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Synthesis and characterization of novel substituted spiro[isobenzofuran-1(3*H*),9'-xanthene]-3-ones

SACHIN V. PATEL, MANISH P. PATEL* and RANGAN G. PATEL

Deparment of Chemistry, Sardar Patel University, Vallabh Vidyanagar-388 120, Gujarat, India
(e-mail: patelmanish1069@yahoo.com)

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Abstract: The ketoacid, 2-(4-diethylamino-2-hydroxybenzoyl)benzoic acid, prepared from *N*,*N*-diethyl-*m*-aminophenol and phthalic anhydride, was reacted with various substituted 3-[6-methoxybenzothiazol-2-yl]-4(3*H*)-quinazolinones in the presence of a dehydration condensing agent to afford novel spiro[isobenzofuran-1(3*H*),9'-xanthene]-3-ones. The benzothiazolyl quinazolinones were synthesized by reacting 2-amino-6-methoxybenzothiazole with various substituted benzoxazinones. All compounds were characterized by melting point determination, elemental analysis, infra-red spectroscopy, NMR-spectroscopy and UV-visible sprectroscopy. All the fluoran compounds are colourless or nearly colourless and produce colour in the presence of acidic media.

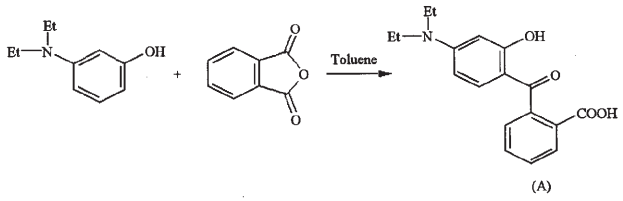
Keywords: synthesis, keto acid, fluoran, benzothiazolyl quinazolinone.

INTRODUCTION

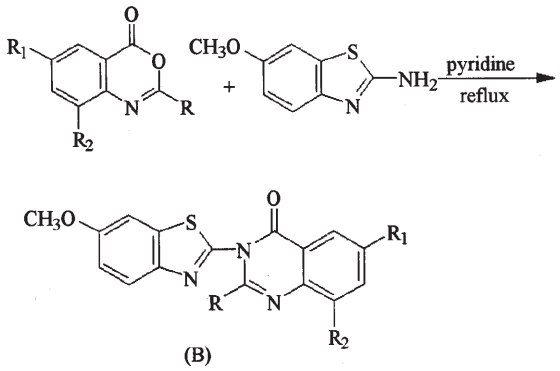
Spiro [isobenzofuran-1(3*H*),9'-xanthene]-3-one[1] is commonly known as fluoran, which is the basis of a class of leuco dye. Fluoran compounds have been used in a variety of fields, such as sublimation transfer printing, thermo indicators, printed circuit writing materials, textile finishing, etc. Nowadays, fluoran compounds are widely used in carbonless copying papers and thermo sensitive recording papers.[2] Fluoran compounds containing various heterocycles, such as benzothiazole,[3] indole,[4] pyridine,[5] pyrimidine,[6] pyrrole,[7] quinolines[8] and triazine[9] are colourless or nearly colourless. When these compounds are brought into contact preferably with an acid developer, *i.e.*, an electron acceptor, they produce a variety of colours depending on the substituent(s). In the present investigation, the synthesis and characterization of nearly colourless fluoran compounds prepared from various substituted benzothiazolyl quinazolinones are introduced. The general reaction scheme is presented in Scheme 1.

* Corresponding author.

Step-1 :-

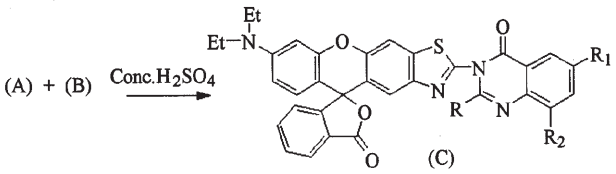


Step-2:-



Where, R = CH_3, C_6H_5; R_1 & R_2 = H, Br

Step-3:-



Scheme 1.

EXPERIMENTAL

All melting points (m.p.) are uncorrected and expressed in ºC. IR spectra of all the compounds were recorded on a Nicolet Impact-400D FT-IR spectrophotometer using the KBr pellet technique. The ^{1}H-NMR spectra were recorded on a Hitachi R-1500 instrument in DMSO-d_6 using TMS as the internal standard. Chemical shifts are given in δ (ppm). Absorption spectra (λ_{max}) of the compounds in toluene and 95 % acetic acid were recorded on a Shimadzu UV-240 instrument.

*General procedure of (**A**) and (**B**)*

2-(4-Diethylamino-2-hydroxybenzoyl)benzoic acid (**A**) was prepared from *N*,*N*-diethyl-*m*-aminophenol (1 mol) with phthalic anhydride (1.1 mol) by refluxing in toluene (400 ml) for 5–6 h, as given in the literature.[10] Mp 207–8 ºC.

2-Amino-6-methoxybenzothiazole was prepared by following the method given in the literature.[11] The various benzoxazine-4-ones,[12–14] such as 2-methyl-4*H*-3,1-benzoxazin-4-one (R = CH_3, R_1, R_2 = H),[12] 2-phenyl-4*H*-3,1-benzoxazin-4-one (R = Ph, R_1, R_2 = H),[13] 6-bromo-2-methyl-4*H*-3,1-benzoxazin-4-one (R = CH_3, R_1 = Br, R_2 = H), 6-bromo-2-phenyl-4*H*-3,1-benzoxazin-4-one (R = Ph, R_1 = Br, R_2 = H), 6,8-dibromo-2-methyl-4*H*-3,1-benzoxazin-4-one (R = CH_3, R_1, R_2 = Br), 6,8-dibromo-2-phenyl-4*H*-3,1-benzoxazin-4-one (R = Ph, R_1, R_2 = Br),[14] were prepared by known methods and reacted with benzothiazole in equimolar proportions using pyridine as the solvent for 10–12 h. After completion of the reaction, the reaction mixture was poured into ice cold hydrochloric acid to yield the benzothiazolyl quinazolinones (**B**) (Table I).

TABLE I. Physical data of benzothiazolyl quinazolinones (**B_{1-6}**)

Comp. No	R	R_1	R_2	Molecular weight	Yield/%	M.p./°C
B_1	CH_3	H	H	323.37	69	204
B_2	Ph	H	H	385.44	72	215
B_3	CH_3	Br	H	402.27	68	256
B_4	Ph	Br	H	464.34	73	213
B_5	CH_3	Br	Br	481.17	68	226
B_6	Ph	Br	Br	543.24	70	202

Preparation of fluoran compound

2-(4-Diethylamino-2-hydroxybenzoyl)benzoic acid (0.01 mol) and benzothiazolyl quinazolinone (0.01 mol) were dissolved in conc. H_2SO_4 (10 ml) and stirred at 60–70 ºC for 48 h. The reaction was monitored by TLC using the solvent system toluene : ethyl acetate 7:3. After completion of the reaction, the reaction mixture was poured into ice-cold water. The precipitates were filtered and washed with water. The acid-free compound was charged into water and the pH was made alkaline (about 9–10) using aqueous NaOH to yield a colourless or very lightly coloured fluoran compound. The product was filtered and washed with water until neutral. TLC showed a purple coloured, single spot in the solvent system toluene : ethyl acetate 7 : 3 (Table II).

TABLE II. Physical data of fluorans (**$C_{1–6}$**)

Comp. No	R	R_1	R_2	Yield/%	M.p./ºC	λ_{max} in 95 % acetic acid/nm	λ_{max} in toluene nm	Colour on silica gel
C_1	CH_3	H	H	60	198	552, 444, 306	346	Purple
C_2	Ph	H	H	62	285	550, 433, 319	336	Purple
C_3	CH_3	Br	H	54	292	552, 441, 309	332	Purple
C_4	Ph	Br	H	61	316	552, 441, 310	336	Purple
C_5	CH_3	Br	Br	62	255	549, 420, 299	342	Purple
C_6	Ph	Br	Br	58	212	551, 437, 305	334	Purple

*Characterization of the benzothiazolyl quinazolinones (**$B_{1–6}$**)*

*3-(6-Methoxybenzothiazol-2-yl)-2-methyl-4(3*H*)-quinazolinone* (**B_1**). IR: 2938 cm^{-1} and 1320 cm^{-1} (Ar–CH_3), 1689 cm^{-1} (C=O), 1602 cm^{-1} (C=N), 836 cm^{-1} (1,2,4-trisubstituted benzene). ^{1}H-NMR: δ 7.2 – 7.3 (7H, *m*, Ar–H), 3.86 (3H, *s*, Ar–OMe), 2.29 (3H, *s*, Ar–CH_3).

*3-(6-Methoxybenzothiazol-2-yl)-2-phenyl-4(3*H*)-quinazolinone* (**B_2**). IR: 1663 cm^{-1} (C=O),

1606 cm^{-1} (C=N), 816 cm^{-1} (1,2,4-trisubstituted benzene) ^{1}H-NMR: δ 7.05 – 8.94 (12H, *m*, Ar–H), 3.86 (3H, *s*, Ar–OMe).

*6-Bromo-3-(6-methoxybenzothiazol-2-yl)-2-methyl-4(3*H*)-quinazolinone* **(B_3)**. IR: 2960 cm^{-1} and 1314 cm^{-1} (Ar–CH_3), 1640 cm^{-1} (C=O), 1607 cm^{-1} (C=N), 823 cm^{-1} (1,2,4-trisubstituted benzene), 546 cm^{-1} (C–Br). ^{1}H-NMR: δ 7.5 – 8.3 (6H, *m*, Ar–H), 3.87 (3H, *s*, Ar–OMe), 2.21 (3H, *s*, Ar–CH_3).

*6-Bromo-3-(6-methoxybenzotiazol-2-yl)-2-phenyl-4(3*H*)-quinazolinone* **(B_4)**. IR: 1686 cm^{-1} (C=O), 1604 cm^{-1} (C=N), 833 cm^{-1} (1,2,4-trisubstituted benzene), 548 cm^{-1} (C–Br). ^{1}H-NMR: δ 7.3 – 8.5 (11H, *m*, Ar–H), 3.84 (3H, *s*, Ar–OMe).

*6,8-Dibromo-3-(6-methoxybenzothiazol-2-yl)-2-methyl-4(3*H*)-quinazolinone* (**B_5**). IR: 2938 cm^{-1} and 1321 cm^{-1} (Ar–CH_3), 1670 cm^{-1} (C=O), 1607 cm^{-1} (C=N), 832 cm^{-1} (1,2,4-trisubstituted benzene), 547 cm^{-1} (C–Br). ^{1}H-NMR: δ 7.0 – 7.9 (5H, *m*, Ar–H), 3.84 (3H, *s*, Ar–OMe), 2.20 (3H, *s*, Ar–CH_3).

*6,8-Dibromo-3-(6-methoxybenzothiazol-2-yl)-2-phenyl-4(3*H*) quinazolinone* (**B_6**). IR: 1673 cm^{-1} (C=O), 1604 cm^{-1} (C=N), 829 cm^{-1} (1,2,4-trisubstituted benzene), 545 cm^{-1} (C–Br). ^{1}H-NMR: δ 7.0 – 8.07 (10H, *m*, Ar–H), 3.82 (3H, *s*, Ar–OMe).

*Characterization of the fluorans (**$C_{1–6}$**)*

C_1 – Calcd. for $C_{34}H_{26}N_4O_4S$: C, 69.60 %; H, 4.46 %; N, 9.55 %; Found: C, 69.65 %; H, 4.52 %; N, 9.45 %. IR: 2972, 2929, 2866, 1454, 1340 cm^{-1} (N–Et), 3072 and 1317 cm^{-1} (Ar–CH_3), 1756 cm^{-1} (C=O group of lactone ring), 1685 cm^{-1} (C=O group of quinazolinone), 1606 cm^{-1} (C=N), 870 cm^{-1} (1,2,4,5-tetrasubstituted benzene). ^{1}H-NMR: δ 6.5–7.7 (13H, m, Ar–H) (4H, *q*, N(CH_2–CH_3)$_2$), 2.12 (3H, *s*, Ar–CH_3), 1.18 (6H, *t*, N(CH_2–CH_3)$_2$).

C_2 – Calcd. for $C_{39}H_{28}N_4O_4S$: C, 72.20 %; H, 4.35 %; N, 8.63 %; Found: C, 72.32 %; H, 4.28 %; N, 8.75 %. IR: 2974, 2927, 2872, 1462, 1334 cm^{-1} (N–Et), 1758 cm^{-1} (C=O group of lactone ring), 1648 cm^{-1} (C=O group of quinazolinone), 1602 cm^{-1} (C=N), 870 cm^{-1} (1,2,4,5-tetrasubstituted benzene). ^{1}H-NMR: δ 6.4–8.1 (18H, *m*, Ar–H), 3.35 (4H, *q*, N(CH_2–CH_3)$_2$), 1.08 (6H, *t*, N(CH_2–CH_3)$_2$).

C_3 – Calcd. for $C_{34}H_{25}BrN_4O_4S$: C, 61.35 %; H, 3.78 %; N, 8.41 %; Found: C, 61.42 %; H, 3.87 %; N, 8,54 %. IR: 2965, 2927, 2869, 1456, 1355 cm^{-1} (N–Et), 3075 and 1339 cm^{-1} (Ar–CH_3), 1760 cm^{-1} (C=O group of lactone ring), 1655 cm^{-1} (C=O group of quinazolinone), 1607 cm^{-1} (C=N), 870 cm^{-1} (1,2,4,5-tetrasubstituted benzene), 585 cm^{-1} (C–Br). ^{1}H-NMR: δ 6.4–8.0 (12H, *m*, Ar–H), 3.34 (4H, *q*, N(CH_2–CH_3)$_2$), 2.13 (3H, *s*, Ar–CH_3), 1.19 (6H, *t*, N(CH_2–CH_3)$_2$).

C_4 – Calcd. for $C_{39}H_{27}BrN_4O_4S$: C, 64.37 %; H 3.74 %; N, 7.70 %; found: C, 64.32 %; H, 3.82 %; N, 7.65 %. IR: 2971, 2930, 2870, 1451, 1355 cm^{-1} (N–Et), 1751 cm^{-1} (C=O group of lactone ring), 1665 cm^{-1} (C=O group of quinazolinone), 1605 cm^{-1} (C=N), 876 cm^{-1} (1,2,4,5-tetrasubstituted benzene), 588 cm^{-1} (C–Br). ^{1}H-NMR: δ 6.4–7.9 (17H, *m*, Ar–H), 3.31 (4H, *q*, N(CH_2–CH_3)$_2$), 1.19 (6H, *t*, N(CH_2–CH_3)$_2$).

C_5 –Calcd. for $C_{34}H_{24}Br_2N_4O_4S$: C, 54,85 %; H, 3.25 %; N, 7.52 %; Found: C, 54.78 %; H, 3.36 %; N, 7.43 %. IR: 2970, 2927, 2868, 1464, 1341 cm^{-1} (N–Et), 2970 and 1327 cm^{-1} (Ar–CH_3), 1761 cm^{-1} (C=O group of lactone ring), 1662 cm^{-1} (C=O group of quinazolinone), 1613 cm^{-1} (C=N), 869 cm^{-1} (1,2,4,5-tetrasubstituted benzene), 580 cm^{-1} (C–Br). ^{1}H-NMR: δ 6.2–7.75 (11H, *m*, Ar–H), 3.32 (4H, *q*, N(CH_2–CH_3)$_2$), 2.15 (3H, *s*, Ar–CH_3), 1.18 (6H, *t*, N(CH_2–CH_3)$_2$).

C_6 – Calcd. for $C_{39}H_{26}Br_2N_4O_4S$: C, 58.07 %; H, 3.25 %; N, 6.94 %; Found: C, 58.17 %; H, 3.34 %; N, 6.86 %. IR: 2973, 2929, 2870, 1460, 1332 cm^{-1} (N–Et), 1762 cm^{-1} (C=O group of lactone ring), 1649 cm^{-1} (C=O group of quinazolinone), 1605 cm^{-1} (C=N), 879 cm^{-1} (1,2,4,5-tetrasubstituted benzene), 586 cm^{-1} (C–Br). ^{1}H-NMR: δ 6.0–7.9 (16H, *m*, Ar–H), 3.4(4H, *q*, N(CH_2–CH_3)$_2$), 1.27 (6H, *t*, N(CH_2–CH_3)$_2$).

RESULTS AND DISCUSSION

The IR spectra of all the fluoran compounds showed the disappearance of the characteristic absorption band of the OMe group and the appearance of the C=O group of the lactone ring at 1745–1790 cm^{-1} and at 1640–1700 cm^{-1} for the C=O group of 4-keto-quinazoline and other characteristic absorption bands for the rest of the molecules.

The investigated chromogenic compounds are soluble in organic solvents and are nearly colorless but exhibit the property of spontaneous colour formation (purple) in aqueous acid solutions and in the presence of acidic colour activating substances. The absorption spectra (λ_{max}) of the compounds in toluene and 95 % acetic acid were recorded. The spectra in toluene show a single peak due to the lactone ring while the three peaks in 95 % acetic acid are due to the quinone, zwitterion and lactone forms.[15,16]

CONCLUSION

The investigated chromogenic compounds are soluble in organic solvents and are nearly colorless. They spontaneously form coloured species in aqueous acid solutions and in the presence of acidic colour activating substances.

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ИЗВОД

СИНТЕЗА И КАРАКТЕРИЗАЦИЈА НОВИХ СУПСТИТУИСАНИХ СПИРО[ИЗОБЕНЗОФУРАН-1(3*H*),9'-КСАНТЕН-3-ОНА

SACHIN V. PATEL, MANISH P. PATEL и RANGAN G. PATEL

Deparment of Chemistry, Sardar Patel University, Vallabh Vidyanagar-388 120, Gujarat, India

Реаговањем *N*,*N*-диетил-*m*-амино-фенола и анхидрида фталне киселине добијена је кето-киселина (2-(4-диетиламино-2-хидроксибензоил)бензоева киселина), која затим реакцијом са различитим супституисаним 3-[6-метоксибензотиазол-2-ил]-4(3*H*)-хиназолинонима у присуству дехидратационог кондензационог агенса даје нове спиро[изобензофуран-1(3*H*),9´-ксантен]-3-оне. Бензотиазолил-хиназолинони су синтетизовани реакцијом 2-амино-6-метокси-бензотиазола са различитим супституисаним бензоксазинонима. Сва добивена једињења карактерисана су одређивањем тачке топљења, елементалном анализом, IR, UV-Vis и NMR спектроскопијом. Сва флуоранска једињења су безбојна или скоро безбојна, док су обојена у киселој средини.

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REFERENCES

1. R. Muthyalal, *Chemistry and Applications of Leuco Dyes*, Plenum Press, New York, 1997, p. 159
2. National Cash Register Company, U.S. 2,548,366 (1954)
3. T. Papenfahs, R. Rehberg, E. Spictshta, (Farbwerke Hoechst A.-G), Ger. Offen. 2,036,817 (1972)
4. Sumitomo Chemical Co. Ltd. Japan, JP 5,845,088 (1983)
5. H. Kast, G. Lamm, (BASF AG), Ger. Offen. 2,603,101 (1977)
6. H. Kast, G. Dumkelmann, (BASF AG), Ger. Offen. 2,509,793 (1976)
7. S. Spatz, U.S. 3,989,716 (1975)
8. U. Nobuhiro (Mitsubishi Paper Mills, Ltd.), JP 04,369,376 (1992)
9. N. N. Crounse, P. J. Schmidt, (Sterling Drug Inc.), U.S. 3,998,826 (1976)

10. M. Kondo, M. Tanaka, N. Sakamoto, H. Ooyoshi (Mitsui Petrochemical Industries Ltd.), Eur. Pat EP511,019 (1993)
11. C. G. Stuckwisch, *J. Am. Chem. Soc.* **71** (1949) 3417
12. N. C. Patel, A. G. Mehta, *J. Indian Council of Chem.* **18** (2001) 83
13. A. M. Abdo, I. F. Zeid, A. G. El-Hiti, O. E. Mohamoud, *Indian J. Chem. Sec. B: Org. Chem. Incl. Med. Chem.* **38B** (1999) 850
14. V. K. Pandey, *J. Indian Chem. Soc.* **54** (1977) 1084
15. A. V. Despande, E. B. Namdas, *J. Photochem. Photobiol. A: Chem.* **110** (1997) 177
16. S. Kimura, T. Kodayashi, S. Ishige, Fuji Photo Film Co. Ltd., Japan, JP 71 12,312 (1968).