Considerations of Electromagnetic Radiation Absorption (ELF and Lower HF Band Frequencies) by Bone marrow

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Abstract: The aim of this research work is investigation of the absorption of electromagnetic waves in frequencies of ELF and lower part of HF Band by bone marrow of adult male Wistar rats. The selected frequencies were 100 Hz, 500 Hz, 1 KHz and 1 MHz .For this purpose, rats were divided into three groups: control group, first and second experimental groups. The control groups did not expose to electromagnetic radiation at all. The first experimental group were exposed to electromagnetic radiation for 30 minutes and the second experimental group were exposed to electromagnetic radiation for 60 minutes .At the end, this three groups were sacrificed and the bone marrow of their femur were removed. The bone marrow mixed with phosphate buffer, then their spectrum were taken in region about 200-800 nm wave length .This research work showed that relative absorption rate of electromagnetic radiation by bone marrow of rats are maximum in frequency of 500 Hz where as there was no absorption in 100 Hz frequency. The cell mutation in this frequency was studied in another paper.
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Introduction

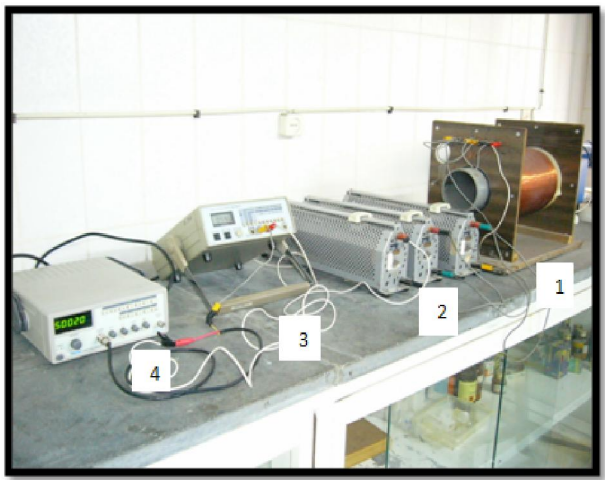
Exposure to electromagnetic fields is inevitable. These waves are produced by many natural and man-made sources [1]. Increased usage of electromagnetic principles for domestic and industrial purposes proves that EMF plays an important role in our daily life [2]. Although the electronic devices and communications have made human life easier, but also they have detrimental effects. The discussion about the negative effects of electromagnetic radiation on biological life, began in the 19th century since the discovery of electricity [3]. So that many studies have been conducted to evaluate the possible side effects of electromagnetic fields on humans and other organisms. Appearance of EMF effects on human being depend on age and health condition while the healthy adults people have the least sensitive refer to electromagnetic radiation, the fetus children and people who have mental or physical hidden disorders will experience significant impacts [4]. Some observations suggest also that electromagnetic radiation had the effect on living organisms and affected tissue function and biochemical, biophysical and physiological processes in their cell and ultimately cause the various diseases such as childhood leukemia, brain tumors, immunodeficiency and allergic in DNA somatic cells and atlast injury can lead to cancer development or cell death and in cells in other hand leads to mutations and transferring into malformation generations .To study the effects of electromagnetic waves on the genetic content of cells are including the important research fields that in recent years has been taken into consideration [5]. The cellular and molecular changes induced by these waves depend on the duration of the radiations, its permeability in tissue and generate heat in body that these factors are also related to the intensity and frequency of the waves. Cell responses also vary according to characteristics of waves such as wave form (sinusoidal or square) rate of their changes, biological effects and types of cells that are exposed to the radiation [6]. Usually, cellular damage is repaired through a natural process; however, if it is not adequately repaired, it may result in a viable but modified cell. After a prolonged and variable latency period, reproduction of a modified somatic cell may result in the appearance of a cancer [7]. The first observations on the association between exposure to magnetic fields and cancer were conducted in 1979 by Wertheimer and Leeper. They showed a possible relationship between electrical power lines and childhood cancer [3, 8]. So that in 2002, the International Agency on Research on Cancer (IARC) published a monograph on the evaluation of carcinogenic risks of static and ELF electric and magnetic fields to humans that ELF magnetic fields were classified into «2B» (possibly carcinogenic to humans) [9, 10,11,12]. Also, ELF electric fields were grouped into «3» (is not classifiable as to its carcinogenicity to humans) [10].

Human exposure to Extremely Low Frequency(ELF) Electro Magnetic Fields(EMF) has risen dramatically this century because of our increasing use of electricity, giving rise to concerns about the effects of long-term exposures. As we know, sources of radiation may be taken into the body by inhalation or ingestion and some forms of electromagnetic radiation can penetrate into the skin to reach other organs of the body [7]. So far, several studies have been reported concerning the effect of EMF on the hematopoietic organs. The bone marrow is the major hematopoietic tissues in adult mammals, which produces all of grainy erythrocytes, platelets and leukocytes [13]. In this study, we have examined ELF and HF wave absorption by the bone marrow.

Materials and methods

This research was done on 9 adult male Wistar rats which weighing 260 gr that were purchased from Mashhad Razi Institute. Rats were kept in plastic cage for one week to bring them under control to the new environmental conditions with adequate access to food and water. Cage also cleaned regularly. Electromagnetic waves used in this research selected 100 Hz, 500 Hz, 1 KHz and 1 MHz respectively. To generate these waves our circuit devices included coils, 3 rheostat (variable resistor), ammeter and signal generator (Figure 1).

Fig- 1. The electromagnetic field generating devices



consisted of 1- coils, 2- rheostat, 3- ammeter and4- signal generator .

After one week, rats were divided randomly into three groups: control group, experimental groups 1 and 2 respectively. Control group rats were not exposed to electromagnetic waves radiation. Experimental 1 involve the rats that exposed to EMF radiation about 30 min and experimental 2 included the rats that were exposed for 60 min under 100 Hz, 500 Hz, 1KHz and 1MHz radiation respectively .Finally all rats femoral bone marrow were removed with syringe and were poured into the special cell with 50 ml phosphate buffer (pH=7.4) for determination the amount of bone marrow electromagnetic waves absorption, cell were placed inside the spectrometer model V-630 that works ranging from 200nm to 800 nm.

Results

The results from relative absorption spectrum of rat bone marrow in presence of electromagnetic field are shown in Figs -2 to 13.

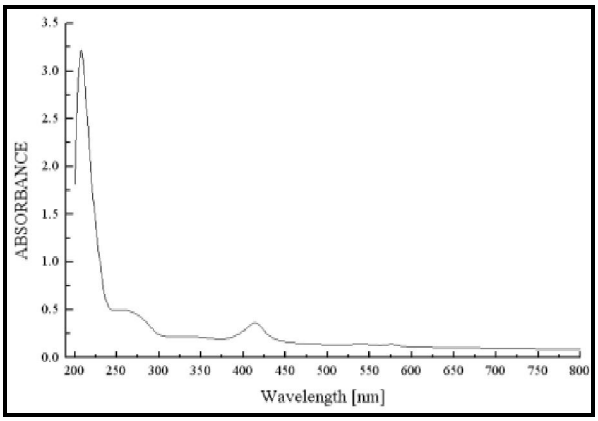


Fig-2 .Relative absorption spectrum of rat bone marrow in the absence of electromagnetic field

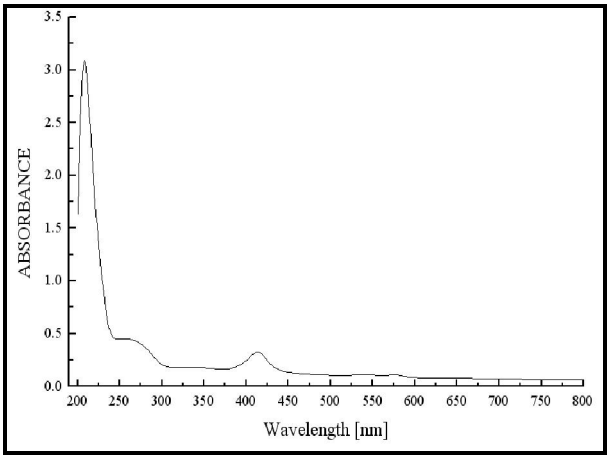


Fig-3. Relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 100 Hz after 30 min radiation exposure.

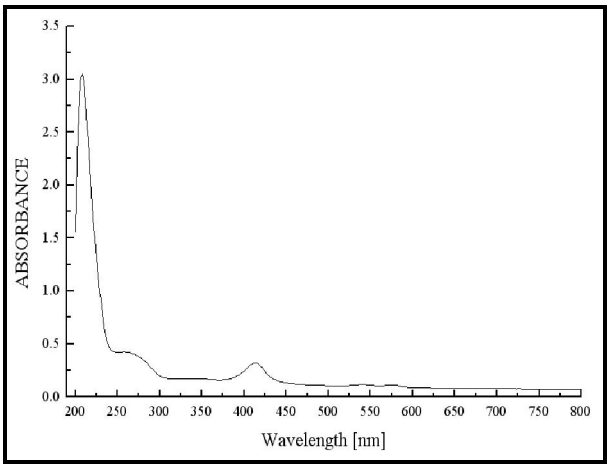


Fig-4. Relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 100 Hz after60 min radiation exposure.

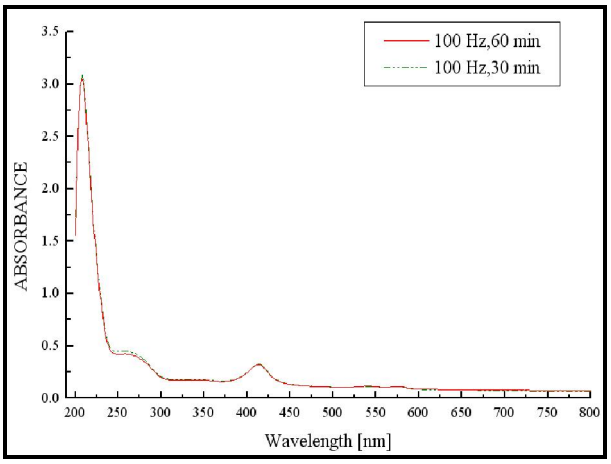


Fig-5. Comparison of the relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 100 Hz after 30 min and 60 min radiation exposure respectively.

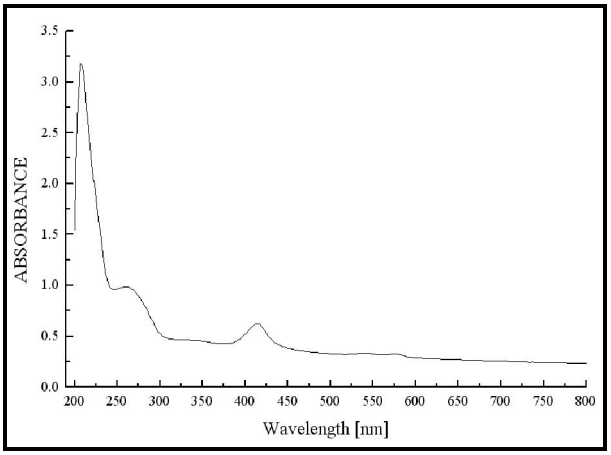


Fig-6. Relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 500 Hz after 30 min radiation exposure.

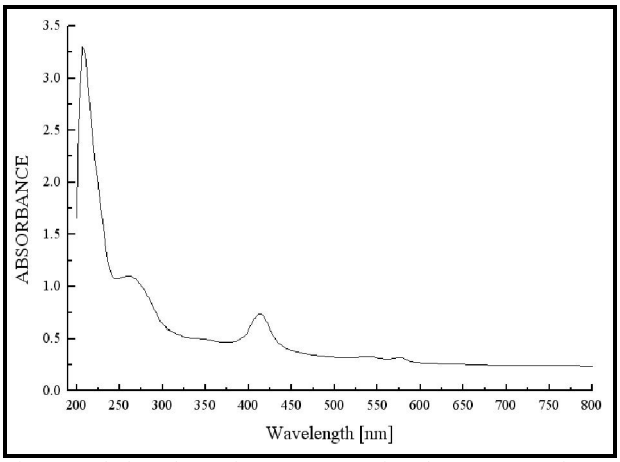


Fig-7. Relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 500 Hz after 60 min radiation exposure

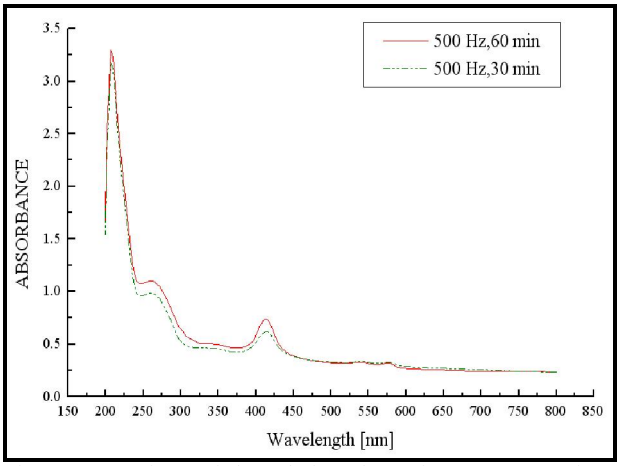


Fig-8. Comparison of the relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 500 Hz after 30 min and 60 min irradiation

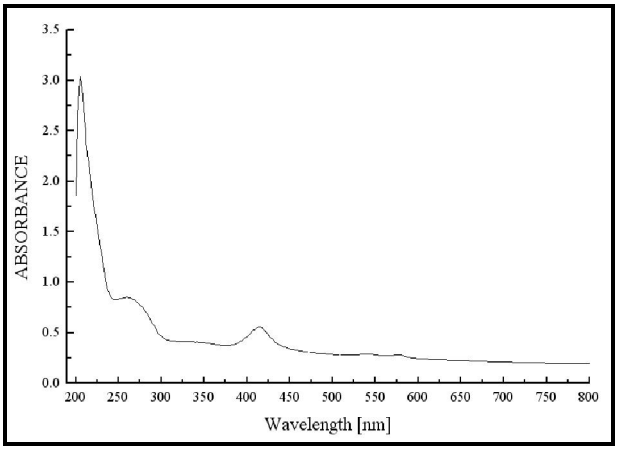


Fig-9. Relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 1 KHz after 30 min radiation exposure.

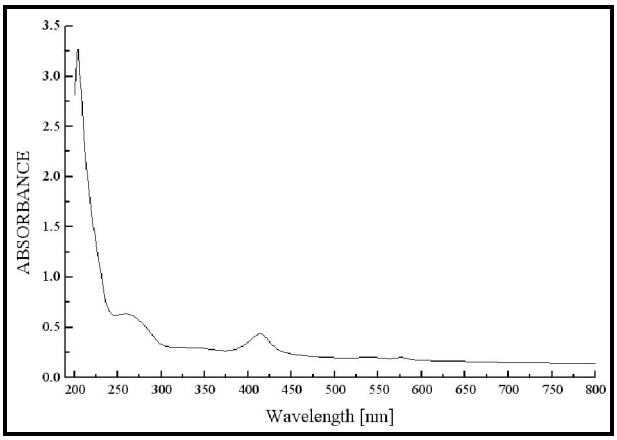


Fig -10. Relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 1 KHz after 60 min radiation exposure

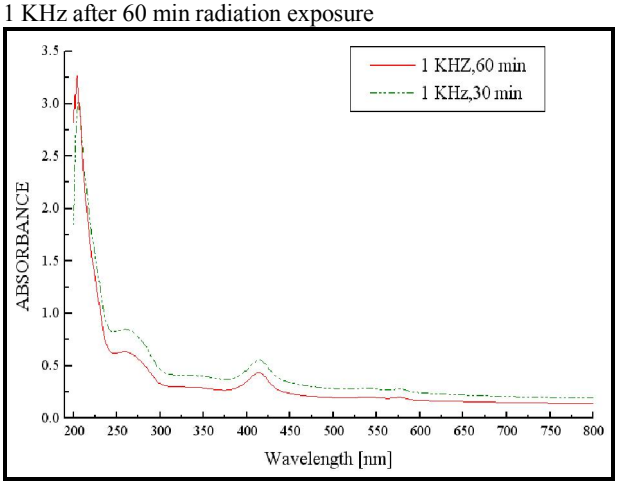


Fig-11. Comparison of the relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 1 KHz after 30 min and 60 min irradiation

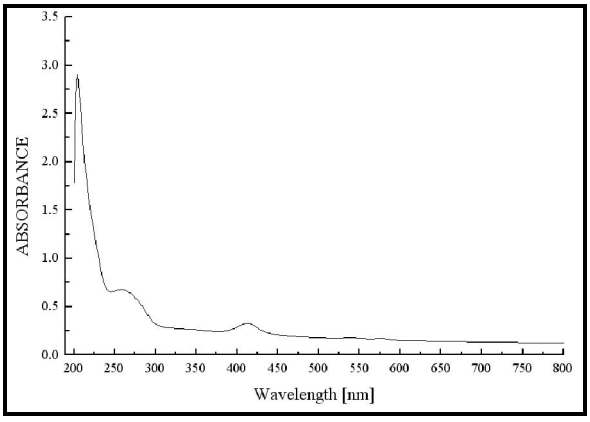


Fig-12. Relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 1MHz after 30 min radiation exposure.

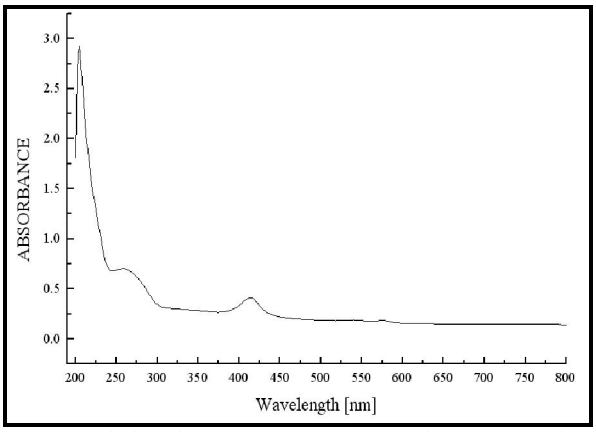


Fig-13. Relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 1MHz after 60 min radiation exposure.

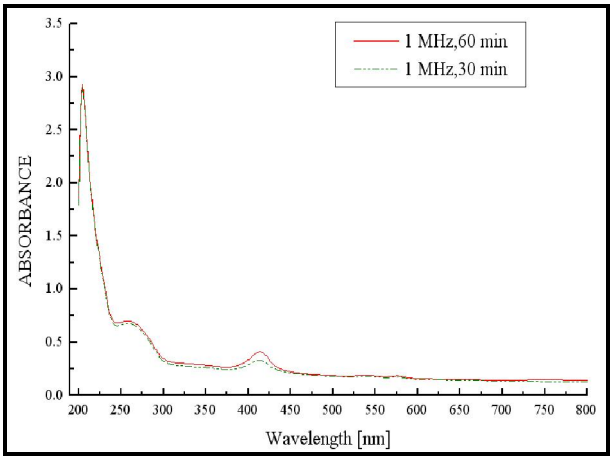


Fig-14. Comparison of the relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 1MHz after 30 min and 60 min irradiation.

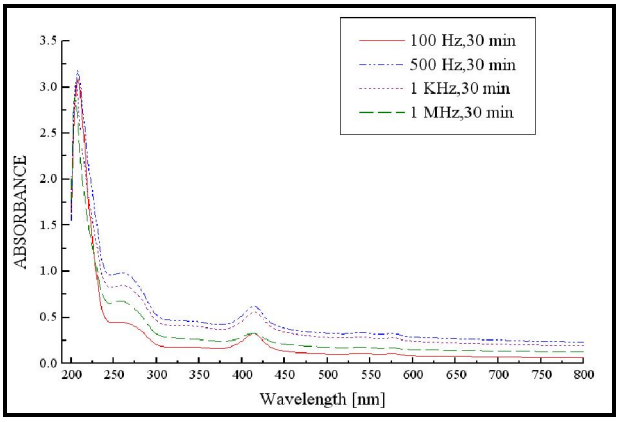


Fig-15. Comparison of the relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 100 Hz, 500 Hz, 1 KHz and 1 MHz after 30 min irradiation.

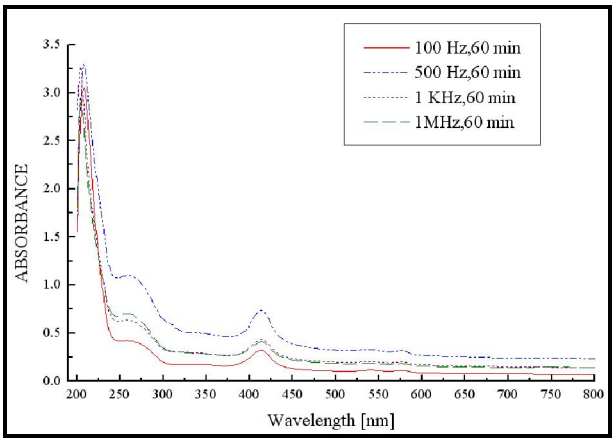


Fig-16. Comparison of the relative absorption spectrum of rat bone marrow in the presence of electromagnetic field with a frequency of 100 Hz, 500 Hz, 1 KHz and 1 MHz after 60 min irradiation.

Discussion

Numerous reports have been published concerning the effects of low frequency electromagnetic fields on biological systems and human health [5].Electromagnetic fields created thermal and non thermal effects which can either have detrimental effects on the molecular and cellular levels [14]. Studies shown that electromagnetic fields due to changing the performance or cells function steps, induced various responses in living organisms that can be noted to effect on cell proliferation and differentiation, impairment in cell cycle, induction of programmed cell death, disruption in communication between cells, gene expression and increased incidence of damage to produce free radicals [6]. Several studies also on human peripheral blood lymphocytes and mammalian cells have shown that, electromagnetic waves with induced oxidative stress and species free radicals reactive oxygen causing antioxidant system defect of body and increase genotoxic effects, such as aneuploidy and chromosomal instability in the DNA. Induced micronucleus is one of the symptoms of chromosomal damage that today, is used as a simple and sensitive buandykatur for the detection of chromosomal damage in short-term laboratory research [5]. It been shown also that, osteo genesis gene expression level in rats bone marrow mesenchymal stem cells changes after exposure to electromagnetic fields [15].

Demsia et al in reviews of male and female rats bone marrow under intermittent 910 MHz frequency found that, in irradiated male rats, an almost threefold induction of micronuclei in bone marrow immature erythrocytes, while in females, the induction of micronuclei was almost two and half times higher compared to control animals [16]. Rageh et al studied on bone marrow cells of newborn rats on 50 Hz magnetic field showed a significant increase in formation of cause a polychromatic erythrocytes (PCE) and micronucleated polychromatic erythrocytes (MNPCE) for exposed group compared to control one and the result of the mitotic index (MI) this in turn showed that MI of bone marrow cells exposed to ELF-MF was increased significantly compared to control one. It also lead to cytogenic and genotoxic hazards and showed that exposure of newborn rats can induce serious DNA damage that may lead to genomic instability, leading to carcinogenesis [17]. Baharara et al showed 50 HZ frequency, increases the polychromatic erythrocyte micronucleus frequency of bone marrow in Balb/C mice treated with waves [18]. Udroiu et al conducted a micronucleus test on the liver and peripheral blood samples from newborn mice that were exposed during uterine to 50 Hz magnetic field and also Blood and bone marrow of adult mice that were exposed to the same field at the same time. They found an increase in frequency of micronucleus in newborn mice. Moreover, there was no significant effect of irradiation in adults [8]. As can be seen, the result obtained are contradictory and comparison between them is difficult, because of the many differences in exposure parameters (periodicity of the exposure, flux intensity and endpoint investigated) [8, 17].

In this study, the sample was adult rats, which is the closest animals to humans and we mostly examined extremely low frequency (ELF) waves that often we are exposed to it at home through home appliances and the electricity in uses. The study was conducted on one of the hematopoietic system of the body namely bone marrow and evaluated wave absorption by bone marrow and comparison was done between irradiated and not irradiated bone marrow. The absorption rate and penetration of electromagnetic radiation energy depended mostly on theEMF frequency, type of radiation and the type of tissue that absorbs [6]. Energy absorbed by tissue produces reactive chemicals called free radicals, which can induce other chemical changes and ultimately biological effects [7]. Review of resulting spectrums implies that, there is acceptable absorption in examined frequency by bone marrow in the visible region of the EMF.

This peak has appeared in 414 nm in frequency 100 Hz after 30 min exposure and 60 min exposure . According to Fig-5, in both experimental groups 1 and 2 absorption is not observed at this frequency because the peak obtained from this Fig is located below the peak in Fig-2 1, which is related to control group. Also by increasing the time of exposure peak will slip to lower level.

In 500 Hz, after 30 min and 60 min irradiation, the peak is observed in 414 nm. At this frequency, as can be seen in Fig-8, there was a significant absorption both in 1 and 2 experimental groups so that, by increasing the time of exposure, the absorption rate of the radiation is also increased.

In 1 KHz, after 30 min irradiation, the peak of radiation absorption can be observed in 415 nm while, after 60 min irradiation, this peak could be observed in 414 nm. At this frequency, as we see in Fig-11, the obtained peak from the 1 experimental group is located higher than that of the second experimental group. in 1 MHz frequency, the absorbed radiation peak is seen after 30 min irradiation in 413 nm and after 60 min irradiation in 414 nm. As can be seen in Fig-14, Peak of radiation absorption obtained from experimental group 1 is lower than that the obtained from the control group and the absorbed peak value resulting from second experimental group is higher than that of the control group where, in both cases we observed a decrease in peak of the absorbed radiation height.

As can be seen in Fig-14 and 16, the 500 Hz frequency has a maximum absorption in both first and second experimental groups, because it has the highest radiation absorption among the tested frequencies.

Conclusion Remarks

The results of this study indicated that:
In almost all Figs, significant absorption was observed in the visible range about nm 414. In the examined (100 Hz, 500 Hz, 1 KHz, 1 MHz)frequencies significant absorption are observed in 500 Hz frequency so that with increased time of exposure of this frequency the greater absorption is seen . Conversely, in 100 Hz frequency peak value of the absorption is located lower than that of the control group, therefore it could be concluded that absorption is observed at all in this frequency so that the resulting peak will be lower with increasing the time of exposure .

Therefore there are some notices from physicians to the people considering the using home devices working in these frequencies of the EMF in their everyday life necessarily some precautions should be taking under account along with the consumption of antioxidants such as E, C, A, vitamins and in daily diet [6] are recommended .

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