Investigation of ultraviolet C (UVC) doses in homemade UVC chambers with items commonly used on swine farms

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Ultraviolet C (UVC) chambers are utilized for disease mitigation by disinfecting items upon farm entry. One study concluded that a UVC dose between 150 and 190 mJ/cm2 inactivates most swine pathogens. The Maschhoffs, LLC, incorporated homemade UVC chambers on their farms that may emit a higher UVC dose than other chambers. Currently, items are disinfected in the homemade UVC chamber for 10 minutes. If the chambers give off a higher UVC dose, a shorter run time may be implemented. The objective of this study was to determine materials UVC light can penetrate by calculating the UVC dose for items commonly found on swine farms. An additional goal of this study was to understand common lunch entry items and their UVC penetration in order to develop recommendations to address food taste concerns among employees.

A UVC meter probe was placed on each shelf of the chamber to establish a baseline UVC dose after one minute. Fourteen items used in swine farms were tested. Items were individually placed on top of the UVC meter probe in the middle shelf of the chamber. The UVC chamber was turned on for one minute and irradiance was recorded. The following formula was used to determine the UVC dose each item received, D = I × T, where D = UV dose (mJ/cm2), I = light intensity or irradiance (mW/cm2), T = treatment time or exposure time. Additionally, five-minute and ten- minute doses were calculated.

The irradiances in the empty UVC chamber were 1.262 mW/cm2 for the top shelf, 0.872 mW/cm2 for the middle shelf, and 1.040 mW/cm2 for the bottom shelf. These differences were expected because the distances from light sources varied between shelves. UVC light did not penetrate the foam to-go cup with plastic lid, cloth-insulated lunch bag, paper grocery bag, glass food storage container, and plastic sports drink bottle. Two main takeaways from this data:

1. Lunch bags and grocery bags cannot be penetrated. Items should be taken out of lunch bags and grocery bags so the outside of lunch items can be disinfected from all angles.
2. If UVC light does alter the taste of food, storage containers such as glass may help with the taste as the food inside will not have contact with UVC light.

The aluminum foil, plastic bottled water, white plastic grocery bag, 0.060" non-acrylic glass, black plastic food container, and blue plastic food container had irradiances between 0.001 and 0.228 mW/cm2. When UVC doses were calculated, they were insufficient to inactivate most swine pathogens. Plexiglass was used in this study because it was initially used as shelving in the UVC chambers. However, items set on top of it would not receive UVC light from the bottom. Additionally, black/colored plastics only received a dose of 3 mJ/cm^2, meaning this could be another food storage container option.

Three types of plastic freezer bags and a clear plastic food storage container had irradiances between 0.254 and 1.035 mW/cm2. There are a few things to consider about these items:

1. Food in clear plastic storage containers are receiving a UVC dose large enough to inactivate most swine pathogens, however, these plastic freezer/storage bags are receiving doses between 516 and 621 (3-4 times greater than the recommended dose!)
2. One of the most common forms of entering lunches onto farms are plastic storage bags and clear containers. There is no research that states UVC light can alter the taste of food items. However, if UVC light alters food taste, this may largely be contributing to these changes because a very large UVC dose can penetrate these food storage bags.

In conclusion, the UVC dose in the empty chamber at 5 and 10 minutes were 261-378 mJ/cm2 and 523-757 mJ/cm2. This suggested that five minutes in the UVC chamber was adequate to inactivate most swine pathogens. Future studies can test the survival of swine pathogens in UVC chambers at different time intervals to determine the optimal disinfection time.

Item	Irradiance (mW/cm2)	60 Second UVC Dose (mJ/cm2)	5 Minute UVC Dose (mJ/cm2)	10 Minute UVC Dose (mJ/cm2)
Empty chamber top shelf	1.262	75.72	378.6	757.2
Empty chamber middle shelf	0.872	52.32	261.6	523.2
Empty chamber bottom shelf	1.04	62.4	312	624
No UVC Penetration				
Cloth insulated lunch bag	0	0	0	0
Foam to-go cup w/plastic lid	0	0	0	0
Paper grocery bag	0	0	0	0
Glass food storage container	0	0	0	0
Plastic sports drink bottle	0	0	0	0
Partial UVC Penetration				
Plexiglass non-glare acrylic 0.060"	0.001	0.06	0.3	0.6
Plastic bottled water	0.001	0.06	0.3	0.6
Black plastic food storage container	0.005	0.3	1.5	3
Blue plastic food storage container	0.072	4.32	21.6	43.2
White grocery bag	0.228	13.68	68.4	136.8
Full UVC Penetration				
Clear food storage container	0.254	15.24	76.2	152.4
Off brand quart plastic freezer bag	0.861	51.66	258.3	516.6
Name brand quart plastic freezer bag	0.92	55.2	276	552
Name brand gallon plastic freezer bag	1.035	62.1	310.5	621