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Corona Virus Sterilization Box

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ABSTRACT
SARS-CoV-2 virus and other pathogenic microbes are transmitted to the environment through contacting surfaces, which need to be sterilized for the prevention of COVID-19 and related diseases. In this study, a prototype of a cost-effective sterilization box is developed to disinfect small items. The box utilizes ultra violet (UV) radiation which leads to kill viruses. For performance assessment, studies were performed. The designed box was effective in damaging the protein's native structure like covid-19 virus indicating the effective inactivation of the SARS-COV-2.

I. INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused a global pandemic resulting in disruption of normal life all over the world through a very infectious disease called coronavirus disease 2019 (COVID-19). The virus is being speared from aerosols and contacting surfaces. It is essential to use personal protective equipment (PPE) for checking the spread of the disease. In developing countries like India, the sanitization of PPE kits and other personal accessories is in high demand as the throwaway kits/accessories require a huge amount of money. Further, the disposal of PPE kits and other routine items to the environment poses a serious threat. Recent studies have confirmed the presence of SARS-CoV-2 in wastewater , which are prone to be transmitted in the soils and further back to the ecosystem. Hence it is essential to sterilize the contacting surfaces before their disposal to the environment. The design of a cost-effective sanitization device for day-to-day life accessories appears to be one of the promising approaches.

The major stability of SARS-CoV-2 is due to the presence of the surface spike-glycoprotein, which is a three-domain protein with an isoelectric point (pI) of ~5.9. The virus can be inactivated by altering the stability of this protein. Various physical (*e.g.*, temperature and adsorption) and chemical (*e.g.*, pH, disinfectants and surface modification) methods have been explored to test the stability of the spike protein. It has been reported that SARS-CoV-2 remains stable on different surfaces but can be inactivated by heating at a temperature greater than 65 °C for more than 5 min of duration. Sterilizers have been a topic of importance among researchers for the disinfection.

Further, the COVID-19 pandemic has emphasized the need to design and develop a sterilization chamber equipped with an appropriate technique studied the influence of five different types of sterilization techniques on the filtration efficiency of face masks.

The five studied techniques were as follows:

(1) heat with humidity

(2) steam

(3) 75% alcohol

(4) household diluted chlorine-based solution

(5) ultraviolet germicidal irradiation

Three techniques of decontaminating face masks:

(1) ultraviolet germicidal irradiation

(2) vaporized hydrogen peroxide

(3) dry heat

Described the technologies of the International Advanced Research Center for Powder Metallurgy and New Materials (ARCI), India, in developing various disinfection systems to combat COVID-19. ARCI used physical, chemical and dry heat processes to disinfect surfaces effectively.

The duration and temperature required for sterilization of SARS-CoV-2 are not sufficient for inactivating the potentially harmful bacteria (*e.g*., *E. coli*), which are commonly present on the surfaces of objects. In this context, an effective ultraviolet (UV) type C based killing of bacteria have been reported, which was also efficient for decontamination from SARS-CoV-2 carried out a comparative study between UV-A and UV-C irradiation for complete inactivation of SARS-CoV-2 and found that UV-C is more effective in inactivating viruses. Complete inactivation of SARS-CoV-2 after 9 min of UV-C exposure was also mentioned demonstrated the combined effect of UV and heat treatment in liquid foods viz., apple juice, orange juice and vegetable and chicken broth from *S. aureus* disinfection studied the degree of deactivation of foodborne pathogens on powdered red pepper under the combined treatment of UV-C irradiation and mild heat. It was concluded that the combination of UV radiation and mild heat treatment is more effective than UV radiation alone for deactivating *E. coli* O157:H7 and *S. typhimurium*. The existence of the synergistic effect of UV and heat treatment process was studied by for microbial inactivation of apple juice. To predict the effect of temperature on UV inactivation kinetics of microorganisms viz., *E.* coli, Salmonella typhimurium, L. monocytogenes *and* S. aureus, mathematical models were also developed. Although these techniques are sufficient alone or in combination for the effective killing of bacteria, the synergistic effect on the microbiome over surfaces is still under scrutiny.

The disinfection capacity of UV radiation is limited to smooth surfaces only. reported that the efficacy of UV based sterilization is affected by the surface properties of the items being sterilized. UV radiation is more effective on fruits and vegetables with smooth surfaces, *e.g*. tomatoes and apples. On the other hand, pathogens in unexposed areas and pores can be killed by a heating process. Thus, it is necessary to design a cost-effective sterilization chamber with both UV radiation and heating facilities. UV radiation is more effective in killing the pathogens in the surfaces and heat is effective in sterilizing the unexposed areas and pores. The combination of UV radiation and heat can be used for disinfecting small items like mask, wallet, currency note, wristwatch and other routine items for their safe reuse or disposal to the environment.

It is clear from the aforementioned discussion that temperature based sanitization has been a promising candidate for various applications. Similarly, UV based sanitization has also been found to be very effective for various surfaces. However, a synergistic effect of UV and temperature is still under extensive research. In this study, a sterilization box was designed and tested for its effectiveness for denaturation of a glycoprotein and

inactivation of bacteria. The glycoprotein Immunoglobulin G (IgG) was used as a model material in lieu of SARS-CoV-2. The effects of heat and ultraviolet type C (UV–C), individually and in combination, were examined. The required temperature and duration without and with UV-C were optimized to destabilize the IgG and disinfect bacterial strain. In order to analyse the actual effect of the optimized conditions on day-to-day life accessories, the real samples were also sanitized at the optimized conditions. The main focus of the present work was to provide an inexpensive alternative to sterilization boxes available in the market.

II. COVID-19

Coronavirus disease 2019 (COVID-19) is a contagious disease caused by a virus, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first known case was identified in Wuhan, China, in December 2019. The disease spread worldwide, leading to the COVID-19 pandemic.

Symptoms of COVID‑19 are variable, but often include fever, cough, headache, fatigue, breathing difficulties, loss of smell, and loss of taste. Symptoms may begin one to fourteen days after exposure to the virus. At least a third of people who are infected do not develop noticeable symptoms. Of those people who develop symptoms noticeable enough to be classed as patients, most (81%) develop mild to moderate symptoms (up to mild pneumonia), while 14% develop severe symptoms (dyspnea, hypoxia, or more than 50% lung involvement on imaging), and 5% develop critical symptoms (respiratory failure, shock, or multiorgan dysfunction). Older people are at a higher risk of developing severe symptoms. Some people continue to experience a range of effects (long COVID) for months after recovery, and damage to organs has been observed. Multi-year studies are underway to further investigate the long-term effects of the disease.

COVID‑19 transmits when people breathe in air contaminated by droplets and small airborne particles containing the virus. The risk of breathing these in is highest when people are in close proximity, but they can be inhaled over longer distances, particularly indoors. Transmission can also occur if splashed or sprayed with contaminated fluids in the eyes, nose or mouth, and, rarely, via contaminated surfaces. People remain contagious for up to 20 days, and can spread the virus even if they do not develop symptoms.

Several COVID-19 testing methods have been developed to diagnose the disease. The standard diagnostic method is by detection of the virus's nucleic acid by real-time reverse transcription polymerase chain reaction (RT- PCR), transcription-mediated amplification (TMA), or by reverse transcription loop-mediated isothermal amplification (RT-LAMP) from a nasopharyngeal swab.

Several COVID-19 vaccines have been approved and distributed in various countries, which have initiated mass vaccination campaigns. Other preventive measures include physical or social distancing, quarantining, ventilation of indoor spaces, covering coughs and sneezes, hand washing, and keeping unwashed hands away from the face. The use of face masks or coverings has been recommended in public settings to minimize the risk of transmission. While work is underway to develop drugs that inhibit the virus, the primary treatment is symptomatic. Management involves the treatment of symptoms, supportive care, isolation, and experimental measures.

III. MATERIALS AND METHODS

A low cost UV based sterilization box was fabricated.

1.1. LOW COST UV STERILIZATION BOX

The sterilization box comprised a box of size 58 cm × 25 cm × 19 cm, four 11 W UV-C lamps, one Digital Temperature Controller (DTC) and one timer. A small part of the box was used as a compartment for electrical equipment and the other part was used as a sterilization chamber. UV-C lamps manufactured by Philips were used for radiation. The UV-C lamp in the sterilization box. Aluminium lamp holders were used in the UV-C lamps because of their lightweight. Two switches were used for turning on/off the UV-C lamps. Incandescent bulbs were connected with a DTC which measured the inside temperature of the sterilization chamber with the help of a thermocouple and showed it in the LED display. It also maintained the temperature inside the sterilization chamber. Once the temperature inside the box crossed the set value in DTC, it would automatically turn off the heating source i.e. incandescent bulb. A timer manufactured by Select 800XA was also placed inside the chamber of electrical equipment. It was connected with the main supply to turn off after sterilizing an item for a pre- decided time. A limit switch controlled top cover was used to prevent the direct exposure of UV light to the human eye and skin. Incandescent bulbs were covered all around with a fencing net to safeguard against burning due to direct contact. To reduce the heat loss through the walls of the box, the inner surfaces were covered by a high reflecting galvanized iron (GI) sheet; the thin layer of air between the surfaces of the box and GI sheet acted as a thermal insulator. Further, to increase the reflectivity of the GI sheet, it was covered through aluminium foil adhesive tape (of about 0.1 mm thickness) on the inner surfaces. Fig. 1 and Fig. 2 show the photograph and a schematic diagram of the box, respectively. Due to efficient design, it takes only about 150 s for an empty box to achieve a temperature of 70 °C from an ambient temperature of 24 °C.

Fig. 1. Photograph of the sterilization box.

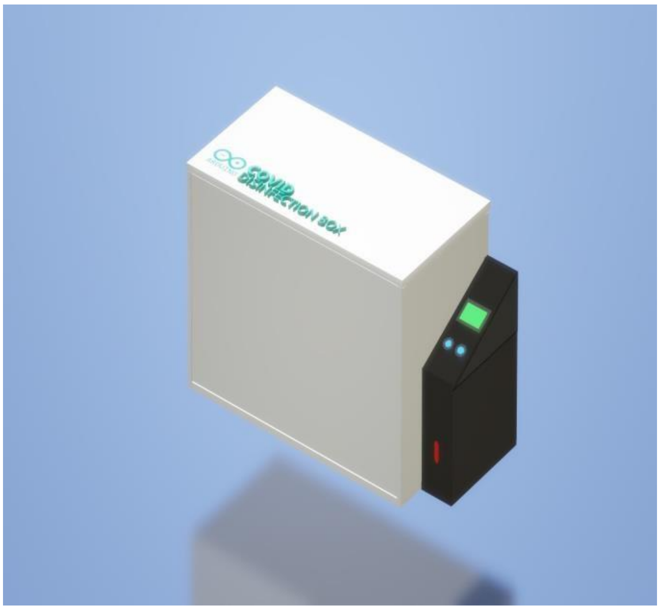


Fig. 2. A whole diagram of the sterilization box.

S. N.	Item	Quantity	Unit cost	Total cost
1	11-W UV-C Lamp	4	240	960
2	Electrical switches	2	20	40
3	Timer	1	400	400
4	Limit switch	1	30	30
5	Arduino Uno	1	800	800
Total				**2230**

Table 1. Material cost in the fabrication of a sterilization box.

1.2. ARDUINO UNO

It has an Arduino Uno board. The Board is equipped with ATmega328P and an 8-bit AVR microcontroller chip; It is the heart of the Arduino Uno board. There are 14 digital input-output pins. Out of 14, six can be used for PWM outputs, and another six have analog input pins to read the analogy sensor. They have all of a GPIO pin.

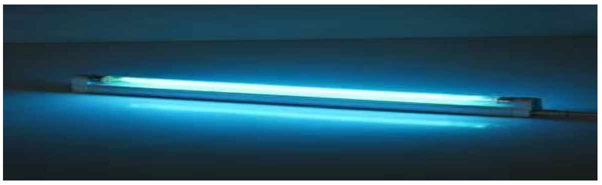
We can give Arduino and external power using an AC to DC converter or battery or, we can connect Arduino to the computer through a USB cable.

Figure 1. Arduino Uno

Arduino Uno controls the sensors, processes the data, and then forwards it to the Firebase website via the ESP8266 Wi-Fi Module.

1.3. UVC TUBES

- A germicidal lamp is an electric light that produces ultraviolet C (UVC) light. This short- wave ultraviolet light disrupts DNA base pairing, causing formation of pyrimidine dimers, and leads to the inactivation of bacteria, viruses, and protozoans. It can also be used to produce ozone for water disinfection.
- UVC is the shortest wavelength of the three forms of UV. UVC light is the type of UV light that's most effective at killing germs. It can be used to disinfect surfaces, air, and liquids.
- UVC light kills germs like viruses and bacteria through damaging molecules like nucleic acids and proteins. This makes the germ incapable of performing the processes that it needs to survive. This relatively obscure part of the spectrum consists of a shorter, more energetic wavelength of light. It is particularly good at destroying genetic material – whether in humans or viral particles.



IV. CONCLUSION

Based on the process of design, manufacture, observation and test results, several conclusions can be drawn for the progress, improvement and development of the application of this system. the following conclusions can be drawn:

- The Arduino Controller module can function properly as the main control device that has uses to control UV-C lights, Buzzers, and indicator lights.
- The Arduino controller takes user input for time setting and starts sterilization when start button is pressed. It automatically shuts off when the sterilization time is completed. Also an automatic shutoff system shuts off the sterilization if lid is opened by user between ongoing sterilization.
- This sterilization box helps to kill all viruses leads to prevent us from covid because all purpose items we are using having some viruses on it so killing them helps us prevention from any kind of diseases.

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