PREPARATION OF SOME MESO-DISUBSTITUTED ANTHRACENES

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ABSTRACT

The synthesis of some 9,10-disubstituted anthracene derivatives are described. 9,10-Bis(2-bromoethyl)anthracene 4, 9 , 10-Bis(2-cyanoethyl)anthracene 5 and 9,10-Bis(4-hydroxybutyl) anthracene 11 are synthesized for the first time .

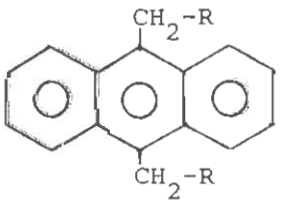
INTRODUCTION

Many 9,10-disubstituted anthracene derivatives have been prepared by use of 9,10-bischloromethyl anyhracene 1 [1-5]. Surface activity and fluorescence property of some of them have been studied[6]. Some derivatives show anti-tumor activity[7,8]. A number of derivatives are used in plastics [9]. Thus,in this work an attempt is made in preparing some of these anthracene derivatives.

RESULTS AND DISCUSSION

By use of Kretov's method a number of 9,10-disubstituted anthracene derivatives were easily prepared . Synthesis of compounds 4,5,11 hitherto have not been reported,but higher and lower homologues have.

All of these compounds are yellow and their solubility vary from being slightly soluble in chloroform for 9,10-bis(3-carboxypropyl) anthracene,to completely soluble in cyclohexane for 9,10-bis(3-bromopropyl)anthracene.



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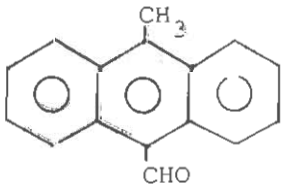

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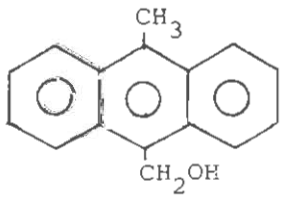

(13)

1) R=Cl
2) R=COOH
3) R=CH_2OH
4) R=CH_2Br
5) R=CH_2CN
6) R=CH_2COOH
7) R=CH_2CH_2OH
8) R=CH_2CH_2Br
9) R=CH_2CH_2CN
10) R=CH_2CH_2COOH
11) R=$CH_2CH_2CH_2OH$

The reduction of acid 2 with $LiAlH_4$ in THF produced diol compound 3. Reaction of compound 3 with phosphorus tribromide gave compound 4 in low yields. Compound 4 was obtained by reacting compound 3 with H_2SO_4 and HBr with reasonable yield. The structure of this compound was established spectroscopically.

Compound 4 was converted to compound 5 with KCN in DMF. Alkaline hydrolysis of compound 5 produced the known diacid compound 6 which together with spectroscopic data confirm the structure of compounds 4, 5 .

All attempts to prepare diacid 6 by the action of CO_2 on the corresponding Grignard reagent 4 failed , because the latter was unobtainable in THF under various conditions.

Reduction of acid 6 with $LiAlH_4$ in THF produced diol 7. Compound 7 is easily converted to compound 8 . Although reactivity of an isomer of compound 8(Br on no.2 Carbon)toward KCN in ethanol is weaker[12,13] compound 8 was more reactive than 4 toward KCN in yielding the di nitrile 9 .

Dinitrile 9 hydrolyzes in alkaline media to diacid 10. The latter was reduced to diol 11 and its structure was established by IR and NMR .

At last,heating of dichloride 1 in DMSO generated dialdehyde 12 in low yield(23%)[14]. By modification of reaction condition dialdehyde 12 was obtained. Compound 12 was reduced to compound 13 by $NaBH_4$.

EXPERIMENTAL

Melting points(°C) were determined with a Reichert microscope and are uncorrected. Spectra were recorded on a Perkin-Elmer NMR spectrometer(ppm)and Perkin-Elmer 257 IR spectrophotometers(Nujol, cm^{-1}). Elemental analysis was done in Sussex University,England.

9,10-Bis(2-hydroxyethyl)anthracene 3 ($C_{18}H_{18}O_2$) .

$LiAlH_4$ was added to a suspension of diacid 2(2g)in 200 ml THF . The mixture was refluxed for 5 hrs , THF evaporated,water added slowly, and then,H_2SO_4 10% added. The precipitate was filtered and washed with NaOH 10% and H_2O (1.7 gr,94%). The crude product was recrystalized from ethanol (mp=217-218°C). This compound was prepared previously by reduction of ester derivative of acid 2 [15] and reaction of anthracene with maleic anhydride[16]. IR 3250 (νOH). NMR(DMSO)δ 4.8(S,2OH),3.7(S,4CH_2),7.5, 8.3(8H,aromatic).

9,10-Bis(2-bromoethyl)anthracene 4 ($C_{18}H_{18}Br_2$).

The mixture of diol 3 (1g), HBr (48%, 20ml) and H_2SO_4 (4ml) was heated at 90°C for 6 hrs. The precipitate was filtered and washed with H_2O. Compound 4 was purified on an alumina column (30% cyclohexane, 70% CH_2Cl_2). The pure compound (700 mg, 50%) melted at 240-242°C. IR 1760 (νCBr). NMR ($CDCl_3$) δ 3.6, 4.2 (2t, 8H, J=9 Hz), 7.6, 8.3 (8H, aromatic). Anal Calcd: Br, 40.75; H, 4.11; C, 55.13, found, Br, 40.69, H, 4.08; C, 55.14 .

9,10-Bis(2-cyanoethyl)anthracene 5 ($C_{20}H_{16}N_2$) .

To a suspension of compound 4 (200 mg) in 50ml DMF, was added a solution of KCN (15 mg) in water (1ml). The mixture was heated at 120°C for 82 hrs . Water (200ml) was added to the reaction mixture. The solid product was filtered (120 mg, 83% yield). The crude product was recrystalized from DMF (mp=283-285°C). IR 2250 (νCN). NMR ($CDCl_3$) δ 2.85, 3.15 (2t, 8H, J=9Hz), 7.7, 8.35 (8H aromatic). Anal Calcd: N, 9.85; H, 5.62; C, 84.51, found; N, 9.97; H, 5.6; C, 84.67 .

9,10-Bis(2-Carboxyethyl)anthracene 6 ($C_{20}H_{18}O_4$).

Dinitrile 5 (50 mgr) and NaOH 10% (5ml) were refluxed in isoamylo alcohol. After 8 hrs, sodium salt of acid 6 was precipitated. The mixture was extracted with water. The aqueous portion was acidified with H_2SO_4 10% and desired product separated as a solid compound (92% yield). Compound 6 recrystalized from methanol (mp = 252-254°C). This acid has been prepared by reaction of malonic ester with 9,10-bis (chloromethyl)anthracene [17]. IR 1700 (νC=O), 2500-3200 (νOH). NMR (CD_3OD) δ 2.3 (t, $2CH_2$, J=9Hz), 3.6 (t, $2CH_2$, J=9Hz), 7.2, 7.9 (8H aromatic).

9,10-Bis(3-hydroxypropyl)anthracene 7 ($C_{20}H_{22}O_2$) .

This compound was prepared by Miller's method [15]. IR 3300 (νOH) . NMR (DMSO) δ 8.4, 7.6 (8H aromatic), 3.7 (t, 4 CH_2, J=8Hz), 2.1, 1.8 (br. $2CH_2$)

9,10-Bis(3-bromopropyl)anthracene 8 ($C_{20}H_{20}Br_2$) .

The mixture of diol 7 (1gr), HBr (20ml) and H_2SO_4 (4ml) was heated at 90°C for 6 hrs. The mixture was filtered and then washed with H_2O. The crude product was purified on an alumina column (CH_2Cl_2 70%, cyclohexane 30%).

Reaction yield: 57% (800mg). Compound 8 was recrystalized from cyclohexane (mp=145-148°C) [13].

This compound has been prepared by reaction of 9,10-bis(3-ethoxypropyl)anthracene [13] with HBr in acetic acid. IR 760 (νC-Br). NMR ($CDCl_3$) δ 3.4, 3.9 (12H); 7.5, 8.3 (8H aromatic). Anal Calcd: Br, 38.03; H, 4.79; C, 57.16 found; Br, 38.02; H, 4.83; C, 56.89 .

9,10-Bis(3-cyanoethyl)anthracene 9 ($C_{22}H_{20}N_2$)

To a mixture of dibromide 8 (700 mg) in DMF (35ml) was added a solution of KCN (350mg) in H_2O (6 ml). The mixture was heated at 100°C for 6 hrs, DMF was evaporated in vacuum the solid product washed with H_2O (500 mg, 96% yield). The product was recrystalized from DMF (mp=183-185°C) [13].

This compound has been obtained from reaction of 9,10-bis(3- iodo - propyl) anthracene with KCN in ethanol. Reaction yield: 82% after 24 hrs. boiling. IR 2250 (νC≡N). NMR ($CDCl_3$) δ 2.4 ($2CH_2$), 2.7, 3.95 (2t, $4CH_2$, J=9Hz); 7.7, 8.4 (8 H aromatic).

9,10-Bis(3-carboxypropyl)anthracene 10 ($C_{22}H_{22}O_4$) .

Dinitrile 9 (800 mg), NaOH 10% (15ml) and isoamylalcohol were heated at 120°C for 11 hrs. Sodium salt of acid 10 precipitated in the mixture. The salt was extracted with H_2O . Acid compound 10 was obtained by acidification (H_2SO_4 10%) of aqueous phase (870 mg, 96% yield). Acid 10 was recrystalized from ethanol (mp= 250-251°C) [18].

This compound has been prepared by action of $AlCl_3$ on 4-chloro- 5 - phenylpentanoic acid [18]. IR 1708 (νC=O) 3300-2600 (ν OH). NMR (DMSO) δ 3.4 ($4CH_2$), 1.8 ($2CH_2$) 8.3, 7.4 (8H aromatic).

9,10-Bis(4-hydroxybutyl) anthracene 11 ($C_{22}H_{26}O_2$)

To a suspension of acid 10 (600 mg) in THF (25ml) was added $LiAlH_4$ (500 mg) and the mixture refluxed for 8 hrs. After evaporation of THF and addition of H_2SO_4 10% , the precipitate was filtered and washed with NaOH 10% and H_2O respectively . Recrystalization from benzene gave diol 11 (500mg) in 90% yield (mp=153-155°C). IR 3300 (νOH). NMR (CD_3OD) δ 1.55 ($4CH_2$), 2.3 ($4CH_2$) 8, 7.1 (8H aromatic). Anal Calcd: C, 82.00%, H, 8.06 found; C, 81.93; H, 8.16 .

Compound 12 .

This aldehyde was prepared by a modification of Klanderman's method and in a higher yield.

Compound 1 (1gr) and DMSO (20 ml) were heated at 130°C for 1 h . Water (200ml) was added to the mixture and solid compound was filtered, washed with H_2O, and purified on an alumina column (50% CH_2Cl_2, 50% cyclohexane) . The weight of compound 12 is 500 mg (62% yield). The yield of 12 by Klanderman's method is 23%. IR 1675 (νC=O). NMR ($CDCl_3$) 2.9 (CH_3), 8.7 (HC(=O)-), 7.5, 8.2, 8.9 (8H aromatic).

10-Methyl-9-(Hydroxymethyl)anthracene 13 ($C_{16}H_{14}O_2$) .

$NaBH_4$ (50mg) in H_2O (2ml) was added to the suspension of aldehyde 12 (200 mg) in THF (10ml). After 10 min., water (200 ml) was added to the reaction mixture. The solid product was filtered and washed with H_2O. The crude product was purified by crstalization from ethanol (200 mg, 99% yield, mp = 229°C [19]) This compound had been prepared by action of KOH on 9,10 - Bis (hydroxymethyl) 9,10- dihydroanthracene

in isoamyl alcohol(80% yield)[19].IR 3420(ν OH).NMR($CDCl_3$)δ1.6(S,3H,CH_3), 3.2(S,CH_2),5.7(S,OH)7.6,8.5(8H aro - matic).

REFERENCES

1. E.Gudriniece and G.Vanags.*Zhobshch. Khim.*26,3123(1956).
2. A.E.Kretov and M.S.Rovinsku.*Zh. obshch.Khim.*30,696(1960).
3. P.Bercot.*Ann. Chem(Paris)* 6 ,193 (1961).
4. J.H.Galden,*J.Chem.Soc.*3741(1961).
5. F.H.C.Stewart,*Australian.J.Chem .* 14,177(1961).
6. F.H.C.Stewart,*Australian.J. Chem.* 13,478(1960).
7. Peck,Richard,M.O'Connell,Anna,P.J., *Med.Chem.*13(5)919-22(1970).
8. Peck.Richard,M.Tan.Tie Keny;Peck , Evelgn *B.Can Cer.Res.*36(7. Pt.1), (1976).
9. A.E.Kretov and V.V.Litvinov, *Zh . Prikl.Khim;*35,464(1962).
10. W.Gerrard and H.Herlst.*J.Chem.Soc .* 277(1955).
11. M.Verny and R.Vessiere.*Bull.Soc. Chem.*3009(1968).
12. K.J.Clark.*J.Chem.Soc.*1511(1956).
13. K.J.Clark.*J.Chem.Soc.*463,(1957).
14. B.H.Klamderman .*J.Org.Chem.*31,2618. (1966).
15. M.W.Miller,R.W.Amidon and P.O Tawney.*J.Am.Chem.Soc.*77,2845 (1955).
16. K.Ziegler.Brit.Patent.803,178(1958).
17. Ya.Postovskii and N.P.Bednyagina , *J.Cem.Chem.U.S.S.R.*7,2919(1937).
18. H.Beyer,Ber,70B,1101(1937).
19. P.Tardieu.*Comp. Rend.*248,2885(1959).