Effect of Magnetic field on the growth of *Escherichia coli* and Staphylococcus aureus

Samir.H.Nasher **Amal.A.Hussein** **

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Abstract

Magnetic fields with two densities (1200 , 3200)gauss experminted on two kinds of bacteria *Escherichia coli* and *Staphylococcus aureus* in Nutrient broth media . The field subjected for (1,2,3) weeks, and the growth monitored using optical density (OD) method.

The results shows greatest effects of 3200 gauss than 1200 gauss on bacteria growth comparing with control sample after third week. The OD resulte of bacteria *Escherichia coli* (0.3) with 3200 gauss and (6) with 1200 gauss comparing with control sample(175.4) and bacteria *Staphylococcus aureus* (1) with 3200 gauss, and (10) with 1200 gauss comparing with control sample (174.4).

Key words: Magnetic field , Bacteria

الخلاصة

تمت تجربة المجال المغناطيسي بشدتين مختلفتين (1200, 3200) gauss لمعرفة تأثيرهما على نمو نوعين من البكتيريا المرضية *Escherichia coli* و *Staphylococcus aureus* في وسط المرق المغذي Nutrient broth. وقد اجري النمو في ثلاث فترات مختلفة (1،2 ،3) اسابيع. بعدها فحص النمو بطريقة قياس الكثافة الضوئية Optical density .

اظهرت النتائج ان تأثير شدة المجال المغناطيسي 3200 gauss كان اكبر من الشدة 1200 gauss على نمو نوعي البكتريا والشدتان اثرتا على النمو بصورة كبيرة قياساً بالسيطرة لاسيما بعد الاسبوع الثالث حيث وصلت الكثافة الضوئية لنمو بكتريا *Escherichia coli*(0.3) عند الشدة 3200gauss و(6) عند الشدة1200 gauss قياساً بنموذج السيطرة (175.4) ولبكتريا *Staphylococcus aureus*(1) على التوالي مع شدة المجال 3200 gauss والى (10) مع الشدة 1200 gauss قياساً بنموذج السيطرة (174.4).

* Dept.of Applied Physics, School of Applied Science, univ. of Tech.. Iraq
** Dept. of Bio-Chemical Techniques, School of Applied Science, univ. ofTech..Iraq

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University of Technology-Iraq, Baghdad, Iraq/2412-0758

Introduction:

Bacteria are unicellular microorganisms .They are typically few micrometers and have many shapes .Bacteria are ubiquitous in every habitat on earth as well as in human body[1] .There are approximately ten times as many bacterial cells as human cells in the human body with large numbers of bacteria on the skin and in the digestive tract[2] .Although the vast majority of these bacteria are rendered harmless or beneficial by the protective effects of the immune system, a few pathogenic bacteria cause infections diseases , including cholera, syphilis, anthrax, leprosy and bubonic plague .The most common fatal bacterial diseases are respiratory infections[3]. Bacterial infections may be treated with antibiotics, which are classified as bacteriocidal (if they kill bacteria), and bacteriostatic (if they just prevent bacterial growth). Infections can be prevented by antiseptic measures such as sterilization[4]. Bacteria despite their apparent simplicity contain a well developed cell structure which is responsible for many of their unique biological property[5]. Perhaps the most elemental structure property is cell wall which is a phospholipids membrane. There are two main types of bacterial cell walls, *Gram positive* and *Gram negative*[6]. In this paper we use a magnetic flux lines for killing bacteria of both kinds (Gram negative and Gram positive cell membrane) megnatic field used for treating water contaminated with bacteria or microorganisms then returing the treated water back to the environment without realesed quantity of toxic chemical treatments to the environment[7]. This technique depends on the fact that there is no such a magnetic proof living tissue because of the ability of magnetic field to penetration.

Materials and Methods:

Two bacterial strains were used; *Escherichia coli* which has gram negative and *Staphylococcus aureus* with gram positive. These bacteria were kindly supplied by the Biotechnology department; College of Science, University of Baghdad, Baghdad, Iraq. The bacterial suspension was prepared and adjusted by comparison against 0.5*M*c-Farland turbidity standard (5×10^{7} cell.ml^{-1}) tubes .It was further diluted to obtain a final of 5×10^{6} cell. ml^{-1}.Both bacteria strains were sub culture on nutrient broth [8].The broth was inoculated by the 0.2ml/10ml broth with both bacteria strains , then the tubes were incubated at 37C^{o} for 24 h. The magnetic field has been subjected to the samples by means of permanent magnets .The magnets used in this research are Nd-Fe-B magnets with magnetic flux densities 3200 Gauss and 1200 Gauss .The magnets are placed outside the test tube and magnetic poles are oriented in opposite charge to each other (North pole in front of positive pole) .One sample from each type did not subjected to the magnetic field which act as control. The growth of bacteria was measured by turbidity at 600nm wavelength for all samples.

Results and Discussion:

Optical density results for *E.coli* and *S. aureus* obtained under different magnetic field (B) are shown in figure 1&2 .As shown in figures the values increase linearly for E&S samples (see table 1), and this part corresponds to Log phase in the growth curve .It seems very clearly that the OD values are higher for E than S, that is to say, the growth rate is higher .Backing to figures, the growth curves for E_m, E_{mm}, S_m and S_{mm} are taking different manner.

The OD values decrease sharply comparing with the start values. This manner has been affected by magnetic field lines .By comparing E_m and E_{mm} samples which differ by the flux density, the decrease rate is faster for E_{mm} than E_m, and this behavior is the same for S_m and S_{mm} but in different values.

It seems very clearly that magnetic field has significant effect on bacteria's cell as well as on its life[9]. The effect of magnetic field enclosed in cell membrane. The purpose of the membrane is two-fold. First, it contains a cell’s organelles and other cellular machinery (proteins) that are needed for survival second, it maintains a separation between the intracellular and extra cellular salt solutions in which the cell exists. The separation of ions across the bacterial cell wall is essential, and is maintained by the impermeable phospholipid membrane. different channel proteins transport different ions across biological membranes. One such ion is the proton, or positively charged hydrogen atom (H+). The flow of protons through ion channels in bacterial cell membranes is used to control the pH of the intracellular solution. The regulation of cellular pH is crucial for the survival of biological cells. This is true because if the pH is too high or too low, the structural integrity of intracellular proteins is compromised. This in turn makes the protein incapable of performing its normal duties, most of which involve catalyzing cellular reactions that are needed to keep the cell alive. A pH of 7 is neutral, and most cells cannot tolerate having an intracellular pH that is very far from this value. Therefore, bacteria (and other microorganisms) have developed ways of controlling their pH. The direction of flow of ions through protein channels is affected by both the electrical and chemical potential that exists across the cell membrane. The presence of a strong magnetic field is a good example of such an environment. The polarized regions of a large magnet will create highly unphysiological electrical potentials in the bacteria's environment. This potential will overcome any existing potentials in these very small cells, and they will no longer have control over the movement of ions across their membranes. The flow of ions across cell membranes is coupled to many important cellular processes Bacterial cells become very 'sick' when they lose the ability to regulate the ionic currents through protein channels. One of the deadliest scenarios is when the flow of protons is disturbed. In this case, the destruction of the protons electrochemical gradient equals the destruction of the ability to expel them from the cell. When the hydrogen ion concentration rises, then, the cell cannot release the ions to the environment, and the pH is lowered to a level that is not tolerable. That explain the behavior of sample E_m,E_{mm},S_m and S_{mm} in figures 1&2 which means the bacteria can not stay live any more.

Conclusion:

Using magnetic field technique for eliminating bacteria is very simple physical method. It can be used for both two kinds of cell wall bacteria .Both kinds interact with magnetic field in great response .Also the response increased when the field intensity increased. This method can be used as sterilization method for its simplicity and effectiveness. So the magnetic field effects on bacteria consider a bacteriocidal.

Sample	*Bacteria Type*	*Magnetic field(B) (gauss)*	*OD after three weeks*
E	E. coli	0	175.4
E_m	E. coli	1200	6
E_{mm}	E. coli	3200	0.3
S	S. aureus	0	174.4
S_m	S. aureus	1200	10
S_{mm}	S. aureus	3200	1

Table 1: Shows changing of OD after three weeks at different magnetization conditions.

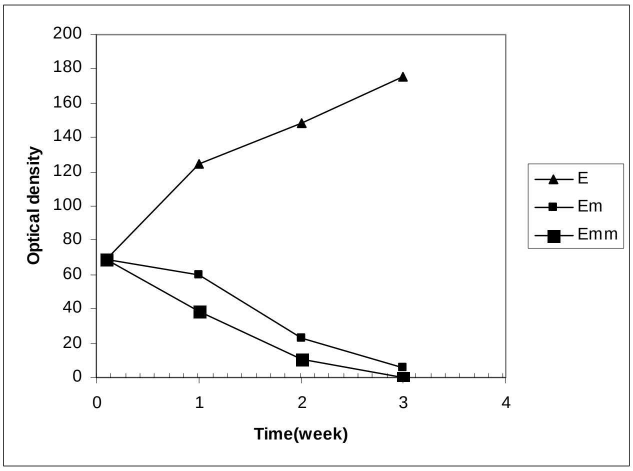

Figure 1: Shows the changing in OD values with B for *Escherichia coli*

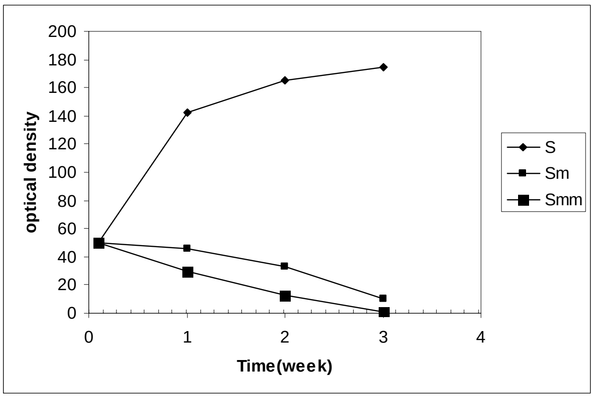

Figure 2: Shows the changing in OD values with B for *Staphylococcus aureus*

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