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Decrease of luminol chemiluminescence upon exposure of human blood serum to 50 Hz electric fields

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Abstract

The chemiluminescence of luminol, after 1 and 2 h in vitro exposure of human serum to 50 Hz electric fields of different intensities, decreases as compared to the controls. This indicates a field-induced decrease in the concentration of the free radicals. The report is limited to the key kinetic and field data, inviting independent kinetic analysis of the data in terms of reaction moments or reaction susceptibilities for the various normal modes indicated by the data.

Keywords: Electric field exposure; Free radicals; Chemiluminescence; Human serum

1. Introduction

Human organisms appear to react to exposure to 50 Hz *electric fields* in an individual manner, but always the response of an individual depends on the field strength and the exposure time [1].

Recently we have found [2,3] that the result of exposing human serum to a 50 Hz *magnetic field* can be monitored by the amplification of the luminol chemiluminescence intensity relative to the control [4], suggesting an increase in the concentration of free radicals. Here we extend the investigations to *electric AC fields*. We report that the luminol chemiluminescence decreases after in vitro exposure of human serum to 50 Hz electric fields of different field intensities.

2. Materials and method

Human blood has been drawn from a healthy donor (female, 34 years old) and centrifuged. The serum has been exposed to 50 Hz electric fields of different intensities: E (kV cm^{-1}) = 5; 7,5; 10;15 and 20 for 1 and 2 h each, respectively. The data refer always to serum from one person, because of the experienced great variability of the individual sera.

The electric field has been applied to the serum samples, positioned between the two condenser plates of size 9 × 6 cm and 1 cm distance between the plates in direct contact, such that the exposure field is uniform and homogeneous.

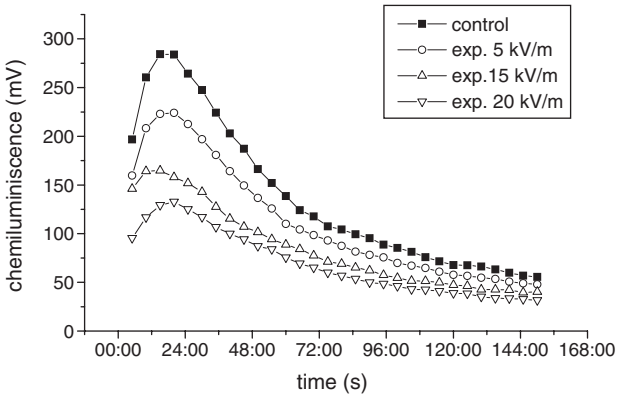

Fig. 1. The chemiluminescence emission of nonexposed and exposed serum for 1 h to different electric field intensities, 50 Hz.

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Table 1
Chemiluminescence quenching factor of serum exposed to different electric field intensities, 50 Hz (n=3)

Electric field intensities E (kV/m)	Chemiluminescence quenching factor S (%)	
	1 h exposed serum	2 h exposed serum
5	21.24±4.24	39.74±2.67
7.5	21.90±2.45	38.54±3.45
10	42.02±3.15	35.87±3.12
15	57.83±2.16	35.60±1.65
20	53.37±1.75	34.98±1.38

The chemiluminescence of luminol has been used as the assay system of luminol-H_2O_2 in TRIS HCl buffer. The TD20/20 (USA)-Luminometer has been operated at the wavelength λ=430 nm. The active reagent LH2 is luminol (5-amino-2,3-dihydro-1,4-phtalazinedione at the concentration of 10^{-5} M in DMSO (dimethyl-sulfoxide),(Merck, Germany); 0.2 M TRIS buffer (Merck, Germany), at pH=8.4; 10^{-5} M hydrogen peroxide (H_2O_2, Merck, Germany). Human serum. Control: 200 µl LH_2+750 µl buffer+50 µl H_2O_2. Sample: 200 µl LH_2+700 µl buffer+50 µl serum+50 µl H_2O_2.

The quenching factor (S) is calculated according to:

$$S = \frac{I_c - I_0}{I_c} \times 100 \quad (1)$$

where I_c is the chemiluminescence intensity of the unexposed serum (control) at time t=5 s and I_0 that of the exposed serum at t=5 s.

3. Results

Fig. 1 shows that the chemiluminescence emission both of the unexposed serum (control) and that of the exposed serum first increases with time and then decreases, but in a different manner. The data are summarized in Table 1 and Fig. 2.

After 2 h of exposure, S has a nearly constant value S=36.95±2.07. for E=5 kV/m and E=7.5 kV/m S, being larger by 18.5% as compared to 16.64%, the values of 1 h exposure. Hence a longer exposure time obviously favors lower concentrations of free radicals.

4. Discussion

The results show that the exposure of human serum to a 50 Hz electric field for 1 and 2 h, causes a decrease in the concentration of free radicals. The response to a 50 Hz magnetic field is different. Note that, unlike in the case of magnetic fields, where the serum is in a glass cuvette, the electric field exposure requires that the metal electrodes have to be in direct contact with the serum.

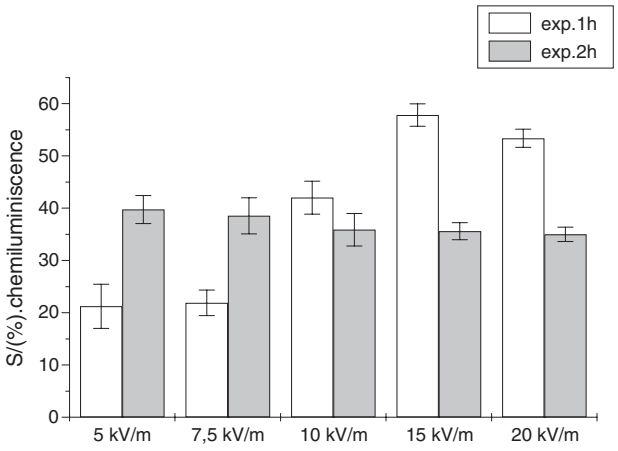

Fig. 2. The quenching factor of chemiluminescence for the serum exposed to different electric field intensities, 50 Hz (n=3).

The data in the present form invite a quantitative analysis of the kinetics in terms of normal mode contributions and of field dependencies in order to derive kinetic rate coefficients and reaction moments or reaction susceptibilities [5]; presently no mechanism for the field action can be suggested.

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