

The Influences of Electromagnetic Field Irradiated by High Voltage Transmission Lines with 50 Hz on the Features of Blood in Animals

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Abstract

The influences of electromagnetic field (EMF) of high voltage transmission lines (HVTL) with 50 Hz on the features of blood in the animals, including the biochemical indicators, routine index, refractive index and infrared absorption of the serum and adtevak as well as the features of hemoglobin molecules in it, are researched and measured extensively by using the biological- chemical methods, LQ-300 K automatic biochemistry analyzer, 670 Nicolet FT-IR spectrometers and Abbe refractometer, respectively. The results obtained showed the variations for the alanine aminotransferase (ALT), total protein (TP), albumin (ALB), total bilirubin (TB), direct bilirubin (DB), indirect bilirubin (IB), globulin (GLO), aspartate aminotransferase (AST), ratio of ALB with CLO (A/C), urea nitrogen (BUN), direct bilirubin (DB), globulin (GLO) as well as refractive index in the blood under the influences of the EMF, but their variations are differences, in which the variation of ALT is most significant ($P < 0.05$), the increase of number of white blood cells is also significant ($P < 0.01$). Thus we can affirm that the EMF of HVTL can vary the properties of the blood in rats. At the same time, we further elucidated the reasons or mechanisms of these change, for which we can say totally that they are due to the variations of the states and properties of the protein molecules, such as the hemoglobin, in blood. This conclusion can be verified by the experimental results in the infrared absorptions of the serum, adtevak and hemoglobin molecules, respectively. Therefore, our investigations manifested clearly that the EMF irradiated by HVTL can influence and vary the properties of the blood in rats; it has an obvious biological effect.

Keywords: Electromagnetic radiation; HVTL; Rat; Blood; Biochemical indicators; General index; Refractive index; Serum; Adtevak; Hemoglobin; Infrared spectrum of absorption; Feature

Introduction

As is known, there are now a large number of the electromagnetic fields (EMF) or waves (EMW) with different frequencies and strengths in our live environment. These electromagnetic-fields are generated and formed by the electromagnetic fields and waves irradiated by the high-voltage transmission lines (HVTL), different electrical appliances and radio equipments, in which but HVTL are main and basic source. As far as the electromagnetic irradiation of HVTL with 50 Hz, which is a transmission system of electric-current with high electric voltage in long-distance spaces, is concerned, it is very necessary to know its influences of the electromagnetic fields (EMF) on the person's health. In practice, this problem has been studied long times by many scientists, but its biological effects and features are not clear as yet, even though some results were obtained [1,2], but an united conclusion and corresponding mechanism of influence of EMF of HVTL on the health of human beings and animals have not revealed up to now, thereupon, we cannot judge the hazards to the hearth for EMF of HVTL. This lead to a long-time controversial to the hazards of EMF of HVTL in science world. This means that we must investigate deeply and widely the biological effects and properties of EMF of HVTL. In recent years a great number of experimental works were done [1-23]. For example, Li et al. [10-15] studied the influences of electromagnetic irradiation of HVTL on the cell proliferation, features of blood, the rheology properties and the electromagnetic properties of biological tissue as well as the features of molecular structure of myoglobin in the rats and mice. Zhang et al. [16,17] researched the expressions of matrix metalloproteinases, the tight junction proteins and the changes of the fluorescence spectrum of the serum in rats arising from the electromagnetic irradiation. Celik et al. [24] studied the influences of EMF of HVTL on hearth of the humans, Sert et al. [25] investigated the effects of chronic 50 Hz sinusoidal weak magnetic field on the pituitary hormones in the rats; Dasdag et al. [26] discussed the influences of microwaves and extremely low

frequency (ELF) magnetic fields on the phagocytic activity of variously macrophages in variously treated rats. Akdag et al. [27] debated the long-term effects of extremely low frequency (50 Hz) magnetic field and its affections of apoptosis, reproduction and oxidative stress, and so on. At the same time, the epidemiological investigations showed that EMF of HVTL is always harmful to the health of animals, men and women [3-15]. However, an exact and correct conclusion for the influences of EMF of HVTL on the hearth of human beings and animals has not been acquired up to now. We think that its reasons resulting in this state are that the correct and credible experimental methods and results have not been obtained on the one hand, the mechanism of influence of EMF of HVTL on the life activity has not revealed as yet on the other hand [1,2]. With the great increases and wide uses for the electrical appliances and instruments in industry, agriculture, medicine and everyday life, in which the strength of electric- currents of HVTL and the density of distribution of the transmission lines as well as their lengths are greatly increased in our live environments in present cases, thus, it is very necessary and urgent to study the really biological effect of EMF of HVTL. This implies that we must investigate carefully and in-depth the properties of biological effect of EMF of HVTL and its mechanism using some new ideas and new methods and techniques for having an insight into the changed features of cell and tissues after the actions of EMF or EMW of HVTL.

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It is well known that the bloods and corresponding blood vessels are the basic configurations and complicated structures in the animals and human beings, in which they have also undertaken the important responsibilities of the absorption and importation of nutrition matters and oxygen atoms absorbed from *in vitro* for the growth of human beings and animals as well as the exclusion of the cost objects and carbon dioxide from *in vivo* for finishing the normal metabolism of life-bodies. Just so, whole life-bodies can grow normally and finish all normal bio-functions and activities of self-duplication, self-assemblage, self-coordination and self-renovation. Therefore, the blood in the life-bodies plays key and important functions in life-bodies and life-activities. Thus it is quite necessary to investigate in detail the changes of feature of blood arising from the EMF irradiated by HVTL and its properties.

In this paper we will research the influences of electromagnetic irradiation of HVTL with 50 Hz on the features and properties of blood using a new method of the high-throughput screening. What is the so-called high-throughput screening technique? Simply speaking, we will study and inspect simultaneously the variations of biological properties in three levels of structure containing the total blood, the cell and molecules, which are contained in this blood, in the animals. We can determine the correctness of the biological effects, which are observed and obtained simultaneously from the variations of the three levels of structures in the animals under the long-time irradiation of electromagnetic-field of HVTL. In this experiment, these animals are exposed long times, instead of short times, in EMF of HVTL for acquiring a good and stable biological effect because we think that only if these properties are changed simultaneously in these cases, then we can confirm that the biological effects obtained are real, credible and available. In our experiment the times of irradiation of the experimental animals are designed as 400 days, instead of 20 days or 30 days. At the same time, our measurements of bio-property are also systematical and complete.

This new idea and method are established based on the properties of bio-tissues and electromagnetic irradiations of HVTL as well as their features of interactions. Why? As it is known that the interactions of electromagnetic irradiations of HVTL having the lower frequencies with blood or life-bodies are in a domain, instead of a point, this means that the interaction between them exist a process of transfer or transport in the blood. On the other hand, the blood possesses the generally biological properties of self-renewal, self-duplication, self-modulation and self-assembly. This confirm that the time of interaction of irradiations of HVTL with the blood must be quite long, or else their interaction is not sufficient and effect, thus its effects produced in this case are also instable or undetermined because the macroscopic biological-effects of blood arising from the EMF of HVTL are the results of the changes of structures and features of the biomolecules, biomacromolecules and cells in it. This property determines that we must inspect simultaneously the biological effects of biomolecules, cell and totally blood or else we cannot affirm the correctness of biological effects of the irradiations of HVTL, even through the features of one organization in them are changed. Therefore the new method is correct and can be used. Therefore we here will use this method to investigate the influences of EMF of HVTL on the properties of blood in the animals.

Experimental Materials

The following materials and devices are used in our experiments; their features are also described as follows.

670 Nicolet FT-IR spectrometers with a resolution of 4 cm⁻¹ made by Nicolet, USA, LQ-300 K automatic biochemistry analyzer made by Epson company, Abbe refractometer made by HyClone, Logan, UT, USA, general and cooled-frozen centrifuge machines with different speeds made by Sigma, USA, Olympus microscope made by Japan, the kits with different indexes made by Sigma, USA, ordinary centrifuge, frozen high-speed centrifuges made by North China pharmaceutical, Beijing in China, the pipettes, ammonium sulfate, anticoagulants (heparin) and reagents with different purities made by Sigma, USA, physiological saline, NaOH and HCl made by Chengdu Qian Bei Technology Co., LTD, 32 Wistar albino rats provided by National experimental laboratory of bred animals in west China College of Medical Science in Sichuan are used in this investigation.

In our experiments the exposure device for the experimental animals are composed of two parts, which are showed in Figures 1 and 2, respectively. They are linked all with the HVTL with 220 V and 50 Hz. In essence, Figure 1 is a parallel capacitor, which can produce the electric field of strength of 4000 V/m; Figure 2 is a Hemholtz coils with square, which can generate the magnetic field of strength of 0.1 G. The electric field of 4000V/m and magnetic field of 0.1 G are just the average strengths of electric and magnetic fields irradiated by HVTL with the voltage of 220 KV and 50 Hz at the height of 1.6-2.3 m distancing the earth plane in surrounding of HVTL, which were measured and obtained accurately and more time by us in Beijing and Chengdu, respectively.

Experimental Methods

The ways of exposures of experimental rats

In our experiments, 32 Wistar rats with the proliferated periods of six month, which are purchased from National Laboratory of animals in Sichuan University, are again bred about 4 weeks for adapting the environment and foods in our experimental laboratory. After 4th weeks they are divided into four groups, in which the male and female controlled as well as male and female experimental groups. Each group contains 8 Wistar rats. The two experimental groups are exposed in electromagnetic field irradiating by HVTL with 220 kV and 50 Hz about 400 days at 27°C, the experimental devices in Figures 1 and 2, which can generates the electric and magnetic fields of 4000 V/m and 0.09-0.1 G, respectively, they are the average values of electric and magnetic fields of HVTL with the voltage of 220 KV and 50 Hz. 32 Wistar rats are separated into four plastic boxes, 2 experimental groups and 2 controlled groups. The experimental rats are again placed in the experimental devices in Figures 1 and 2 to irradiate by the EMF of HVTL about 20 h each day, but each experimental group is, in practice, exposed only 10 h each day in one of two device in Figures 1 and 2, namely, two experimental groups are alternately exposed in electric and magnetic fields about 10 h each day. The two corresponding controlled groups are placed in the same laboratory having same environment conditions with the experimental group, but they have about 7 m distant with the experimental groups.

Measured method for the biochemical indexes and general indexes of bloods of 32 animals.

After the exposures of 400 days for 32 Wistar rats we extracted the blood of about 8-10 mL from the femoral artery. Subsequently, we extracted again the serums from these bloods using the centrifuge machine after 10 min of extracted blood without the anticoagulants. Where after, the anticoagulants are added into the serums to inspect and determine their counts of white blood cell and red blood cell as

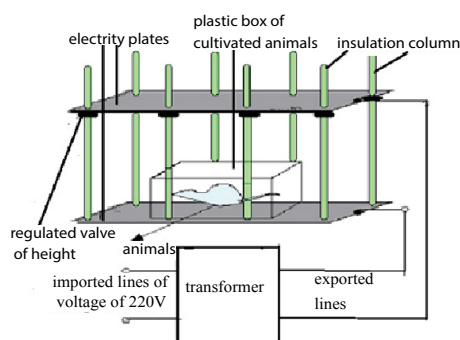


Figure 1: The exposed device of the electric field irradiated by HVTL in the animal experiment.

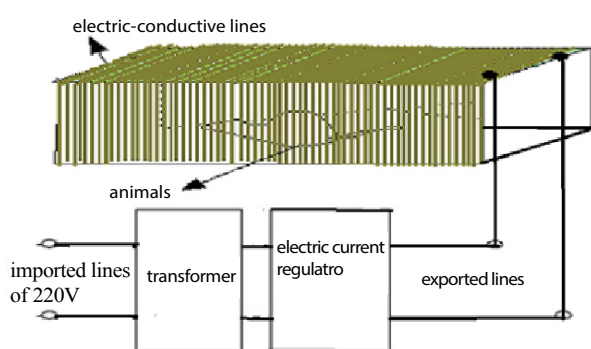


Figure 2: The exposed device of the magnetic field irradiated by HVTL in the animal experiment.

well as the content of the hemoglobin in bloods in the experimental and controlled groups using the Olympus microscope and colorimetric method, respectively [27-30]. In the meanwhile, to use the LQ-300 K automatic biochemistry analyzer to measure and determine the biochemical indexes of the serum, liver and kidney, respectively. At the same time, we measured also the infrared spectra of the blood, the serum and the adtevak in the region of 400-4000 cm^{-1} using 670 Nicolet FT-IR spectrometers with a resolution of 4 cm^{-1} , in which the above bio-samples are first injected into the liquid bath of ZnSe in this spectrometer the measured values of the experiments are obtained from an average values for the data of 64 scanning.

The refractive indexes of the serum and adtevak are inspected and determined by Abbe refractometer, in which the supernatants extracted from the adtevak or bloods are first diluted as the half-translucent liquid by the physiological saline, which are just used in our experimental measurements and inspections.

The above measured data are further processed with SPSS software and using t test.

Experimental Results

The Influences of EMF irradiated by HVTL on the biochemical indexes and general indexes of bloods in animals

The variations of the biochemical indexes and general indexes of bloods extracted from these rats in controlled and experimental groups under the influences of the EMF irradiated by HVTL, which

are obtained by the LQ-300 K automatic biochemistry analyzer, are shown in Table 1. This table indicated that the chemical indexes of the bloods occur all some variations with different degree under the actions of EMF of HVTL through the comparisons between the experimental and controlled groups, although the changes of some indexes are very small, in which but the variation of ALT is quite obvious ($P < 0.05$).

On the other hand, the e variations of the general indexes of bloods in rats arising from EMF irradiated by HVTL are exhibited in Table 2. Quite clearly, the changes of white blood cell are very obvious.

The Influences of EMF irradiated by HVTL on the refractive indexes and dielectric constants of the serum in animals

We used the Abbe refractometer to measure the changes of the refractive indexes of the serum arising from EMF irradiated by HVTL. Its results are exhibited in Table 3, in which we gave the values of refractive indexes of serum for 16 rats in the experimental and controlled groups. From these results we find out the average values of refractive indexes, which are $n=1.3353$ for the experimental group, but $n=1.3361$ for controlled group, thus we can also found out and give the dielectric constant of the serum from the above values of the refractive indexes through the relation of $\epsilon=n^2$, in this case where the magnetic permeability $\mu=1$, then they are $\epsilon=1.7852$ for the experimental group and $\epsilon=1.7830$ for controlled group. The above results tell us that the refractive indexes and the dielectric constant of serum are increased under the influences of EMF irradiated by HVTL, although their changes are very small. Therefore we can conclude that EMF irradiated by HVTL can affect and vary the refractive indexes and the dielectric constant of serum or blood in the living systems.

Discussion

However, what are the reasons resulting in the above variations in biochemical indexes, general indexes, refractive indexes and dielectric constants of bloods? In order to respond and reveal the essences and mechanisms of these variations we should study and measure deeply the infrared spectra of protein molecules in serum, adtevak and hemoglobin by Nicolet FT-IR 670 spectrometer because these infrared spectra can have insight into the features of the structures of biomolecules and their changes in the bloods and bio-tissues [31-35].

Infrared absorption of book, serum and adtevak and their properties

Figures 3 and 4 showed the comparison results of infrared spectra of absorption for the adtevak in 4000~1500 cm^{-1} between the experimental and controlled groups. Figure 3 indicates only the peak at 1652 cm^{-1} occurs, but two peaks at 1669 cm^{-1} and 1632 cm^{-1} eliminate in the experimental group, but they are contrary in controlled group. Figure 4 showed the results of comparison for the second derivative of Fourier transform infrared spectra of the adtevak in 1200~1800 cm^{-1} between the experimental and controlled groups. They exhibited clearly the results of the experimental group are different from those of controlled group in both the intensity and positions of the absorbed peaks.

According to the theory of molecular biology the peak 3133 cm^{-1} corresponds the stretching vibrations of biological macromolecules such as nucleic acid, C-H bond in $\nu_s\text{CH}_2$, $\nu_{as}\text{CH}_2$ and $\nu_{as}\text{CH}_3$ in the nucleic acids, proteins and lipids [36,37]; the peaks at 1537 cm^{-1} and 1652 cm^{-1} and 1669 cm^{-1} correspond to the vibrations of amide-I and amide-II (C=O) bond in protein molecules [38-40]. Their variations in Figure 3 indicated clearly that the structure and states of the

	ALT (U/L)	HB	AST (U/L)	TP (g/L)	ALB (g/L)	TB (μmol/L)	DB (μmol/L)
EG	108 ± 39	15 ± 1.9	345 ± 106	60.4 ± 5.1	28.3 ± 1.7	9.7 ± 4.2	4.1 ± 1.8
CG	67.5 ± 30	15 ± 1.4	273 ± 143	59.3 ± 6.2	24.6 ± 10	8.5 ± 3.2	3.31 ± 1.1
	WBC (10 ⁹ /mm ³)	RBC (10 ⁹ /mm ³)	IB (μmol/L)	CLO (g/L)	A/C	BUN (mmol/L)	creatinine (μmol/L)
EG	7.025 ± 1.373	6.58 ± 1.32	5.5 ± 2.5	32.1 ± 3.5	0.88 ± 0.05	6.90 ± 2.8	73.5 ± 11.1
CG	10.50 ± 1.18	5.95 ± 0.86	5.21 ± 2.1	34.7 ± 11.2	0.81 ± 0.33	6.08 ± 3.9	70.2 ± 14.6

Where "EG" denotes the experimental group, "CG" denotes the controlled group

Table 1: The influences of EMF irradiated by HVTL on the biochemical indexes of bloods in rats.

	White blood cell (*10 ⁹ /mm ³)★	Red blood cell (*10 ⁹ /mm ³)	Hemoglobin (g/100 ml)
CQ.	7.025 ± 1.373	6.58 ± 1.32	15.2 ± 1.9
EQ	10.50 ± 1.18	5.95 ± 0.86	15.0 ± 1.4

Where ● P<0.05, ★P<0.01

Table 2: The variations of the general indexes of bloods in rats arising from EMF of HVTL.

Rated group	The measured value of each rat in 8 rats							
	1	2	3	4	5	6	7	8
EG	1.335	1.3382	1.3357	1.3356	1.3354	1.336	1.3355	1.3374
CG	1.3355	1.3361	1.3352	1.3355	1.3348	1.3357	1.3351	1.3346

Where "EG" denotes the experimental group, "CG" denotes the controlled group

Table 3: The Influences of EMF irradiated by HVTL on the refractive index, n, of serum in rats.

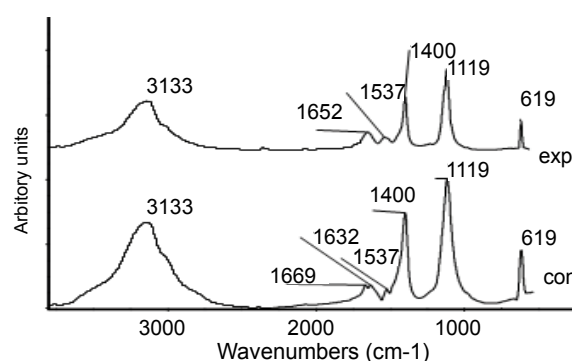


Figure 3: The comparison of infrared spectra of absorption for the adtevak in 4000~1500 cm⁻¹ between the experimental (exp) and controlled (con) groups.

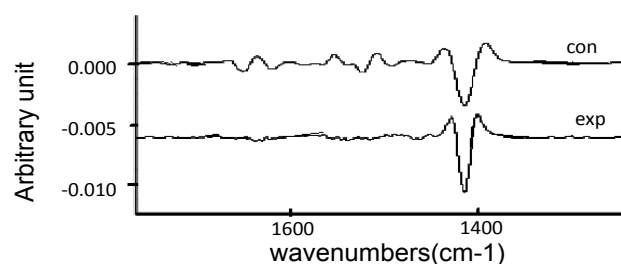


Figure 4: The results of comparison for the second derivative infrared spectra of the adtevak in 1200~1800 cm⁻¹ between the experimental (exp) and controlled (con) groups.

protein molecules in bloods are changed under the influences of EMF irradiated by HVTL.

Due to second derivative infrared spectra can distinguish and identify the overlapped peaks in the infrared spectra and small shoulder peak on the strong peak, thus some unobvious structure information in the infrared spectrum can appear and be exhibited in this case. Therefore, Figure 4 showed clearly the differences of intensity and

positions of peaks between the experimental and controlled groups. Therefore we can determinate from these results in Figures 3 and 4 that EMF irradiated by HVTL change the molecular structures in the adtevak at different degree.

We measured also infrared spectrum in the serum and blood of the rats in the experimental and controlled groups by Nicolet FT-IR 670 spectrometer. Their results are shown in Figures 5 and 6, respectively,

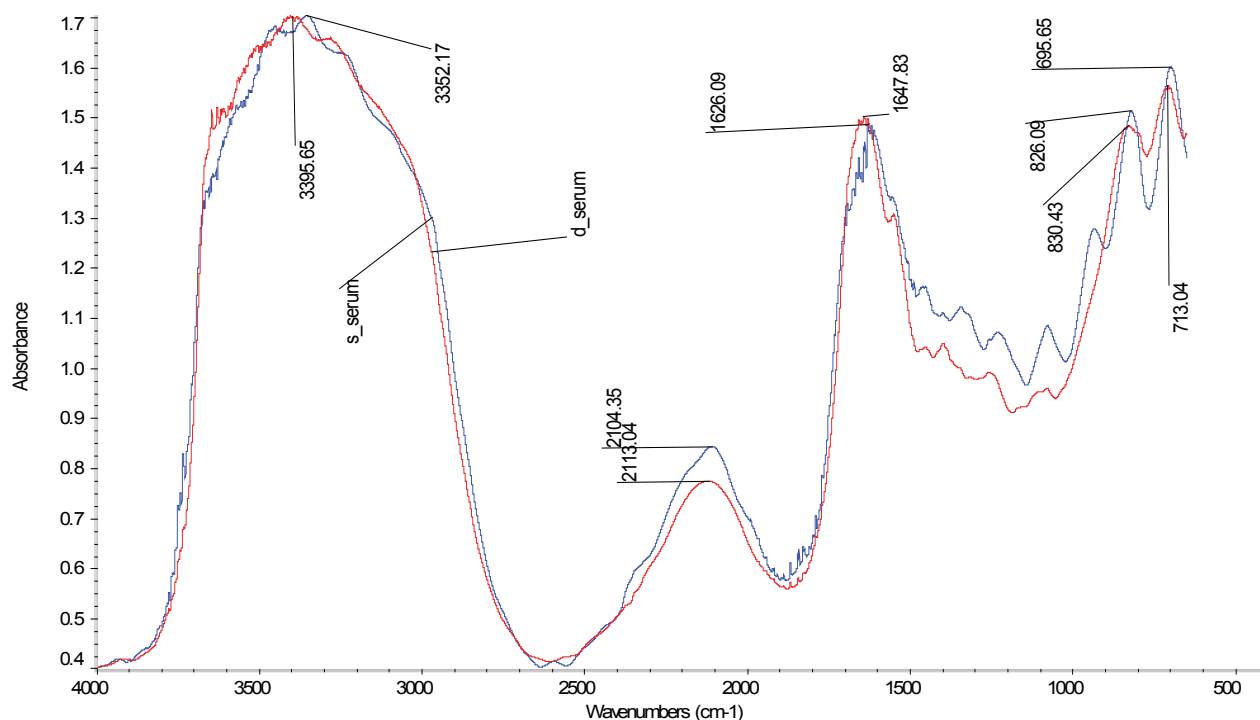


Figure 5: The infrared spectra of the serum in the experimental and controlled groups, where s-blood denotes the results of experimental group, d-blood is the values of controlled group.

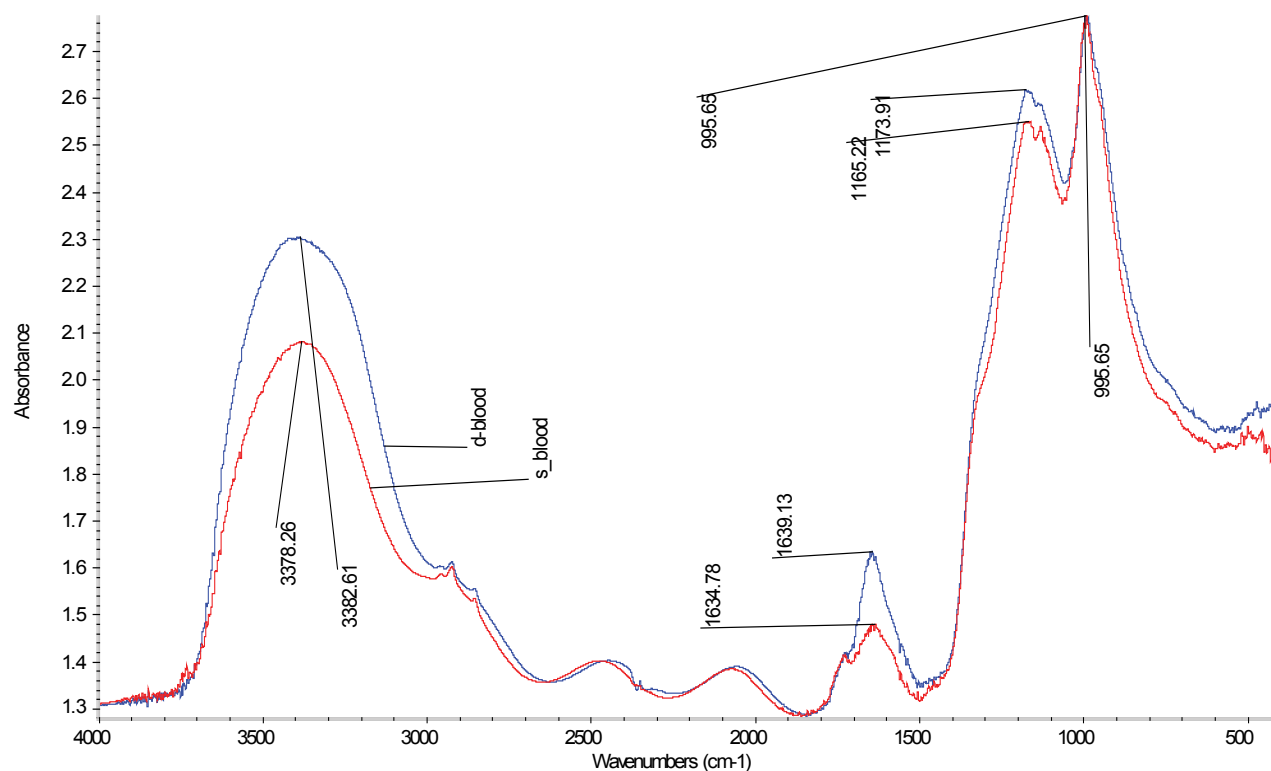


Figure 6: The infrared spectra of the blood in the experimental and controlled groups, where s-serum denotes the results of experimental group, d-serum is the values of controlled group.

which are some average values of 8 rats by using the scanning of 64 times. These figures exhibited the distinctions of intensity, number and position of the peaks in the infrared spectrum in the serum and blood of the rats between the experimental and controlled groups. These distinctions verified clearly that EMF irradiated by HVTL can affect the variations of construct and states of the molecules, such as the proteins in the bloods.

Because the two-dimensional correlation spectroscopy for the infrared absorption can distinguish and separate the overlapping peaks in the spectra and the second derivative Fourier transform infrared spectrum can eliminate the error of first item of wavelength of the infrared spectrum and it can also distinguish and identify easily the small shoulder peak on the strong peak, thus some not obvious structure information are highlighted and displayed. Just so, we give the two-dimensional correlation spectroscopy for the infrared spectra of the bloods of the rats in experimental and controlled groups. Because there is the most abundant infrared spectral information in the regions of $1300\sim 1800\text{ cm}^{-1}$, so we here choose this region as a comparison domain. Figures 7 and 8 shows the synchronous and asynchronous correlation spectrum for the second derivative of Fourier transform infrared spectra of the serum in $1300\sim 1800\text{ cm}^{-1}$ in the rats in experimental and controlled groups, respectively. They are the average results of values of 8 rats in each group. At the same time, the spectra are smoothed automatically using omnic 6.2 software, ATR and baseline, subsequently, we used the matlab 6.5 software to treat second related image. Since the infrared spectra in $1300\sim 1800\text{ cm}^{-1}$ exhibit some important physical effects, thereupon we here showed the second derivative of Fourier transform infrared spectra in Figures 7 and 8 in this region [32-36].

From Figure 7 we see that the peaks of 1652 cm^{-1} and 1400 cm^{-1} , 1537 cm^{-1} are the relevant and related to change synchronously, which suggests that these absorption peaks are caused by the same component or configuration or components. However, 1669 cm^{-1} and 548 cm^{-1} in Figure 8 have not these features, i.e., they have the cross of peaks, but there are not the cross peaks on the synchronous spectrum. This means these peaks are induced by another components or configuration, which are different with the results in Figure 7. Very evidently, the variations are induced by the EMF irradiated by HVT EL, namely, it reveals that the EMF of HVTL results in the changes of configuration or the secondary structure of the protein molecules in blood. Therefore, we confirmed that the EMF of HVTL has an obviously biological effect.

Infrared absorption of the hemoglobin and its feature under influence of EMF of HVTL

In this study we should first extract and separate the hemoglobin from the blood. A simple method is described as follows:

After the exposures of 400days for 32 Wistar rats we extracted the blood of about 8-10 mL from the femoral artery, After 10 min we extract the serum and red blood cells (RBC) from the blood without the anticoagulants using the centrifuge machine, which have again saved in incubator with 4°C about 10 h. Subsequently, RBC is washed by the physiological saline three times and is cracked and diluted by the distilled water, in this case they are larger triploid than the volume of RBC and are again centrifuged using the centrifuge machine with about 60 min at 4°C . We extract again and retain the supernatant liquid containing the hemoglobin after the precipitation of cell fragments is removed. The PH value of the supernatant liquid is regulated to reach the neutral using 1 N NaOH and 1 N HCL, in which the neutral salt ammonium sulfates are added until a slight crystallization of the amine

sulfate. At this time the hemoglobin solutions became a saturated liquid, which is retained again in the refrigerator to freeze at 4°C about 12 h. When suitable salts are added, the hemoglobin are precipitated as the floccule form; those are floated above of the liquid. Then we sucked out the floccule matter and moved them into another centrifuge tubes to centrifuge using the centrifuge mechine with 5000 r/min about 10 min. Final sediments obtained are just the hemoglobin having the high purity after the supernatant liquid is removed [37-40]. Thus the samples of hemoglobin used in this experiment are prepared and obtained using this method of salting out.

The infrared spectra of absorption for the hemoglobin at 25°C are inspected by Nicolet FT-IR 670 spectrometer. Figures 9 and 10 showed its average values of infrared spectra of absorption of the hemoglobin for 8 rats and the infrared spectrum of absorption for each rat in experimental and controlled groups, respectively.

Figures 9 and 10 indicated that the infrared spectra of absorption of the hemoglobin in rats in the experimental and controlled group. From these figures we see that they are different due to the influences of EMF of HVTL. Their concrete changes are described in detail in Tables 4 and 5.

From this investigations of the infrared spectra of the hemoglobin in blood in Figures 9 and 10 and Tables 4 and 5 we can obtain the following results.

(1). There are red shift of 2 peaks and blue shifts of 2 peaks in 8 peaks in the rats in the experimental and controlled groups. In individual measurement of infrared spectrum of 8 rats there are 16 red shift and 31 blue shifts in the position of absorbed peaks relative to those in average case of controlled group.

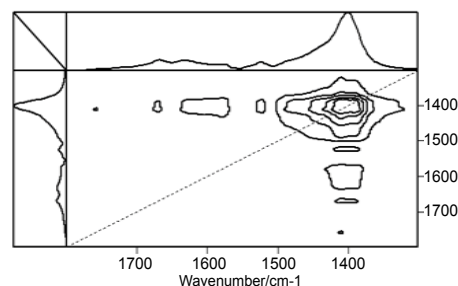


Figure 7: The synchronous correlation spectrum for the second derivative of Fourier transforms infrared spectra of the serum in the rats in experimental relatively to those of controlled groups.

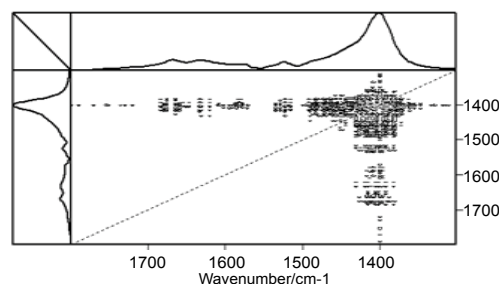


Figure 8: The asynchronous correlation spectrum for the second derivative of Fourier transforms infrared spectra of the serum in the rats in experimental relatively to those of controlled groups.

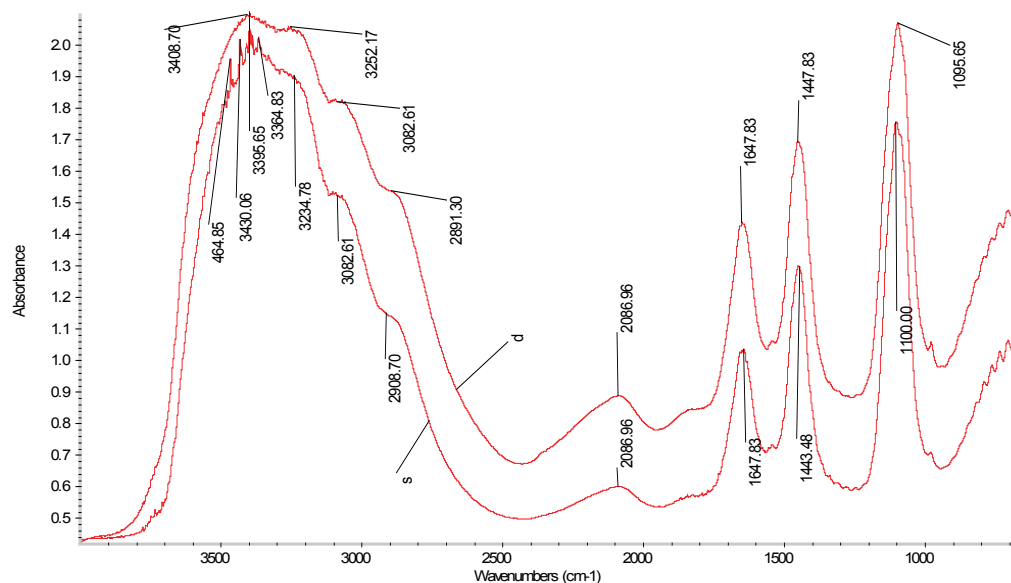


Figure 9: The comparison of average value of infrared spectra of absorption of the hemoglobins for 8 rats between the experimental and controlled groups, where “s” is the values of controlled group, “d” denotes the values of experimental group.

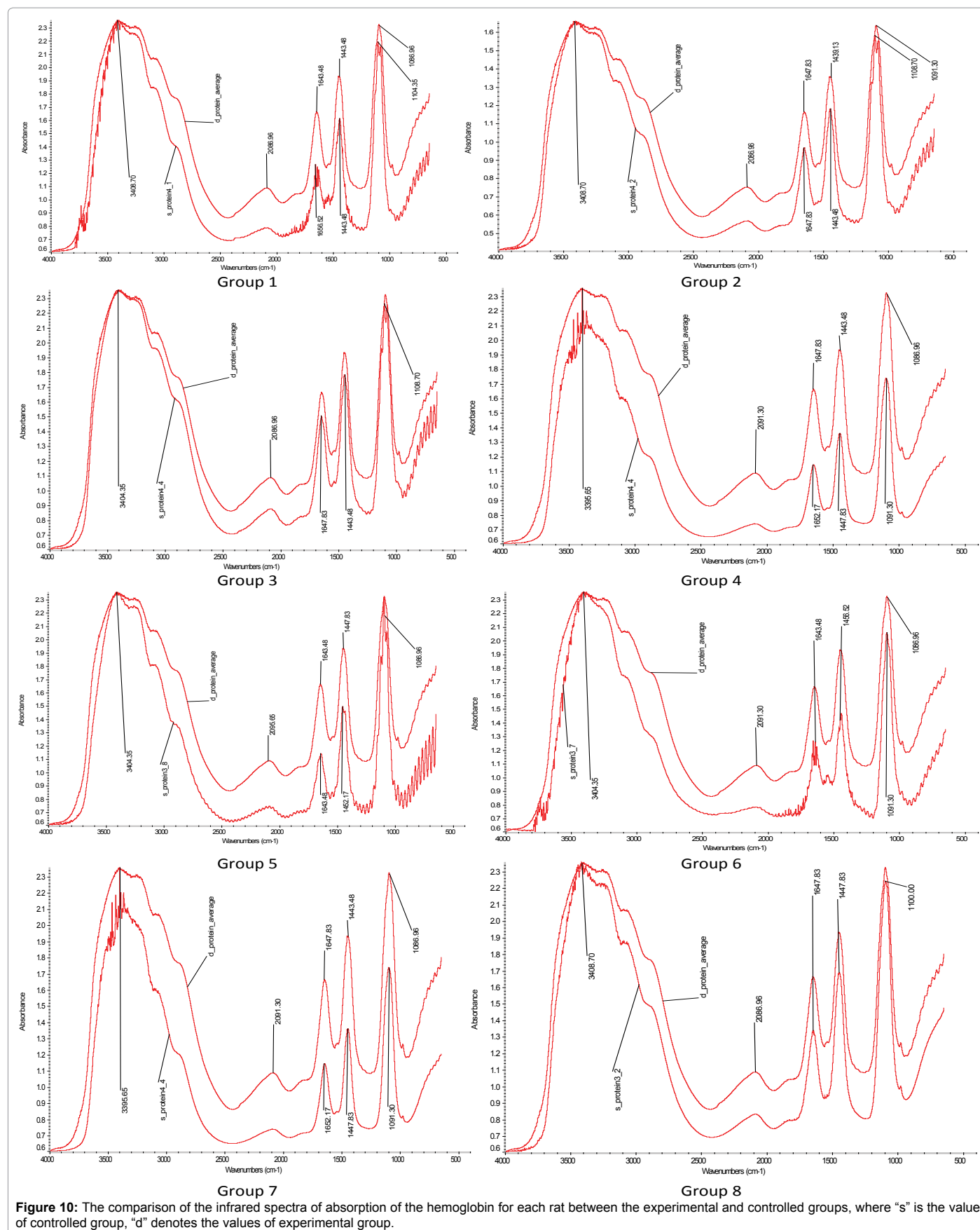
	The positions of absorbed peaks (cm ⁻¹)							
	1 peak	2 peak	3 peak	4 peak	5 peak	6 peak	7 peak	8 peak
CQ	3408.70	3252.17	3082.61	2891.30	2086.96	1647.83	1447.83	1086.66
EQ	3395.65	3234.78	3082.61	2908.70	2086.96	1647.83	1443.48	1100
	The intensity of absorbed peaks							
	1 peak	2 peak	3 peak	4 peak	5 peak	6 peak	7 peak	8 peak
CQ	2.30	2.08	1.84	1.56	0.90	1.46	1.72	2.10
EQ	2.3	1.92	1.54	1.14	0.60	1.04	1.30	1.74
Difference	0	0.16	0.30	0.42	0.30	0.42	0.42	0.36

*Where red denotes red shift of peak, the blue denotes the blue shift of peak

Table 4: The properties of infrared absorption spectra of the hemoglobin in the rats in the experimental group (EQ) and controlled groups (CQ).

		The positions of absorbed peaks (cm ⁻¹)							
		1 peak	2 peak	3 peak	4 peak	5 peak	6 peak	7 peak	8 peak
CQ (average)		3408.70	3252.17	3082.61	2891.30	2086.96	1647.83	1447.83	1086.66
EQ	1	3408.70	3220.10	3095.44	2925.11	2086.96	1656.52	1443.48	1104.35
	2	3408.70	3255.05	3085.12	2911.23	2086.96	1647.83	1443.48	1108.70
	3	3395.65	3222.45	3080.90	2905.10	2086.96	1652.17	1447.83	1091.30
	4	3404.35	3265.65	3088.64	2911.78	2086.96	1647.83	1443.48	1108.70
	5	3408.70	3250.65	3086.10	2900.78	2086.96	1647.83	1447.83	1100.00
	6	3404.35	3245.14	3085.50	2915.55	2091.30	1643.48	1456.52	1091.30
	7	3404.35	3225.98	3090.56	2910.78	2084.15	1643.48	1452.17	1086.96
	8	3395.65	3220.18	3093.36	2911.18	2091.30	1652.17	1447.83	1091.30
		The intensity of absorbed peaks							
		1 peak	2 peak	3 peak	4 peak	5 peak	6 peak	7 peak	8 peak
CQ (average)		2.30	2.08	1.84	1.56	0.90	1.46	1.72	2.10
EQ	1	2.36	2.26	1.84	1.40	0.78	1.26	1.60	2.20
	2	1.64	1.60	1.32	1.06	0.58	0.98	1.18	1.58
	3	2.36	2.30	1.96	1.62	0.88	1.50	1.78	2.32
	4	2.21	2.04	1.60	1.20	0.74	1.14	1.36	1.74
	5	2.28	2.15	1.56	1.43	1.00	1.58	1.84	2.24
	6	2.36	2.24	1.74	1.34	0.80	1.28	1.48	2.06
	7	2.36	2.25	1.81	1.36	0.74	1.16	1.51	2.28
	8	2.36	2.20	1.84	1.30	1.08	1.66	1.92	2.32
*Where red denotes red shift of peak, the blue denotes the blue shift of peak									

Table 5: The comparisons of the feature of the infrared absorption spectra of the hemoglobin in each rat in the experimental group (EQ) and controlled groups (CQ).



(2). In the investigation of intensity of absorbed peaks we found that the intensities of all peaks in the cases of both average and individual measurement in the experimental group are small than those in controlled group.

(3) We found that there are five new peaks around 3395.65 cm^{-1} in the region of $3200\text{--}3500\text{ cm}^{-1}$ in the experimental group in Figure 9.

These results indicated that the states and properties of the hemoglobin's in blood in the rats are changed under the influences of EMF irradiated by HVTL because the changes of the positions and intensities of peaks are closely related to the variations of the states and properties of the protein molecules, such as the hemoglobin [32-36].

Conclusion

In this paper we studied the influences of EM irradiated by HVTL with 50 Hz on the features of blood in animals, including the biochemical indicators, routine index, refractive index and the properties of infrared absorption of the serum, adtevak and hemoglobin molecules in them using the biological- chemical methods and LQ-300 K automatic biochemistry analyzer and the infrared spectrum technique and 670 Nicolet FT-IR spectrometers as well as Abbe refractometer, respectively. The biochemical inspection of blood indicated that ALT, TP, ALB, TB, DB, IB, CLO, AST, A/C, BUN and the creatinine and refractive index of bloods in the rats are all varied under the influences of the EMF of HVTL relative to those, which have not irradiated by the EMF, but in which the variation of ALT is most significant ($P < 0.05$), the increase of number of white blood cells is also significant ($P < 0.01$). Therefore we can affirm that the EMF of HVTL varied the properties of the blood in rats.

At the same time, we further elucidated the reasons arising from these changes, which are due to the variations of the states and properties of the protein molecules, such as the hemoglobin in blood [31-35]. The changes of the latter are verified by the experimental results of the properties of infrared absorption of the serum, adtevak and hemoglobin molecules in these bloods shown in Figures 3-10 and Table 4 because the infrared spectra of these matters can have a insight into the states and properties of the protein molecules and their variations in them.

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