

Exposure of Infrared Rays to the Growth of Escherichia Coli Causes Diarrhea

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Exposure of Infrared Rays to the Growth of *Escherichia Coli* Causes Diarrhea

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Introduction

Acute diarrhea are common in children and adults. The condition is describe as defecating with unformed or watery stools and the acute onset of three or more in 24 hours [1]. According to [2] diarrhea is a world problem, in 2018 in the toddler age group, the prevalence of diarrhea in Indonesia was 12.30/o. The incidence of diarrhea lead to poor nutritional status and growth failure resulting in permanent weight loss due to loss of fluids to dehydration. The incidence of diarrhea includes 2 types, namely acute and chronic diarrhea [2].

Sudden loss of Fluids and electrolytes causes various complications such as dehydration, hypovolemic shock, organ damage and even coma. One of the factors causing the incidence of diarrhea in Indonesia is poor sanitation and environmental hygiene [3].

Diarrhea in developing countries mostly caused by infection of pathogenic bacterium *Escherichia coli*. *Escherichia coli* are pathogenic if they are not in their habitat, have the ability to produce toxins that cause disease [a]. The activity of bacteria can be inhibited or even growth of bacteria can be stopped. One of method that act as antibacterial is infrared rays [5] through the process of heat generated. Infrared rays are electromagnetic waves resolves within frequency 300 GHz ro 40,000 cHz16).

Discussion

Infrared rays are electromagnetic waves, with a wavelength of 700 nm and 1 mm, it define that infrared is included in invisible light. The light of infrared is not visible, but the heat radiation generated can be felt. Based on (Tanaka, 2013) that more than half of the sun's energy consists of near infrared. Infra red has three kinds, Near infrared (NIR) 0.75 - 1.5 m, Mid infrared (MIR) 1.50 - 10 m, Far infrared (FIR) 10 - 100 m, and in this case NIR is used for health therapy and in the field of imaging technotogy [8].

Infrared rays are included in electromagnetic waves and are in have the frequency range of 300 GHz to 40,000 GHz. Infrared light is produced [8] processes within molecules and hot obiects. Infrared according to is electromagnetic radiation of a wavelength that longer than visible light, but shorter than microwave radiation. It has long

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been known that hot objects due to atomic and molecular activity (vibrations) in infrared are thought to emit heat waves in the form of infrared rays. Infrared rays are often called heat radiation. In the health sector founded that radiant heat of infrared rays to the body's organs will describe condition on the health of these organs. Infrared rays are useful for doctors in diagnosis and making decisions according to the patient's condition [1]. Moreover, the study found that infrared may act as antibacterial.

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In the body, *Escherichia coli* lives as an opportunistic normal flora in the digestive tract. The number of *Escherichia coli* within normal limits will be beneficial, but if the number exceeds normal it will become pathogenic (Faridah et al.,2020). Pathogenic *Escherichia coli* is divided into strains that cause disease in the digestive tract, as well as strains that have the ability to infect outside the intestine[3]. *Escherichia coli* are Gram-negative bacteria with a protective cell wall layer or peptidoglycan that is easily destroyed when exposed to high temperatures. The colonies of *Escherichia coli* has a smaller size than the common bacterial colonies. Exposure to infrared rays with higher temperatures can interfere the growth of *Escherichia coli* which result in the growth is not optimal.

Escherichia coli bacteria belong to the family Enterobacteriaceae, gram negative with facultative anaerobes. Microscopic morphology is a short rod (coliform), has a peritrichous flagellum, with a cell size of 0.4µm-0.7µm x 2.4µm (Faridah et al.,2020). These bacteria do not have spores, are opportunistic pathogens that always increase their resistance to antibiotics [4].

Lately, reported by the researchers that *Escherichia coli* has loss sensitivity to many antibiotics, Several antibiotics including amoxicillin and cefuroxime have reduced activity against *Escherichia coli* (Esti & Rosandria,2021), whereas it was reported that in Urinary tract infection (UTI) patients in South India, showed increased resistance to ciprofloxacin (Mandal et al.,2010). Several studies showed that *Escherichia coli* resistance to Antibiotic from food sources can spread to humans, colonize in the intestines and have the potential to cause infections, generally urinary tract infections (UTIs) [7], in addition causing bloodstream infections, food-borne infections, and meningitis in infants [8]. Some strain of *Escherichia coli* can become pathogenic and could contribute to biofilm formation [9].

Conventional antibacterial therapy with antibiotic especially against pathogenic *Escherichia coli* could be unsuccessful. Therefore, approach in physical stimulation promising to be developed. These strategies have a broad spectrum and highly effective to inhibit and

stop the growth of bacteria both normal or multidrug-resistant (MDR) bacteria [10]. Infrared is a method using physical stimulation to works with their function.

Research conducted by (Rianti,2021) explained that the use of infrared exposure at distance of L cm, 2 cm and 3 cm for 20 minutes against Escherichia coli growth with the number of colonies as the indicator, showed that the number of Escherichia coli colonies was decline within the groups (p value = 0.000) which indicated that there was an effect of exposure to infrared rays on growth of Escherichia coli colonies. Research conducted by Listyawati [9] showed that the ability of Near infrared to inhibit of Escherichia coli growth has a potential effect by using variations of exposure time. In this study, time variations of infrared exposure are 20 minutes, 30 minutes and 35 minutes. The results showed that the number of Escherichia coli colonies with infrared exposure for 35 minutes is the lowest number, and significantly different with the other infrared exposure time.

According to previous research showed that exposure of infrared for the number of colonies of Escherichia coli with the variations of distance and time shows difference on the number of Escherichia coli colonies. infrared rays has the characteristics of being easily absorbed by organic materials. Escherichia coli with a peptidoglycan layer will be more easily destroyed by infrared exposure, because the organic materials in the bacteria will quickly absorb exposure to infrared light, so that the temperature of the bacteria will rise. This was stated by et (Rianti,2021) in a study with infrared exposure at a wavelength of 940 nm that can affect bacterial growth, and produce endogenous porphyrins, which are lightabsorbing and photosensitizing molecules [6].

Bacterial cells are excited to generated heat on the surface under light irradiation, aftermath the bacterium attached on the surfaces are killed by local hyperthermia. High temperature will destroy the bacterial rapidly by damaged their protein. Besides, photo-electrons are captured by environmental oxygen atoms and produce radical oxygen species (ROS) which killed the bacterial by protein oxidation and destroyed their membrane [12].

In general, light has the property of being able to damage the cells of microorganisms that do not have photosynthetic pigments. Cell damage and inhibition of microorganism growth can be caused by ultraviolet, infrared, X-ray and gamma rays [5]. Infrared rays are found in sunlight by 80%, and the wavelength is 4-1000 micrometers. Infrared rays generate heat, and that heat can be absorbed and reused [10].

According to in a study using ultraviolet light for the growth of Enterotoxigenic Escherichia coli, it was shown that bacterial growth was influenced by the distance of ultraviolet intensity. The results obtained show that the closer the distance of ultraviolet intensity, the greater the death rate of bacteria [5].

It was explained in research [10] that infrared cause heat radiation that can be felt within low frequency. Infrared rays can generate heat, and then the heat can be absorbed for further reused. It is clearly concluded that the infrared exposure inhibiting Escherichia coli by generating heat. Peptidoglycan properties in Escherichia coli is easily destroyed when exposed to high temperatures or heat. Escherichia coli is one of the causative agents of infection, and these bacteria are commensal bacteria or normal flora in the peritoneum or lower intestine. Escherichia coli is one of the pathogenic bacteria which causes diarrhea symptoms [11].

Diarrhea is one of the environmental-based diseases which means that the low level of sanitation will reduce the quality of life of the community. The word sanitation is a condition that affects health, such as disposal management of feces in humans and infections that are specifically related to drainage, sewage and garbage originating from households. The important role of sanitation is to create a healthy environment and prevent various environment diseases. Bad social behavior and poor environmental conditions seems to contribute on a person's susceptibility to diarrhea.

The state of health that is influenced by environmental conditions is influenced by toilet, garbage and drainage conditions. Healthy toilet fulfill the specified requirements, such as having a distance more than 10 meters from a water source, therefore the water source will be protected from dirt pollutants, free from odors and not polluting the ground surface. The most important thing is that the condition of the toilet that does not meet the requirements will pollute the environment with human waste and become a medium for transmission of pathogenic microorganisms that cause diarrhea.

Environmental factors that can cause diarrhea are garbage disposal places and drainage conditions. Based on [12] explained that waste is related to the incidence of diarrhea, and public health. This is caused by the condition of the waste contains microorganisms that cause disease and insects as vectors. Therefore, waste must be managed properly so have the minimum probability to disturbing and threatening health in society. Another factor that causes diarrhea is the condition of the sewage drainage channel, because it cause water

pollution from the surface or ground water that used for daily needs by the community.

[13]said that weather have a significant effect on the incidence of diarrhea, with differences factors such as temperature, rainfall, and humidity affecting the host resistance, virulence, and transmission of pathogens as well as changes in microbial exposure patterns [13]. The temperature causes diarrhea is varied, because each pathogen i has a different sensitivity to changes in temperature and humidity. Pathogenic bacteria that cause diarrhea have range temperature of 4°C - 45°C with an optimal temperature of 37°C, especially *Escherichia coli*. In *Escherichia coli* capable of fermenting lactose by producing gas. The optimum temperature for growth is 37° - 42°C. These bacterial colonies can survive for several weeks in culture storage at room temperature and can live for several months in soil and water [6]. The occurrence of high rainfall intensity increase the risk of diarrhea cases, because flood contaminate the water supply system easily.

Sunlight is very necessary to prevent diarrhea, because natural lighting reduces humidity [14], Some bacteria will die within 15 - 20 minutes at 60°C [6]. Sunlight is a source of energy and radiation. The sunlight radiation to the earth is influenced by the distance, the intensity of radiation from the sun [14]. The sun radiation is a natural radiation. Irradiation can be applied in various fields, such as sterilization, medicine, industrial chemistry, security, agriculture, and food. Irradiation is a method that applies electromagnetic waves, with the aim of reducing losses due to damage and decay. Irradiation can kill microorganisms that directly attack the DNA so that microorganisms cannot reproduce and can cause death for microorganisms.

Escherichia coli as the agent of diarrhea can be overcome by exposure to infrared which is electromagnetic waves and sunlight as well as electromagnetic waves. So that exposure to electromagnetic waves can inhibit the growth of *Escherichia coli* and prevent diarrhea.

Conclusion

Escherichia coli are Gram-negative bacteria have a protective cell wall layer or peptidoglycan layer that easily destroyed by high temperatures. *Escherichia coli* is pathogenic bacteria that cause diarrhea symptoms. Diarrhea is an environmental-disease, low level of sanitation will reduce the quality of community life. Infrared exposure with high temperatures can interfere the growth of *Escherichia coli* lead to suboptimal bacterial growth.

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