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Chemical Papers 67 (9) 1231–1239 (2013)
DOI: 10.2478/s11696-013-0343-7

ORIGINAL PAPER

Synthesis and spectroscopic characterisation of (*E*)-2-(2-(9-(4-(1*H*-1,2,4-triazol-1-yl)butyl)-9*H*-carbazol-3-yl)vinyl)-3-ethylbenzo[*d*]thiazol-3-ium, a new ligand and potential DNA intercalator‡

Agata Głuszyńska*, Ewa Rajczak, Bernard Juskowiak

Laboratory of Bioanalytical Chemistry, Faculty of Chemistry, A. Mickiewicz University, Umultowska Str. 89b, 61-614 Poznań, Poland

Received 15 June 2012; Revised 22 November 2012; Accepted 24 November 2012

Three new compounds based on carbazole planar skeleton were synthesised. Among them there is a new ligand and a potential DNA intercalator which contains a benzothiazolium moiety connected to the carbazole ring by a vinyl bridge. The absorption and emission spectral properties of this new ligand have been studied by spectroscopic methods.

Keywords: carbazole derivative, UV-VIS absorption spectra, fluorescence, G-quadruplexes, DNA

Introduction

Small molecules can noncovalently interact with DNA via intercalation or minor groove binding. The majority of classical DNA ligands have been addressed to the applications with double stranded DNA. In recent years, interest in ligands capable of interacting with the triple stranded DNA helix and stabilising G-quadruplexes has increased significantly (Kerwin, 2000; Cuesta et al., 2003; Davis, 2004; Riou, 2004; White et al., 2007; De Cian et al., 2008; Ou et al., 2008; Franceschin, 2009; Jain & Bhattacharya, 2011). G-quadruplexes are unusual structural forms of nucleic acids, first reported by Gellert et al. (1962). The G-rich nucleic acid sequences are able to form of G-quadruplex conformation (containing flat G-quartets) which consist of four guanines held together by eight hydrogen bonds. These tetraplex structures are stabilised in the presence of specific metal cations (Na^+, K^+) or small organic ligands. The first report on biological activity of G-quadruplexes (inhibition of human telomerase) was published by Sun et al. (1997), the number and diversity of "G-quadruplex ligands" with potential anticancer properties has grown rapidly (Riou, 2004; Kelland, 2005; De Cian et al., 2008; Folini et al., 2009; Brooks & Hurley, 2010). Among them, one derivative of carbazole, 3,6-bis[2-(1-methylpyridinium)vinyl]carbazole (BMVC), can recognise specific quadruplex structures, particularly the quadruplex of the human telomeric sequence $d(T_2AG_3)_4$, and can thus inhibit telomerase ($IC_{50} = 5 \times 10^{-8}$ M) (Chang et al., 2003a, 2003b, 2004a, 2004b, 2006a, 2007; Chang & Chang, 2010; Tsaia et al., 2007; Yang et al., 2007; Huang et al., 2008).

Carbazole derivatives are interesting also because of their other biological and photophysical properties (Chang et al., 2006a, 2006b; Li et al., 2009; Patrick et al., 1997; Spychała, 2009; Tanious et al., 2001; Dias et al., 2004; Hotzel et al., 2002; Saengkhae et al., 2007; Głuszyńska et al., 2010, 2012; Dumat et al., 2011; Qu et al., 2008). For example, carbazole dications represent an unusual class of DNA binding agents that are active against opportunistic infections (Patrick et al.,

*Corresponding author, e-mail: aglusz@amu.edu.pl
‡Presented at the 39th International Conference of the Slovak Society of Chemical Engineering, Tatranské Matliare, 21–25 May 2012.