Hazardous Effects of High Voltage on Albino Rats and Role of Rosmarinus Officinalis

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Abstract

Electromagnetic fields (EMFs) are common in our everyday lives. They have many origins and severe effects on individuals and environments where they inflict a great deal of health and psychological harm. The current study investigated the impact of high voltage (H.V.) EMF 5.4 k / v for 2, 4 h per day with a frequency equal to 50 Hz on body weight(b.wt), blood indices, and certain liver enzymes of albino rats after 25 days of exposure to the electromagnetic field. This work focuses on the therapeutic action of methanol extract of Rosmarinus officinalis (R. officinalis) leaves at a dose (5 mg/kg b. wt) against harmful EMF-induced effects. The findings showed that electromagnetic field exposure induced a substantial decrease in red blood cells (RBC), haemoglobin concentration (Hb), and catalase activity (CAT). Although white blood cells (WBCs), aspartate aminotransferase (AST), alanine aminotransferase (ALT), Total Bilirubin, Urea, Creatinine, Uric Acid, and Malondialdehyde (MDA) levels have increased significantly under EMF treatment. Treatment with R. officinalis showed attenuation in these parameters that were induced in rats exposed to H.V. These findings were followed by the histopathological analysis of the liver in the observations. Finally, we conclude that R. officinalis leaves extract offered substantial protection against H.V induced liver damage and can be applied in drug production.

Introduction

Electromagnetic fields (EMFs), a physical field generated by moving electrically charged objects (Khaki et al. 2011), and influencing the actions of charged objects in the field's vicinity, are emitted by abundant natural and human-made sources that play significant roles in everyday life. It stretches over space indefinitely and explains electromagnetic interaction (Emre et al. 2011). You may distinguish mainly four types of signals from EMFs. They are known as static, electrical, and MF (DC, 0 Hz), shallow frequency (ELF) fields, ranging from 1Hz to 300 Hz. An ELF-EMF symbol is the time-varying EMFs. Other technologies create intermediate frequency (IF) fields with frequencies from 300 Hz to 10 MHz and high frequency (HF) fields in the radio frequency (RF, 10 MHz–300 GHz) and microwave (MW, above 3 GHz) (ICNIRP. 2010). EMFs are present everywhere in our setting, but they are invisible to the human eye. The local build-up of electrical charges generates electric fields in the atmosphere associated with thunderstorms. The earth's MF causes the compass needle to be positioned in the north-south direction and is used by birds and fish for navigation (WHO. 2007). EMFs have several chemical impacts, such as imbalances in ion ratios, reaction to biological processes, stress and oxidative stress in the body's abundant tissues, and physiological and psychological effects on human health (Thakare and Utane 2018).

Medicinal properties produced by various medicinal plants are attributable to secondary metabolites such as flavonoids, tannins, phenolic carbohydrates, glycosides, and alkaloids, which are the most significant bioactive plant components (Khalid et al. 2018). Rosemary (R. Officinalis L.), An aromatic plant, is a widespread household plant that belongs to the Lamiaceae family and grows in great accessories from around the world, Europe, Asia and Africa, mainly in areas surrounding the Mediterranean Sea. The bitter principle, resin, tannic acid, volatile oils, and flavonoids are among the chemical constituents. It is used
for the central nervous system, cardiovascular system, genito-urinary diseases, liver treatment, reproductive system and respiratory system disorders. Rosemary spices and their essential oil allow the lipid profile, oxysterol scale, liver function, kidney function and glucose to be assumed processed. The remedy groups indicate a presumed decrease in the serum of interactive thiobarbituric acid (MDA) substances Hassanen (2015).

The current work aims to investigate the role of \textit{R. officinalis} leaves extract against EMF.

**Materials And Methods**

**Preparation of leaves \textit{R. officinalis} extract:**

Leaves extract preparation: The extraction was performed separately using ethanol and methanol. The extract was prepared by stirring 100 g of plant leaves with 700 ml of solvent made up of 800 ml ethanol 95% or methanol 95% and 200 ml of distilled water on a magnetic stirrer at room temperature for 24 hours. The infusion was pumped through a piece of double-layer gauze and centrifuged for 10 min at 3000 rpm. The remainder was also re-extracted. The combined filtrates were evaporated using a rotary evaporator system connected to dryness at 40 °C with a vacuum pump. Around 100gm of rosemary leaves give a crude extract of 18.6gm and are kept in a refrigerator (Khalafalla et al. 2010 with a minor modification).

Qualitative and Quantitative Phytochemical Analysis of \textit{R. officinalis}:

**Qualitative Phytochemical Analysis:**

Preliminary phytochemical analysis was carried out on the extracts as described by Harborne (1973) as follow: Detection of Steroids (Gibbs 1974), Detection of Terpenoids (Ayoola et al. 2008), Detection of Tannins (Treare and Evans 1985), Detection of Saponins (Kumar et al. 2009), Detection of Anthocyanins (Paris and Moyse 1969), Detection of Glycosides (Khandewal 2008), Detection of Emodins (Rizk 1982), Detection of Alkaloids Preparation of Mayer's reagent (Gibbs 1974), Detection of Fatty Acids (Ayoola et al. 2008), Detection of Phenol (Gibbs 1974) and Detection of Flavonoids (Khandewal 2008).

**2. Quantitative Phytochemical Analysis**

Total Phenols and Total flavonoids were estimated according to (Total Phenols and Total flavonoids were evaluated according to (Maurya and Singh (2010) and Ebrahimzadeh et al. (2008), respectively. Determination of total antioxidant activity by estimate the DPPH of different solvent extracts described by Brand-williams et al. (1995).

**Experimental Animals:**

Sprague-Dawley strain adult male albino rats, weighing 130 ± 20 g, were obtained from Animal House, Faculty of Pharmacy, University of Al Nahda, Beni Suef. The rats were lodged in air-conditioned rooms in
plastic cages at 25 ° C ± 2 (under laboratory condition). For two weeks prior to the trial, a commercially available diet and tap water were given ad libitum. All trial proceedings were performed in compliance with ethical principles verified by animal treatment and use guidelines of the Institutional Animal Ethics Committee, Minia University, Egypt.

**Experimental Design:**

After two weeks of acclimatization, forty-eight rats were divided into six groups (each 8 rats), on the following:

Control group; Healthy group.

Rosemary group (R); Rats in this group were given a dose of rosemary ethanol extract (5 mg/kg b.wt/ daily) for 25 days (Ghasemzadeh et al. 2011).

HV 2 h group (HV 2h); Rats in this group were exposed to two hours of high voltage daily for 25 days.

HV 4 h group (HV 4h); Rats in this group were exposed to four hours of high voltage daily for 25 days.

Rosemary + HV 2 h group (HV 2h & R); Rats in this group were given a dose of rosemary ethanol extract (5 mg/kg b.wt/ daily) for 5 days before exposure to HV 2 h and continued for 25 days with rosemary.

Rosemary + HV 4 h group (HV 4h & R); Rats in this group were given a dose of rosemary ethanol extract (5 mg/kg b.wt/ daily) for 5 days before exposure to HV 4 h and continued for 25 days simultaneously with rosemary.

**Electromagnetic field exposure:**

Exposure to electromagnetic fields was performed according to the method Gazwi et al. (2020).

**Sampling**

**Blood samples**

At the end of 30 days, rats were fasted overnight and anesthetized to collect the blood samples from the retro-orbital plexus (Schermer 1967). For hematological tests, appropriate volumes of fresh blood were taken directly into the heparinized tube. The other blood sample accessories were allowed to coagulate at room temperature, then the clear non-haemolysed sera at 4°C were isolated and stored at -20°C before biochemical analysis was used.

**Tissues samples**

Rats were sacrificed, excised the liver cleaned with philter paper. Small liver accessories were set for histopathological tests in 10 percent formalin solution. Other liver tissue accessories were homogenized and used to assess the concentration of CAT and MDA.

**Hematological evaluation**
For the determination of red blood cells (RBCs), and white blood cells (WBCs), hemoglobin concentration (Hb), packed cell volume (PCV), utilizing Animal Blood Counter (Genius-KT-6400).

**Biochemical assays**

Serum enzyme vigor of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured according to the manner described by Reitman and Frankel (1957). Total protein, albumin, urea, creatinine, and uric acid scale were certain according to the methods described by Gornall et al. (1949); Doumas et al. (1971); Fawcett and Scott (1960); Bartles et al. (1972) Barham and Trinder (1972). Globulin was certain by the difference between total protein and albumin. Total and direct bilirubin were certain calorimetrically (Walters and Gerarde 1970), using enzymatic colorimetric proceedings Kits from Bio- Diagnostic Co., Egypt.

**Measuring of liver CAT and MDA**

Half a grams of liver tissue from each animal is homogenized in 5 ml of 100 mM phosphate buffer, pH 7.4 on ice using Universal laboratory Help homogenizer, and then centrifuged at 3000 rpm 4oC for 15 min. The supernatants of the creatures were composed and stored at -20oC until the concentration of catalase vigor (CAT) and malondialdehyde (MDA) was calculated in the manner mentioned in Aebi (1984) and Ohkawa et al. (1979).

**Histopathological examination:**

Specimens of liver were set in 10 percent formalin solution. It was cut into 5 cm thick sections after 24 h of fixation accompanied by embedding in a paraffin block and stained with hematoxylin-eosin (H&E) for routine histopathological analysis according to Bancroft et al. (1996).

**Statistical analysis:**

The results gained in this work were evaluated by the SPSS Statistics One Way ANOVA test. The results were expressed as mean ± standard error, and values of P < 0.05 were considered statistically presumed (Snedecor and Cochran 1986).

**Results And Discussion**

**Qualitative Analysis of Phytochemicals:**

Phytochemical findings in (Table 1) suggest the presence of phytochemicals in *R.officinalis* leaves such as steroids, saponins, tannins, anthocyanins, emodins, flavonoids, terpenoids, glycosides and alkaloids and phenols in two extracts. In contrast, fatty acids were absent in ethanol and methanol extracts, whereas emodins and alkaloids were absent in methanol extract.

This data agree with Edrah et al. (2017), who reveal that the *R.officinalis* ethanolic extract contains flavonoids, terpenoids, glycosides, and phenols, whereas saponins have been absent. Also, in the same line with Khamis and Aly (2017), who found that terpenoids, alkaloids, glycosides, saponins, and
flavonoids were widely present in ethanolic extract *R. officinalis*. These plants were used as preservatives for food and as folk medicines. Terpenoids are used in cough, asthma, and hay fever treatments. Saponins have antibiotic properties and guard against hypercholesterolemia (Mir et al. 2013).

| Chemical Constituents | *R. officinalis* Ethanol 80% | *R. officinalis* Methanol 80% |
|-----------------------|-------------------------------|-------------------------------|
| Steroids             | ++                            | +                            |
| Terpenoids           | ++                            | +                            |
| Tannins              | ++                            | ++                           |
| Saponins             | +++                           | ++                           |
| Anthocyanins         | +++                           | +                            |
| Emodins              | +                             | -                            |
| Alkaloids            | +                             | -                            |
| Glycosides           | ++                            | +                            |
| Flavonoids           | ++                            | +++                          |
| Phenols              | +++                           | ++                           |
| Fatty acids          | -                             | -                            |

* (+++), (++), (+) and (-) refer to high, moderate, low and absent amount, respectively.

Quantitative Analysis of Phytochemicals:

**Total Phenolics and Flavonoids Content:**

Total phenols and flavonoid contents of *R. officinalis* are manifest in Table 2. Phenolic compounds are one of the primary, secondary metabolites that protect against oxidative stress since they can act as reducing agents through single-oxygen scavengers and donors of hydrogen atoms with subsequent stabilization of the generated free radicals that form stable compounds that do not initiate or propagate oxidation (Karthivashan et al. 2013).

Previous studies manifest the relationship between the total flavonoid content and antioxidant vigor of medicinal plants (Kaur and Mondal 2014). Flavonoids commonly contain anthocyanins, flavanols, flavones, flavanones, and flavonols as the polyphenols. The difference in solvent polarity and diffusion forces, the structural complexity, or the selective solubility of phytochemicals in a given solvent may
explain the distinction between phenolic and flavonoid content and the extraction solvent (Medini et al. 2014).

**Table 2**

| Total phenolic compounds (mg/g) | Total flavonoids (mg/g) |
|---------------------------------|-------------------------|
| **Rosemary**                    | **Rosmary**             |
| Methanol extract                | 5.40 ± 0.14**           | 6.54 ± 0.023***         |
| Ethanol extract                 | 6.67 ± 0.14***          | 5.90 ± 0.045**          |

*a: mg GAE /g of dryleafes extract; b: mg QE/g of dryleafes extract. Each value is expressed as the mean.± SE (n = 3). (**) and (***) are Significant and highly significant respectively at P < 0.05.

**Antioxidant Activity**

The DPPH is a stable free radical at room temperature and accepts an electron/hydrogen radical to become a stable diamagnetic molecule (David et al. 2004). The DPPH is usually used as a substrate to evaluate the antioxidant vigor (Edamatsu et al. 1989). The antioxidants react with the stable free radical DPPH and turn into it to 1,1-diphenyl-2-picryl hydrazine with decoloration (Kumar et al. 2012). DPPH radical’s reduction potential is certain by the dwindling in its 517 nm absorbance, which is caused by antioxidants. Visually visible, like a change in color from purple to yellow. The latest findings for *R. officinalis* extract manifest free radical scavenging vigor (Table 3). The highest DPPH scavenging vigor is manifest by ethanol (80%) with *R. officinalis* extract.

Results manifest that aqueous methanolic extract (80%) extract of rosemary exhibited inhibition of 50 % while ethanolic extract 53.8%. Therefore the aqueous ethanolic extract (80%) is the more efficient solvent for extracting the phytochemical compounds from *R. officinalis*. This extract may contain plentiful phenolic and flavonoid compounds identified as nutritional and medicinal properties (Shanmugavel et al. 2018). in the same line with data gained by Gîrd et al. (2017), who found that the ethanol extract of *R. officinalis* contains a high amount of phenolic compounds which consider as antioxidant vigor of plant materials (Kim et al. 2011).
Table 3
Antioxidant Activity of R. officinalis*

| Solvent       | %inhibition | IC$_{50}$ (µg/ml) |
|---------------|-------------|-------------------|
|               | Rosemary    | Rosemary          |
| Methanol extract | 50          | 62.87             |
| Ethanol extract  | 53.8        | 54.5              |

*The IC$_{50}$ values correspond to the amount of extract required to scavenge 50% of radicals present in the reaction mixture.

Effect of R. officinalis extract on hematological parameters in blood rats exposed to HV 2 and 4 h.

In this study the hematological tests of the animals treated for 30 days with the ethanolic extract R. officinalis were carried out. Table (1) shows no presumed divergence in the scale of Hb, WBCs, and RBCs relative to the control. It was estimated that Hb (P < 0.05) decreased by around 15 and 11 % in the exposed HV groups for 2 or 4 h, compared with the control group, respectively. In the meantime, remedy groups with ethanolic R. officinalis extract increased probably (P < 0.05) this reduction of Hb and restored it to normal control. RBCs (P < 0.05) were assumed to decrease by about 12 and 6 % respectively in the exposed group to HV for 2 or 4 h compared to the control group. Meanwhile, remedy groups with ethanolic R. officinalis extract improved presumed and returned RBCs to normal control. WBCs (P < 0.05) were assumed to increase by about 22 percent and 54 percent respectively in the exposed group to HV for 2 or 4 h compared to the control group. Packed cell volume (PCV) was thought to decrease by about 24 % and 30 % in the exposed group to HV for 2 or 4 h, respectively, compared to the control group. In the meantime, remedy groups with ethanolic extract of R. officinalis strengthened presumed PCV and took it back to normal regulation. The RBCs are assumed to dwindle (P < 0.05) by around 12 % and 6 % relative to the control group in the exposed group to HV for 2 or 4 h, respectively. In the meantime, presumed remedy groups with ethanolic extract of R. officinalis strengthened and returned RBCs to normal regulation. WBCs are assumed (P < 0.05) to increase by around 22 % and 54 %, respectively, in the exposed group to HV for 2 or 4 h relative to the control group. Meanwhile, it was thought that remedy groups with ethanolic R. officinalis extract (P < 0.05) decreased this increase in WBCs by around 9 % compared to the 2 h exposed group to HV. In contrast, this refining was 25 % compared to the 4 h exposed group to HV.

Xiao-Feng and Gun confirm the current data (2017) 's data, who found the elevation of white blood cells in rats exposed to HVT and radiation exposure (Hsu et al. 2010). Also, in harmony with about hematological parameters (Eid et al. 2015). The depletion in the values of hematological parameters following EMF radiation may be attributed to direct deterioration caused by radiation and overproduction of ROS by microwave radiation interaction, causing hemolysis (Aweda et al. 2004). The dwindling of
RBCs may be due to the interaction between heme (iron) and SMF, where the magnetic field penetrates the body and acts ions in all organs, altering the cell membrane's potential disrupting the ions (Kula and Drozds 1996).

| Groups    | HB (mg/dl) | PCV (mg/dl) | RBCs ($10^6$/mm$^3$) | WBCs ($10^3$/mm$^3$) |
|-----------|------------|-------------|----------------------|----------------------|
| Control   | 13.88 ± 0.64 | 0.37 ± 0.05 | 6.34 ± 0.41          | 12.33 ± 1.66         |
| R         | 14.85 ± 0.27 | 0.37 ± 0.03 | 6.52 ± 0.15          | 12.05 ± 1.62         |
| HV2h      | 11.80a ± 0.89 | 0.28a ± 0.15 | 5.56a ± 0.69         | 15.00a ± 1.01        |
| HV4h      | 12.40 ± 0.78 | 0.26a ± 0.06 | 5.94 ± 0.48          | 19.03a ± 6.27        |
| HV2h&R    | 14.20 ± 1.39 | 0.35b ± 0.03 | 6.14 ± 1.11          | 13.70b ± 0.86        |
| HV4h&R    | 14.50 ± 1.52 | 0.33b ± 0.05 | 6.55 ± 1.27          | 14.25ab ± 3.03       |

Data represent the mean ± S.E. of observations from eight rats. a Significantly different from control group at P < 0.05. b Significantly different from HV group at P < 0.05.

**Effect of *R. officinalis* extract on liver function in serum of rats treated with HV:**

These enzymes are essential to biological processes occurring within a living organism's body, and are one of health indicators. Results in Table (2) show that there was no presumed 30-day difference between *R. officinalis* extract remedy groups as compared with normal AST and ALT vigor regulation. Meanwhile, HV exposure for 2 or 4 h elevated presumed (P < 0.05) AST serum vigor is approximately 50 % and 61 % respectively, while ALT vigor is 30 % and 36 % compared with control group.

The size of these enzymes in serum, however, showed a suspected diminishing (P < 0.05) by handling either *R. officinalis* extract for 2 or 4 h at the same time as HV exposure. In contrast with groups exposed to HV for 2 or 4h, respectively, AST vigor was manifested to be less by 27 % and 31 %. *R. officinalis* extract simultaneously with the presumed sensitivity to HV (P < 0.05) reducing AST vigor by about 30 percent and 34 percent compared to HV for groups of 2 or 4 h, respectively. Also, data shows that there was no presumed divergence in the TB, DB and IB scale of 30 days between *R. officinalis* extract remedy groups. Meanwhile, the serum TB scale increased by about 42 % and 65 % (P < 0.05) for 2 or 4 h, while the DB scale increased by 97 % and 140 %, while the IB scale increased by 18 and 32 % relative to the control group. However, the TB serum scale indicated a presumed (P < 0.05) decrease in either *R. officinalis* extract remedy groups.
extract handling simultaneously with 2,4h HV exposure. TB scale decreases by about 20 % and 37 % compared to 2, 4h, respectively. At the same time, the DB serum scale showed a presumed (P < 0.05) decrease in handling with \textit{R.officinalis} extract in accordance with HV treatment of approximately 22 percent and 27 percent compared with HV groups for 2 and 4 hours, respectively.

Although IB serum scale was assumed to diminish (P < 0.05), handling with either \textit{R.officinalis} extract was simultaneously with 2 or 4 h HV treatment and restored to almost control. With accordance to these data Salem et al. (2005) postulated that the damaging impact of static magnetic field on the liver is manifested by an raise in blood AST and the most specific marker of liver cell deterioration ALT vigor. The exposure to ELF-EMF of 2 mT and 50Hz raised presumed serum transaminases vigor in mice. Hashem and El-Sharkawy (2009). ALT and AST vigor improved presumed (P<0.05) for two months in serum and liver tissue homogeneous to EMF exposed rats in the same manner as standard control group Eid et al. (2015). These results coincide with the findings of abundant authors who found a presumed increase in the scale of enzyme vigor, ALT and AST in rats exposed to electromagnetic field radiated from base stations on cell phones with a frequency equal to 900 MHz (Sharma et al. 2017). Reduction of both transferases as a result of radiation released by base station due to liver parenchymal damage, suggesting liver dysfunction (Achudume et al. 2012). The vigor of all liver function tests raised as a result of raise in the intensity of magnetic field and mostly affected with a percentage > 90% (Ibrahim et al. 2008). Also, the results in the current work are consistent with the previous observation of Hashish et al. (2008) who reported that exposure to a 50-Hz ELF EMF for 30 days caused a presumed raise in AST scale which may be due to oxidative stress or apoptosis caused by the ELF EMF (Emre et al. 2011). EMFs induced structural changes in hepatocytes, primarily in mitochondria and induced liberation of free radicals and oxygen species which can induce liver disease which also the main organ of detoxication (Eid et al. 2015). Exposing to EMFs in humans or animals resulted in increasing glucocorticoids (cortisol) which enhance transamination processes, stress oxidative compounds, and produced hipoxy. This is an substantial reason for increasing the amount of transaminases in trialal groups. Hipoxy production could raise the AST and ALT value in serum, up to thousands of units in liter (Kulkarni and Gandhare 2015). Rosemary essential oils exhibited on refinement in the actions of ALT and AST enzymes in hypercholesterolemic rats (Hassanen 2015) or after lead exposure (Abd El Kader et al. 2012). These may be attributed to the stabilizing ability of the cell membrane preventing enzymes leakages (Pari and Karthikesan, 2007). These result in the same line with abundant authors who found that the serum bilirubin scale in trial rats was higher than both control group exposure to EMR (Sharma et al. 2017) and EMF exposure group(Berrahal et al. 2011). Along with the apparent presumed impact on bilirubin, a byproduct of red blood cell lysis prove the possibility of hemolysis. Previously (El-Bediwi et al. 2011) also reported a rise in the bilirubin in rats following cell phone exposure. Bilirubin values increased as a result of magnetic field strength (1.4 mT), and it was also influenced by magnetic field penetration to 50 Hz. Ibrahim et al. (2008) increased the amount of bilirubin serum after exposure relative to control. The elevation in the serum bilirubin scale can result from deteriorating cells leaking into circulation after magnetic field exposure (Novikov et al. 1999).
Table 5
Effect of *R.officinalis* (5 mg / kg b.w ) extract on liver functions in rats exposed to HV 2 and 4 h.

| Groups       | AST (U/ml)         | ALT (U/ml)       | T.Bilirubin (mg/dl) | D.Bilirubin (mg/dl) | Ind.Bilirubin (mg/dl) |
|--------------|--------------------|------------------|---------------------|---------------------|-----------------------|
| Control      | 40.10 ± 0.3        | 45.17 ± 0.52     | 1.02 ± 0.01         | 0.30 ± 0.06         | 0.73 ± 0.02           |
| R            | 40.20 ± 0.04       | 43.06 ± 0.96     | 1.03 ± 0.03         | 0.26 ± 0.01         | 0.73 ± 0.05           |
| HV2h         | 60.13a ± 0.05      | 58.84a ± 0.04    | 1.45a ± 0.05        | 0.59a ± 0.03        | 0.86a ± 0.02          |
| HV4h         | 64.56a ± 0.03      | 61.44a ± 0.05    | 1.68a ± 0.06        | 0.72a ± 0.02        | 0.96a ± 0.04          |
| HV2h&R       | 43.83ab ± 0.04     | 54.83ab ± 0.03   | 1.16ab ± 0.04       | 0.45ab ± 0.02       | 0.73b ± 0.01          |
| HV4h&R       | 44.51ab ± 0.04     | 56.11ab ± 0.01   | 1.23ab ± 0.02       | 0.53ab ± 0.06       | 0.72b ± 0.07          |

Data represent the mean ± S.E. of observations from eight rats. a Significantly different from control group at P < 0.05. b Significantly different from HV group at P < 0.05.

**Effect of *R.officinalis* extract on Total Protein and Albumin parameters in the serum of rats treated with HV**

Results in Table (3) indicate no presumed difference in the 30-day serum protein and albumin scale between *R.officinalis* extract remedy groups compared with the control group. Meanwhile, HV exposure for 2 or 4 h increased the serum protein scale by around 39.5% and 43.1%, respectively (p > 0.05), while the albumin scale increased by 58% and 75% compared to the control group.

In a group remedy with *R.officinalis*, the serum protein scale was assumed to dwindle by around 20 % simultaneously with HV treatment for 2 or 4 h. In conjunction with exposure to HV for 2 or 4 h, *R.officinalis* also decreased albumin by around 17 % compared with HV for groups of 2 or 4 hours. These results are in agreement with those data reported by plentiful authors (Hashem and El-Sharkawy 2009). Kulkarni and Gandhare (2015) found that total protein, albumin, and globulin display a transient 30-hour increase that decreases at 60 hours relative to the regulated community. The period of intensity and exposure of EFs has been found to play a vital role in inducing internal fields and activating biological differentiation.
Table 6
Effect of *R.officinalis* extract on serum total protein and albumin in rats exposed to HV 2 and 4 h.

| Groups  | Protein (mg/dl) | Albumin (mg/dl) | Globulin (g/dl) | Albumin/globulin |
|---------|----------------|-----------------|-----------------|-----------------|
| Control | 7.70 ± 0.03    | 4.12 ± 0.01     | 3.57            | 1.15            |
| R       | 7.91 ± 0.04    | 4.31 ± 0.05     | 3.57            | 1.20            |
| HV2h    | 10.74\textsuperscript{a} ± 0.08 | 6.51\textsuperscript{a} ± 0.04 | 4.28            | 1.51            |
| HV4h    | 11.02\textsuperscript{a} ± 0.02 | 7.21\textsuperscript{a} ± 0.05 | 3.84            | 1.87            |
| HV2h&R  | 8.60\textsuperscript{ab} ± 0.06 | 5.41\textsuperscript{ab} ± 0.06 | 3.23            | 1.66            |
| HV4h&R  | 8.85\textsuperscript{ab} ± 0.05 | 5.61\textsuperscript{ab} ± 0.03 | 3.29            | 1.69            |

Data represent the mean ± S.E. of observations from eight rats.\textsuperscript{a}Significantly different from control group at *P* < 0.05.\textsuperscript{b}Significantly different from HV group at *P* < 0.05.

Effect of *R.officinalis* extract on kidney function parameters in the serum of rats treated with HV:

Results in Table (4) show that there were no presumed divergences in urea, uric acid, and creatinine scale after 30 days between *R.officinalis* extract remedy groups relative to regular control.
Table 7
Effect of *R. officinalis* extract on kidney function in rats exposed to HV 2 and 4 h.

| Groups     | Urea (mg/dl) | Creatinine (mg/dl) | Uric Acid (mg/dl) |
|------------|--------------|-------------------|-------------------|
| Control    | 28.41 ± 0.02 | 2.64 ± 0.05       | 4.59 ± 0.02       |
| R          | 28.47 ± 0.02 | 2.92 ± 0.03       | 4.63 ± 0.02       |
| HV2h       | 35.31 ± 0.15 | 4.81 ± 0.02       | 7.98 ± 0.02       |
| HV4h       | 39.63 ± 0.06 | 5.49 ± 0.03       | 8.33 ± 0.01       |
| HV2h&R     | 33.37 ± 0.05 | 3.29 ± 0.02       | 6.29 ± 0.02       |
| HV4h&R     | 33.91 ± 0.03 | 3.52 ± 0.02       | 6.55 ± 0.01       |

Data represent the mean ± S.E. of observations from eight rats. a Significantly different from control group at *P* < 0.05. b Significantly different from HV group at *P* < 0.05.

These findings are consistent with abundant authors who reported no presumed divergence in kidney function parameters in rats that feed on rosemary (Hassanen 2015). Rosemary aqueous extracts also contained high antioxidant content, such as certain phenolic compounds. They are rosemary and carnosic acids (El-sherif and Issa 2015). Meanwhile, HV treatment for 2 or 4 h increased the serum urea scale by approximately 24% and 40%, while creatinine increased by around 82% and 108%, while uric acid scale increased by about 74% and 82% compared to control group. However, the urea, uric acid, and creatinine serum scale showed a suspected diminishing (*p* > 0.05) in the handling of *R. officinalis* extract. *R. officinalis*, in combination with 2 h exposure to HV, indicates a small decrease in concentration of urea. The urea scale decreased by approximately 14% after 4 h relative to the group exposed to HV for 4 h. On the other hand, creatinine was assumed to be reduced by about 32%, and 36% by *R. officinalis* extract simultaneously as HV exposure (*p* > 0.05) compared with groups exposed to HV 2 or 4 h, respectively. Also, *R. officinalis* extracts reduced uric acid by around 22% simultaneously with the assumed exposure to HV (*p* > 0.05). The current findings are consistent with Sharma et al. (2017). In rats exposed to electromagnetic radiation, those who reported serum uric acid, urea, creatinine (*p* > 0.05) were presumed to have increased. Irradiation can cause DNA molecules to split, and their bases (purines) broken, which can be catabolized into uric acid (Ganong 1999). Creatinine is predominantly produced in the muscles, and freely appears in the blood plasma and urine. Also, a reported rise in serum urea (*p* < 0.05) and creatinine due to sensitivity to extremely low-frequency electrical fields (Kulkarni and Gandhare 2015) and exposure to EMF of 2 mT, 50Hz (Hashem and El-Sharkawy 2009).

**Effect of *R. officinalis* extract on oxidative stress in liver tissue homogenate of rats treated with HV:**
ROS formation may be derived from oxidized dietary fats. It may lead to increased protein deterioration in
the liver by enhancing cell membrane LPO. Increasing ROS generation can lead to calcium homeostasis
disorders, increased membrane fluidity, and cell death (Hassanen 2015). Table (5) shows no presumed
divergences between R.officinalis extract remedy groups compared to standard control in CAT and MDA
vigor after 30 days.

Meanwhile, HV sensitivity increased by approximately 36.8 % (p > 0.05) and 42.4 % (p > 0.05) respectively,
while CAT vigor increased by approximately 20.2 % and 30.4 % relative to the control group (p > 0.05).
However, the MDA scale showed a suspected diminishing (p > 0.05) in handling with R.officinalis extract
simultaneously as 2 or 4 h exposure to HV. R.officinalis in rats exposed to HV for 2 or 4 h, respectively,
decreasing the elevation in MDA by around 16 and 13 percent. Meanwhile, the catalase vigor scale
showed a presumed increase (p>0.05) in handling with R.officinalis extract at the same time as HV
exposure for 2 and 4 h R.officinalis at the same time as HV exposure for 2 and 4 h, increased CAT vigor
by around 31 % and 5 % compared with HV exposure groups for 2 and 4 h, respectively. EMF extends the
existence of free radicals and may function as a cancer promoter or co-promotor.

Changes in the MDA scale thus indicate increased ROS development during exposure periods, which may
represent the pathological process of exposure to EMF (Ozguner et al. 2005). Plentiful studies have
shown that exposure to EMF is capable of causing the body's significant oxidative degradation (Sharma
et al. 2017). Other researchers reported similar observations in these parameters when rats were
magnetically exposed to 50 Hz (Ibrahim et al. 2008), low-frequency electric field (Guler et al. 2008),
microwave (Sokolovic et al. 2008), EMF (900 MHz) (Abd El Rahman et al. 2014), EMF (Khaki 2016). EMF
led to enhanced MDA content and raised H2O2 accumulation by inducing oxidative stress and cellular
deterioration (Grigor’ev et al. 2010). The electromagnetic field may be harmful by accelerating the loss of
hepatocyte plasma membrane integrity (Điđić et al. 2010). Rosemary has increased renal CAT reduction
and decreased MDA scale elevation, which can be due to the antioxidant properties that inhibit LPO
(Hassanen 2015). The Usage of food, which contains high antioxidants, became immensely popular
since plentiful diseases have been associated with oxidative stress (Hamzaa et al. 2012). The most
crucial function of antioxidants is to stimulate endogenous antioxidant defense systems or scavenge
interactive species (Labban et al. 2014). The reduction in CAT's enzymatic vigor may be Because of the
raised utilization of this antioxidant to counteract LPO production (Kalpana and Menon 2004). The
suspected decrease in CAT vigor may be due to the excess ROS that interacts with the enzyme molecules
that cause denaturation and partial inactivation (Mansour 2013).
Table 8
Effect of *R. officinalis* extract on liver oxidative enzymes in liver rats exposed to HV 2 and 4 h.

| Groups     | CAT (U/L) | MDA(nmole/g) |
|------------|-----------|--------------|
| Control    | 2.63 ± 0.01 | 4.95 ± 0.04 |
| R          | 2.70 ± 0.03 | 4.93 ± 0.05 |
| M          | 2.71 ± 0.04 | 4.73 ± 0.04 |
| MIX        | 2.80 ± 0.07 | 4.65 ± 0.02 |
| HV2h       | 2.10a ± 0.06 | 6.77a ± 0.03 |
| HV4h       | 1.83a ± 0.01 | 7.05a ± 0.06 |
| HV2h&R     | 2.40ab ± 0.02 | 5.67ab ± 0.05 |
| HV4h&R     | 2.20ab ± 0.05 | 6.17ab ± 0.02 |

*Data represent the mean ± S.E. of observations from eight rats.*

| Significantly different from control group at P < 0.05. |
| Significantly different from HV group at P < 0.05. |

Effect of *R. officinalis* extract on histological examination of rats exposed to HV for 2 and 4 h

Histological changes to help the tested biochemical markers of damage to organs were screened. It is noted that autopsy samples taken from rat liver exposed to HV for 2 or 4 h manifest several alterations such as activation of kupffer cells, central vein and sinusoid swelling, hydropic hepatocyte degeneration, and fibroplasia in a portal triad with the emergence of focal hepatic necrosis associated with inflammatory cell infiltration in a community exposed to HV for 4 h. However, handling with either *R. officinalis* improved hepatic histopathology, with only mild kupffer cell activation in the group exposed to HV for 2 and 4 h. concomitant with *R. officinalis*. (Table 6 & Fig. 1).

The ELF-EMF caused focal centrilobular necrosis of the hepatic cells surrounded by severe hydropic degeneration involving most hepatic parenchyma in liver mice (Hashem and El-Sharkawy 2009).
Table 9
Histopathological notes on liver tissue of rats exposed to HV for 2 and 4 h plus *R. officinalis*.

| Histo-pathological lesion | Kupffer cells activation | Congestion of central vein and sinusoids | Vacuolation or hydropic degeneration of hepatocytes | Focal hepatic necrosis associated with inflammatory cells infiltration | Portal fibroplasia |
|--------------------------|--------------------------|------------------------------------------|---------------------------------------------|-------------------------------------------------|----------------------|
| Treatment                |                          |                                          |                                             |                                                 |                      |
| Control                  | -                        |                                          |                                             |                                                 |                      |
| R                        | +                        | -                                        |                                             |                                                 |                      |
| HV2h                     | +                        | ++                                       | ++                                         | -                                               | +                    |
| HV4h                     | ++                       | ++                                       | ++                                         | -                                               | ++                   |
| R&HV2h                   | ++                       | -                                        | -                                          | -                                               |                      |
| R&HV4h                   | +                        | -                                        | -                                          | -                                               |                      |

(-) no histopathological change (+) mild histopathological changes
(+++) moderate histopathological changes (++++) severe histopathological changes.

Conclusion

*R. officinalis* is considered one of the most substantial medicinal plants because it has effectively reduced the harmful impact of high voltage.

Declarations

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None.

Authors’ contributions

Sallam, K. Tony and Magda, E. Mahmoud: experimental investigation, analysis, data interpretation, writing and editing of original draft.

Dr. Hamadi, A. Ismail and Fawzy, S. Hatour: conceptuality, writing and editing, experimental investigation of computational study and interfacial behaviour.

Data availability
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Competing interests

The authors declare that they have no competing interests.

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