Design And Study UV Sterilization System For COVID19

by Raghad Wessam Al-deen Kareem Abd

Submission date: 10-Sep-2024 10:26AM (UTC+0700)
Submission ID: 2449752748
File name: KG24-3418_1.pdf (1.73M)
Word count: 5371
Character count: 29088

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Raghad Wessam Al-Deen Kareem Abd

Al-Nahrain University, College of Engineering, Biomedical Engineering

Email: raghadkarem8@gmail.com

Abstract: ***This Project Focuses On The Disinfection Of Surfaces And Items From Microorganisms, Particularly COVID-19, Using Ultraviolet Radiation. UV Germicidal Irradiation, Particularly In The 200-280 Nm Range, Is Highly Effective In Killing Many Microorganisms. To Test Klebsiella, Two Designs Were Constructed Using Canadian UV Leds And Chinese UV LEDS. The Results Showed Successful Disinfection With A High Microorganism Killed Ratio. The Chinese Design Had The Highest Disinfection Percentage Ratio Of 69.24%, While The Canadian Design Achieved 89.66%. Although The Canadian Design Is More Expensive, It Shows Excellent Results And Is Worth The Cost.***

Keywords: Genera Electric, Covid19, Sterilization,

1.1 INTRODUCTION

COVID-19, a contagious and dangerous viral infection caused by the SARS-Cov-2 virus, has spread globally, resulting in over 3.8 million cases and 265,000 deaths. The virus is enveloped and can be transmitted through respiratory droplets, nasal, oral, and ocular mucus, and can remain viable in aerosols for up to 72 hours on plastic surfaces. Radiation disinfection, particularly ultraviolet (UV) radiation, is a widely recognized method for inactivating microorganisms and viruses. Advancements in UV laser imaging and beam delivery systems have made UV light more practical and energy efficient. The ultraviolet spectrum is divided into four sections: vacuum ultraviolet radiation (VUV), UVC, UVB, and UVA, with UVC having the most potent antimicrobial/antiviral properties. Various UVGI systems and equipment are available for disinfecting air and surfaces, including lamps, fixtures, ballasts, filters, light baffles, and surfaces that absorb UV radiation.

1.2 Literature Survey

In **(2005), K. Murai1, Et Al,** Analyzed the effectiveness of sterilization using UV emissions from laser plasmas by laser-induced gas breakdown. A laser plasma was created in a gas cell using a pulsed YAG laser system through laser-induced gas breakdown. The breakdown of Xe gas produces the highest intensity of UV emission in the wavelength range of 200 to 300 nm and exhibits superior sterilization performance compared to other gas breakdowns. [5]

In **(2009), Xiaohui Huang, Et Al,** Ultraviolet Light Emitting Diodes (UV LEDs) are employed as a light source in TiO2 photocatalysis due to their numerous benefits, including extended lifespan, safety, and less pollution. The researchers successfully fabricated a light source panel using UV LEDs, which exhibited a somewhat uniform distribution of light

intensities. The UV LED light source panel had a greater surface area for irradiation compared to a mercury lamp. Therefore, its sterilization efficiency surpassed that of conventional methods. The viability of using UV LED/TiO2 for photocatalysis has been demonstrated. [6]

In (2013), Kyou-Hwa Park, Et Al, A study in rabbits examined the impact of UV-C radiation on anodized titanium surfaces and tissue response. Using a bactericidal UV sterilizer, the study found no significant changes in the topography or surface roughness of the titanium surface. The study also found UV-C exposure promoted an early bone response in rabbits. [7]

In **(2015), Yu, N., Zhang, Et Al,** The study evaluated the sterilizing effects of nano-ZnO and ultraviolet radiation on ready-to-eat vegetable dishes, comparing their bacteriostatic effects to potassium sorbate and sodium benzoate treatments. Results showed nano-ZnO inhibited microorganism growth, indicating a promising approach for preserving vegetable dishes. [8]

In **(2019), Qasim Husain, Et Al,** The study compares ultraviolet light to traditional sterilization methods in saline irrigation bottles for treating sinus disorders. Results show that all methods significantly reduce bacterial load, with UV light treatment achieving simultaneous disinfection of both water sources and bottles. [9]

In 18 July (2020), K. O'Hearn, Et Al, A study found that UV germicidal irradiation can effectively decontaminate N95 and SN95 masks without affecting their performance or safety. The level of decontamination was linked to cumulative UV dose and conditions used to simulate viral spread. The study suggests UV light decontamination can be a successful method for removing infectious pathogens from masks. [10]

In 28 September (2020), Yoram Gerchman, Et Al, Researchers tested the effect of UV-LED wavelengths on COVID19 using two UV-LED systems. The circular system included LEDs with peak emission wavelengths at 279 and 297 Nm, while the rectangular system included LEDs with peak emission at 267 and 279 Nm. Both systems effectively inactivated the virus. [2]

In 19 October (2020), Davis T. Weaver, Et Al, Provide a step-by-step process for decontaminating personal protective equipment (PPE) using ultraviolet (UV) radiation in biosafety cabinets (BSCs), which are commonly found in academic, public health, and hospital laboratories. The laboratory's Gard Bscs were outfitted with a General Electric germicidal lamp that emits UV-C radiation at a wavelength of 253.7 nm. This lamp delivers an average intensity of 100 μwcm−2 to the floor of the cabinet. The Thermofisher BSC was equipped with an Atlanta.

Researchers have demonstrated complete inactivation of Human Coronavirus NL63 on N95 mask material after 15 minutes of UV-C exposure, providing support for healthcare organizations seeking to extend PPE reserves. Decontamination time is estimated to be 4.3 hours per side. [11].

1.3 Aim Of The Project

The objective of this study is to assess the impact of UV light on COVID-19.This sterilization method is highly suitable and advanced, making it applicable in many settings such as medical clinics, hospital rooms (including surgical rooms), and waiting rooms, among others. This is accomplished by attaining the subsequent objectives:

-Develop a fixed-position sterilization device with the capability to do a 270-degree scanning in a given area.

Identify the most suitable recommendation for a microorganism that closely resembles COVID-19 in terms of its characteristics and effects.

Conduct an experiment on this accessible microorganism by subjecting it to radiation and observe the alterations it undergoes before and after the exposure.

Discover the optimal conditions to achieve maximum efficiency and successful decontamination in your experiment..

1.4 Outline Of The Project

1. Chapter One provides an introduction to the virus and the use of UV for disinfection. It also includes a literature survey that examines various applications of UV disinfection. The chapter concludes with a discussion of the project's objectives.
2. Chapter Two provides an introduction to UV (ultraviolet) and its germicidal irradiation theory. It also discusses the impact of COVID-19 on the lungs and the application of UV in the medical system.
3. Chapter Three encompasses the experimental work, which entails the experimental setup and the procedure employed in the study.
4. Chapter Four Includes The Results And Discussion.
5. Chapter Five Includes The Conclusion And Future Work.

2. Theoretical Background

This chapter explores the concept of Ultraviolet Germicidal Irradiation (UVGI), a method that utilizes UV wavelengths to effectively disinfect both air and surfaces. UVGI, or ultraviolet germicidal irradiation, is different from UVA wavelengths such as UVC and UVB, which do not have germicidal properties. Ultraviolet A (UVA) radiation with a wavelength below 320 nm is considered actinic, meaning it has the ability to cause photochemical reactions. The UVA and UVB bands have been redefined to encompass all actinic UV radiation, rendering UVA completely non-germicidal. This categorization classifies germicidal UV into two distinct bands: UVB and UVC.

Table 2.1 Primary Bands Of Ultraviolet Radiation. [4]

Band	Wavelength, nm	Type And Classification		
UVA	320-400	Non-Germicidal (Near-UV, Blacklight)		
UVB	280-320	Erythemal	Germicidal	Actinic
UVC	200-280	Ozone-Production		
VUV	100-200	Vacuum Ultraviolet		

2.2 Ultraviolet Germicidal Irradiation (UVGI) DisinfectionTheory

Ultraviolet Germicidal Irradiation (UVGI) is electromagnetic radiation that inhibits microorganisms' reproductive ability by causing photochemical alterations in nucleic acids. UVC wavelengths are particularly harmful, with maximum germicidal effectiveness at 260-265 nm. UVB wavelengths have minor impact. [4]

UV irradiation is a common method for sterilizing materials, but it has mutagenic properties due to the generation of free radicals that disrupt large molecules and their absorption by DNA, threatening cell viability, despite its low penetrating power. [12]

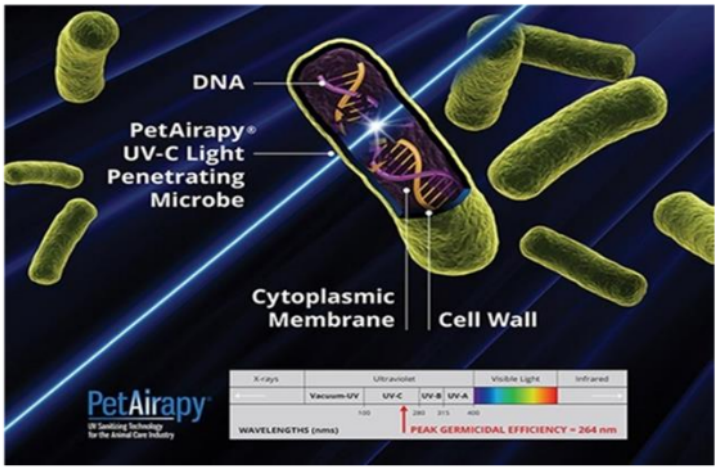

Figure (2.1): The Science Behind UV Sanitization. [13]

UV-induced mutations in humans lead to skin cancer, causing uncontrolled cell proliferation. Preventing skin cancer is easy with appropriate clothing and sunscreen, shielding the skin from harmful UV rays. [12]

2.2.1 UVC Tube Characteristic

UVC refers to the range of germicidal wavelengths that includes wavelengths between 200 and 280 nanometers (nm). The tubes contain a mixture of argon and mercury gas, with electrodes positioned at each ends. An electric current of high voltage flows through the gas located between the electrodes. When a single electron from the current collides with a mercury molecule, a portion of its energy is absorbed, causing the mercury to become excited. The Mercury subsequently emits the energy in the form of an ultraviolet photon. UVGI, or ultraviolet germicidal irradiation, is not visible to the human eye. However, even though it cannot be seen, small amounts of energy are emitted at visible wavelengths, which results in the blue glow that is commonly observed with UVC lamps. UVGI is now generated through the use of specialized lamps that emit UVGI at a wavelength of 254 nm.. [14]

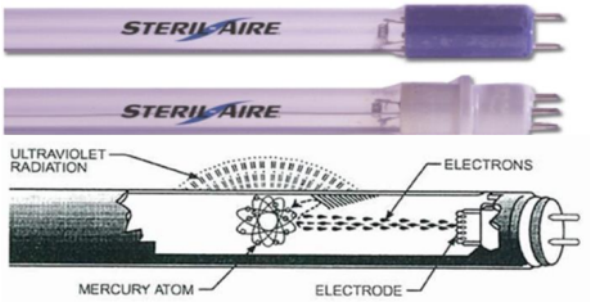

Figure (2.2): The Principle Work Of UV Lamps. [13]

2.2.1.1 UV Leds

Ultraviolet Light Emitting Diodes (LEDs) are small light sources that emit ultraviolet light. They are available in several shapes, such as small bulb shapes, hemispherical, and flat chips. UV LEDs offer distinct advantages compared to UV lamps. UV LEDs can be installed in areas where there is insufficient space for conventional UV lamps. Another benefit is that UV LEDs do not utilize the toxic heavy metal mercury. An LED is a type of semiconductor lamp that emits radiation when biased in a forward direction due to the presence of a P-N junction.

The junction is formed by utilizing two semiconductor materials: one with an abundance of electrons (known as negative or N-type material) and one with a deficiency of electrons (known as positive or P-type material).

Despite their relatively low power of approximately 100 mW, LEDs can be arranged in larger arrays to generate power levels that are appropriate for disinfecting airstreams. For analytical purposes, LEDs can be represented as point sources. An advantage of UV LEDs is their ability to generate UV light at the optimal wavelength of approximately 265 nm, which is highly effective for germicidal purposes. [4]

2.2.1.2 Lamp Shapes

UV lamps are available in many shapes and sizes, with the most commonly used ones being cylindrical, U-tube, and biaxial, as depicted in Figure 2.3. Cylindrical lamps can have varying lengths and diameters and are typically distinguished by having connectors at both ends, necessitating a compatible fixture. Cylindrical lamps, which were previously the most prevalent type of lamp, are now being substituted by the more convenient single-ended U-tube and biaxial lamps. U-Tube lamps resemble biaxial lamps, except they feature a smoothly curved bend at the outer end. U-Tube and Biaxial lamps are equipped with a single connector at the base end, which has greatly contributed to their widespread use in various applications. UV lamps can be custom-made to meet specific requirements and can be designed in various shapes, including those with multiple coils. UV lamps with multiple coils typically necessitate the use of connectors at both ends of the lamp. [4]

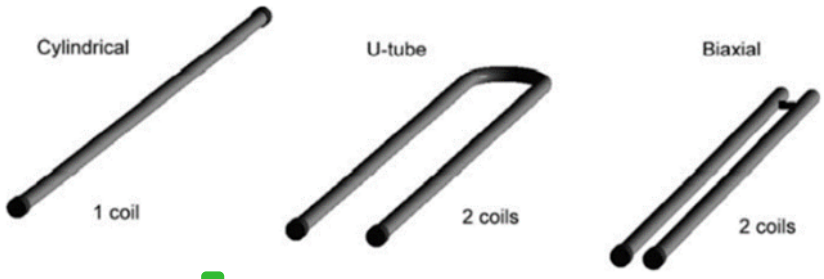

Figure (2.3): Cylindrical, U-Tube, And Biaxial UV Lamps. [4]

2.2.2 Surface Disinfection Systems

UV surface disinfection systems are employed for the specific purpose of sanitizing surfaces, particularly in the food industry and healthcare sectors. Several systems exist for sterilizing bathrooms. Certain systems are portable units designed for remediation.

Area disinfection or decontamination systems are effective in eradicating surface pollution in open spaces, serving either to remediate existing contamination or to prevent potential hazards. Portable Ultraviolet Germicidal Irradiation (UVGI) systems are accessible for decontaminating open spaces, and they are exclusively operated in areas that are not currently occupied. After Hours UVGI systems are area disinfection systems that are permanently affixed to walls or ceilings and are activated when there are no occupants present.. [4]

2.2.3 UV Effect On Microorganism

The UV-C range, found within the UV spectrum, is regarded as the most potent form of UV radiation due to its high energy. It is readily absorbed by DNA, RNA, and proteins. This range

is commonly referred to as germicidal because of its high efficacy in disinfecting bacteria and viruses. The most effective wavelength range for germicidal activity is between 205-280 nm, with the highest sensitivity of microorganisms occurring at 265 nm.

The germicidal effect is derived from the absorption of photons by DNA and RNA molecules. Photochemical reaction induces the dimerization of DNA and RNA bonds, hence impeding the replication capacity of microorganisms. This process is referred to as microbial inactivation. The user's text is."[15]"

In order to comprehend the mutagenic impacts of UV irradiation at a molecular level, it is widely acknowledged that short wavelength rays, such as UV, engage with water molecules within the cell, resulting in the generation of free radicals (-OH). Free radicals are molecules that lack an electron and engage in attacking other molecules, such as cell proteins or DNA, in order to steal an electron from them. Multiple free radicals can extract electrons from a single large cell molecule, resulting in alterations that render the molecule ineffective in fulfilling its function.

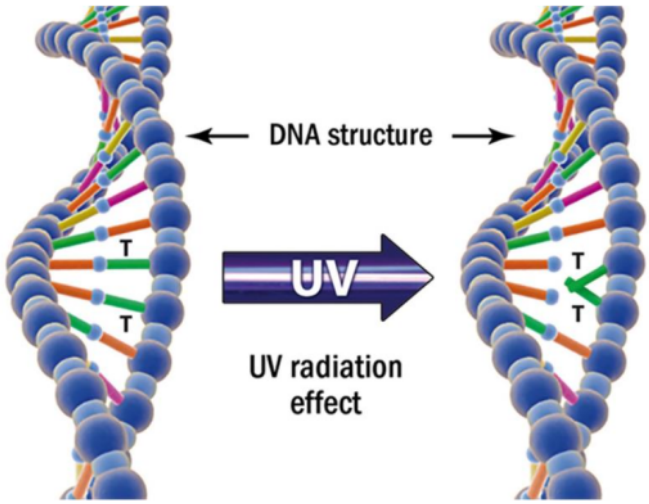

Figure (2.4): Mechanism Of UV Disinfection. [12]

The primary alteration in the DNA molecule caused by UV irradiation and subsequent free radicals often takes place at sites where two adjacent thymine (T) bases are present. UV irradiation induces the fusion of two adjacent thymine (T) bases on the same DNA strand. These structures are referred to as thymine dimers and they result in a deformation in the structure of DNA [12]

2.3 Effect Of COVID 19 On The Lung (COVID Pneumonia)

COVID-19 has the potential to induce pulmonary complications, including pneumonia and, in the most critical instances, acute respiratory distress syndrome (ARDS). Sepsis, a potential complication of COVID-19, can also result in long-term damage to the lungs and other organs[17] .

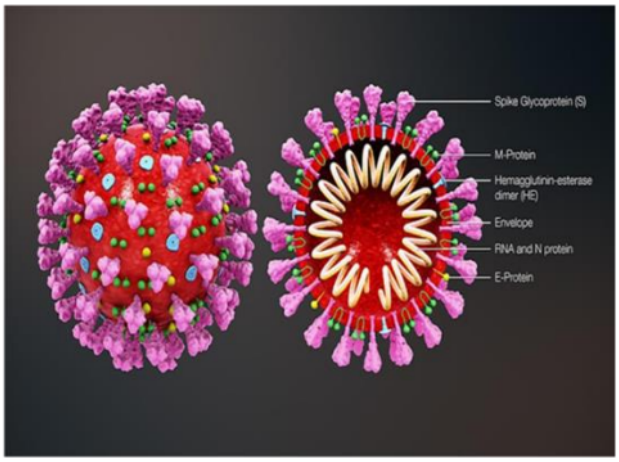

Figure (2.5): Coronavirus (Covid-19) Image. [16]

Pneumonia is a condition in which the lungs become congested with fluid and inflamed, resulting in respiratory difficulties. Some individuals may experience respiratory difficulties that necessitate hospitalization and treatment with supplemental oxygen or mechanical ventilation.

COVID-19 induces a form of pneumonia that often affects both lungs. The air sacs in the lungs get filled with fluid, which restricts their capacity to absorb oxygen. This leads to symptoms such as difficulty breathing, coughing, and other related symptoms.

Although the majority of individuals recuperate from pneumonia without enduring any long-term harm to their lungs, the pneumonia linked to COVID-19 can be quite severe. Post-disease, lung injury can lead to prolonged respiratory difficulties that may take several months to ameliorate.. [17]

UVC Effect On COVID19

Thus far, UVC radiation has proven to be effective against all types of coronaviruses in all documented studies. However, the success of inactivation may be diminished due to the absorption properties of the sample media[1] .

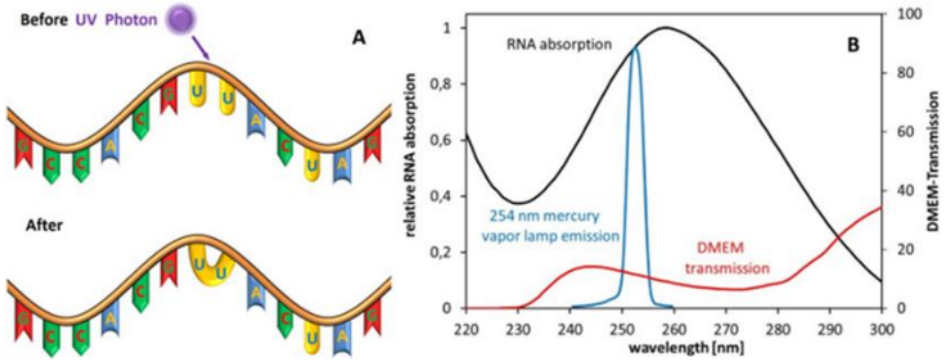

Figure (2.6): A) Scheme Of UV-RNA-Damaging Mechanism By Dimer Formation. B) Relative Absorption Spectra Of RNA, Relative Emission Spectrum Of A Low-Pressure Mercury Vapour Lamp And Transmission Of A Typical (Eagle) Cell Culture Medium. [1]

These findings were derived from extensive investigations on various coronaviruses, such as SARS-CoV and MERS-CoV, excluding SARS-CoV-2. However, it can be inferred that they are also relevant for SARS-CoV-2 and any subsequent genetic variations. RNA mutations can significantly impact the pathogenicity of a virus, but they do not lead to significant structural differences, particularly in terms of the RNA's ability to absorb UV radiation. This UV absorption property is primarily responsible for the antiviral effect of ultraviolet radiation. [1]

2.3.1 UV Application In Medical Systems

The utilization of ultraviolet germicidal irradiation in hospitals for the management of hospital acquired, or nosocomial, infections is one of the earliest and most significant implementations of this technology. UVGI has been employed for more than fifty years to disinfect medical equipment, entire rooms, ventilation air, and surgical sites, often with conclusive outcomes. Contemporary advancements continue to produce fresh applications, and while UVGI is not a comprehensive remedy for disease transmission in healthcare facilities, it can serve as a cost-effective and efficient element in any program aimed at minimizing hospital-acquired infections. [4]

2.4.1 Nosocomial Infections

Nosocomial infections, or hospital-acquired infections, are characterized by increasing drug resistance among microbes. These infections, primarily spread through airborne transmission, are categorized as infectious, noncontagious, or endogenous. With decreasing drug effectiveness, there is a growing need for engineering methods like UVGI to effectively address the problem, as traditional treatments are insufficient. [4]

2.4.2 Operating Rooms And ICUS

> Operating rooms (ORs), surgery suites, procedure rooms, treatment rooms, intensive care units (ICUs), and related facilities often maintain extremely high levels of surface and air cleanliness. However, it is important to note that these facilities are not completely sterile

Possible methods for addressing air and surface contamination originating from within operating rooms consist of upper and lower room UVGI systems, local recirculation units, continuous UV exposure systems, equipment disinfection systems, barrier UV systems, and overhead surgical UVGI systems [4].

3. Experimental Work

This chapter details the design of two devices using UV LEDs from two different manufacturing countries. The selection was based on availability and a two-month study to

find a suitable substitute sample. The experimental work is explained with a flow chart for each step.

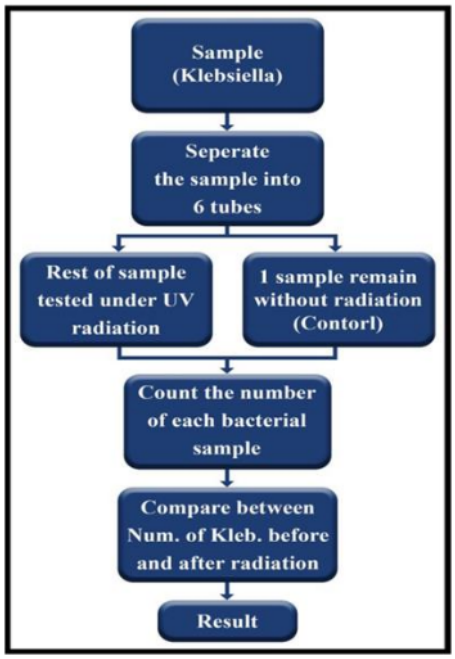

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Figure (3.1): Flow Chart Of The Procedure.

18

Figure (3.2): Flow-Chart Of Experimental Work.

3.1.1 Effective UV Wavelength

According to recent studies and research on the impact of UV radiation on COVID-19, it has been determined that the most effective UV wavelength is 254nm. The text "[10[11]" remains unchanged.

There were two UV LEDs available in the market from different manufacturers, one from Canada (shown in Figure 3.3) and the other from China (shown in Figure 3.4). Both LEDs emit light at a wavelength of 254 nm.

Figure (3.3): Canadian UV Leds.

Figure (3.4): Chinese UV Leds With Holder.

3.1.2 Selection Of The Sample (Nearest To COVID19)

After extensive research to identify a microorganism that closely resembles COVID-19 in terms of its effects and the organ it infects, Klebsiella has been selected as the sample to be subjected to UV radiation. This suggestion was made by the Biotechnology Department at Al-Nahrain University and the College of Science at Baghdad University.

3.1.2.1 Klebsiella Pneumonia

Klebsiella pneumoniae, depicted in Figure (3.5), is a type of bacterium that is gram-negative, encapsulated, and nonmotile. It can be found in many environments such as soil, surface waters, and on medical devices. Klebsiella pneumoniae efficiently colonizes several mucosal surfaces in humans, such as the gastrointestinal (GI) tract and oropharynx, without causing any harmful effects. Klebsiella pneumoniae strains can infiltrate other tissues and induce severe infections in humans through these sites. [18]

Figure (3.5): Klebsiella Pneumonia.

3.2 Experimental Setup

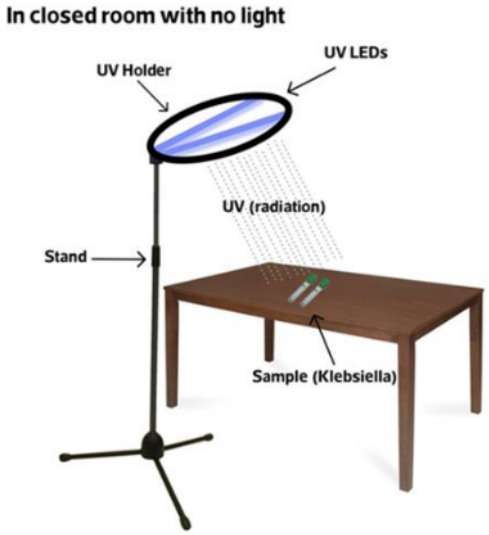

Figure (3.6): Experimental Setup Of Test1 Using Two (Kontec-China) UV Leds.

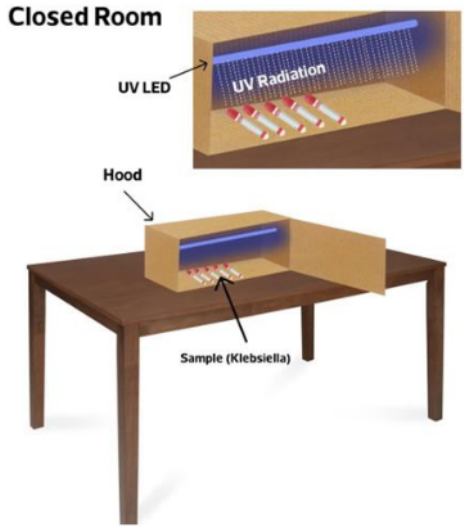

Figure (3.7): Experimental Setup Of Test2 Using (Sterilight Vique- Canada) UV LED

a- 2 UV Tubes 254 Nm (Kontec-China) With Its Electrical Transformers.

Figure (3.8): 2 UV Leds 254 Nm (Kontec-China) With The Stand.

b- 1 UV Tube 254 Nm (Sterilight Vique-Canada) With Its Electrical Transformer.

Figure (3.9): UV LED 254 Nm (Sterilight Vique-Canada) In The Hood.

c- Stand (Movable With Different Length).

d- Box As A Closed Hood.

3.3 Procedure

Two separate tests were conducted using the following procedure. The initial test was conducted utilizing two UV LEDs from Kontec-China, whereas the subsequent test employed a UV LED from Sterilight Vique-Canada.The steps are as follows:

1) Activation Of Klebsiella Sample A Day Before.

Figure (3.10): Klebsiella Samples

2) Check The Sample Under Microscope To Ensure It Is Ready To Use.

3) Divide The Sample Into 6 Tubes Equally

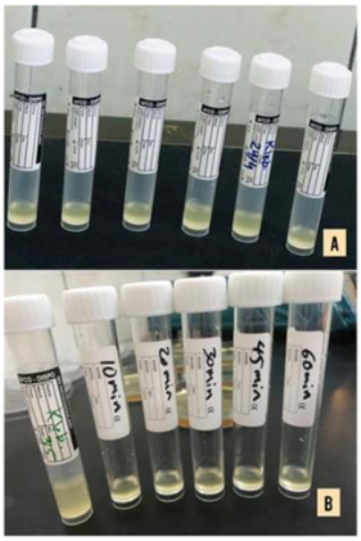

Figure (3.11): Sample Division In Test1 (A) And (B) In Test2.

4) One Tube Will Be Left Without Exposure To UV Radiation.

5) The remaining five tubes will undergo UV radiation exposure under varying conditions, including different durations of exposure and different distances between the sample and the tube.

5- (A) Two different distances (15 cm, 30 cm) were used between the UV tube and the samples during the first test.Three samples were tested at a distance of 15 cm at specific time intervals, namely 10 minutes, 20 minutes, and 30 minutes. Two samples were tested at a distance of 30 cm at specific time intervals, namely 10 minutes and 20 minutes.The experiment was conducted in a sealed room devoid of illumination or individuals.

The second (B) - 5 test was conducted at a fixed distance of 15 cm between the UV tube and the samples, as determined by the use of a hood. Five samples were tested at a distance of 15 cm at specific time intervals, namely 10 minutes, 20 minutes, 30 minutes, 45 minutes, and 60 minutes. The experiment was conducted in a sealed room devoid of illumination or individuals.

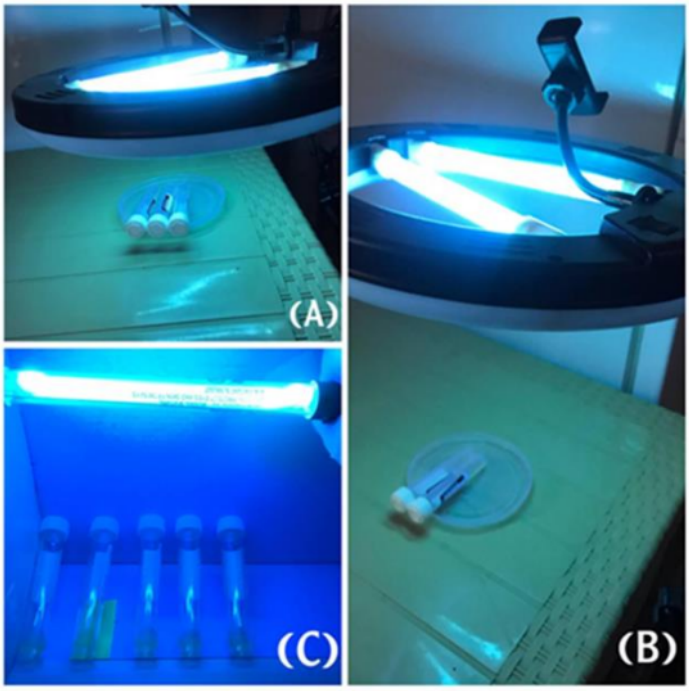

Figure (3.12): Exposure Of Samples To The UV Radiation. (A)Test1 At 15cm. (B) Test1 At 30cm. (C) Test2 At 15cm.

6) During The Time Taken To Radiate The Samples A Medium (Nutrient Agar) Will Be Prepared In Plates To Implant The Samples In It.

Figure (3.13): Preparation Of The Nutrient Agar Medium

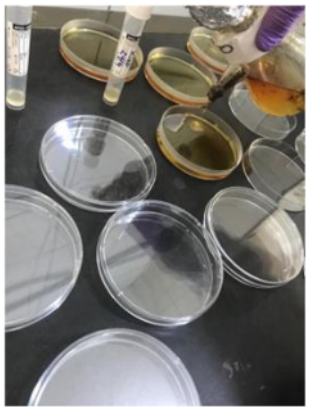

Figure (3.14): Preparing The Medium By Putting The Nutrient Agar In The Plates.

7) Each Sample Will Be Diluted 3 Times Then The Last Dilution Will Be Distributed Equally Over The Medium Using Cotton Swab And Then The Plate Will Be Covered And Left For The Next Day.

Figure (3.15): Cotton Swab.

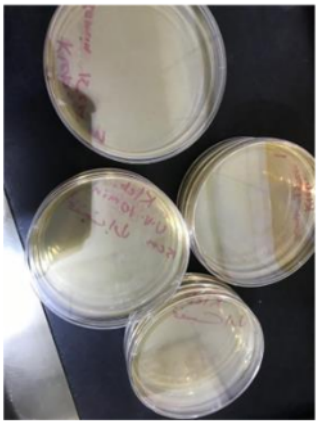

Figure (3.16): Covered Plates After Radiated Sample Distributed Over The Medium.

8) After 12hr The Bacteria Grow On The Medium And Can Be Seen By Eye.

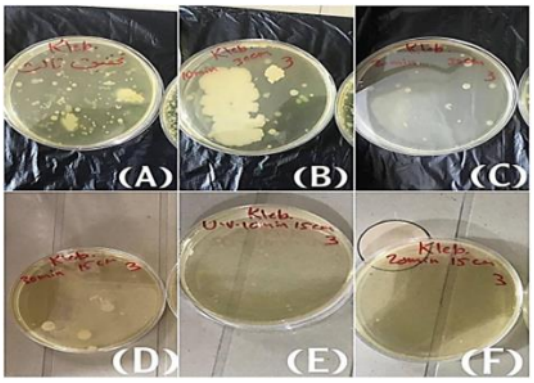

Figure (3.17): Test1 Result After 12h (A) Is The Sample Without Radiation (B) Is The Sample After 10 Min At 30cm Distance Between The UV And The Sample (C)

Is The Sample After 20 Min At 30cm Distance Between The UV And The Sample

(D) Is The Sample After 30 Min At 15cm Distance Between The UV And The Sample (E) Is The Sample After 10 Min At 15cm Distance Between The UV And The Sample (F) Is The Sample After 20 Min At 15cm Distance Between The UV And The Sample.

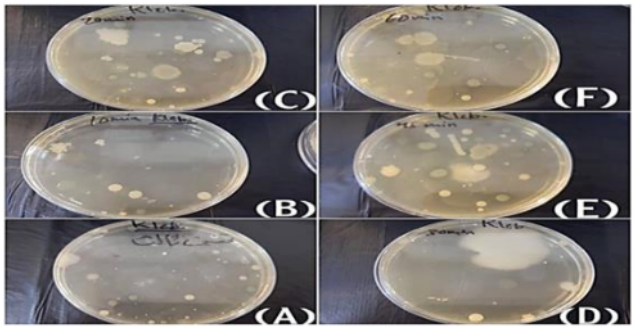

Figure (3.18): Test2 Result After 12h. (A) Is The Sample Without Radiation (B) Is The Sample After 10 Min At 15cm Distance Between The UV And The Sample

(C) Is The Sample After 20 Min At 15cm Distance Between The UV And The Sample (D) Is The Sample After 30 Min At 15cm Distance Between The UV And The Sample (E) Is The Sample After 45 Min At 15cm Distance Between The UV And The Sample (F) Is The Sample After 60 Min At 15cm Distance Between The UV And The Sample.

9) The Number Of Grown Bacteria Is Calculated By Eye And Then Using Microscope To Get Exact Results.

4.1 Results And Discussion

The results were assessed and analyzed in this chapter. Every sample in both tests was taken into consideration. Each test has six samples that are examined under distinct conditions from the remaining samples. The disinfection result was determined by calculating the ratio between the original (non-radiated) sample and the radiated sample for each state. The outcome is depicted in a graph that illustrates the efficacy of disinfection by UV radiation.

4.4.1 Test1 Results (Using Kontec-China UV Leds)

In Test1, six samples were exposed to Kontec-China UV LEDs for a duration of 12 hours.One group was kept under conditions without exposure to UV radiation, while the rest of the groups were subjected to UV radiation. The original sample was found to have a count of 13* 10^10, with the dilution ratio represented as 10^10. The results of the rest are provided in Table 4.1. The percentage ratio of remaining Kleb. after radiation was calculated as follows:

$$\%percentage\ of\ remaining\ Kleb. = \frac{count\ of\ Kleb.\ after\ UV\ radiation}{count\ of\ Kleb.\ without\ radiation} * 100\%$$

The table below demonstrates that the initial result, representing the number of remaining Klebsiella after being exposed to UV radiation for 10 minutes at a distance of 15cm between the UV source and the sample, is only 38.46%. This indicates that more than half of the Klebsiella were eradicated after just 10 minutes. This outcome may be attributed to the short distance and the efficacy of the UV radiation.

Table (4.1): Results Of Decontamination Process Of The First Test.

Sample No.	Kleb. Count	Distance Of The U.V From The Sample	Time Of Exposure	The Remaining Percent OfKleb. %	Disinfection Percentage%
1	$5*10^{10}$	15 Cm	10 Min	38.46%	61.54%
2	$4*10^{10}$	15 Cm	20 Min	30.76%	69.24%
3	$4*10^{10}$	15 Cm	30 Min	30.76%	69.24%
4	$4*10^{10}$	30 Cm	10 Min	30.76%	69.24%
5	$4*10^{10}$	30 Cm	20 Min	30.76%	69.24%

The second result, which indicates the remaining number of Klebsiella after being exposed to radiation for 20 minutes at a distance of 15cm between the UV source and the sample, is only 30.76%. This implies that a greater number of Klebsiella were affected after a longer duration of exposure.

The third result, indicating the remaining number of Klebsiella after being exposed to UV radiation for 30 minutes at a distance of 15cm between the UV source and the sample, is also 30.76%. This outcome could be attributed to the specific type of UV used and its efficacy.

The fourth and fifth results, representing the number of remaining Klebsiella after being exposed to UV radiation for 10 minutes and 20 minutes at a distance of 30cm between the UV source and the sample, show a reduction of 30.76%. This indicates that increasing the distance will not decrease the effectiveness of UV radiation.

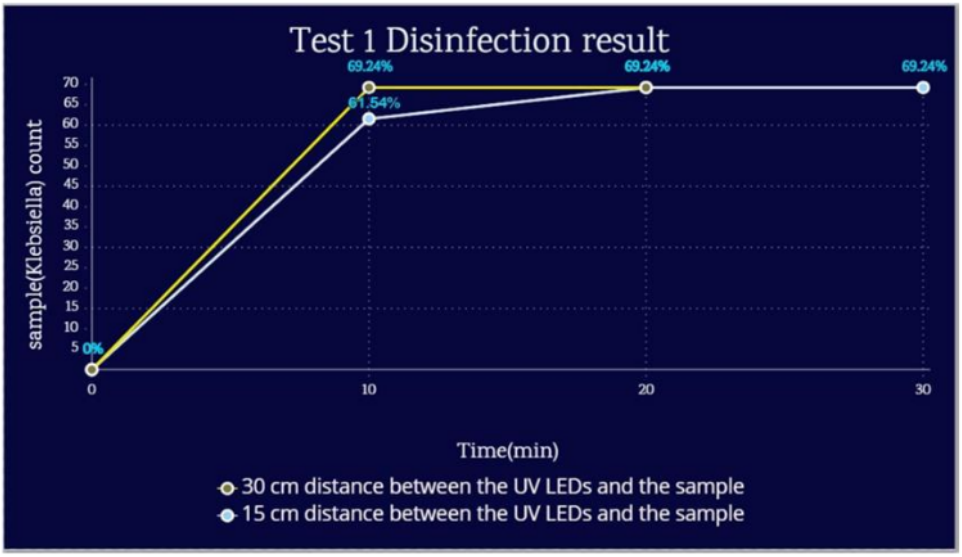

Figure (4.1): Disinfection Result Diagram Of Test1.Which Shows An Increase In The Number Of Killed Klebsiella As The Time Increase

4.1.2 Test 2 Results (Using Sterilight Vique-Canada UV LEDS)

During Test 2, Sterilight Vique-Canada UV LEDs were used, and six samples were left for a duration of 12 hours.One group was shielded from UV radiation while the other group was exposed to it. The original sample was determined to be 29*10^10. The remaining results are reported in Table 4.2. The percentage ratio of surviving Klebsiella bacteria after exposure to radiation was determined using the same method as in Test 1.

From The Table Below It Is Shown That The First Result Which Represent Number Of Remaining Klebsiella [After Radiating For 10min At 15cm Distance Between UV And The Sample] Is Only 62.06% Which Is Lower Than The First Test (Was Under The Same Conditions).

Table (4.2): The Results Of Decontamination Process Of The Second Test.

Sample No.	Kleb. Count After Exposure	Time Of Exposure	The RemaininggPercent Of Kleb. %	Disinfection Percentage%
1	$18*10^9$	10 Min	62.06%	37.94%
2	$10*10^9$	20 Min	34.48%	65.52%
3	$8*10^9$	30 Min	27.58%	72.42%
4	$4*10^9$	45 Min	13.79%	86.21%
5	$3*10^9$	60 Min	10.34%	89.66%

The study found that exposure to UV radiation for 20 minutes at a 15cm distance affected only 34.48% of Klebsiella, with the majority being eliminated after 30 minutes. After 45 minutes, only 13.79% survived, and after 60 minutes, 10.34% of Klebsiella bacteria remained, indicating the highest level of bacterial elimination after one hour of exposure. Longer exposure time had a greater impact on affected Klebsiella..

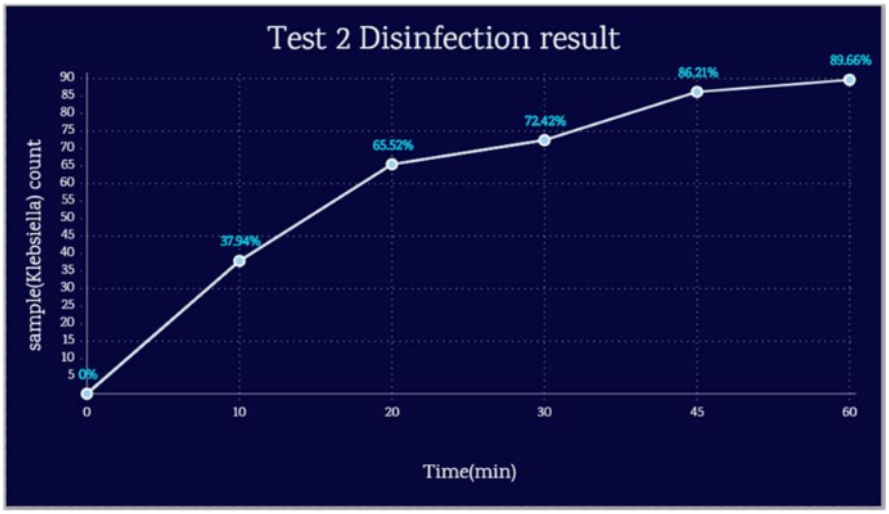

Figure (4.2): Disinfection Result Diagram Of Test2.Which Shows An Increase In The Number Of Killed Klebsiella As The Time Increase. The Test Was Done At Fixed Distance Between The Sample And The Uvleds (15cm).

Conclusion

Decontamination Is One Of The Most Important Part Of Our Lives Especially In The Last Couple Of Years Therefore The Present Work Is A Live Saving And As Important As The Vaccine Because It Proves That It Affects And Kills COVID19 By Many Recent Studies.

UV Leds Are Low Cost, Available In The Market And Really Affective To Provide The Required Sterilization In Short Amount Of Time. The Wavelength Used (254 Nm) Affect Not Only On COVID19 But Also On A Wide Range Of Undesirable Harmful Microorganism. The Device Can Be Used In Hospitals, Medical Clinic, Malls, Supermarkets, As Well As Houses.

The Present Work Provides An Option Between Two UV Leds With Different Manufacturers And Costs But Both Shows An Effective Result. And Although The Canadian UV Leds Are Higher In Cost But The Disinfection Result Is Quite Impressive And Worth It Cost.

The Two Important Parameters In UV Disinfection Procedure Are The Time Taken To Radiate The Sample And The Distance Between The Sample And The UV Leds. These Parameters Were Concentrated On In This Study. The Effectiveness Increased As The Time Increased And As The Distance Between The UV Leds And The Sample Decreases.

Future Work

From The Present Study, It Can Be Suggested That The Future Plan Can Include:

- May Be Possible To Test On COVID19 And Get The Best Features To An Excellent Final Result.
- Test On Different UVC Wavelengths.
- More Tests Using More Parameters (Different Distances & Periods).

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