.00 (d, J = 8 Hz, 2H, benzene H), 8.51 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{18}H_{24}N_2OS$: 316.1607. Found: 316.1604.

2-(2-Phenylethylsulfinyl)-3,6-diisopropylpyrazine (3e)

Colorless plates; mp 91-93°C (n-hexane); yield 81%; ms: m/z 316 (M^+); ir (KBr): 1040 (ν_{SO}) cm^{-1}; ^{1}H-nmr ($CDCl_3$): δ 1.28 (d, J = 7 Hz, 3H, $CH(C\underline{Ha}_3)CHb_3$), 1.34 (d, J = 7 Hz, 3H, $CH(CHa_3)C\underline{Hb}_3$), 1.36 (d, J = 7 Hz, 6H, $CH(C\underline{H}_3)_2$), 3.06 (dd, J = 7 and 9 Hz, 2H, $SCH_2C\underline{H}_2Ph$), 3.34 (ddd, J = 7, 9 and 13 Hz, 1H, $SC\underline{Ha}CH_2Ph$), 3.52 (ddd, J = 7, 9 and 13 Hz, 1H, $SC\underline{Hb}CH_2Ph$), 7.21-7.33 (m, 5H, benzene H), 8.54 (s, 1H, pyrazine H) ppm; Anal. Calcd. for $C_{18}H_{24}N_2OS$: C, 68.32; H, 7.64; N, 8.85. Found: C, 68.58; H, 7.67; N, 8.88.

2-Octadecylsulfinyl-3,6-diisopropylpyrazine (3f)

Colorless solid; mp 45-47°C (crude); yield 62%; ms: m/z 464 (M^+); ir (KBr): 1050 (ν_{SO}) cm^{-1}; ^{1}H-nmr ($CDCl_3$): δ 0.88 (t, J = 7 Hz, 3H, $S(CH_2)_{17}C\underline{H}_3$), 1.18-1.71 (m, 44H, 2 X $CH(C\underline{H}_3)_2$, $SCH_2(C\underline{H}_2)_{16}CH_3$), 3.07 (ddd, J = 7, 9 and 13 Hz, 1H, $SC\underline{Ha}(CH_2)_{16}CH_3$), 3.15-3.25 (m, 1H, $C\underline{H}(CH_3)_2$), 3.21 (ddd, J = 7, 9 and 13 Hz, 1H, $SC\underline{Hb}(CH_2)_{16}CH_3$), 3.67-3.77 (m, 1H, $C\underline{H}(CH_3)_2$), 8.54 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{28}H_{52}N_2OS$: 464.3797. Found: 464.3772.

2-Hexadecylsulfinyl-3,6-diisopropylpyrazine (3g)

Colorless solid; mp 47-48°C (crude); yield 74%; ms: m/z 436 (M^+); ir (KBr): 1050 (ν_{SO}) cm^{-1}; ^{1}H-nmr ($CDCl_3$): δ 0.88 (t, J = 7 Hz, 3H, $S(CH_2)_{15}\underline{CH_3}$), 1.21-1.69 (m, 40H, 2 X $CH(\underline{CH_3})_2$, $SCH_2(\underline{CH_2})_{14}CH_3$), 3.06 (ddd, J = 7, 9 and 13 Hz, 1H, $SC\underline{Ha}(CH_2)_{14}CH_3$), 3.14-3.25 (m, 1H, $C\underline{H}(CH_3)_2$), 3.21 (ddd, J = 7, 9 and 13 Hz, 1H, $SC\underline{Hb}(CH_2)_{14}CH_3$), 3.66-3.77 (m, 1H, $C\underline{H}(CH_3)_2$), 8.54 (s, 1H, *pyrazine H*) *ppm; High resolution ms Calcd. for* $C_{26}H_{48}N_2OS$: 436.3484. Found: 436.3474.

2-Tetradecylsulfinyl-3,6-diisopropylpyrazine (3h)

Colorless solid; mp 34-36°C (crude); yield 71%; ms: m/z 408 (M^+); ir (KBr): 1050 (ν_{SO}) cm^{-1}; ^{1}H-nmr ($CDCl_3$): δ 0.87 (t, J = 7 Hz, 3H, $S(CH_2)_{13}\underline{CH_3}$), 0.60-1.80 (m, 36H, 2 X $CH(\underline{CH_3})_2$, $SCH_2(\underline{CH_2})_{12}CH_3$), 3.06 (ddd, J = 7, 9 and 13 Hz, 1H, $SC\underline{Ha}(CH_2)_{12}CH_3$), 3.14-3.24 (m, 1H, $C\underline{H}(CH_3)_2$), 3.20 (ddd, J = 7, 9 and 13 Hz, 1H, $SC\underline{Hb}(CH_2)_{12}CH_3$), 3.66-3.76 (m, 1H, $C\underline{H}(CH_3)_2$), 8.54 (s, 1H, pyrazine H) ppm; High resolution ms Calcd. for $C_{24}H_{44}N_2OS$: 408.3172. Found: 408.3206.

General Procedure for Preparation of Aldehydes from 2-Benzylsulfinyl-3,6-diisopropylpyrazines (3a-d)

A mixture of 2-benzylsulfinyl-3,6-diisopropylpyrazines (**3a-d**, 0.50 g) and TFAA (2 ml) was stirred for 10 min at room temperature and poured into ice water (25 ml). The aqueous solution was neutralized with K_2CO_3 and extracted with Et_2O (20 ml X 3) and the extract was washed with 1N NaOH and then water. After being dried over Na_2SO_4, Et_2O was removed off by distillation in vacuo. The residue was dissolved in 80% CH_3CN (20 ml) and 3 eq. of NBS was added to the mixture, which was stirred for 20 min at room temperature and worked up according to the previous report[4] to give the corresponding benzaldehydes. The ir spectrum of the aldehyde was identical with that of the corresponding authentic samples[7].

General Procedure for Preparation of Aldehydes from 2-Alkylsulfinyl-3,6-diisopropylpyrazines (3e-h)

Reactions of 2-alkylsulfinyl-3,6-diisopropylpyrazines (**3e-h**, 0.50g) and TFAA (2 ml) were carried out according to the procedure for the preparation of aldehydes from **3a-d**. The reaction mixture was poured into ice water (25 ml) and stirred for 1 min. To the aqueous solution, K_2CO_3 (10 g) and 40%

CH_3CN aq. (50 ml) were added. The mixture was stirred for 10 min and extracted with Et_2O (20 ml X 3). The extract was washed with 1N NaOH and then saturated NaCl, and worked up by the usual manner to obtain the corresponding aldehydes. The ir spectrum of the aldehyde was identical with that of the corresponding authentic samples[7].

REFERENCES

1. H. Sugihara, R. Tanikaga, and A. Kaji, Synthesis, 1978, 881.
2. A. Ohta, K. Okimura, Y. Tonomura, M. Ohta, N. Yasumuro, R. Fujita, and M. Shimazaki, Heterocycles, 1988, 27, 261.
3. A. Ohta, M. Shimazaki, N. Tanekura, and S. Hayashi, Heterocycles, 1983, 20, 797.
4. E. J. Corey and B. W. Erickson, J. Org. Chem., 1971, 36, 3553.
5. R. L. Burwell, Jr., A. D. Shields, and H. Hart, J. Am. Chem. Soc., 1954, 76, 908.
6. J. Buckingham, " Dictionary of Organic Compounds ", 5th edition, Chapman and Hall, New York, 1982.
7. C. J. Pouchert, " The Aldrich Library of FT-IR Spectra ", 1st edition, Aldrich Chemical Co., Milwaukee, 1985.

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