Supporting Information for

Synthesis of Naphthoic Acids as Potential Anticancer Agents

Lorraine M. Decka,*, Jacob A. Greenberga, Lisa J. Whalena, David L. Vander Jagtb and
Robert E. Royerb

a Department of Chemistry and Chemical Biology, University of New Mexico, Albuquerque, NM 87131
b Department of Biochemistry and Molecular Biology, University of New Mexico School of Medicine, Albuquerque, NM 87131

*Corresponding author: ldeck@unm.edu; Phone: (505) 277-5438

List of Contents

General Procedure for Syntheses of compounds 2, 3, 4, 6, 9, 13  Page S2
General Procedure for Syntheses of compounds 7, 10, 11, 12, 14  Page S3
Characterization data for compounds 2a-2c, 3, 4a  Page S4
Characterization data for compounds 4b-4e  Page S5
Characterization data for compounds 5a-5c, 6a  Page S6
Characterization data for compounds 6b-6c, 7a-7b  Page S7
Characterization data for compounds 7c, 8-11  Page S8
Characterization data for compounds 12a-12e  Page S9
Characterization data for compounds 13a-13d  Page S10
Characterization data for compounds 13e, 14a-14d  Page S11
Characterization data for compound 14e  Page S12
Experimental
Reagents were purchased from commercial sources (Aldrich, Acros). The reactions were monitored by thin layer chromatography (TLC), which was carried out on silica gel 60F254 plates and visualized using UV light. If necessary products were purified by column chromatography using EM type 60 silica gel (230-400 mesh). Melting points were taken on a Thomas-Hoover Uni-Melt capillary melting point apparatus and reported uncorrected. Infrared spectra were obtained using a Bruker ALPHA spectrometer. Unless otherwise noted, 1H spectra were recorded by using CDCl3 solutions at 300 or 500 MHz; 13C NMR spectra were recorded in CDCl3 at 75 or 125 MHz. The data were collected on a Bruker Avance III HD 500 MHz, or a Bruker Avance III 300 MHz. Chemical shifts are reported in ppm relative to TMS at 0.0 ppm for 1H NMR and for 13C NMR. Proton NMR data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, quin = quintet, sept = septet, dd = doublet of doublets, td = triplet of doublets, ddd = doublet of doublets of doublets, m = multiplet), coupling constant (J in Hz) and integration. Peak assignments were made with the aid of DEPT and HMBC spectra. The samples for accurate mass analysis (HRMS) were run by electrospray ionization in positive mode on a Waters LCT Premier time of flight mass spectrometer after they were dissolved in ethyl acetate with subsequent dilution into methanol and water (037 with formic acid). High resolution mass spectra (HRMS) were obtained at the UNM Mass Spectrometry Facility, Albuquerque, New Mexico.

General Procedure for Synthesis of Compounds 2a-2c, 3, 4a-4e (7-Aryl-2,3-dihydroxy-6-methyl-4-propyl-1-naphthalene carboxylic acid)

A reaction mixture containing 1 mmol of the corresponding carboxylic acid (compound 7a-7c, 10, 14a-14e) in 15 mL of dichloromethane under nitrogen was cooled in a dry ice/2-propanol bath. Boron tribromide was added with stirring: 1 equiv for each ether group, 1 equiv for each functional group and an additional 0.5 equiv (total of 4 equiv). The mixture was stirred under nitrogen for 1 h periods at successively dry ice bath, ice bath and ambient temperature. The mixture was cooled in an ice bath and poured with vigorous stirring onto 50 g of ice with 2 mL of 6M HCl. The organic material was extracted into ether and the ether layer washed with water and brine and dried over magnesium sulfate. The solvent was evaporated and the residual solid (compound 2a-2c, 3, 4a-4e) was crystallized.

General Procedure for Synthesis of Compounds 6a-6c, 9, 13a-13e (7-Aryl-2,3-dimethoxy-6-methyl-4-propyl-1-naphthalene carboxaldehyde)

A reaction mixture consisting of 1 mmol of the corresponding benzyl or phenyl naphthalene (compounds 5a-5c, 8, 12a-12e) and dichloromethyl methyl ether (2.6 mmol) in 20 mL of dichloromethane was cooled in an ice bath. Titanium tetrachloride (1.5 mmol) was added slowly with stirring. The mixture was allowed to come to ambient temperature and stirred for 2 h. The mixture was added with stirring to 100 g of ice containing 10 mL of 6M HCl and the organic layer was washed with water and brine and dried over magnesium sulfate. Filtration and evaporation of the solvent gave crude aldehydes (compounds 6a-6c, 9, 13a-13e).
General Procedure for the synthesis of Compounds 7a-7c, 10, 14a-14e (7-Aryl-2,3-dimethoxy-6-methyl-4-propyl-1-naphthalene carboxylic acid)

The corresponding crude aldehyde (compounds 6a-6c, 9, 13a-13e) was dissolved in 15 mL of acetonitrile at room temperature and cooled in an ice bath. Sodium dihydrogen phosphate (0.2 mmol) and 30% \( \text{H}_2\text{O}_2 \) (1.1 mol) were added followed by 1.4 mmol of sodium chlorite dissolved in 5 mL of water. The reaction mixture was stirred at ambient temperature for 2 h and then poured onto 100 g of ice containing 10 mL of 6M \( \text{HCl} \) and extracted with ether. The ether layer was washed with water and brine and dried over magnesium sulfate. Filtration and evaporation of the solvent gave crude carboxylic acid (compounds 7a-7c, 10, 14a-14e).

Procedure for Synthesis of Compound 11 (6-Bromo-2,3-dimethoxy-7-methyl-1-propynaphthalene)

3,4-Dihydro-6,7-dimethoxy-3-methyl-5-\( n \)-propyl-1(2\( H \))naphthalenone (3.5g, 13.4 mmol) was reduced with sodium borohydride as described previously. The resulting alkene (2.5 g, 10.1 mmol) was dissolved in 100 ml of dry dichloromethane and bromine (1.62 g, 10.1 mmol) in 5 ml of dichloromethane was added dropwise with stirring over a period of fifteen minutes. The solvent was evaporated and the residue was taken up in 15 ml of DMF and warmed to 50-60 °C for 1 h. The reaction mixture was poured onto ice and stirred, after which the solid was filtered, dried and recrystallized from petroleum ether to give 2.46 g (7.56 mmol, 75% yield) of white crystals. The vinylic bromide (1.23 g, 3.78 mmol) was dissolved in 25 ml of benzene, 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (857 mg, 3.78 mmol) was added slowly with stirring and stirring was continued for 2 h. The reaction mixture was filtered through a short column of alumina and eluted with benzene. The solvent was evaporated and the residual oil was purified by silica gel column chromatography using dichloromethane to give 1.04 g (3.21 mmol, 85% yield) of 11 as colorless crystals.

General Procedure for Synthesis of Compounds 12a-12e (6-Aryl-2,3-dimethoxy-7-methyl-1-propynaphthalene)

Bromide 11 (1.33 mmol) was combined with phenylboronic acid or the appropriately substituted phenylboronic acid (3.12 mmol) in 4 ml of ethanol. Potassium phosphate (3.77 mmol), tetrabutylammonium bromide (0.07 mmol), palladium (II) chloride (0.06 mmol) and water (1 ml) was added. The mixture was stirred at room temperature or heated until the starting material was completely consumed by TLC. The mixture was filtered through a small pad of silica gel, eluting with ethyl acetate, and the filtrate was washed with 1M sodium hydroxide solution. The organic phase was separated, washed with saturated sodium chloride, dried over magnesium sulfate and filtered. The solvent was evaporated to give a crude product, which was chromatographed (hexane/ethyl acetate, 19:1) to give phenynaphthalenes 12a-12e as oils or solids in 45-60% yield.
Data for compounds 2: 2,3-Dihydroxy-7-(phenylmethyl)-4-propyl-1-naphthalene carboxylic acid 2a: solid, 40% yield; mp 147-148 °C; IR (ATR): $\nu_{\text{max}}$ 3485, 1632 (carbonyl) cm$^{-1}$; $^1$H NMR (CDCl$_3$, 300 MHz): $\delta$ 8.74 (s, 1H, NaH$^8$), 7.86 (d, $J = 8.6$ Hz, 1H, NaH$^3$), 7.26 (m, 6H, NaH$^6$), ArH$_2$, ArH$_3$, ArH$_4$, ArH$_5$, ArH$_6$), 6.12 (br s, 1H, NaOH$^3$), 4.17 (s, 2H, CH$_2$Ar), 3.08 (t, $J = 7.7$ Hz, 2H, NaCH$_2$), 1.71 (sextet, $J = 7.7$ Hz, 2H, C-CH$_2$-C), 1.06 (t, $J = 7.3$ Hz, 3H, CH$_3$); $^{13}$C NMR (acetone-$d_6$), 75 MHz): $\delta$ 175.2 (C=O), 156.5 (NaC$_2$), 143.2 (NaC$_5$), 142.5, 139.1, 129.8, (ArC$_3$H, ArC$_5$H) 129.3 (ArC$_2$H, ArC$_6$H), 128.9, 128.2, 127.2, 126.8 (CH), 126.3 (CH), 126.2 (CH), 124.7 (CH), 103.4 (NaC$_1$), 43.1 (CH$_2$:Ar), 28.2 (NaCH$_2$), 23.5 (CH$_2$), 14.6 (CH$_3$). HRMS (EI) calcd for C$_{21}$H$_{20}$O$_4$ [M-H]$^-$: 335.1283; found, 335.1283.

2,3-Dihydroxy-7-(4-methylbenzyl)-4-propyl-1-naphthalene carboxylic acid 2b: mp 144-145 °C; IR (ATR): $\nu_{\text{max}}$ 3482, 1630 (carbonyl) cm$^{-1}$; $^1$H NMR (CDCl$_3$, 300 MHz): $\delta$ 8.74 (s, 1H, NaH$^8$), 7.85 (d, $J = 8.5$ Hz, 1H, NaH$^5$), 7.25 (d, $J = 6.5$ Hz, 1H, NaH$^6$), 7.14 (d, $J = 7.4$ Hz, 2H, ArH$_2$), 7.10 (d, $J = 7.6$ Hz, 2H, ArH$_3$), 6.11 (br s, 1H, NaOH$^3$), 4.12 (s, 2H, CH$_2$Ar), 3.07 (t, $J = 7.3$ Hz, 2H, NaCH$_2$), 2.32 (s, 3H, ArCH$_3$), 1.70 (sextet, $J = 7.7$ Hz, 2H, C-CH$_2$-C), 1.05 (t, $J = 7.2$ Hz, 3H, CH$_3$); $^{13}$C NMR (acetone-$d_6$), 75 MHz): $\delta$ 175.3 (C=O), 156.5 (NaC$_2$), 143.2 (NaC$_5$), 139.5, 139.4, 136.1, 129.8 (ArC$_3$H, ArC$_5$H), 129.7 (ArC$_2$H, ArC$_6$H), 128.8, 128.2, 127.1, 126.2 (CH), 124.6 (CH), 103.4 (NaC$_1$), 42.7 (CH$_2$:Ar), 28.2 (NaCH$_2$), 23.7 (CH$_2$), 21.1 (ArCH$_3$), 14.6 (CH$_3$). HRMS (EI) calcd for C$_{22}$H$_{22}$O$_4$ [M-H]$^-$: 349.1440; found, 349.1441.

7-(3-Fluorobenzyl)-2,3-dihydroxy-4-propyl-1-naphthalene carboxylic acid 2c: mp 163-164 °C; IR (ATR): $\nu_{\text{max}}$ 3517, 1633 (carbonyl) cm$^{-1}$; $^1$H NMR (CDCl$_3$, 300 MHz): $\delta$ 8.71 (s, 1H, NaH$^8$), 7.87 (d, $J = 8.6$ Hz, 1H, NaH$^5$), 7.23 (m, 3H, NaH$^6$), ArH$_2$, ArH$_3$, 6.95 (m, 2H, ArH$_2$), ArH$_3$), 6.14 (br s, 1H, NaOH$^3$), 4.15 (s, 2H, CH$_2$Ar), 3.08 (t, $J = 7.7$ Hz, 2H, NaCH$_2$), 1.71 (sextet, $J = 7.8$ Hz, 2H, C-CH$_2$-C), 1.05 (t, $J = 7.3$ Hz, 3H, CH$_3$); $^{13}$C NMR (acetone-$d_6$), 75 MHz): $\delta$ 175.2 (C=O), 164.0 (d, $J = 239.2$, ArC$_3$F), 156.6 (NaC$_2$), 145.5 (d, $J = 7.1$ Hz), 143.3, 138.4, 131.0 (d, $J = 8.3$ Hz, CH), 128.9, 128.3, 127.3, 126.4 (CH), 126.2 (CH), 125.8 (d, $J = 4.7$ Hz, CH), 124.8, 116.4 (d, $J = 21.3$ Hz, ArC$_3$H), 113.6 (d, $J = 21.1$ Hz, ArC$_4$H), 103.4 (NaC$_1$), 42.6 (CH$_2$:Ar), 28.2 (NaCH$_2$), 23.7 (CH$_2$), 21.1 (ArCH$_3$), 14.6 (CH$_3$). HRMS (EI) calcd for C$_{21}$H$_{19}$FO$_4$ [M-H]$^-$: 353.1189; found, 353.1188.

Data for compound 3: 2,3-Dihydroxy-6-(phenylmethyl)-4-propyl-1-naphthalene carboxylic acid 3: white solid, mp 173-175 °C; IR 3488, 1622 (carbonyl) cm$^{-1}$; $^1$H NMR (CDCl$_3$, 300 MHz): $\delta$ 8.72 (d, $J = 8.7$ Hz, 1H, NaH$^8$), 4.12 (s, 2H, CH$_2$:Ar), 3.02 (t, $J = 7.8$ Hz, 2H, C-CH$_2$:C), 1.63 (sextet, $J = 7.8$ Hz, 2H, C-CH$_2$:C), 1.02 (t, $J = 7.3$ Hz, 3H, CH$_3$); $^{13}$C NMR (acetone-$d_6$), 75 MHz): $\delta$ 175.2 (C=O), 156.0 (NaC$_2$), 143.7, 142.5, 137.9, 129.9 (ArC$_3$H, ArC$_5$H), 129.9 (ArC$_3$H, ArC$_5$H), 129.0, 128.6, 127.5 (CH), 126.9 (CH), 126.7 (CH), 126.3, 124.0 (CH), 103.5 (NaC$_1$), 42.4 (CH$_2$:Ar), 28.1 (NaCH$_2$), 23.4 (CH$_2$), 14.6 (CH$_3$). HRMS (EI) calcd for C$_{21}$H$_{20}$O$_4$ [M-H]$^-$: 335.1283; found, 335.1279.

Data for compounds 4: 2,3-Dihydroxy-6-methyl-7-phenyl-4-propyl-1-naphthalene carboxylic acid 4a: white crystals mp 156-158 °C; IR (ATR): $\nu_{\text{max}}$ 3531, 1629 (carbonyl)
S5

2,3-Dihydroxy-6-methyl-7-[4-methylphenyl]-4-propyl-1-naphthalene carboxylic acid 4b: mp 164-166 °C; IR (ATR): ν\textsubscript{max} 3463, 1653 (carbonyl) cm\textsuperscript{-1}; \textsuperscript{1}H NMR (CDCl\textsubscript{3}, 300 MHz): δ 8.73 (s, 1H, NaH\textsubscript{8}), 7.77 (s, 1H, NaH\textsubscript{5}), 7.29 (d, 2H, J = 8.5 Hz, ArH\textsubscript{2}, ArH\textsubscript{6}), 7.26 (d, 2H, J = 8.5 Hz, ArH\textsubscript{3}, ArH\textsubscript{5}), 6.14 (br s, 1H, NaOH\textsubscript{3}), 3.10 (t, J = 8.3 Hz, 2H, NaCH\textsubscript{2}), 2.43 (s, 3H, ArCH\textsubscript{3}), 2.41 (s, 3H, NaCH\textsubscript{3}), 1.74 (sextet, J = 7.8 Hz, 2H, C-CH\textsubscript{2}-C), 1.09 (t, J = 7.2 Hz, 3H, CH\textsubscript{3}); \textsuperscript{13}C NMR (CDCl\textsubscript{3}, 75 MHz): δ 176.2 (C=O), 154.7 (NaC\textsubscript{2}), 141.7 (NaC\textsubscript{3}), 140.7, 139.3, 136.5, 132.2, 129.2 (ArC\textsubscript{3}H, ArC\textsubscript{5}H), 129.0, 128.8 (ArC\textsubscript{2}H, ArC\textsubscript{6}H), 127.6, 125.2, 124.5, 101.4 (NaC\textsubscript{1}), 27.8 (NaCH\textsubscript{2}), 22.8 (CH\textsubscript{2}), 21.3 (ArCH\textsubscript{3}), 21.1 (NaCH\textsubscript{3}), 14.4 (CH\textsubscript{3}). HRMS (EI) calced for C\textsubscript{22}H\textsubscript{22}O\textsubscript{4} [M-H]: 349.1440; found, 349.1442.

2,3-Dihydroxy-6-methyl-7-[3-methylphenyl]-4-propyl-1-naphthalene carboxylic acid 4c: mp 140-142 °C; IR (ATR): ν\textsubscript{max} 3535, 1627 (carbonyl) cm\textsuperscript{-1}; \textsuperscript{1}H NMR (CDCl\textsubscript{3}, 300 MHz): δ 8.74 (s, 1H, NaH\textsubscript{8}), 7.77 (s, 1H, NaH\textsubscript{5}), 7.30 (m, 4H, ArH\textsubscript{2}, ArH\textsubscript{4}, ArH\textsubscript{5}, ArH\textsubscript{6}), 6.10 (br s, 1H, NaOH\textsubscript{3}), 3.11 (t, J = 8.3 Hz, 2H, NaCH\textsubscript{2}), 2.43 (s, 3H, ArCH\textsubscript{3}), 2.40 (s, 3H, NaCH\textsubscript{3}), 1.74 (sextet, J = 7.8 Hz, 2H, C-CH\textsubscript{2}-C), 1.09 (t, J = 7.2 Hz, 3H, CH\textsubscript{3}); \textsuperscript{13}C NMR (CDCl\textsubscript{3}, 75 MHz): δ 176.2 (C=O), 154.7 (NaC\textsubscript{2}), 141.7 (NaC\textsubscript{3}), 140.7, 139.3, 136.5, 132.2, 129.2 (ArC\textsubscript{3}H, ArC\textsubscript{5}H), 129.0, 128.8 (ArC\textsubscript{2}H, ArC\textsubscript{6}H), 127.3, 126.5, 125.2, 124.5, 101.4 (NaC\textsubscript{1}), 27.8 (NaCH\textsubscript{2}), 22.8 (CH\textsubscript{2}), 21.6 (ArCH\textsubscript{3}), 21.1 (NaCH\textsubscript{3}), 14.4 (CH\textsubscript{3}). HRMS (EI) calced for C\textsubscript{22}H\textsubscript{22}O\textsubscript{4} [M-H]: 349.1440; found, 349.1436.

2,3-Dihydroxy-6-methyl-7-[3-chlorophenyl]-4-propyl-1-naphthalene carboxylic acid 4d: mp 142-144 °C; IR (ATR): ν\textsubscript{max} 3531, 1629 (carbonyl) cm\textsuperscript{-1}; \textsuperscript{1}H NMR (CDCl\textsubscript{3}, 300 MHz): δ 8.70 (s, 1H, NaH\textsubscript{8}), 7.77 (s, 1H, NaH\textsubscript{5}), 7.36 (m, 4H, ArH\textsubscript{2}, ArH\textsubscript{4}, ArH\textsubscript{5}, ArH\textsubscript{6}), 3.10 (t, J = 7.2 Hz, 2H, C-CH\textsubscript{2}-C), 1.09 (t, J = 7.2 Hz, 3H, CH\textsubscript{3}); \textsuperscript{13}C NMR (CDCl\textsubscript{3}, 75 MHz): δ 175.1 (C=O), 156.4 (NaC\textsubscript{2}), 145.7 (NaC\textsubscript{3}), 144.0, 139.2, 134.5, 131.8, 130.7 (CH), 130.0 (CH), 128.9 (CH), 128.6, 128.2, 127.8 (CH), 127.5 (CH), 126.3, 125.5 (CH), 103.4 (NaC\textsubscript{1}), 28.2 (NaCH\textsubscript{2}), 23.5 (CH\textsubscript{2}), 21.0 (NaCH\textsubscript{3}), 14.7 (CH\textsubscript{3}). HRMS (EI) calced for C\textsubscript{21}H\textsubscript{19}ClO\textsubscript{4} [M-H]: 369.0896; found, 369.0894.

2,3-Dihydroxy-6-methyl-7-[4-chlorophenyl]-4-propyl-1-naphthalene carboxylic acid 4e: mp 185-186 °C; IR (ATR): ν\textsubscript{max} 3483, 1630 (carbonyl) cm\textsuperscript{-1}; \textsuperscript{1}H NMR (CDCl\textsubscript{3}, 300 MHz): δ 8.68 (s, 1H, NaH\textsubscript{8}), 7.77 (s, 1H, NaH\textsubscript{5}), 7.41 (d, 2H, J = 8.5 Hz, ArH\textsubscript{2}, ArH\textsubscript{6}), 7.33 (d, 2H, J = 8.5 Hz, ArH\textsubscript{3}, ArH\textsubscript{5}), 6.16 (br s, 1H, NaOH\textsubscript{3}), 3.09 (t, J = 7.5 Hz, 2H, NaCH\textsubscript{2}), 2.38 (s, 3H, NaCH\textsubscript{3}), 1.63 (sextet, J = 7.6 Hz, 2H, C-CH\textsubscript{2}-C), 1.08 (t, J = 7.2 Hz, 3H, CH\textsubscript{3}); \textsuperscript{13}C NMR (acetone-d\textsubscript{6}, 75 MHz): δ 175.2 (C=O), 156.3 (NaC\textsubscript{2}), 143.9.
(NaC₃), 142.3, 139.4, 133.3, 131.9 (ArC₂H, ArC₆H), 129.1 (ArC₃H, ArC₅H), 128.4, 128.2, 127.5 (CH), 126.3, 125.5 (CH), 103.4 (NaC¹), 28.2 (NaC₂H), 21.0 (NaC₃H), 14.7 (CH₃). HRMS (EI) calcd for C₂₁H₁₉ClO₄ [M-H]⁻: 369.0894; found, 369.0890.

Data for compounds 5: 2,3-Dimethoxy-6-(phenylmethyl)-1-propylnaphthalene 5a: white crystals mp 66-67 °C; IR (ATR): \( \nu_{\text{max}} \) 1625, 1602 cm⁻¹; \(^1\)H NMR (CDCl₃, 300 MHz): δ 7.80 (d, \( J = 8.7 \) Hz, 1H, NaH₈), 7.48 (s, 1H, NaH⁵), 7.26 (m, 6H, NaH², ArH², ArH³, ArH⁴, ArH⁵, ArH⁶), 4.11 (s, 2H, CH₂Ar), 3.95 (s, 3H, OCH₃), 3.86 (s, 3H, OCH₃), 3.01 (t, \( J = 7.9 \) Hz, 2H, NaCH₂), 1.68 (sextet, \( J = 7.9 \) Hz, 2H, C-CH₂-C), 1.04 (t, \( J = 7.4 \) Hz, 3H, CH₃); \(^13\)C NMR (CDCl₃, 75 MHz): δ 152.3 (NaC₃), 146.4 (NaC¹), 141.1 (ArC¹), 137.6, 131.7, 130.7, 129.0 (ArC₃H, ArC₅H), 128.4 (ArC₂H, ArC₆H), 126.5, 126.0, 125.4, 124.2, 124.1, 105.1 (NaC₄H), 61.0 (OCH₃), 55.4 (OCH₃), 41.8 (CH₂Ar), 27.7 (NaCH₂), 24.0 (CH₂), 14.5 (CH₃). HRMS (EI) calcd for C₂₂H₂₄O₂ [M+H]⁺: 321.1855; found, 321.1854.

2,3-Dimethoxy-6-(4-methylphenylmethyl)-1-propylnaphthalene 5b: white crystals, mp 58-59 °C; IR (ATR): \( \nu_{\text{max}} \) 1627, 1603 cm⁻¹; \(^1\)H NMR (CDCl₃, 300 MHz): δ 7.78 (d, \( J = 8.6 \) Hz, 1H, NaH₈), 7.46 (s, 1H, NaH⁵), 7.18 (dd, \( J = 8.6, 1.8 \) Hz, 1H, NaH¹), 7.10 (d, \( J = 8.5 \) Hz, 2H, ArH², ArH³), 7.07 (d, \( J = 8.5 \) Hz, 2H, ArH³, ArH⁴), 6.95 (s, 1H, NaH⁴), 4.03 (s, 2H, CH₂Ar), 3.89 (s, 3H, OCH₃), 3.85 (s, 3H, OCH₃), 3.01 (t, \( J = 7.7 \) Hz, 2H, NaCH₂), 2.29 (s, 3H, ArCH₃), 1.66 (sextet, \( J = 7.6 \) Hz, 2H, C-CH₂-C), 1.03 (t, \( J = 7.3 \) Hz, 3H, CH₃); \(^13\)C NMR (CDCl₃, 75 MHz): δ 152.2 (NaC₃), 146.3 (NaC¹), 138.0, 137.8, 135.4, 131.6, 130.6, 129.0 (ArC²H, ArC⁵H), 128.4 (ArC²H, ArC⁶H), 126.4, 125.3, 124.0, 105.1 (NaC⁴H), 60.9 (OCH₃), 55.3 (OCH₃), 41.4 (CH₂Ar), 27.7 (NaCH₂), 23.9 (CH₂), 20.9 (ArCH₃), 14.4 (CH₃). HRMS (EI) calcd for C₂₃H₂₆O₂ [M+H]⁺: 335.2011; found, 335.2009.

2,3-Dimethoxy-6-(3-fluorophenylmethyl)-1-propylnaphthalene 5c: white crystals mp 79-80 °C; IR (ATR): \( \nu_{\text{max}} \) 1613 cm⁻¹; \(^1\)H NMR (CDCl₃, 300 MHz): δ 7.80 (d, \( J = 8.6 \) Hz, 1H, NaH₈), 7.46 (s, 1H, NaH⁵), 7.18 (d, \( J = 8.5 \) Hz, 1H, NaH³), 6.98 (s, 1H, NaH⁴), 6.93 (m, 2H, ArH², ArH⁵), 4.05 (s, 2H, CH₂Ar), 3.92 (s, 3H, OCH₃), 3.86 (s, 3H, OCH₃), 3.02 (t, \( J = 7.8 \) Hz, 2H, NaCH₂), 1.67 (sextet, \( J = 7.7 \) Hz, 2H, C-CH₂-C), 1.04 (t, \( J = 7.3 \) Hz, 3H, CH₃); \(^13\)C NMR (CDCl₃, 75 MHz): δ 152.2 (NaC₃), 146.3 (NaC¹), 138.0, 137.8, 135.4, 131.6, 130.6, 129.0 (ArC²H, ArC⁵H), 128.4 (ArC²H, ArC⁶H), 126.4, 125.3, 124.0, 105.1 (NaC⁴H), 60.9 (OCH₃), 55.3 (OCH₃), 41.4 (CH₂Ar), 27.7 (NaCH₂), 23.9 (CH₂), 20.9 (ArCH₃), 14.4 (CH₃). HRMS (EI) calcd for C₂₃H₂₃FO₂ [M+H]⁺: 339.1760; found, 339.1762.

Data for compounds 6: 2,3-Dimethoxy-7-(phenylmethyl)-4-propyl-1-naphthalene carboxaldehyde 6a: oil; 95% yield; IR (ATR): \( \nu_{\text{max}} \) 1676 (carbonyl), 2869 (C-H) cm⁻¹; \(^1\)H NMR (CDCl₃, 300 MHz): δ 10.8 (s, 1H, CHO), 9.23 (s, 1H, NaH®), 7.88 (d, \( J = 8.7 \) Hz, 1H, NaH⁴), 7.28 (m, 6H, NaH², ArH², ArH³, ArH⁴, ArH⁵, ArH⁶), 4.17 (s, 2H, CH₂Ar), 4.08 (s, 3H, OCH₃), 3.94 (s, 3H, OCH₃), 3.08 (t, \( J = 7.9 \) Hz, 2H, NaCH₂), 1.70 (sextet, \( J = 7.7 \) Hz, 2H, C-CH₂-C), 1.06 (t, \( J = 7.3 \) Hz, 3H, CH₃); \(^13\)C NMR (CDCl₃, 75 MHz): δ 192.0 (C=O), 160.5 (NaC²), 148.6 (NaC⁵), 141.1, 140.6, 129.0 (ArC³H, ArC⁶H), 128.6, 128.5 (ArC²H, ArC⁶H), 128.2, 127.4, 126.1, 125.1, 124.2 (2C), 121.6 (NaC⁴), 62.6
(OCH_3), 61.1 (OCH_3), 42.4 (CH_2Ar), 28.4 (NaCH_2), 24.1 (CH_2), 14.5 (CH_3). HRMS (EI) calcd for C_{23}H_{24}O_3 [M+H]^+: 349.1804; found, 349.1807.

2,3-Dimethoxy-7-(4-methylbenzyl)-4-propyl-1-naphthalene carboxaldehyde 6b: oil; IR (ATR): ν_{max} 1676 (carbonyl), 2869 (carbonyl C-H) cm^{-1}; ^1H NMR (CDCl_3, 300 MHz): δ 10.8 (s, 1H, CHO), 9.21 (s, 1H, NaH^8), 7.84 (d, J = 8.7 Hz, 1H, NaH^5), 7.28 (dd, J = 8.7, 1.6 Hz, 1H, NaH^6), 7.12 (d, J = 8.0 Hz, 2H, ArH^2, ArH^6), 7.06 (d, J = 8.0 Hz, 2H, ArH^3, ArH^5), 4.09 (s, 2H, CH_2Ar), 4.03 (s, 3H, OCH_3), 3.90 (s, 3H, OCH_3), 3.04 (t, J = 7.8 Hz, 2H, NaCH_2), 2.28 (s, 3H, ArCH_3), 1.66 (sextet, J = 7.8 Hz, 2H, C-CH_2-C), 1.08 (t, J = 7.4 Hz, 3H, CH_3); 13C NMR (CDCl_3, 75 MHz): δ 191.9 (C=O), 160.3 (NaC_2), 148.3 (NaC_3), 141.7, 140.5, 137.9, 129.1 (ArC^3H, ArC^5H), 128.7 (ArC^2H, ArC^6H), 128.1, 127.3, 124.9, 124.1, 121.5 (NaC_4), 62.4 (OCH_3), 60.9 (OCH_3), 41.9 (CH_2Ar), 28.3 (NaCH_2), 24.0 (CH_2), 20.9 (ArCH_3), 14.5 (CH_3). HRMS (EI) calcd for C_{24}H_{26}O_3 [M+H]^+: 363.1960; found, 363.1956.

7-(3-Fluorobenzyl)-2,3-dimethoxy-4-propyl-1-naphthalene carboxaldehyde 6c: oil; IR (ATR): ν_{max} 1675 (carbonyl), 2777 (carbonyl C-H) cm^{-1}; ^1H NMR (CDCl_3, 300 MHz): δ 10.8 (s, 1H, CHO), 9.21 (s, 1H, NaH^8), 7.87 (d, J = 8.7 Hz, 1H, NaH^5), 7.28 (d, J = 8.7 Hz, 1H, NaH^6), 7.22 (m, 1H, ArH^5), 7.00 (d, J = 7.6 Hz, 1H, ArH^4), 6.87 (m, 2H, ArH^2, ArH^6), 4.12 (s, 2H, CH_2Ar), 4.05 (s, 3H, OCH_3), 3.91 (s, 3H, OCH_3), 3.07 (t, J = 7.6 Hz, 2H, NaCH_2), 1.69 (sextet, J = 7.7 Hz, 2H, C-CH_2-C), 1.09 (t, J = 7.3 Hz, 3H, CH_3); 13C NMR (CDCl_3, 75 MHz): δ 192.0 (C=O), 163.0 (d, J = 247.5 Hz, ArC_3F), 160.5 (NaC_2), 148.6 (NaC^1), 143.6, 140.6, 140.1, 129.8 (d, J = 8.2 Hz), 128.7, 128.2, 127.5, 125.2, 124.5, 124.3, 121.5, 115.7 (d, J = 21.1 Hz, ArC^3H), 112.9 (d, J = 20.9 Hz, ArC^4H), 62.5 (OCH_3), 61.0 (OCH_3), 41.9 (CH_2Ar), 28.4 (NaCH_2), 24.0 (CH_2), 14.5 (CH_3). HRMS (EI) calcd for C_{23}H_{23}FO_3 [M+H]^+: 367.1709; found, 367.1709.

Data for compounds 7: 2,3-Dimethoxy-7-(phenylmethyl)-4-propyl-1-naphthalene carboxylic acid 7a: oil; 95% yield; IR (ATR): ν_{max} 1685 (carbonyl) cm^{-1}; ^1H NMR (CDCl_3, 300 MHz): δ 8.08 (s, 1H, NaH^8), 7.86 (d, J = 8.8 Hz, 1H, NaH^5), 7.25 (m, 6H, NaH^6, ArH^2, ArH^3, ArH^4, ArH^5, ArH^6), 4.14 (s, 2H, CH_2Ar), 4.06 (s, 3H, OCH_3), 3.92 (s, 3H, OCH_3), 3.04 (t, J = 7.8 Hz, 2H, NaCH_2), 1.67 (sextet, J = 7.8 Hz, 2H, C-CH_2-C), 1.06 (t, J = 7.3 Hz, 3H, CH_3); 13C NMR (CDCl_3, 75 MHz): δ 170.6 (C=O), 151.0 (NaC_2), 148.5 (NaC^1), 140.8, 139.1, 135.3, 128.9 (ArC^3H, ArC^4H), 128.4 (ArC^2H, ArC^5H), 128.2, 127.2, 126.1, 124.6, 124.5, 120.3, 116.4 (NaC^6), 61.9 (OCH_3), 61.1 (OCH_3), 42.1 (CH_2Ar), 28.0 (NaCH_2), 24.0 (CH_2), 14.5 (CH_3). HRMS (EI) calcd for C_{23}H_{24}O_4 [M-H]^−: 363.1596; found, 363.1591.

2,3-Dimethoxy-7-(4-methylbenzyl)-4-propyl-1-naphthalene carboxylic acid 7b: oil; IR (ATR): ν_{max} 1694 (carbonyl) cm^{-1}; ^1H NMR (CDCl_3, 300 MHz): δ 7.98 (s, 1H, NaH^8), 7.85 (d, J = 8.7 Hz, 1H, NaH^5), 7.26 (d, J = 8.7 Hz, 1H, NaH^6), 7.10 (d, J = 7.5 Hz, 2H, ArH^2, ArH^6), 7.06 (d, J = 7.6 Hz, 2H, ArH^3, ArH^5), 4.08 (s, 2H, CH_2Ar), 4.05 (s, 3H, OCH_3), 3.92 (s, 3H, OCH_3), 3.04 (t, J = 7.7 Hz, 2H, NaCH_2), 2.27 (s, 3H, ArCH_3), 1.66 (sextet, J = 7.5 Hz, 2H, C-CH_2-C), 1.05 (t, J = 7.2 Hz, 3H, CH_3); 13C NMR (CDCl_3, 75 MHz): δ 171.7 (C=O), 150.6 (NaC^2), 148.5 (NaC^3), 139.2, 137.7, 135.5, 134.7, 129.1 (ArC^3H, ArC^5H), 128.7 (ArC^2H, ArC^6H), 128.4, 127.9, 127.1, 124.4, 124.3 (NaC^6),
7-(3-Fluorobenzyl)-2,3-dimethoxy-4-propyl-1-naphthalene carboxylic acid 7c: oil; IR (ATR): $\nu_{\text{max}}$ 1682 (carbonyl) cm$^{-1}$; 1H NMR (CDCl$_3$, 300 MHz): $\delta$ 7.96 (s, 1H, NaH8), 7.86 (d, $J = 8.7$ Hz, 1H, NaH5), 7.23 (d, $J = 8.6$ Hz, 1H, NaH6), 7.16 (m, 1H, ArH6), 6.88 (m, 3H, ArH2, ArH3, ArH4), 4.05 (s, 5H, CH2Ar, OCH3), 3.92 (s, 3H, OCH3), 3.04 (t, $J = 7.2$ Hz, 2H, NaCH2), 1.66 (sextet, $J = 7.3$ Hz, 2H, C-CH2-C), 1.05 (t, $J = 7.2$ Hz, 3H, CH3); 13C NMR (CDCl$_3$, 75 MHz): $\delta$ 172.0 (C=O), 162.7 (d, $J = 245.6$ Hz, ArC3F), 150.4 (NaC2), 148.6 (NaC3), 143.1 (d, $J = 7.1$ Hz), 137.9, 134.4, 129.6 (d, $J = 8.2$ Hz), 128.3, 127.7, 126.7, 124.4, 124.3, 121.2, 115.5 (d, $J = 21.1$ Hz, ArC2H), 112.7 (d, $J = 21.0$ Hz, ArC4H), 61.5 (OCH3), 60.7 (OCH3), 41.4 (CH2Ar), 27.7 (NaCH2), 23.8 (CH2), 14.2 (CH3). HRMS (EI) calcd for C$_{23}$H$_{23}$FO$_4$ [M-H]$^-$: 381.1502; found, 381.1509.

Data for compound 8: 2,3-Dimethoxy-7-(phenylmethyl)-1-propylnaphthalene 8: oil; 1H NMR (CDCl$_3$, 300 MHz): $\delta$ 7.64 (s, 1H, NaH8), 7.62 (d, $J = 8.4$ Hz, 1H, NaH5), 7.21 (m, 6H, NaH6, NaH7, NaH8), 6.99 (s, 1H, NaH4), 4.12 (s, 2H, CH2Ar), 3.94 (s, 3H, OCH3), 3.85 (s, 3H, OCH3), 2.98 (t, $J = 7.6$ Hz, 2H, C-CH2-C), 1.62 (sextet, $J = 7.3$ Hz, 3H, CH3); 13C NMR (CDCl$_3$, 75 MHz): $\delta$ 152.1 (NaC3), 148.0 (NaC2), 141.5, 135.2, 130.1, 129.2, 128.3, 126.4, 126.1, 125.7, 125.3, 124.1, 122.0, 105.1 (NaC4H), 60.8 (OCH3), 55.8 (OCH3), 41.8 (CH2Ar), 27.6 (NaCH2), 23.9 (CH2), 14.4 (CH3). HRMS (EI) calcd for C$_{22}$H$_{24}$O$_2$ [M+H]$^+$: 321.1855; found, 321.1852.

Data for compound 9: 2,3-Dimethoxy-6-(phenylmethyl)-4-propyl-1-naphthalene carboxaldehyde 9: oil; 1H NMR (CDCl$_3$, 300 MHz): $\delta$ 10.7 (s, 1H, CHO), 9.16 (d, $J = 8.8$ Hz, 1H, NaH8), 7.67 (s, 1H, NaH5), 7.42 (dd, $J = 8.8$, 1.7 Hz, 1H, NaH7), 7.25 (m, 5H, ArH2, ArH3, ArH4, ArH5, ArH6), 4.13 (s, 2H, CH2Ar), 4.03 (s, 3H, OCH3), 3.90 (s, 3H, OCH3), 3.01 (t, $J = 7.9$ Hz, 2H, NaCH2), 1.58 (sextet, $J = 7.8$ Hz, 2H, C-CH2-C), 1.01 (t, $J = 7.3$ Hz, 3H, CH3). HRMS (EI) calcd for C$_{23}$H$_{23}$O$_3$ [M+Na]$^+$: 371.1623; found, 371.1625.

Data for compound 10: 2,3-Dimethoxy-6-(phenylmethyl)-4-propyl-1-naphthalene carboxylic acid 10: oil; 1H NMR (CDCl$_3$, 300 MHz): $\delta$ 8.27 (d, $J = 8.8$ Hz, 1H, NaH8), 7.68 (s, 1H, NaH5), 7.35 (dd, $J = 8.8$, 1.7 Hz, 1H, NaH7), 7.25 (m, 5H, ArH2, ArH3, ArH4, ArH5, ArH6), 4.14 (s, 2H, CH2Ar), 4.04 (s, 3H, OCH3), 3.90 (s, 3H, OCH3), 3.00 (t, $J = 7.9$ Hz, 2H, NaCH2), 1.61 (sextet, $J = 7.9$ Hz, 2H, C-CH2-C), 1.01 (t, $J = 7.3$ Hz, 3H, CH3). HRMS (EI) calcd for C$_{23}$H$_{24}$O$_4$ [M-H]$^-$: 363.1596; found, 363.1599.

Data for compound 11: 6-Bromo-2,3-dimethoxy-7-methyl-1-propylnaphthalene 11: colorless crystals, mp 64-66 °C [lit3 64-66 °C]; 1H NMR (CDCl$_3$, 300 MHz): $\delta$ 7.90 (s, 1H, NaH8), 7.69 (s, 1H, NaH5), 6.90 (s, 1H, NaH4), 3.94 (s, 3H, OCH3), 3.87 (s, 3H, OCH3), 2.99 (t, $J = 7.9$ Hz, 2H, NaCH2), 2.54 (s, 3H, NaCH3), 1.64 (sextet, $J = 7.7$ Hz, 2H, C-CH2-C), 1.05 (t, $J = 7.9$ Hz, 3H, CH3); 13C NMR (CDCl$_3$, 75 MHz): $\delta$ 152.1 (NaC3), 146.9 (NaC5H), 132.5, 131.0, 130.1, 129.7 (NaC6H), 127.1, 124.8 (NaC9H), 122.3
Data for compounds 12: 2,3-Dimethoxy-7-methyl-6-phenyl-1-propylnaphthalene 12a: white crystals, 60% yield; mp 111-113 °C; 1H NMR (CDCl3, 300 MHz): δ 7.81 (s, 1H, NaH8), 7.63 (s, 1H, NaH5), 7.45 (m, 5H, ArH2, ArH3, ArH4, ArH5, ArH6), 7.07 (s, 1H, NaH4), 3.98 (s, 3H, OCH3), 3.94 (s, 3H, OCH3), 3.12 (t, J = 7.9 Hz, 2H, NaCH2), 2.46 (s, 3H, NaCH3), 1.78 (sextet, J = 7.5 Hz, 2H, C-CH2-C), 1.15 (t, J = 7.3 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 152.1 (NaC3), 147.1 (NaC2), 142.2, 140.0, 131.6, 130.2, 130.1, 129.5 (ArC3H, ArC5H), 128.2 (ArC2H, ArC6H), 128.0, 127.6, 126.9, 124.7 (NaC1), 105.3 (NaC4H), 61.2 (OCH3), 55.6 (OCH3), 27.9 (NaCH2), 24.2 (CH2), 21.5 (NaCH3), 14.8 (CH3). HRMS (EI) calcd for C22H25O2 [M+H]+: 321.1855; found, 321.1849.

2,3-Dimethoxy-7-methyl-6-[4-methylphenyl]-1-propylnaphthalene 12b: oil; 1H NMR (CDCl3, 300 MHz): δ 7.76 (s, 1H, NaH8), 7.58 (s, 1H, NaH5), 7.31 (d, J = 8.4 Hz, 2H, ArH2, ArH3), 7.25 (d, J = 8.1 Hz, 2H, ArH3, ArH4), 7.03 (s, 1H, NaH5), 3.96 (s, 3H, OCH3), 3.91 (s, 3H, OCH3), 3.09 (t, J = 7.8 Hz, 2H, NaCH2), 2.44 (s, 3H, NaCH3), 2.43 (s, 3H, ArCH3), 1.75 (sextet, J = 7.6 Hz, 2H, C-CH2-C), 1.11 (t, J = 7.3 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 152.0 (NaC3), 147.0 (NaC2), 139.9, 139.2, 136.5, 131.7, 130.1, 129.3 (ArC3H, ArC5H), 128.9 (ArC2H, ArC6H), 127.9, 127.4, 124.6 (NaC1), 105.2 (NaC4H), 61.2 (OCH3), 55.5 (OCH3), 27.9 (NaCH2), 24.1 (CH2), 21.5 (NaCH3), 21.3 (ArCH3), 14.7 (CH3). HRMS (EI) calcd for C23H27O2 [M+H]+: 335.2011; found, 335.2004.

2,3-Dimethoxy-7-methyl-6-[3-methylphenyl]-1-propylnaphthalene 12c: oil; IR (ATR): νmax 1601, 1462 cm−1; 1H NMR (CDCl3, 300 MHz): δ 7.77 (s, 1H, NaH8), 7.58 (s, 1H, NaH5), 7.31 (d, J = 8.4 Hz, 2H, ArH2, ArH3), 7.25 (m, 3H, ArH2, ArH3, ArH4), 7.04 (s, 1H, NaH5), 3.97 (s, 3H, OCH3), 3.92 (s, 3H, OCH3), 3.09 (t, J = 7.8 Hz, 2H, NaCH2), 2.44 (s, 6H, NaCH3, ArCH3), 1.76 (sextet, J = 7.8 Hz, 2H, C-CH2-C), 1.12 (t, J = 7.3 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 152.0 (NaC3), 147.1 (NaC2), 142.1, 140.1, 137.7, 131.6, 130.2, 130.1, 130.0, 128.0, 127.9, 127.6, 126.5, 124.6, 105.2 (NaC4H), 61.2 (OCH3), 55.5 (OCH3), 27.8 (NaCH2), 24.1 (CH2), 21.5 (NaCH3), 21.3 (ArCH3), 14.7 (CH3). HRMS (EI) calcd for C23H27O2 [M+H]+: 335.2011; found, 335.2008.

2,3-Dimethoxy-7-methyl-6-[3-chlorophenyl]-1-propylnaphthalene 12d: oil; 1H NMR (CDCl3, 300 MHz): δ 7.74 (s, 1H, NaH8), 7.54 (s, 1H, NaH5), 7.34 (m, 4H, ArH2, ArH3, ArH4, ArH5), 7.01 (s, 1H, NaH5), 3.94 (s, 3H, OCH3), 3.89 (s, 3H, OCH3), 3.05 (t, J = 7.8 Hz, 2H, NaCH2), 2.39 (s, 3H, NaCH3), 1.71 (sextet, J = 7.8 Hz, 2H, C-CH2-C), 1.09 (t, J = 7.3 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 152.2 (NaC3), 147.3 (NaC2), 143.9, 138.5, 134.0, 131.1, 130.2, 130.0, 129.5, 129.4, 128.0, 127.8, 127.7, 127.1, 124.8, 105.2 (NaC4H), 61.2 (OCH3), 55.6 (OCH3), 27.8 (NaCH2), 24.1 (CH2), 21.3 (NaCH3), 14.7 (CH3). HRMS (EI) calcd for C22H24ClO2 [M+H]+: 355.1465; found, 355.1461.
2,3-Dimethoxy-7-methyl-6-[4-chlorophenyl]-1-propynaphthalene 12e: mp 87-88 °C; \(^1\)H NMR (CDCl\(_3\), 300 MHz): \(\delta\) 7.74 (s, 1H, NaH8), 7.54 (s, 1H, NaH5), 7.40 (d, \(J = 8.5\) Hz, 2H, ArH2, ArH3), 7.31 (d, \(J = 8.6\) Hz, 2H, ArH2, ArH3), 7.02 (s, 1H, NaH3), 3.95 (s, 3H, OCH3), 3.89 (s, 3H, OCH3), 3.06 (t, \(J = 7.8\) Hz, 2H, NaCH2), 2.39 (s, 3H, NaCH3), 1.73 (sextet, \(J = 7.8\) Hz, 2H, C-CH2-C), 1.09 (t, \(J = 7.3\) Hz, 3H, CH3); \(^1\)C NMR (CDCl\(_3\), 75 MHz): \(\delta\) 152.2 (NaC3), 147.3 (NaC2), 140.5, 138.7, 133.0, 131.2, 130.8 (ArC2H, ArC6H), 130.2, 130.0, 128.4 (ArC3H, ArC5H), 127.9, 127.7, 124.8, 105.2 (NaCH3), 61.2 (OCH3), 55.6 (OCH3), 27.8 (NaCH2), 24.1 (CH2), 21.3 (NaCH3), 14.7 (CH3). HRMS (EI) calcd for C\(_{22}\)H\(_{24}\)ClO2 [M+H]\(^+\): 355.1465; found, 355.1462.

Data for compounds 13: 2,3-Dimethoxy-6-methyl-7-phenyl-4-propyl-1-naphthalene carboxaldehyde 13a: mp 101-103 °C; IR (ATR): \(\nu\) max 1675 (carbonyl), 2871 (C-H) cm\(^{-1}\); \(^1\)H NMR (CDCl\(_3\), 300 MHz): \(\delta\) 10.8 (s, 1H, CHO), 9.19 (s, 1H, NaH7), 7.83 (s, 1H, NaH5), 7.40 (m, 5H, ArH2, ArH3, ArH4, ArH5, ArH6), 4.06 (s, 3H, OCH3), 3.95 (s, 3H, OCH3), 3.13 (t, \(J = 7.9\) Hz, 2H, NaCH2), 2.44 (s, 3H, NaCH3), 1.75 (sextet, \(J = 7.8\) Hz, 2H, C-CH2-C), 1.13 (t, \(J = 7.3\) Hz, 3H, CH3); \(^1\)C NMR (CDCl\(_3\), 75 MHz): \(\delta\) 191.9 (C=O), 160.1 (NaC2), 149.1 (NaC3), 143.0, 141.7, 139.9, 133.9, 129.4 (ArC3H, ArC5H), 129.2, 128.1 (ArC2H, ArC6H), 127.1, 126.9, 126.4, 124.6, 121.8 (NaC4), 62.7 (OCH3), 61.2 (OCH3), 28.5 (NaCH2), 24.2 (CH2), 21.5 (NaCH3), 14.7 (CH3). HRMS (EI) calcd for C\(_{23}\)H\(_{25}\)O3 [M+H]\(^+\): 349.1804; found, 349.1810.

2,3-Dimethoxy-6-methyl-7-[4-methylphenyl]-4-propyl-1-naphthalene carboxaldehyde 13b: oil; IR (ATR): \(\nu\) max 1677 (carbonyl), 2868 (C-H) cm\(^{-1}\); \(^1\)H NMR (CDCl\(_3\), 300 MHz): \(\delta\) 10.8 (s, 1H, CHO), 9.12 (s, 1H, NaH7), 7.78 (s, 1H, NaH5), 7.40 (m, 5H, ArH2, ArH3, ArH4, ArH5, ArH6), 3.92 (s, 3H, OCH3), 3.09 (t, \(J = 8.1\) Hz, 2H, NaCH2), 2.44 (s, 3H, NaCH3), 2.43 (s, 3H, ArCH3), 1.74 (sextet, \(J = 7.4\) Hz, 2H, C-CH2-C), 1.10 (t, \(J = 7.4\) Hz, 3H, CH3); \(^1\)C NMR (CDCl\(_3\), 75 MHz): \(\delta\) 192.0 (C=O), 160.1 (NaC2), 149.1 (NaC3), 143.0, 141.7, 139.9, 133.9, 129.4 (ArC3H, ArC5H), 129.2, 128.1 (ArC2H, ArC6H), 127.1, 126.9, 126.4, 124.6, 121.8 (NaC4), 62.7 (OCH3), 61.2 (OCH3), 28.5 (NaCH2), 24.2 (CH2), 21.5 (NaCH3), 14.7 (CH3). HRMS (EI) calcd for C\(_{24}\)H\(_{27}\)O3 [M+H]\(^+\): 363.1960; found, 363.1953.

2,3-Dimethoxy-6-methyl-7-[3-methylphenyl]-4-propyl-1-naphthalene carboxaldehyde 13c: oil; IR (ATR): \(\nu\) max 1678 (carbonyl), 2869 (C-H) cm\(^{-1}\); \(^1\)H NMR (CDCl\(_3\), 300 MHz): \(\delta\) 10.8 (s, 1H, CHO), 9.14 (s, 1H, NaH7), 7.80 (s, 1H, NaH5), 7.25 (m, 4H, ArC2H, ArC4H, ArC5H, ArC6H), 4.05 (s, 3H, OCH3), 3.94 (s, 3H, OCH3), 3.12 (t, \(J = 7.7\) Hz, 2H, NaCH2), 2.42 (s, 6H, NaCH3, ArCH3), 1.74 (sextet, \(J = 7.7\) Hz, 2H, C-CH2-C), 1.12 (t, \(J = 7.2\) Hz, 3H, CH3); \(^1\)C NMR (CDCl\(_3\), 75 MHz): \(\delta\) 191.6 (C=O), 159.8 (NaC2), 148.9 (NaC3), 143.0, 141.6, 139.6, 137.5, 133.9, 130.0, 129.0, 127.8, 127.6, 126.8, 126.3, 126.1, 124.4, 121.7 (NaC4), 62.6 (OCH3), 61.1 (OCH3), 28.4 (NaCH3), 24.1 (CH2), 21.5 (ArCH3), 21.4 (NaCH3), 14.6 (CH3). HRMS (EI) calcd for C\(_{24}\)H\(_{27}\)O3 [M+H]\(^+\): 363.1960; found, 363.1953.

2,3-Dimethoxy-6-methyl-7-[3-chlorophenyl]-4-propyl-1-naphthalene carboxaldehyde 13d: oil; IR (ATR): \(\nu\) max 1674 (carbonyl), 2870 (C-H) cm\(^{-1}\); \(^1\)H NMR (CDCl\(_3\), 300 MHz):
δ 10.7 (s, 1H, CHO), 9.13 (s, 1H, NaH8), 7.80 (s, 1H, NaH5), 7.31 (m, 4H, ArH2, ArH4, ArH5, ArH6), 4.05 (s, 3H, OCH3), 3.93 (s, 3H, OCH3), 3.10 (t, J = 7.9 Hz, 2H, NaCH2), 2.40 (s, 3H, NaCH3), 1.73 (sextet, J = 7.8 Hz, 2H, C-CH2-C), 1.11 (t, J = 7.3 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 192.0 (C=O), 160.3 (NaC2), 149.4 (NaC3), 143.6, 141.5, 140.0, 134.0, 133.7, 129.5, 127.7, 127.3, 126.9, 126.4, 124.8, 121.8 (NaC4), 62.8 (OCH3), 61.2 (OCH3), 28.5 (NaCH3), 24.2 (CH2), 21.4 (NaCH3), 14.7 (CH3). HRMS (EI) calcd for C23H24ClO3 [M+H]+: 383.1414; found, 383.1413.

2,3-Dimethoxy-6-methyl-7-[4-chlorophenyl]-4-propyl-1-naphthalene carboxaldehyde 13e: mp = 111-113 °C; IR (ATR): νmax 1672 (carbonyl), 2870 (carbonyl C-H) cm⁻¹; 1H NMR (CDCl3, 300 MHz): δ 10.8 (s, 1H, CHO), 9.15 (s, 1H, NaH7), 7.82 (s, 1H, NaH5), 7.39 (d, J = 8.5 Hz, 2H, ArH2, ArH6), 7.31 (d, J = 8.5 Hz, 2H, ArH3, ArH5), 4.06 (s, 3H, OCH3), 3.94 (s, 3H, OCH3), 3.12 (t, J = 7.8 Hz, 2H, NaCH2), 2.40 (s, 3H, NaCH3), 1.73 (sextet, J = 7.6 Hz, 2H, C-CH2-C), 1.12 (t, J = 7.3 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 191.9 (C=O), 160.2 (NaC2), 149.3 (NaC3), 141.6, 140.2, 140.0, 133.7, 133.2, 130.8 (ArC3H, ArC5H), 129.3, 128.4 (ArC2H, ArC6H), 127.1, 126.4, 124.8, 121.7 (NaC4), 62.7 (OCH3), 61.2 (OCH3), 28.5 (NaCH3), 24.2 (CH2), 21.4 (NaCH3), 14.7 (CH3). HRMS (EI) calcd for C23H24ClO3 [M+H]+: 383.1414; found, 383.1408.

Data for compounds 14: 2,3-Dimethoxy-6-methyl-7-phenyl-4-propyl-1-naphthalene carboxylic acid 14a: oil; IR (ATR): νmax 1693 (carbonyl) cm⁻¹; 1H NMR (CDCl3, 300 MHz): δ 8.01 (s, 1H, NaH8), 7.84 (s, 1H, NaH5), 7.42 (m, 5H, ArH2, ArH3, ArH4, ArH5, ArH6), 4.06 (s, 3H, OCH3), 3.96 (s, 3H, OCH3), 3.11 (t, J = 7.8 Hz, 2H, NaCH2), 2.44 (s, 3H, NaCH3), 1.77 (sextet, J = 7.6 Hz, 2H, C-CH2-C), 1.13 (t, J = 7.2 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 172.4 (C=O), 150.5 (NaC2), 149.3 (NaC3), 141.6, 141.3, 134.2, 133.7, 129.4 (ArC3H, ArC5H), 129.0 (ArC4), 128.2 (ArC2H, ArC6H), 127.1, 126.4, 125.8, 124.9, 121.1 (NaC1), 62.0 (OCH3), 61.2 (OCH3), 28.0 (NaCH2), 24.2 (CH2), 21.4 (NaCH3), 14.7 (CH3). HRMS (EI) calcd for C23H23O4 [M-H]-: 363.1596; found, 363.1589.

2,3-Dimethoxy-6-methyl-7-[4-methylphenyl]-4-propyl-1-naphthalene carboxylic acid 14b: semi solid; IR (ATR): νmax 1694 (carbonyl) cm⁻¹; 1H NMR (CDCl3, 300 MHz): δ 7.99 (s, 1H, NaH8), 7.81 (s, 1H, NaH5), 7.29 (d, J = 8.1 Hz, 2H, ArH2, ArH6), 7.24 (d, J = 8.0 Hz, 2H, ArH3, ArH5), 4.03 (s, 3H, OCH3), 3.94 (s, 3H, OCH3), 3.09 (t, J = 7.8 Hz, 2H, NaCH2), 2.43 (s, 3H, NaCH3), 2.42 (s, 3H, ArCH3), 1.73 (sextet, J = 7.8 Hz, 2H, C-CH2-C), 1.11 (t, J = 7.3 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 172.0 (C=O), 150.5 (NaC2), 149.2 (NaC3), 141.3, 141.3, 134.2, 133.7, 129.4 (ArC3H, ArC5H), 128.2 (ArC2H, ArC6H), 127.1, 126.4, 125.8, 124.9, 121.1 (NaC1), 62.0 (OCH3), 61.2 (OCH3), 28.0 (NaCH2), 24.2 (CH2), 21.5 (NaCH3), 14.7 (CH3). HRMS (EI) calcd for C24H25O4 [M-H]-: 377.1753; found, 377.1748.

2,3-Dimethoxy-6-methyl-7-[3-methylphenyl]-4-propyl-1-naphthalene carboxylic acid 14c: semi solid; IR (ATR): νmax 1731 (carbonyl) cm⁻¹; 1H NMR (CDCl3, 300 MHz): δ 7.99 (s, 1H, NaH8), 7.81 (s, 1H, NaH5), 7.32 (t, J = 7.9 Hz, 1H, ArH3), 7.21 (s, 1H, ArH5), 7.19 (d, J = 7.5 Hz, 2H, ArH4, ArH6), 4.05 (s, 3H, OCH3), 3.95 (s, 3H, OCH3), 3.10 (t, J = 7.8 Hz, 2H, NaCH2), 2.42 (s, 6H, NaCH3, ArCH3), 1.74 (sextet, J = 7.8 Hz, 2H, C-CH2-C), 1.12 (t, J = 7.3 Hz, 3H, CH3); 13C NMR (CDCl3, 75 MHz): δ 172.4 (C=O), 150.5 (NaC2),
149.2 (NaC²), 141.6, 141.5, 137.9, 134.4, 133.8, 130.2, 129.5, 128.1, 127.9, 126.5, 126.4, 125.7, 124.8, 121.1 (NaC¹), 62.1 (OCH₃), 61.2 (OCH₃), 28.1 (NaCH₂), 24.2 (CH₂), 21.7 (NaCH₃), 21.5 (ArCH₃), 14.7 (CH₃); HRMS (EI) calcd for C₂₄H₂₇O₄ [M+H⁺]: 379.1909; found, 379.1900.

2,3-Dimethoxy-6-methyl-7-[3-chlorophenyl]-4-propyl-1-naphthalene carboxylic acid 14d: semi solid; IR (ATR): ν max 1692 (carbonyl) cm⁻¹; ¹H NMR (CDCl₃, 300 MHz): δ 7.97 (s, 1H, NaH₈), 7.81 (s, 1H, NaH₅), 7.37 (s, 1H, ArH²), 7.36 (d, J = 8.1 Hz, 2H, ArH⁴, ArH⁵), 7.25 (m, 1H, ArH³), 7.03 (s, 3H, OCH₃), 3.94 (s, 3H, OCH₃), 3.08 (t, J = 7.8 Hz, 2H, NaCH₂), 2.39 (s, 3H, NaCH₃), 1.71 (sextet, J = 7.8 Hz, 2H, C-CH₂-C), 1.10 (t, J = 7.3 Hz, 3H, CH₃); ¹³C NMR (CDCl₃, 75 MHz): δ 172.0 (C=O), 150.8 (NaC²), 149.4 (NaC¹), 143.4, 139.9, 134.5, 134.1, 133.3, 129.7, 129.6, 129.4, 127.7, 127.3, 126.4, 125.8, 125.1, 120.9 (NaC¹), 62.1 (OCH₃), 61.2 (OCH₃), 28.1 (NaCH₂), 24.2 (CH₂), 21.4 (NaCH₃), 14.7 (CH₃). HRMS (EI) calcd for C₂₃H₂₂ClO₄ [M-H⁻]: 397.1207; found, 397.1198.

2,3-Dimethoxy-6-methyl-7-[4-chlorophenyl]-4-propyl-1-naphthalene carboxylic acid 14e: mp 152-154 °C; IR (ATR): ν max 1698 (carbonyl) cm⁻¹; ¹H NMR (CDCl₃, 300 MHz): δ 7.99 (s, 1H, NaH₈), 7.86 (s, 1H, NaH₅), 7.41 (d, J = 8.5 Hz, 2H, ArH², ArH³), 7.32 (d, J = 8.5 Hz, 2H, ArH⁴, ArH⁵), 4.07 (s, 3H, OCH₃), 3.98 (s, 3H, OCH₃), 3.12 (t, J = 7.6 Hz, 2H, NaCH₂), 2.42 (s, 3H, NaCH₃), 1.78 (sextet, J = 7.5 Hz, 2H, C-CH₂-C), 1.14 (t, J = 7.2 Hz, 3H, CH₃); ¹³C NMR (CDCl₃, 75 MHz): δ 172.5 (C=O), 150.6 (NaC²), 149.4 (NaC¹), 140.0, 139.9, 134.3, 133.3, 133.2, 130.7 (ArC²H, ArC⁰H), 129.5, 128.4 (ArC¹H, ArC⁰H), 126.3, 125.7, 125.0, 121.1 (NaC¹), 61.9 (OCH₃), 61.1 (OCH₃), 28.0 (NaCH₂), 24.1 (CH₂), 21.3 (NaCH₃), 14.6 (CH₃). HRMS (EI) calcd for C₂₃H₂₂ClO₄ [M-H⁻]: 397.1207; found, 397.1199.