Final Report

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Applicants: M. Urech, puls Umweltberatung, Mühlemattstrasse 45, CH-3007 Bern, Switzerland
C. Pickl, ÖkoTox GmbH, Wollgrasweg 49, D-70599 Stuttgart, Germany
H. Lehmann, Environment and Electromagnetic Compatibility, Swisscom Ltd., Innovations, CH-3050 Bern, Switzerland

Project title: Investigations on the Mutagenicitiy of GSM- and UMTS-Electromagnetic fields with the Tradescantia micronucleus bioassay

1. State of Research

1.1 Research activities performed

Background: The Tradescantia micronucleus bioassay is commonly used for the detection of genotoxicity of chemical agents. Recently, it was used also to determine whether electromagnetic fields at short-wave frequencies induce an increase of micronucleus (MCN) formation and show thus a mutagenic behaviour. For short short-wave electromagnetic fields we found inconsistent results: for the vertical polarisation of the electric field (parallel to the stem of the plants) and field strength of about 100 V/m a significantly increase in MCN frequency was observed. This has not been found for the horizontal polarisation of the electric field at the same intensity and the same exposure conditions.

Objectives: The aim of this project was to analyse possible genotoxical effects of electromagnetic fields generated by the two mobile phone standards GSM and UMTS.

Exposure unit: For both GSM and UMTS studies an exposure unit with two cages was constructed, one faraday cage for the two control groups and one plastic cage for the exposed group. The plants were exposed in the cages for 30 h and the mutation rates of the groups expressed by numbers of micronuclei in the tetrads of pollen mother cells were compared.
In each experiment a reference substance (maleic acid) was sham exposed as positive control and a negative control was tested parallel to evaluate the sensitivity of the plants under the conditions of the exposure unit. Additionally, the spontaneous mutation rate was determined by scoring a greenhouse control.

GSM study: Characteristics of the GSM fields used in 10 different experiments were:
high frequency GMSK modulated signal of 940 MHz with the low frequency pulse (2, 8 and 217 Hz) generated by the GSM standard; field strengths of 5, 46 and 87 V/m; vertical or horizontal field polarisation; with or without pulse, with or without modulation.

UMTS study: Characteristics of the UMTS fields used in 12 different experiments were:
A W-CDMA modulated signal; simulation of the fast power control by modulating the UMTS signal by 1500 Hz up and down variations of 3 dBm; electrical field strengths of 0.5 and 5 V/m; with our without pulse, with or without modulation.

1.2 Findings

GSM study: Both experiments with 5 V/m show no increase of the MCN numbers. For both higher field strengths (46 and 87 V/m) one half of the experiments show significantly higher MCN numbers, the other half doesn't show an increase.

UMTS study: The MCN numbers aren't influenced by the lower field strength (0.5 V/m), whereas the higher field strength leads to significant more MCN, but not in all of the experiments. The UMTS field strength showing a reaction of the plants is lower than the one of GSM.

Conclusions: Some of our experiments with electromagnetic fields generated by GSM and UMTS caused higher MCN numbers in Tradescantia. However, the results of all experiments are not consistent.

Identical results in all experiments were found only for the lowest field strengths: The MCN numbers were not increased. At all other field strengths the reaction of the plants wasn't stable: Different experiments with the same field characteristics show different reactions, in one experiment the MCN numbers was significantly higher, and in a second identically one the MCN numbers didn't change.

We conclude that above certain field strength the MCN numbers can be elevated, however until now these elevations can't be found in regular manner. The reasons for the inconsistent reaction of the Trad-MCN bioassay on the tested electromagnetic fields are unknown.

High temperatures in the plant might be a possible explanation for the increase in MCN. Therefore, in addition to this project, we will perform measurements of temperature and SAR-values on plants of Tradescantia (in colaboration with the it'is foundation, funded by Swisscom) to check the possibility of temperature effects in the plants during the exposure.

2. Annex

2.1 Publications
The results of the GSM and UMTS studies will be published in Bioelectromagnetics as soon as the measurements of temperature and SAR-values will be performed (see above).

2.2 Documents and presentations
H. Lehmann, M. Urech, C. Pickl, Tradescantia micronucleus bioassay for detecting mutagenicity of GSM-fields, Proceedings to the 15th International Zürich Symposium, February 03, p. 301
Katrin Schaller (2003): Empfindlicher Biosensor. Spektrum der Wissenschaft 9/2003, S. 76-77.
Seminarvortrag am Bundesamt für Gesundheit, Bern, 27.11.03: Ökotoxikologie-Test für die Wirkungsuntersuchung elektromagnetischer Felder; M. Urech und C. Pickl.

Bern, 23.12.04
M. Urech