Bundesamt
für Strahlenschutz

Spotlight on EMF Research

Spotlight on "Low Frequency Electromagnetic Field Induced Oxidative Stress in Lepidium sativum L." by Abyaneh et al. in Iranian J. Science and Technology (2018)

Category [low frequency, plant study]

Spotlight - Jun/2023 no.1 (Eng)

Competence Centre Electromagnetic Fields (KEMF)

1 Putting the paper into context by the BfS

Oxidative stress is often discussed as a possible mechanism of action for health effects that are mediated by Electromagnetic fields (EMF). The term oxidative stress describes an imbalance between the production of reactive oxygen species (ROS), and the cellular antioxidative defense system existing in biological systems from the human organism down to plant cells. ROS are naturally produced during cellular energy production or by immune cells for pathogen defense, but also functions as a signal transducer. The level of ROS is normally controlled by antioxidative mechanisms, e.g. antioxidative enzymes. In this context it is important to distinguish between physiological oxidative stress (Eustress) that is necessary for cellular processes and harmful oxidative stress (Distress) between which there is no clearly defined boundary [1].

2 Results and conclusions from the authors perspective

According to the authors, exposure to low frequency electromagnetic fields (LF-EMF) leads to abiotic stress in plants, which activates the cellular stress response. This stress could affect plant growth, metabolism and general development. To clarify the impact of LF- EMF on oxidative stress in plants, the authors analyzed how LF-EMF alters the antioxidant system of Lepidium sativum (Garden cress, a small edible herb).

Seeds from Lepidium sativum were either kept dry or soaked in distilled water for 7 or 14h and then exposed to a magnetic flux density of 3.8 mT at a frequency of 60 Hz for 30 min or 1h. The seeds were then kept in moist petri dishes for another 14 days without further exposition. For analysis, the leaves of these 14 days old plants were homogenized and the activity of antioxidant enzymes, the total antioxidant capacity and the level of lipid peroxidation was measured with a photo spectrometer.

Results showed that the activity of enzymatic antioxidants (superoxide dismutase, catalase and ascorbate peroxidase) as well as nonenzymatic antioxidants (flavonoid content, reducing power and total antioxidant capacity) increased in all treatments. This phenomenon was more pronounced when seeds were exposed to LF-EMF for 60 min. In addition, the amount of peroxidation of membrane lipids increased in all treatments.

The authors concluded that exposure to LF-EMF caused accumulation of ROS and alterations of enzyme activities, increased the amount of leaf lipid peroxidation and induced different levels of oxidative stress in L. sativum leaf cells.

3 Comments by the BfS

The underlying question of the study is of scientific interest and of relevance for radiation protection. Unfortunately, the study does not fulfill widely accepted criteria for good scientific practice that were summarized by the Cochrane review group [2]: the study does not provide positive (ionizing radiation, hydrogenperoxide etc.) and negative controls (radical scavengers, e.g. N-acetylcysteine) which are needed in order to classify the measured effect strength. As no information is given whether the experiments and their measurements were carried out in a blinded manner, bias cannot be ruled out. Instead of a sham-exposed control a non-exposed control is used. No information is provided how the LF-EMF exposure is measured and the exposure of 3.8 mT is very high, this corresponds to 19 times the reference value for power lines at 60 Hz, which is 200 µT (regulated by the 26. BImSchV in Germany). To determine the activity of antioxidant enzymes, lipid-peroxidation rate, reductive capacity and antioxidant capacity the authors used established photochemical assay systems in which the enzyme activity is determined by an activity-dependent color change, which is read out by a photometer. Technically, the used methods are adequate to determine enzyme activity, but inappropriate to measure oxidative stress. Antioxidant enzymes often increase in response to the production of electrophiles that activate the Nrf2 and KEAP1 transcription factors, which regulate antioxidant enzyme genes [1, 3]. Those same compounds (and there are thousands of them) are produced in metabolism or induced by environmental factors like UV-radiation, air pollutants etc [4, 5]. So, while oxidative stress can result in an increase in antioxidant enzymes, they are not a reliable indicator. Another problem is the delayed measurement of enzyme activity; this was only determined 14 days after exposure, so a vast number of factors may have influenced the expression and activity of the enzymes studied. Biological endpoints like antioxidative capacity or measurement of Malondialdehyde (MDA) are also not suitable to reliably determine oxidative stress, because for MDA there are too many non-oxidative stress related reactions that could cause lipid peroxidation, and antioxidative capacity is a very inaccurate endpoint in a biological context [6]. Based on the methods used the results of this study are not reliable and do not support the author's conclusion.

In the introduction as well as in the discussion of the study, the authors tend to cite studies that more or less confirm the results of their own study, whereas a large body of literature that found different results is ignored [7].

Overall, the paper at hand does not meet several established quality criteria of scientific practice. In addition, the methods chosen and the markers/endpoints examined are not suitable for answering the question and thus, this study is not providing a reliable contribution to the state of the art in this field.

References

The first reference is always the manuscript at hand and the reference in the curly braces at the end of a reference {xx} correspond to a reference in the manuscript at hand and is consistent with the manuscripts reference style.

[0] Abyaneh E et al. "Low Frequency Electromagnetic Field Induced Oxidative Stress in Lepidium sativum L." Iran J Sci Technol (2018); 1419-1426, doi:10.1007/s40995-016-0105-9

[1] Sies, H. and D.P. Jones, “Reactive oxygen species (ROS) as pleiotropic physiological signalling agents” Nat Rev Mol Cell Biol, 2020. 21(7): p. 363-383

[2] Ryan R, H.S., Prictor M, McKenzie J; “Cochrane Consumers and Communication and R. Group. Study Quality Guide” 2013 05/30/2013

[3] Cebula, M., E.E. Schmidt and E.S. Arner, “TrxR1 as a potent regulator of the Nrf2-Keap1 response system” Antioxid Redox Signal, 2015. 23(10): p. 823-53.

[4] Forman, H.J. and H. Zhang, “Targeting oxidative stress in disease: promise and limitations of antioxidant therapy” Nat Rev Drug Discov, 2021. 20(9): p. 689-709.

[5] Xie, X., Z. He, N. Chen, Z. Tang, Q. Wang and Y. Cai, “The Roles of Environmental Factors in Regulation of Oxidative Stress in Plant” Biomed Res Int, 2019. 2019: p. 9732325.

[6] Henschenmacher B et al., “The effect of radiofrequency electromagnetic fields (RF-EMF) on biomarkers of oxidative stress in vivo and in vitro: A protocol for a systematic review” Environ Int, 2022. 158: p. 106932.

[7] Schuermann, D. and M. Mevissen, “Manmade Electromagnetic Fields and Oxidative Stress-Biological Effects and Consequences for Health” Int J Mol Sci, 2021. 22(7).

Impressum

Bundesamt für Strahlenschutz
Postfach 10 01 49
38201 Salzgitter

Tel.: +49 30 18333-0
Fax: +49 30 18333-1885
E-Mail: spotlight@bfs.de
De-Mail: epost@bfs.de-mail.de

www.bfs.de

Bitte beziehen Sie sich beim Zitieren dieses Dokumentes immer auf folgende URN:
urn:nbn:de:0221-2023060938305

Spotlight - Jun/2023 no.1 (Eng)