

VIRALYSER 1.0: A Portable Box to Sanitize Inanimate Items

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Background

In wake of COVID-19 outbreak, it has become mandatory to stay home and be safe. With social distancing and self-isolation increasingly becoming the norm (Government mandate) during coronavirus pandemic, people have grown increasingly *wary* about shopping in crowded malls or grocery stores and nervous about confronting empty shelves amid the coronavirus pandemic. This has led to increased delivery of items to our door steps. COVID-19 is a respiratory virus and is transmitted person-to-person through respiratory droplets. Delivered items including, groceries, online shopping pose a great threat to contract COVID-19. A recent study in the New England Journal of Medicine found that the virus was detectable on plastic and stainless steel for up to 72 hours, and on cardboard for up to 24 hours. Centers for Disease Control and Prevention (CDC), USA, also suggested that novel coronavirus may remain viable for hours to days on variety of surfaces. It was demonstrated that in a small scale study, it could survive upto 24 hrs on cardboard. Newyork times also reported that two dozens postal workers have contracted COVID-19 as of March 23rd, 2020.

There is growing evidence that COVID-19 could be transmitted to humans who are staying at home due to PAN India lockdown and are receiving vegetables, Fruits, groceries etc delivered at their doorsteps. This prompted Department of Biotechnology, Motilal Nehru National Institute of Technology Allahabad to design a portable box with ability to sanitize items received at our doorsteps. In addition, the same can also be applied to various other inanimate items viz., files, papers, currency etc.

UV-C (254 nm) Irradiation as Germicidal agent:

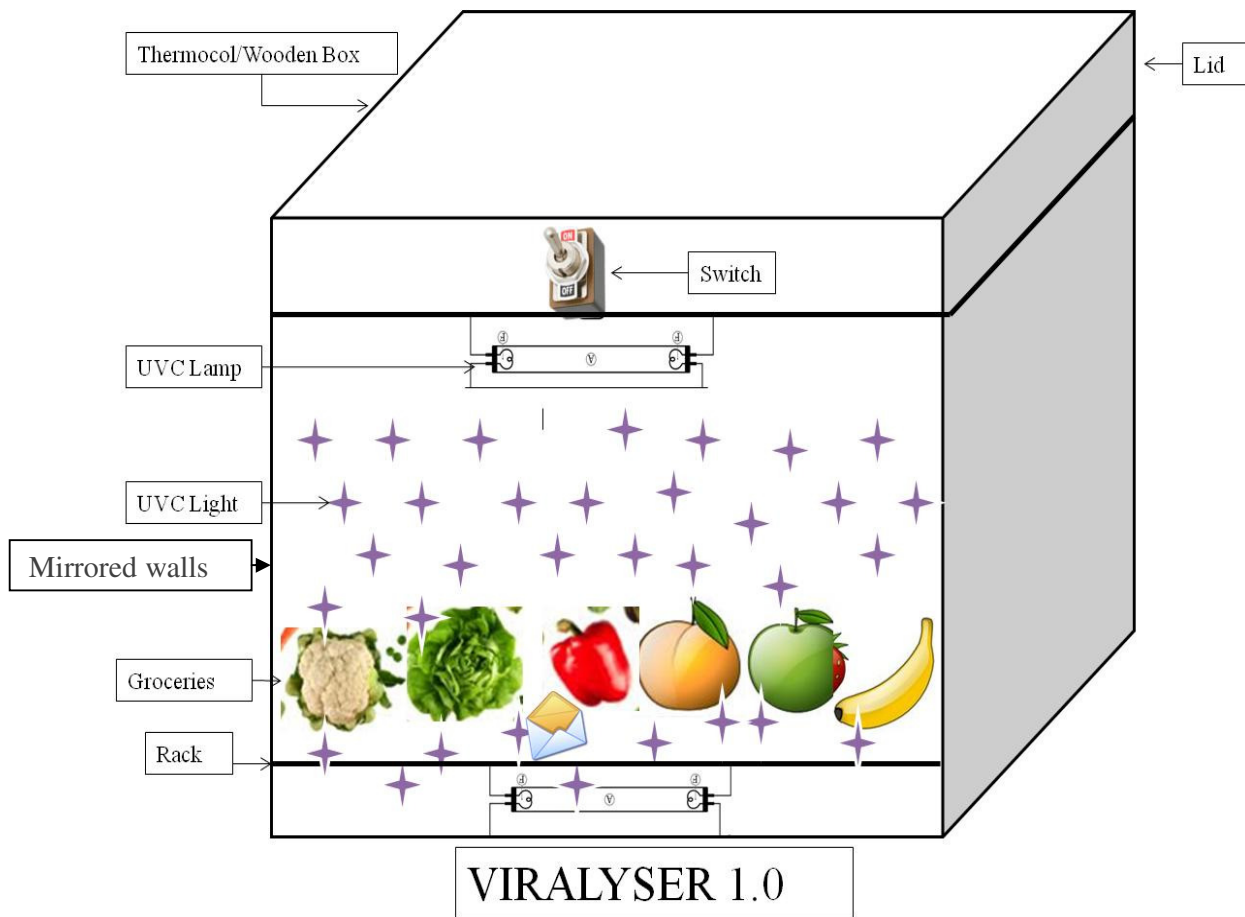
Coronaviruses constitute the subfamily *Orthocoronavirinae*, in the family *Coronaviridae*, order *Nidovirales*, and realm *Riboviria*. They are enveloped viruses with a positive-sense single-stranded RNA genome and a nucleocapsid of helical symmetry. The genome size of coronaviruses ranges from approximately 26 to 32 kilobases, one of the largest among RNA viruses. They have characteristic club-shaped spikes that project from their surface, which in electron micrographs create an image reminiscent of the solar corona from which their name derives. COVID-19 is caused by novel coronavirus and has infected approximately 1.8 million people worldwide and causing death to ~ 117000 humans (WHO, 15-04-2020). India is witnessing an increase in cases and till date more than 10000 cases have been reported with above 350 deaths.

In order to ensure microbial safety many studies utilizing UV irradiation have been performed. The CDC recommends UV germicidal irradiation (UVGI) as a supplementary process in order to contain transmission of bacteria causing tuberculosis. UVC light is well known to possess a very powerful germicidal effect capable of inactivating a wide spectrum of microorganisms, such as viruses, bacteria, protozoa, fungi, yeasts, and algae. The mechanisms of UVGI on microbes are uniquely vulnerable to light at wavelengths at or near 253.7 nm, because the maximum absorption wavelength of a DNA molecule is 260 nm. The pyrimidine of DNA base can strongly absorb UV light. UV Irradiation causes formation of pyrimidine dimers. These dimers can change the DNA double helix structure and interfere with DNA replicative and transcription ability of cells leading to its death. Until now, UV irradiation has mostly been performed with conventional low-pressure mercury UV lamps (LP lamps), which emit a 254-nm peak wavelength. Tseng & Li, 2005, demonstrated 90% virus inactivation, the ssRNA virus (MS2) required only an extremely low dose (339–423 $\mu\text{W sec/cm}^2$), the ssDNA virus (phi X174) a relatively low dose (444–494 $\mu\text{W sec/cm}^2$), the dsRNA virus (phi 6) a moderate dose (662–863

$\mu\text{W sec/cm}^2$). They also showed that to obtain 99% virus inactivation, the ssRNA virus (MS2) required a dose of 803–909 $\mu\text{W sec/cm}^2$, the ssDNA virus (phi X174) a dose of 974–1031 $\mu\text{W sec/cm}^2$, the dsRNA virus (phi 6) a dose of 1388–1771 $\mu\text{W sec/cm}^2$, and dsDNA (T7) a dose of 1906–2005 $\mu\text{W sec/cm}^2$.

Design

Based on above discussed features of UV-C we have designed & fabricated a box with installed UV-C (Phillips, TUV 11W G11 T5) lights to sanitize items inside the box. A diagram of the design is given below. Inner wall is equipped with reflecting mirror to facilitate proper reflection throughout the inanimate item. Minimum time required to sanitize is 10 mins. Dimensions may vary based on the size of UVC fluorescent tubes. Appropriate distance from UV light and subject must be not more than 10-15 cm.



References

Jui-Hsuan Yang , Un-In Wu, Huei-Min Tai, Wang-Huei Sheng. Effectiveness of an ultraviolet-C disinfection system for reduction of health care associated pathogens. *Journal of Microbiology, Immunology and Infection* (2019) 52, 487-93

Do-Kyun Kim, Dong-Hyun Kanga. UVC LED Irradiation Effectively Inactivates Aerosolized Viruses, Bacteria, and Fungi in a Chamber-Type Air Disinfection System. *Applied and Environmental Microbiology* (2018) 84(17), 00944-18.

Chun-Chieh Tseng & Chih-Shan Li. Inactivation of Virus-Containing Aerosols by Ultraviolet Germicidal Irradiation. *Aerosol Science and Technology* (2005) 39(12), 1136-1142.

Andrea Guridi , Elena Sevillano, Iñigo de la Fuente, Estibaliz Mateo , Elena Eraso, Guillermo Quindós. Disinfectant Activity of A Portable Ultraviolet C Equipment. *Int. J. Environ. Res. Public Health* (2019) 16, 4747.