

HABILITATION THESIS

STUDIES ON THE INFLUENCE OF VARIOUS POLLUTANTS ON PLANTS. DECONTAMINATION TESTS

– ABSTRACT –

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The *Habilitation Thesis* summarizes the results of my scientific research activities carried out in the period 2005-present, at the National Institute for Research and Development of Isotopic and Molecular Technologies, after obtaining the PhD in Chemistry at “Babeş-Bolyai” University.

Therefore, the thesis summarizes the main results obtained in the research projects that I coordinated as project director or project responsible. The activity was based on four national projects and one international project as follows: CEEX C-2995 / 11.10.2005 “*Separation and determination of certain metals from water samples, using dithiophosphoric derivatives as complexing agents*” (2005-2007), CEEX 1433/27.04.2006 “*Quality analysis of vegetable oils by applying an assembly of performing chromatographic and optothermal methods*” (2006 – 2008), PNII 51-098 / 2007 “*Influence of microwaves on bioactive compounds from inland plants*” (2007 – 2010), PN2-RU-TE 76/2011 “*Effects of microwave fields on essential oils and secondary metabolites of some indigene plants*” (2011 – 2014), EEA Grants 3499/20.05.2015 “*Methodological guide for monitoring antibiotic residues and antimicrobial resistance in the environment as a supporting instrument for an enhanced quality management of surface waters and groundwater*” (2015 - 2016).

The work is structured into three main parts: Chapter 1. “The influence of microwaves on aromatic plants”, Chapter 2. “Determination of antibiotics in various environmental samples and assessment of their influence on the plants. Studies on water remediation”, Chapter 3. “Perspectives on development of research activity”. The thesis also contains a brief introduction to the motivation for adopting this field of research and also a selection of bibliographical resources used.

The first chapter presents an overview of the results obtained from the study of the effects of microwaves on some aromatic plants. In this study the microwave frequency band, GSM

(mobile phone) and WLAN (wireless), was selected and its effect on the content in polyphenolic compounds, assimilating pigments, essential oils, and emitted volatile organic compounds from some seasoning plants belonging to the Apiaceae family: *Petroselinum crispum* (parsley), *Anethum graveolens* (dill), *Apium graveolens* (celery) and Lamiaceae: *Ocimum basilicum* (basil), *Satureja hortensis* (savory), *Rosmarinus officinalis* (rosemary) was monitored. The structural changes were also monitored. It was found that the quantity of polyphenols and volatile oils in irradiated plants had increased while the quantity of carotenoids and chlorophyll had decreased. The effects of the two types of microwaves on the leaf cells of the plants were studied and it was concluded that the WLAN microwaves induced significantly more negative changes than those seen in the case of GSM microwaves. Within the selected group of plants, celery was found to be the most resistant specie to microwaves from an anatomic point of view, while dill was the most affected in this regard.

In Chapter 2, a method for the analysis of 14 antibiotics (ampicillin, ceftazidime, cefepime, imipenem, piperacillin, tazobactam, tetracycline, erythromycin, ciprofloxacin, norfloxacin, vancomycin, gentamicin, sulfamethoxazole and trimethoprim) was developed in order to identify and quantify them in the liquid matrix and manure, using HPLC-DAD / FD / MS. A method for extracting the selected antibiotics from the liquid matrix using the technique of solid phase extraction has also been optimized. On the other hand, a method for the extraction of antibiotics from manure was optimized. For this purpose, two methods i.e. sonication and extraction in a microwave field were tested, and it was established that sonication was the best one to be used for manure samples. From these studies, it was observed that the water out of sewage treatment plants contained up to 2-3 times less antibiotics than the incoming water. The water discharged from hospitals contained a large amount of ampicillin ($530.5 \mu\text{g L}^{-1}$) and surface water had a large content of various antibiotics (for the 12 antibiotic monitored the concentrations ranged from $4.67 \mu\text{g L}^{-1}$ to $568 \mu\text{g L}^{-1}$).

In another study the influence of antibiotics on plants was investigated and it was found that in the case of treated plants the quantity of pigments decreased with up to 10% compared to the control plants. The effects of antibiotics on photosynthesis were moderate and indirectly represented by stomatal conductance changes. These situations have been observed when the plants were treated with tetracycline and doxycycline, the penicillins: amoxicillin, ampicillin and

penicillin G and cephalosporin: ceftriaxone. The negative effects of antibiotics on photosynthesis were increased by increase of the dose of antibiotics administered to plants by watering.

In the second chapter, some studies on water decontamination by removal of antibiotics are also presented. The tests were performed with multiwall carbon nanotubes (MWCNTs) at different pH values and it was found that retention values of over 50% were obtained at pH = 2 in the case of piperacillin using a functionalized MWCNT-COOH / Fe₃O₄ / PVP (Polyvinylpyrrolidone) system, while for cefepime and erythromycin using a MWCNT-COOH / Fe₃O₄ / NaDBS (Sodium dodecylbenzenesulfonate) system. At a pH of 5.5 the antibiotics norfloxacin, ciprofloxacin and tetracyclines were removed with over 50% efficiency by using MWCNT-COOH / Fe₃O₄ / NaDBS, while for imipenem and ceftazidime by using unmodified MWCNT's.

The third chapter, "Perspectives on development of research activity", presents the plans related to my future evolution in the research career. The research directions that I wish to continue in are:

- Improvement of extraction and determination of bioactive compounds in plants, using statistical optimization programs.
- The evolution with time of changes in plants due to different stress factors.
- Synthesis of new classes of nanomaterials for use in the environmental remediation

On the other hand, together with the team that I coordinate, I want to open and develop new research directions as follows:

- Observation and modelling of climate change in Romania and its comparison them with that of other countries. The effect of stress induced by climate change on plants.
- Preservation of food using plant extracts.
- Phyto- and bioremediation of the environment.
- Obtaining of biofuels from plant wastes.

The *Habilitation Thesis* ends with the "References" section, which includes a list of selected bibliographical references used in the preparation of this *Habilitation Thesis*.