EE&AE
2025 10th International Conference
on Energy Efficiency and Agricultural Engineering
5-7 November 2025, Starozagorski Bani, Bulgaria
IEEE

Synthesis of 5-bromonaphthalimide derivatives with 3-aminocycloalkanespiro-5-hydantoins

Marin Marinov *, Iliana Nikolova, Iliana Kostova

Department of Chemistry, Phytopharmacy, Ecology and Environmental Protection, Agricultural University – Plovdiv, 4000 Plovdiv, Bulgaria, e-mail: m_n_marinov@abv.bg

GOAL OF THE STUDY

The present work reports a study on the interaction of 5-bromo-1H,3H-naphtho[1,8-cd]pyran-1,3-dione with various 3-aminocycloalkanespiro-5-hydantoins, aimed at the development of new biologically active compounds. As a result of this condensation, seven new 5-bromonaphthalimide derivatives were synthesized. The newly synthesized naphthalimides were characterized by physicochemical parameters as well as IR, ^{1}H NMR, and ^{13}C NMR spectral data. The antimicrobial activity of the described compounds was evaluated against Gram-positive bacteria, Gram-negative bacteria, yeasts, and molds. The tested products exhibited the strongest activity against the Gram-positive bacteria *Bacillus subtilis* and *Bacillus cereus*.

METHODOLOGY OF THE INVESTIGATION

All chemicals used were obtained from Merck and Sigma-Aldrich. Melting points were measured using an SMP-10 digital melting point apparatus. The IR spectra were recorded on a Perkin-Elmer FTIR-1600 spectrometer using KBr disks. The NMR spectra were obtained with a Bruker Avance III HD spectrometer (operating at 500.13 MHz for ^{1}H and 125 MHz for ^{13}C) in DMSO-d_6 solutions. The chemical shifts were referenced to tetramethylsilane (TMS). The purity of the compounds was checked by thin layer chromatography on Kieselgel 60 F_{254}, 0.2 mm Merck plates, eluent system (vol. ratio): ethyl acetate : petroleum ether = 1 : 2.

MAIN RESULTS FROM THE STUDY

The starting compound, 5-bromo-1*H*,3*H*-naphtho[1,8-*cd*]pyran-1,3-dione was reacted with 3-aminocycloalkanespiro-5-hydantoins in glacial acetic acid according to Fig. 1.

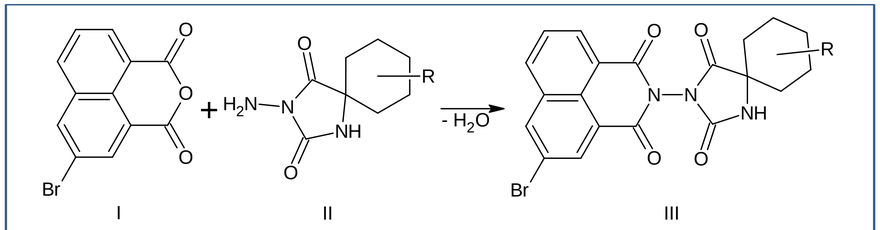

Fig. 1. Synthesis of compound IIIa-g

The formation of the products was confirmed *via* melting points (m. p., °C), R_f (retention factor) values (Table 1).

Compared to the starting 3-aminocycloalkanespiro-5-hydantoins (m. p.: 166-200°C), the synthesized naphthalimide derivatives exhibited significantly higher melting points (247-296°C).

Table 1. Physicochemical parameters of compounds IIIa-g

Compound	Systematic name	Yield, %	M. p., °C	R_f
IIIa	5-bromo-2-(2,4-dioxo-1,3-diazaspiro[4.5]decan-3-yl)benzo[de]isoquinoline-1,3-dione	91	247-248	0.53
IIIb	5-bromo-2-(6-methyl-2,4-dioxo-1,3-diazaspiro[4.5]decan-3-yl)benzo[de]isoquinoline-1,3-dione	83	263-264	0.51
IIIc	5-bromo-2-(7-methyl-2,4-dioxo-1,3-diazaspiro[4.5]decan-3-yl)benzo[de]isoquinoline-1,3-dione	85	295-296	0.55
IIId	5-bromo-2-(8-methyl-2,4-dioxo-1,3-diazaspiro[4.5]decan-3-yl)benzo[de]isoquinoline-1,3-dione	94	272-273	0.49
IIIe	5-bromo-2-(8-ethyl-2,4-dioxo-1,3-diazaspiro[4.5]decan-3-yl)benzo[de]isoquinoline-1,3-dione	96	263-264	0.46
IIIf	5-bromo-2-(2,4-dioxo-8-propyl-1,3-diazaspiro[4.5]decan-3-yl)benzo[de]isoquinoline-1,3-dione	92	288-289	0.50
IIIg	5-bromo-2-(2,4-dioxo-1,3-diazaspiro[4.7]dodecan-3-yl)benzo[de]isoquinoline-1,3-dione	97	256-257	0.43

The IR spectra indicate the disappearance of the characteristic vibrations of the NH_2 group in the region between 3200 and 3320 cm^{-1}, accompanied by the appearance of new absorption bands corresponding to NH group vibrations, observed in the region between 3250 and 3335 cm^{-1}. The aromatic and aliphatic vibrations are observed at 3058–3072 cm^{-1} and 2918–2943/2855–2876 cm^{-1}, respectively. Evidence for the presence of the two carbonyl groups of the hydantoin ring is provided by the absorption bands at 1796–1825 cm^{-1} and 1757–1775 cm^{-1}, corresponding to the C^2=O and C^4=O vibrations, respectively.

Spectral data from NMR analysis confirm the structure of the compounds.

The antimicrobial activity of compounds IIIa–g was evaluated against Gram-positive bacteria, Gram-negative bacteria, and yeast using the agar diffusion method.

CONCLUSIONS

Seven new derivatives of 5-bromonaphthalimide with 3-aminocycloalkanespiro-5-hydantoins were synthesized. Their structures were confirmed using IR and NMR spectroscopy, and some physicochemical parameters were determined.

The compounds' antimicrobial activities were evaluated against various Gram-positive and Gram-negative bacteria, and yeast. It was found that the compounds exhibit activity against the tested microorganisms, with the strongest effect observed against the Gram-positive bacteria *Bacillus subtilis* and *Bacillus cereus*. The obtained results clearly indicate that the synthesized products possess promising antibacterial potential, particularly against Gram-positive strains. These findings highlight the need for further studies on related compounds aimed at the discovery and development of new and effective antimicrobial agents.

ACKNOWLEDGMENT

The authors acknowledge the support of the Science Fund of the University of Ruse, Bulgaria (Project 2025/BRz-01). We are also grateful to Ms. Yoana Marinova (Sofia) for the valuable discussions.