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SUPPORTING INFORMATION

Title: Synthesis of New ß-Hydroxy Nitrate Esters as Potential Glycomimetics or Vasodilators
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Ref. No.: O200800481

Contents

General methods

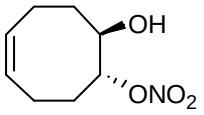
Melting points were determined on Buchi 539 capillary melting apparatus and uncorrected. Infrared spectra were recorded on a Mattson 1000 FT-IR spectrophotometer. ^{1}H NMR and ^{13}C NMR spectra were recorded on 200 (50) and 400 (100)-MHz Varian spectrometer and are reported in δ units with $SiMe_4$ as internal standard. Elemental analyses were carried out with a Leco CHNS-932 instrument.

Calculation methods

All calculations were performed by using SPARTAN04 software for windows, version 1.0.0 on a personal computer.[26] Energies were refined using the semi-emprical AM1, PM3.

Typical procedure for the ß-hydroxy nitrates: To a solution of epoxide (1 mmol) in 1 mL of CH_2Cl_2 was added $Bi(NO_3)_3{\cdot}5H_2O$ (1 mmol) at room temperature. The reaction was completed in 5 min-18 h as verified by TLC. Then, the reaction mixture was filtered over filter paper and the solvent was concentrated under reduced pressure. The crude product was purified by column chromatography or crystallization.

***trans*-(1*S*(*R*),8*S*(*R*),*Z*)-8-hydroxycyclooct-4-enyl nitrate (9):**

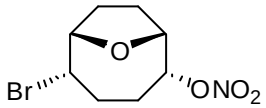


9

The product **9** was obtained from **8** (250 mg, 2.02 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (978 mg, 2.02 mmol) as described above by typical procedure for 16 h. After the filtration, the residue was submitted to column chromatography (silica gel, 30 g) eluting with ethyl acetate/hexane (15:85). The elution gave the product **9** as colourless oil (280 mg, 74%). ^{1}H NMR (400 MHz, $CDCl_3$): δ 5.71 (ddd, *J* = 17.3, 11.2, 7.3 Hz, A part of AB system, =CH, 1H), 5.62 (ddd, *J* = 17.3, 11.2, 7.3 Hz, B part of AB system, =CH, 1H), 5.18 (ddd, *J* = 13.0, 8.8, 3.9 Hz, $CHONO_2$, 1H), 3.96 (ddd, *J* = 13.0, 8.8, 3.9 Hz, CHOH, 1H), 2.48–2.37 (m, CH_2, 2H), 2.28–2.08 (m, CH_2, 4H), 1.84–1.23 (m, CH_2, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 130.2, 128.5, 86.0, 71.8, 33.2, 28.6, 23.0, 22.7; IR (CH_2Cl_2): $\tilde{\nu}$ = 3418, 3018, 2937, 2867, 1722, 1629, 1576, 1482, 1467, 1449, 1318, 1283, 1209, 1138, 1122, 1059, 1014, 973, 863, 737. $C_8H_{13}NO_4$ (187.19): calcd. C, 51.33; H, 7.00; N, 7.48; found: C, 51.02; H, 7.18; N, 7.60.

Bromination of *trans*-(1*S*(*R*),8*S*(*R*),*Z*)-8-hydroxycyclooct-4-enyl nitrate (9): To a solution of **9** (500 mg, 2.67 mmol) in CH_2Cl_2 (7 mL) was added dropwise a solution of Br_2 (427 mg, 2.67 mmol) in CH_2Cl_2 (5 mL) at -30 ^{o}C and the mixture was stirred for 1 h. After the reaction mixture was allowed to warm to room temperature, the solvent of the mixture was removed under pressure. The residue was submitted to column chromatography (silica gel, 30 g) eluting with ethyl acetate/hexane (3:97). The first elution gave the tetrabromide **11** (350 mg, 30%). The second fraction provided the **10** (485 mg, 68%).

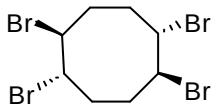
(1*S*(*R*),2*S*(*R*),5*R*(*S*),6*R*(*S*))-5-bromo-9-oxabicyclo[4.2.1] nonan-2-yl nitrate (10):



10

(360 mg, 51%, recrystallized from CH_2Cl_2/hexane as white crystals, M.p. 61–62 ^{o}C). ^{1}H NMR (200 MHz, $CDCl_3$) δ 5.38–5.31 (m, $CHONO_2$, 1H), 4.83–4.75 (m, OCH, 1H), 4.64–4.61 (m, CHBr, 1H), 4.20–4.10 (m, OCH, 1H), 2.30–1.90 (m, CH_2, 8H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 85.10, 84.11, 79.34, 54.59, 31.50, 30.12, 28.22, 27.66; IR (CH_2Cl_2): $\tilde{\nu}$ = 2958, 1630, 1280, 1062, 936, 857. $C_8H_{12}BrNO_4$: calcd. C, 36.11; H, 4.55; N, 5.26; found. C, 35.99; H, 4.52; N, 5.25.

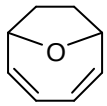
(1*S*(*R*),2*S*(*R*),5*S*(*R*),6*S*(*R*))-1,2,5,6-tetrabromocyclooctane (11):



11

(260 mg, 22%, recrystallized from CH_2Cl_2/hexane as white crystals, M.p. 129–130 ^{o}C). ^{1}H NMR (200 MHz, $CDCl_3$): δ 4.78–4.75 (m, CHBr, 4H), 2.86–2.79 (m, CH_2, 4H), 2.15–2.08 (m, CH_2, 4H); ^{13}C NMR (50 MHz, $CDCl_3$): δ 59.2, 28.8; IR (CH_2Cl_2): $\tilde{\nu}$ = 2922, 1426, 1217, 1065, 994, 762. $C_8H_{12}Br_4$ (427.80): calcd. C, 22.46; H, 2.83; found. C, 22.68; H, 2.59.

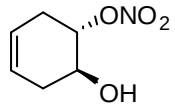
(2*Z*,4*Z*)-9-oxabicyclo[4.2.1]nona-2,4-diene (12):



12

To a solution of **10** (100 mg, 0.38 mmol) in 3 mL of toluene was added DBU (1.15 g, 7.57 mmol) and the mixture was refluxed for 3 h. After cooling, H_2O was added to the reaction mixture and the mixture was extracted with ether. The organic layer was washed with water, dried over $MgSO_4$. After removal of solvent in vacuo, the residue was purified by silica gel thin-layer chromatography. Elution with ether/hexane (25:75) gave **12** (40 mg, 87%, oil at room temperature). ^{1}H NMR (200 MHz, $CDCl_3$): δ 6.14–6.06 (m, AA' part of AA'BB' system, =CH, 2H), 5.85–5.75 (m, BB' part of AA'BB' system, =CH, 2H), 4.71–4.63 (m, OCH, 2H), 2.24–2.12 (m, CH_2, 4H); ^{13}C NMR (50 MHz, $CDCl_3$): δ 140.6, 126.4, 80.1, 41.9; IR (CH_2Cl_2): $\tilde{\nu}$ = 2925, 1732, 1633, 1067, 913, 744. $C_8H_{10}O$ (122.16): calcd. C, 78.65; H, 8.25; found. C, 79.01; H, 8.08.

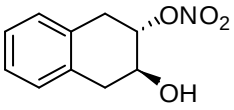
***trans*-(1*S*(*R*),6*S*(*R*))-6-hydroxycyclohex-3-enyl nitrate (18):**



18

Reaction was performed as described above by typical procedure for 20 min by starting from **16** (200 mg, 2.08 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (1.01 g, 2.09 mmol). After the mixture was filtered, the residue was submitted to column chromatography (silica gel, 30 g) eluting with ethyl acetate/hexane (5:95). The elution gave the product **18** as colourless oil (280 mg, 85%). ^{1}H NMR (200 MHz, $CDCl_3$): δ 5.65–5.49 (m, =CH, 2H), 5.10 (ddd, *J* = 15.3, 8.9, 6.3 Hz, $CHONO_2$, 1H), 3.98 (ddd, *J* = 15.3, 8.9, 6.3 Hz, CHOH, 1H), 2.78–2.50 (m, CH_2, 2H), 2.30–2.03 (m, CH_2, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ 126.4, 124.9, 85.2, 69.1, 35.0, 31.1; IR (CH_2Cl_2): $\tilde{\nu}$ = 3570, 3392, 3040, 2908, 2854, 1631, 1557, 1441, 1422, 1348, 1314, 1278, 1213, 1159, 1100, 1070, 1040, 997, 973, 867, 792, 755. $C_6H_9NO_4$ (159.14): calcd. C, 45.28; H, 5.70; N, 8.80; found. C, 44.93; H, 5.53; N, 8.70.

***trans*-(2*S*(*R*),3*S*(*R*))-3-hydroxy-1,2,3,4-tetrahydronaphthalen-2-yl nitrate (19):**

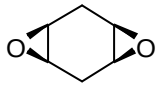


19

Reaction was performed as described above by typical procedure for 16 h by starting from **17** (140 mg, 0.96 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (465 mg, 0.96 mmol). The product **19** was recrystallized from CH_2Cl_2/hexane as yellow crystals (145 mg, 73%, M.p. 54–55 ^{o}C). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.26–7.20, (m, aryl, 2H), 7.19–7.07 (m, aryl, 2H), 5.27 (ddd, *J* = 12.9, 8.3, 5.4 Hz, $CHONO_2$, 1H), 4.16 (ddd, *J* = 12.9, 8.3, 5.4 Hz, CHOH, 1H), 3.25 (dd, *J* = 16.8, 5.4 Hz, A part of AB system, CH_2, 1H), 2.97 (dd, *J* = 16.8, 8.3 Hz, A part of AB system, CH_2, 1H), 2.92–1.30 (m, CH_2, 2H), 2.82 (m, OH, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 132.9, 132.0, 129.2, 129.0, 127.2, 127.0, 83.4, 67.7, 36.3, 32.4; IR (CH_2Cl_2): $\tilde{\nu}$ = 3565, 3402, 3066, 3025, 2908, 2853, 1717, 1635, 1585, 1496, 1455, 1440, 1423, 131, 1321, 1276, 1217, 1161, 1111, 1059, 983, 953, 871, 749. $C_{10}H_{11}NO_4$ (209.20): calcd. C, 57.41; H, 5.30; N, 6.70; found. C, 57.51; H, 5.08; N, 6.63.

The reaction of 1,4-cyclohexadiene with *m*-CPBA: A mixture of 1,4-cyclohexadiene (2.50 g, 31.25 mmol) and *m*-CPBA (15.54 g (70%), 62.50 mmol) in dichloromethane (100 mL) was colled by salt-ice bath and stirred for 2 h. After dichloromethane (50 mL) was added and the reaction mixture washed with 10% NaOH (3 x 100 mL) and water (50 mL), dried over $MgSO_4$, filtered and the solvent removed under reduced pressure. The residue (3.42 g) was subjected to silica gel chromatography using ethyl acetate/hexane (10:90). The first fraction gave **21** (2.35 g, 67%). Then, the column was eluted by CH_2Cl_2 to give **20** (850 mg, 24%).

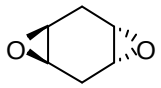
***syn*-1,4-Cyclohexadiene bisepoxide (20):**



20

(625 mg, 18%, colourless crystals from CH_2Cl_2/hexane, M.p. 61–62 ^oC). ^1H NMR (200 MHz, $CDCl_3$): δ 3.02 (d, *J* = 1.4, Hz, OCH, 4H), 2.68 (d, *J* = 16.5 Hz, A part of AB system, CH_2, 2H), 2.24 (dd, *J* = 16.5, 1.4, Hz, B part of AB system, CH_2, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ 51.1, 25.5; IR (CH_2Cl_2): $\tilde{\nu}$ = 3009, 2990, 2929, 1470, 1424, 1353, 1279, 1266, 1095, 1023, 933, 897, 835, 810, 788, 771. $C_6H_8O_2$ (112.13): calcd.C, 64.27; H, 7.19; found. C, 64.01; H, 6.99.

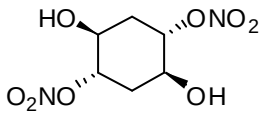
***anti*-1,4-Cyclohexadiene bisepoxide (21):**



21

(1.95 g, 56%, colourless crystals from CH_2Cl_2/hexane, M.p. 181–182 ^oC). ^1H NMR (200 MHz, $CDCl_3$): δ 3.07–3.05 (m, OCH, 4H), 232–2.30 (m, CH_2, 4H); ^{13}C NMR (50 MHz, $CDCl_3$) δ 50.9, 25.9; IR (CH_2Cl_2): $\tilde{\nu}$ = 2925, 2854, 1729, 1464, 127, 1074, 750. $C_6H_8O_2$ (112.13): calcd. C, 64.27; H, 7.19; found. C, 64.30; H, 7.38.

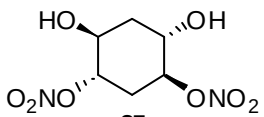
(1*R*(*S*),2*R*(*S*),4*R*(*S*),5*R*(*S*))-2,5-dihydroxycyclohexane-1,4-diyl dinitrate (24):



24

The product **24** was prepared as described above by typical procedure for 20 min by starting from **20** (250 mg, 2.23 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (2.18 g, 4.46 mmol). The product **24** was recrystallized from CH_2Cl_2/hexane as white crystals (395 mg, 74%, M.p. 113–114 ^oC). ^1H NMR (200 MHz, CD_3COCD_3): δ 5.25 (ddd, *J* = 10.7, 7.1, 4.0 Hz, $CHONO_2$, 2H), 5.86 (d, *J* = 4.0 Hz, OH, 2H), 4.05 (ddd, *J* = 10.7, 7.1, 4.0 Hz, CHOH, 2H), 2.25 (ddd, *J* = 10.7, 7.1, 4.0 Hz, A part of AB system, CH_2, 2H), 2.02 (ddd, *J* = 10.7, 7.1, 4.0 Hz, B part of AB system, CH_2, 2H); ^{13}C NMR (50 MHz, CD_3COCD_3): δ 84.8, 68.6, 34.3; IR (CH_2Cl_2): $\tilde{\nu}$ = 3398, 2925, 2856, 1716, 1635, 1442, 1276, 1181, 1067, 1015, 961, 854, 751. $C_6H_{10}N_2O_8$ (238.15): calcd. C, 30.26; H, 4.23; N, 11.76; found. C, 30.50; H, 4.08; N, 11.67.

(1*S*(*R*),3*S*(*R*),4*S*(*R*),6*S*(*R*))-4,6-dihydroxycyclohexane-1,3-diyl dinitrate (25):

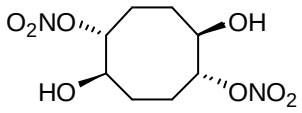


25

The product **25** was prepared as described above by typical procedure for 20 min by starting from **21** (850 mg, 7.59 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (7.36 g, 15.18 mmol). The product **25** was recrystallized from CH_2Cl_2/hexane as white crystals (1.29 g, 71%, M.p. 172–173 ^oC). ^1H NMR (200 MHz, $CDCl_3$): δ 5.10 (q, *J* = 5.8 Hz, $CHONO_2$, 2H), 4.18 (q, *J* = 5.8 Hz, CHOH, 2H), 2.31 (t, *J* = 5.8 Hz, CH_2, 2H), 2.07 (t, *J* = 5.8 Hz, CH_2, 2H); ^{13}C NMR (50 MHz,

$CDCl_3$): δ 83.1, 67.7, 37.7, 29.2; IR (CH_2Cl_2): $\tilde{\nu}$ = 3753, 3378, 2931, 1638, 1441, 1326, 1279, 1181, 1090, 1069, 1015, 950, 862, 752. $C_6H_{10}N_2O_8$ (238.15): calcd. C, 30.26; H, 4.23; N, 11.76; found. C, 30.41; H, 4.20; N, 11.70.

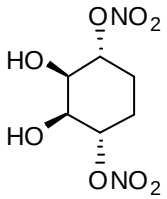
(1*R*(*S*),2*R*(*S*),5*R*(*S*),6*R*(*S*))-2,6-dihydroxycyclooctane-1,5-diyl dinitrate (31):



31

The product **31** was prepared as described above by typical procedure for 16 h by starting from **30** (600 mg, 4.29 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (4.16 g, 8.57 mmol). The residue was submitted to column chromatography (silica gel, 30 g) eluting with ethyl acetate/hexane (40:60). The elution gave the product **31** (800 mg, 70%, recrystallized from CH_2Cl_2/hexane as white crystals, M.p. 91–92 °C). ^{1}H NMR (400 MHz, CD_3OD): δ 5.05 (ddd, *J* = 10.5, 8.0, 2.3 Hz, $CHONO_2$, 2H), 3.79 (ddd, *J* = 10.5, 8.0, 2.3 Hz, CHOH, 2H), 2.12–2.00 (m, CH_2, 4H), 1.98–1.84 (m, CH_2, 4H); ^{13}C NMR (100 MHz, CD_3OD): δ 87.9, 70.8, 28.5, 24.3; IR (CH_2Cl_2): $\tilde{\nu}$ = 3386, 2941, 1629, 1365, 1278, 1086, 1008, 977, 860, 755. $C_8H_{14}N_2O_8$ (266.21): calcd. C, 36.09; H, 5.30; N, 10.52; found. C, 35.99; H, 5.38; N, 10.65.

(1*R*(*S*),2*R*(*S*),3*S*(*R*),4*S*(*R*))-2,3-dihydroxycyclohexane-1,4-diyl dinitrate (34):

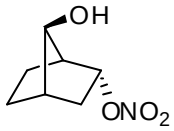


34

The product **34** was prepared as described above by typical procedure for 30 min by starting from **33** (500 mg, 4.46 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (4.34 g, 8.94 mmol). The product **34** was recrystallized from CH_2Cl_2/hexane as white crystals (900 mg, 85%, M.p. 88–89 °C). ^{1}H NMR (200 MHz, $CDCl_3$): δ 5.30–5.19 (m, $CHONO_2$, 2H), 4.04 (d, *J* = 5.6 Hz, CHOH, 2H), 3.04–2.91 (m, OH, 2H), 2.22–2.03 (m, AA' part of AA'BB' system, CH_2, 2H), 1.97–1.26 (m, BB' part of AA'BB' system, CH_2, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ 82.4, 71.6, 24.7; IR (CH_2Cl_2): $\tilde{\nu}$ = 3403, 2940, 1634, 1440, 1315, 1276, 1068, 996, 853, 755. $C_6H_{10}N_2O_8$ (238.04): calcd. C, 30.26; H, 4.23; N, 11.76; found. C, 30.03; H, 4.40; N, 11.75.

The reaction of norbornene-epoxide (35) with $Bi(NO_3)_3{\cdot}5H_2O$: Reaction was performed as described above by typical procedure for 30min by starting from **35** (800 mg, 7.27 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (3.53 g, 7.27 mmol). After the mixture was filtered, the residue was submitted to column chromatography (silica gel, 30 g) eluting with ethyl acetate/hexane (5:95). The first elution gave the product **36** as colourless oil (380 mg, 30%). Then, the column was eluted by ethyl acetate/hexane (7:93) to give **37** (850 mg, 68%).

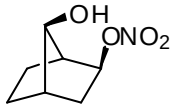
(2*R*(*S*),7*R*(*S*))-7-hydroxybicyclo[2.2.1]heptan-2-yl nitrate (36):



36

^{1}H NMR (200 MHz, $CDCl_3$): δ 4.78 (dd, *J* = 7.9, 2.9 Hz, $CHONO_2$, 1H), 4.25 (m, CHOH, 1H), 2.31–2.29 (m, CH, 1H), 2.18–2.13 (m, CH, 1H), 2.05–1.95 (m, CH_2, 2H), 1.87 (dd, *J* = 14.5, 7.9 Hz, A part of AB system, CH_2, 1H), 1.69–1.53 (m, CH_2, 1H), 1.27–1.20 (m, CH_2, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ 86.5, 78.7, 46.6, 41.2, 37.2, 26.8, 23.6; IR (CH_2Cl_2): $\tilde{\nu}$ = 3375, 2967, 2882, 1618, 1282, 1148, 1037, 1005, 935, 867, 758. $C_7H_{11}NO_4$ (173.17): calcd. C, 48.55; H, 6.40; N, 8.09; found. C, 48.82; H, 6.55; N, 8.45.

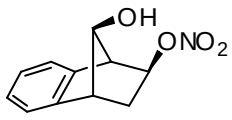
(2*S*(*R*),7*R*(*S*))-7-hydroxybicyclo[2.2.1] heptan-2-yl nitrate (37):



37

(730 mg, 58%, colourless crystals from CH_2Cl_2/hexane, M.p. 47–48 ^{o}C). ^{1}H NMR (200 MHz, $CDCl_3$): δ 4.98 (ddd, *J* = 7.1, 3.6, 2.8 Hz, $CHONO_2$, 1H), 4.05 (bs, CHOH, 1H), 2.35 (d, *J* = 4.4 Hz, CH, 1H), 2.26–2.20 (m, CH, 1H), 2.14–2.11 (m, CH_2, 1H), 2.03 (dd, *J* = 13.9, 7.1 Hz, A part of AB system, CH_2, 1H), 1.98–1.54 (m, CH_2, 2H), 1.28–1.16 (m, CH_2, 2H); ^{13}C NMR (50 MHz, $CDCl_3$): δ 88.7, 81.3, 46.4, 42.6, 37.4, 26.7, 24.4; IR (CH_2Cl_2): $\tilde{\nu}$ = 3343, 2965, 2925, 1625, 1279, 1157, 1085, 1068, 966, 865, 757. $C_7H_{11}NO_4$ (173.17): calcd. C, 48.55; H, 6.40; N, 8.09; found. C, 48.77; H, 6.35; N, 8.23.

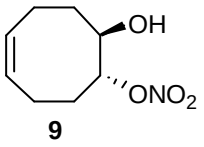
9(*R*(*S*))-hydroxy-1,2,3,4-tetrahydro-1,4-methano-naphthalen-2(*R*(*S*)-yl nitrate (44):



44

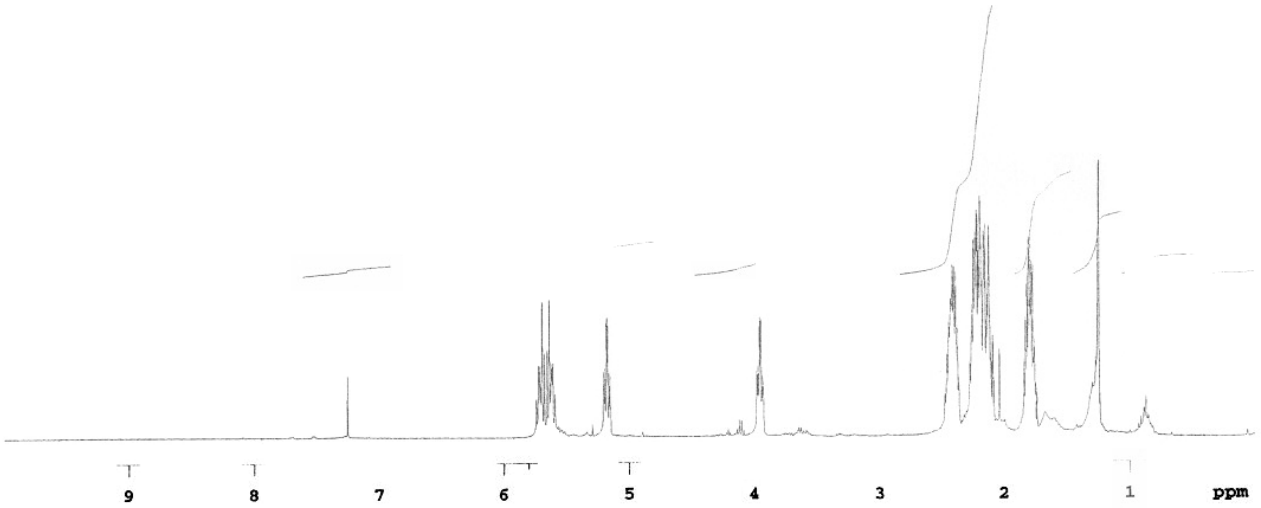
The product **44** was prepared as described above by typical procedure for 18 h by starting from **43** (400 mg, 2.53 mmol) and $Bi(NO_3)_3{\cdot}5H_2O$ (1.23 g, 2.53 mmol). The residue was submitted to column chromatography (silica gel, 10 g) eluting with ethyl acetate. The elution gave the product **44** (350 mg, 63%, recrystallized from CH_2Cl_2/hexane as white crystals, M.p. 102–103 ^{o}C). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.29–7.21 (m, aryl, 1H), 7.20–7.15 (m, aryl, 3H), 4.95 (dd, *J* = 7.3, 3.3 Hz, $CHONO_2$, 1H), 4.08 (m, CHOH, 1H), 3.53 (m, CH, 1H), 3.36–3.35 (m, CH, 1H), 2.35 (m, OH, 1H), 2.33 (ddd, *J* = 13.4, 7.3, 3.3 Hz, A part of AB system, CH_2, 1H), 2.12 (dd, *J* = 13.4, 7.3 Hz, B part of AB system, CH_2, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 145.0, 139.0, 128.0, 123.3, 122.4, 85.3, 83.8, 52.4, 48.2, 32.3; IR (CH_2Cl_2): $\tilde{\nu}$ = 3386, 2941, 1629, 1365, 1278, 1086, 1008, 977, 860, 755. $C_{11}H_{11}NO_4$ (221.21): calcd. C, 59.73; H, 5.01; N, 6.33.; found. C, 60.03; H, 4.82; N, 6.25.

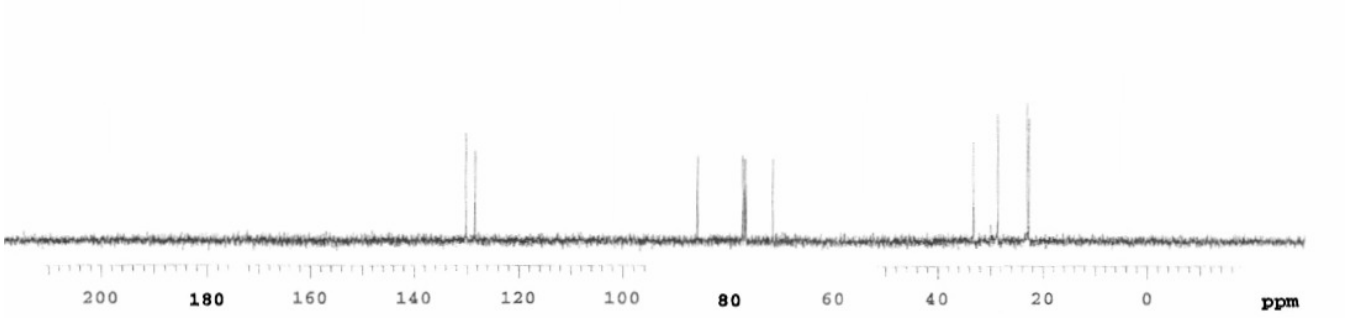
^{1}H and ^{13}C NMR Spectra

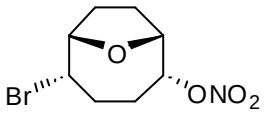


9

INDEX	FREQUENCY	PPM	HEIGHT
1	13083.302	130.154	20.8
2	12912.404	128.454	17.4
3	8648.335	86.035	16.4
4	7797.657	77.572	16.5
5	7765.614	77.253	15.7
6	7733.571	76.935	15.7
7	7220.875	71.834	15.9
8	3334.462	33.172	23.3
9	2872.120	28.572	24.5
10	2309.071	22.971	26.7
11	2279.316	22.675	23.8



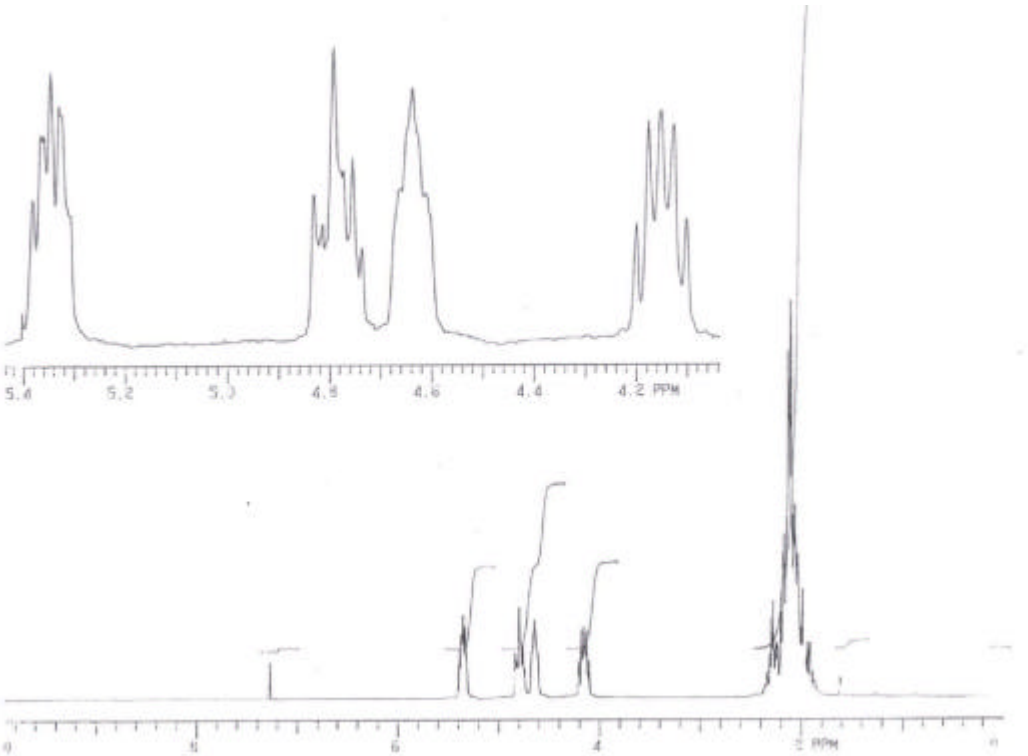


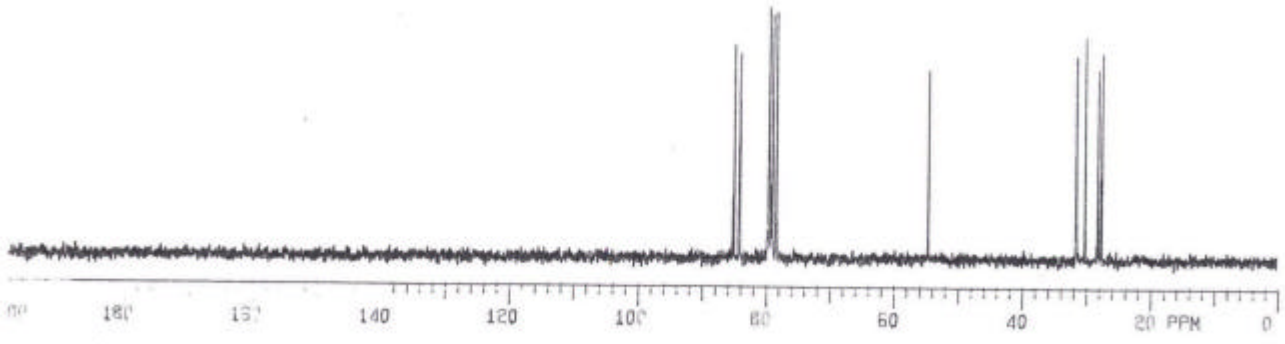


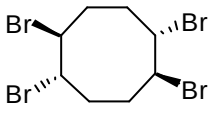
10

GEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR TM= 4.81
RFL= 1738.7 RFP= 0

INDEX	FREQ	PPM	INTENSITY
01	4279.4	85.095	40.439
02	4230.0	84.112	38.614
03	4004.7	79.634	45.965
04	3990.8	79.341	40.713
05	3372.7	70.097	44.698
06	3940.8	78.362	45.562
07	2745.2	54.588	35.235
08	1584.8	31.498	37.184
09	1514.6	30.117	40.522
10	1419.0	28.217	39.374
11	1390.8	27.656	38.494



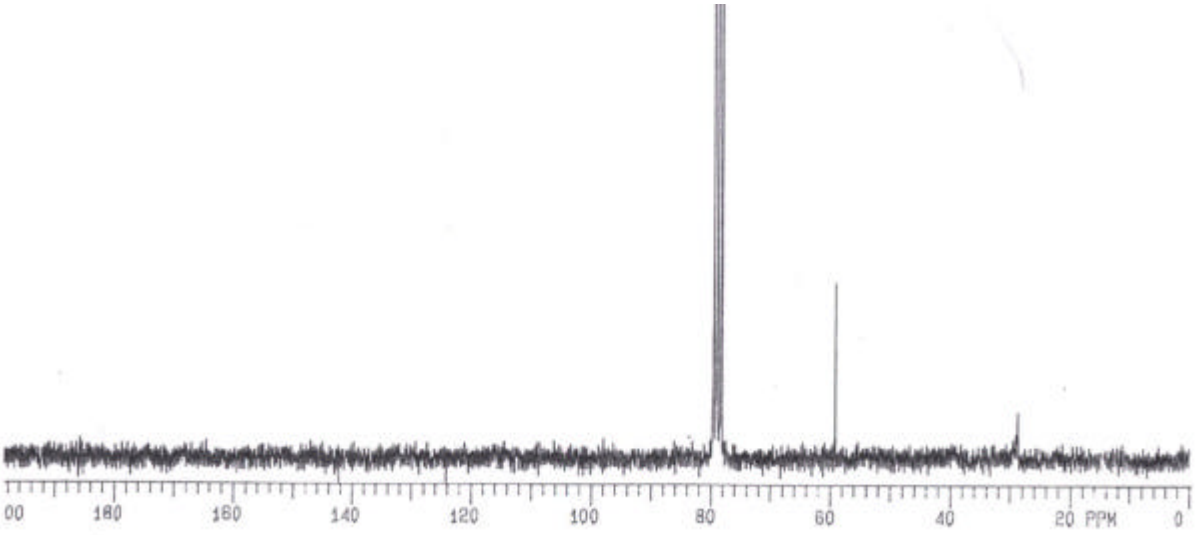


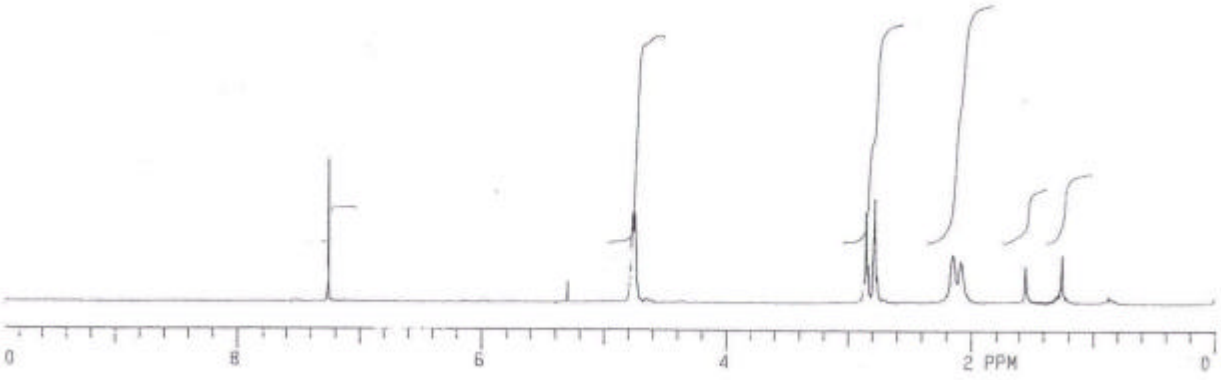


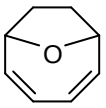
11

GEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR TH= 7.72
RFL= 1738.7 RFP= 0

INDEX	FREQ	PPM	INTENSITY
01	4002.8	79.595	122.940
02	3970.9	78.960	125.503
03	3938.9	78.326	123.703
04	2978.8	59.233	34.322
05	1448.5	28.803	9.465



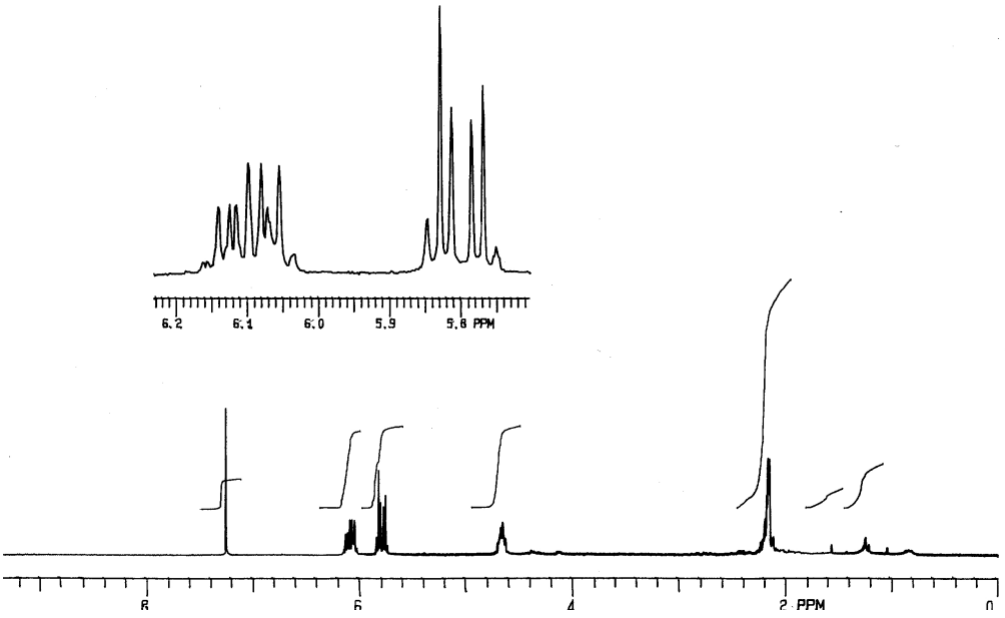


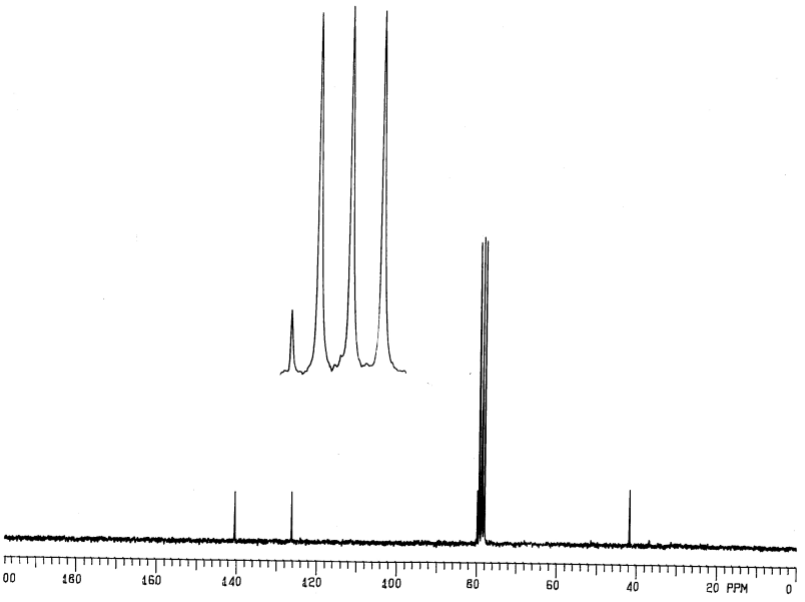


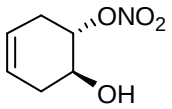
12

GEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR TH- 13.96
RFL- 1738.7 RFP- 0

INDEX	FREQ	PPM	INTENSITY
01	7059.4	140.554	14.644
02	6356.7	126.493	14.744
03	4029.6	80.259	15.310
04	3999.0	79.520	86.056
05	3967.1	78.996	97.529
06	3935.1	78.249	86.484
07	2105.8	41.970	16.176



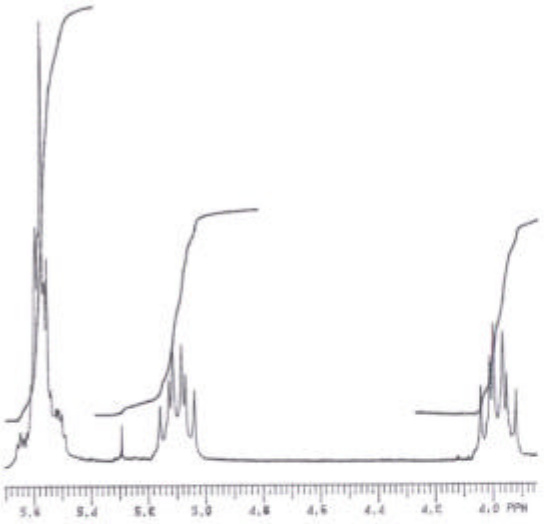


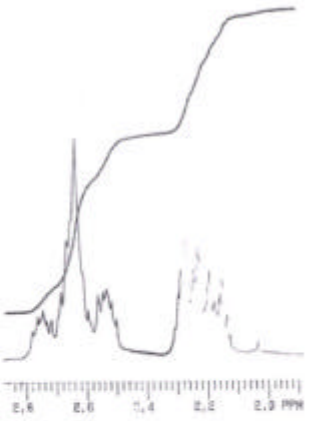


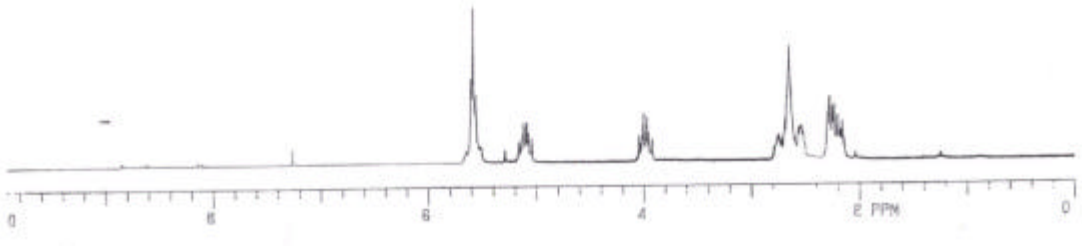
18

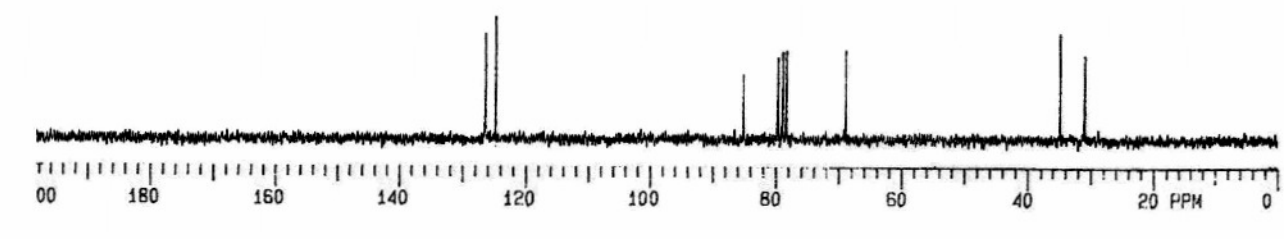
GEMINI-200 GAMMA HZ TEST
SPECTRAL LINES FOR TH= 14.03
RFL= 1738.7 RFP= 0

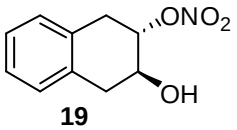
INDEX	FREQ	PPM	INTENSITY
01	5354.6	126.360	86.754
02	5280.5	124.886	89.968
03	4282.1	85.149	54.540
04	4008.1	79.700	67.475
05	3976.0	79.062	71.905
06	3944.2	78.431	72.710
07	3473.2	69.065	77.549
08	1756.9	34.935	89.084
09	1561.4	31.049	78.568





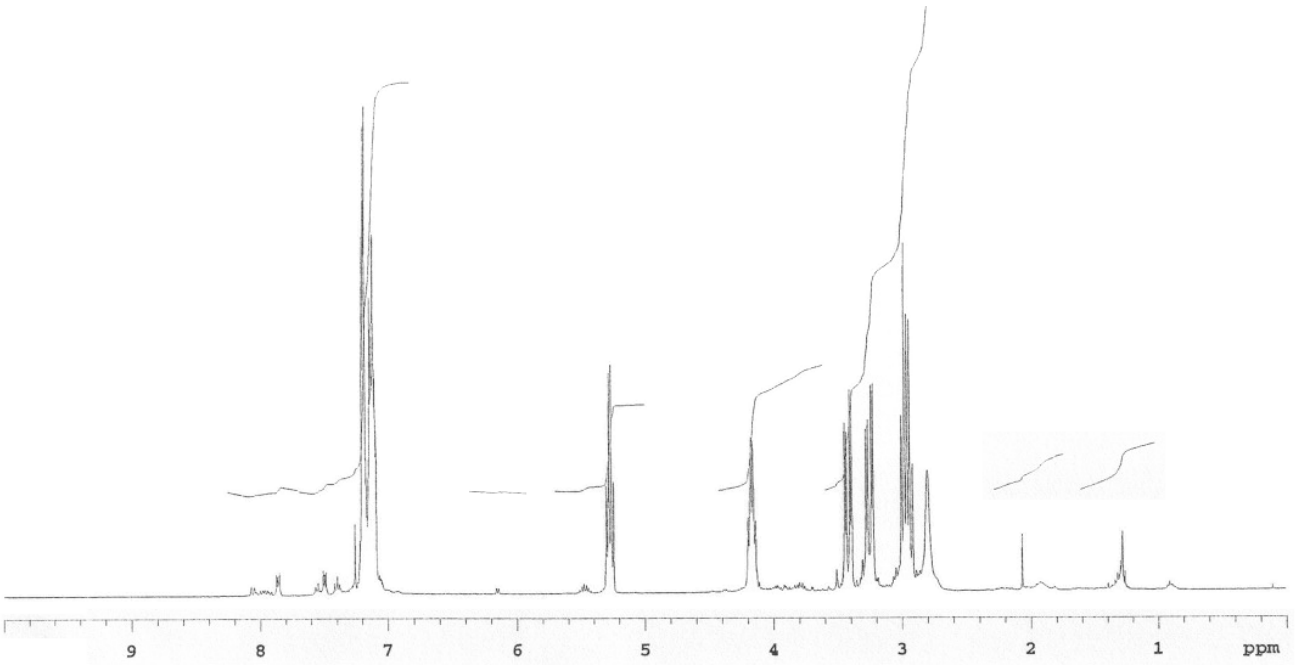


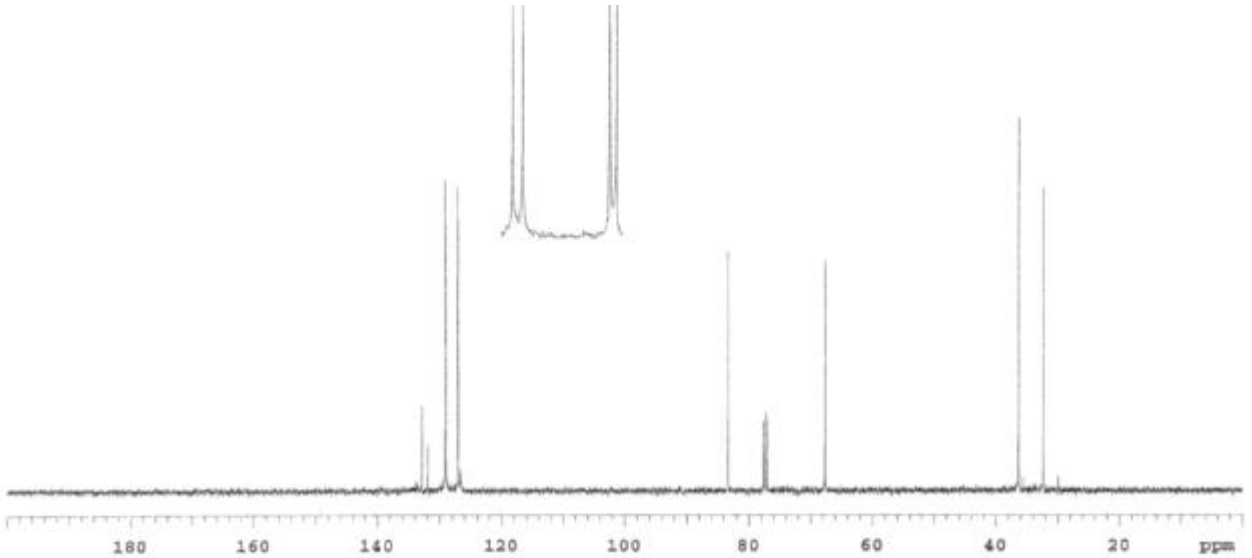


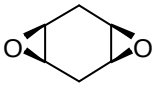


19

INDEX	FREQUENCY	PPM	HEIGHT
1	13358.723	132.894	17.2
2	13264.119	131.953	9.4
3	12984.120	129.168	63.3
4	12963.520	128.963	54.4
5	12781.178	127.149	61.9
6	12766.682	127.005	55.1
7	8383.595	83.401	48.6
8	7806.050	77.656	14.3
9	7774.006	77.337	16.0
10	7741.963	77.018	14.9
11	6801.259	67.660	46.8
12	3651.082	36.321	76.0
13	3253.590	32.367	61.6



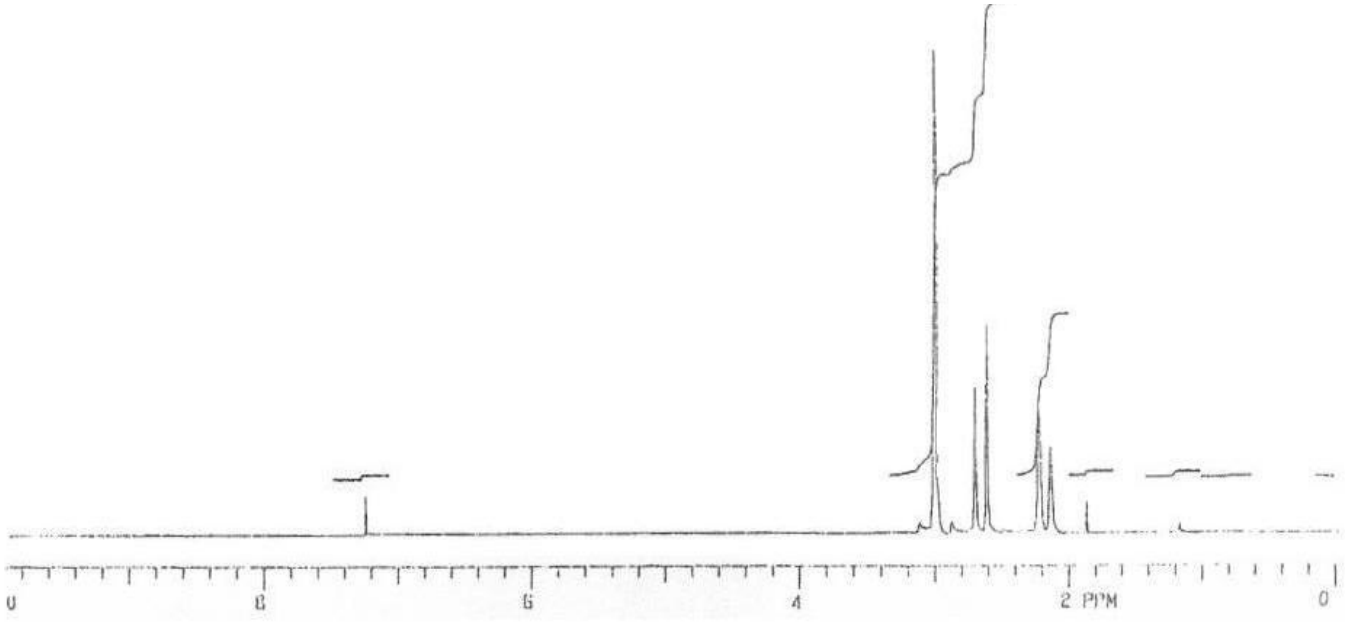


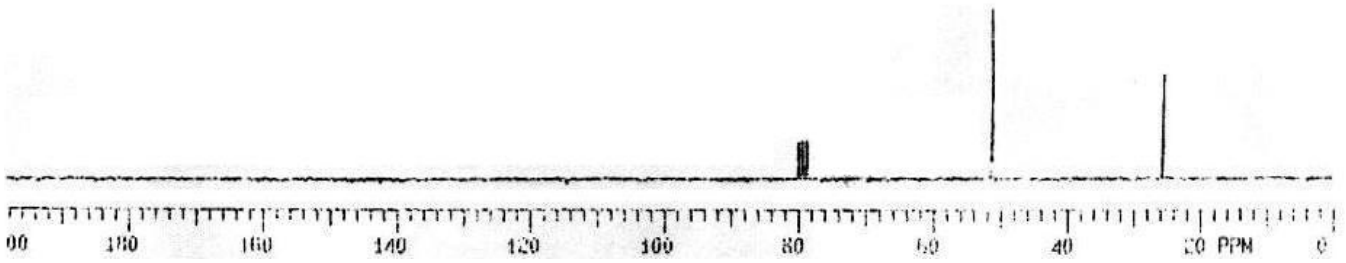


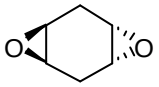
20

GEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR TH= 3.48
RFL= 1738.7 RFP= 0

INDEX	FREQ	PPM	INTENSITY
01	4012.9	79.795	6.546
02	3980.8	79.159	6.789
03	3948.8	78.522	6.782
04	2569.9	51.103	29.792
05	1279.6	25.445	17.946



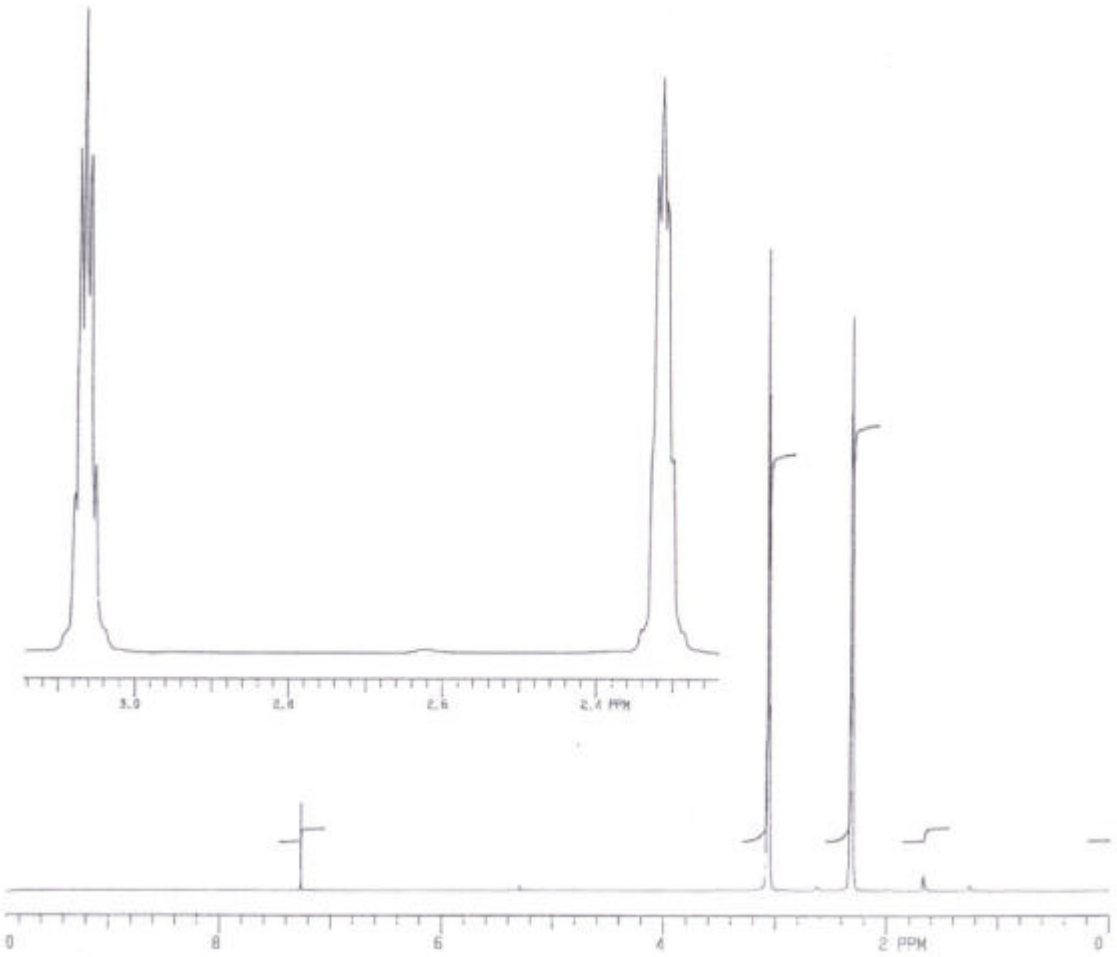


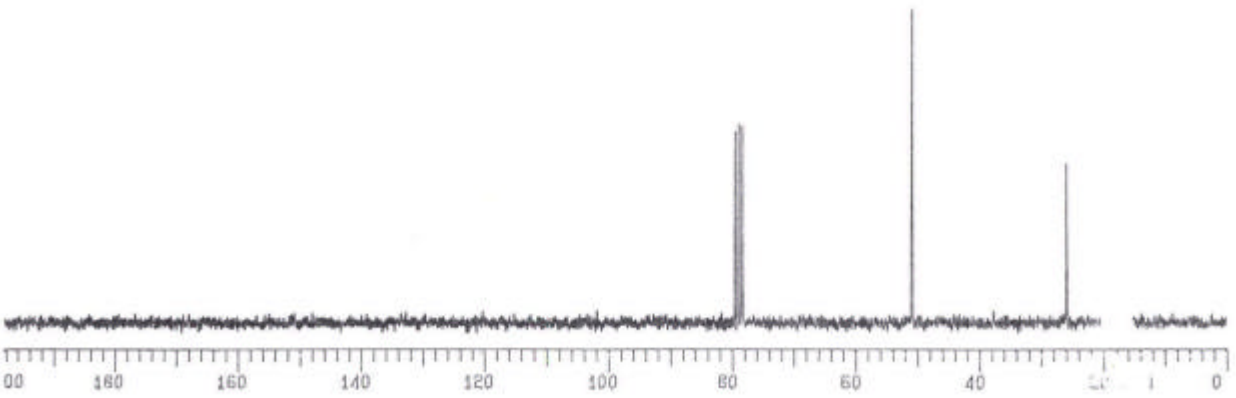


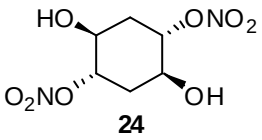
21

GEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR "H- 28.5E
RFL= 1750.7 RFP= 0

INDEX	FREQ	PPM	INTENSITY
01	4004.5	79.632	364.185
02	3972.6	78.995	378.678
03	3940.6	78.358	374.788
04	2559.5	50.898	603.923
05	1302.1	25.891	388.405



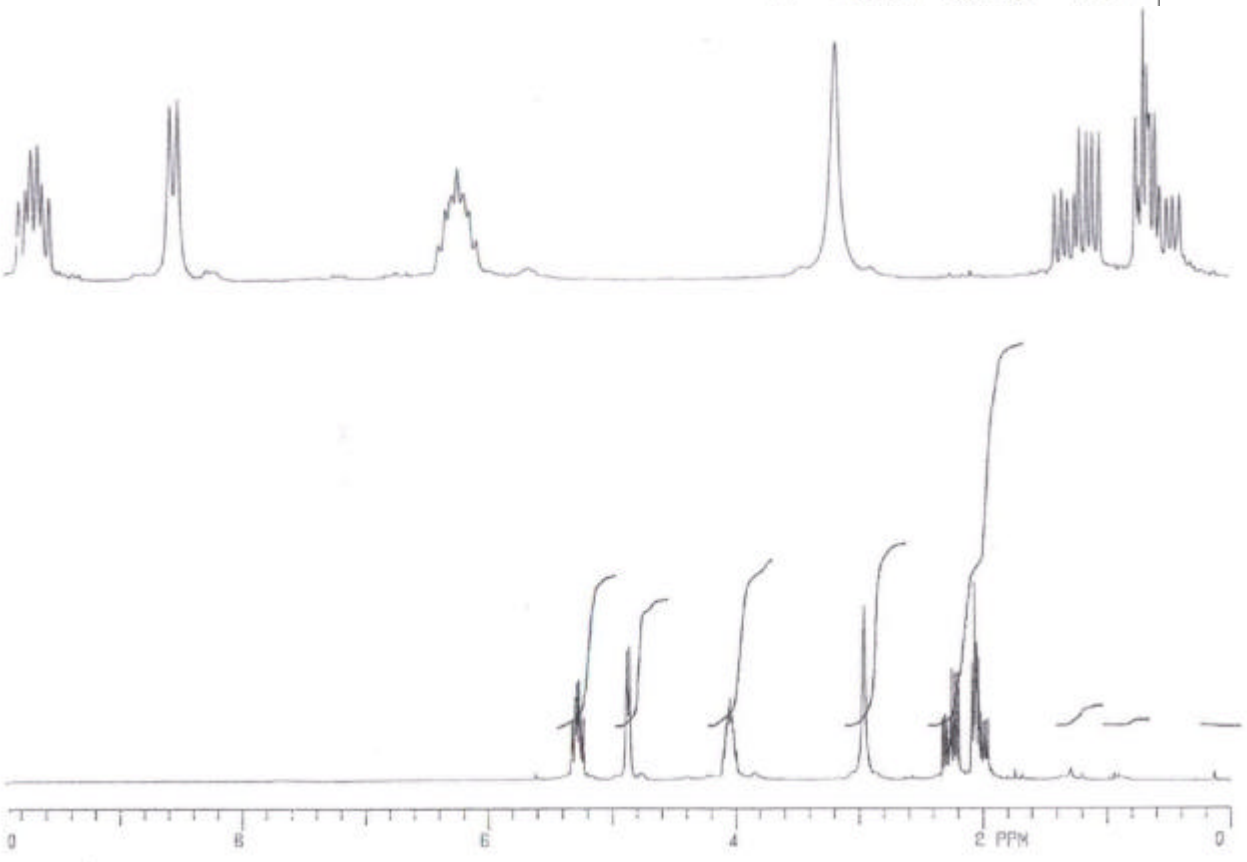


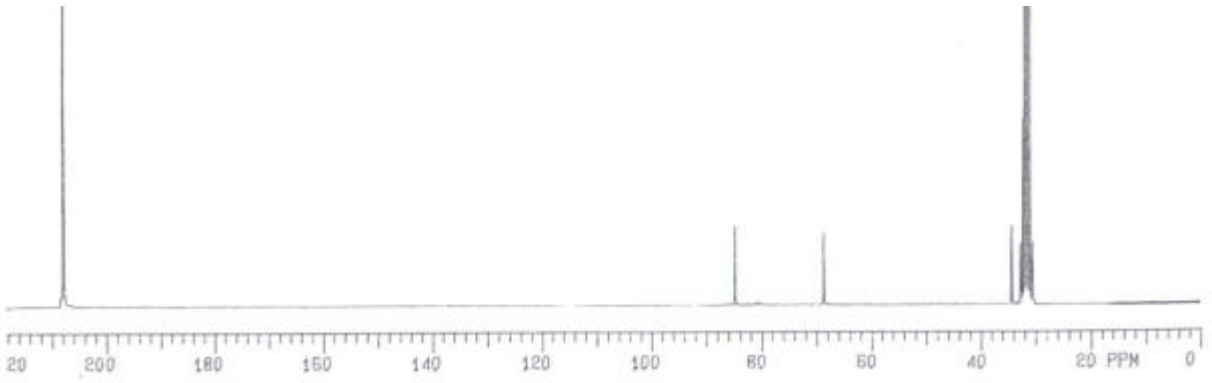


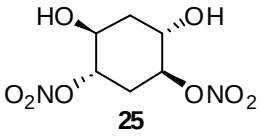
24

SPECTRAL LINES FOR TH= 9.10
RFL= 1951.3 RFP= 0

INDEX	FREQ	PPM	INTENSITY
01	10448.7	207.772	153.038
02	4286.1	84.832	15.767
03	3452.0	68.642	14.692
04	1724.8	34.298	15.622
05	1646.1	32.733	12.360
06	1626.9	32.351	36.459
07	1607.7	31.969	72.542
08	1588.5	31.587	84.157
09	1569.3	31.205	71.583
10	1549.1	30.804	36.259
11	1529.9	30.422	12.617







25

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BEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR TH=     3.12
  REF=   1738.7  REFP=        0

INDEX    FREQ        PPM       INTENSITY
 01     4177.7     83.073        8.817
 02     3999.3     79.527       51.683
 03     3967.5     78.894       52.120
 04     3935.6     78.259       51.304
 05     3406.6     67.741        7.938
 06     1896.8     37.717        3.859
 07     1466.6     29.163        3.743
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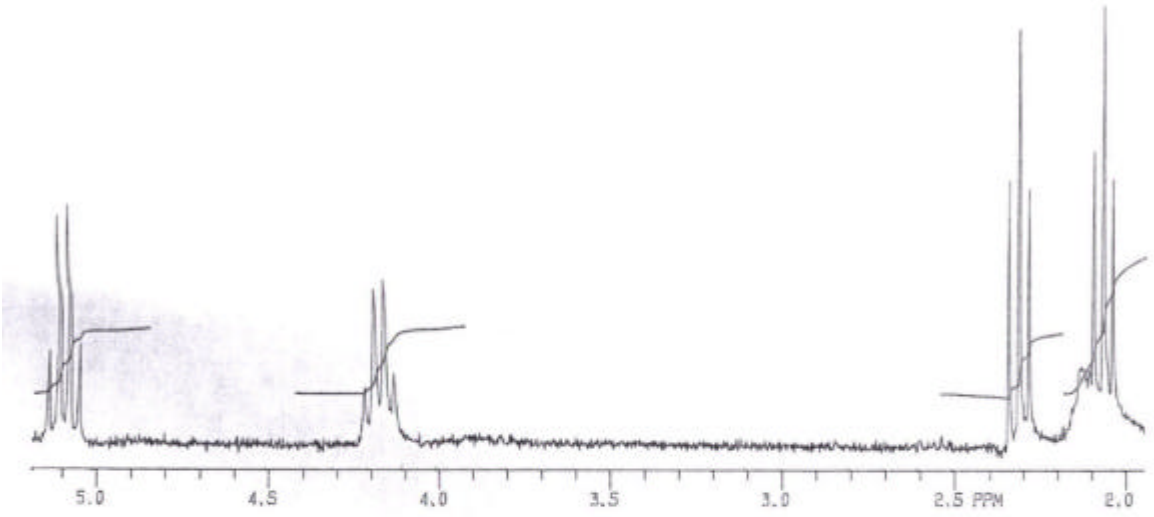
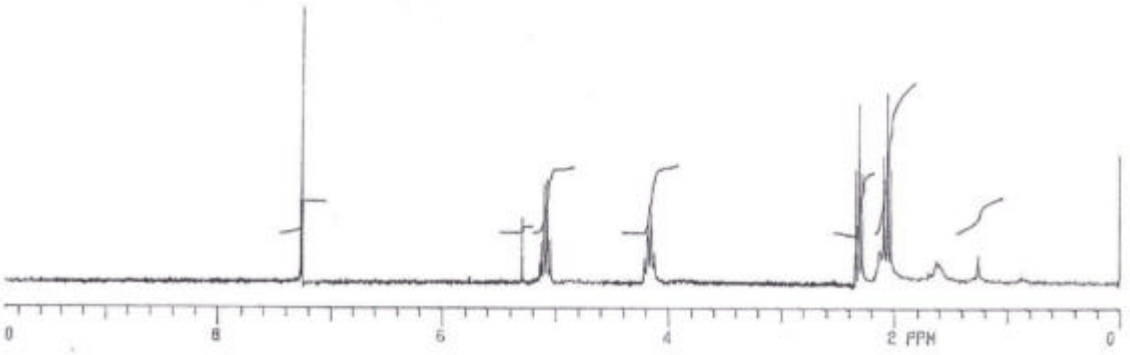
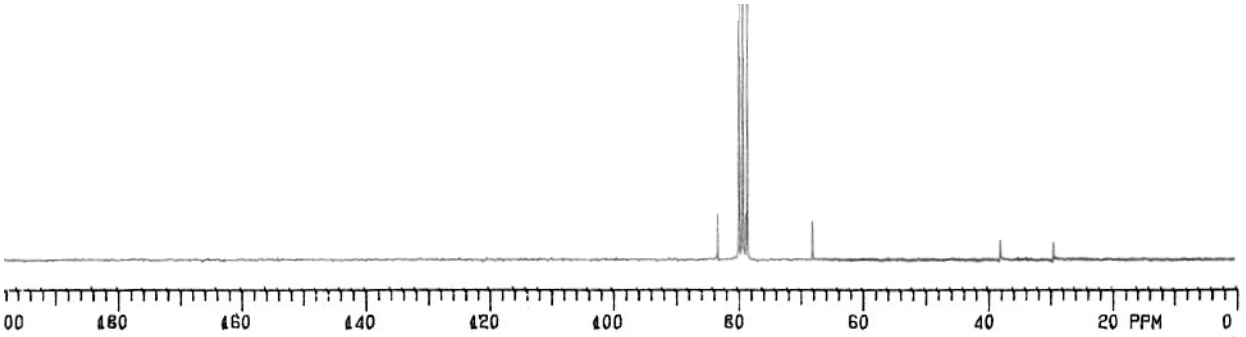
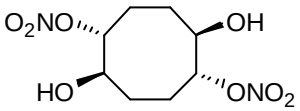


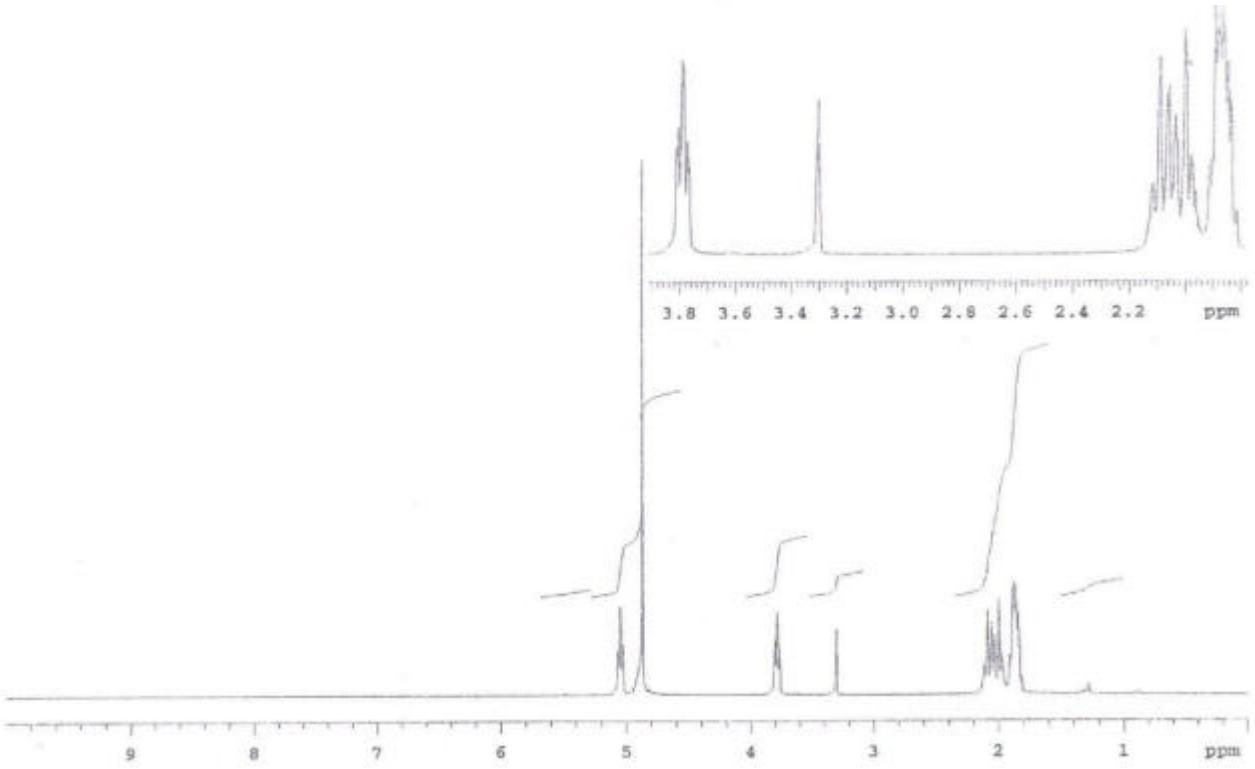


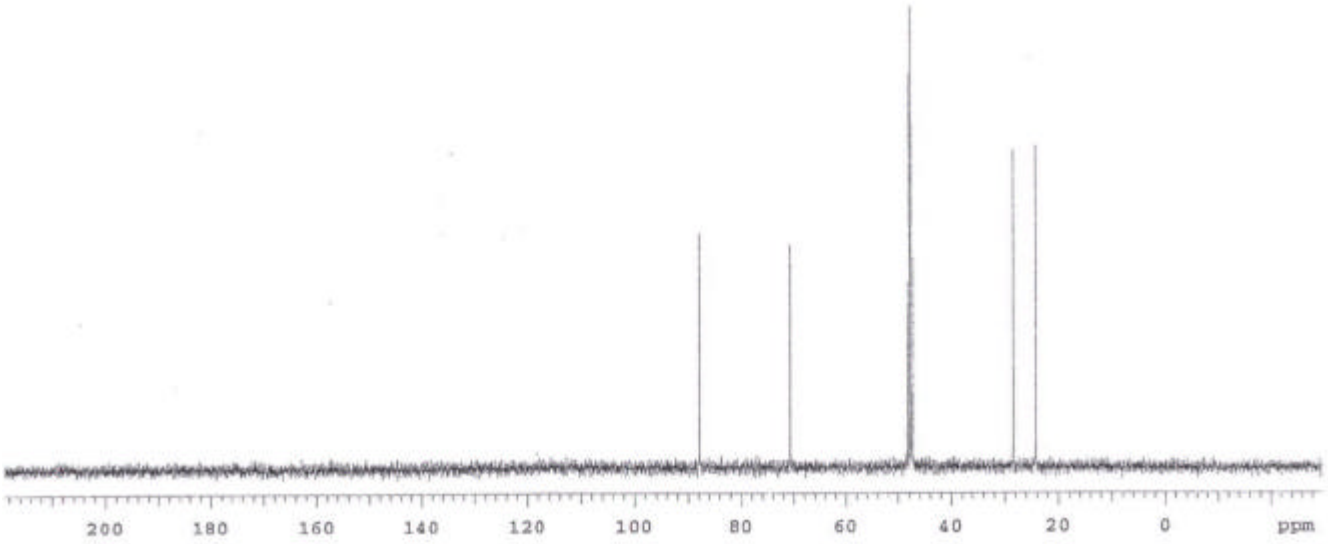


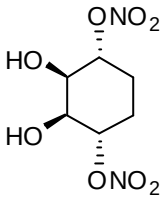


31

INDEX	FREQUENCY	PPM	HEIGHT
1	8831.479	87.856	44.2
2	7114.865	70.779	42.3
3	4851.224	48.260	35.0
4	4829.099	48.040	74.6
5	4807.736	47.828	87.4
6	4786.374	47.615	65.3
7	4765.012	47.403	39.5
8	2859.952	28.451	60.2
9	2436.521	24.239	60.9



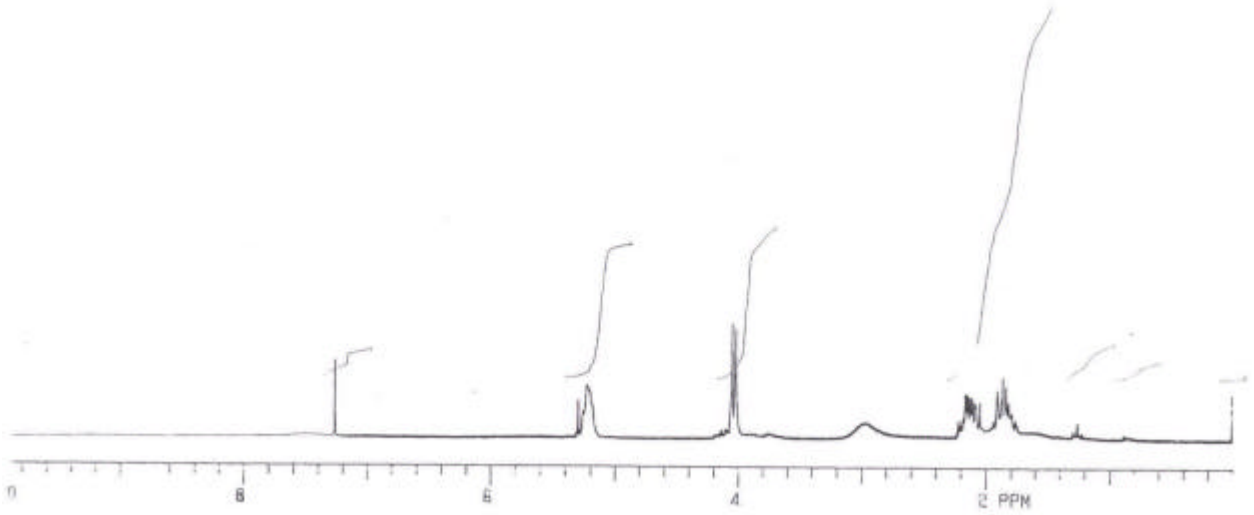


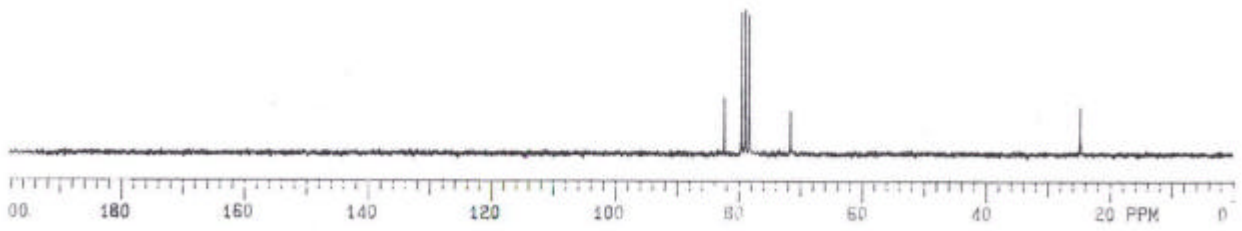


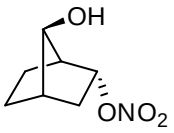
34

GEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR TH= 5.95
REL= 1738.7 REF= 0

INDEX	FREQ	PPM	INTENSITY
01	4145.4	82.430	10.921
02	4003.7	79.613	25.684
03	3971.0	78.979	27.435
04	3939.9	78.344	26.523
05	3600.8	71.621	6.418
06	1243.2	24.721	9.728







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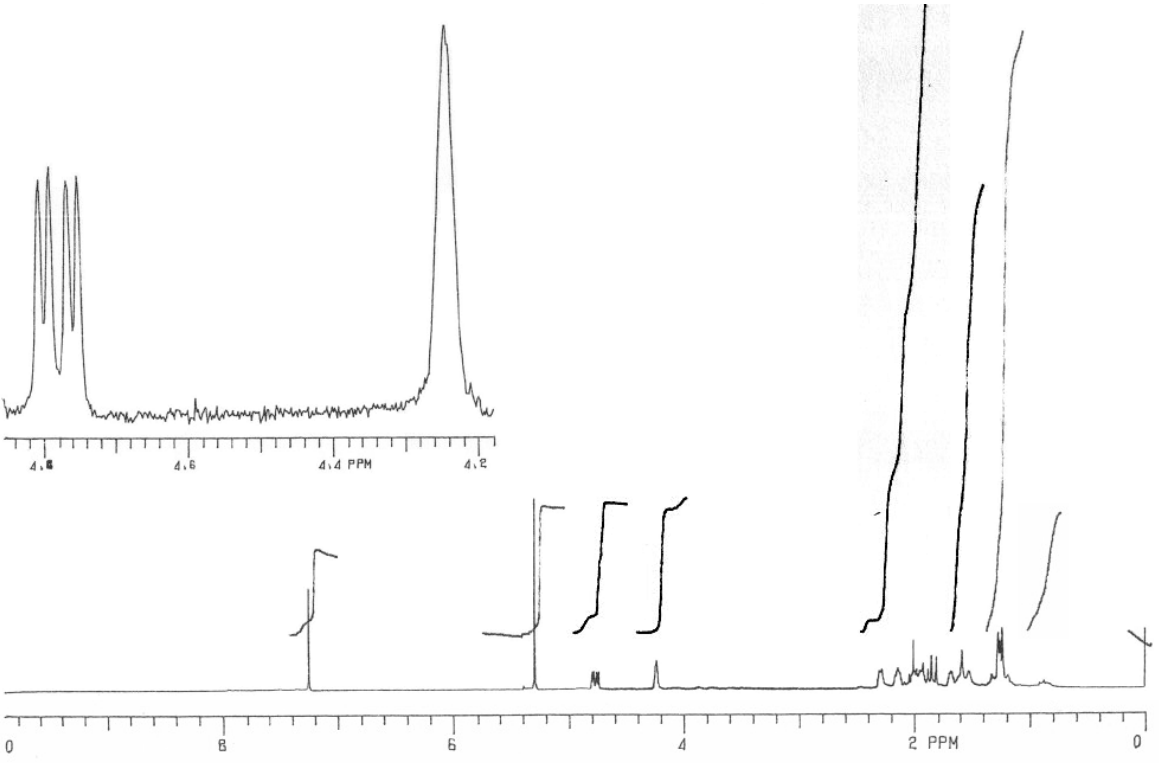
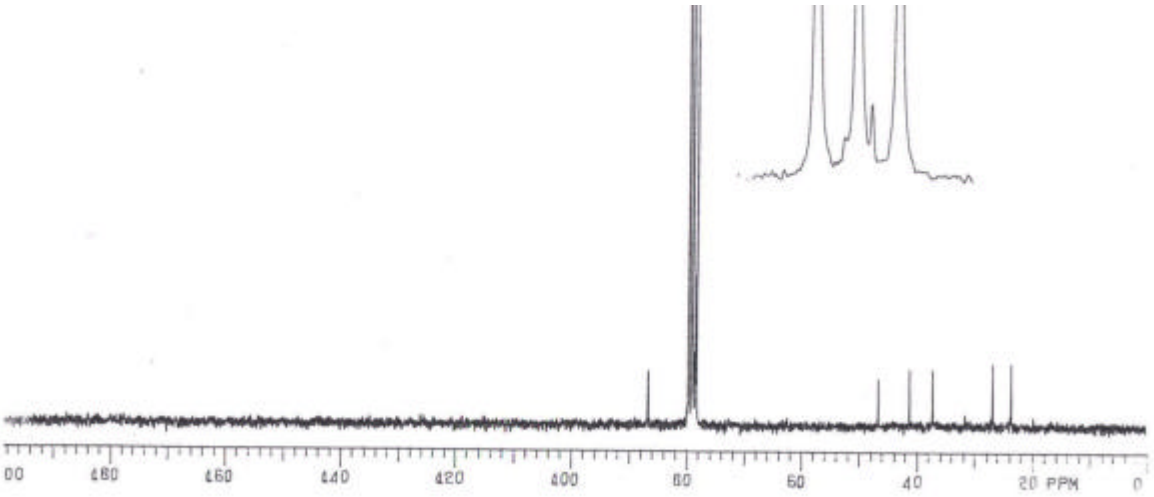
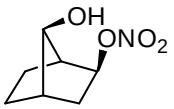
SEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR TH= 4.94
REL= 1738.7 REF= 0

INDEX	FREQ	PPM	INTENSITY
01	4350.9	86.516	11.922
02	3989.4	79.529	151.878
03	3977.6	79.094	8.828
04	3967.5	78.894	153.228
05	3956.5	78.675	16.151
06	3935.7	78.261	151.276
07	2341.5	46.561	10.662
08	2069.1	41.145	11.880
09	1870.7	37.198	11.904
10	1349.8	26.842	13.172
11	1190.0	23.663	13.251







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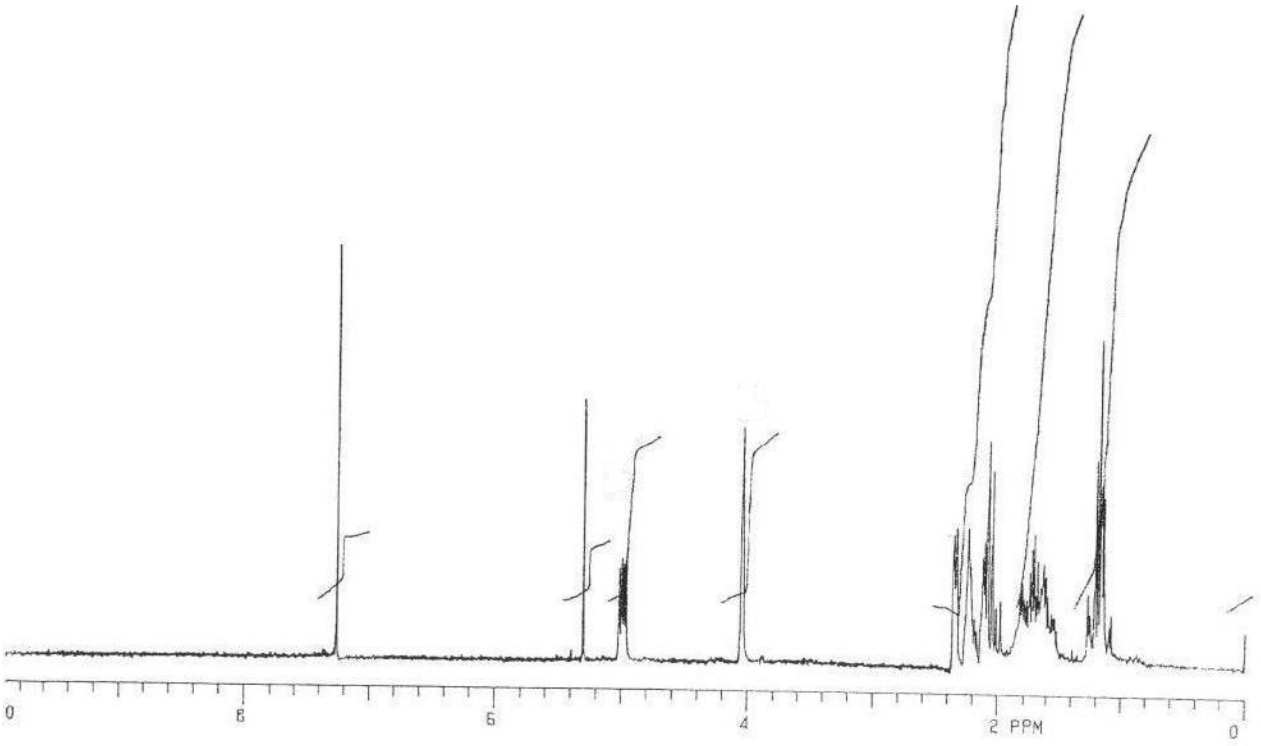
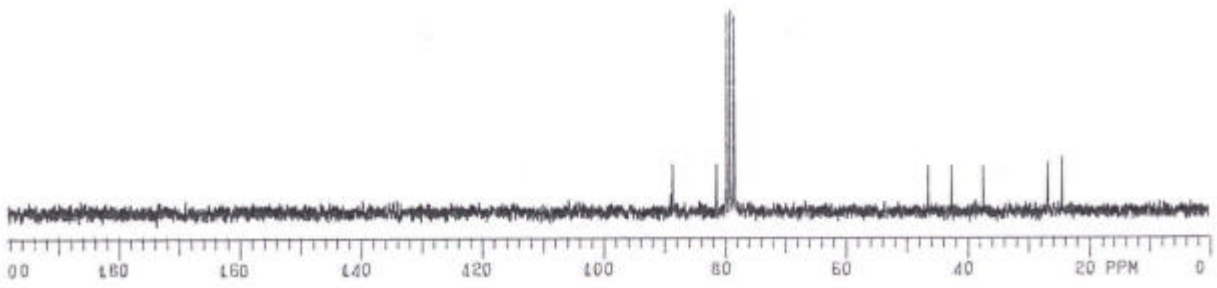
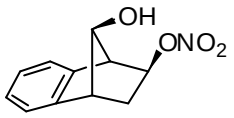
GEMINI-200 GAMMA H2 TEST
SPECTRAL LINES FOR TH= 13.59
RFL= 1738.7 RFP= 0

INDEX	FREQ	PPM	INTENSITY
01	4459.5	88.678	24.170
02	4088.3	81.296	26.586
03	4003.2	79.603	103.512
04	3971.4	78.971	102.916
05	3939.5	78.336	98.714
06	2333.8	46.408	23.950
07	2141.4	42.582	23.057
08	1878.7	37.358	22.987
09	1340.7	26.660	24.825
10	1224.5	24.349	27.291







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INDEX	FREQUENCY	PPM	HEIGHT
1	14578.663	145.030	22.2
2	13976.704	139.042	18.5
3	12865.864	127.991	82.8
4	12788.044	127.217	66.5
5	12398.182	123.339	65.8
6	12302.815	122.390	61.3
7	8569.752	85.253	65.5
8	8424.030	83.803	79.0
9	7797.657	77.572	62.8
10	7765.614	77.253	62.1
11	7734.333	76.942	62.0
12	5268.513	52.412	62.2
13	4842.030	48.169	70.1
14	3249.775	32.329	100.0