

Investigation of the Antibacterial Properties of Polychlorinated Cyclic Bisimides

A.I. Alikhanova¹, N.Sh. Rasulzadeh¹, S.Q. Zeynalova², N.Sh. Rasulov²

¹ Institute of Polymer Materials, National Academy of Sciences of Azerbaijan, Sumgayit, 5004 Azerbaijan,

² Azerbaijan Medical University, 23 Bakikhanov Street Baku 370022, Azerbaijan

Abstract

This work is devoted to the study of the influence of polychlorinated cyclic bisimides based on the Diels-Alder reaction for antibacterial properties and structure. As test cultura *Pseudomonas aeruginosa*, *intestinal bacillus*, *staphylococcus* and *Candida albicans* have been used. The research of the antibacterial properties of polychlorinated cyclic bisimides has been studied in a series with dilution method. According to the antibacterial activities of the studied substances, *N*-[2-maleinimido] ethyl bisimide of *endo*, *exo*-1,2,3,4,11,11-hexachlorotricyclo [6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid and *N*-[4-maleinimidobenzyl] phenyl bisimide of 1,4,5,6,7,7-hexachlorobicyclo[2.2.1]hept-5-ene-2,3-dicarboxylic acid have more active antimicrobial and fungicidal properties.

Keywords - antibacterial polymer additives, antibacterial composition materials, polychlorinated cyclic bisimides, antimicrobial and fungicidal properties

I. INTRODUCTION

As it is known, during the exploitation, the polymer materials are subjected to biocorrosion under the influence of microbes and microfungi. In addition to their physical and mechanical properties, their quality also deteriorates. Typically, bactericidal and fungicidal additives are included in their composition to get rid of this. For this purpose, many antibacterial additives have been developed and widely used for polyolefins, polystyrene and styrene copolymers. For this purpose, many antibacterial additives for copolymers of polyolefins, polystyrene and styrene have been developed and widely used. Range of organic antibacterial supplements is quite broad. Currently, more than 3,000 antibacterial compounds have been tested in various polymeric materials [1]. All organic antibacterial additives contain halogen, thiazole, salicylates, acid amides and other biologically active groups.

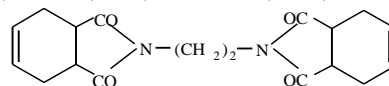
It is widely disclosed in scientific papers published on the results of our previous studies on the acquisition of biomolecular active monomers of the salicylic group and their antibacterial polymers [2]. The purpose of this article is to study the antibacterial properties of polychlorinated cyclic bisimides, which

are intended for use as additives when purchasing antibacterial polymeric materials that are new biologically active compounds on our part as a continuation of previous research.

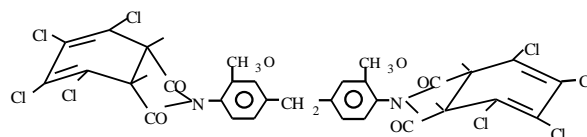
II. EXPERIMENTAL PART

Cyclic bisimides obtained from the Diels-Alder reaction were synthesized by known methods [3-5] and have composition and structure as shown below:

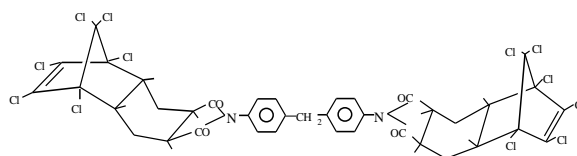
I *N*, *N*'-(2-aminoethyl) bisimide of *cis*-cyclohex-4-ene-1,2-dicarboxylic acid. Melting point 146-147 °C (benzene), R_f 0.68. IR-spectrum cm^{-1} : 1715, 1780 (C=O), 1608 (C=C), 680-750 (C-Cl).



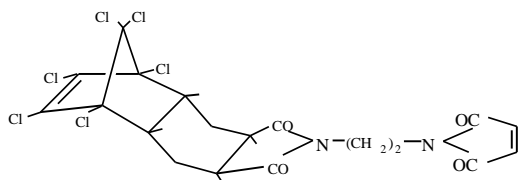
II *N*, *N*'-(3,3-dimethoxy-4,4'-diphenylmethane) bisimide of 2,3,4,5-tetrachloro-1,3-cyclohexadiene-5,6-dicarboxylic acid. m.p. 205 °C (benzene), R_f 0.61. IR-spectrum cm^{-1} : 1720, 1780 (C=O), 1602 (C=C), 650-710 (C-Cl).



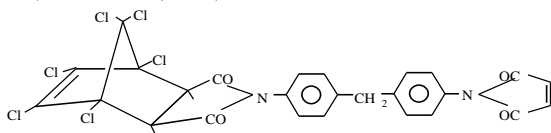
III *N*, *N*'-(4,4'-diphenylmethane) bisimide of 2,3,4,5,11,11-hexachlorotricyclo [6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid. m.p. 305 °C (hexane), R_f 0.44. IR-spectrum cm^{-1} : 1720, 1780 (C=O), 1603 (C=C), 660-750 (C-Cl).



IV *N*-[2-maleinimide] ethyl bisimide of *endo*, *exo*-1,2,3,4,11,11-hexachlorotricyclo [6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid m.p. 400 °C (chloroform), R_f 0.67. IR-spectrum cm^{-1} : 1717, 1780 (C=O), 1600 (C=C), 650-770 (C-Cl).



V N-[4-maleinimidobenzyl] phenyl bisimide of 1,4,5,6,7,7-hexachlorobicyclo [2.2.1]hept-5-en-2,3-dicarboxylic acid m.p. 300 °C (benzene+hexane), R_f 0.67. IR-spectrum cm^{-1} : 1720, 1780 (C=O), 1600 (C=C), 660-740 (C-Cl).



The structure and degree of purity of monomers (I, II, III, IV, V) were proved by IR- and NMR spectrums [6]. In IR spectrums of monomers in 1720, 1780, 1602-1610 and 650-780 cm^{-1} areas corresponding absorption zones belonging to C=O, C=C and C-Cl groups were recorded.

III. RESULTS AND DISCUSSION

The research of antimicrobe properties was studied in series by dilution method [7]. It was held in the following ratios (1:100, 1:200, 1:400, 1:800). Test results were shown in Table I-II.

TABLE I
Antimicrobial effects of new synthesized compounds and controls

Test cultures	Exposure time (minute)	Synthesized new compounds																			
		I				II				III				IV				V			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
St.aureus	10	-	-	+	+	-	-	+	+	-	+	+	+	-	-	+	+	-	-	+	+
	20	-	-	+	+	-	-	+	+	-	+	+	+	-	-	+	+	-	-	+	+
	40	-	-	+	+	-	-	+	+	-	+	+	+	-	-	+	+	-	-	+	+
	60	-	-	+	+	-	-	+	+	-	+	+	+	-	-	+	+	-	-	+	+
Ps.aerugi noza	10	-	-	+	+	-	-	-	+	-	-	+	+	-	-	+	+	-	-	-	+
	20	-	-	+	+	-	-	-	+	-	-	+	+	-	-	-	+	-	-	-	+
	40	-	-	-	+	-	-	-	+	-	-	+	+	-	-	-	+	-	-	-	+
	60	-	-	-	+	-	-	-	+	-	-	+	+	-	-	-	+	-	-	-	-
E.coli	10	-	-	+	+	-	-	+	+	-	-	+	+	-	-	-	+	-	-	+	+
	20	-	-	-	+	-	-	+	+	-	-	+	+	-	-	-	-	-	-	+	+
	40	-	-	-	+	-	-	+	+	-	-	+	+	-	-	-	-	-	-	+	+
	60	-	-	-	+	-	-	+	+	-	-	+	+	-	-	-	-	-	-	+	+
Candida albicans	10	-	-	+	+	-	-	+	+	-	-	+	+	-	-	-	+	-	-	-	+
	20	-	-	+	+	-	-	+	+	-	-	+	+	-	-	-	+	-	-	-	-
	40	-	-	-	+	-	-	+	+	-	-	+	+	-	-	-	+	-	-	-	-
	60	-	-	-	+	-	-	-	+	-	-	+	+	-	-	-	+	-	-	-	-

Symbols: Diluted in proportion 1(1:100), 2 (1:200), 3 (1:400), 4 (1:800).

“+” shows full end, “-” does not end

Table II
Antimicrobial effects of Control Ingredients

Test cultures	Exposure time (minute)	Control Ingredients											
		Rivanol				Ethanol				Nitrofungin			
		1	2	3	4	1	2	3	4	1	2	3	4
St.aureus	10	+	+	+	+	-	+	+	+				
	20	+	+	+	+	-	+	+	+				
	40	+	+	+	+	-	+	+	+				
	60	-	-	+	+	-	+	+	+				
Ps.aerugi noza	10	+	+	+	+	+	+	+	+				
	20	+	+	+	+	-	+	+	+				
	40	+	+	+	+	-	+	+	+				
	60	-	-	-	+	-	+	+	+				
E.coli	10	-	-	-	+	+	+	+	+				
	20	-	-	-	+	-	+	+	+				
	40	-	-	-	+	-	+	+	+				
	60	-	-	-	+	-	+	+	+				
Candida albicans	10	+	+	+	+	+	+	+	+	+	+	+	+
	20	+	+	+	+	+	+	+	+	+	+	+	+
	40	+	+	+	+	-	+	+	+	-	+	+	+
	60	+	+	+	+	-	+	+	+	-	+	+	+

As it is seen from Table I newly synthesized substances influence to various microorganisms differently and when diluted in 1:100 ratio these substances show strong antimicrobe activity against all tested test culturas. Antimicrobe impact of these substances was studied comparatively with alcohol, rivanol and nitrofungine that are widely used in medicine.

IV. CONCLUSIONS

Tested substances N-[2-maleinimido] ethyl bisimide of *endo*, *exo*-1,2,3,4,11,11-hexachlorotricyclo [6.2.1.0^{5,10}]undec-2-ene-7,8-dicarboxylic acid (IV) and N-[4-maleinimidobenzyl] phenyl bisimide of 1,4,5,6,7,7-hexachlorobicyclo [2.2.1]hept-5-ene-2,3-dicarboxylic acid (V) are more active. So, substance (IV) has killed intestinal bacillus in 1:800 ratio dilution during 20 minute, intestinal bacillus and Candida in 1:400 ratio during 10 minute, pseudomonas aeruginosa during 20 minute. Substance (V) keep from developing pseudomonas aeruginosa in 1:400 ratio during 10 minute, Candida in 1:800 ratio for 10 minute. Substances (I, II, IV, V) keep from developing staphylacoccus in 1:200 ratio for 10 minute, but substance (III) could not influence to staphylacoccus.

Examined compounds can be suggested as antimicrobial substances.

REFERENCES

- [1] Штильман М.И. Полимеры в биологически активных системах // Соросовский образовательный журнал, 1998, №5, с. 48-53
- [2] Rasulzadeh N.Sh., Ibadov E.A. The synthesis and properties of acrylic and methacrylic ether of salicylic acid // International Journal of Research studies in Science, Engineering and Technology, Volume 4, Issue 3, 2017, PP 1-3
- [3] Salakhov M.S., Umaeva V.S., Alikhanova A.I. Synthesis of polychlorinated unsaturated cyclic dicarboxylic acid imides // "Russian Journal of "Organic Chemistry", 2008, vol. 44, № 10, p. 1438-1443
- [4] Salakhov M.S., Umaeva V.S., Alikhanova A.I. Synthesis of polychlorinated mono- and bisimides of cyclic dicarboxylic acids containing diene-dienophile fragments // "Russian Journal of "Organic Chemistry", 2014, vol. 50, n. 2, p. 211-218
- [5] Alikhanova A.I. Synthesis of polyimides of polychlorinated cyclic dicarboxylic acids on the basis of diene-dienophilic bisimides on the Diels-Alder reaction // Azerbaijan chemical journal, 2018, №1, pp-45-52
- [6] Lagunin A., Stepanchikova A., Filimonov D., Poroikov V. PASS: prediction of activity spectra for biologically active substances // Bioinformatics, 2000, 16 (8), p.747-748
- [7] О.К.Поздеев., В.И. Покровский. Медицинская микробиология // Учеб. для вузов ГЭОТАР МЕД, 2001. 768 p.