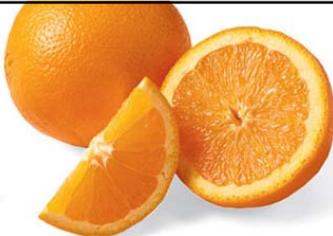


## Potential New Food Safety Tools for the Packing Line



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### Folta's Research Program

Connecting genes to function in strawberry

Understanding how light can improve plant product quality

Identifying the genetic elements that are required for light signaling.



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### A Solution, Before the Problem

Assurances about use of groundwater

Enhancing product safety

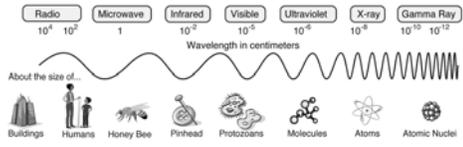
- Can we devise a non-chemical, non-consumable, strategy to enhance current protocols?
- What about using light treatments to ensure ultimately 'clean' fruit?



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### A Solution, Before the Problem

Ultraviolet light can be used as a germicidal agent



Radio  $10^4$   $10^3$  Microwave 1 Infrared  $10^{-2}$  Visible  $10^{-5}$  Ultraviolet  $10^{-6}$  X-ray  $10^{-8}$  Gamma Ray  $10^{-10}$   $10^{-12}$

Wavelength in centimeters

About the size of...

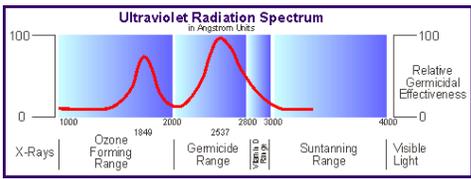
Buildings Humans Honey Bee Pinhead Protozoans Molecules Atoms Atomic Nuclei



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### A Solution, Before the Problem

Ultraviolet light can be used as a germicidal agent



**Ultraviolet Radiation Spectrum**  
 in Angstrom Units

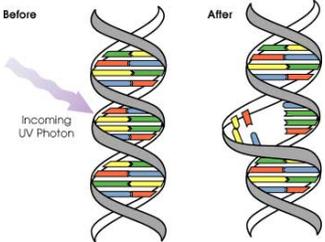
Relative Germicidal Effectiveness

X-Rays Ozone Forming Range 1949 Germicide Range 2537 Sunbanning Range Visible Light



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### A Solution, Before the Problem



Before After

Incoming UV Photon

Ultraviolet light, especially at 260 nm, is absorbed by the bases of DNA, causing physical changes that disrupt DNA replication and gene expression.

Also damages proteins.



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### A Solution, Before the Problem

Current methods of germicidal UV delivery are not compatible with the food packing environment.

UV-Generating Bulbs

- Decay with time
- Glass
- Mercury
- Energy

### A Practical Safeguard

Typical Electrical/Optical Characteristic Curves (H=400V, I=1.5A, 50°C)

### A Practical Safeguard

Light Emitting Diodes (LED)

Strengths

- Low cost
- One installation
- Lower power consumption
- Precise wavelength
- No special regulation

Limitations

- Not cheap for UV 260 nm (price ↓)
- Dangerous wavelengths

### Lab Scale Prototype

If it works, why don't we use it?

Different lighting applications turn on at different LED cost/lumen points

### Lab Scale Prototype

Thanks to:

- IFAS Citrus Initiative LBR
- Light Emitting Computers (Victoria, BC)

Time On	FW	Rate
250us	0.00	0
310us	0.00	0
370us	0.00	0
430us	0.00	0
490us	0.00	0
550us	0.00	0
610us	0.00	0
670us	0.00	0
730us	0.00	0
790us	0.00	0
850us	0.00	0
910us	0.00	0
970us	0.00	0
1030us	0.00	0
1090us	0.00	0
1150us	0.00	0
1210us	0.00	0
1270us	0.00	0
1330us	0.00	0
1390us	0.00	0
1450us	0.00	0
1510us	0.00	0
1570us	0.00	0
1630us	0.00	0
1690us	0.00	0
1750us	0.00	0
1810us	0.00	0
1870us	0.00	0
1930us	0.00	0
1990us	0.00	0
2050us	0.00	0
2110us	0.00	0
2170us	0.00	0
2230us	0.00	0
2290us	0.00	0
2350us	0.00	0
2410us	0.00	0
2470us	0.00	0
2530us	0.00	0
2590us	0.00	0
2650us	0.00	0
2710us	0.00	0
2770us	0.00	0
2830us	0.00	0
2890us	0.00	0
2950us	0.00	0
3010us	0.00	0
3070us	0.00	0
3130us	0.00	0
3190us	0.00	0
3250us	0.00	0
3310us	0.00	0
3370us	0.00	0
3430us	0.00	0
3490us	0.00	0
3550us	0.00	0
3610us	0.00	0
3670us	0.00	0
3730us	0.00	0
3790us	0.00	0
3850us	0.00	0
3910us	0.00	0
3970us	0.00	0
4030us	0.00	0
4090us	0.00	0
4150us	0.00	0
4210us	0.00	0
4270us	0.00	0
4330us	0.00	0
4390us	0.00	0
4450us	0.00	0
4510us	0.00	0
4570us	0.00	0
4630us	0.00	0
4690us	0.00	0
4750us	0.00	0
4810us	0.00	0
4870us	0.00	0
4930us	0.00	0
4990us	0.00	0
5050us	0.00	0
5110us	0.00	0
5170us	0.00	0
5230us	0.00	0
5290us	0.00	0
5350us	0.00	0
5410us	0.00	0
5470us	0.00	0
5530us	0.00	0
5590us	0.00	0
5650us	0.00	0
5710us	0.00	0
5770us	0.00	0
5830us	0.00	0
5890us	0.00	0
5950us	0.00	0
6010us	0.00	0
6070us	0.00	0
6130us	0.00	0
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7150us	0.00	0
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7270us	0.00	0
7330us	0.00	0
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7510us	0.00	0
7570us	0.00	0
7630us	0.00	0
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8890us	0.00	0
8950us	0.00	0
9010us	0.00	0
9070us	0.00	0
9130us	0.00	0
9190us	0.00	0
9250us	0.00	0
9310us	0.00	0
9370us	0.00	0
9430us	0.00	0
9490us	0.00	0
9550us	0.00	0
9610us	0.00	0
9670us	0.00	0
9730us	0.00	0
9790us	0.00	0
9850us	0.00	0
9910us	0.00	0
9970us	0.00	0
10030us	0.00	0

### Lab Scale Prototype

First Test - Can I kill bacteria on a plate?

1 mW/cm<sup>2</sup>

### Lab Scale Prototype

Next Test - Can I Clear an Orange of a Surrogate Pathogen?



Surface sterilize fruits with bleach, add known amount of bacteria in a known area.



Surface sterilize fruits with bleach, add known amount of bacteria in a specific area.

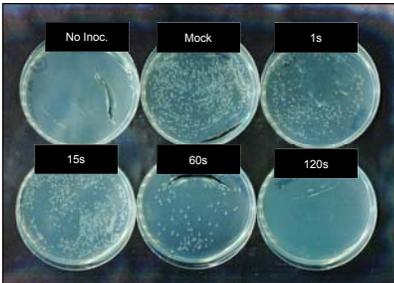
Treat with UV.

Remove inoculated area, culture, measure.




### Lab Scale Prototype

Results



1 mW/cm<sup>2</sup>




### Lab Scale Prototype

Results

Observations

Valencia oranges come out "cleaner" even in controls.

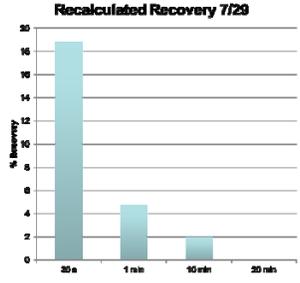
Navel oranges seem to be better for these experiments, as they do not have inherent anti-microbial properties.




### Lab Scale Prototype

Results

**Recalculated Recovery 7/29**

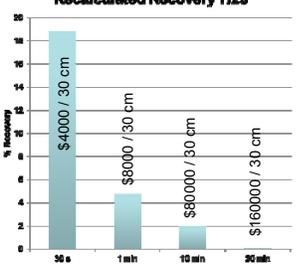


Jayne Hart & Kevin Folta (in prep)




### What does it cost to get the gain?

**Recalculated Recovery 7/29**



Assuming that the fruit is rolling at 1 m 5 s, and that the whole fruit is being exposed, to achieve each standard we're looking at:

Jayne Hart & Kevin Folta (in prep)




Good news – it can work

Bad news – cost is prohibitive

What we don't know-

Can lower-cost suppliers be sourced?

What is the future cost projected?

Are there other ways to use more lower-output emitters to make this work?

Jayne Hart & Kevin Folta (in prep)




**Lab Scale Prototype**

Conclusions

- The UV can be germicidal at practical levels for LED use
- UV can substantially decrease inoculated bacterial populations on fruit
- We are in an economic argument at this point... can we source cheaper materials?



Additional Capacities



Can UV-B generate coloration?



Next Steps

- How much energy can be applied before affecting fruit?
- Does the UV affect the rollers/mechanisms/dryer?
- Repeat trials using better surrogates at CREC, actual safety evaluations.
- Identify how timing/power/etc practically fit with the actual packing lines
- Test ability to clear additional microbes (plant pathogens?)
- Install on packing line at CREC, USDA Indian River

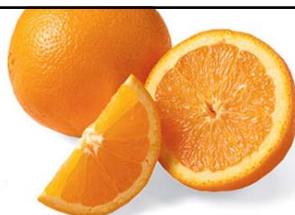


Thanks to:

- Jayne Hart UF undergrad
- Dr. Jackie Burns / IFAS Citrus Initiative Fund
- Light Emitting Computers, Victoria BC
- Dr. Michelle Danlyuk, UF/IFAS CREC
- Dr. Jose Chaparro, UF/IFAS Gainesville
- Dr. Mark Ritenour, UF/IFAS IRREC



Thank you for the opportunity to participate in citrus research



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