

EXPOSURE TO INFRARED RAY EFFECTIVELY REDUCES THE TOTAL GERMS ON EATING EQUIPMENT IN THE INDUSTRIAL CANTEEN

Viyasa Rezkananda, Kahar, Agus Saputra Somad

Bandung Ministry of Health Polytechnic, Department of Environmental Health
Jl. Babakan Loa, Gunung Batu, Cimahi, West Java
Email: viyasarezkan@gmail.com

Article Info

Article history:

Received October 13, 2022

Revised October 14, 2022

Accepted January 01, 2023

Keywords:

Number of germs

Cutlery

Sterilization

Infrared rays

ABSTRACT

Exposure To Infrared Rays Effectively Reduces the Total Germs on Eating Equipment in The Industrial Canteen.

Traditional food processing methods, unclean presentation and storage, and poor cutlery washing contribute to food-related diseases. The research occurred in an industry that transports oil and natural gas, fills LPG cylinders, and provides canteen facilities for workers to eat. According to Minister of Health Regulation No. 1096 of 2011, which pertains to Food Service Sanitation Hygiene, the permissible limit for the number of germs on cutlery surfaces is 0 colonies per cm². The inspection results showed that the number of germs on the plate did not meet the recommended 321 colonies/cm² threshold. We conducted this study to investigate the impact of varying infrared irradiation times on the number of germs on cutlery. The research was conducted using an experimental design, including a posttest and a control group, and involved three different irradiation time treatments: 10 minutes, 15 minutes, and 20 minutes, each with six repetitions. The study population consisted of 35 cutlery plates with a sample size 24. Data analysis was performed using the Kruskal-Wallis's test, with results obtained at $p < 0.05$ (0.000). After being irradiated for 10 minutes, 15 minutes, and 20 minutes, the average number of germs was 32 colonies/cm², 11 colonies/cm², and 0 colonies/cm². The study's findings on reducing the number of germs in the industry were influenced by differences in the length of time for infrared light irradiation. It is recommended that sterilization cabinets be used in industry to reduce the number of germs in industrial cutlery.

This is an open access article under the [CC BY-SA](#) license.



INTRODUCTION

Food is one thing that can fulfill basic human needs for growth and survival. Food poisoning is caused by the food itself, which can act as an intermediary for disease spread. Poor food management is the cause of disease transmission. This is influenced by several environmental factors (physical, chemical, and biological) as well as behavioral factors, namely the cleanliness of food handlers ⁽¹⁾.

Eating utensils play a significant role in the transmission of disease and are included in the principles of food sanitation and hygiene. Therefore, tableware quality must be considered,

including chemical, physical, and bacteriological quality. The quality of cutlery that does not meet the requirements is a factor in the presence of *Escherichia coli* bacteria ⁽²⁾.

The results of the total plate number test for cutlery plates carried out in the industrial canteen on February 26, 2022, were 321 colonies/cm² of cutlery area, and during the inspection on March 1, 2022, the results were 9.4×10^2 colonies. The germ number on the cutlery does not meet the requirements because it is above the specified value, namely no more than 0 colonies/cm². This refers to the Republic of Indonesia Minister of Health Regulation Number 1096 of 2011 concerning Jasa Boga Sanitation Hygiene Requirements ⁽³⁾. Implementing food sanitation is one effort that can be made to reduce contamination. Food sanitation is a preventive effort that focuses on activities and actions to eliminate food hazards, starting with food preparation, processing, storage, and serving. Food sanitation carries out efforts to prevent the transmission of disease to consumers, prevent the sale of food that could be detrimental to buyers, and ensure food safety ⁽⁴⁾.

Sterilizing cutlery can prevent bacterial contamination. In a medical sense, sterilization is a process using certain methods, with the result being that no more microorganisms are found ⁽⁵⁾. In the sterilization process, pathogens will be destroyed, including endospores ⁽⁶⁾. Endospores serve as a survival structure for bacteria, allowing them to survive under unfavorable conditions. One method of sterilization involves using infrared rays, which, in the irradiation process, can prevent the growth of cancer cells, bacteria, and fungi.

According to research, infrared sterilization for 15 minutes is the most successful sterilization in reducing the presence of *Bacillus subtilis* bacteria compared to using an autoclave with 70% alcohol and ozone. Infrared light is invisible to humans; it can only penetrate transparent materials, and components that can produce heat can also produce infrared rays ⁽⁸⁾. Other research shows that photoinactivation can occur when exposed to an infrared light-emitting diode (LED) with a wavelength of 950 nm, resulting in a 53% death rate for *Bacillus subtilis* bacteria at a light distance of 1.5 cm with an exposure time of 15 minutes ⁽⁹⁾. Then, infrared radiation with a wavelength of 700–1200 nm and a power of 150 watts for 70 minutes causes the death of *Escherichia coli* bacteria by 100%. 10. Infrared light is used in medical devices to stop the formation of *Escherichia coli* bacteria. With an exposure time of 20 minutes, it can inhibit bacteria for up to 2 days and prevent the formation of new bacteria for up to one week ⁽⁷⁾. Infrared exposure for 10 minutes with a wavelength of 950 nm and an exposure distance of 4 cm can reduce the number of germs on cutlery by up to 99.94% ⁽¹¹⁾. There was a reduction in the number of germs on cutlery by 99.98% by irradiating infrared light with a wavelength of 950 nm and an exposure time of 5 minutes ⁽¹²⁾.

Based on this background, we conducted research on sterilizing plates using the method of shining infrared rays with a wavelength of 950 nm, 150 watts, and 220 volts at different exposure times of 10 minutes, 15 minutes, and 20 minutes at a distance of 4 cm. Research was conducted to determine the effect of differences in length of exposure to infrared rays on reducing the number of germs on plates in industrial canteens.

MATERIALS AND RESEARCH METHODS

This type of research employs an experimental design with a posttest and control design. The posttest measures the number of germs on eating utensils that have been exposed to infrared light for 10 minutes, 15 minutes, or 20 minutes, while the control represents the number of germs on eating utensils without treatment. The research was conducted in an industrial canteen, with 35 eating utensils used as a sample. Sampling was carried out randomly, with a sample size of 24 plates.

The research was carried out using a cupboard measuring 60 cm by 35 cm by 50 cm, which can accommodate five plates. The sterilization cabinet is constructed from stainless steel due to its ability to reflect infrared light, maximizing its utilization⁹. The study used a sterilization

cabinet equipped with infrared lamps with a wavelength of 950 nm, 150 watts, and 230 volts. In this study, there was a distance of 4 cm between the infrared lamp and the eating utensils. The tool's design is shown in Figures 1 and 2.

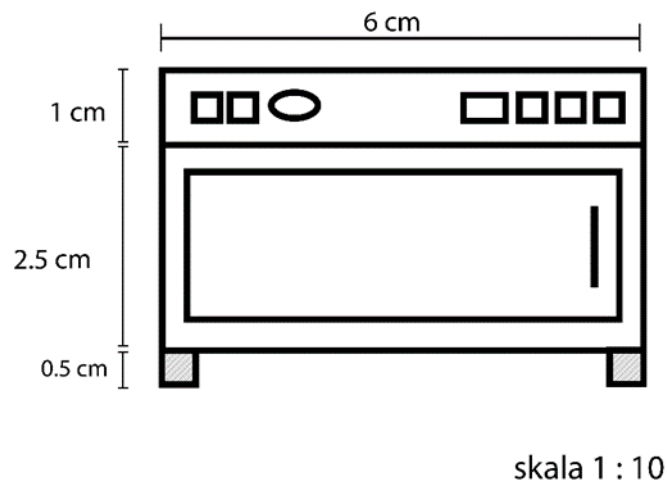


Figure 1. Front view tool design

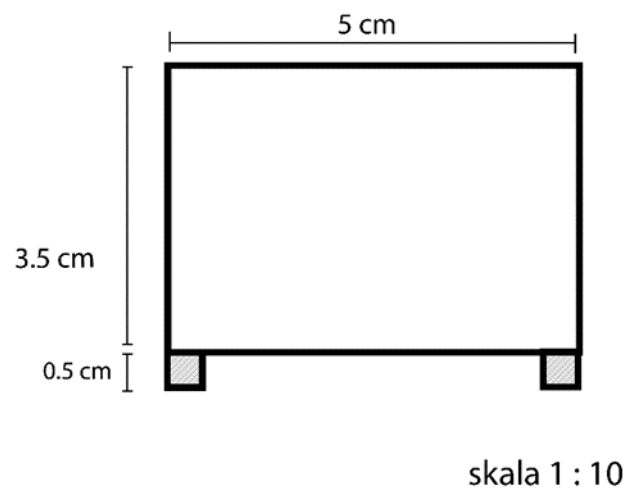


Figure 2. Side view of the tool design

RESULTS OF RESEARCH AND DISCUSSION

The results of the research that has been carried out are as follows:

Germ Numbers Without Treatment and With Treatment

The results of checking germ numbers on plates in industrial canteens are shown in table 1.

Table 1. Number of germs without treatment and with treatment

Repetition	Control (colonies/cm ²)	Treatment (colonies/cm ²)		
		10 minutes	15 minutes	20 minutes
1	290	28	9	0
2	265	32	14	0
3	235	19	8	1
4	335	25	11	0
5	310	38	7	0
6	350	45	13	0
Minimal	235	19	8	0
Maximum	350	45	14	1
Average	298	32	11	0

The number of germs decreased between cutlery that was not exposed to light and cutlery that was exposed to infrared light for 10 minutes, 15 minutes, and 20 minutes. The total number of germs on plates without treatment had an average of 298 colonies/cm² of surface area of cutlery and the total number of germs with treatment for 10 minutes, 15 minutes, and 20 minutes, respectively, had an average of 32 colonies/cm², 11 colonies/cm², and 0 colonies/cm². The decrease in the number of germs on the plate after treatment was caused by cell death and the organism's inability to form new cells due to the bacteria's absorption of radiation energy. A photoinactivation process occurs during infrared irradiation. This process occurs in three stages, namely photophysical, photochemical and photobiological processes ⁽⁹⁾.

Cutlery Washing Techniques



Figure 3 Graphic of Cutlery Washing Facilities



Figure 4 Graphic of Cutlery Washing Techniques

According to observations, the techniques for washing cutlery in industrial canteens are the stages of scraping (disposal of food waste), washing (washing), and rinsing (rinsing with water). Meanwhile, the washing stages that do not meet the requirements are flushing (soaking in water), sanitizing (disinfecting) and toweling (drying). The technique for washing cutlery in industrial canteens, with an observation percentage of 62.5%, does not meet the requirements.

Cutlery washing activities in industrial canteens have not been performed optimally. Factors that impact on this situation include inadequate washing facilities, which hinder the completion of several washing stages, and the conduct of the canteen staff during the washing process. Cutlery plays an important role in disease transmission, so efforts to reduce the number of germs can be made by washing cutlery properly¹³. Good washing facilities consist of at least three washing tubs (three compartment sinks). Using this method, along with detergent and chlorine solutions, can significantly reduce the number of germs on cutlery. Before washing, the germ number was 832 colonies/cm², and after washing, it was 51.11 colonies/cm² on the cutlery surface area⁽¹⁴⁾.

Cutlery Storage Facilities

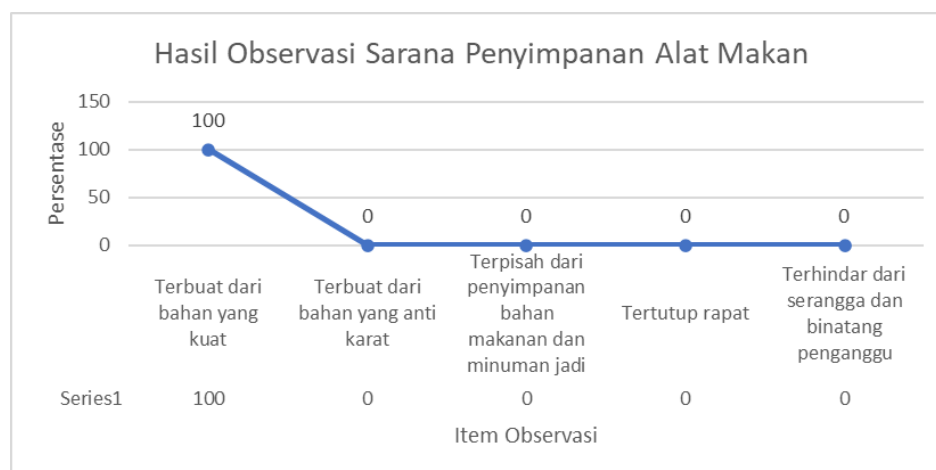


Figure 5 Graph of Cutlery storage facilities

The cutlery storage facilities used in industrial canteens only meet the cabinet's shape and material requirements. Storing cutlery in an open cupboard allows for contamination by

microbes and bacteria. This practice exposes food and ready-made food to vectors and pest animals, thereby increasing the risk of contamination.

Differences in Length of Contact Exposure to Decrease in Germ Numbers on Eating Utensils

After conducting research with three different exposure times, the number of different germs decreased. This is supported by the results of the Kruskal-Wallis test, with a p value of 0.000. Because the p value is less than 0.05, H_0 is rejected, indicating that there is a difference between the three-time variations in reducing the number of germs on cutlery in industrial canteens.

After being given radiation treatment using infrared rays, the number of germs on the plates decreased. The average number of germs on cutlery without treatment was 298 colonies/cm², and the average number of germs given irradiation using infrared light for 10 minutes was 32 colonies/cm², 15 minutes was 11 colonies/cm², and 20 minutes was 0 colonies/cm². Therefore, it can be concluded that the optimal time for exposure to infrared rays to reduce the number of germs on cutlery is 20 minutes.

In previous research, there was a difference in the number of germ numbers decreasing after being exposed to infrared rays with three different time variations; the number of germ numbers at a 2-minute exposure time variation was 43 colonies/cm², a 4 minute exposure was 18 colonies/cm², and a 6 minute exposure was 1 colony/cm²⁽¹⁵⁾.

Bacteria absorb radiation energy, which causes cell death and the organism's inability to form new colonies, resulting in a decrease in the number of germs on eating utensils. The effectiveness of infrared irradiation in reducing germ numbers depends on the intensity of the photoinactivation process; therefore, the longer the exposure time, the higher the number of germ deaths on cutlery.

CONCLUSIONS AND RECOMMENDATIONS

Based on the number of germs for each variation in length of time, we can conclude that differences in the length of infrared irradiation time influence the number of germs on cutlery. 20 minutes of exposure is the most effective time to reduce the number of germs on eating utensils. Suggestions are given for using sterilization cabinets in industry to reduce the number of germs on cutlery.

REFERENCES

1. Riyanto A, Abdillah AD. Faktor yang Memengaruhi Kandungan E. coli Makanan Jajanan SD di Wilayah Cimahi Selatan. *MKB*. 2012;44:77-82.
2. Putri KR, Nurjazuli, Hanani D yusniar. Hubungan Higiene Dan Sanitasi Makanan Dengan Kontaminasi Bakteri Escherichia Coli Dalam Makanan Di Warung Makan Sekitar Terminal Borobudur, Magelang. *J Kesehat Masy*. 2015;3(1).
3. Kemenkes RI. Permenkes RI No. 1096/Menkes/Per/ VI/2011 tentang Higiene Sanitasi Jasaboga. *J Chem Inf Model*. 2011;53(9):1689-1699. <https://peraturanpedia.id/peraturan-menteri-kesehatan-nomor-1096-menkes-per-vi-2011/>
4. Prabu. *Higiene Sanitasi Makanan*.; 2008.
5. Raudah R, Zubaidah T, Santoso I. Efektivitas Sterilisasi Metode Panas Kering pada Alat Medis Ruang Perawatan Luka Rumah Sakit dr. H. Soemarno Sosroatmodjo Kuala Kapuas. *J Kesehat Lingkung J dan Apl Tek Kesehat Lingkung*. 2017;14(1). doi:10.31964/jkl.v14i1.56

6. L T, Bossemeyer D, McIntosh N. *Panduan Pencegahan Infeksi Untuk Fasilitas Pelayanan Kesehatan Dengan Sumber Daya Manusia*. Yayasan Bina Pustaka Sarwoso Prawiroharjo; 2004.
7. Yudianti I, Suprapti S, Hupitoyo H. Perbandingan Efektifitas Sterilisasi Panas Kering dan Desinfeksi Tingkat Tinggi Teknik Rebus terhadap Pertumbuhan Escherichia Coli. *J Pendidik dan Pelayanan Kebidanan Indones*. 2017;2(1). doi:10.24198/ijemc.v2i1.66
8. Adji D, Zuliyanti, Larashanty H. Perbandingan efektivitas sterilisasi alkohol 70% inframerah, otoklaf dan ozon terhadap pertumbuhan bakteri Bacillus subtilis. *J Sain Vet*. 2007;25(1):17-24.
9. Dyah Astuti S, Basalamah R, Yasin M. Potensi Pemaparan Light Emitting Diode (LED) Inframerah Untuk Fotoinaktivasi Bakteri Bacillus subtilis. *J Biosains Pascasarj*. 2015;17(1):10. doi:10.20473/jbp.v17i1.2015.10-18
10. Hussein IMS, Abdullah SH, Mohammed SF. Effects of infrared radiation on escherichia coli isolated from appendectomy. *Indian J Public Heal Res Dev*. 2019;10(6). doi:10.5958/0976-5506.2019.01373.1
11. Afifah ZI, Hasan, Yuniarti, Nia dan Lubis B. Efektivitas Variasi Waktu Kontak Sinar Inframerah terhadap Penurunan Angka Kuman pada Alat Makan. *J Ris Kesehat poltekkes depkes bandung*. 2019;11.
12. Fauzianti F. *Efektifitas Waktu Kontak Sinar Inframerah Terhadap Penurunan Angka Kuman Pada Alat Makan Di Kantin Pujasera PT. Pupuk Kujang*.; 2020.
13. Marisdayana R, Harahap PS, Yosefin H. TEKNIK PENCUCIAN ALAT MAKAN, PERSONAL HYGIENE TERHADAP KONTAMINASI BAKTERI PADA ALAT MAKAN. *J Endur*. 2017;2(3). doi:10.22216/jen.v2i3.2052
14. Andriyani A. Pengaruh Larutan Detergent dan Larutan Klorin Pada Proses Pencucian Alat Makan dengan Metode Three Compartment Sink Terhadap Penurunan Jumlah Angka Kuman pada Alat Makan di RS PKU Muhammadiyah Surakarta. *GASTER*.:378-379.
15. Windi. *Perbedaan Waktu Kontak Sinar Inframerah Terhadap Penurunan Jumlah Bakteri Pada Alat Makan Di PT. Insansindang Internusa Rancaekek Sumedang*. Poltekkes Kemenkes Bandung; 2017.

