Journal of Faculty of Science (Menoufia University). **Vol. 27(1)**, (2023), 101-117
Title: The effect of radiation and cement dust …
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Received: 23/06/2023
Accepted: 05/09/2023
Published: 15/12/2023

Scientific Journal of Faculty of Science (Menoufia University)
ISSN: 1110-2195

The effect of radiation and cement dust on the DNA of femaleand male samples

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Abstract: The Nyquist plots of female and male DNA Samples were recorded using electrical impedance spectroscopy. The recorded curves were of the same features. The peak of each curve and its half-width were increased and shifted to higher impedance component values as, the expresser time increased 0,5,10,15,20,25 and 30 min, under the effect of any of laser radiation or gamma radiation. The obtained results for the female healthy DNA samples were: The electrical resistance was increased from 346.11KΩ to 922.4KΩ, while the electric capacity was increased from 15.3µF to 24.6µFunder the effect of laser radiation of constantPower100mW, (λ=532nm).These results under the effect of gamma radiation were the increase of the electric resistance from 145.37KΩ to 161.45KΩ and the increase of the electric capacity from 9.5µFto 14.1µF. For the male healthy DNA samples, the obtained results were: The electric resistance increased from 140.12KΩ to 929.17KΩ, while the electric capacity was increased from 2.02µF to 7.10µF. This means that the DNA efficiency of the female samples decreased more than that of the male samples. The effect of cement dust on female and male healthy DNA Samples was studied. The selected cement dust concentrations were 0, 1, 2, 3, and 4µL. The results of the DNA female samples were anincreasein the electrical resistance from 131.30KΩ to 2853.34KΩand the increase of the electric capacity from 7.86µF to 71.4µF. The obtained results of the DNA healthy male, samples were the increase of the electric resistance from 583.07KΩ to 4440KΩ and the electric capacity from 19.9µFto 4.82µF. These results confirm the decrease of the female DNA efficiency as a result of the increase of the cement dust concentration, more than that of the DNA male sample.

Keywords: radiation and cement dust effect, DNA, female and male samples.

1. Introduction

The nature and artificial electromagnetic radiation (EMR) sources are present (Panagopoulos 2018; Panagopoulos et al 2019) The EMR interacts with living cells and can be controlled using electromagnetic and thermodynamic laws (Roy 2020; Alcocer 2021; Salih 2020; Gupta 2020; Murphy 2018). Non-ionizing radiation does have not enough energy to remove electrons from atoms, but enough to move or vibrate atoms in a molecule (Alcocer et al 2021). Ionizing radiation has enough energy to knock electrons out of atoms, of living organs causing tissue and DNA in genes to be treated (Salih 2020; Gupta 2020; Murphy 2018). Ionizing radiation is clinically important for diagnostic and treatment (Mu and et al 2018; Miousse and et al 2017; Dong and et al 2017; Penninckx and et al 2020; Vanraes and et al 2020; Messori 2021; Chen 2022; Sauler and et al 2019; Alhaddad and et al 2021; Nolte 2019). Ionizing radiation can cause cells to die within a narrow time of irradiation. Mitosis, or the cell's ability to divide and proliferate endlessly, can be inhibited by high levels of radiation dose (Mori and et al 2021; Marci and et al 2018; Zastko and et al 2021; Ji and et al 2019; Helfinger and et al 2018; Angeli and et al 2019). Excessive radiation exposure can result in acute health problems such as skin burns and acute radiation syndrome "radiation sickness" (Tomonaga 2018. Exposure to low levels of ionizing radiation in the environment has no immediate health consequences, but it is a modest contributor to our overall cancer risk (Tapio and etal 2021). The penetrating power of gamma rays is so great and stopping it needs the use of perfect shielding material of highly absorption mass co-efficient (Elregig and et al 2020; Matthews 2019; Kars 2019; Subramanian 2020). Laser is artificial electromagnetic radiation that can be obtained with a certain frequency from different laser sources

(Gupta and et al 2022; Otsuji and et al 2022; Mahamood and Akinlabi 2021; Webb and et al 2020).The laser may have a high energy density, allowing it to be utilized as a focused laser in surgery or for Low-Level Laser therapy (Mahamood and Akinlabi 2021; Webb and et al 2020; Zhu and et al 2020; Sommer 2019; Stoica 2020; Goswami and et al 2020).

Other environmental factors affect mankind and DNA, such as human exposure to cement dust. Cement dust causes lung function impairment, chronic obstructive lung disease, restrictive lung disease, pneumoconiosis, and carcinoma of the lungs, stomach, and colon (Meo 2004; Meo 2021). Other research has found that cement dust can enter the systemic circulation and so reach virtually all of the body's organs, impacting various tissues such as the heart, liver, spleen, bone, muscles, and hairs, changing their microstructure and physiological function (Meo 2021; Dorrigiv and et al 2020; Owonikoko and et al 2021). The cement industry is a significant generator of environmental toxins (Lamare and Singh 2020) encountered during the production, distribution, and use of cement products occupational and environmental exposure to cement dust has been linked to a number of systemic injuries, particularly in the respiratory, gastrointestinal, and integumentary systems, including fibrosis, emphysema, cough, cancer, inflammation, and liver disease in cement factory workers and residents (Jalilian and et al 2020; Chen and et al 2018). A homogeneous mixture of hazardous heavy metals is used to make cement, which is widely used in the building industry Cobalt (Co), Iron (Fe), Lead (Pb), Cadmium (Cd), Chromium (Cr), Nickel (Ni), Manganese (Mn), and Arsenic (As) in various relative quantities have been regarded harmful to the body system (Jalilian and et al 2020; Owonikoko and et al 2020).

The aim of this research paper is to study the effect of Laser gamma radiation, and cement dust on the DNA blood samples in vitro of female and male samples using the electrical impedance spectroscopy and the electric capacitance.

2. Experimental technique

2.1 DNA preparation:

The DNA solution was prepared in vitro by the separation of the red and white blood cells by adding 9 milliliters from cold extraction buffer to only one milliliter of the given blood sample using the rate of 12,000 rpm centrifuge for 10 minutes to get rid of pure red blood cells. The same steps were repeated until the white blood cells were precipitated on the bottom of the falcon tube. The falcon tube containing white blood cells was poured into Eppendorf of lysis buffer and kept at 37 °C for 24 hours. Then 200 µl of NaCl was added to the Eppendorf content and centrifuged at 12,000 rpm within 10 minutes to get rid of the protein. 600µl of Isopropanol was added to the remaining in the Eppendorf (the upper liquid) and centrifuged again to get the DNA. The obtained DNA was washed using ethyl Alcoholat 70 % concentration and centrifuged at8000 rpm for 5 minutes Then 50 µl of Tris Edta (TE) buffer was added to the DNA and kept under healthy conditions.

2.2. The electrical impedance spectroscopy (EIS) measurements:

A.C electric potential of the value of 10mVwas applied across the two stainless steel electrodes dipped in their sample cell parallel to each other. These two electrodes were adjusted to be of the same area. The EIS measurements were curried in vitro at room temperature in the frequency range of 100 kHz to 10 mHz.

2.3. Cement treatment:

A mixture of 0.01 g of cement added to 1 cm of distilled water was vibrated to eliminate air inclusions andleft for 15 minutes. With increasing cement concentration, the needed electrical parameters were obtained.

DNA Irradiation:

Cobalt57 was used as a Gamma irradiation source with energy 122Kev.Also, the green laser beam of wavelength 532nm and power 100mW was used as a laser irradiation source. The exposure time period was 5 minutes, repeated 6 times as a cumulative dose with minutes separation. This was applied for Gamma and Laser irradiations.

3. Results and Discussion:

Fig (1a) shows the Nyquist graph of the DNA electrical impedance of female samples. This was recorded for the DNA sample before and after laser irradiation of constant power 100mW and wavelength 532nm, during successive different exposure periods5, 10, 15, 20, 25, and 30 min in a cumulative manner. The obtained results show that the electrical impedance was increased, and as a result, the a.c electrical resistance was increased. This may bedue to the gradual drying of the DNA Sample as a result of the generated and accumulated quantity of heat from, the used laser radiation. Also, from fig(1a) the values of the DNA capacities were increased all over the given periods. This may mean that the drying process leads to the increase of the dielectric constant of the DNA female samples.

Fig (1b) shows the Bode graph of the DNA of female samples under the effect of constant power laser radiation for the same previous given exposure periods. The results of fig (1b) are more sensitive than that of the Nyquist graph of fig (1a). This was noticed in the electric resistance decreases at low-frequency values and increases at high-frequency values. This may illustrate that the effect of the heat generated and accumulated may take some time to contribute to the drying process of the DNA given samples. Consequently, the drying process leads to an increase in both the values of the ac electric resistance on one side and an increase in the values of the electric capacitance as a result of the increase of the DNA dielectric constant on the other side.

Also, the qualitative results of table (1) illustrate the increase of the electric resistance from 346.11KΩ to 922.4KΩas the exposure laser time irradiation was increased at 0, 5, 10, 15, 20, 25, and 30 min. The electric capacitance has been increased also from 15.3µFto 24.6µF within the same laser exposure periods.

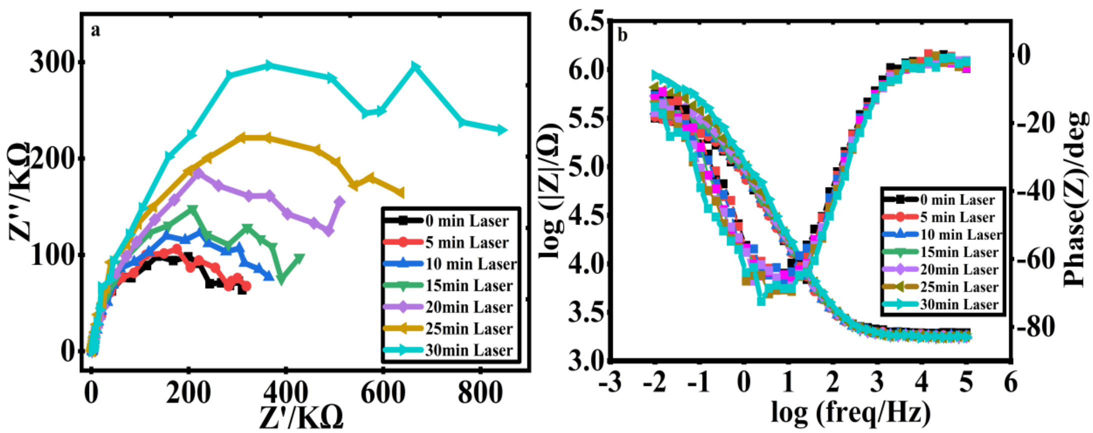

Fig. $1_{(a,b)}$ Show (a) Nyquist plot and (b) Bode plotsof female DNA irradiated by a green laser beam.

Table (1)

Laser Exposure Time (min)	**R_{ct}/KΩ**	**C (μF)**
0	346.11	15.3
5	353.80	9.56
10	412.08	12.2
15	437.72	6.86
20	595.79	8.74
25	693.33	10.1
30	922.40	24.6

Fig(2a) shows the Nyquist graph under the effect of gamma irradiation ofconstant energy122Kevwithin the time periods 0, 5, 10, 15, 25, and 30 min on the DNA of female Samples. The obtainedresults illustrate that as the exposure period increases the values of each of the a.c electric resistance and that of the electric capacitance were increased. These results, confirm the obtained results under the effect of laser irradiation on the female DNA samples.

Fig (2b) shows the Bode graph of the DNA female samples under the effect of gamma irradiation during the same given exposure time periods. These results confirm the previously obtained results under the effect of laser radiation i.e confirm the increase of the a.c electric resistance and the increase of the electric capacitance due to the increases of the dielectric constant.

Also, the quantitative results of table (2) show that the a.c electric resistance increased from 145.38KΩ to 161.45KΩ, while the electric capacitance was increased from 9.50μFto 14.1μF within the same exposure periods.

It is clear from the table (1, 2)that the effect of gamma radiation on the DNA female sample is more than the effect of laser on the values of electric resistance and electric capacitance. From table (2), the results of electric resistance and electric capacitance may reflect that the gamma dose corresponding to the exposure time of 30 min may be very close to the lethal dose.

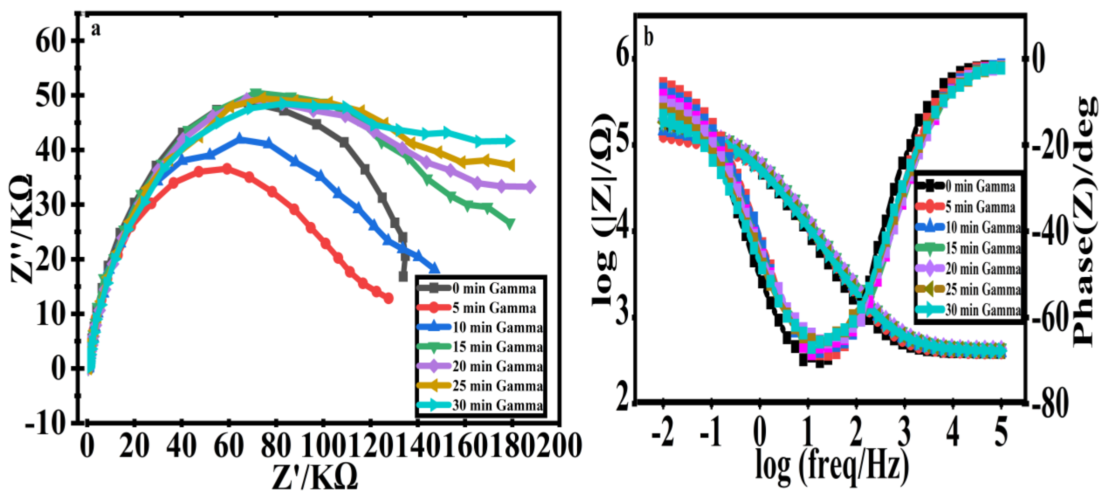

Fig. $2_{(a,b)}$ show(a) Nyquist plot and (b) Bode plots of female DNA irradiated by gamma ray.

Table (2)

GammaExposure Time (min)	R_{ct}/KΩ	C (μF)
0	145.38	9.50
5	103.96	8.54
10	122.95	7.45
15	157.30	6.19
20	160.30	6.34
25	164.18	9.36
30	161.45	14.1

The same experiment was repeated on the DNA Female Samples under the effect of different cement dust concentrations.

The cement dust concentrations were 1, 2, 3 and 4μl in a cumulativemanner, Fig (3a) shows the Nyquist graph of ac electric impedance under the effect of the increase of the cement dust concentration. The obtained resultsof the electric resistance and electric capacitance were increased. This means that the cement dust absorbs the DNA water content gradually. This leads to an increase in the DNA a.c electric resistance and an increase in the DNA dielectric constant. The datainthe table (3) illustrate that the a.celectric resistance was increased from 131.30KΩ to 2853.34KΩ and the electric capacitance increased from 7.86μFto 71.4μF as a result of the increase of the dielectric constant of the given sample.

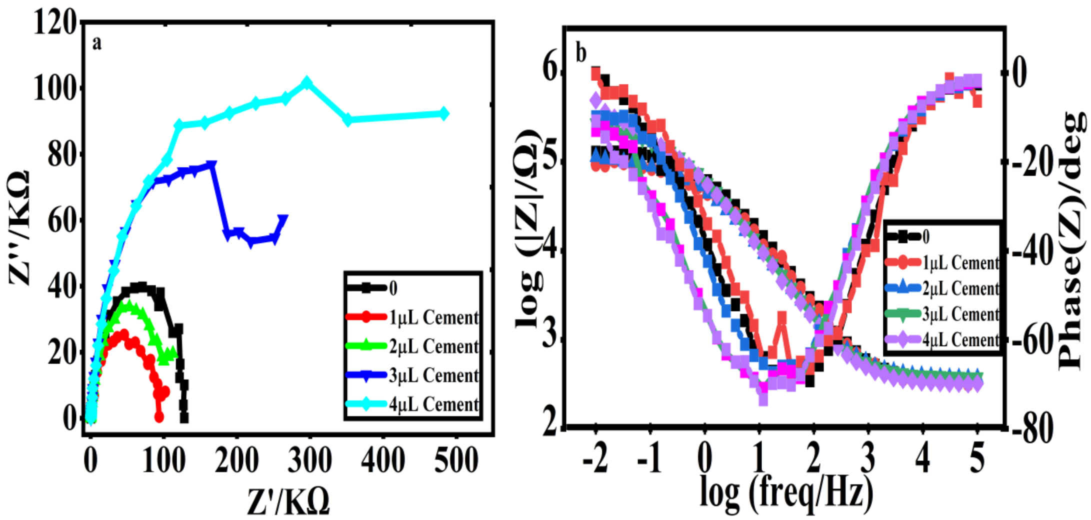

Fig. $3_{(a,b)}$ illustrate(a) Nyquist plot and (b) Bode plots for female samples and the effect of different cement dust concentrations.

Table (3)

Cement Concentration(μl)	R_{ct}(KΩ)	C (μF)
0	131.30	7.86
1	84.39	8.34
2	107.79	9.27
3	222.77	29
4	2853.34	71.4

All previous studies were repeated to investigate the effect of laser radiation and the cement dust concentration on the DNA of male samples in vitro.

Fig(4a) shows the Nyquist graph of the DNA of male samples under the effect of laser irradiation in a cumulative manner as the exposure time increases as 0, 10, 15, 20, 25, and 30 min. The obtained results show the increase of the a.c electric resistance as well as the increase of the electric capacitance of male DNA samples.

Fig (4b) shows the Bode graph of the male DNA samples, which confirms the results of fig(4a) for both a.c electric resistance and the electric capacitance. This means that the drying process due to the generated and accumulated quantity of heat, by the laser radiation increases the electric resistance and increases the electric capacitance of the DNA male samples.

Table (4) shows the increase of the air electric resistance from 140.12KΩ to 929.17KΩ and the increase of the electric capacitance from 2.02μF to 7.10μF as the exposure time increased from zero to 30 min, for the DNA male samples. These results confirm the given point of view of the drying process of the DNA male samples and the increase of both the a.c electric resistance and the increase of the electric capacitance.

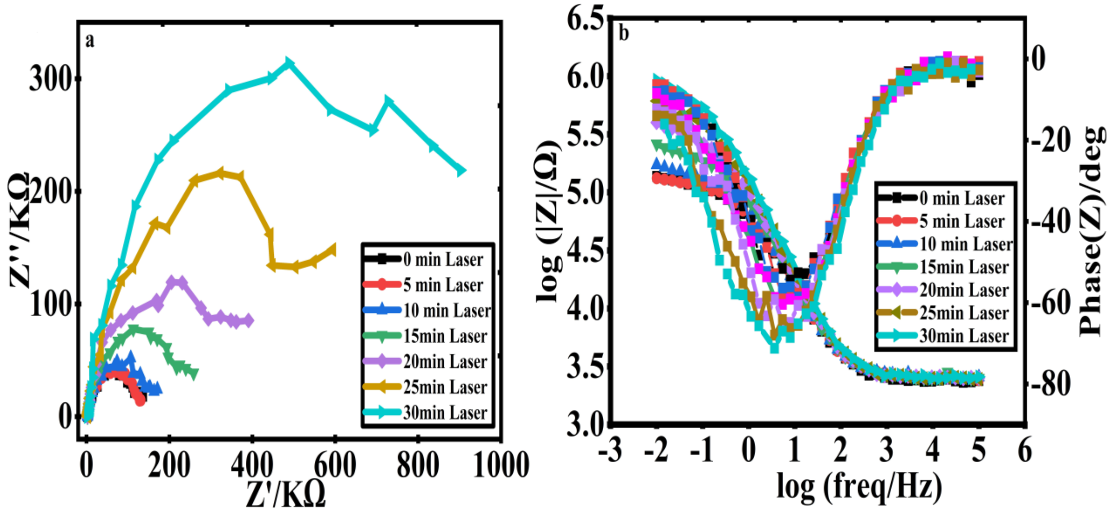

Fig. $4_{(a,b)}$ Show (a) Nyquist plot and (b) Bode plots of male DNA irradiated by a green laser beam (532nm/100mW).

Table (4)

Laser Exposure Time (min)	R_{ct}(KΩ)	C (μF)
0	140.12	2.02
5	136.14	2.04
10	174.27	1.67
15	268.25	5.95
20	342.21	4.49
25	576.31	6.95
30	929.17	7.10

Fig (5a) shows the Nyquist graph of the electric Impedance of the male DNA sample DNA under the effect of cement dust Concentration of the values 1, 2, 3, and 4μL. The obtained results show the increase of the DNA a.c electric resistance and the increase of the electric capacitance, In the given cement, dust concentration range. This means that the cement was absorb the DNA water content gradually. Consequentially, the DNA a.c electric resistance and the dielectric constant were increased.

Fig (5b) shows the Bode graph of the male DNA samples. These results confirm the results of fig (5a) for both a.c electric resistance and the electric capacitance.

The quantitative results of table (5), show the increase of the a.c electric resistance from 583.01KΩ to 4440KΩ and the increase of the electric capacitance from 19.98 µFto 4.82µF.

Generally, the previous investigation illustrates that the factor affecting the DNA sample in the case of female samples is more than its effect in the case of male samples. Consequently, the main result is a decrease in the female DNA efficiency much more than adecrease in the male DNA efficiency.

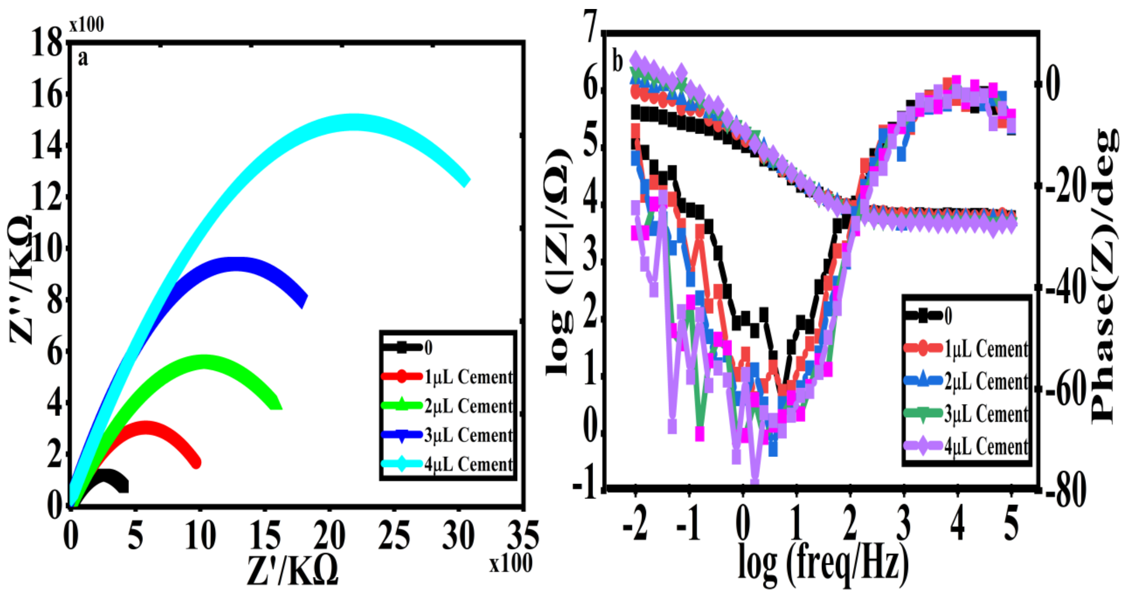

Fig. 5$_{(a,b)}$ show(a) Nyquist plot and (b) Bode plots of male DNA effected by cement dust .

Table (5)

Cement Concentration (µl)	R_{ct}(KΩ)	C(µF)
0	583.07	3.78
1	1400	11.29
2	1380	8.72
3	2720	5.5
4	4440	7.06

4. Conclusion

- The main conclusions of the effect of laser, Gamma radiation, and cement dust concentration are as follows.
- As the laser and gamma radiation exposure time was increased, each of the a.c electric resistance and electric capacitance of the DNA female samples was increased.
- The results of each a.c resistance and electric capacitance using the Bode diagram are more sensitive, and as the result the generated and accumulated quantity of heat, due to the effect of the laser and gamma radiation separately need some time to contribute to the drying process of the DNA water content of female samples.
- The drying process of the DNA of female samples leads to an increase in each of the a.c electric capacitance as well as the increase of the electric capacitance.
- The drying process of DNA was more severe under the effect of gamma irradiation than the effect of laser irradiation and care must be considered to be for away from reaching the lethal Gamma dose.
- The addition of 1, 2, 3, and 4µl of the cement dust concentration stepwise gradually leads to the increase of the a.c electric resistance and the increase of the electric capacitance of the DNA female samples. this may be due to that the cement dust concentration absorbs the DNA water content gradually.

- The obtained results for DNA male samples confirm all results of DNA female samples.
- The studied environmental factors illustrate that the efficiency of the female DNA sample decreases more than that of the efficiency of the DNA of male samples.

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Availability of data and material

All data supporting this work are original and is included within the manuscript. The corresponding author is responsible for supplying any additional data.

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