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RESEARCH ARTICLE

Mode of constant magnetic power effects on Escherichia coli viability and antibiotics activities

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ABSTRACT

Background: The region that a magnetic force has an effect on is known as a magnetic field. Normally, two poles of this field are concentrated. Most magnetic objects are made up of a variety of tiny fields known as domains. There are many different techniques that have been published in the literature for using magnetic energy as a diagnostic tool and for treating illnesses in both humans and animals. **Aims**: To investigate the effects of different levels of static magnetic field on the ultra structure of *Escherichia coli a* bacterium as well as their antibiotics activities changes. **Materials and Method:** Locally created dipolar static magnetic field with strength 400, 800, 1200, and 1600 Gauss and used. Between July and October 2022, ten patients with urinary tract infections at Hawler Teaching Hospital and Raparren Hospital for Children in Erbil were isolated for *E. coli* and then identified by Vitek test. Bacterial culture medium in equal amounts of broth was subjected to the magnetic field for 24 hours. Additionally, treated *E. coli* culture media (Vitek test) was compared with untreated negative control samples in the bacterial growth subculture, which was checked for bacterial population using spectrophotometer and Vitek diagnosis kit depended on response to different types of antibiotics. **Results:** An recognized bacterial strain known as *E. coli* was subjected to magnetic field with two poles pressures of (400, 800, 1200, and 1600) Gausses while it was incubated for 24 hours at a temperature of 37^{o}C. Optical density (O.D.) measurements at 620 nm were used. The results showed that the microorganisms' exposure to the magnetic field produced noticeable alterations on response to different types of antibiotics (Ceftazidime, Azetroname, Ceftazidime, Cefepime, Minocyclin, Azetroname, Ticarcillin/ Clavulanic acid, Azetroname, Piperacillin, Ceftazidime, Cefepime, Ciprofloxacin, Tobramycin, Imipenem, Meropenem, Amikacin, Nitrofurantin, Trimethoprim/ Sulfamethoxazole and Gentamycin) and significantly reduced the number of cells in the exposed bacteria as compared to the control. **Conclusions*:*** We came to the conclusion that due to bacterial mutation, the magnetic field could alter bacterial response to different types of antibiotics and bacterial population.

Keywords: Bacteria; Optical density; Magnetic field, E.coli. Antibiotic sensitivity

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1. Introduction:

For more than billion years, Earth has been producing a weak static magnetic field (SMF), also known as the geomagnetic field (GMF), near the surface with an intensity of about 50 T (Li, Haodong, *et al.* 2022). Indeed, there is mounting evidence that GMF can operate as energy to sporadically alter metabolic activities or as signals to aid many organisms in adapting to environmental changes [(Mouritsen, Henrik,2018; Clites, Benjamin L., and Jonathan T. Pierce ,2017).

The area that a magnetic force can affect is called a magnetic field. The two poles of this field are typically in the spotlight. These poles are typically referred to as north and south. Because the majority of magnetic objects are made up of numerous tiny fields known as domains, a magnetic field is not limited to these two directions. For the past century, people have been looking for evidence of a biological effect caused by magnetic fields (Kamel F. H., *et al.*, 2018).

All living things have experienced a static magnetic field (SMF) as a permanent environmental component throughout evolution. Numerous animals have shown that they can sense the magnetic field (MF) to help them navigate while migrating, returning home, eloping, and making nests (Fedele, Giorgio, et al. 2009).

Research on the effects of biomagnetic fields development and expansion of various species have produced both positive and unfavorable findings. Strong magnetic fields have positive effects on development rates, enzyme activity, cellular metabolism, DNA synthesis, and animal direction, to name a few (Gremion G, et al., 2009).

Enterobacter *E. coli*, which cause diarrhea, and extra-intestinal infection , which causes a variety of diseases in people, including Hemolytic uremic syndrome, persistent UTI, septicemia, and newborn meningitis, are two more subtypes of pathogenic *E. coli* strains (Croxen MA, Finlay BB ,2010).

Even while E. coli infections typically lead to full recovery, they can frequently have negative, even fatal, effects. Older persons, expectant women, young children, and those with weakened immune systems are more likely to experience these issues (Madappa, Tarun,2019).

Our objectives were to find out how different exposure durations to locally generated static magnetic fields of 400, 800, 1200, and 1600 G affected cell activity and growth rate.

2- Materials and Procedures:

2.1. Magnetic Field: Magnetic field with two poles was generated locally using 400, 800, 1200, and 1600 Gauss forces, among others, and was measured using a Teslometer in College of Science's , Physical Department of the University of Salahddin in Erbil, Iraq.

2.2. Growing Bacteria: From July to October 2022, patients with urinary tract infections at Hawler Teaching Hospital and Raparren

Hospital for Children in Erbil had their E. coli cultures isolated. These cultures were subsequently identified at the Hawler Medical Research Center using the Vitek test method (BioMerieux Company).

2.3. *E. coli* bacterial suspension will be divided to five distinct groups of the tube containing medium for nutrient broth, then incubated for 24 hours at 37oC. One group was subjected to 400 G, another to 800 G, and a third to 1200 G. Group 4 received 1600 G. and Group 5 was the control (lacking magnetic force) (Kamel F. H., *et al.*, 2013).

2.4. Because of some kind of process improvement made by the BioMerieux Company, Vitek kits analysis was developed by that company.

2.5. Evaluation of the impact of various magnetic field forces on growth rate using optical density measurement utilizing the McFarland Turbidity Standards (0.5) procedure (Koch, AL., Gerhardt, Pet a! 1994).

2.6. Antibiotic susceptibility test: Vitek diagnosis kit depended on response to different types of antibiotics (Ceftazidime, Azetroname, Ceftazidime, Cefepime, Minocyclin, Azetroname, Ticarcillin/ Clavulanic acid, Azetroname, Piperacillin, Ceftazidime, Cefepime, Ciprofloxacin, Tobramycin, Imipenem, Meropenem, Amikacin, Nitrofurantin, Trimethoprim/ Sulfamethoxazole and Gentamycin).

3. Results and discussion:

E. coli was subjected to various MF forces (400, 800, 1200 and 1600 Gausses). Exposure to these magnetic forces dramatically slowed *E. coli* cell development, especially after 24 hours of incubation, and significantly reduced the number of cells in the exposed bacteria as compared to the control (Table 1).

Table 1: A spectrophotometer is used to figure out how fast E. coli grows in each group.

Magnetic force	**OD 620 nm at 24 hours**	**Rate of bacterial cell count CFU (x10^6/ml)**
Control	**1.19**	**6.08**
400 G	**1.10**	**3.52**
800 G	**1.09**	**3.488**
1200 G	**1.06**	**3.392**
1600 G	**1.01**	**3.232**

Additionally, the magnetic field enhanced the logarithmic phase within the first four to six hours of treatment, but it reduced in comparison to the control after 16 to 24 hours Kamel F. H., *et al.* (2013).

With more exposure time and/or induction, the viability declines. The strength of magnetic force must be understood, though. In this investigation, E. coli showed the greatest reduction in viability employing the strongest magnetic field as compared to growth of unexposed bacteria just after the magnetic field was turned on.

The antibiotics were chosen to have various mechanisms of action (2). 4 hours after the exposure procedure, the suppression of bacterial growth with various magnetic forces was assessed in comparison to unexposed samples.

As resistant E. coli cells grew more susceptible to specific antibiotics, such as Ceftazidime, Gentamycin, Minocycline, Trimethoprim/Sulfamethoxazole, Piperacillin,

and Cefepime, increases in antibiotic sensitivity were also noted following a 24-hour exposure period. At the same time, other antibiotics changed from sensitive to resistant, e.g. Ciprofloxacin, Trimethoprim/ Sulfamethoxazole, Ceftazidime, Ceftazidime, Cefepime, Azetroname and Trimethoprim/ Sulfamethoxazole.

Table 2: Susceptibility test for *E.coli* result before and after different MG field exposure

Antimicrobial	Without MG (Negative control)		After MG power 1(400G)		After MG power 2(800 G)		After MG power 3 (1200G)		After MG power 4(1600 G)	
	MIC	Interpretation	MIC	Interpretation	MIC	Interpretation	MIC	Interpretation	MIC	Interpretation
Ceftazidime	16	R	4	R	8	R*	4	R*	4	R*
Cefepime	>=64	R	2	R*	2	R*	2	R*	2	R*
Azetroname	>=64	R	16	R*	16	R*	16	R*	16	R*
Azetroname	2	R*	<=1	R*	<=1	R*	-	-	-	-
Ceftazidime	16	R	>=64	R	-	-	>=64	R	4	R*
Cefepime	4	R	>=64	R	32	R	32	R	2	R*
Minocyclin	4	S	8	I	-	-	-	-	-	-
Azetroname	>=64	R	-	-	-	-	-	-	16	R
Ticarcillin/Clavulanic acid	>=128	R	32	-	-	-	-	-	-	-
Azetroname	16	R	-	-	16	R*	16	R*	16	R*
Piperacillin	>=128	R	64	R*	-	-	-	-	64	R*
Piperacillin	>=128	R	64	R*	-	-	-	-	64	R*
Ceftazidime	0.5	R**	1	R*	R*	R*	1	R*	1	R*
Cefepime	0.5	R**	1	R*	1	R*	1	R*	1	R*
Ceftazidime	<=1	R*	-	-	>=64	R	-	-	16	R*
Cefepime	1	R*	-	-	2	R*	2	R*	2	R*
Azetroname	1	R*	-	-	>=64	R*	16	R*	16	R*
Ceftazidime	<=1	R*	>=64	R	16	R*	>=64	R*	16	R*
Cefepime	<=1	R*	>=64	R	>=64	R	>=64	R	>=64	R
Azetroname	<=1	R*	>=64	R	>=64	R	>=64	R	>=64	R
Ciprofloxacin	2	R*	>=4	R	>=4	R	>=4	R	>=4	R
Piperacillin	32	R*	<=128	R	<=128	R	<=128	R	<=128	R
Tobramycin	8	R*	4	S	>=16	R	>=16	R	>=16	R
Minocycline	2	S	<=1	S	<=1	S	<=1	S	<=1	S
Imipenem	1	S	<=0.2	S	<=0	S	<=0.2	S	<=0.2	S

			5		.25		5		5	
Meropenem	0.5	S	<=0.25	S	<=0.25	S	<=0.25	S	<=0.25	S
Ceftazidime	<=0.12	S	<=0.25	S	-	-	-	-	-	-
Amikacin	<=1	S	2	S	2	S	-	-	-	-
Imipenem	0.25	S	-	-	-	-	-	-	0.5	S
Amikacin	2	S	-	-	16	S	16	S	16	S
Piperacillin/Tazobactam	<=4	S	-	-	8	S	8	S	8	S
Piperacillin/Tazobactam	8	S	64	I	-	-	16	S	<=4	S
Imipenem	>=0.25	S	1	S	0.5	S	0.5	S	32	I
Amikacin	<=2	S	-	-	4	S	4	S	4	S
Ciprofloxacin	0.5	S	-	-	1	S	1	S	1	S
Imipenem	<=0.25	S	-	-	-	-	0.5	S	0.5	S
Minocyclin	2	S	-	-	<=1	S	<=1	S	<=1	S
Minocyclin	25	S	<=1	S	<=1	S	<=1	S	<=1	S
Amikacin	16	I*	16	S	16	S	16	S	16	S
Nitrofurantoin	<=16	S	64	I	-	-	-	-	-	-
Ciprofloxacin	0.25	S	-	-	>=4	R	>=4	R	>=4	R
Trimethoprim/ Sulfamethoxazole	>=20	S	320	R	320	R	320	R	320	R
Ceftazidime	4	S	-	-	-	-	-	-	64	R
Ceftazidime	0.5	S	<=1	R*	<=1	R*	<=1	R*	<=1	R*
Cefepime	<=0.12	S	<=1	R*	<=1	R*	<=1	R*	<=1	R*
Azetroname	<=1	S	<=1	R*	<=1	R*	<=1	R*	<=1	R*
Trimethoprim/ Sulfamethoxazole	<=20	S	>=320	R	>=320	R	>=320	R	>=320	R
Ceftazidime	2	R*	<=1	S	2	S	2	S	16	R
Gentamicine	16	R	-	-	<=1	S	<=1	S	<=1	S
Minocycline	8	I	<=16	R	<=1	S	<=1	S	<=1	S
Trimethoprim/ Sulfamethoxazole	>=320	R	<=20	S	<=20	S	<=20	S	<=20	S
Piperacillin	8	R*	8	S	-	-	-	-	-	-
Cefepime	<=0.12	R*	<=1	S	-	-	-	-	-	-

Whatever the third group of antibiotics remain as it's without change in their response to the antibiotic. It has been studied in bacteria how magnetic fields of varied flux densities affect the viability of germs. These findings show that the physical features of the magnetic signal, notably the wave forces, which were connected to damage to cell membranes, may have a considerable impact on the biological repercussions that magnetic fields have.

Other research has produced comparable findings (Ji, Wenjin, et al., 2009; Kohno M, et al., 2000). The Vitek test kit results for antibiotic action can therefore be inhibited or promoted by treating enzymes with various magnetic fields. By using this assay, we could also determine the kind of E coli.

The data in table (1) show that the growth rate has significantly changed for exposure times of 24 hours. These data also show that the lag phase was brief and that the exposure groups' active growth periods were shorter than those of the unexposed cells in all times.

Additionally, after being exposed to various drugs for 24 hours, the bacterial sensitivity to those antibiotics changed, but after 24 hours, the bacterial resistance developed. The impact of magnetic fields on bacterial cells' genetic material came to an end at that point.

4. Conclusion: We got to the conclusion that the magnetic field could change how bacteria respond to certain antibiotics and how many germs there are due to bacterial mutation.

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