RADIOFREQUENCY WAVE EFFECTS ON DNA AND RNA LEVELS IN SOME ANIMAL TISSUES*

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The electromagnetic stress generated by radiofrequency waves either from natural or artificial sources on the fresh food of animal origin was studied. Various tissue samples were irradiated using specialized laboratory device which is basically a wave guide for the radiofrequency transverse waves with a power density of 0.6 mW/cm² and the frequency of 418 MHz. The extraction of DNA and respectively RNA biomolecules was carried out in adequate selective solvents, their levels being assayed by means of light absorption in ultraviolet range. Slight influences were evidenced following acute exposures of different time durations: 1–2–4–8–16 hours. The main result is regarding the overlapping of the disruptive effect of radiation absorption in the living cell and the cell ability of recover part of the damages induced by radiation.

Key words: electromagnetic exposure, lung, liver, muscle, spectrophotometric assay, DNA and RNA.

1. INTRODUCTION

The industrial era means not only benefic effects of electricity and magnetism but also putative electromagnetic pollution of the environment. Various RADAR devices so useful in the control of terrestrial, maritime, atmospheric and cosmic traffic are, in the same time, widely spread but insufficiently studied sources of radiofrequency electromagnetic waves. The experimental investigation presented in the next was designed as a simulated accidentally over-exposure of fresh food of animal origin, i.e. acute irradiations were carried out in controlled environmental conditions. The references data provided independently by Kakita [1] and Lai and Sing [2–3] suggested that DNA molecules can be broken down during microwave exposure even if the photon energy of microwave radiation is million times lower than that required to break chemical bonds. Though geneticists are interested more in qualitative changes of DNA and RNA molecules the


quantitative assay of the nucleic acid levels are useful in the understanding of radiation biological effects.

2. MATERIALS AND METHODS

THE BIOLOGICAL SAMPLE EXPOSURE

Tissues freshly extracted from the body and provided by the same animal (pork) were cut to adequate dimensions. The specimens were placed in Petri dish situated in the area with uniform electromagnetic field and energy distribution within a transverse electromagnetic cell (TEM) having adequate calculated dimensions [4]. The TEM device, built in aluminum, has the dimensions: $a = 715$ mm, $b = 340$ mm, $w = 450$ mm, where $a$ – the length, $b$ – the height of the rectangular area, $w$ – the septum length, that were calculated to assure the characteristic impedance. This way a rectangular coaxial wave guide was obtained that was connected to the power generator through adequate bi-directional cable so that the transverse propagation mode is the dominant. The frequency was of 418 MHz while the power density was of 0.6 mW/cm$^2$. The acute exposure time durations were: 1–2–4–8–16 hours.

NUCLEIC ACID ASSAY

The levels of DNA and RNA were measured separately in the supernatant and respectively the pellet obtained during selective extraction procedure (in solvent mixtures of perchloric acid 6%, ethanol, chloroform and ether) on the basis of light extinction values in the ultraviolet range: at 270 nm for RNA and 290 nm for DNA (basically the Spirin method) [5–6]. Carl Zeiss–Jena VSU 2 P spectrophotometer with quartz cells was utilized for spectral quantitative assay. Five repetitions of the experiment were carried out in order to ensure statistical significance (by applying t-test, pair typed, two tailed) considering the significance criterion of 0.05 and 0.01.

3. RESULTS AND DISCUSSIONS

In Figs. 1–3 the data resulted from repeated spectrophometric assay are given.

The general tendency of DNA diminution was shaped using the 3-D mathematical approaches of the actual experimental data. For some irradiation time durations the RNA content was found also diminished. The interpretation of the diminished nucleic acid levels might be related mainly to the disruptive effect
Radiofrequency wave effects on DNA and RNA levels

Fig. 1 – 3-D representation of DNA and RNA contents in muscle irradiated tissue; x represents the exposure time (hours) while z is the nucleic acid content (mg/g).

Fig. 2 – The 3-D representation of DNA and RNA contents in irradiated liver tissue; x represents the exposure time (hours) while z is the nucleic acid content (mg/g).

of radiofrequency (RF) radiation upon the nucleic acid molecules as well as on the inhibitory effect of the electromagnetic exposure on the nucleic acid biosynthesis.

In some exposed samples it seems that the living cells were still able to recover some of the damages induced following the exposure to radiation; more, possible mechanisms of biosynthesis stimulation could be activated resulting in the recovering of the lost molecules so that the nucleic acid levels we measured appeared relatively enhanced.

In Figs. 4 and 5 the averaged data resulted from five assays carried out on the same exposed tissue can be seen.
Fig. 3 – The 3-D representation of DNA and RNA contents in irradiated lung tissue; x represents the exposure time (hours) while z is the nucleic acid content (mg/g).

Fig. 4 – Averaged DNA values in muscle, liver, lung samples exposed to RF waves.

For all RF exposed samples the average value was divided by that of the control, non-exposed sample so that for zero exposure time the reference value is equal to the unit.

One can see that the DNA content (Fig. 4) was generally diminished (with statistical significance of 0.05 except the long exposure time of 8 and 16 hours where non significant variations were noticed). Standard deviations ranged between 6.0 and 9.2%. However no precise correlation in dependence on the
exposure time could be revealed. In the case of RNA average values some distinct enhancements (more than twice with statistic significance of 0.01) could be remarked in the muscle tissue samples corresponding to small-medium exposure times (such results being not surprisingly is the analogy to the ionizing radiation [7] is considered – where small radiation doses are known to have some stimulatory effects). The peculiarities of each tissue type (water content, lipid content, metabolism level etc.) might be very important during the radiation exposure. In the present case the muscle tissue is characterized by the highest water content, which could have similar significance as in the case of ionizing radiation were the indirect radiation effects are favored by the presence of water molecules.

4. CONCLUSIONS

The acute exposure to radiofrequency electromagnetic waves might affect the nucleic acid level in some animal tissues freshly withdrawn from the body indicating that fresh food of animal origin still can be affected. Though the direct absorption of electromagnetic energy in the radiofrequency range can not break down chemical bonds however complex synergic phenomena might be triggered and finally result in the molecules damage. The living cells can recover some of the damages due to adaptation mechanisms consisting in the metabolism intensification and consequently biosynthesis stimulation. This study can be useful in the frame of the electromagnetic pollution issues so that further experimental project is going to be developed based on the study of enzymes controlling the free radicals production following the irradiation.
REFERENCES