# INACTIVATION OF MICROORGANISMS BY ELECTRIC FIELDS

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**Annotation.** *The basic principles of the inactivation of microorganisms by constant electric fields are discussed. It is shown that applied electric fields can selectively inactivate sensory functions of microorganisms.*

**Key words:** ***inactivation, electric fields, microorhanisms***

Inactivation is a partial or complete loss by biologically active substance or organism of its activity. Inactivation is used to destroy any microorganisms and viruses, for disruption of their functions, decontamination and disinfection, sterilization.

Various physical methods for food safety and microbial inactivation with thermal processing are known [Rastogi, 2003]. But the thermal processing leads to change in the sensory attributes, such as flavours, stability of thermolabil compounds as vitamins, aminoacids as well as the modifying nutritional quality of the products.

In recent years, the use of electric fields for inactivation of microorganisms has received much attention in applied microbiology and technological processes. Among all emerging non-thermal technologies, electric fields have been applied to the food technologies due to its short treatment times and reduced heating effects.

The electrical inactivation of microorganisms can be realized usually by the application of pulsed electric fields.

A lethal effect of high electric fields on a number of species of vegetative bacteria and yeasts has been demonstrated by Sale and Hamilton (1967). The degree of kill of a population was determined by the product of the pulse length and number of pulses, and by the field strength (up to 25 kV/cm) in the suspension.

Effect of submicrosecond electric fields on microorganisms such as two strains of *E. coli* and a marine crustacean was studied [Schoenbach et al., 1995]. The observed dependance of microorganism lethality or temporary damage on field

strength and pulse duration makes it possible to use this effect in sterilizers (for food and water) and electrical filters for the prevention of biofouling in cooling systems.

Inactivation of *Salmonella typhimurium* (CRA 1005) and *Listeria monocytogenes* (NCTC 11994) was achieved by pulsed high electric field treatment in distilled water (10, 15 and 20 kV/cm) [Russell et al., 2000].

Inactivation of *Leuconostoc mesenteroides*, *E. coli*, *Listeria innocua*, and *Saccharomyces cerevisiae* in orange juice was induced by electric field levels of 30 kV/cm and 50 kV/cm [McDonald et al., 2000]. Both electric field levels were effective in inactivating microorganisms at temperatures below standard thermal treatment, however, the number of pulses applied was particularly important in inactivation.

Pulsed electric field (PEF) as a food preservation method has proved to inactivate the spoilage microorganisms and also pathogens. The process consists in the application of a short duration high electric field to food product, which is placed between two electrodes. Successful application of PEF depends strongly on the cells morphology and physiological properties, the fluid medium properties, the type and characteristics of the used electric field waveform [Barbosa-Cánovas and Altunakar, 2006].

Pulsed electric fields can inhibit the viability, motility, movement speed and even cause lethal effects, but can not selectively inactivate sensory functions of microorganisms, such as reception, sensory transduction, spatial orientation etc. This is a disadvantage of PEF method.

**Objectives**. The main aim of the article is to examine the application of constant electric fields for inactivation of sensory functions of microorganisms.

**Materials and Method.** Unialgal culture of *D. salina* Teod. strain №10 from the collection of the N.G. Kholodny Institute of Botany, Ukrainian Academy of Sciences [Posudin et al., 2010], was used in this study.

A special rectangular cuvette was constructed for investigating the effect of electrical fields on photomovement of alga. The cuvette consisted of an observation chamber (40×10×4 mm) that contained the algal suspension, two electrode chambers that were separated from the observation chamber by gelatine and a 0.3 M solution of

*KCl* to prevent electrolysis. Gold electrodes, positioned at a 90° angle to the lateral light source, were attached to an electrical source. The distance between the parallel electrodes was 30 mm.

To study the photomovement of *Dunaliell*a, a special experimental videomicrography system was developed [Posudin et al., 2010]. It allows the observation and measurement of the velocity and direction of movement of individual cells as modulated by light stimulus parameters. The system utilizes a microscope connected to light source, monochromator and videosystem.

Fourier-transform was used to determine the level of phototopotaxis inhibition by the electrical field [Posudin et al., 2010]. The method allowed analyzing changes in the amplitude of the principal harmonics to elucidate the possible participation of membrane electrical potentials in algal photomovement.

**Results.** Application of an electrical field (10-20 V/m) inhibited phototopotaxis in *D. salina* during lateral illumination with white light (500 lx illuminance). The histograms of angular distribution in the absence and presence of an electrical field (20 V/m) is displayed at Fig.1.

Fourier analysis allowed estimating the reduction in amplitude of the principal harmonics (the first harmonic 3 times, the second 3.7 times, etc.). The histogram of angular distribution demonstrates the inhibition of phototopotaxis in *D. salina* when the electrical field was switched on and its recovery 2 minutes after the electrical field was switched off.

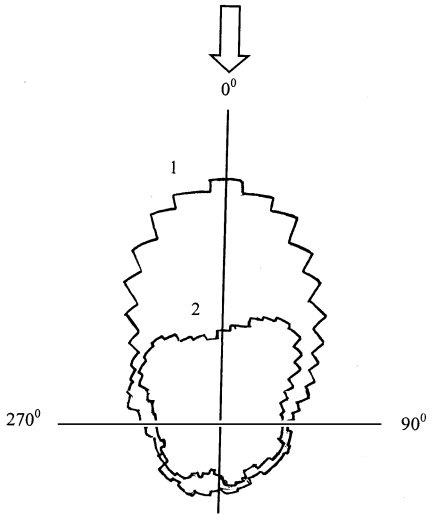


Fig.1. **Effect of external electric field at the strength 20 V/cm, applied to the algal suspension, on the angular distribution of the cells and intensity of phototopotaxis of** *D. salina*: 1 – field is switched on; 2 – field is switched off. An arrow indicates the direction of propagation of the light stimulus (illuminance 500 lx).

## Conclusions

Our experimental results support the hypothesis participation of light induced changes in membrane potential during photomovement. The application of an external electrical field disturbs the propagation of the potential from the receptor to the flagellar apparatus causing an inhibition of phototopotaxis.